University of Mosul

College of Nursing

Medical Physiology

(First Stage)

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BLOOD

- Blood is a bright to dark red , viscous, slightly alkaline **(** pH 7.4)
- Accounts about 8 % of the body weight .
- The total volume of blood in the healthy adult human is about 5 L.
- It is heavier than water and five times thicker.
- **Temperature**; 38ºC or 100.4º F.
- Blood rich in oxygen is bright red (arterial blood)
- The blood rich in carbon dioxide gives blood its bluish color (venous blood).

- **Blood is made up of two parts:**

1. **Formed Elements (Blood cells) which consist of :**
   - **Erythrocytes** (Red Blood Cells)
   - **Leukocytes** (White Blood Cells)
   - **Platelets** (thrombocytes)

2. Plasma , the liquid in which the blood cells are suspended .

The Function of Blood.

1. Transport, gases, nutrients , hormones, antibodies, chemical ions ,
2. Defends against harmful Microorganisms, cells and viruses.
3. Prevent blood loss through coagulation (clotting)
4. Helps regulate body temperature
5. Regulation of pH and osmosis

When blood is removed from the body and placed in a test tube clotting occurs unless the tube is coated by an anticoagulant such as an heparin. .

Centrifugation the blood separates into two layers*:*

1. The lower layer that represents **44 %** of the blood volume, is red and made of **Red Blood Cells.**

2. The layer immediately above (**1%** of the blood volume **)** which is called **Buffy coat** and consist of **White Blood Cells** and **Platelets**

3 .The fluid (plasma)remains on top as the supernatant (55 % of the blood volume).

Plasma

It is the yellowish colored slightly alkaline —liquid part of blood in which the blood cells float in it .

- It is about **91 °/o water**.
- **2 %** composed of electrolytes, enzymes , hormones .metabolic wastes , and traces of many inorganic and organic molecules.
- **7 %** proteins **(** albumin , fibrinogen , and globulins **)**.
- Fibrinogen can removed from the plasma, the remaining fluid is called **serum**
- So Plasma ═ serum ┼ fibrinogen
- OR Serum ═ plasma ─ fibrinogen
- . **<u>Fibrinogen</u>** is necessary for blood **<u>coagulation (clotting)</u>** .
- The **<u>globulin</u>** functions in **<u>immune response because it consists of antibodies</u>**.

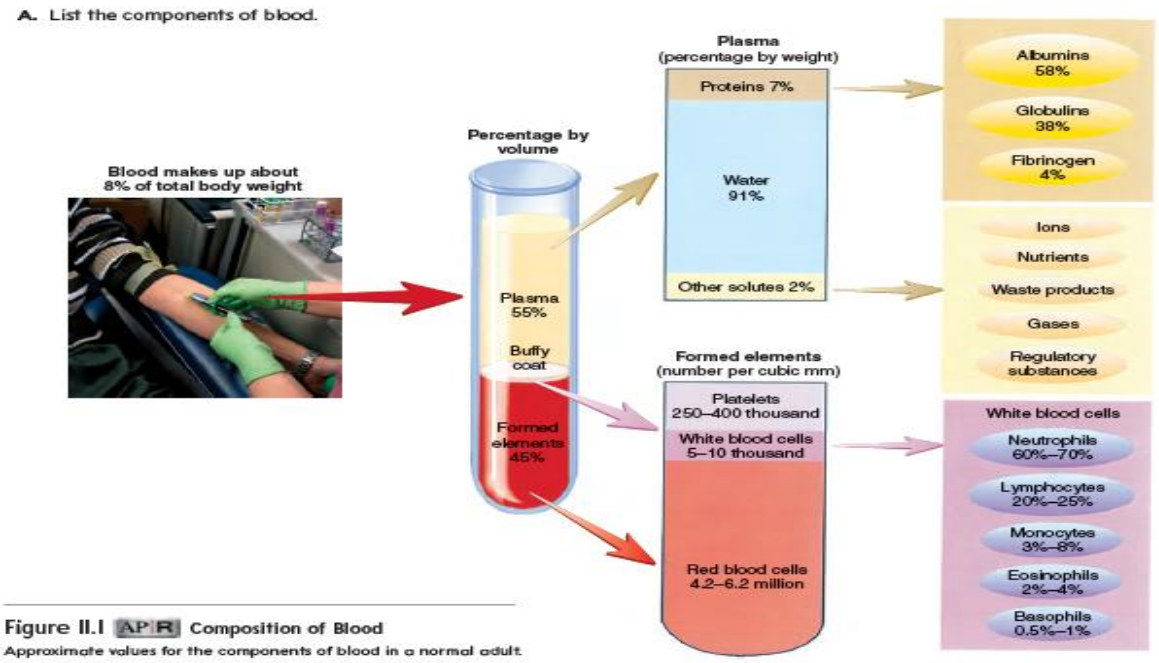


Figure II.1 APR **Composition of Blood**
Approximate values for the components of blood in a normal adult.

Formation of blood cells

The process by which formed elements of blood develop is called **haemopoiesis**.

Red bone marrow is the primary center for haemopoiesis
Under normal conditions, about 2.5 million red blood cells are destroyed every second.
Fortunately, new red blood cells are produced just as rapidly.
In this process all blood cells are derived from single type of stem cell in bone marrow, this stem cell is capable of producing all blood cell types.

Erythrocytes (Red blood cells….RBC)

RBC is characterize by the followings :

1. RBCs are the most abundant blood cells :
The normal number of erythrocytes in blood is: **4 .2– 6.2** million per micro liter

2. They are biconcave disks.
The biconcave shape is maintained by a network of proteins called **spectrin .**
The biconcave shape provides a larger surface area for gas exchange this network of protein will allow the red blood cells to change shape as they are transported through the blood vessel.

3. Without nuclei :
Immature RBC contain a nucleus; however,
Mature RBC, the **nucleus is absent** , which is without any organelles such as mitochondria thus increasing the oxygen carrying capacity of the red blood cell.
4. . They contain **hemoglobin** (protein carrying for oxygen)

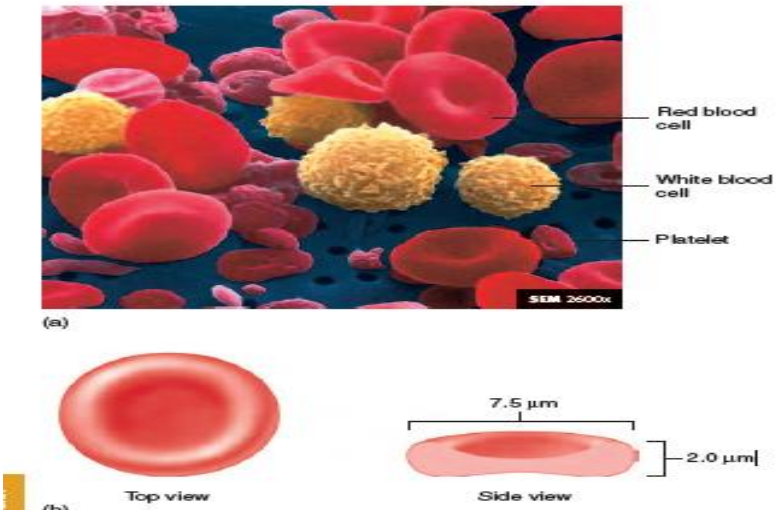


Figure 6.1 Red blood cell shape

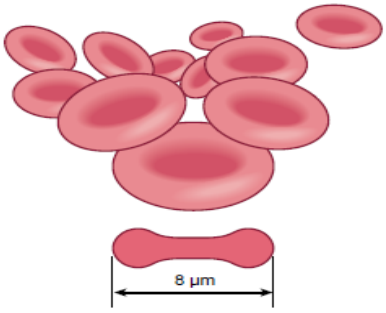
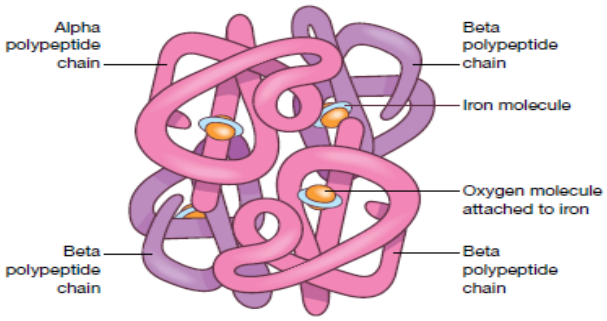


Figure 6.2 Haemoglobin molecule



The primary functions of RBC:
are to transport oxygen from the lungs to the various tissues of the body and to help transport carbon dioxide from the tissues to the lungs.

Hemoglobin that is bound to oxygen is bright red, ----whereas
Hemoglobin without bound oxygen is a darker red.

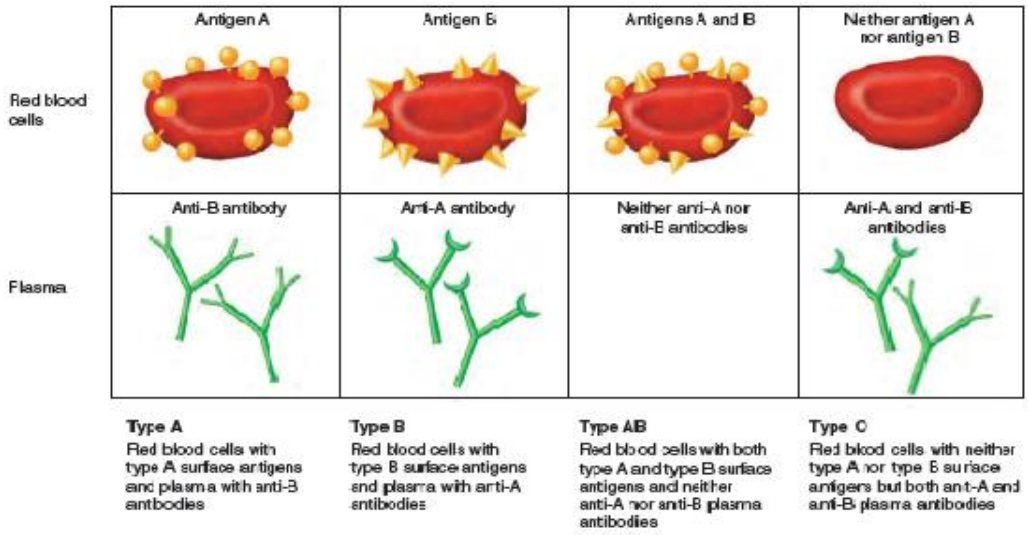
Hemoglobin is responsible for **98.5% of the oxygen transported in blood**
The remaining **1.5% is transported dissolved in plasma**.

Recycling of RBC

RBC life span is approximately about 120 days.
The breakdown (haemolysis) of the red blood cell is carried out by macrophages in the spleen, liver and the bone marrow .

ABO Blood Group

The extracellular surfaces of red blood cells have molecules called **antigens** and the plasma have proteins called **antibodies.**



The **ABO blood group** system is used to categorize human blood.

In this blood group system, there are two types of **antigens** (A&B) that may appear on the surface of the red blood cells :

Antibodies against the antigens are usually present in the plasma of blood.

ABO Blood Group System

Blood group	Antigens present	Antibody present	blood that can be received
A	Antigen A	Anti- B	A,O
B	Antigen B	Anti-A	B,O
AB	Both antigen A and B	None	A,B.AB,O, **universal recipient**
O	Neither antigen A or B	Anti-A , Anti- B	O **universal donor**

- **Type AB Blood: is the universal recipient.**
- **Type O Blood: is the universal donor.**

An important blood group is Rh groups. Three of the Rh antigens (C, D, and E) are so common in the human. when the R.B.C have one of these antigens on their surface they are said to be Rh+

Leukocytes (WBC)

The number of leukocytes **(** White Blood Cells **)** is much smaller than that of red blood cells ; in a normal adult there are only between 4,000- 11,000 White Blood Cells per mm of blood.
Leukocytes are **nucleated cells** and are classified into two groups :

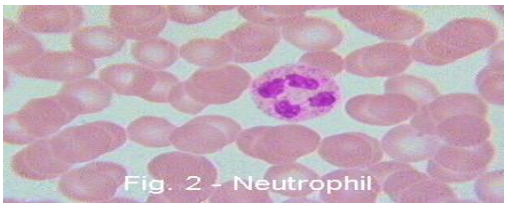
1- Granulocytes, which have specific granules. and nonspecific granules in their cytoplasm.
There are three types of granulocytes :**(Neutrophils, Eosinophils , and Basophils**

2- **Agranulocytes** , they **do not have specific granules** .
There are two types of agranulocytes (Lymphocytes and Monocytes) .

