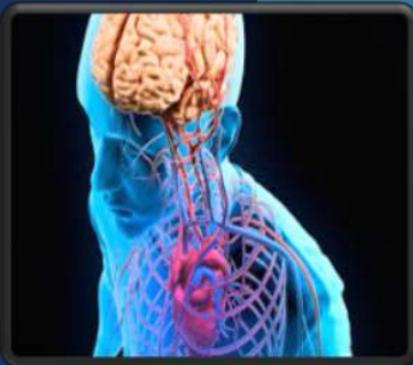


# General Overview

## Branches of science are:

- 1- Anatomy (structures of body parts)
- 2- Physiology (functions of these parts)

Anatomy



Physiology



## Difference from Pathology

- Pathology emphasizes the structural changes
- Pathophysiology focuses on the functional and metabolic alterations and the mechanisms



### Vocabulary

**anatomy** -The study of the form and structure of an organism.

**gross anatomy** - The study of the organs, parts, and structures of a body that are visible to the naked eye.

**physiology** - The study of the processes of living organisms, or how and why they work.

**pathophysiology** - The study of how disease occurs and response of the body to disease process.



shutterstock.com - 184759286



Local

Systemic

Local: Manifestations found at the site of disease, e.g local swelling or redness, pain.

Systemic: Manifestations present throughout the body, e.g. fever, lethargy, and high BP.

# ACUTE



# CHRONIC



حاد

subacute

مزمن



## ACUTE

**ACUTE** pain is the one that is severe, intense, but also usually is short in duration.

## CHRONIC

can't tell easily

**CHRONIC** pain is continual and recurring.

exacerbation

تفاقم  
(ألم أكثر)

subacute

REMISSION

فترات

تخفيف  
ألم  
ألم مؤقت

asymptomatic

pathogenesis

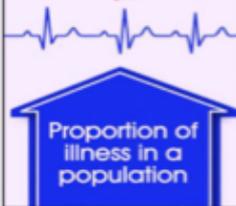
Prognosis VS Diagnosis

Your **diagnosis** is the flu.

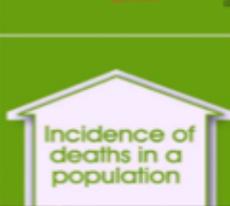
General Point

Your **prognosis** is a full recovery after lots of rest.

Morbidity



Mortality



Epidemiology

noun

the scientific study of diseases and how they are found, spread, and controlled in groups of people.

Epidemiology

<b>Prevalence</b>	Measures <b>existing cases</b> of disease and is expressed as a proportion (نسبة)
<b>Incidence</b>	Measures <b>new cases</b> of disease and is expressed in person-time units (شخص/سنة)

Endemic



Endemic (adj.) means native to a particular area or region or an exclusive characteristic of a thing, place, or concept.

FOR EXAMPLE, MALARIA IS A DISEASE THAT IS ENDEMIC TO CERTAIN COUNTRIES, SUCH AS SUB-SAHARAN AFRICAN COUNTRIES, CENTRAL AND SOUTH AMERICA, AND SOME ASIAN COUNTRIES.

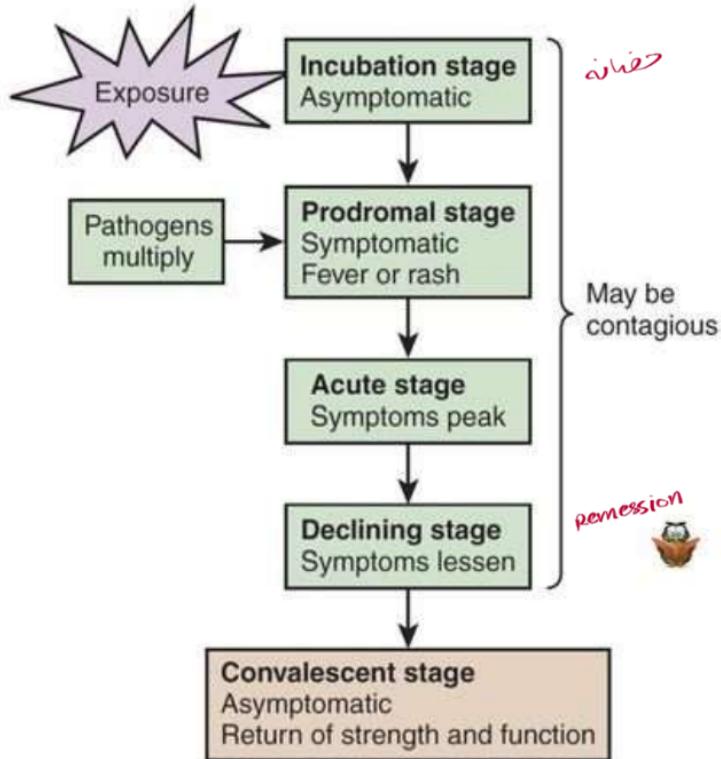
EPIDEMIC VS PANDEMIC

A disease that spreads quickly in a specific region.

