Al-Noor University College.
Dentistry Department.
Second Stage / 2022 – 2023.
Laboratories of General Histology.

# NERVOUS TISSUES

## Practical Lab. 11

Made by:

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# Nervous tissue

Nervous tissue consist of two types of constructional units.

**1- Neurons:**

- Able to warning.
- Forming nervous signals and transmit it.

**2- neuroglia:**

- Support neurons and protect it.

# Neurons

A typical neuron has all the parts that any cell would have, and a few specialized structures that set it apart. The main portion of the cell is called the **soma** or **cell body**. It contains the **nucleus**, which contains the genetic material in the form of chromosomes.

# Neurons

- The most important specialized structures in the cell body are "**Nissl bodies**" that its bestrewed granules in cell body and didn't found in the axon.
- **Origin:** **rough** endoplasmic reticulum.
- **Structure:** **RNA** (most important Structure).
- **Function:** aliment to the cell during activity.

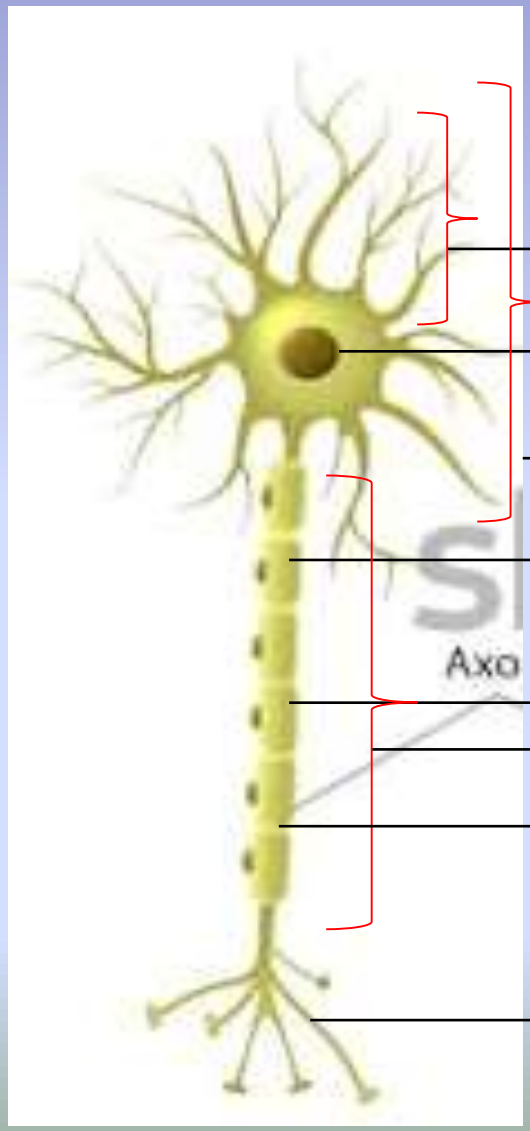
# Neurons

- Neurons have a large number of extensions called **dendrites.**
- One extension is different from all the others, and is called the **axon**. The purpose of the axon is to transmit an electro-chemical signal to other neurons. Longer axons are usually covered with a **myelin sheath**, a series of fatty cells which have wrapped around an axon many times. They serve a similar function as the insulation around an electrical wire.

# Neurons

- At the very end of the axon is the **axon ending**. It is there that the electro-chemical signal that has traveled the length of the axon is converted into a chemical message that travels to the next neuron.

# Neurons



**Dendrites**

**Nucleus**

**Soma** or **Cell body**

**Schwann cell**

**Myelin sheath**

**Axon**

**Node of Ranvier**

**axon ending**

# Types of neurons

## A. According to their shapes (axons):

### 1. Unipolar neurons:

These have two axons, One axon communicates with the spinal cord; one with either the skin or muscle. (Examples are dorsal root ganglia cells).

### 2. Bipolar neurons:

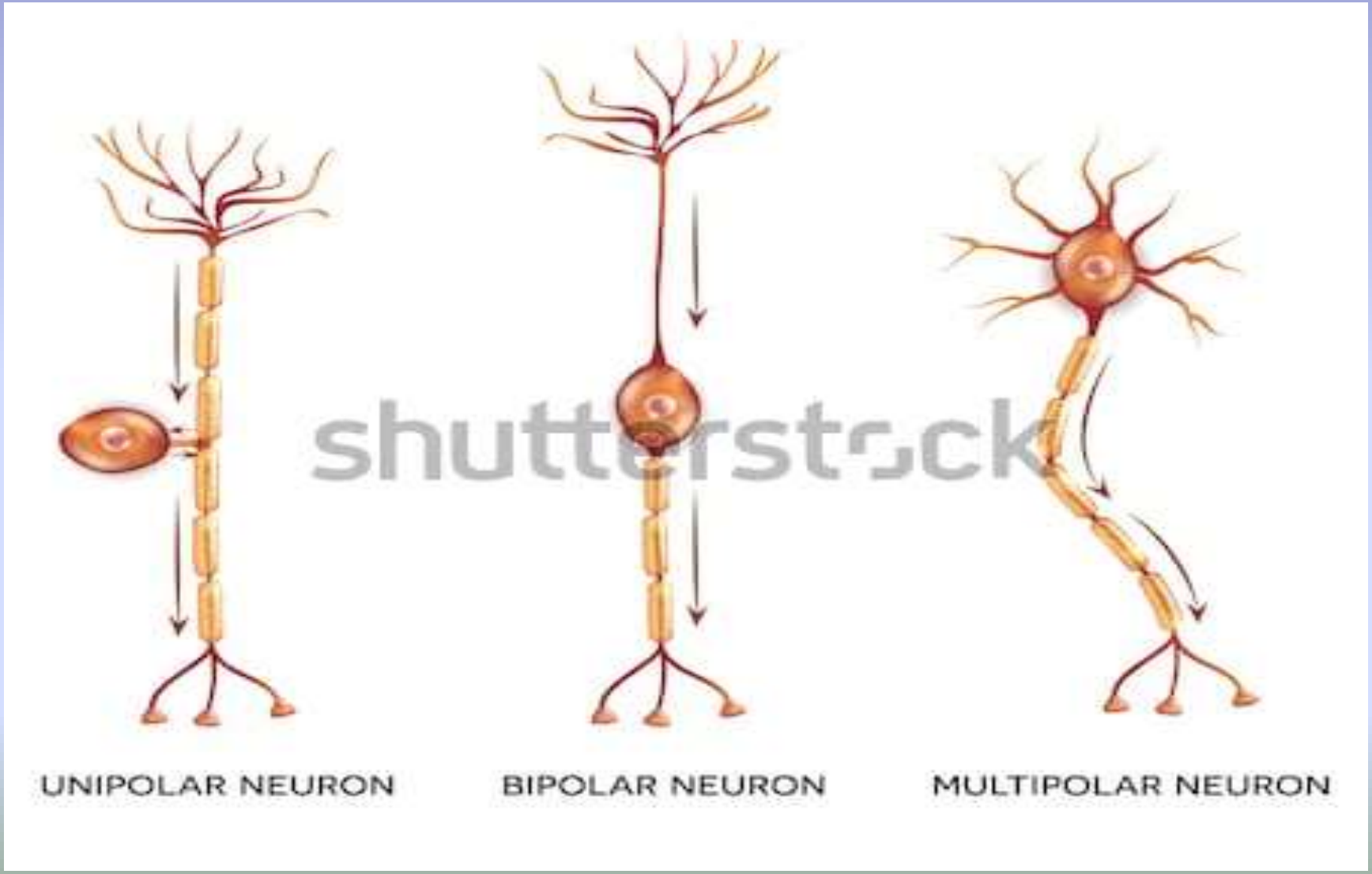
Carry messages from the body's sense receptors (eyes, ears, etc.) to the CNS. (Examples are retinal cells, and olfactory epithelium cells.)

# Types of neurons

## 3. Multipolar neurons:

Carry signals from the CNS to the muscles and glands. (Examples are spinal motor neurons, pyramidal neurons, and Purkinje cells).

# Types of neurons



# Types of neurons

## B. According to their functions :

### 1. Sensory neurons:

Transmit signals from organs of the body to CNS.

### 2. Locomotors neurons:

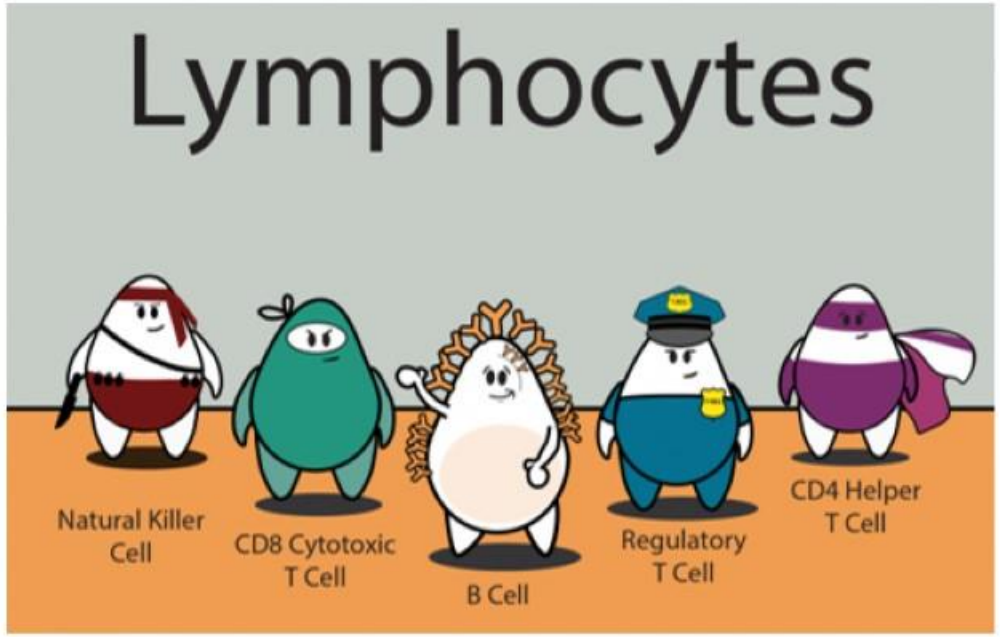
Transmit signals from CNS to muscles.

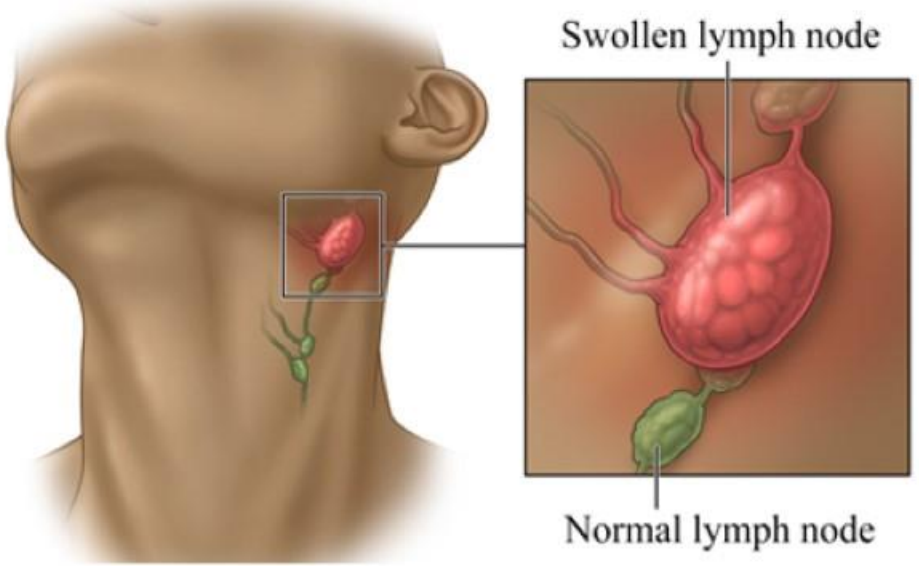
### 3. Intermediate neurons:

Arriving between locomotors neurons and sensory neurons.


Any Questions ???

# General Histology
# SECOND STAGE
# DENTISTRY DEPARTMENT
# Lymphoid system



# Immune (lymphatic) system

The body defends itself against microorganisms and foreign bodies by non-specific and specific defense mechanisms.

**a) The non-specific defense mechanisms include**:

-*Surface protection*: e.g. keratin of the skin, mucous on the mucous membranes of alimentary, respiratory, urinary and genital passages.

***-Acute inflammation*** :This is a sequence of events that occur in the same manner whatever the cause is.

**b) The specific defense mechanism is known as immunity.**

**Immunity** is the ability to distinguish between ones own molecules (self) and foreign (non-self) substance or antigen, and inactivation or destruction of this antigen.

**So, the immune response** to a specific antigen comprises two processes:

1- Recognition of the specific antigen (non-self) and its cellular source.

2- Promotion for elimination of such antigen and/or its source from the body.

# Immune (lymphatic) system

**Types of immune response**:

**1- Primary immune response**: when the antigen enters the body for the first time.

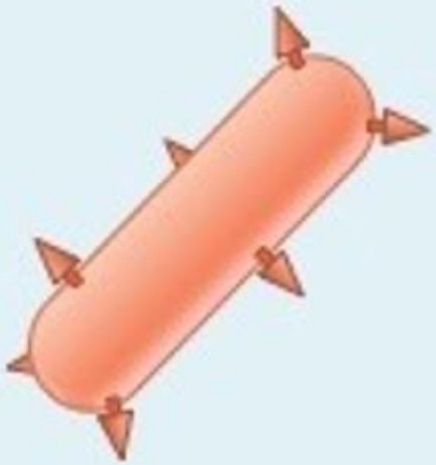
**2- Secondary immune response:** when the same antigen enters the body again.

- The immune response is performed by the immune system.

The immune system; comprises structures and cells that are distributed throughout the body. Lymphocytes are the main immuno-competent cells present giving the system its name as lymphoid system.

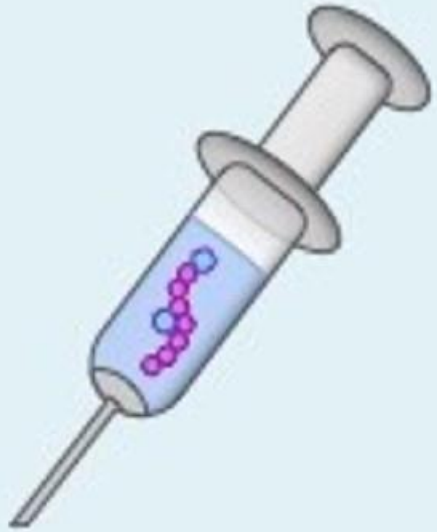
## ACTIVE IMMUNITY

### Natural



Infection

### Artificial



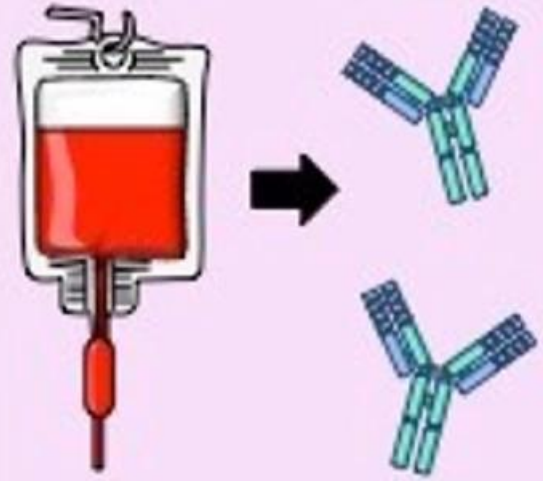
Vaccination

## PASSIVE IMMUNITY

### Natural

Maternal antibodies

### Artificial



Monoclonal antibodies

# The immune (lymphoid) system includes:

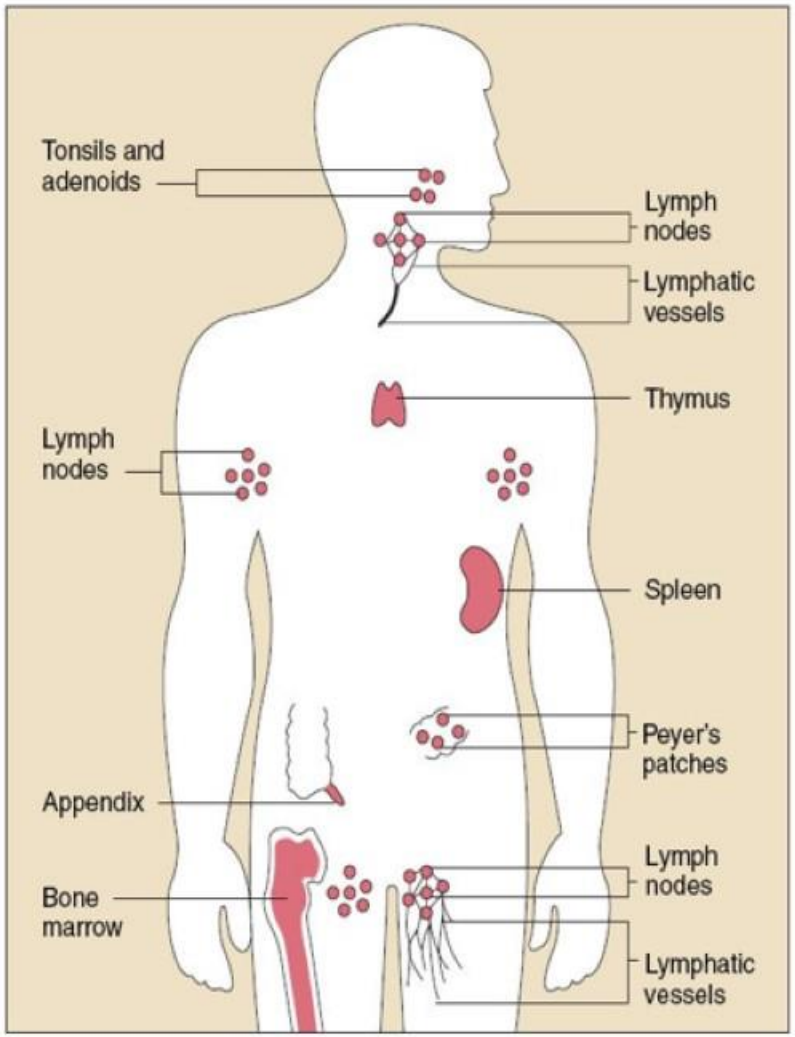
**1- Lymphoid organs:**

a) Encapsulated (spleen, thymus and lymph nodes)

b) Unencapsulated (tonsils, Peyers patches, lymphatic nodules in the walls of alimentary, respiratory, urinary and genital tracts).