- **Granulocytes**

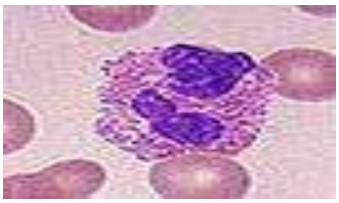
Neutrophils (poly morphonuclear leukocytes)

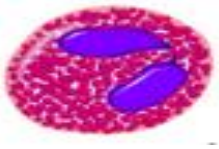
They comprising 40 % - 70% of the total WBC . Neutrophils constitute a defense against invasion of microorganisms by active vagocytosis



Eosinophils

They constituting only 1-4 % of the WBC in normal blood.
The cells increase in number during parasitic infection and allergic reaction.





Basophils

Basophils make up less than 1% of blood leukocytes..The function of basophils is similar to that of **Mast cell.** Their granules contain **histamine** and **heparin** .

- **Agranulocytes**

Monocytes :

- **Monocytes** constitute 3 %- 8 % of the blood leukocytes.
- Monocytes can live in the blood for 2 to 3 days , after which they move into the connective tissue , where they may remain for a few months or longer .
- In connective tissue, Monocytes change to **macrophages** which destroy bacteria, foreign bodies and dead cells .

Lymphocytes :

- They make up 20 – 25 % of white blood cells .
  Lymphocytes can be subdivided into

- , **B-lymphocytes (B-cell) ,**
  , **T –lymphocytes (T- cells)**
  ,

- Lymphocytes have a central role in the immunological defense of the body.

- B-lymphocytes when stimulated by specific antigen, change to into plasma cells and produce antibodies.

Platelets (Thrombocytes)

- Platelets are the smallest formed elements in the blood .

- They have no nucleus .

- Platelets are produced when small portions of cytoplasm separate from the Megakaryocytes.

- The main function of platelets is to promote blood clotting

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Physiology ***Chapter - 2***

Digestive system

Gastrointestinal Tract (GIT).

***Salivary glands*:** 3- pairs of salivary glands empty their secretions into the mouth:

1. The parotid glands (large glands lies anterior to the ear)
2. The submandibular gland
3. Small sublingual gland

The function of salivary glands is to secrete saliva into the floor of the mouth.

1.0 - 1.5 liters of saliva secreted per day : a. 25% by parotid glands,

b. 5% by sublingual glands, and

c. 70% by submandibular glands

I. Composition and Functions of Saliva

- Water 99.4%.
- Electrolytes (Na^+,Cl^-, Hco_3^-) to regulate osmotic pressure.
- Buffers keep pH near (7.0).
- Glycoprotein.
- Antibody (IgA) and lysozyme .
- Enzyme –amylase (ptyalin) to digest carbohydrates.
- Waste product like urea.

0.6%

Function of saliva

1. Contain bactericidal agents
2. Facilitate swallowing
3. Aid speech by facilitating movement of the lips and tongue
4. The PH of the saliva ranges between 6-7 which help to neutralize gastric acid and relieve heartburn when there is regurgitation from the stomach to esophagus.

Deficient salivation is called **xerostomia(**and those are more liable for dental caries ulceration and infection of the gums and oral cavity than normal people.

Histological Structure of the Stomach

Gastric glands: found in the **fundus** and body of stomach and composed from the following cells:

a. Mucous cells. Produce alkaline mucous, which protects the stomach wall itself from being damaged by the acid.

b. Parietal cells. Produce Hcl – hydrochloric acid, which makes the stomach content acidic.

c. Chief cells. Produce enzymes, mostly pipsonogen.

d. G-cells. Produce Gastrin hormone.

e.D-cells. Secrete **Somatostatin.**

SMALL INTESTINE

Digestive Hormones that secreted from small intestine and Their Functions

Hormone	Origin	Effect(function)
Cholecystokinin (CCK)	Duodenum	**contraction of gallbladder**
Gastric inhibitory peptide (GIP)	Duodenum	**Stimulate release of insulin**
Gastrin	Stomach	.**Stimulate production of acid and enzyme**
Secretin	Duodenum	.**increase bile secretion**

LARGE INTESTINE

I. Functions of Large Intestine

1. Absorptions of less than 10% of the nutrients in large intestine.

2. Large intestine prepares fecal material for ejection from the body.

3. Reabsorption of water and other substances such as, bile salts, vitamins, urobilinogen, toxins of bacteria.

4. **Bacteria in the colon produce 3 vitamins** .

a. Vitamin K. b. Biotin. c. Vitamin B_5.

LIVER

Functions of the liver:

1. Formation and secreted of bile.--
2. Nutrients and vitamins metabolism.--
3. Inactivated some substances(toxins, steroid, and other hormones)--

4. Synthesis of plasma proteins.--
5. Contributes with immunity.--

- Produces bile that leaves the liver through **the common hepatic duct and enters the duodenum through the common bile duct.**

- **Bile** is a yellow-to-green watery solution containing bile salts, **bile pigments**, cholesterol, **phospholipids** and a variety of electrolytes.
- **Bile Functions :** Bile secretion contain bile salts and phospholipids which break the fat globules , in the process called "Emulsification"

. The gall bladder is a small sac

Function : storage of bile

PANCREAS

. Exocrine tissue (pancreatic acini):

1. Secrete pancreatic digestive enzymes.
2. The pancreatic enzymes secreted into the duodenum are an alkaline fluid (pH 8), which neutralizes the acidic chyme coming from the stomach.
3. The **acini glands** of the exocrine pancreas produce 1 – 1.5 L of **pancreatic juice** daily.

Pancreatic juice consists of the following enzymes :

1. **Amylase**: which digest carbohydrates;
2. **Lipase** : which digest of fat;
3. **Trypsin**, **chymotrypsin**, which digest protein

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Self assessment : Test your yourself

1. Outlines the functions of saliva
2. Enumerate the types of cells in the gastric glands .What are their functions .
3. Enumerate the 3 hormones secreted by doudenum . clarify their actions .
4. Discuss the functions of large intestine .
5. Mentions of functions of liver .
6. Enumerate the pancreatic enzymes .Outlines their actions .

Nervous System

The Nervous System controls and coordinates all the functions of the body
It is the major controlling and communicating system of the body.

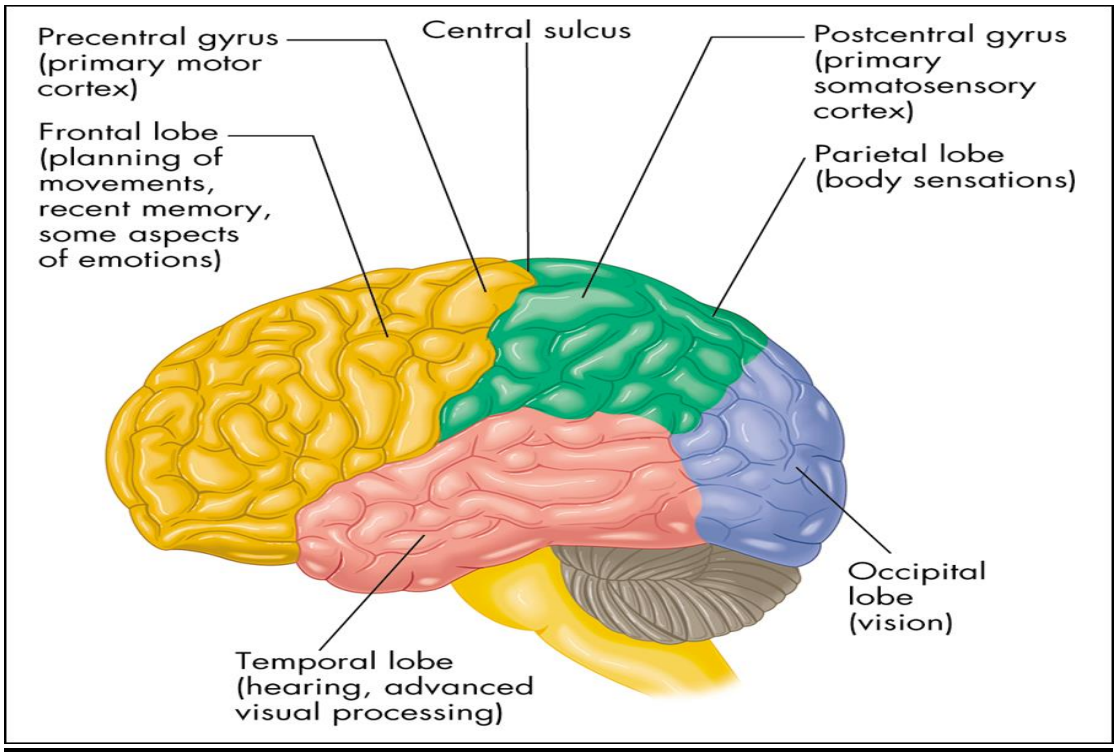
- The Nervous System consists of two main sub-divisions:
  - Central Nervous System (CNS): consist of **brain** and **spinal cord**
  - Peripheral Nervous System (PNS)

- The **Peripheral Nervous System** -- is the nerves outside the brain and spinal cord divided into two sub-divisions:
  - Somatic - voluntary (sensory and motor)
  - Autonomic - involuntary (sympathetic and parasympathetic)

Cerebral cortex: its functions include speech, memory, logical and emotional response as well as consciousness, interpretation of sensations and voluntary movement.

Lobes of cerebral cortex

Cerebral Lobe	Function
1. Frontal lobe	Planning of movement, recent memory, Emotion
2. Parietal lobe	Interprets the body sensation
3. Temporal Lobe	Receives impulses from inner ear.
4. Occipital Lobe	Interprets vision



Diencephalons (interbrain)

The major structures of the diencephalons are the **thalamus, hypothalamus and epithalamus.**

1. **Thalamus**: responsible for:
   Touch, pain and temperature and control the level and state of consciousness.

2. **Hypothalamus**: (under the thalamus).
   a. Regulates the body temperature, water balance and metabolism.
   b. Regulates the pituitary gland (an endocrine gland) .

3. **Epithalamus:** The important parts of the epithalamus are the **pineal body (part of the endocrine system) and the choroids plexus**

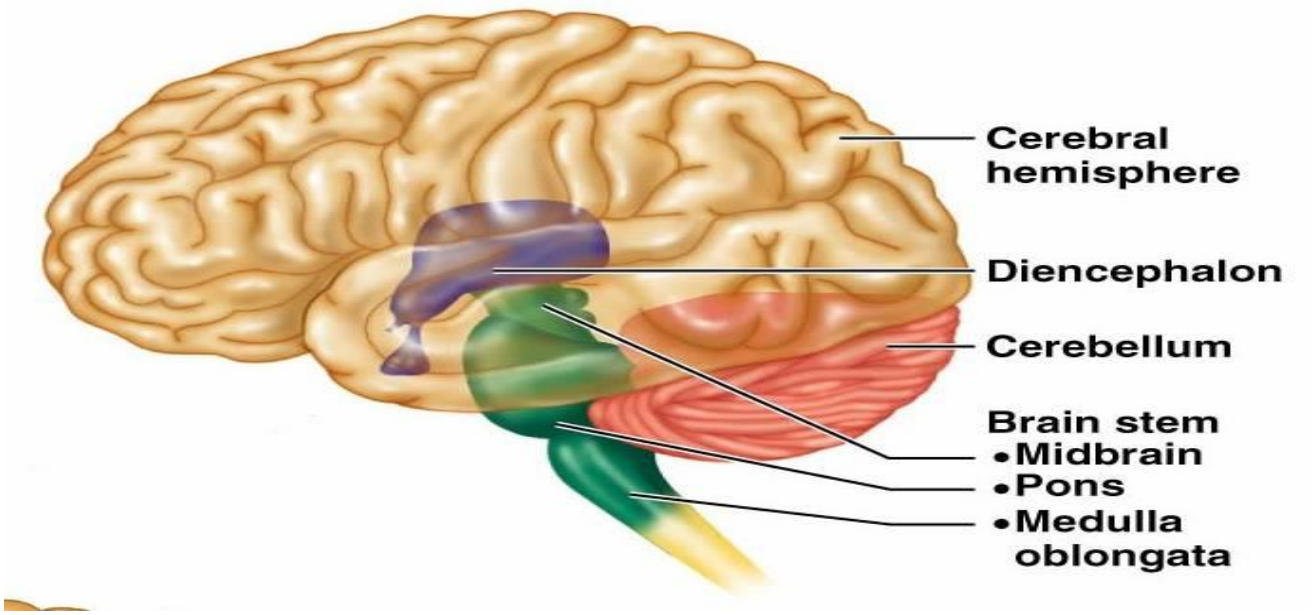
Brain stem

Its structures are **midbrain, pons and medulla oblongata**.