A disease that spreads quickly across a large geographical area, like a continent or the world.



# Stages of Disease *(General of Acute)*



- ▶ Incubation stage
- ▶ Prodromal stage
- ▶ Acute stage
- ▶ Declining stage
- ▶ Convalescent stage

# The Levels of Prevention

Family history  
التاريخ العائلي

دون التماثل  
التشخيص المبكر

منع المضاعفات  
prevent complication

	PRIMARY Prevention	SECONDARY Prevention	TERTIARY Prevention
Definition	An intervention implemented before there is evidence of a disease or injury	An intervention implemented after a disease has begun, but before it is symptomatic.	An intervention implemented after a disease or injury is established
Intent	Reduce or eliminate causative risk factors (risk reduction)	Early identification (through screening) and treatment	Prevent sequelae (stop bad things from getting worse)
Example	Encourage exercise and healthy eating to prevent individuals from becoming overweight.	Check body mass index (BMI) at every well checkup to identify individuals who are overweight or obese.	Help obese individuals lose weight to prevent progression to more severe consequences.



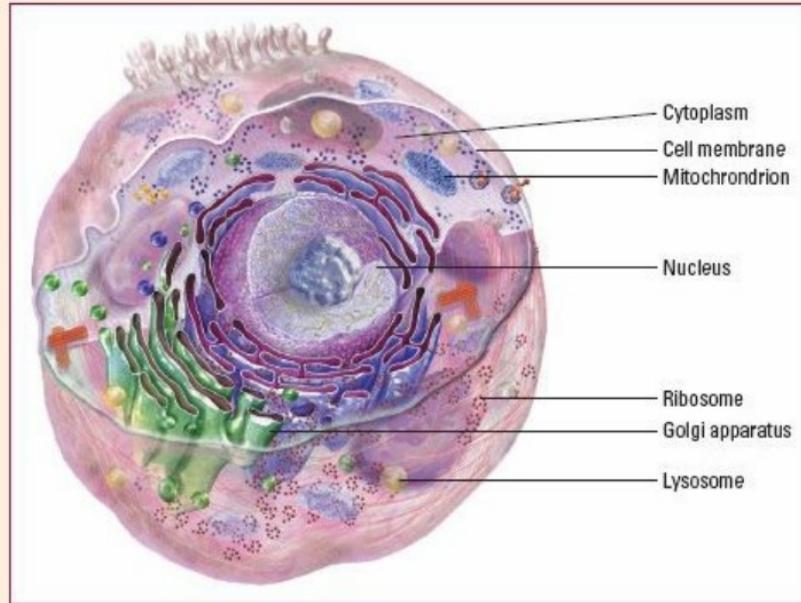
## Pathophysiology-Introduction

Faculty of Pharmaceutical Sciences

Dr. Amjaad Zuhier Alrosan, Dr. Abdelrahim Alqudah

## Just your average cell

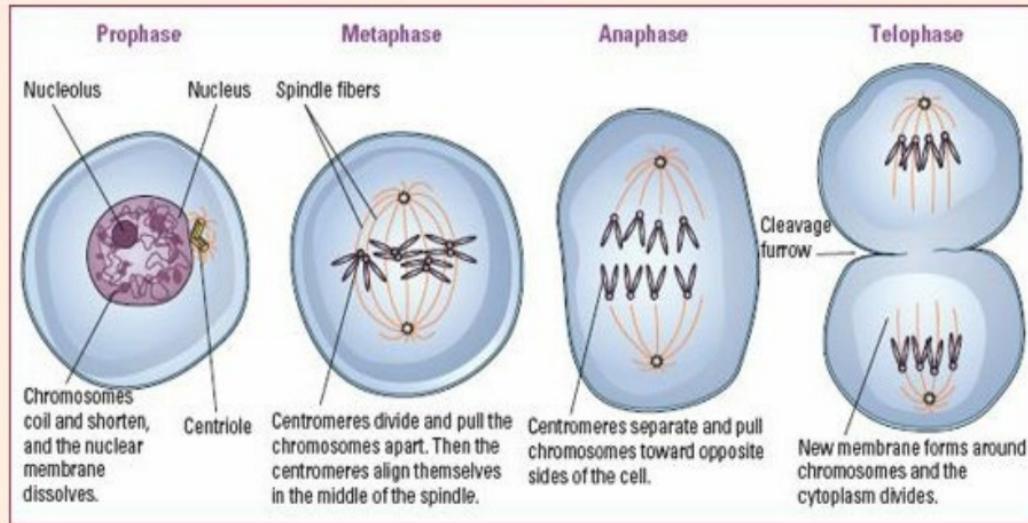
The illustration below shows cell components and structures. Each part has a function in maintaining the cell's life and homeostasis.