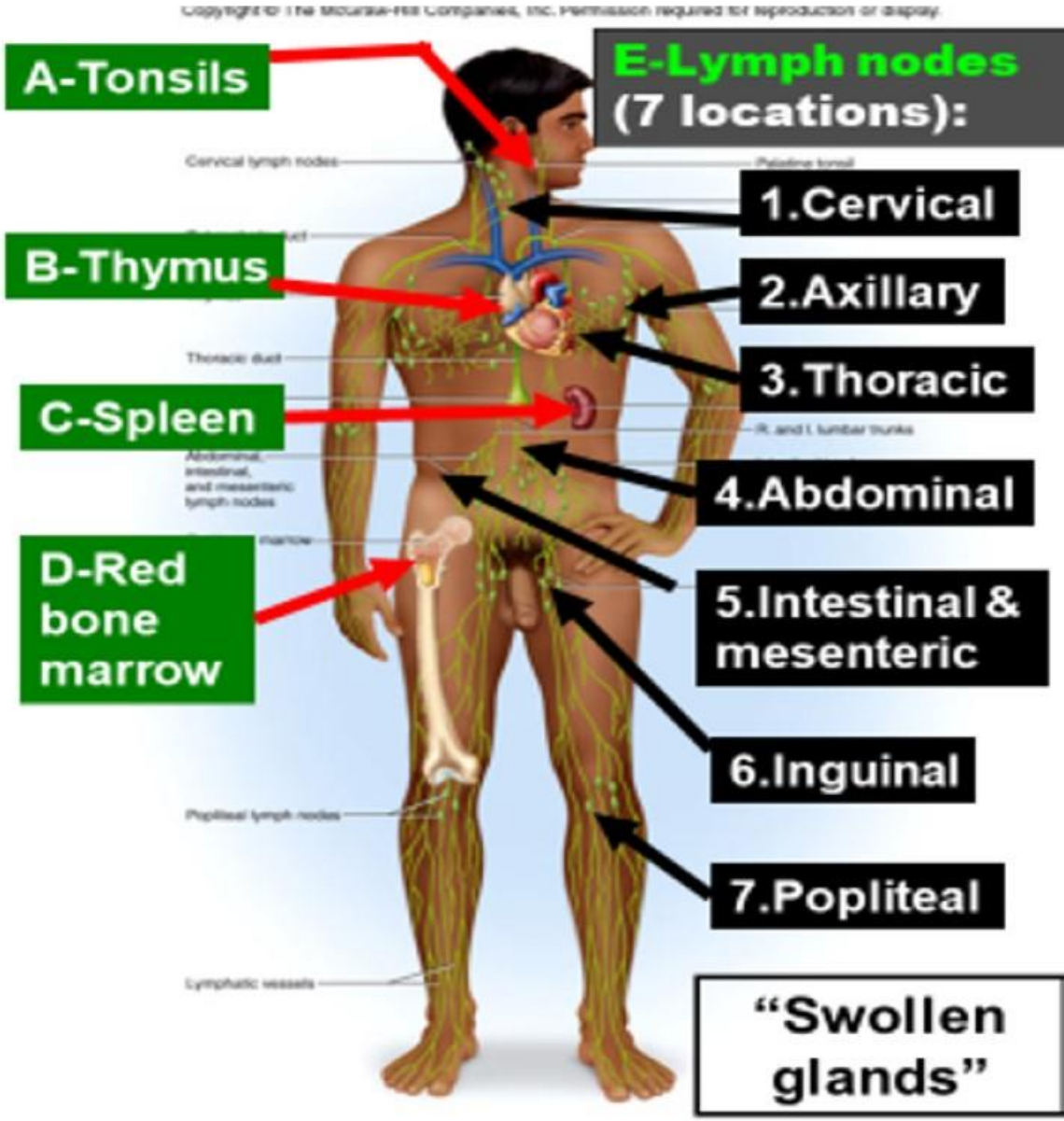
**2- Free cells:**

T and B lymphocytes **(**are the main immuno-competent cells present giving the system its name as lymphoid system), antigen presenting cells, and cells of the mononuclear phagocyte system present in the blood, lymph and connective tissue.



- 5 lymphatic organs– (A-E)

The thymus and bone marrow are called **central lymphoid organs** from which T & B lymphocytes originate respectively then migrate to the other lymphatic organs that are known as **peripheral lymphoid organs** (e. g. spleen, lymph nodes, tonsils, etc…).



**There are two different, but related, mechanisms of immune response:**

1- ***Cellular (cell–mediated) immunity;*** in which T-lymphocytes interact with and destroy microorganisms and foreign cells (e.g. tumor cells, virus infected cells).

2- ***Humeral (antibody–mediated) immunity;*** in which B-lymphocytes differentiate into plasma cells that produce specific antibodies that inactivate or destroy the foreign substance (antigen).

Both mechanisms need the cooperation of each other and of other cells as antigen presenting cells (cells which identify the antigen) and macrophages (which complete its destruction).

# B- Lymphocytes

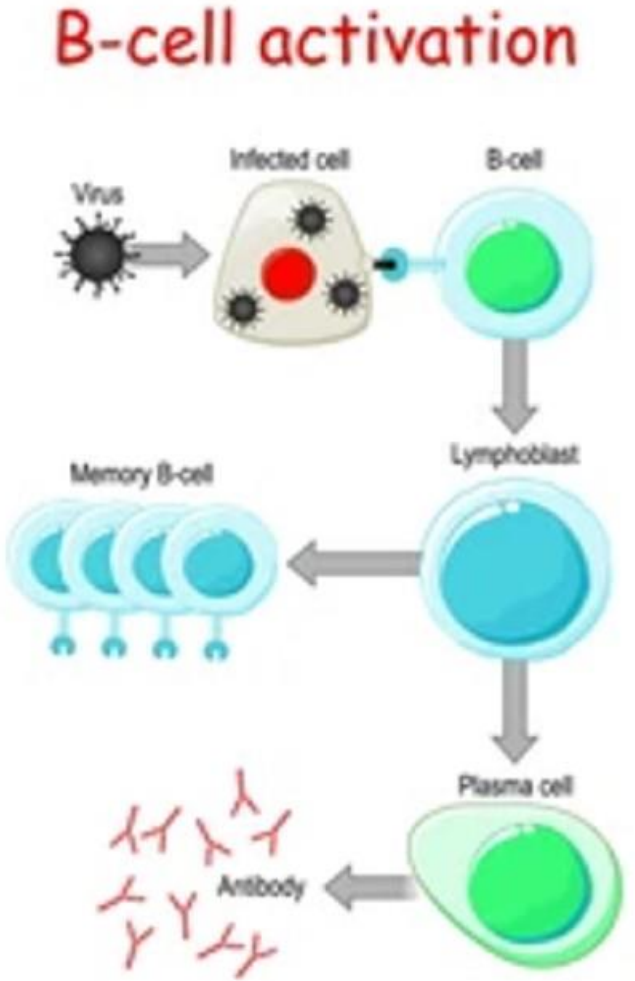
Originate from the bone marrow in man.

When activated by an appropriate antigen, they differentiate into plasma cells and B-memory cells.

Plasma cells produce antibodies that inactivate micro-organisms and their toxins.

This process is called humoral immunity.

***Humeral (antibody–mediated) immunity;*** in which B-lymphocytes differentiate into plasma cells that produce specific antibodies that inactivate or destroy the foreign substance (antigen).



## Antigen

- It is a substance that produces an immune response (cellular, humeral or both).

## Antibodies

- They are circulating plasma proteins (immunoglobulins, gamma-globulins) secreted by plasma cells that arise from B–lymphocytes.

- There are five classes of antibodies in the human:

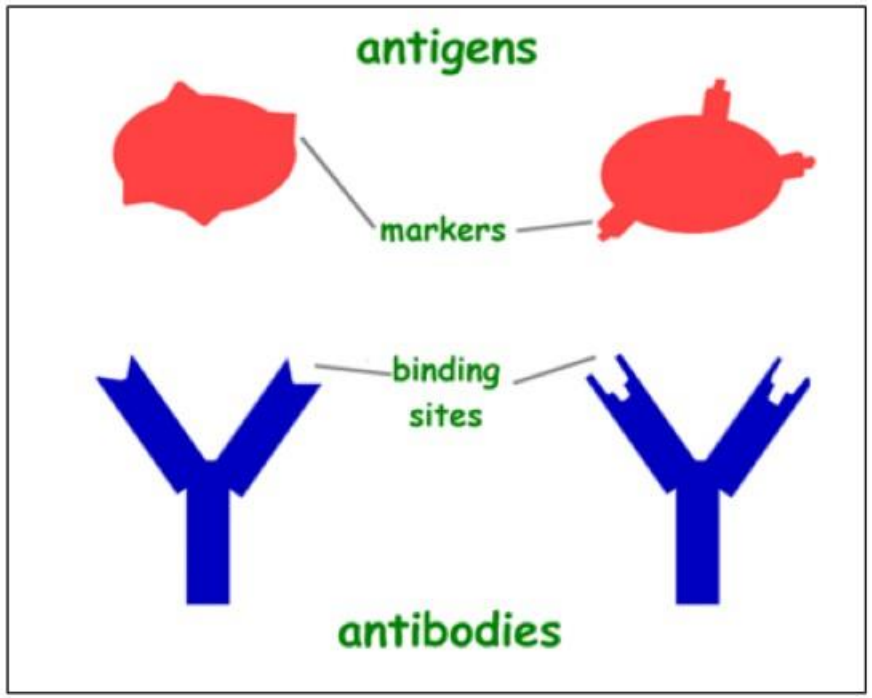
**1- IgG** (Immunoglobulin G)

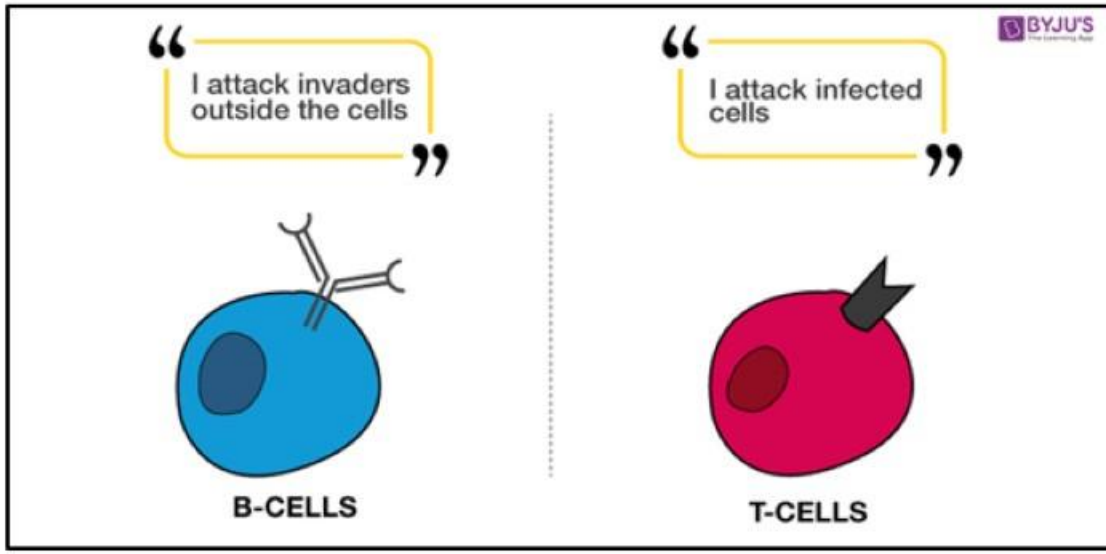
**2- IgA**

**3- IgM**

**4- IgE**

**5- IgD**



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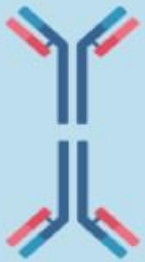
# 5 Types of Antibodies

Antibodies or immunoglobulins (Ig) are Y-shaped proteins that recognize unique markers (antigens) on pathogens.



**IgA**

Secreted into mucous, saliva, tears, colostrum. Tags pathogens for destruction.

**IgD**

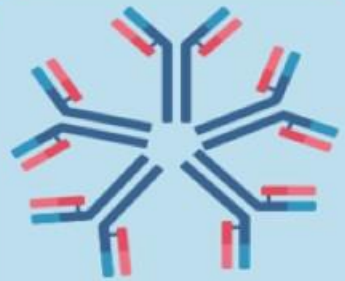
B-cell receptor. Stimulates release of IgM.

**IgE**

Binds to mast cells and basophils. Allergy and antiparasitic activity.

**IgG**

Binds to phagocytes. Main blood antibody for secondary responses. Crosses placenta.



**IgM**

Fixes complement. Main antibody of primary responses. B-cell receptor. Immune system memory.

# T-Lymphocytes

Develop in the thymus. When activated by an appropriate antigen, they differentiate into:-

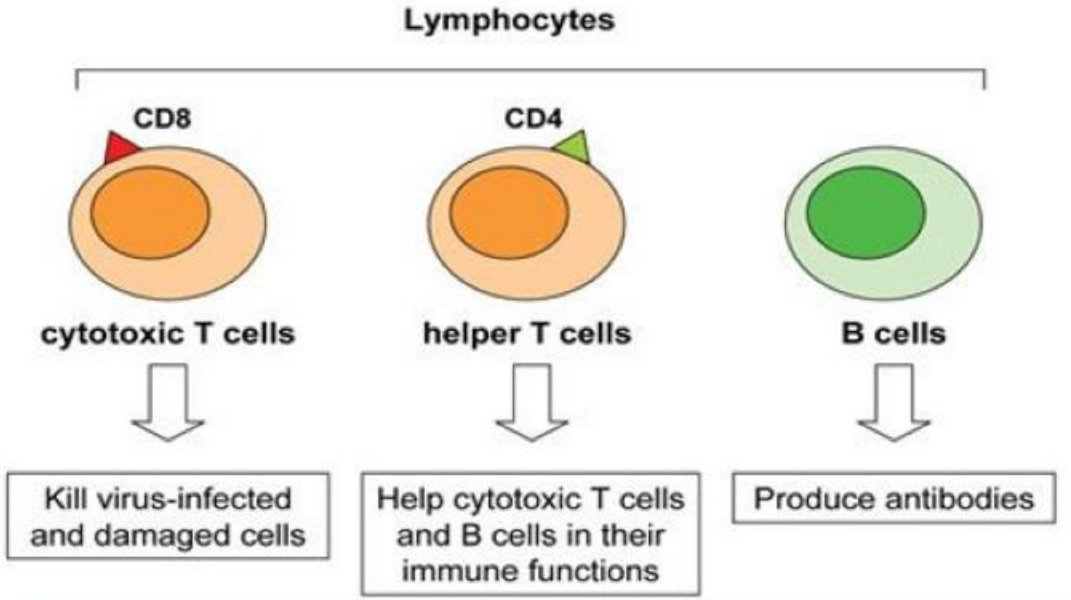
**1- Cytotoxic (Killer) cells:** will secrete protein called perforins which perforate the cell membrane of foreign cells, virus infected cells or tumour cells and lyses them.

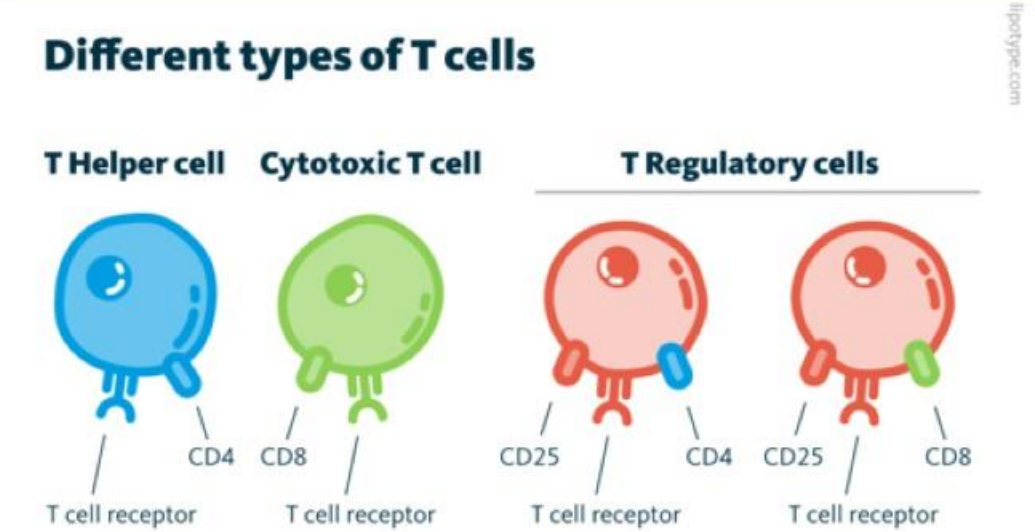
**2- Helper T- cells:** activate both B- and T- cells.

**3- Suppressor T- cells:** interfere with the immune response.

**4- Memory cells:** When the same antigen enters the body again, memory cells will react against it immediately but more extensively in the same way.

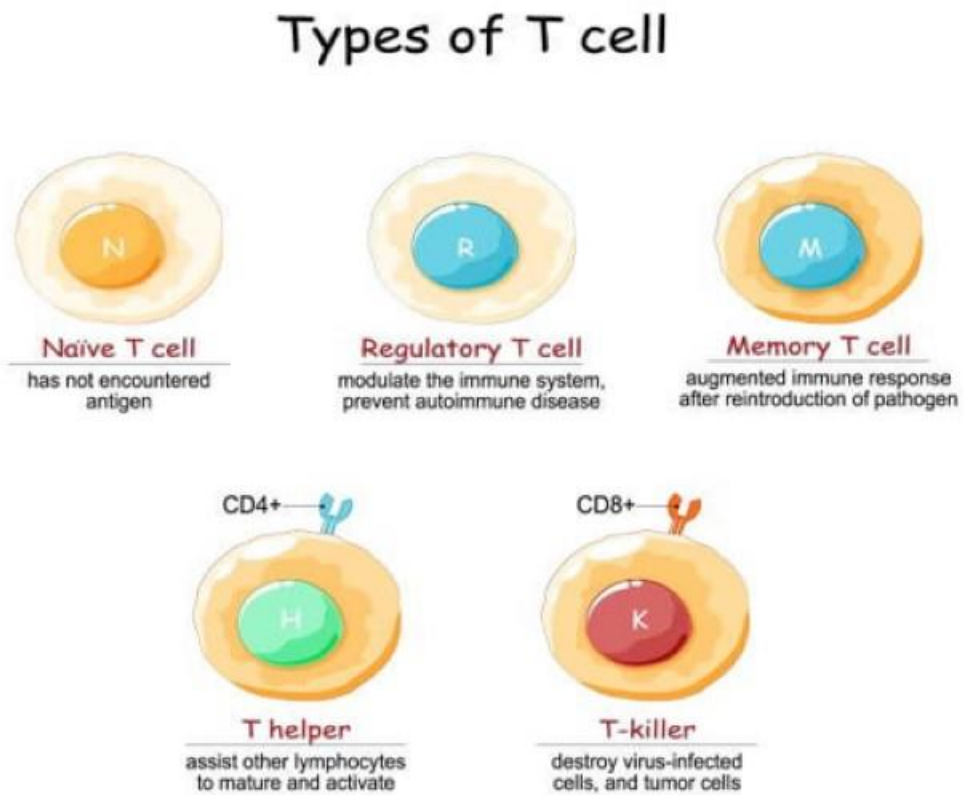
This process is called **cellular immunity.**



# T-Lymphocytes

***Cellular (cell–mediated) immunity;*** in which T-lymphocytes interact with and destroy microorganisms and foreign cells (e.g. tumor cells, virus infected cells).