1. **Midbrain الدماغ المتوسط** : It is the smallest part of brain stem, contains the centers of visual and auditory reflexes and it helps to control skilled muscular movements.
2. **Pons** (الجسر) : just below the midbrain. It is important in the control of breathing.
3. **Medulla oblongata**: It is the most inferior part of the brain stem.

Functions:

a. Controls heart rate, blood pressure.
b. Controls breathing, swallowing and vomiting.



Cerebellum

The large cauliflower like structure, projects dorsally from under the occipital lobe of cerebrum.

Functions:

a. Provides the precise timing for skeletal muscle activity.
b. Controls balance and equilibrium.

When cerebellum is damaged, ataxia occurs and the patient loss his balance .

The Effects of autonomic nervous system on the different body organs.

Organ	Sympathetic response	Parasympathetic response
Heart	Increases heart rate	Decreases heart rate
Lungs	Bronchodilatation .	Bronchoconstriction
Digestive system	• Decreases peristalsis • constricts digestive system sphincters	• Increases peristalsis • relaxes sphincters. • Increase glands secretion
Urinary bladder	Constricts sphincters (Prevents voiding)	Relaxes sphincters (allows voiding)
Eye	Dilates pupil , and prepares for distant vision.	Constricts pupil and prepares for close vision.
Metabolism	• Increase metabolic rate • increase blood sugar levels • stimulate fat breakdown.	Glycogen synthesis

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Brain meninges

The meninges refer to the **membranous** coverings of the brain and spinal cord. There are three layers of meninges:

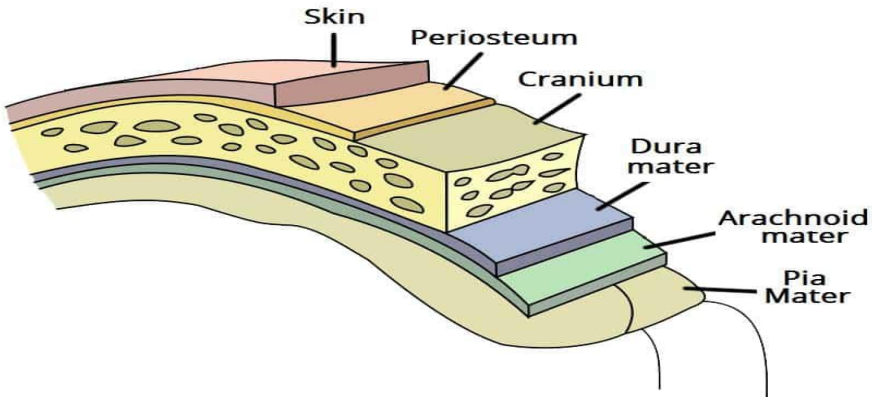
1. **Dura mater,**
2. **Arachnoid mater**
3. **Pia mater**.

These coverings have two major functions:

1.Provide a **supportive framework** for the cerebral and cranial vasculature.

2. Acting with cerebrospinal fluid to **protect** the CNS from mechanical damage.

The meninges are often involved cerebral pathology, as a common site of **infection** (meningitis), and **intracranial bleeds**.



Dura Mater

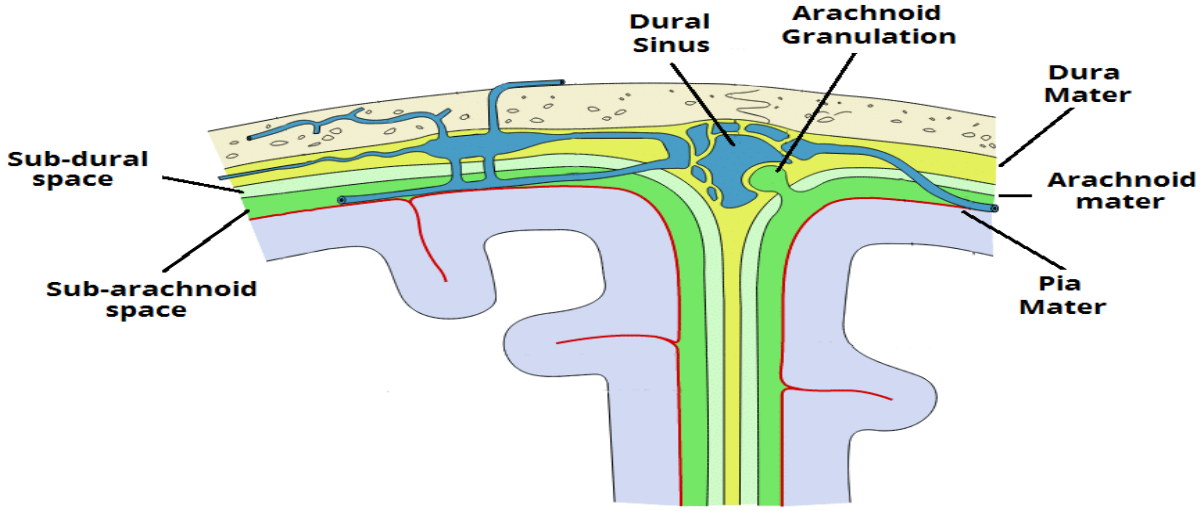
The dura mater is the **outermost** layer of the meninges and is located directly underneath the bones of the skull and vertebral column. It is thick, tough, and inextensible.

Arachnoid Mater

The arachnoid mater is the middle layer of the meninges, lying directly underneath the dura mater. is **avascular** **(has no blood supply).**

Underneath the arachnoid is a space known as the **sub-arachnoid space**. It contains **cerebrospinal fluid**, which acts to cushion the brain.

Small projections of arachnoid mater into the dura (known as **arachnoid granulations**) allow CSF to re-enter the circulation via the dural venous sinuses.



Pia Mater

The pia mater is located underneath the sub-arachnoid space. It is very thin, and **tightly adhered** to the surface of the brain and spinal cord.

Like the dura mater, it is **highly vascularized**, with blood vessels perforating through the membrane to supply the underlying neural tissue.

Clinical relevant

1. **Meningitis** : inflammation of meningitis
2. **Extradural and Subdural Hematomas** (hematoma is collection of blood)

CT scan of a massive extradural hematoma

Cerebrospinal fluid

Clear, colorless slightly alkaline fluid with a specific gravity of 1007 that surrounds the brain and spinal cord and fills the spaces in them , and act as a lubricant, protect the brain from shocks due to body movements and from blows to the head .

The brain floats on a liquid cushion of cerebrospinal fluid (CSF) within the rigid bony skull. The CSF is contained between layers of the meninges .

.it secreted by the choroid plexuses of the ventricles .
.it occupies the 1. ventricles of the brain
2. subarachnoid space

* choroid plexuses : are very vascular structure , consisting largely of a network of fine blood vessels

Analysis of CSF obtained by a spinal tap (lumbar puncture) helps diagnose a number of disorders, including meningitis and hemorrhage in the central nervous system.

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Why the Test is Performed

This test is done to measure pressures within the cerebrospinal fluid and to collect a sample of the fluid for further testing. CSF analysis can be used to diagnose certain neurologic disorders, particularly infections (such as meningitis) and brain or spinal cord damage.

Normal Results

Normal values typically range as follows:

- Pressure: 70 - 180 mm H20
- Appearance: clear, colorless
- CSF total protein: 15 - 60 mg/100 mL
- Gamma globulin: 3 - 12% of the total protein
- CSF glucose: 50 - 80 mg/100 mL (or greater than 2/3 of blood sugar level)
- CSF cell count: 0 - 5 white blood cells (all mononuclear), and no red blood cells
- Chloride: 110 - 125 mEq/L

What Abnormal Results Mean:

If the CSF looks cloudy, it could mean there is an infection or a build up of white blood cells or protein.

If the CSF looks bloody or red, it may be a sign of bleeding or spinal cord obstruction.

If it is brown, orange, or yellow, it may be a sign of increased CSF protein or previous bleeding (more than 3 days ago). Occasionally, there may be blood in the sample that came from the spinal tap intself. This makes it harder to interpret the test results.

Increased CSF pressure may be due to increased intracranial pressure (pressure within the skull).

Decreased CSF pressure may be due to spinal cord tumor, shock, fainting, or diabetic coma.

Increased CSF protein may be due to blood in the CSF, diabetes, polyneuritis, tumor, injury, or any inflammatory or infectious condition.

Decreased protein is a sign of rapid CSF production.

Increased CSF gamma globulin levels may be due to diseases such as

- 1. multiple sclerosis,
  2. neurosyphilis.

Increased CSF glucose is a sign of high blood sugar.

Decreased CSF glucose may be due to

1. hypoglycemia (low blood sugar),
2. bacterial or fungal infection (such as meningitis), TB.

Increased white blood cells in the CSF may be a sign of meningitis, acute infection, beginning of a chronic illness, tumor, abscess, stroke, or demyelinating disease (such as multiple sclerosis).

Red blood cells in the CSF sample may be a sign of bleeding into the spinal fluid or the result of a traumatic lumbar puncture.

Male Reproductive System

It composed from the following organs :
Testis , **Epididymis**, ductus deferens (vas deference) and urethra

Testis .

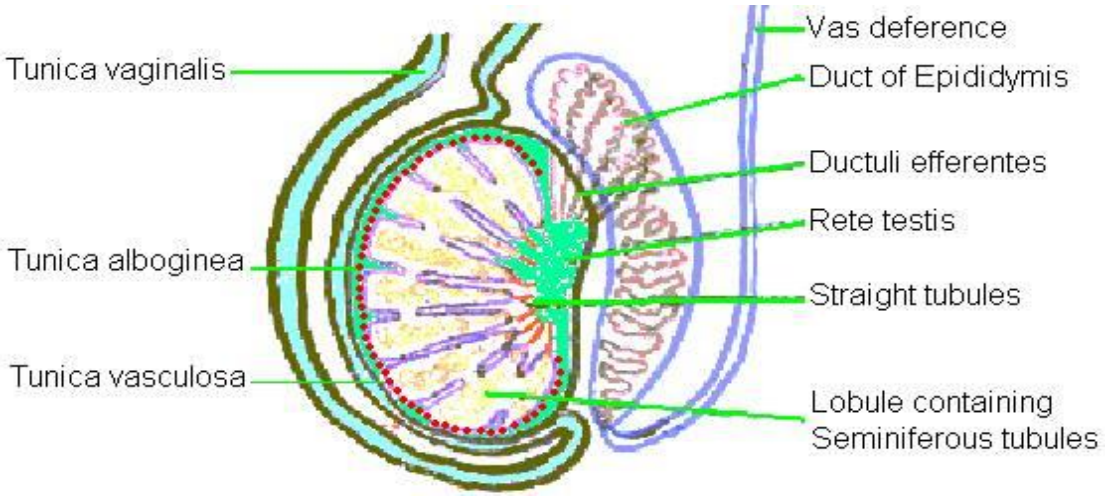
The testes (testicles) are the primary male reproductive organs.

The testes are firm, mobile organs. They are normally two testes approximately 5 cm long, 3 cm wide. Weighing 10–15 g each, the testes are suspended outside the body in a sac called the scrotum.

The testes consist of a series of tubules covered by a multi-layered tunica which covers the testes, It facilitate blood supply to the testes and divide the testis into many parts .