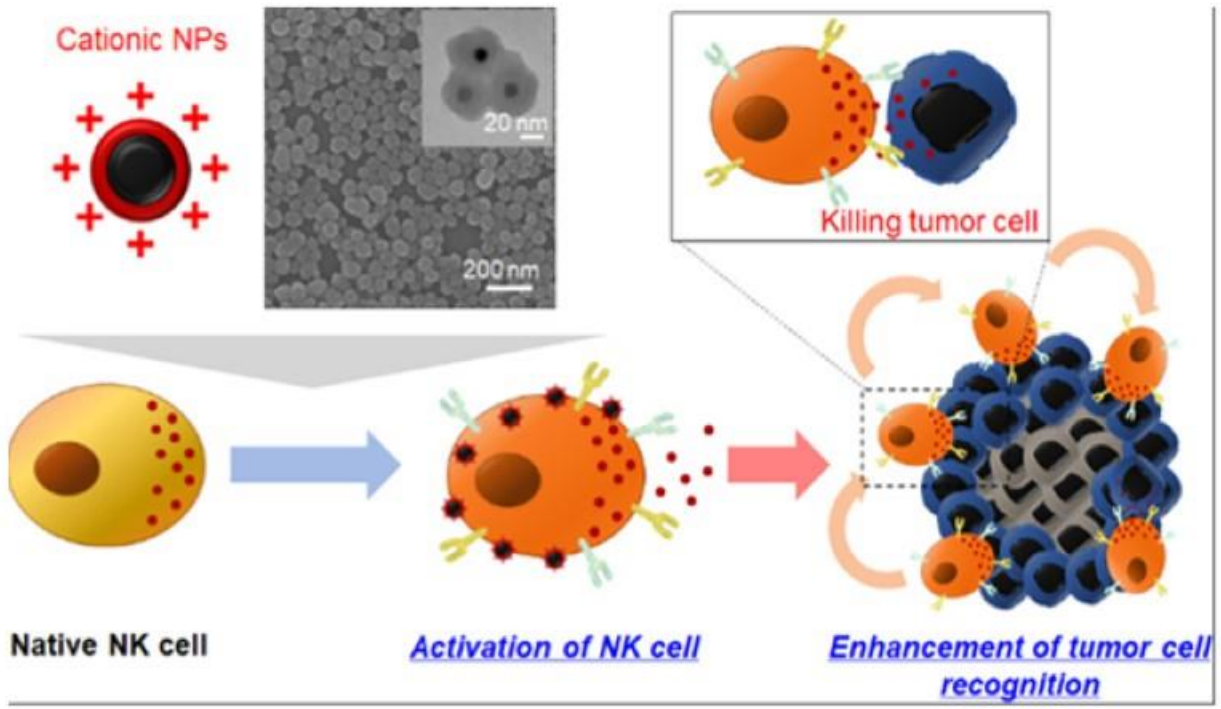


# Natural killer (NK) cells :

- They are lymphocytes that lack the marker molecules characteristic of B and T cells and act non specifically.

- They may have an important role in killing virus infected cells without previous activation.

- They also take part in immunologic defense against cancer by killing malignant cells.

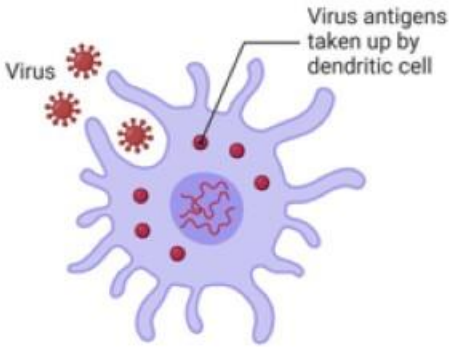


# Antigen presenting cells :

- They are derived **from the bone marrow.**
- They have the ability to make antigen processing, i.e. ingest the antigen, and partially digest them into peptide fragments.
- They carry the peptide fragments on their surface and present them to T-lymphocytes promoting their selective activation, whereas B-cells can directly recognize proteins and other antigens.
- They include macrophages, epidermal Langerhans' cells, dendritic cells of lymphatic organs, epithelial reticular cells of the thymus, and microglia of C.N.S.

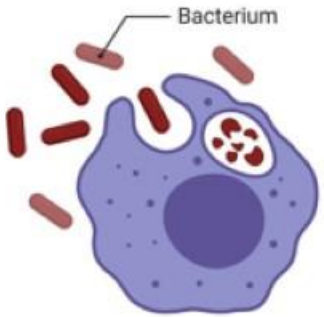
# Different Types of Antigen Presenting Cells

**Dendritic cell**



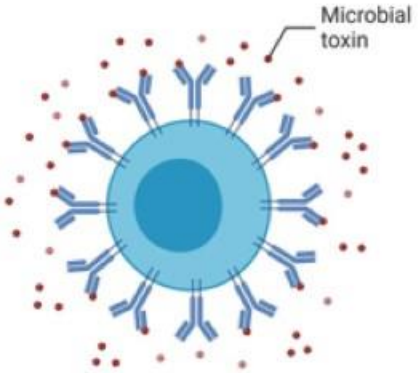

Viruses infecting dendritic cell

**Macrophage**

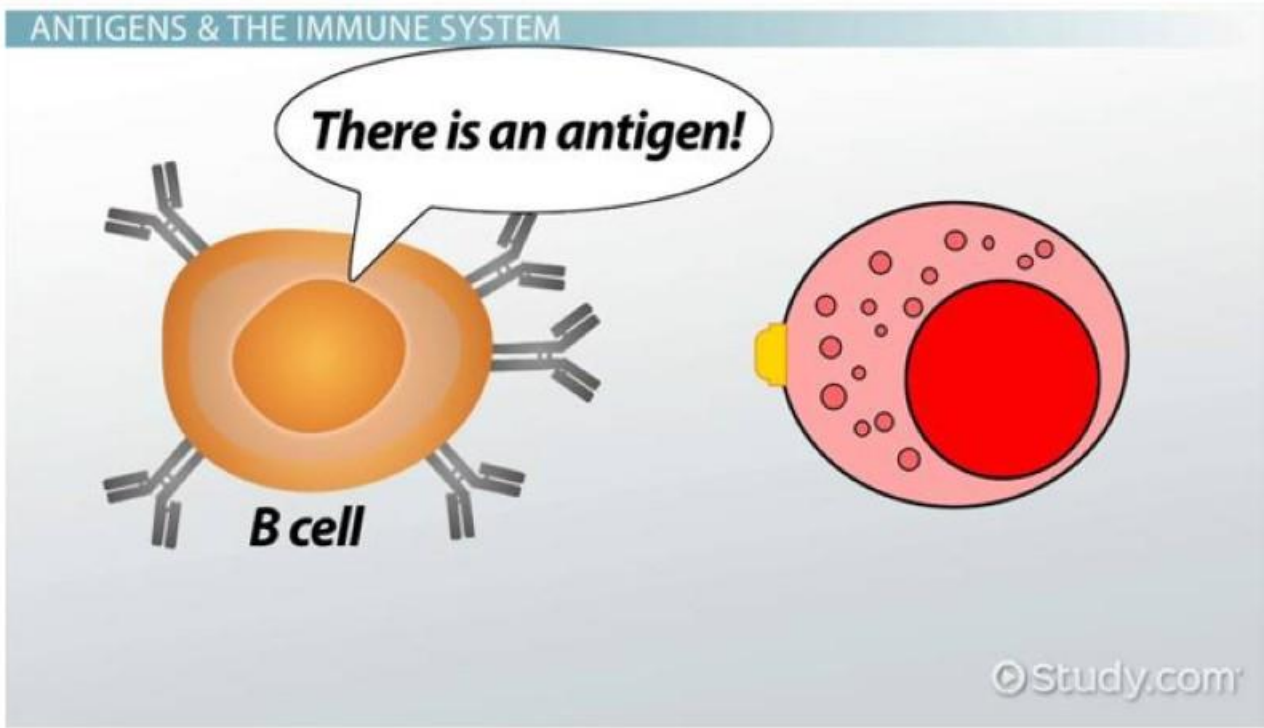



Bacteria infecting macrophage

**B cell**




Microbial toxins binding to B-cell receptors

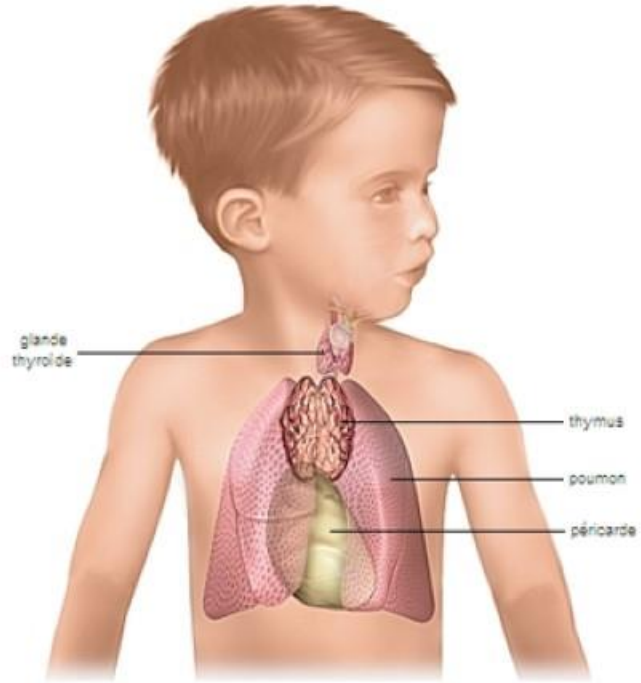


- **The B&T memory cells** may remain in the lymphatic tissue for long time, during which they can proliferate, so maintain or even increase their number.
- When they encounter the same antigen again, they produce the secondary immune response which will be stronger and faster than the primary one.
- **The lymph:**

The extravasated fluid that did not enter the circulation again is collected by blind–ended lymphatic capillaries and passes through lymphatic vessels back to the circulation.

# THYMUS

- It is a central lymphoid organ situated behind the sternum.
- It is large during fetal life and involutes after puberty.

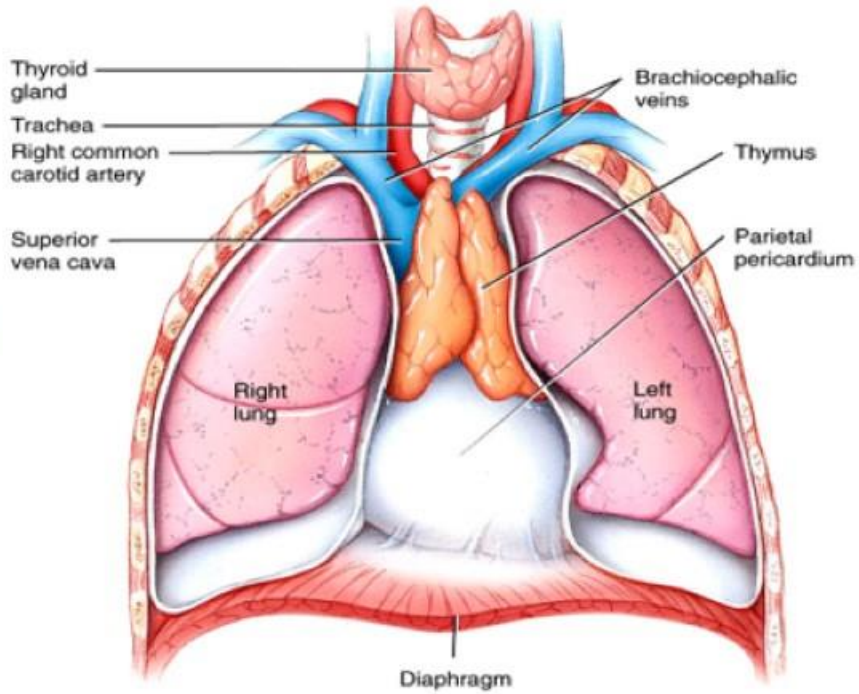



## Development

It has a double origin:

1- The lymphocytes and stromal connective tissue arise from mesoderm.

2- The epithelial reticular cells arise from endoderm of 3rd and 4th pharyngeal pouches.



# Structure

## I) Stroma is formed of:

a) Capsule of connective tissue.

b) Incomplete septa descend from the capsule dividing the organ into two lobes and incomplete lobules which are continuous with each other.

## II) Parenchyma

- Each lobule has a peripheral cortex and a central medulla.

## A – The cortex

The cortex is the peripheral dark zone passing from one lobule to the other.

It is composed of

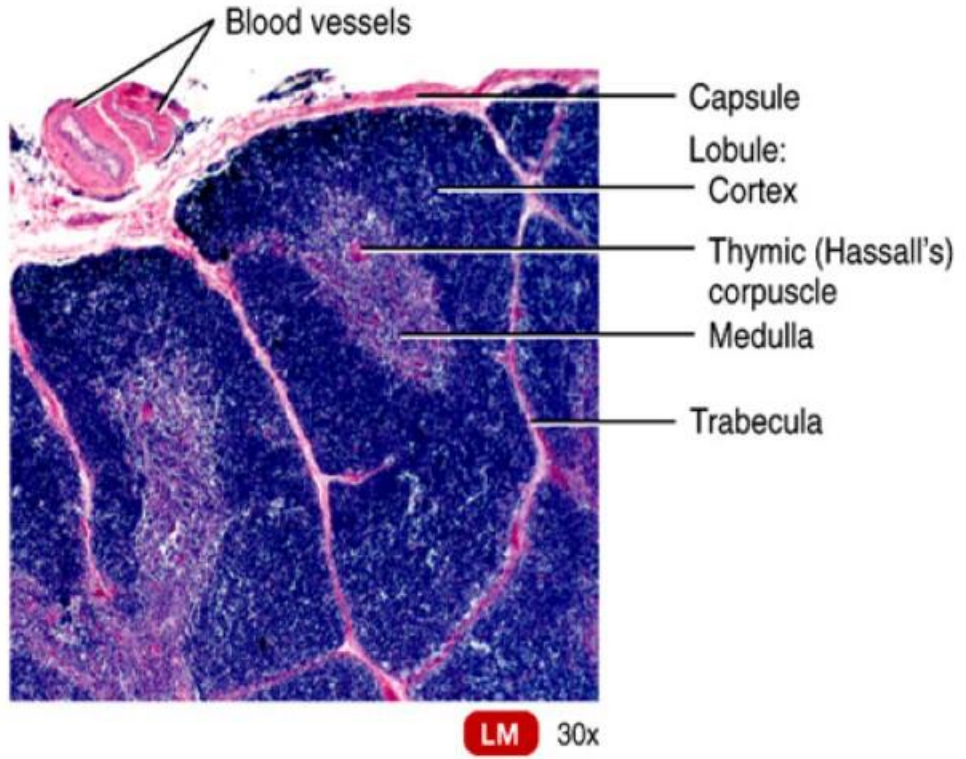
1- Small T-lymphocytes

2- Epithelial reticular cells: They are branched cells with oval lightly stained nucleus

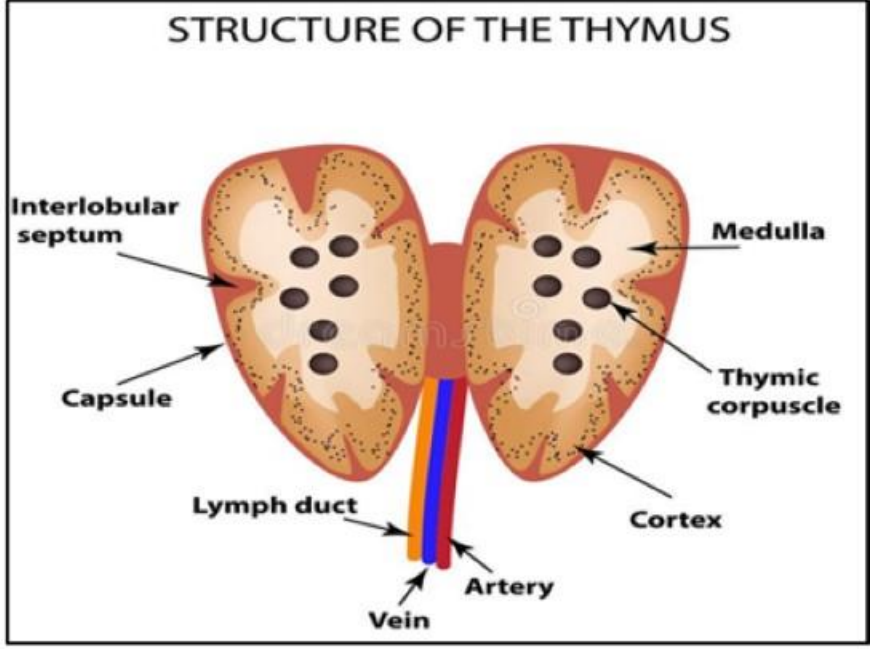
The cytoplasm has processes that extend between and around small groups of lymphocytes and are joined together by desmosomes.

3- Few macrophages.

4- Large lymphocytes.



# B – The medulla:




It is lightly stained because it contains large number of epithelial reticular cells and large lymphocytes.

- There are fewer small T- lymphocytes than in cortex.

- It contains Hassle's corpuscles which consist of concentric layers of epithelial reticular cells. The innermost cells degenerate and become filled with kertohyaline granules and cytokeratin filaments.

- There is in no blood–thymic barrier in the medulla.

# The blood- thymic barrier:

During development and programming of T- lymphocytes they are protected from foreign antigens as follows:

The thymus has no afferent lymphatics, only few efferents.

So, antigens present in the lymph don't reach the thymus.

T-lymphocytes are separated and protected from antigens present in the blood by the blood–thymic barrier, which is present in the cortex and consists of:

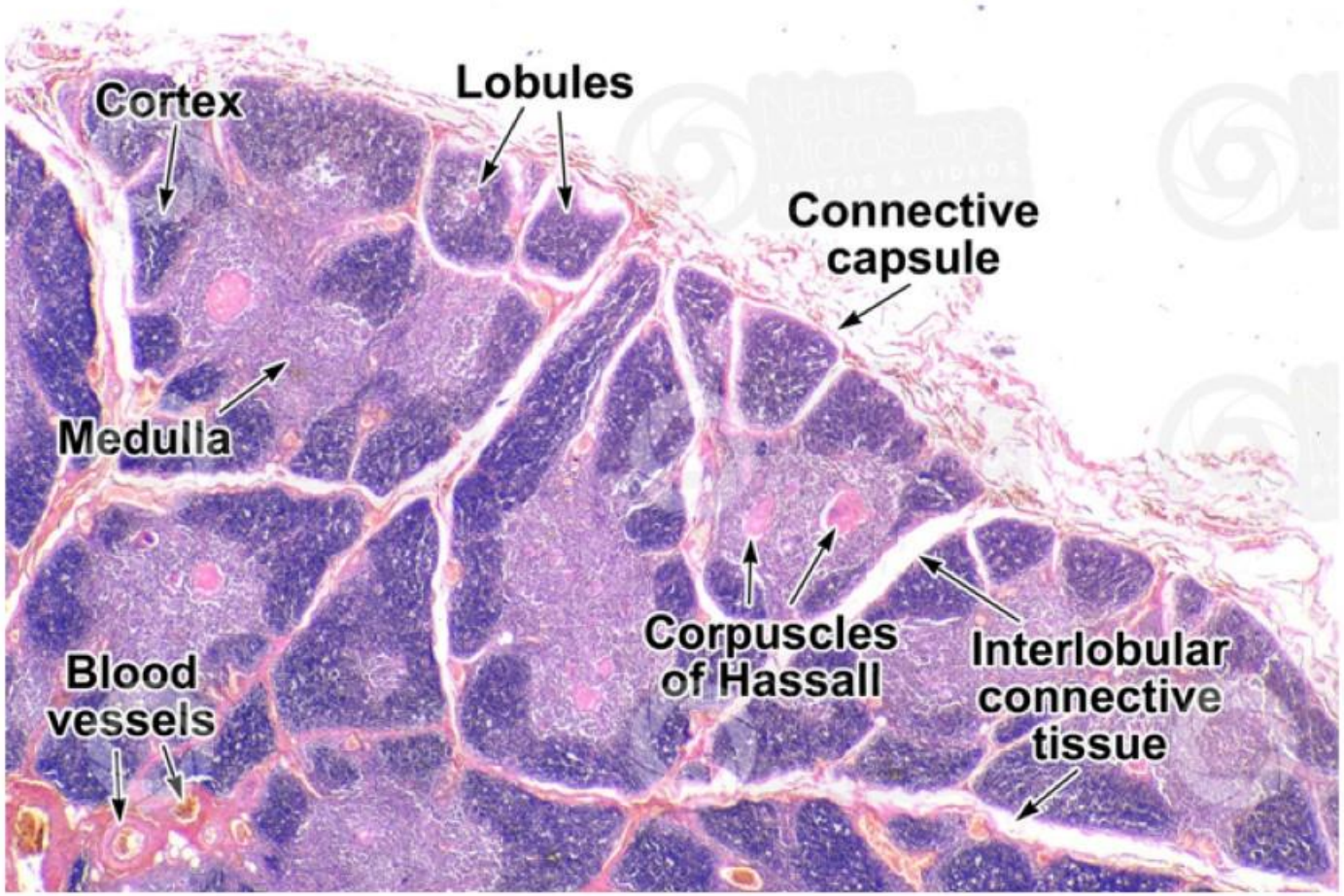
1. Continuous endothelium of blood capillaries.

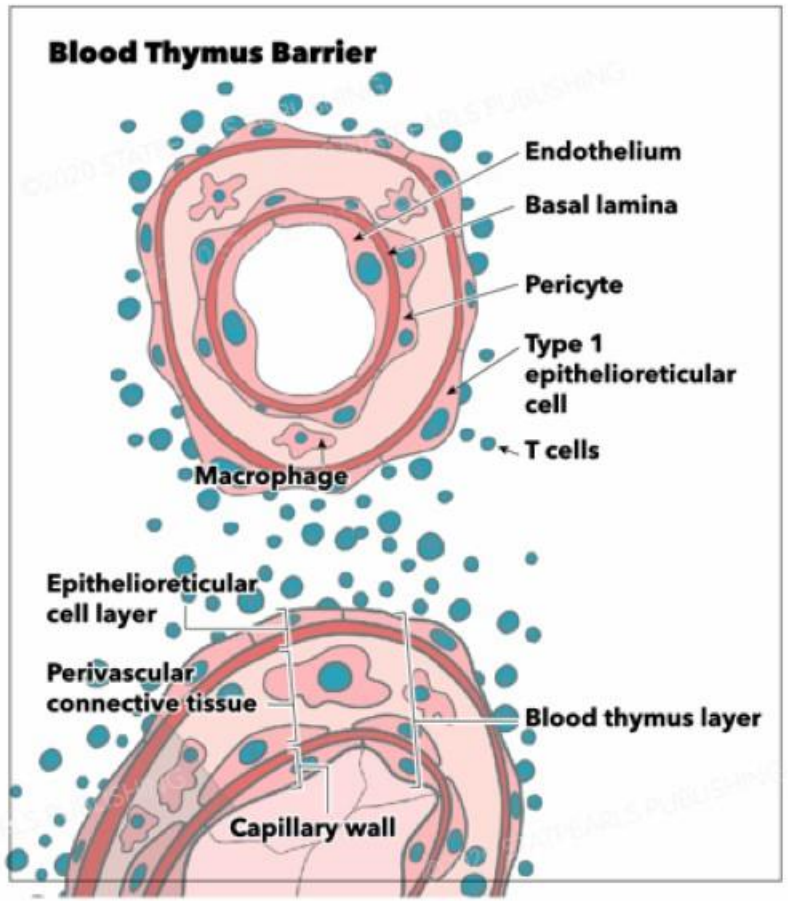
Thick basal lamina of the endothelium.

3. Small connective tissue space (may contain macrophages).

4. Basal lamina of epithelial reticular cells.

5. Epithelial reticular cells whose processes are joined together by desmosomes and form a sheath around the cortical blood capillaries.


Cortex
Lobules
Connective capsule
Medulla
Corpuscles of Hassall
Interlobular connective tissue
Blood vessels


Blood Thymus Barrier
Endothelium
Basal lamina
Pericyte
Type 1 epithelioreticular cell
T cells
Macrophage
Epithelioreticular cell layer
Perivascular connective tissue
Blood thymus layer
Capillary wall

## Effect of Hormones

1. Sex hormones, ACTH and corticosteroids → accelerate involution of thymus.
2. Growth hormone → stimulate its development.

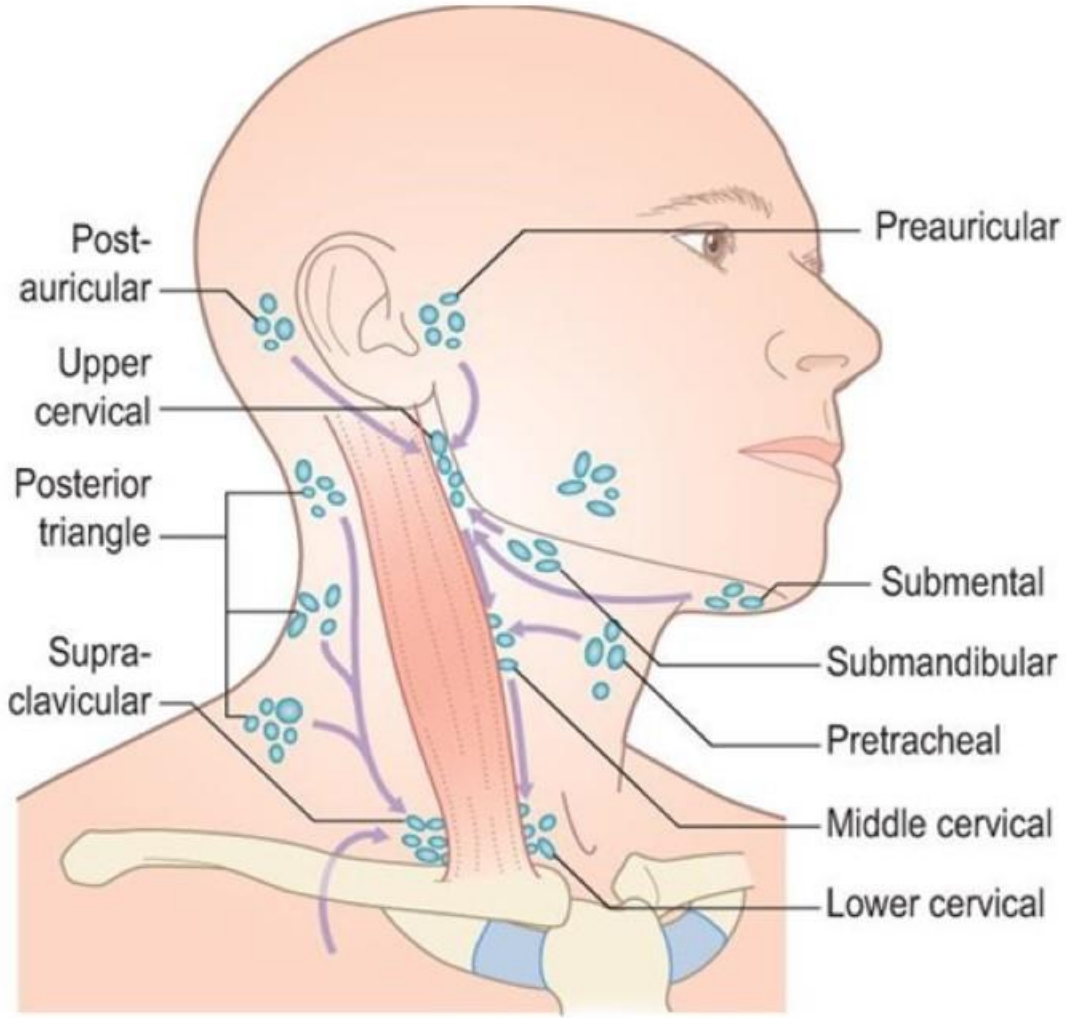
## Functions of thymus

1– Production of T-lymphocytes responsible for cellular (cell–mediated) immunity

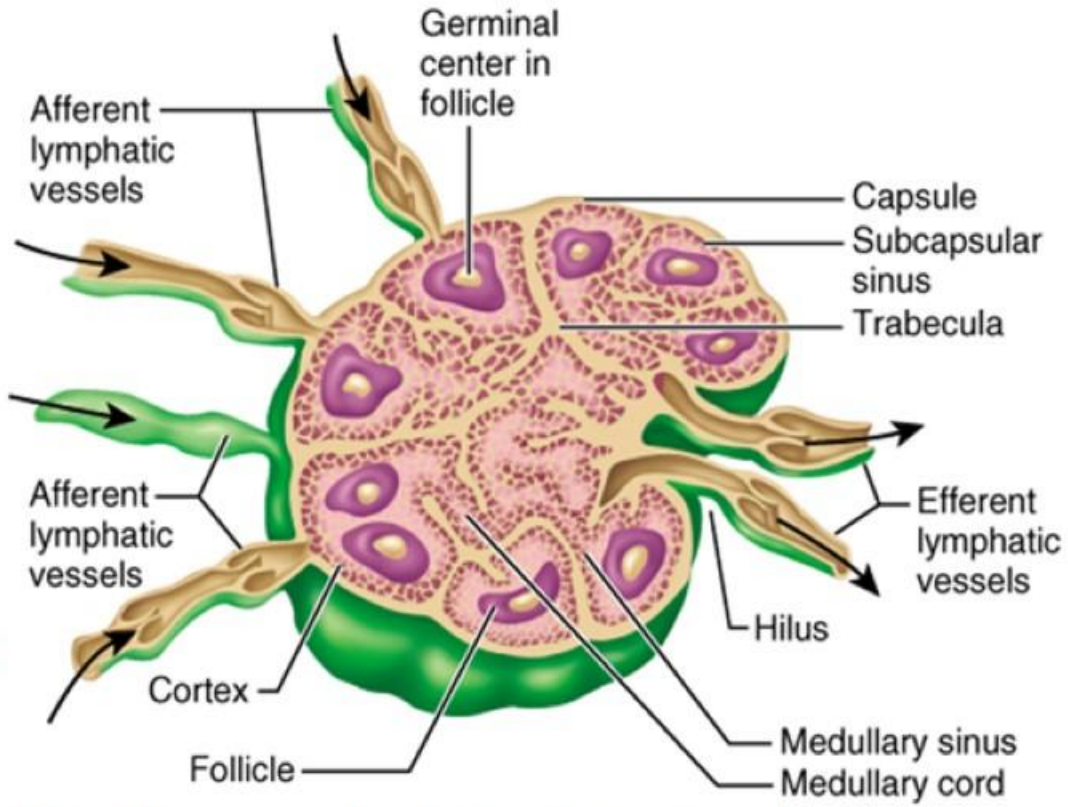
2– Production of some factors (probably by epithelial reticular cells) called thymic factors or hormones. (e.g. thymosin, thymopoeitin, thymulin), that stimulate T- cell proliferation and differentiation.

# Lymph Nodes

- Lymph nodes are encapsulated, kidney shaped or rounded lymphatic organs
- They are distributed throughout the body along the course of lymphatic vessels (neck, axilla, groin, thorax, and abdomen).
- Lymph nodes have a convex surface and a depression called hilum.
- The afferent lymphatic vessels enter the node through the convex surface and the efferent leaves through the hilum with blood vessels & nerves.



# Structure




The lymph node is composed of:

**1- Stroma** (supportive connective tissue):

a) Capsule of dense connective tissue

b) Trabeculae (septa) from the capsule divide the node into incomplete compartments.

c) Reticular network of reticular fibers and reticular cells.

**2- Parenchyma:**

It can be divided into cortex and medulla.

# A – The cortex consists of:

**1-Outer (superficial) cortex:**

- Is formed of round or oval aggregations of lymphocytes called lymphatic nodules (follicles), two types of lymphatic follicles may be present:

- **Primary lymphatic follicles**: are follicles not exposed to antigen and contains B–lymphocytes, some T-lymphocytes, macrophages, reticular cells and antigen presenting cells (follicular dendritic cells). They lack germinal centers.

- **Secondary lymphatic follicle**: when exposed to antigen, the central area of the follicle becomes paler in color and contains activated B- lymphocytes. This central area is known as germinal center.

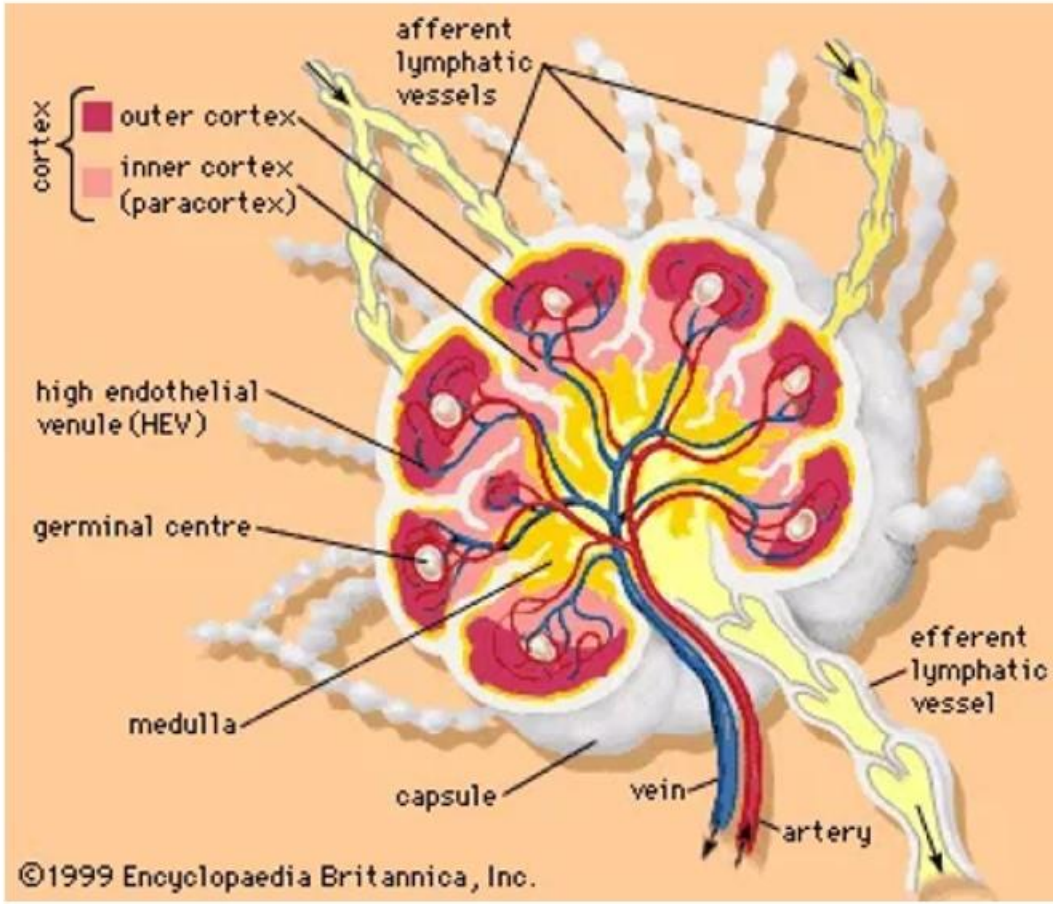
- **Activated B-lymphocytes** differentiate into plasma cells that migrate to the medulla, and memory cells. that are present around the germinal center in the mantle zone.

# 2-Inner (deep) cortex: (Para cortex)

- The deeper part of the cortex, between the outer cortex and the medulla is called paracortical zone.

- It contains high concentration of

**T-lymphocytes** derived from the thymus and so is considered as thymus dependent area.



# 3-Cortical sinuses:

Through these sinuses, lymph passes and is filtered through the lymph node.

- They are irregular spaces lined by reticular cells and macrophages.
- Under the capsule there are ***Subcapsular sinuses*** that receive lymph from the afferent lymphatics.
- ***Paratrabecular (intermediate) sinuses*** connect the subcapsular sinuses to the medullary sinuses.
- Through these sinuses, lymph passes and is filtered through the lymph node.

# B–The medulla consists of:

***1- Medullary cords***

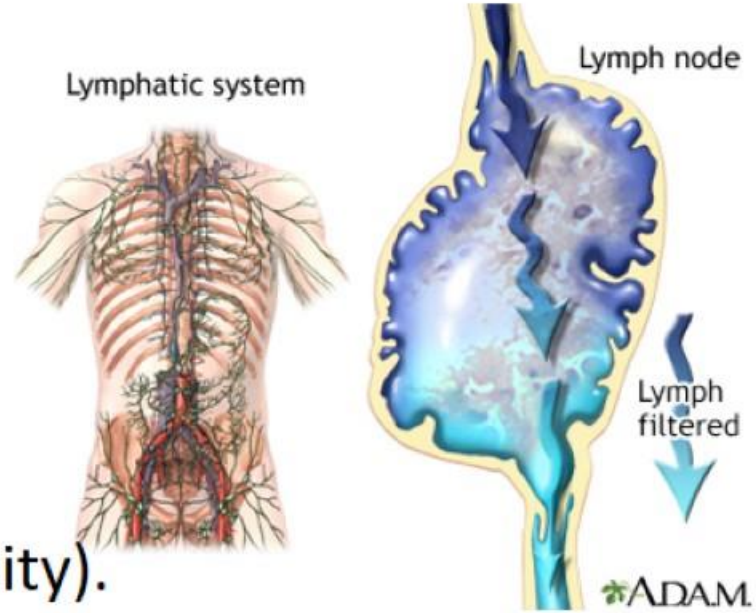
They are cord like of the lymphoid tissue composed of lymphocytes and plasma cells.

***2- Medullary sinuses***

-Receive lymph from cortical sinuses and communicate with efferent vessels through which lymph leaves the node.

-The movement of lymph through the node is unidirectional due to valves in afferent and efferent lymphatic vessels.

# Functions of lymph nodes




1–Immunological function (both cellularand humoral immunity).

2–Filtration of lymph from microorganisms.

- Each node receives lymph from limited area of the body.
- About 99% of antigens and foreign bodies are removed by phagocytoses in the sinuses.
- About 1% passes through the follicles where the bulk of antigenic material is destroyed into separate selected antigens to be presented to lymphocyte by antigen presenting cells (APCs).

# THE SPLEEN

The spleen is the largest lymphatic organ in the body

It is situated in the left side of the abdomen just beneath the diaphragm.