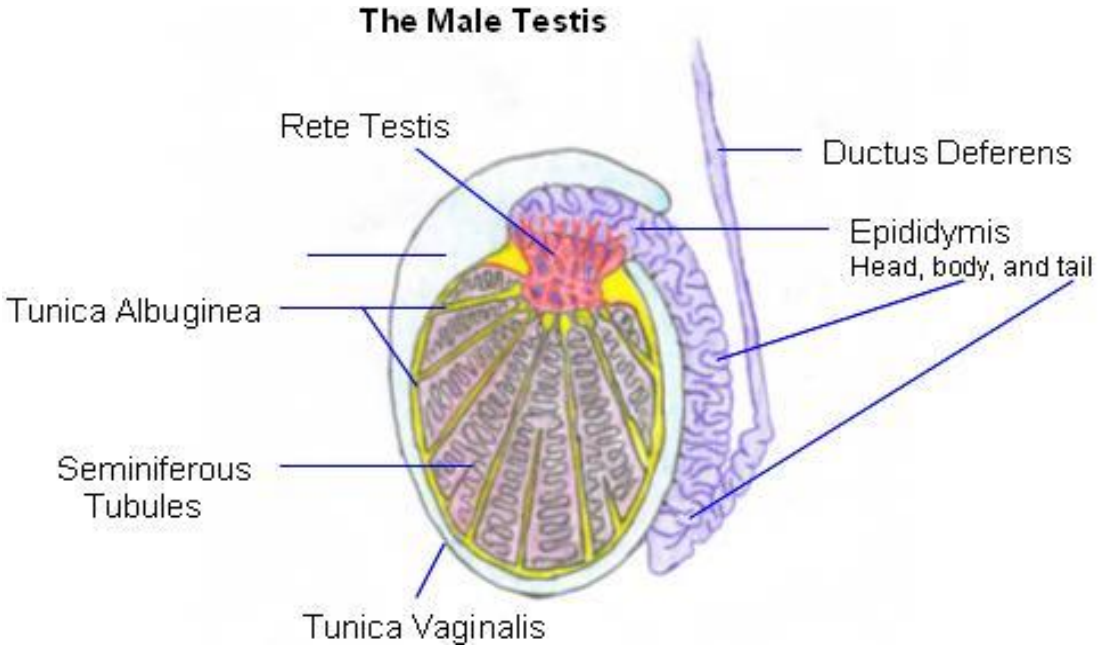
There are three layers to the tunica :

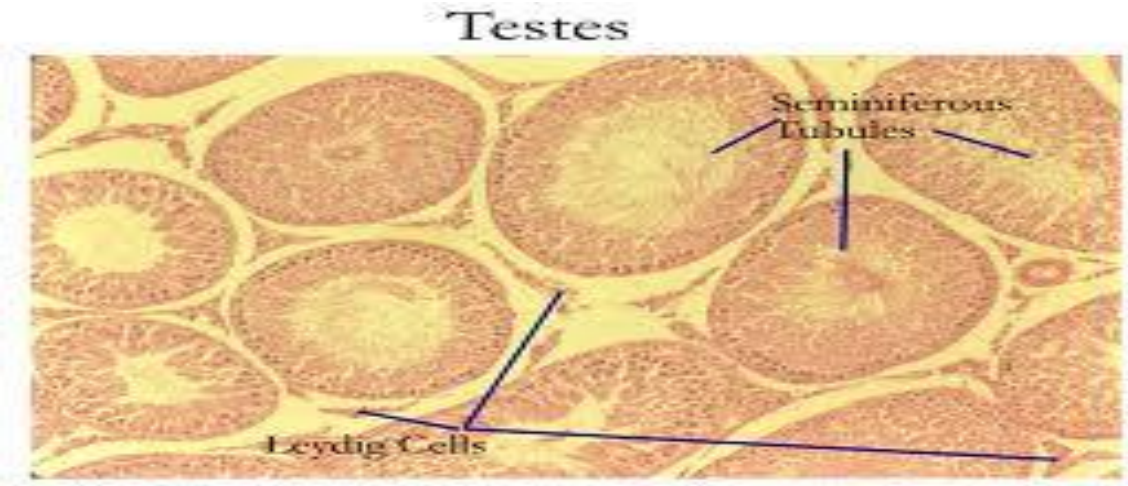
Tunica vasculosa: inner layer
Tunica albuginea : middle layer
Tunica vaginalis. : outer layer



The inside of the testes is divided into small compartments known as lobules.
Each lobule contains seminiferous tubules and are separated by partitions.

---Each lobule contains 1–4 seminiferous tubules and
---Each testis may contain up to 900 of these tubules. which are tightly coiled within the testis.





Functions of testes:

a. Producing the sperms (inside seminiferous tubules by sertoli cells)
b. Producing the testosterone hormone by leydig cell(outside seminiferous tubules)

Duct system

There are a series of ducts and tissues **(duct system)** which play an in transporting sperm from the testes and these are :

a. **Epididymis**,
, b. **ductus deferens (vas deference)**
, c. **urethra**.

a. **Epididymis**: Epididymis is the first part of the duct system It is a highly coiled tube about 6m long that caps the superior part of the testis and then runs down its postero-lateral side.

Function of epididymis:

1. Provides temporary storage site for the immature sperm until the sperm becomes completely matured. (About 20 days)
2. Expels the sperm into the ductus deferens,

b. Ductus deferens (vas deferens) :

Runs upwards from the epididymis through the inguinal canal into the pelvic cavity and arch over the superior aspect of the bladder. This tube is enclosed in a connective tissue sheath called the spermatic cord. The end of the ductus deferens empties into the ejaculatory duct, which passes through the prostate gland to merge with the urethra.

Functions:

Propels sperm from the epididymis into the urethra.

c. Urethra: It is the terminal part of the male duct system

It has three regions:

1. Prostatic urethra
2. Membranous urethra
3. Spongy urethra

Function of male urethra: It carries both urine and sperm to outside of the body

Accessory glands :

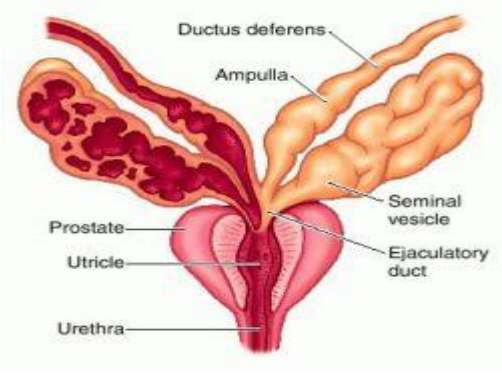
The accessory glands of male reproductive system include: -

a. Seminal vesicles
b. Prostate gland
c. Bulb urethral glands (cowper's gland

a. Seminal Vesicles

a. Pair of exocrine glands
b. About 2 inches in length
c. Produces about 60% of the fluid volume of semen

It produces thick yellowish fluid rich in sugar (fructose), vitamin C, prostaglandin and other substances, **which nourish and activate the sperm passing through the tract**. Each seminal vesicle joins the ductus deferens on the same side to form the ejaculatory duct



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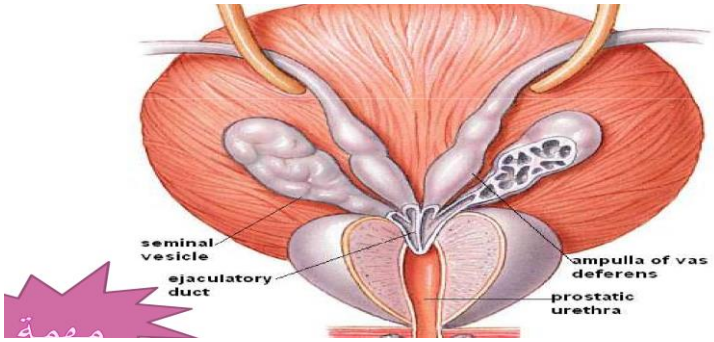


b. Prostate gland: It is a single gland about the size and shape of a chestnut (كستناء).
It encircles the upper part of the urethra just below the bladder.
Function: Secreting a milky fluid that plays a role in activating sperm, **and contributes with sperm motility**.

c. Bulb urethral glands (Cowper's Glands):
are tiny, pea-sized (بازلاء) glands inferior to the prostate gland.

Functions:
Produce thick clear mucus that drain into the urethra to clean it from traces of acidic urine.

Spermatogenesis:

Sperm production or spermatogenesis begins during puberty and continues throughout life. **Sperm formation occurs in the seminiferous tubules of the testis.**

Testosterone production:
The interstitial cells (leydig cells) produce **testosterone**, **the most important hormonal product of the testes.**
During puberty, the interstitial cells are being activated by Luteinizing hormone (LH), (which is released by the anterior pituitary gland), to form testosterone.

Functions of testosterone:

1. Develop the reproductive organs to their adult size.
2. Enhance the appearance of secondary sex characteristics, which includes: -
    - Deepening of voice due to enlargement of the larynx.
    - Increase hair growth all over the body .
    - Enlargement of skeletal muscles.
    - Increased heaviness of the skeleton due to thickening of the bone.

Female Reproductive System

Female reproductive organs composed from :

1.Ovary 2. Fallopian tube 3. Uterus 4. Cervix 5.Vagina

1.Ovaries

The ovaries are small, oval-shaped paired glands that are attached to each side of the uterus by a thin, fibrous ovarian ligament.

2. Fallopian tubes :

a.The fallopian tubes (also called the salpinges) are two delicate, thin cylindrical channels that connect the ovaries to the uterus .

b.Approximately 8–14 cm long ..

c. The lateral ends of the fallopian tubes are open and made of projections called fimbriae

They are the main structure that facilitate fertilization. Each tube is further divided into 3main portions:

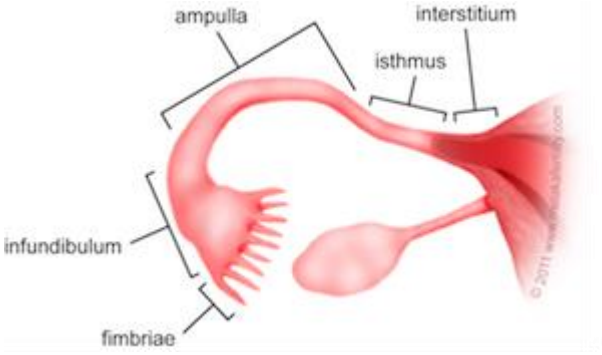


Figure 3: Anatomy of Fallopian tube.

1.Fimbriae:

The fringe-like structure located at the end of the tube that pick up the ovum after it is discharged from the ovary

2. Infundibulum: The funnel-like structure of the tube which is margined with fimbriae.

3.Ampulla: The longest portion of the tube with thin wall (almost muscle-free) and wide lumen. It is usually the portion where fertilization takes place.

Uterus:
This hollow organ is also known as the womb. It is a very muscular organ lying in the pelvic Cavity posterior and superior to the urinary bladder; it lies anterior to the rectum.

Regions of the uterus:
There are three regions:

1. **The body**: The major portion of the uterus.
2. **The fundus**: It is a superior rounded region above the entrance of the uterine tubes.
3. **Cervix**: It is a narrow outlet, which protrudes into the vagina below.

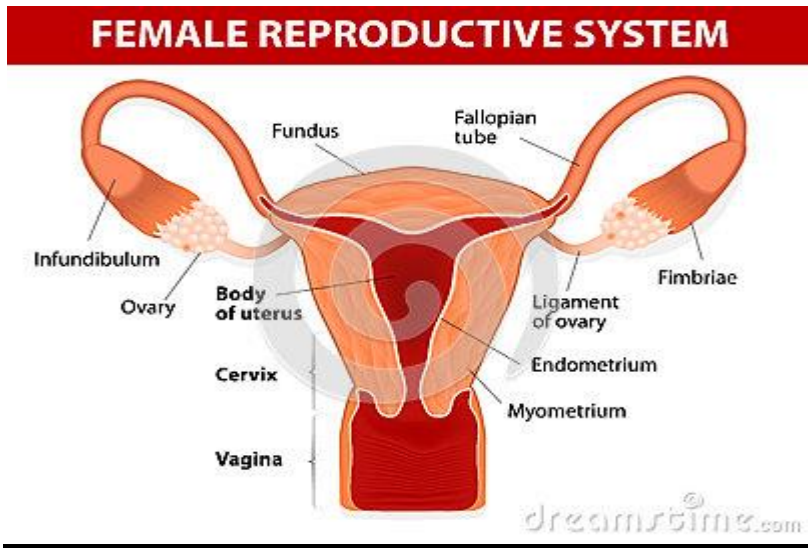
The walls of the uterus are thick and composed of three layers.
1. Endometrium: The inner layer or mucosa.
Functions:

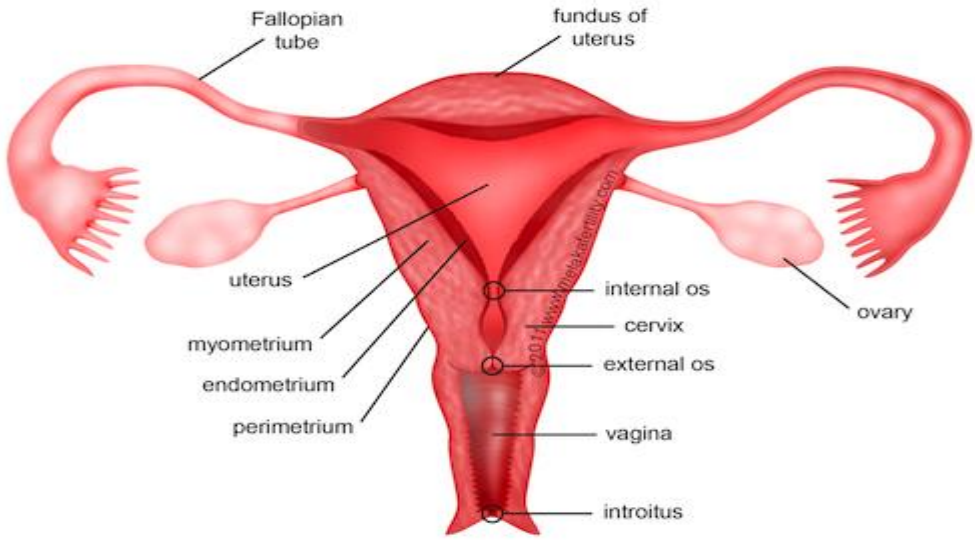
- If fertilization occurs, the young embryo implant into the endometrium (this process called implantation and stay there for the rest of its development).
- If the woman is not pregnant, the endometrium lining sloughs off periodically (about 28 days) in response to hormonal changes, this process called menses.