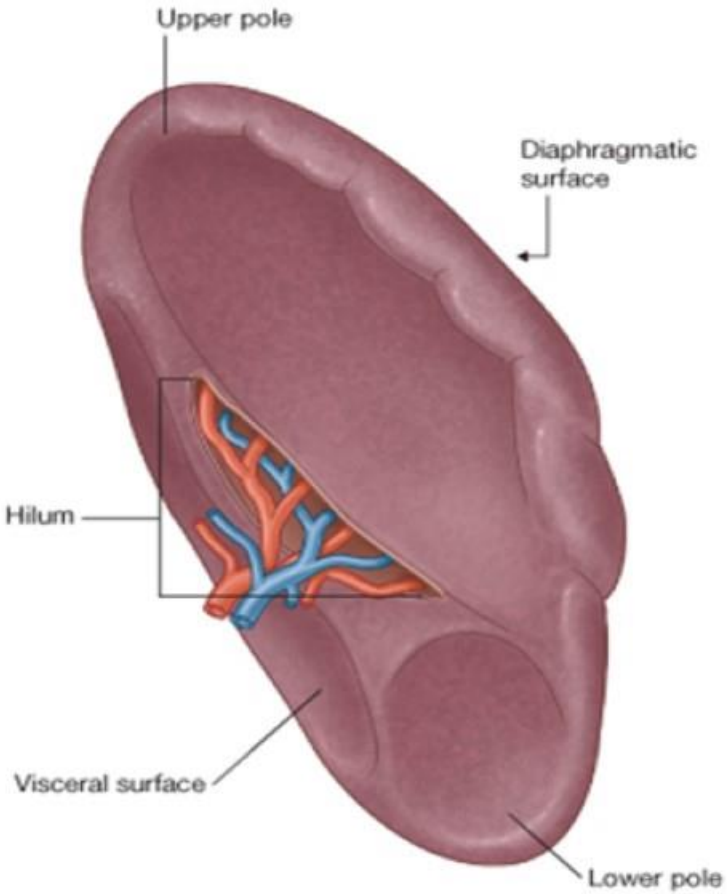
## Structure

### I) Stroma:

1- Capsule of dense connective tissue and some smooth muscle cells.

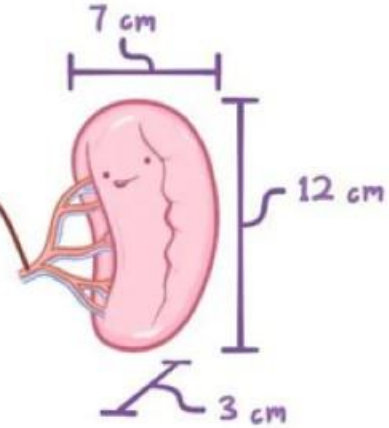
2- Trabeculae some from the capsule and others from the hilum. They are connected with each other.

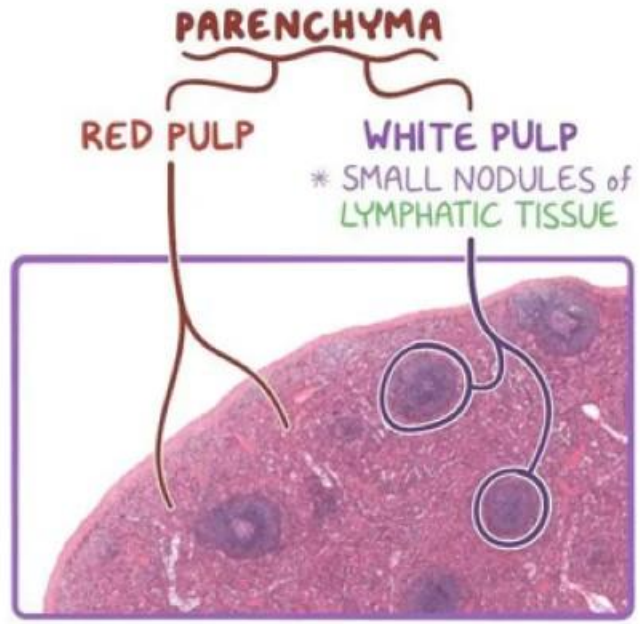
3- Reticular network formed of reticular fibers, reticular cells and macrophages.




# SPLEEN

* LARGEST LYMPHOID ORGAN
* RECEIVES BLOOD from the **SPLENIC ARTERY**
* ONLY LYMPHOID ORGAN that PRIMARILY FILTERS **BLOOD**
* ENCAPSULATED ORGAN



# II) Parenchyma (splenic pulp):-

A fresh section of the spleen shows dark red tissue (the red pulp), within which white spots (white pulp) are observed.

***I- The white pulp formed of:***

***a-The lymphoid follicles:*** Composed mainly of B- lymphocytes

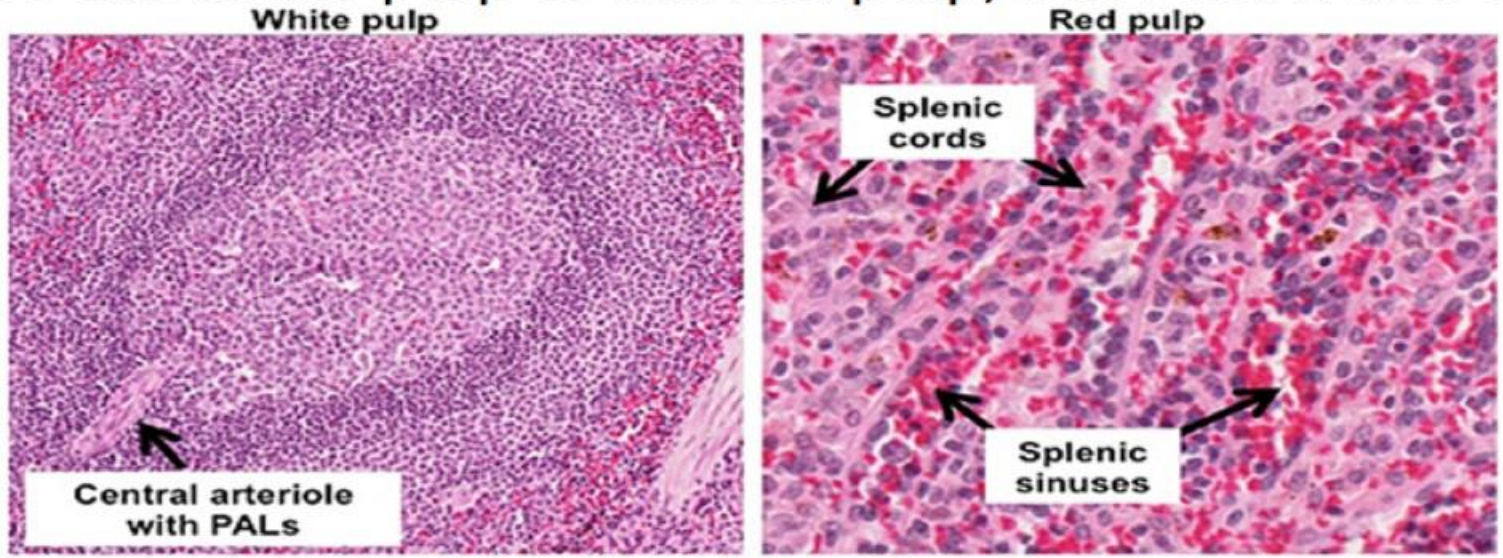
They may show germinal centers

It contains an artery called central artery that penetrates the follicles in an eccentric position.

***b- Lymphatic tissue*** which forms sheaths around the central arteries (Peri-arterial lymphatic sheaths) in the lymphatic follicles. These sheaths composed mainly of T-lymphocytes (thymus dependent area).

## *c- The marginal zone:*

- It is present between white pulp and red pulp.
- It is composed of loose lymphatic tissue and many blood sinuses around the periphery of the lymphatic follicles and periarterial sheaths.
- It contains many macrophages, B-lymphocytes, dendritic cells and some T-lymphocytes.
- The central artery gives branches that pass through the follicle and end in the blood sinuses.
- Other branches leave the white pulp to the red pulp, but return and empty in the same sinuses.



- So, these sinuses have two roles:
- Traps for antigens that are presented to lymphocytes by dendritic cells (APCs).
- Route for entry of both B- and T- lymphocytes to the white pulp from the blood.
- T-cells migrate to the periarterial lymphatic sheaths (PALs).
- Activated B-cells migrate to germinal centers where they change to plasma cells that migrate to the red pulp releasing antibodies into blood sinusoids.

# B - The red pulp

It is the major part of the spleen and appears red because it contains large number of erythrocytes. It is composed of:

## 1 – Blood sinusoids

- They are large thin walled dilated spaces containing blood.
- They are lined by discontinuous layer of elongated endothelial cells parallel to the long axis of the sinusoids with slit-shaped gaps between their lateral borders allowing exchange of cells between blood in the sinusoids and adjacent tissue.
- These cells are enveloped by reticular fibers arranged mainly perpendicular to the long axis of the sinusoids.

## *2 – The splenic (Billroth cords)*

- They are cords of cells of varying thickness between blood sinusoids.
-They contain blood elements as well as reticular cells, macrophages and plasma cells.

# Functions of the spleen:

1- Filtration of blood.

2- Cellular and humoral immunity.

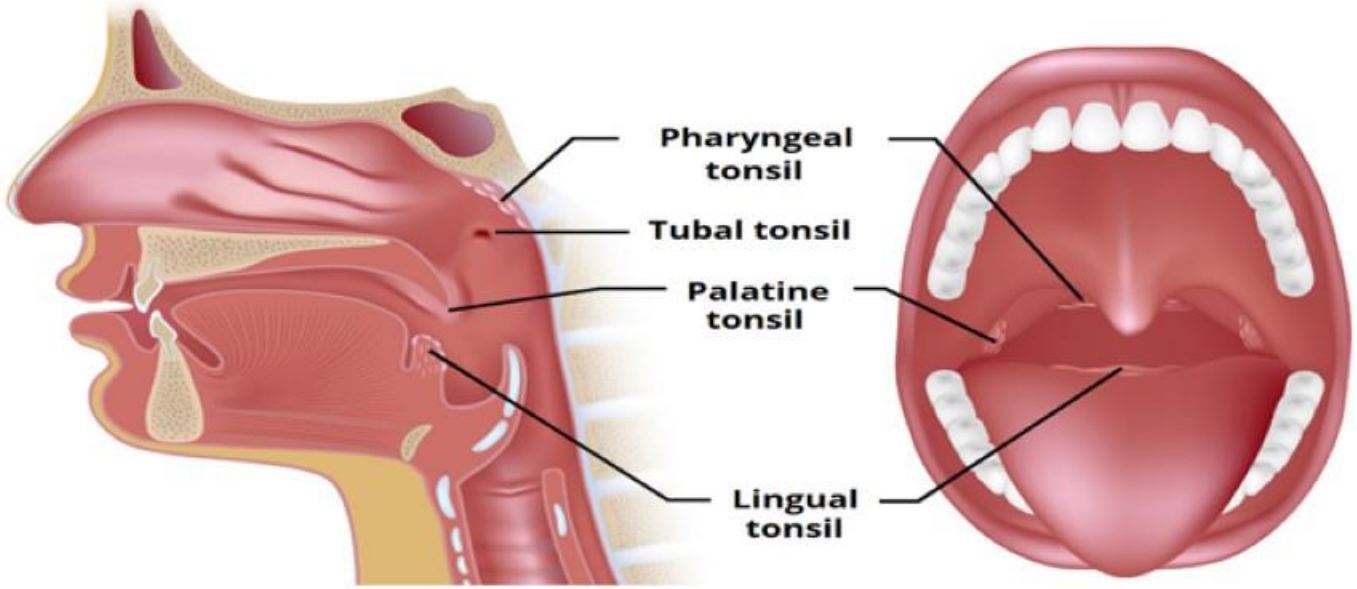
3- Destruction of old RBCs.

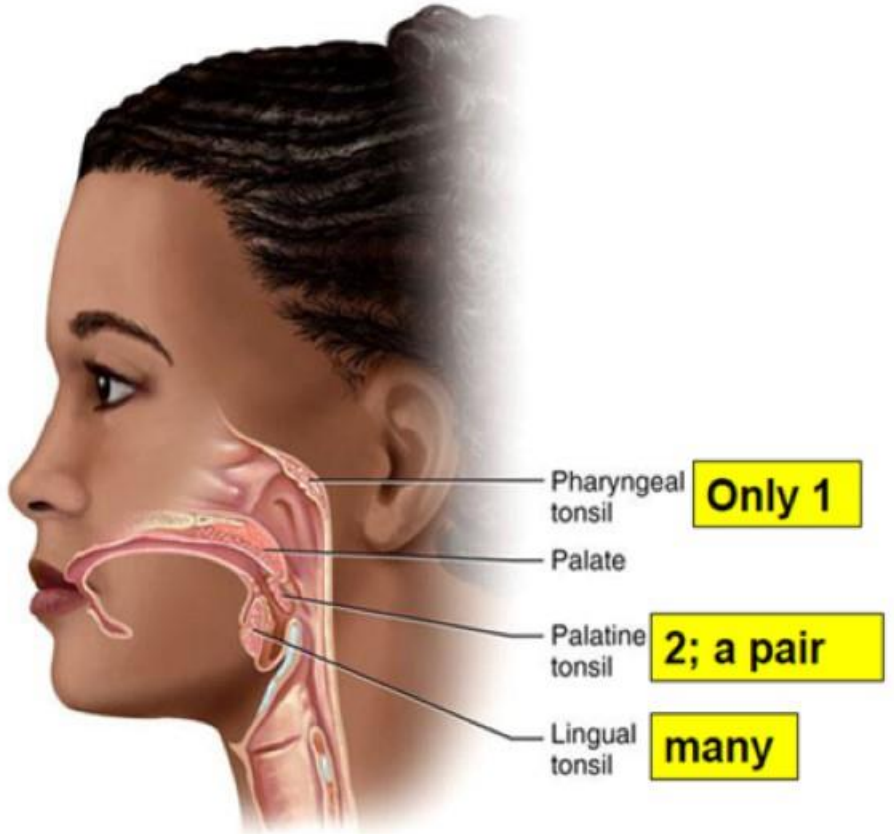
4-Haemopoietic function in fetus.

5- Storage of blood in some animals.

# Tonsils

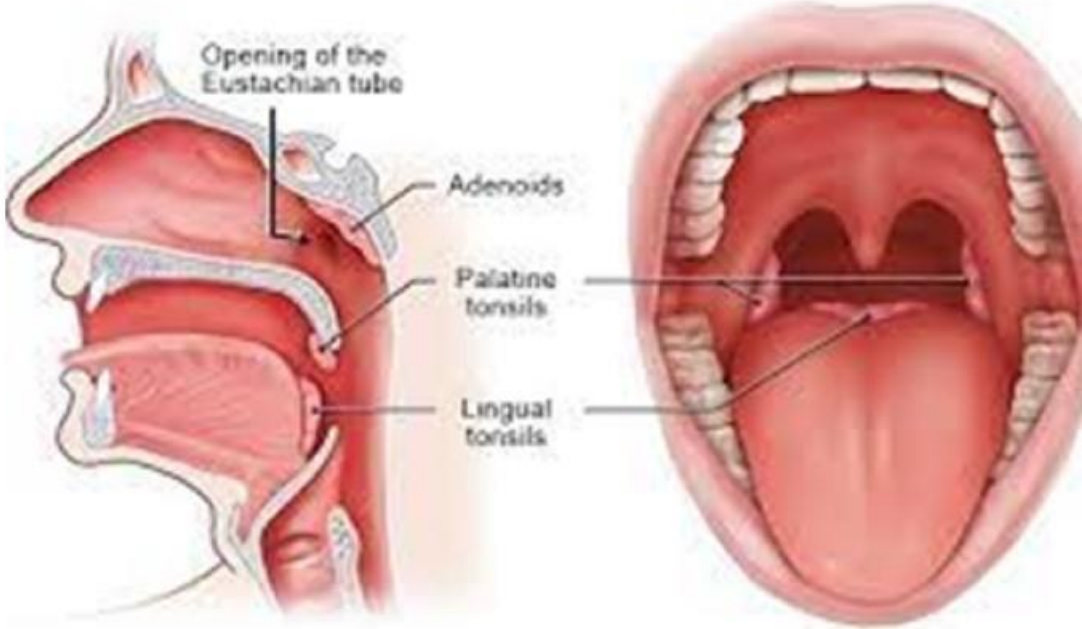
They are incompletely encapsulated aggregates of lymphoid tissue beneath the epithelium of the initial part of the digestive tract.



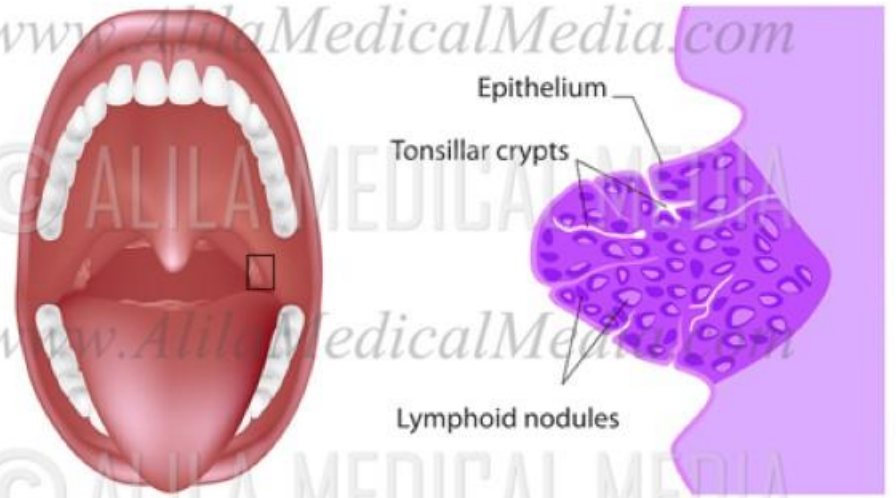



# 1- Palatine tonsils

- They are two tonsils of dense lymphatic tissue situated in the oral part of the pharynx.
- Each is composed of a band of lymphoid tissue, containing follicles with germinal centers, covered by stratified squamous epithelium, with invaginations into the lymphoid tissue forming 10 – 20 crypts.
- They are separated from surrounding structures by dense C.T. (capsule).