2. Myometrium: It is the middle layer of the uterus. It is composed of smooth muscles.
Function:

- Plays a major role during delivery, when it contracts rhythmically to force the baby out.

3. Epimetrium: The outer layer of the uterus. It protects and supports the uterus. It is a part of the visceral peritoneum.





Physiology of ovary:

- The ovaries are responsible for storing and nurturing immature egg cells into mature eggs
- Every month, one of them releases a mature egg into Fallopian tube.
- The ovaries produces two main female sex hormones: the **oestrogen** and **progesterone**.

Hormones production by ovaries

1. **Estrogen**: Secreted by follicle cells of mature follicle.
   Functions:

Causes the appearance of secondary sex characteristics, which includes:

1. Enlargement of the accessory organs (uterine tubes, uterus, vagina, external genitalia)
2. Development of the breast.
3. Appearance of axillary and pubic hair.
4. Increased deposits of fat beneath the skin in the hips and breasts.
5. Widening and lightening of the pelvis.
6. Onset of the menstrual cycle.

2. **Progesterone**: It is produced by corpus luteum (after ovulation occurs, the ruptured follicle is converted to corpus luteum). The corpus luteum stops producing hormones by 10-14 days after ovulation.

Functions:

- Maintains pregnancy
- Prepares the breasts for milk production.

Note: The source of progesterone during pregnancy is the placenta not ovaries.

Menstrual Cycle

The menstrual cycle is necessary for reproduction.

It begins from menarche (the first menstrual cycle in girl life) and continues until menopause(when the woman's primary ovarian functions stop permanently and no cycle after that) .

The length of a menstrual cycle is calculated from the first day of the menstruation to the day before the next menstruation. The average menstrual cycle length is 28 days, although it can vary from woman to woman.

Menstrual cycle is comprised of 4 phases:

1.Menstruation

2. Proliferative phase,
3. Ovulation
4. Luteal phase.

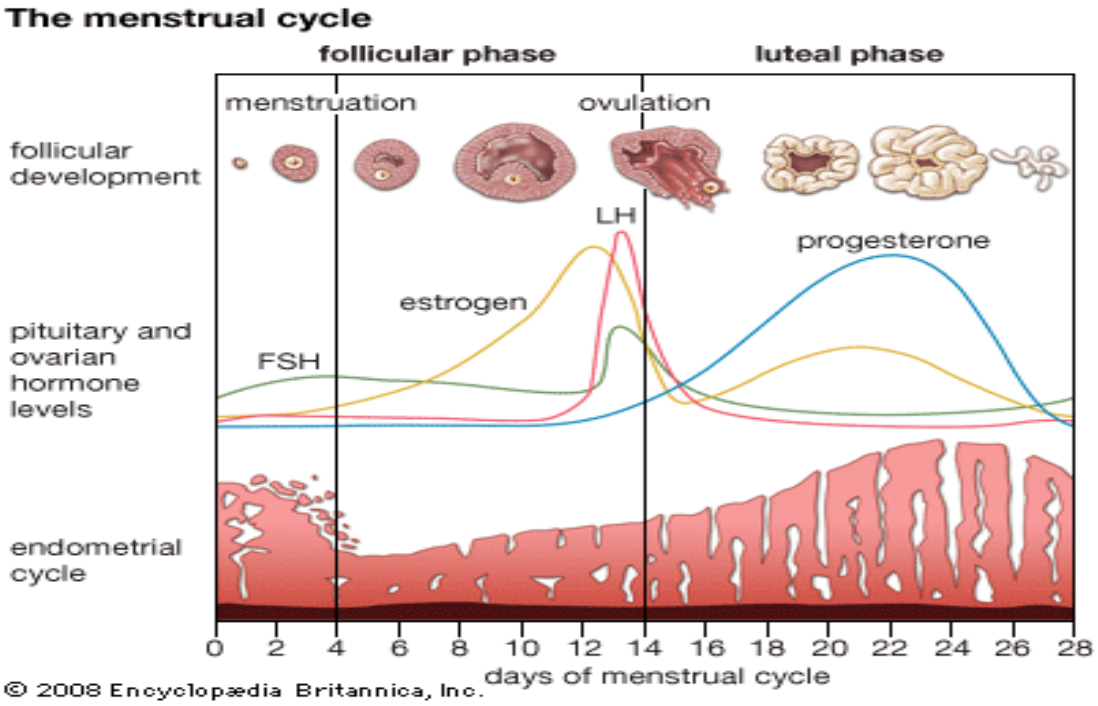
- **Menstruation**

  1. Menstruation or menses refers to the monthly shedding of uterine lining (endometrium), which normally lasts from 3 to 7 days.

  2. Menstruation is triggered by the sudden decline in female sex hormones - oestrogen and progesterone.

- Follicles are fluid-filled sacs that contain an immature egg or oocyte, which can potentially develop into mature ovum

  3. During menstruation, the follicle stimulating hormone (FSH) level rises, which, stimulates the follicles in the ovaries to grow.



a. Follicle – stimulating – hormone (FSH)

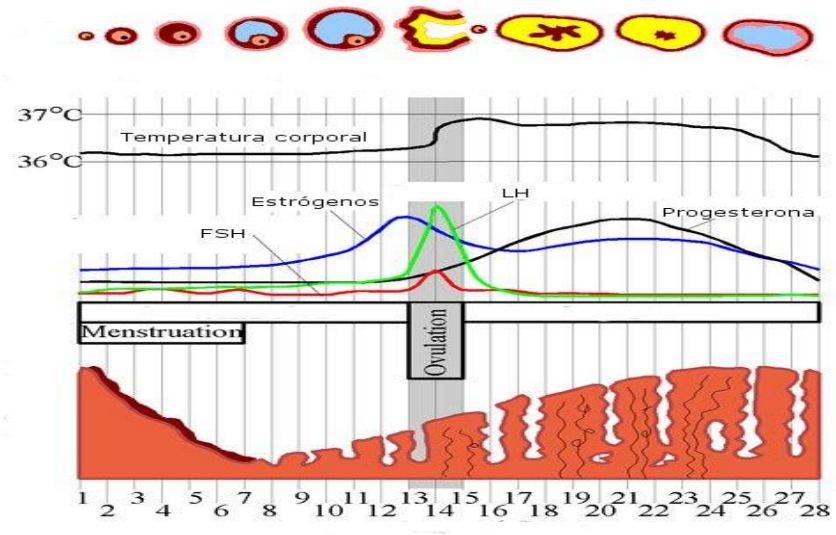
- **Action**:

Female: ovaries : Development of follicles; secretion of estrogen

b. Luteinizing hormone (LH).

- **Action**:

Females: ovaries : - Rupture of follicle and ovulation



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- **Proliferative Phase**

  It begins soon after menstruation and ends with ovulation.

- **<u>During this phase :</u>**

  1.The endometrium begins to grow and thicken in preparing for possible pregnancy.

  2. The maturing follicles secrete **increasing amount of oestrogen**, which lead to:

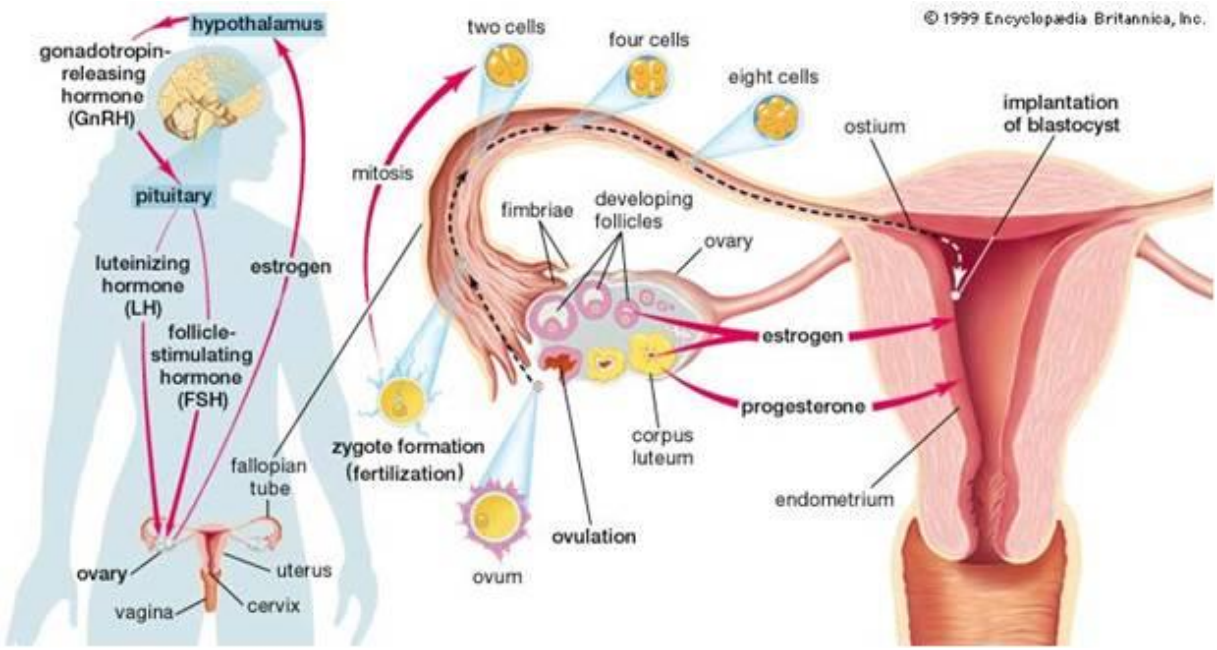
  a. suppression of FSH secretion

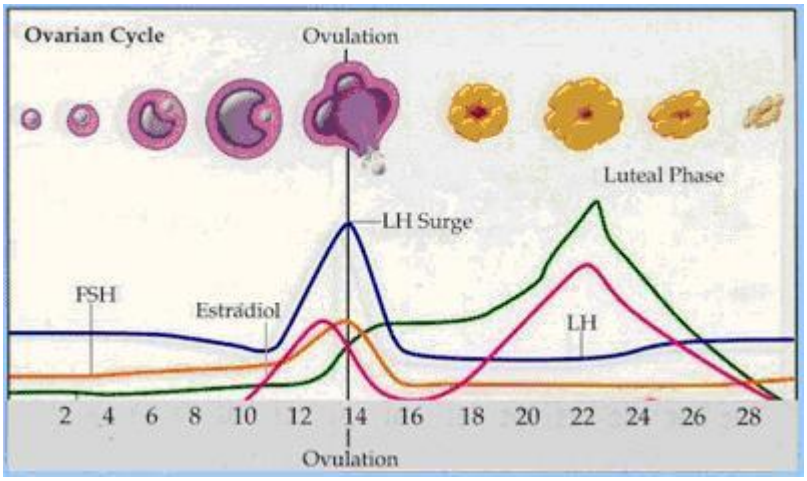
  b. increases of LH secretion

- The changes in both hormones are responsible for degeneration of most maturing follicles. One follicle (sometimes two), however, will become dominant and continue to develop into its tertiary stage, in which it is called Graafian follicle.
- About 2 to 3 days prior to ovulation, the LH level increases dramatically to facilitate the ovulation.
- 

- **Ovulation**

  The rapid rise of luteinizing hormone, or more commonly known as the LH surge, causes the Grafian follicle to burst and release the mature egg, which is later caught by the fimbrial end of the fallopian tube. The entire process is called ovulation and usually occurs in the middle of the menstrual cycle, about day 14.

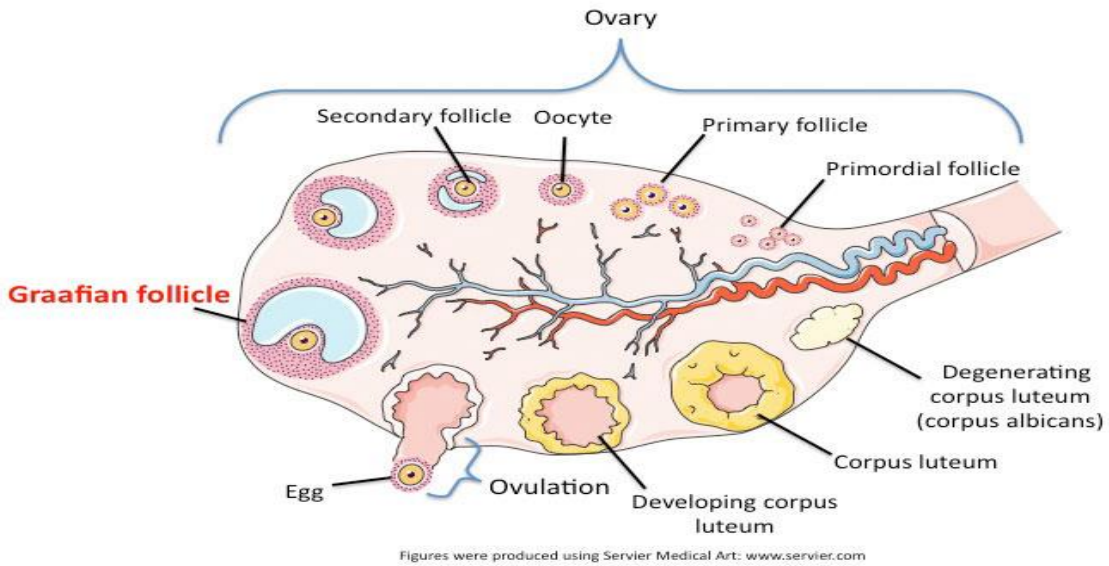
- 

- 

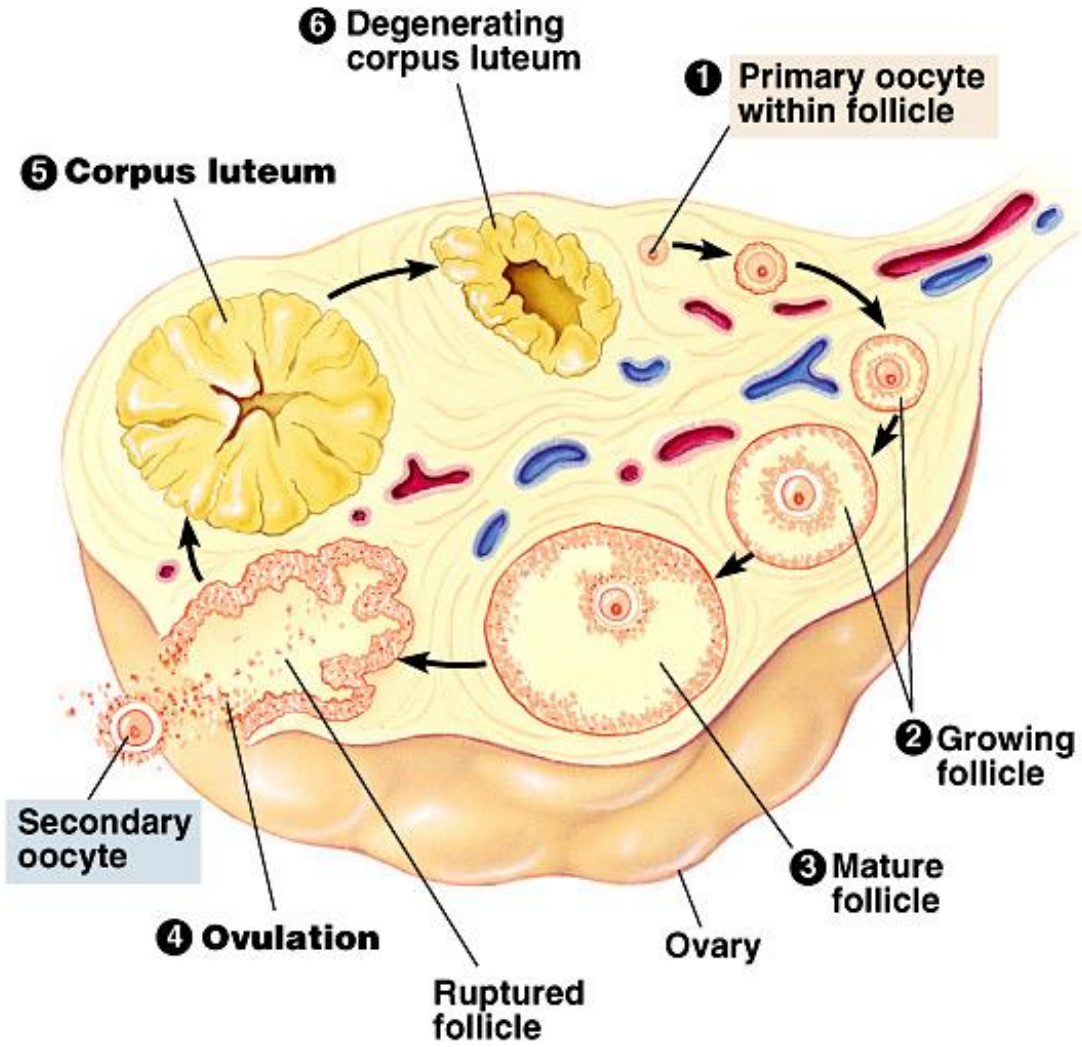
- **Lutueal Phase**

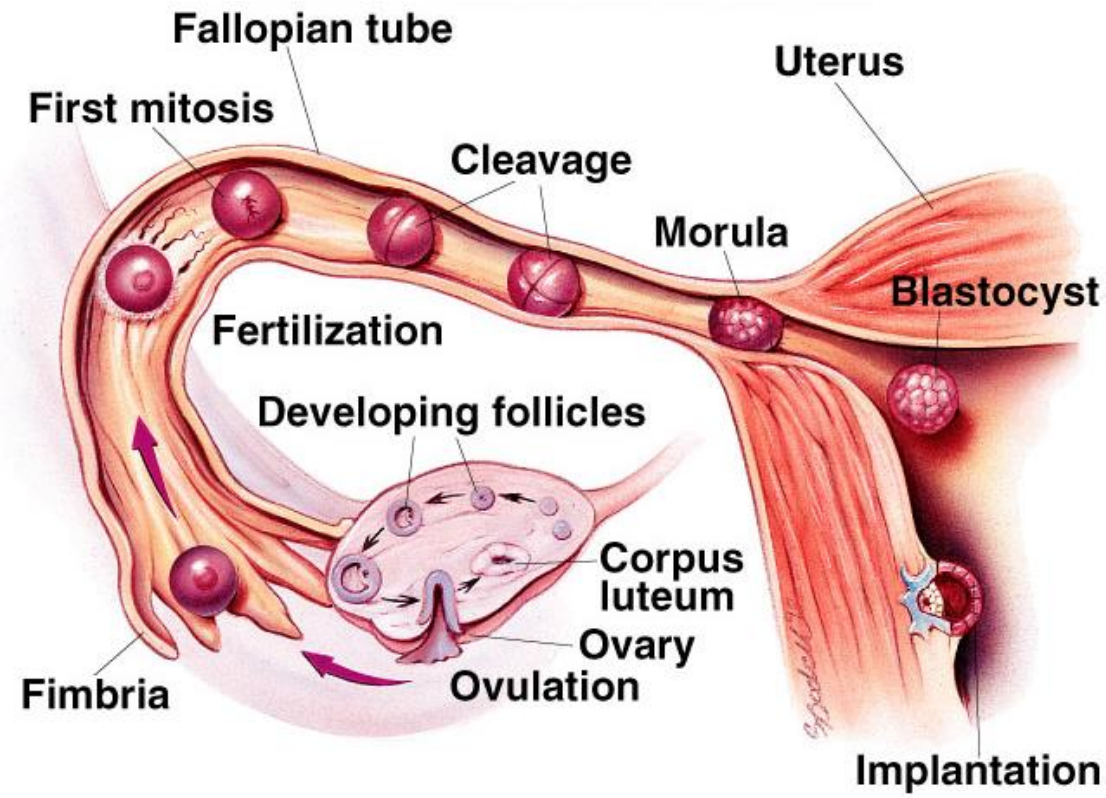
  The occurrence of ovulation also marks the beginning of luteal phase. **<u>During this phase</u>** :

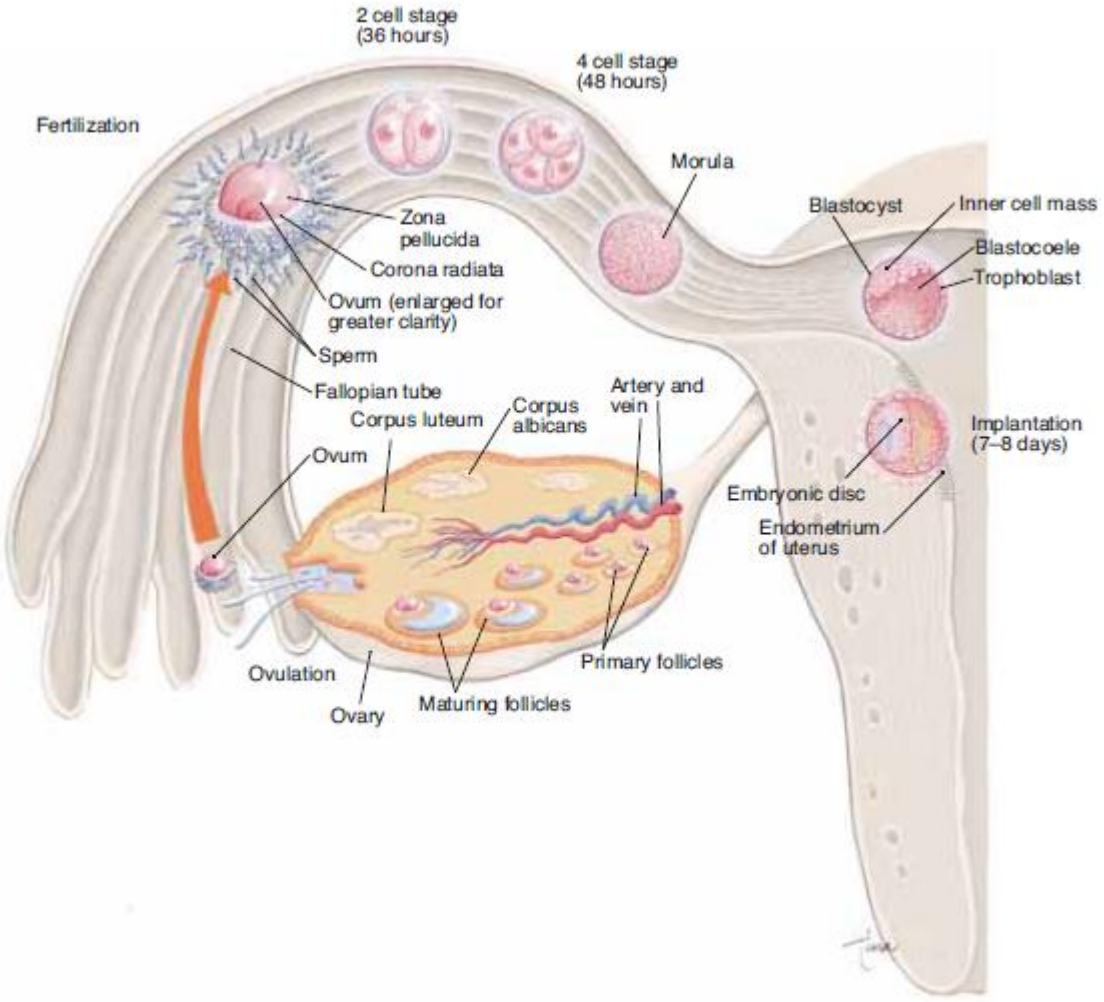
- **1.** the ovum is propelled through the fallopian tube into the uterus. Meanwhile, under the influence of the LH surge, the remaining, ruptured follicle is transformed into a solid glandular structure called corpus luteum.