Palatine Tonsil

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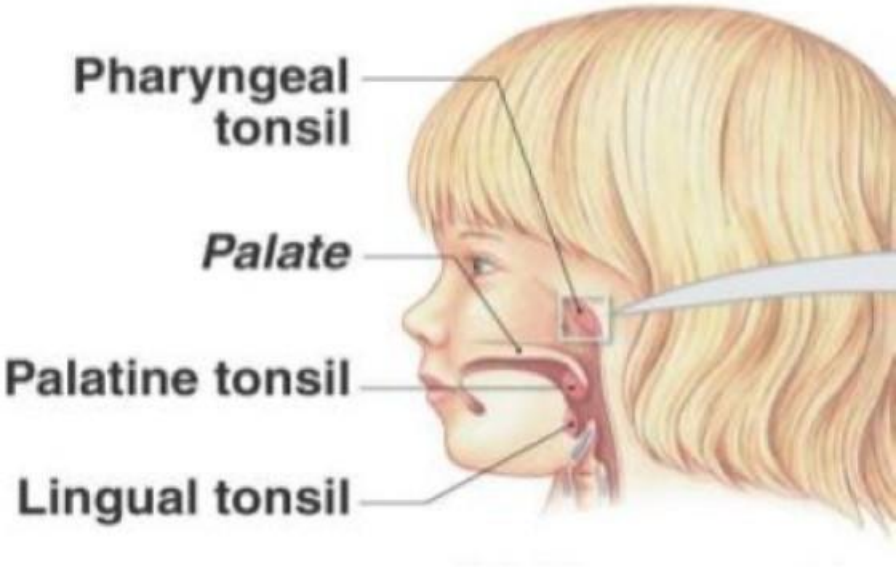
## 2- Pharyngeal tonsil (adenoids):

It is one tonsil in the wall of the nasopharynx.

It is covered by pseudostratified columnar ciliated epithelium.

It has no crypts and its capsule is thin.

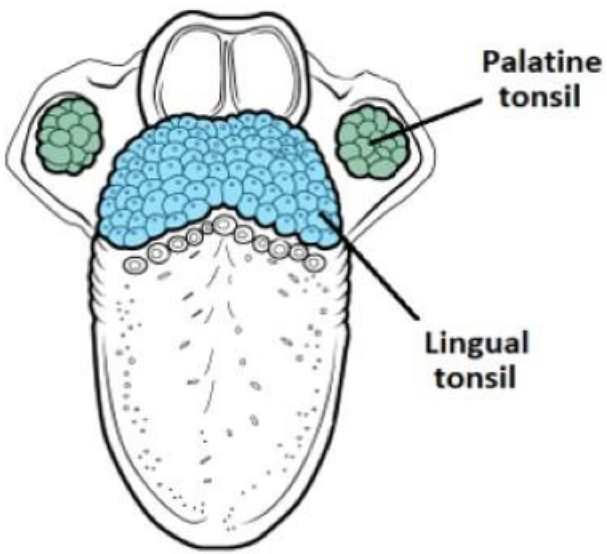



## 3- Lingual tonsils:

They are smaller, more numerous and present at the base of the tongue.

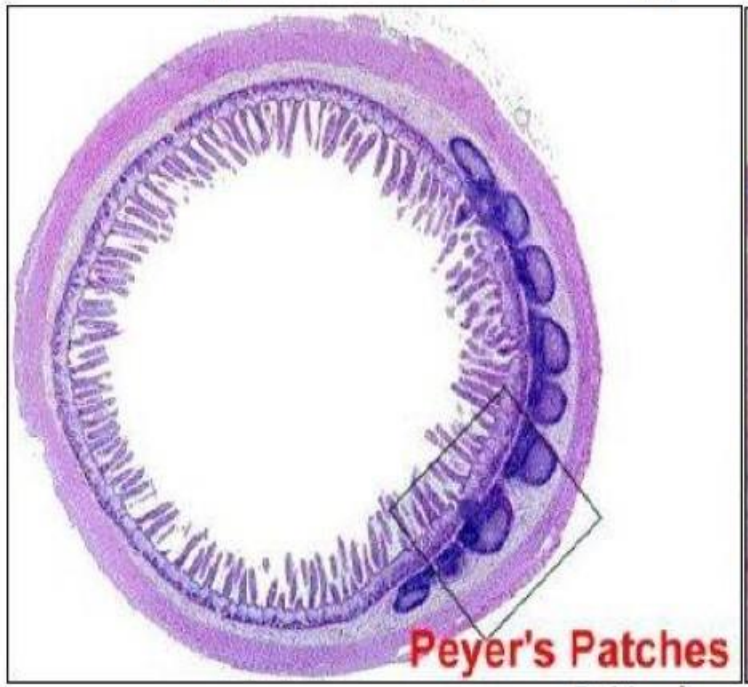
They are covered by stratified squamous epithelium.

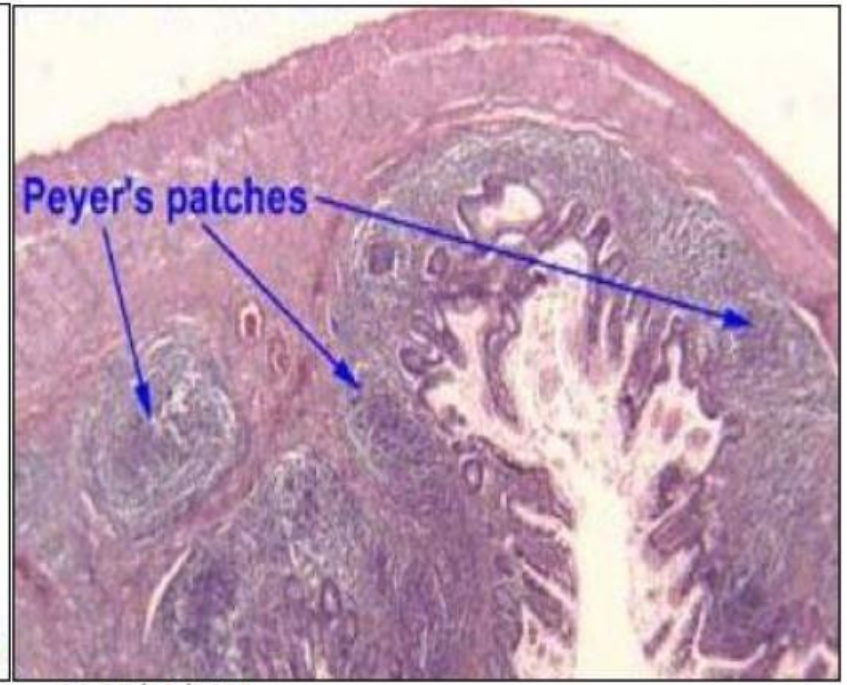
Each has a single crypt.



# Payer's Patches

- Small masses of lymphatic tissue found throughout ileum region of small intestine
- roughly egg shaped lymphatic tissue nodules that are similar to lymph nodes in structure
- analyze and respond to pathogenic microbes in the ileum

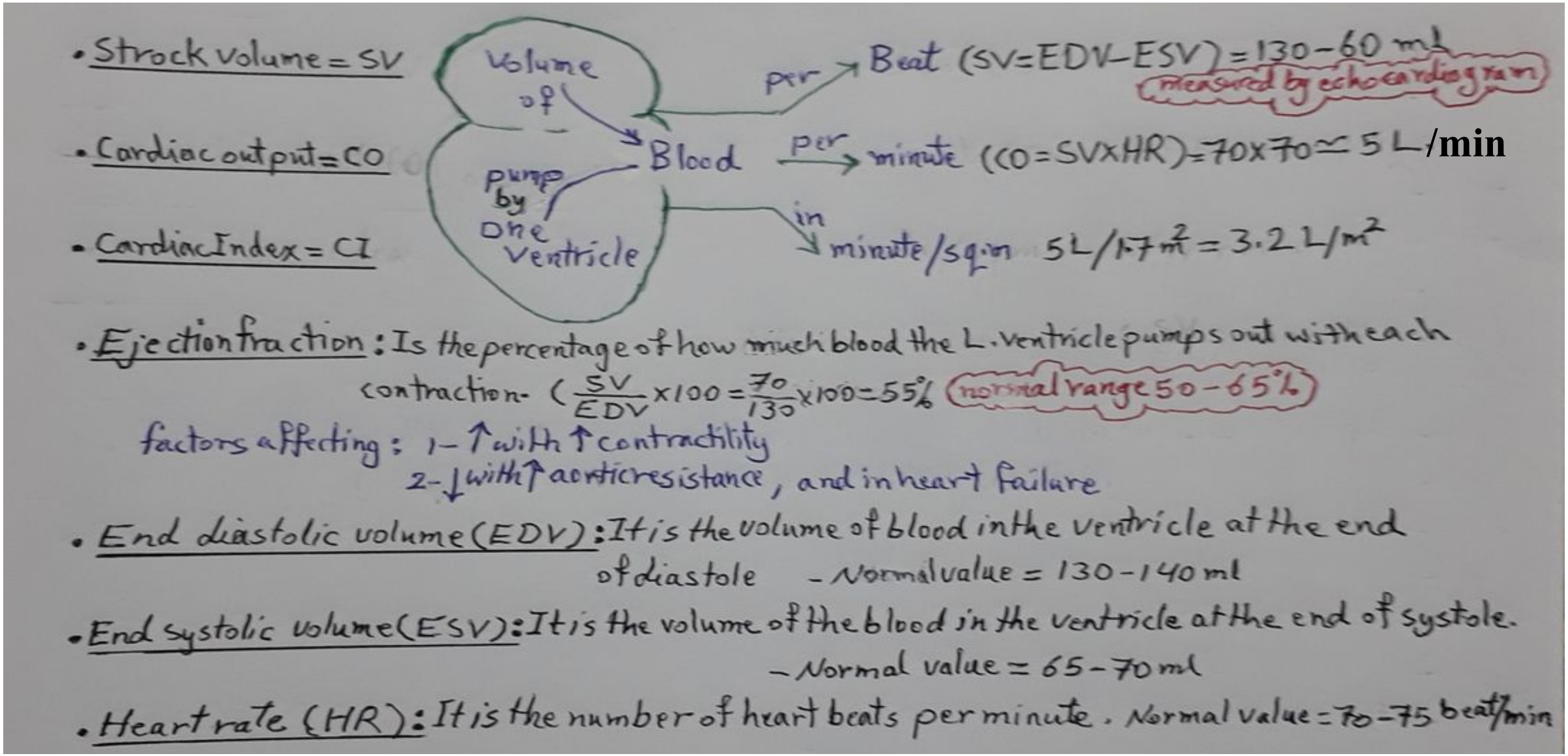


# Cardiac output (CO)

# Lect. 11

**Cardiac output (CO)** : It is **the amount of blood pumped by each ventricle in one minute.**




**Heart rate (HR):** It is the **speed of the heartbeat** measured by **number of contractions during one minute.** (70 – 75 beats/min.)

**Calculation of CO,** by equation: **CO = H.R. beat/min x S.V. ml/beat = 70 beat/min x 70ml/beat = 4900 ml/min.**

**SV( strock volume)=EDV(end diastolic volume) – ESV(end systolic volume)** Measured by **echocardiogram.**

**Ejection fraction:** It is the **percentage** of how much of the L. ventricle blood that pumps out with contraction

= SV / EDV x 100 = 70 / 130 x 100= 54 % ( Normal range 50 – 65 % )

Factors affecting: 1 - increase with increase contractility.

2 – decrease with increase with aortic resistance and in heart failure

## Factors affecting cardiac output:

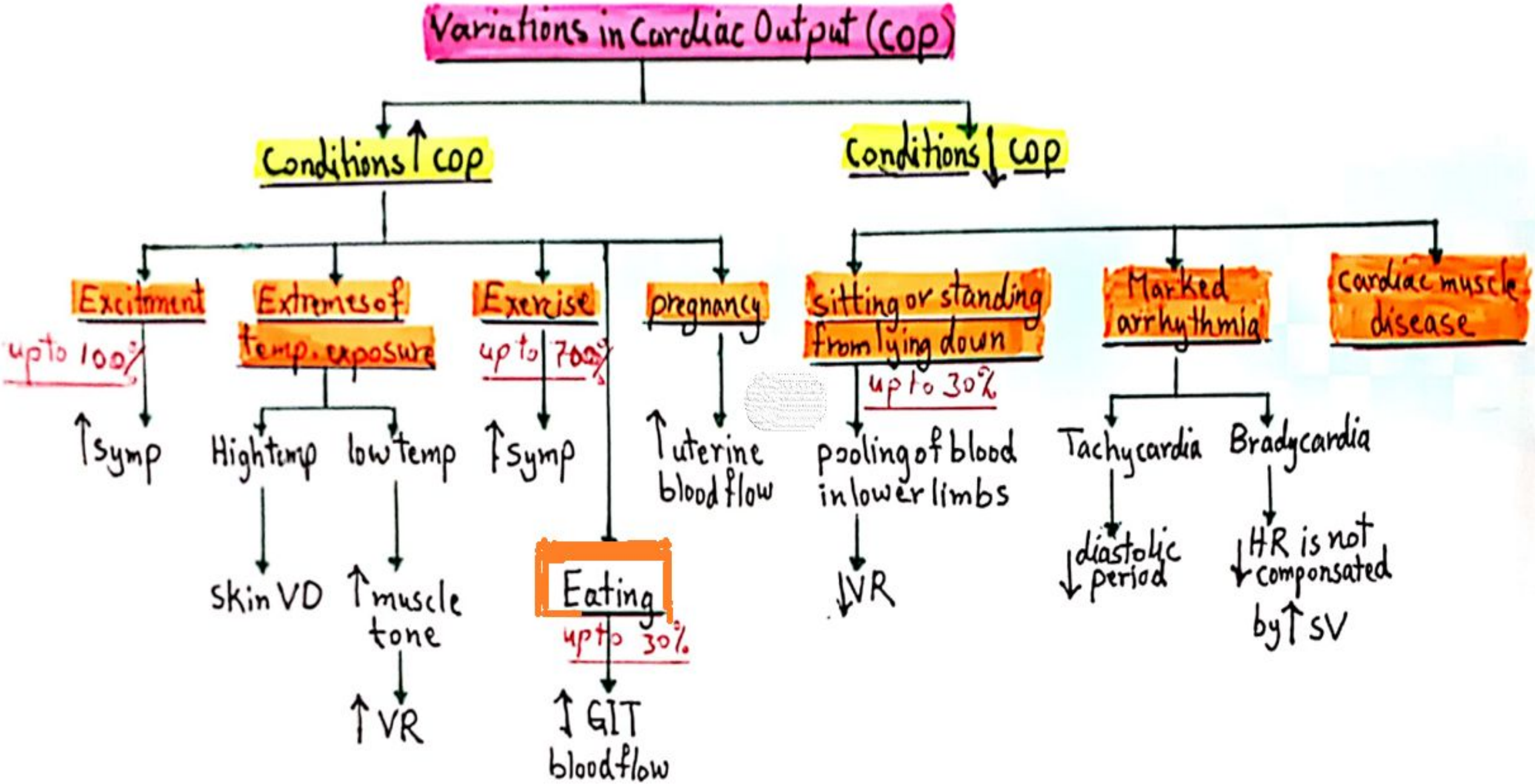
**1 – Heart rate -** the faster the H. beats, the more blood pumped over a particular period of time.(more important)

**2 – preload -** increase in the distension of ventricle - result in an increase in force of contraction, lead to increase CO.

**3 – After load -** dependent on the arterial blood pressure and vascular tone.

Factors that increase afterload include: aortic and pulmonary stenosis, pulmonary hypertension, vasoconstriction

**4 – Contractility -** an increased or decrease heart contractility(inotrope – factors affect on contractility- drugs, hormones, sympathy., parasymp.) resulting in increased cardiac output. Infarction ,Ischemic tissue decreases contractility


Variations in Cardiac Output (COP)
Conditions ↑ COP
Conditions ↓ COP
Excitment
upto 100%
↑symp
Extremes of temp. exposure
Hightemp
skin VD
low temp
↑muscle tone
↑VR
Exercise
up to 70%
↑symp
pregnancy
↑uterine blood flow
Eating
upto 30%
↕GIT bloodflow
sitting or standing from lying down
up to 30%
pooling of blood in lower limbs
↓VR
Marked arrhythmia
Tachycardia
↓diastolic period
Bradycardia
↓HR is not componsated by ↑SV
cardiac muscle disease

**Heart rate (HR):**

**Factors influencing heart rate:** The heart rate can **vary according to**

**(1)** The body's **physical needs (**need to absorb **oxygen** and excrete **carbon dioxide)**.

**(2) Activities provoke change in heart rate** include **exercise, sleep - stress dream** , **anxiety**, **illness**, **age** , **basal metabolic rate** , **Posture (standing , lying), Anemia(less viscosity)** and **drugs**.

**(3) Other factors** can affect **autonomic NS** (include **epinephrine**, **norepinephrine**, Thyrotoxicosis.) , **fever**

**(4) Levels of various ions** (**calcium**, **potassium**, and **sodium**), **(5) Body temperature**; **(6) Hypoxia**; **(7) pH**

**Stroke volume (SV)** :

It is the **volume** of blood **pumped** from **one ventricle / beat**. 70-kg individual eject around 70ml

The formula: **Stroke volume** = **end-diastolic volume** – **end-systolic volume**.

**End-diastolic volume** (EDV) is the **amount of blood in a ventricle immediately before the contraction**, at the **end** of **diastole**. It is about **130 mL** of blood. An **increase of EDV** means an **increase of preload (affected** by **venous blood pressure** and the **rate of venous return)** lead to **increases** the **stroke volume**.

**End-systolic volume (ESV),** is the **amount of blood remaining in the ventricle at the end of systole, after the heart has contracted**. It is about 50 - 70 mL of blood. **Depends on two factors:**

**1 - Contractility** - **Increasing contractility reduces end-systolic volume**, which results in a greater stroke **volume** and thus **greater cardiac output.**

**2 – Afterload** - **High aortic pressure** lead to the **residual volume of blood within the ventricle** is **increased** because less blood is ejected.

## Cardiac Cycle:

**A single cycle of cardiac (sequence of one systole followed by one diastole), it last 0.8 sec.**

**Ventricular systole:** It is a **contraction phase of the ventricular** of the heart at rest, **last 0.3 sec.**

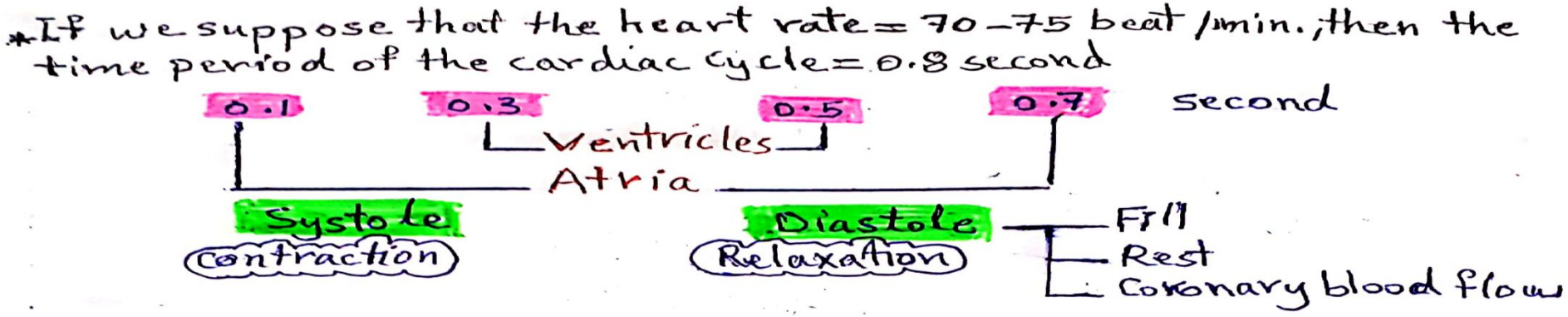
**Ventricular diastole:** It is a **relaxation phase of the ventricle** of the heart at rest, **last 0.5 sec.**

**Atrial systole:** It is a **contraction phase of the atrium** of the heart at rest, **last 0.1 sec.**

**Atrial diastole:** It is a **relaxation phase of the Atrium** of the heart at rest, **last 0.7 sec.**

-Also it is **a series of pressure changes that take place within the heart**, result in the movement of blood through different chambers of the heart and the body as a whole.