- 

- **2.**The corpus luteum produces an increasing amount of progesterone, with some secretion of oestrogen. The progesterone is essential for preparing the endometrium for implantation of embryo if fertilization occurs.
- When the endometrium is stimulated by progesterone it will transform into its secretory phase and attains its full maturity.
-
- If fertilization does not occur, the corpus luteum will degenerate into a white fibrous scarred tissue called corpus albicans, which leads to a decline in progesterone and oestrogen. The endometrium will then shed and menstruation takes place.
  The next menstrual cycle begins.




Fallopian tube
Uterus
First mitosis
Cleavage
Morula
Blastocyst
Fertilization
Developing follicles
Corpus luteum
Ovary
Fimbria
Ovulation
Implantation

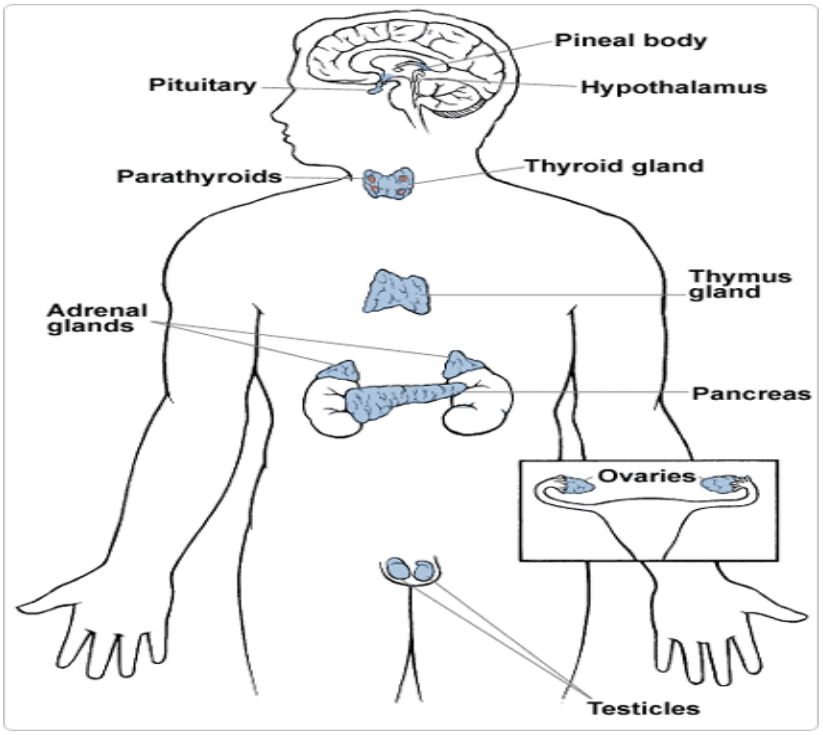

2 cell stage (36 hours)
4 cell stage (48 hours)
Fertilization
Morula
Blastocyst
Inner cell mass
Blastocoele
Trophoblast
Zona pellucida
Corona radiata
Ovum (enlarged for greater clarity)
Sperm
Fallopian tube
Corpus luteum
Corpus albicans
Artery and vein
Ovum
Implantation (7–8 days)
Embryonic disc
Endometrium of uterus
Primary follicles
Ovulation
Ovary
Maturing follicles

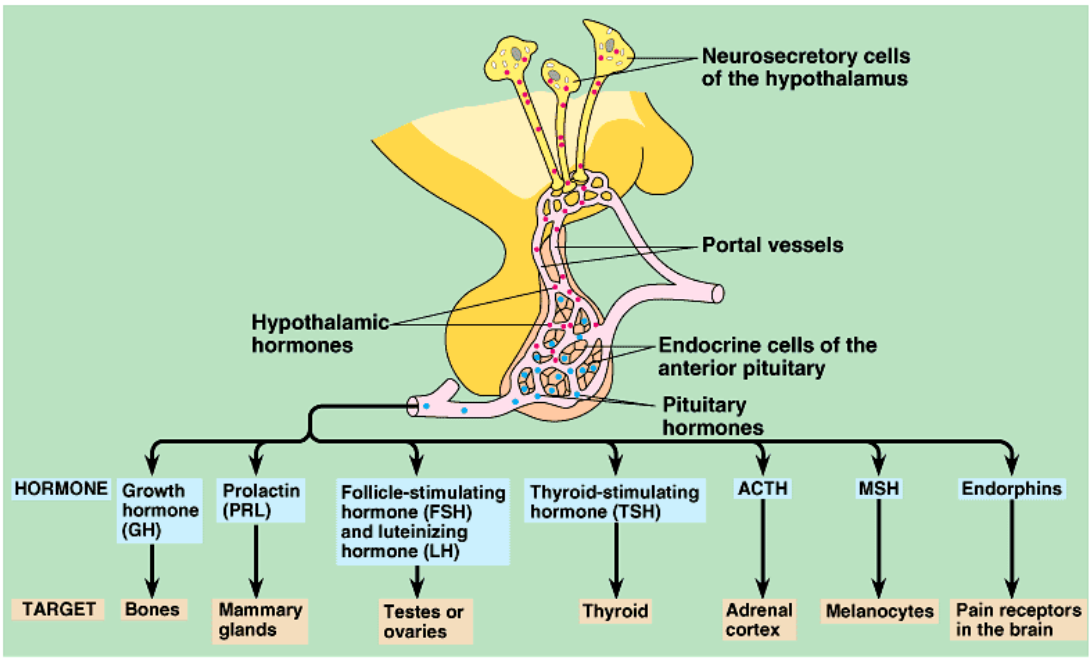
Endocrine System

Hormones: Chemical substances secreted by cells into the extra cellular fluids, that regulate the metabolic activity of other cells in the body.

Difference between endocrine and exocrine glands :

1. **Endocrine glands**: are ductless glands that produce their hormones and release into the blood or lymph. They have a very rich blood supply. The endocrine glands of the body include: **pituitary, thyroid, parathyroid, adrenal, pineal , thymus, pancreas, the gonads (ovaries and testes) and hypothalamus.**
2. **Exocrine glands**: These glands release their products at the body's surface or into body cavities through ducts.





(b) The anterior pituitary

Pituitary glands

The hypothalamus is responsible for the control of pituitary gland

Pituitary gland has two functional lobes :

* **Anterior** pituitary (**glandular tissue)**

* **Posterior** Pituitary (**nervous tissues**)

- ## Hormones of the anterior pituitary

1. Growth hormone (GH):

- **Action**:
  - **a.** Directed to growth of skeletal muscles and long bones.
  - **b.** Stimulate protein synthesis .
  - **c.** Maintain blood sugar homeostasis.

2.Prolactine (PRL):

- **Action:**

  It stimulates and maintains milk production by the mother breast

  Its function in males is not known

3.Adrenocorticotropic hormone (ACTH):.

- **Action**:

Regulates the endocrine activity of the cortex of the adrenal gland

4. Thyroid – stimulating – hormone (TSH)

- **Action**:

It control the activity of the thyroid gland to secrete thyroid hormones(T3 and T4).

5.Gonadotropic hormones. (FSH, LH).

Regulate the activity of the gonads (ovaries and testes)

a. Follicle – stimulating – hormone (FSH)

Action: **Female**: ovaries : Development of follicles; secretion of estrogen
Males: testis : Stimulate sperm development by the testes.

b. Luteinizing hormone (LH).

- **Action**:

Females: ovaries : - Rupture of follicle and ovulation
Males: testes. **:** stimulates testosterone production

- **Hormones of the posterior pituitary gland**

1. Antidiuretic hormone (ADH or vasopressin)

Actions:

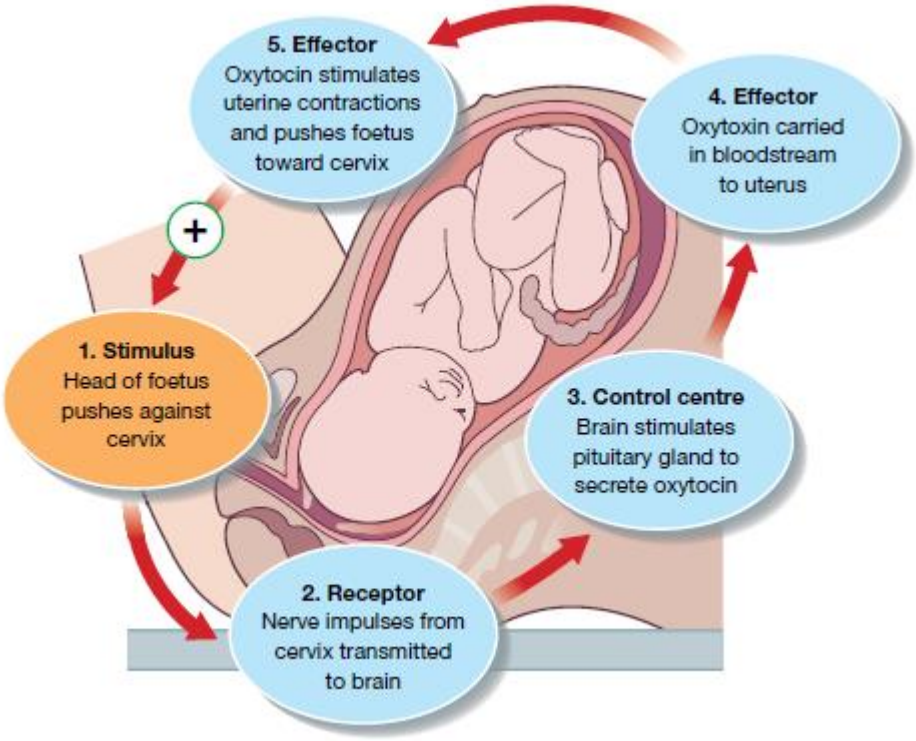
a. Antidiuretic action : increase water re-absorption by the kidneys (raises blood pressure),

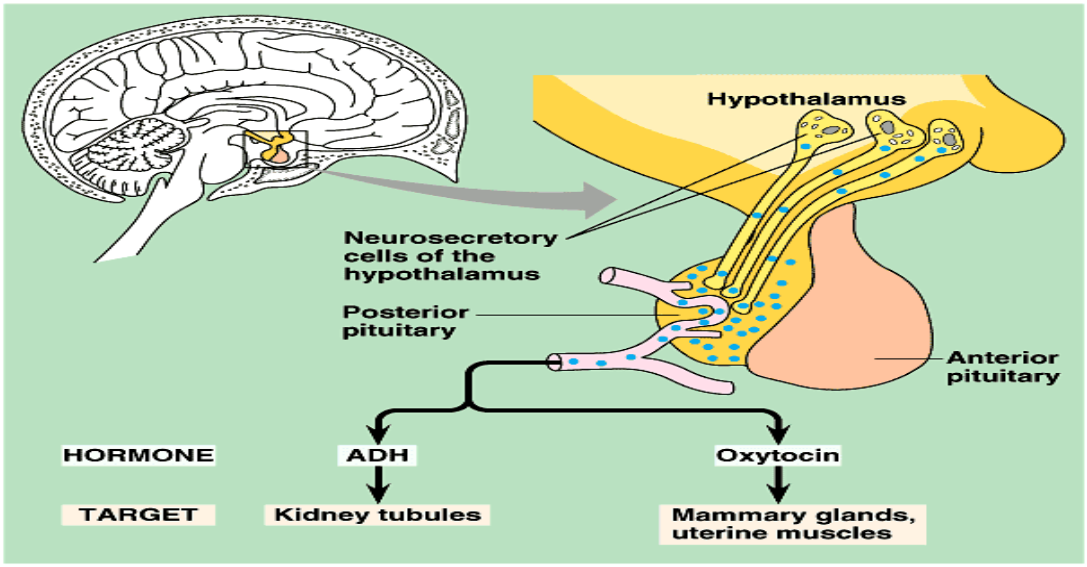
b. . Vasoconstrictor : constriction of arterioles during severe hemorrhage.

2. Oxytocin (OT):

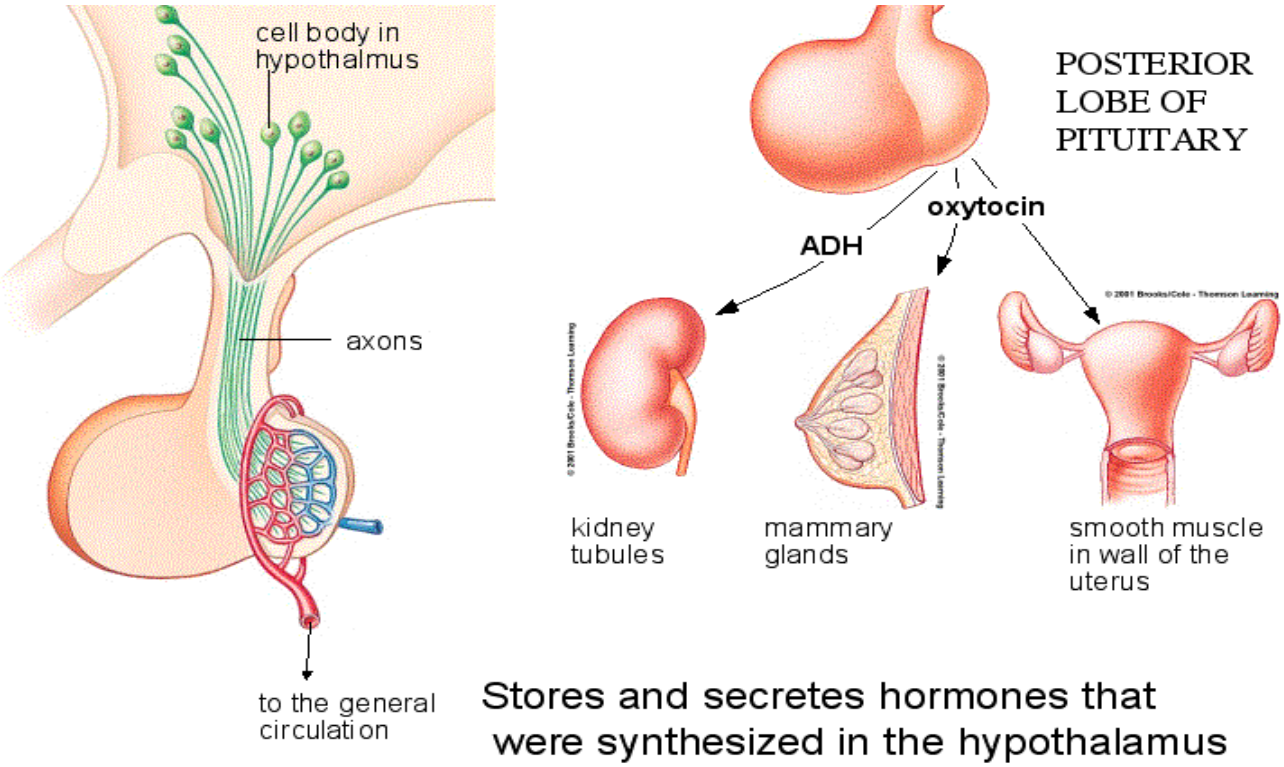
- **Action**: - **In the female**:
  - - stimulates uterine contractions during labor,
  - stimulates milk ejection

-**In the male** : contraction of vas deferens to transport of sperm



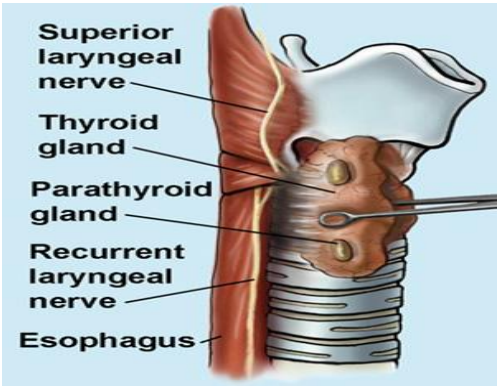


(a) The posterior pituitary



Thyroid gland

- It is a big structure located at the midline of the neck in front of the larynx and trachea below Adam's apple. It consists of 2 lobes right and left



It secretes two hormone

1. Thyroid hormones - thyroxin T4
   - T3
2. Calcitonin

The T means thyroid and the (3,4) refers to the numbers of iodine atoms that are present in the molecule of the hormone

- **The function of thyroid hormone as follows**:

1. Control and regulate the amount of O2 that are consumed by the cells.(regulation of cellular respiration).
2. Control and regulate the rate of metabolism of lipids, carbohydrates , and proteins
3. Important for normal growth and maturation of somatic and mental cells.
4. Important in fertility.

Calcitonin :

It acts **antagonistically** to parathyroid hormone**.**

- **Secreted** by Para follicular cells (C cells).
- **Actions**: decreases blood calcium levels.

Parathyroid gland

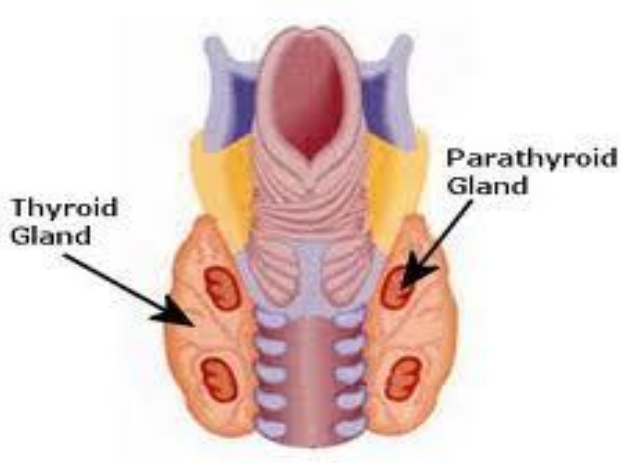
They are four collection of cells embedded in the substances of the thyroid gland.

Secrete **Parathormone hormon**e,.

The action of the parathyroid hormones

is to keep the level of calcium and phosphate within normal limit

- **Action**: increases calcium levels, decreases blood phosphate levels.
- **Bone**: increase the rate of calcium release from bones.
- **Kidneys**: increase calcium re-absorption .
- **Small intestine**: increase calcium absorption.

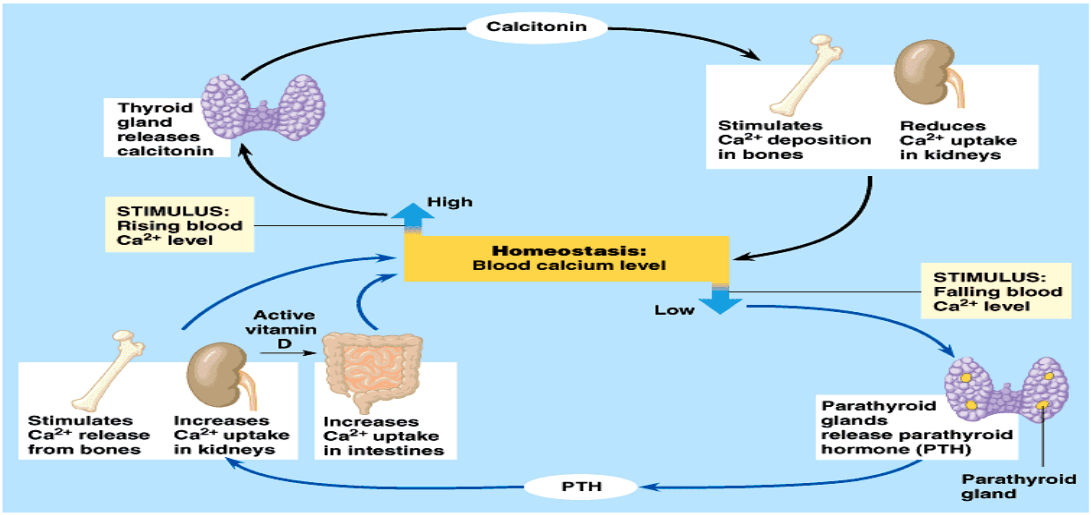


The hormones that regulate calcium (Ca) level :

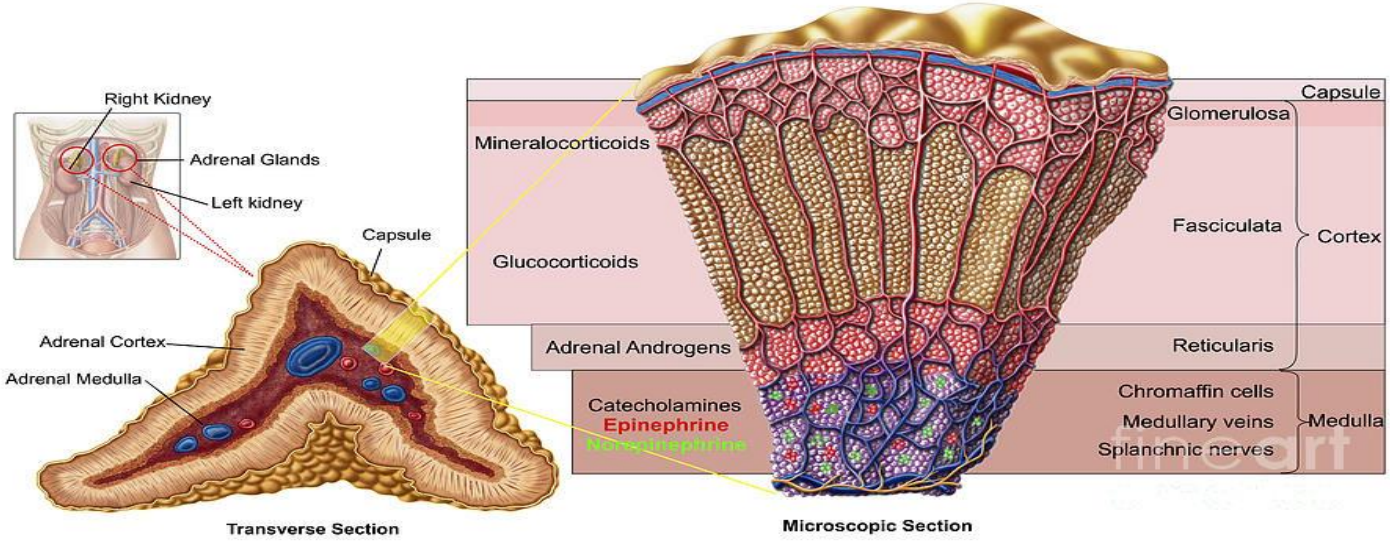
1. Parathyroid hormone (PTH)
2. 1,25 –dihydroxycholecalciferol (DHCC) , it is the active form vitamin D
3. Calcitonin : it is secreted by special cells in thyroid gland called clear cells(C- cells)

- **The target organs of these hormones are**
    1. Bone
    2. Urinary tubules of the kidneys
    3. Intestine.

- Calcitonin are secreted when there is hypercalcemia to decrease Ca level
- PTH and DHCC are secreted when there is hypocalcemia to increase Ca level.



Adrenal glands



There are two adrenal glands, one above each kidney. The outer portion of each gland is called the adrenal cortex; the inner portion is called the adrenal medulla.

Histologically , the glands consist of **cortex** and **medulla** .

The adrenal cortex has three layers:

1. **The outer layer** is secretes **Aldosterone.**
2. **The middle layer** is secretes **Cortisol.**
3. **The inner layer** is **(Sex hormones)** androgen and estrogens in both sexes.

Aldosterone

- **Their target organs are mainly :**
    1. Renal tubules
    2. Sweat glands
    3. Intestine.

- **The effects of aldosterone on its target organs**:
  keep the level of sodium and potassium in blood within normal limit by increase reabsorption of the sodium and secretion of potassium.

- **The effects of Cortisol**

.

- **Effect of cortisol on carbohydrates metabolism:** Elevated blood glucose

The adrenal medulla is the center of the adrenal gland.

It secretes catecholamine hormone (epinephrine (80%) and non-epinephrine (20%)).

Hormones of adrenal medulla-

- The hormones secreted by the adrenal medulla are called catecholamine and include adrenaline and noradrenalin.
- . The catecholamines increased the peripheral resistance and cause, thus increase blood pressure.

Pancreas

The pancreas is located close to the stomach in the abdominal cavity. It contains both exocrine and endocrine cells.

- **The exocrine cells** release digestive enzymes into the duodenum via the pancreatic duct.
- **The endocrine cells** release hormones into the blood stream. The endocrine portion of the pancreas called islets of Langerhans which contain 4 distinct types of cells, but we are just going to look at the main two.

1. Alpha cells: secrete **glucagons.**

- **Action**: increases blood glucose levels.
  Its primary target organ is the liver, which is stimulated to breakdown the stored glycogen to glucose and to release the glucose into the blood stream .

2. Beta cells: secretes **insulin**

- **Action**: decreases blood glucose levels**.**
- **Body cells**: stimulate the uptake of glucose and its conversion into glycogen.
- **Liver cells**: stimulate the conversion of glucose into glycogen.

CONTROL AND REGULATION OF SECRETION OF INSULIN:

- B- cells of islets of Langerhans are highly sensitive to glucose level in blood,
- After the meals, increase in glucose level will stimulate the B-cells to secrete insulin to deal with this excess of glucose.
- In **contrast** ,hypoglycemia inhibits the B-cells to secrete insulin