-Or it is **the coordination of the filling and emptying of the heart with blood by electrical signals that cause the heart muscles to contract and relax.**




**Variables affect cardiac cycle, including:** **size** of the **heart**, **sex**, **contractility**, **physical** and **mental condition**, **preload** and **afterload** (**resistance**)

# Heart Sounds

One of methods of **assessing the heart's condition** is to **listen** to it, using a **stethoscope**.

In a **healthy heart**, there are only **first two** audible **heart sounds**.

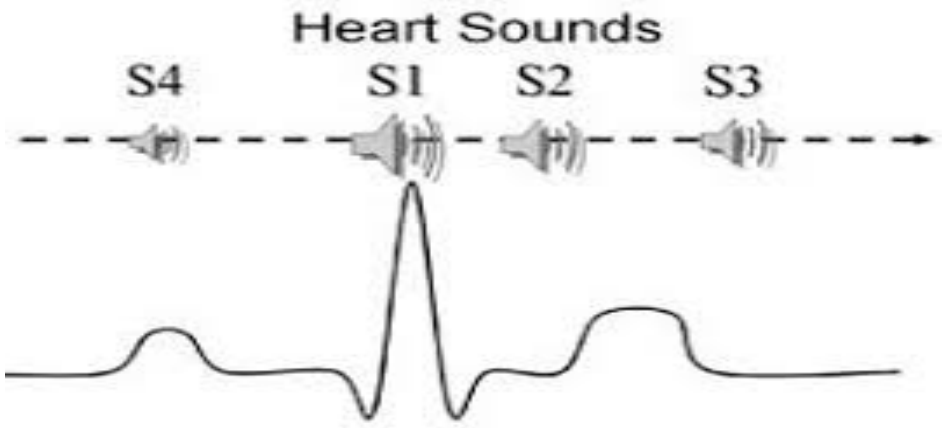
**First heart sound S1**,a sound created by the **closing of the atrioventricular valves** during ventricular contraction (systole), is hears as the word "**lub**".

**Second heart sound S2**, is the sound of the **semilunar valves closing** during ventricular relaxation (diastole) and is hears as the word "**dub**".

**Third heart sound**, **S3 -** usually indicates an **increase in ventricular blood volume**.(speed fill) striking a very compliant left ventricle. **S3** heart sounds may **indicate a severe tricuspid or mitral valve regurgitation.** Regurgitation means that the heart valve becomes leaky.

**Fourth heart sound S4 -** produced by the **sound of blood being forced into a stiff ventricle**.

**Phonocardiogram**: An instrument **can record** the four heart sounds.



Heart sound (**S3 and S4**) are two **abnormal heart sound** components which are proved to **be indicators** of **heart failure during diastolic period**.

The **S3** also known as the **"ventricular gallop"** can be **normal**, at times, but **may be pathologic,** S3 indicates **heart failure** or **volume overload**

A **S4** heart sound is **almost always pathologic** also known as the **"atrial gallop"** occurs just before S1 when the atria contract to force blood into the LV.

## Murmur

**Abnormal heart sound (**:- Heart murmurs are **produced as a result of turbulent flow** of blood **strong** enough to **produce audible noise.** They are usually heard as a whooshing sound.
The **term murmur** only refers to a **sound believed to originate within blood flow through or near the heart**; rapid blood velocity is necessary to produce a murmur) usually due to:

**1)-** a **faulty action** of the **heart valves** (fail to close tightly), **blood leaks back**
- **valve cannot open completely** make a **noise sound** during passing of blood

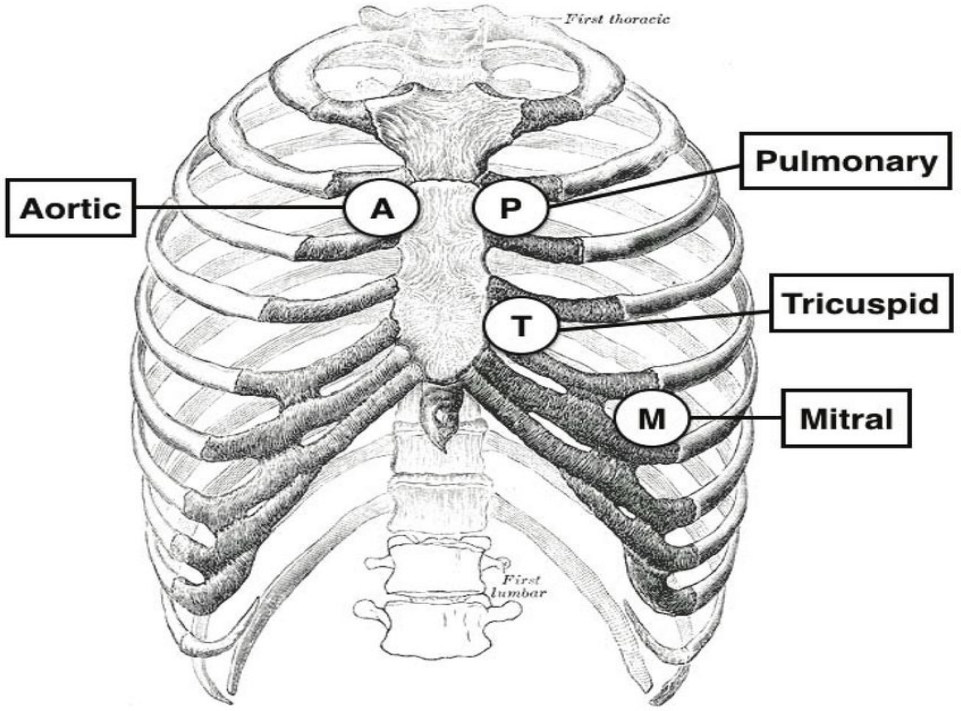
**2)** **narrowing of valve opening** (**stenosis**) and this state called: - Incompetence or regurgitation.
**3)** Also the abnormal sound may be caused by a **congenital defects**, **disease**, and **Physiological variations**.

# Areas on the chest can be heard the heart valves sound

The heart **sounds are heard best** where there is **no lung tissues** between the heart and the chest wall , because the lung was poor conductor of sound.

Heard the sound of :

- **Aortic valve** At right second intercostal space upper right sternal border
- **Pulmonary valve** At left second intercostal space upper left sternal border
- **Tricuspid valve** At left fourth intercostal spaces lower left sternal border
- **Mitral valve** At left fifth intercostal space left midclavicular line



# Blood pressure

# Blood pressure (BP):

- **Definition:** Is the **force** of the blood **exerting** against **arterial walls**. It is necessary for **maintain blood flow**, by pushing the blood and perfusion of body tissue. -

**Blood pressure** - due to the **pumping action** of the heart.

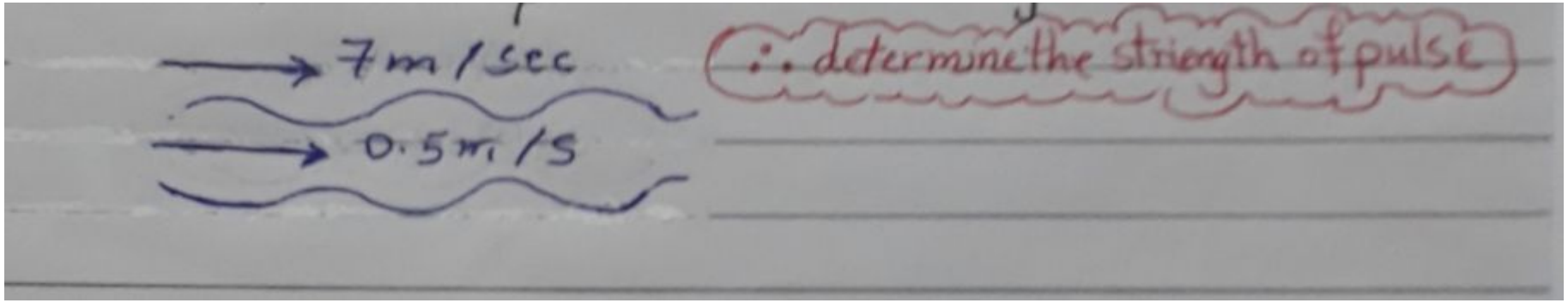
**Measured** - in **millimeter of Mercury** (**mmHg**), using the **sphygmomanometer.**

**Normal blood pressure -** In adult - "**120/80 mmHg**". Generate by left ventricle.

– **systolic 120 mmHg** (89 – 139mmHg) – **diastolic 80 mmHg** (60 – 90 mmHg)

**Pulse pressure (pp)** – It is the cause of pulse wave in artery

= **systolic p. – diastolic p.** = 120 – 80 = 40 mmHg

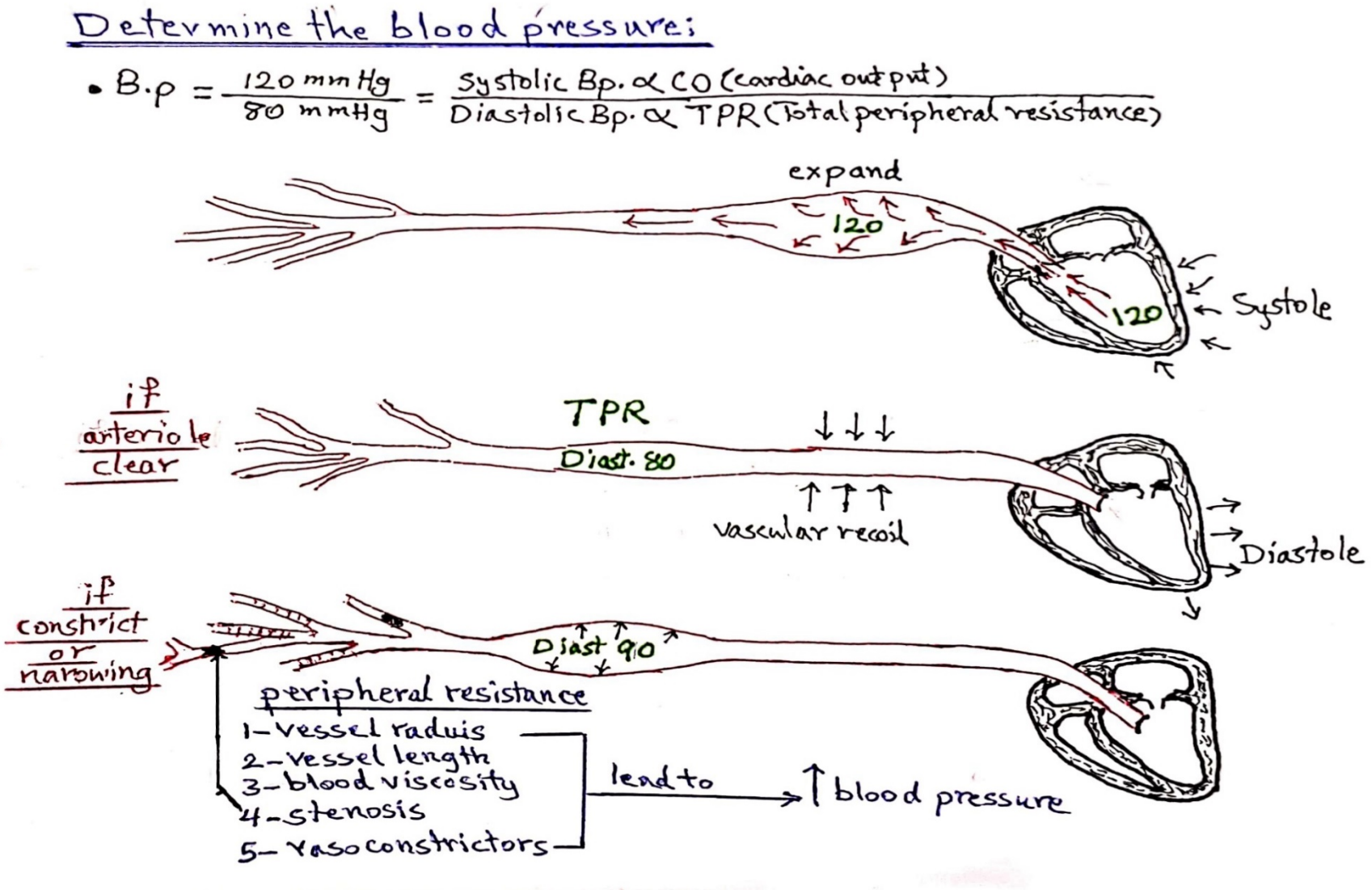



**Mean arterial blood pressure (MABP)** = **Diastolic p. + 1/3 pp.**

It is close to diastolic p. because the **Sys. Time** (0.3 sec) less than **Dias. Time** (0.5sec)

**then 80 +1/ 3 of 40 = 93 mmHg.**

**Mean blood pressure decreases as** the **circulating blood** **moves away** from the **heart** through **arteries** and **capillaries** due to **much losses of energy.**




## Importance of Arterial Blood Pressure:

1 ) Driving force of blood transmission ( Deference pressure)

2 ) Opening of blood vessels (By volume of blood pressured)

3 ) Filtration – in capillaries, in glomerulus in kidney nephron.

**For adult:**

# Blood Pressure Stages

| Blood Pressure Category | Systolic mmHg | | Diastolic mmHg |
|---|---|---|---|
| Low Blood Pressure | Less than 90 | or | Less than 60 |
| Normal Blood Pressure | 90 - 119 | and | 60 - 79 |
| Prehypertension (High Normal) | 120 - 139 | or | 80 - 89 |
| Hypertension Stage 1 | 140 - 159 | or | 90 - 99 |
| Hypertension Stage 2 | 160 or higher | or | 100 or higher |
| Hypertensive Crisis (Medical Emergency!) | Higher than 180 | or | Higher than 110 |

# Factors determine the blood pressure are:

## 1 - Cardiac output:

The **pumping action** of the heart is **responsible for blood pressure**. **Increases or decreases** in cardiac output (**SV x HR**) can result in **increases or decreases** respectively in **blood pressure.**

## 2 - Systemic vascular resistance( TPR):

**The higher the resistance to blood flow, the higher the arterial pressure.**

**A - Vessel radius** - the smaller the radius, the much higher the resistance.

**B - Vessel length** (the longer the vessel, the higher the resistance).

**C - Blood viscosity** (the higher the viscosity, the higher the resistance).

**D - Vasoconstrictors** Substances , can reduce the caliber of blood vessels, thereby increasing blood pressure.

## 3 - Blood volume:

The **greater the blood volume**, the **higher the cardiac output**.

**Dietary salt intake** cause an increased blood volume**, potentially** resulting in **higher arterial pressure.**

## 4 – Arterial compliance:

**Stenosis** of an artery, increases resistance to flow. In atherosclerosis ++ systole, and - - diastole.

# Physiological variation of blood pressure ( factors affecting blood pressure)

**1 - Exercise**

**2 - Emotional reactions** (like- **Anxiety**)

**3 - Digestion**

**4 - Sex** – **show little influence in** blood pressure

**5 - Age -** In the **elderly-** systolic blood pressure exceeds the normal adult range-due to increased **stiffness of the arteries**

**6 - Which arm - Differences** between **left and right arm blood pressure** (**be small**)**.**

**7 – Situation (posture) – standing, sitting, laying**

**8 - Obesity**

**9 - Pain**

**10 - Alcohol/Caffeine** - too **much** drink

**11 - Full bladder -** blood pressure is **lower when bladder is empty**. As bladder gradually fills, blood pressure could **increases up to 10 to 15mmHg when you have a full bladder**.

**12 - Temperature -** Blood pressure tends to **increase when you are cold**.

**13 - Circadian rhythm (normally variation) -** over a **24-hour period - highest** in the **early morning** and **evenings** and **lowest at night**. **Loss** of the **normal fall** in blood pressure **at night** is associated with a **greater future risk** of cardiovascular disease.

# Regulation of Blood pressure

## Short term (Neurological) (minute → hours)

### Nervous (main) ①

- Baroreceptor (strech receptor)
  - work well incase of ↑ Bp.
  - Found: carotid A. and aorta
  - Keep Bp. control in range (70–150 mmHg) (MBp. about 100 mmHg)
  - work as a pressure buffer – reduce Bp.
  - Flactuation (changing in posture, Resp., excitment...)
- peripheral chemoreceptor (reflex)
  - work well in case of ↓ Bp.
  - Found: carotid A. and aorta
  - act at 40–70 mmHg
  - Monitor changes of $O_2$, $CO_2$ and $H^+$
- CNS – Scheamic response
  - work when Bp. below 40 mmHg

### Hormonal: (Epinephrine Norepinephrine, ANP, ADH) ②

- Cardiovascular center in medulla
  - A – Cardiac center
    - autonomic control of the heart
    - 1 – Cardio acceleratory center: Sympathetic
    - 2 – Cardio inhibitatory center: parasympathetic
  - B – Vasomotor center (affect smooth m. fiber tone)
    - autonomic control of the blood vessels
    - Stimulation of vasomotor center: symp. (vasoconstriction)
    - Inhibition of vasomotor center: parasymp. (vasodilation)

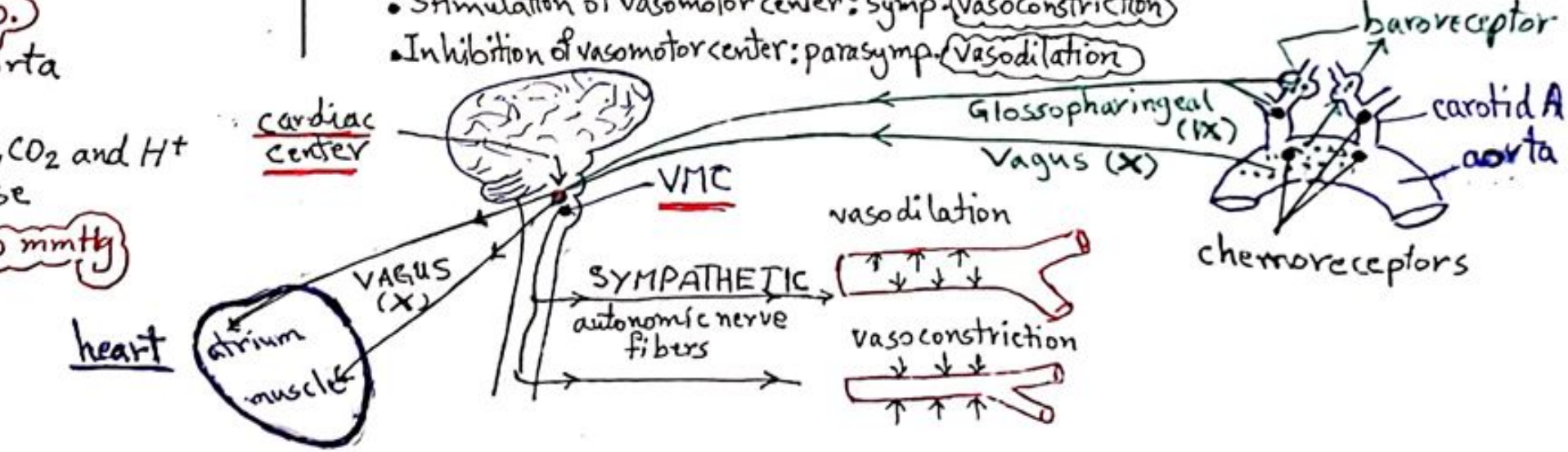
## Long term (Kidney) (days months)

Renine, angiotensin, aldosterone axis

Control level of $H_2O$, NaCl (in the body)

↓

then controlling ECF and blood volume



## Regulation

**Medulla**, by way of the autonomic nervous system, adjusts the mean arterial pressure by **altering both** the **force** and **speed** of the heart's contractions, as well as the **vascular resistance**.

**Mechanisms regulating arterial pressure:**

**Short – term regulation**

**1 - Baroreceptor reflex:**

Baroreceptors(**sensory nerve endings** in blood vessels ) - **detecting** stretching in the blood vessel walls. - **detect blood pressure levels.** Then **send signals** to **medulla in the brain stem**.

**CNS - responds by Regulating (1)** the **resistance of the blood vessels.**

**(2)** the **rate of heart beat**

**(3) strength of the heart's contractions**.

**Two types of baroreceptors;**

**1 – High pressure baroreceptors**

A - **Arterial high pressure baroreceptors:** Found only in the **aortic arch**. It is receptors have a **higher threshold pressure** and are **less sensitive** than the **carotid sinus** receptors.

B - **Arterial high to low pressure baroreceptors:**

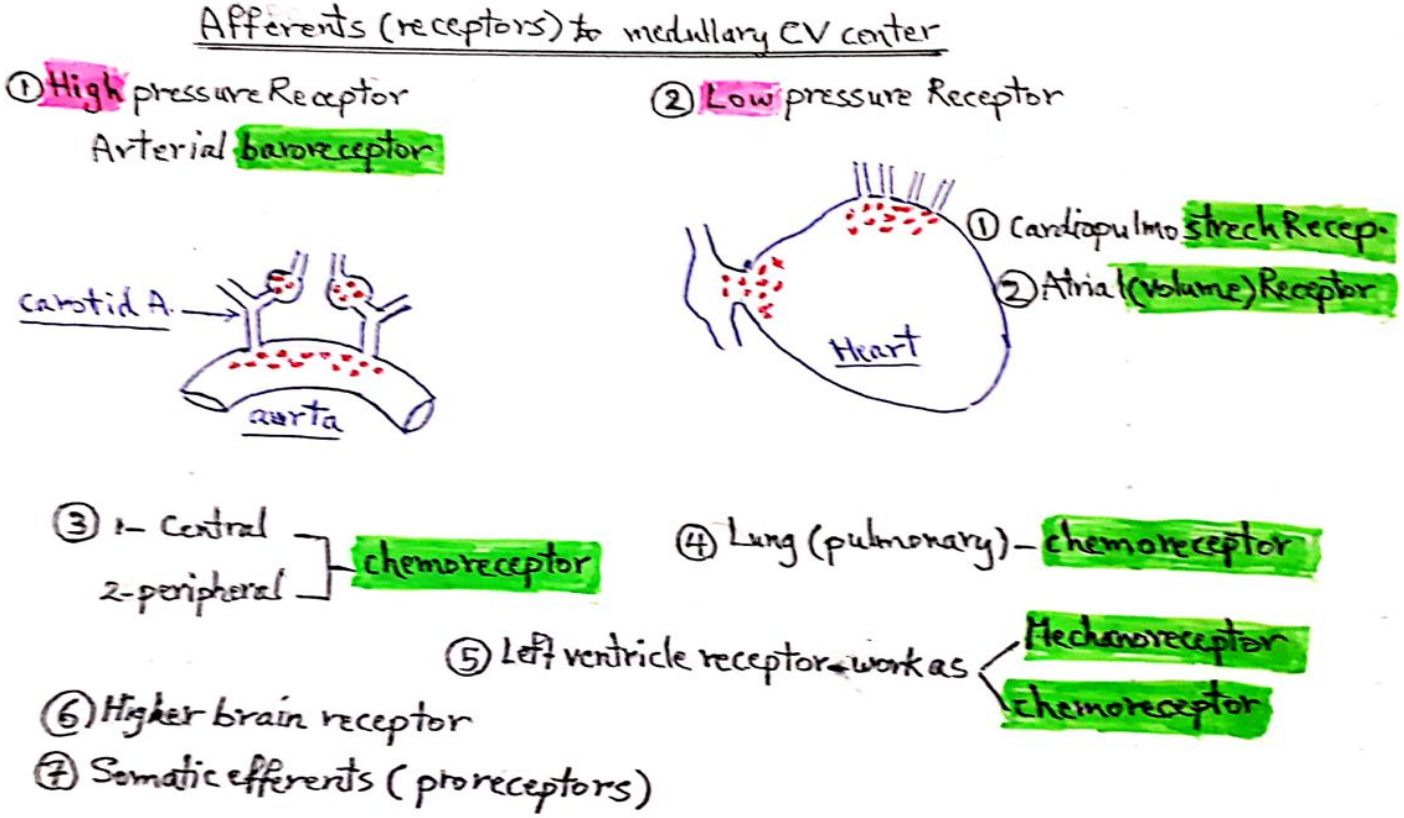
-**High pressure** and **low pressure** (in the **carotid sinuses**)

-The **carotid sinus** baroreceptors **are quantitatively the most important for regulating arterial pressure**. It's receptors **respond** to pressures **ranging from 60-180 mmHg**.

## 2 - Low pressure baroreceptors (the atrial volume receptors)

**Found:** Located in the walls **of right atrium of the heart**, near **(venae cava, pulmonary veins)** **Function:** **atrial volume receptors,** Then help regulate **blood volume** in the body.

**Mechanism:** Have an **effect on the kidneys(**when decrease blood volume**)**, by regulating the **secretion of** **antidiuretic hormone** , **renin** and **aldosterone** causing the **retention of salt and water** if blood volume is too low. Then **resultant increase in blood volume** lead to **an increased cardiac output**, in turn **increasing blood pressure.**




**2 - Chemoreceptors reflex:** Found only in the **aortic arch** and in the **carotid sinuses,** work in case **low blood pressure,** between 40 – 70 mmHg

# 2 - Long-term adjustment of arterial pressure

## Renin–angiotensin system:

This system is known for its **long-term adjustment** of arterial pressure.

- **Allows the kidney to :**

**1 - Compensate** the **loss** in **blood volume** **or**

**2 - Prevent** a **drops in arterial pressure** by **activating** an endogenous **vasoconstrictor (angiotensin II)**.

**Aldosterone release:**

**Steroid hormone** is **released** from the **adrenal cortex** in response to

**1- Angiotensin II** **or**

**2- High serum potassium levels**.

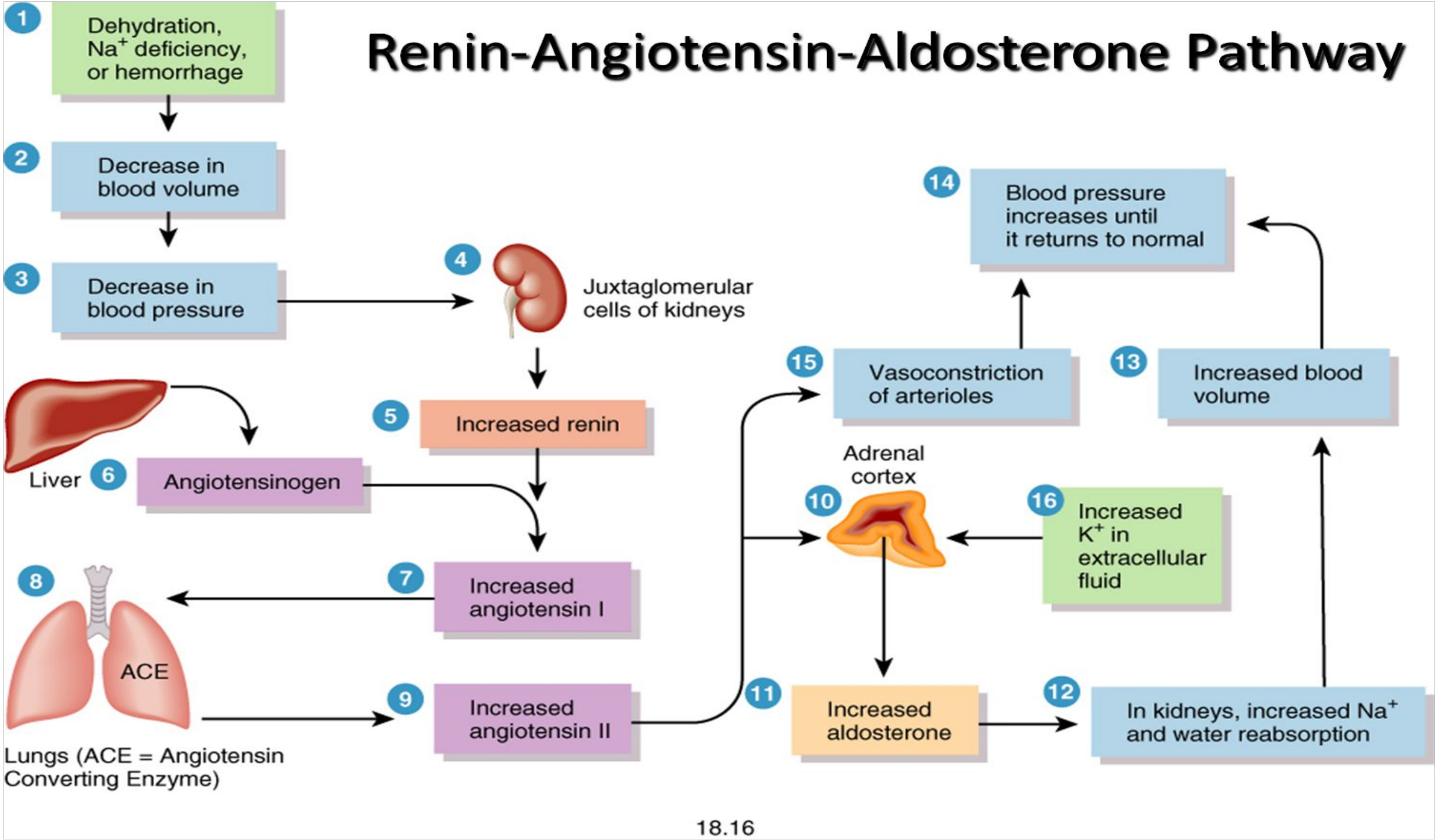
**Aldosterone** stimulates:

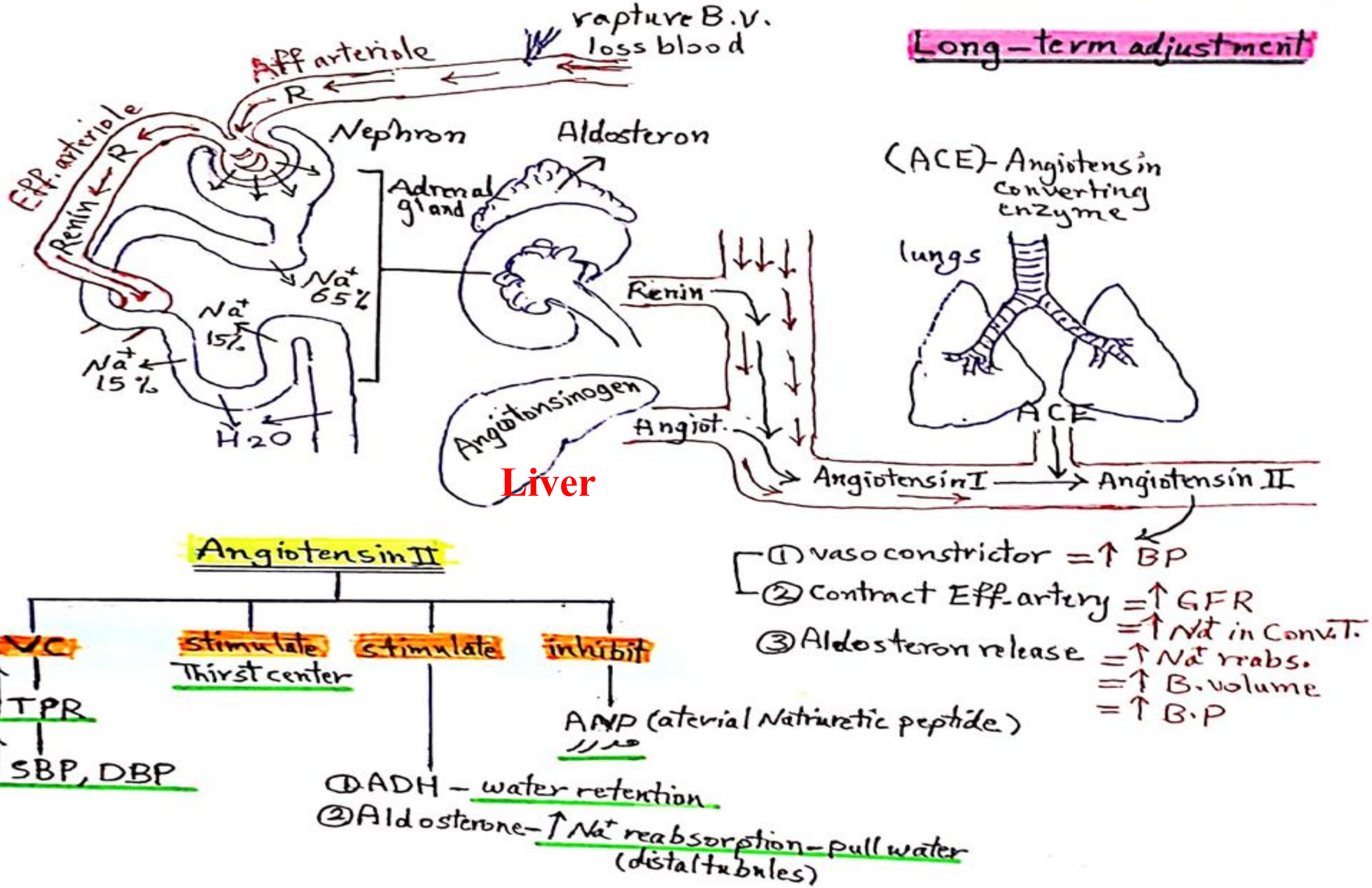
**sodium retention and potassium excretion** by the kidneys.

Since **sodium** is the main ion that **determines the amount of fluid** in the blood vessels by osmosis.

**Aldosterone will increase fluid retention, and indirectly, arterial pressure**

# Renin-Angiotensin-Aldosterone Pathway




rapture B.V.
loss blood
Aff arteriole
R
Eff. arteriole
Renin
R
Nephron
Aldosteron
Adrenal gland
Na+ 65%
Na+ 15%
Na+ 15%
H20
Long-term adjustment
(ACE)- Angiotensin converting enzyme
lungs
Renin
Angiotensinogen
Angiot.
ACE
Liver
Angiotensin I
Angiotensin II
Angiotensin II
VC
TPR
SBP, DBP
stimulate
Thirst center
stimulate
inhibit
ANP (aterial Natriuretic peptide)
① ADH – water retention
② Aldosterone – ↑ Na+ reabsorption – pull water (distal tubules)
① vaso constrictor = ↑ BP
② Contract Eff. artery = ↑ GFR
= ↑ Na+ in Convt.
③ Aldosteron release = ↑ Na+ reabs.
= ↑ B. volume
= ↑ B.P

# Systemic venous pressure

**1 - Venous pressure** is the pressure in a **vein** or in the **atria** - **much less** than arterial pressure:

**values: 5 mmHg** in **right atrium**

**8 mmHg** in **left atrium**.

**2 - portal venous pressure** :the pressure in the **portal vein**, is **5-10 mmHg**.

**3 - Pulmonary artery pressure**: Generate by right ventricle. Normally (about **15 - 20 mmHg)**.

**pulmonary hypertension**, **Any increase in blood pressure in the capillaries of the lung ,** leading to:

**1 - Interstitial edema** if the pressure **increases to above 20 mmHg**

**2 - Pulmonary edema** at pressures **above 25 mmHg**.

# Hypertension

- If your blood pressure **readings** are consistently **140 / 90**, or higher **over a number of weeks, or if just one of the numbers is higher**.
- **Signs and symptoms of high blood pressure:**
  High blood pressure usually has **no signs or symptoms**.
  Only way to know is **to have yours measured**. But must take a **number of readings over time**.

**The Scenario is like following, if not treated.**

- This higher pressure **puts extra strain** on the heart and blood vessels, **may cause heart failure** and **chronic kidney failure**, and is closely linked to some forms of **dementia**.
- Higher pressures **increase heart workload** and **progression of unhealthy tissue growth** (**atheroma**) that develops within the **walls of arteries.**

  Where **atheroma** tend to progress and the **heart muscle** tends to **thicken**,

  **enlarge** the **ventricle** and become **weaker over time**.
- **Over time**, this extra strain **increases risk** of a **heart attack** or **stroke**.

# High blood pressure can affect body in a number of ways:

- **Your heart:** Hypertension can cause a **heart attack**. May also cause **heart failure**.
- **Your brain:** High blood pressure is a leading cause of **strokes**. It has also been closely linked to some **forms of dementia**.
- **Your kidneys:** High blood pressure can cause **kidney disease**.
- **Your limbs:** Hypertension can cause **peripheral arterial disease** (affect legs).
- If you have other health conditions, such as **diabetes** or **high cholesterol**, this **increases risks.**

## 10 Factors That Can Affect Blood Pressure Readings:

**1 - Cuff is too Small** - cause systolic pressure measurement to **increase 10 to 40 mmHg**.
**2 - Cuff Used Over Clothing** -Impact a systolic pressure **from 10 to 50 mmHg**.
**3 - Not Resting 3-5 minutes -** Exercise or eating can affect systolic pressure **10 to 20 mmHg**.
**4 – Talking -** talking while having systolic pressure measurement may **increase 10 to 15mmHg**
**5 – Smoking -** Tobacco products **temporarily increase your blood pressure**, so refrain from smoking at least **30 minutes before** having a blood pressure measurement.
**6 - Alcohol/Caffeine -** causes blood **pressure levels to spike**, **rest 30 minutes** before having a blood pressure measurement taken.

**7 – Temperature -** Blood pressure tends to **increase when you are cold**.

**8 - Arm/Back/Feet Unsupported -** -
should always be **seated in a comfortable chair**, **legs uncrossed**, with **back and arm supported**.
**- If your back is not supported**, measurement may be **increased by 6 mmHg**.
**- Crossing your legs**, raise your systolic blood pressure by **2 to 8 mmHg**.
- **positioning** the **arm below** the heart level, result in **higher measurements**. -
**positioning** the **arm above** the heart level will **give you lower measurements**.
**These differences can increase/decrease .2mmHg for every inch above/below your heart level**.

**9 - Emotional State -** Stress or anxiety can cause large **increases** in blood pressure.

**10 - Full bladder -** blood pressure is **lower when bladder is empty**. As bladder gradually fills, blood pressure measurements could **increase 10 to 15mmHg when you have a full bladder**.