Pathophysiology made incredibly easy!—5th ed

## Replicate and divide

These illustrations show the different phases of cell reproduction, or *mitosis*.



Pathophysiology made incredibly easy!—5th ed

# Pathophysiologic concepts

مفهوم

**Stressors**, changes in the body's health, disease, and other extrinsic and intrinsic factors can alter the cells' normal functioning.

Cells generally continue functioning despite challenging conditions or stressors. However, severe or prolonged stress or changes may injure or destroy cells. When cell integrity is threatened, the cell reacts by drawing in its reserves to keep functioning, by **adaptive changes** or by cellular dysfunction. If the cellular reserve is insufficient, the cell dies (cell death (necrosis, is usually localized and easily identifiable, occurs). If enough reserve is available and the body doesn't detect abnormalities, the cell adapts by atrophy, hypertrophy, hyperplasia, metaplasia, or dysplasia.

When cell integrity is threatened, the cell reacts by

①

Adaptive changes

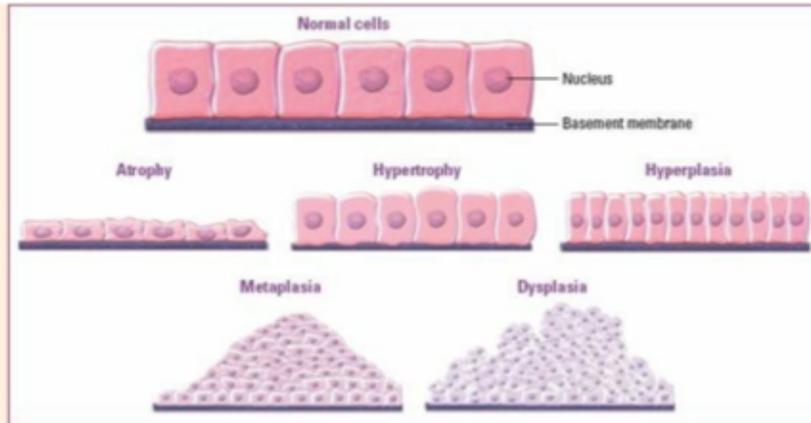
the body doesn't detect abnormalities, the cell adapts by atrophy, hypertrophy, hyperplasia, metaplasia, or dysplasia.

②

cellular Dysfunction

If the cellular reserve is insufficient, the cell dies (necrosis, is usually localized and easily identifiable, occurs).

## Adaptive cell changes



**Atrophy** → less size (ageing)

Atrophy is a reversible reduction in the size of the cell. It results from disuse, insufficient blood flow, malnutrition, denervation, or reduced endocrine stimulation.

**Hypertrophy** → more size (muscles)

Hypertrophy is an increase in the size of a cell due to an increased workload. It can result from normal physiologic conditions or abnormal pathologic conditions.

**Hyperplasia** → more No. of cells

Hyperplasia, an increase in the number of cells, is caused by increased workload, hormonal stimulation, or decreased tissue.

**Metaplasia** → replacement (type)

Metaplasia is the replacement of one adult cell with another adult cell that can better endure the change or stress. It's usually a response to chronic inflammation or irritation.

**Dysplasia** → size / shape / No.

In dysplasia, deranged cell growth of specific tissue results in abnormal size, shape, and appearance. Although dysplastic cell changes are adaptive and potentially reversible, they can precede cancerous changes. → all reversible expect this

	Atrophy	Hypertrophy	Hyperplasia	Metaplasia	Dysplasia
Definition	size ↓	size ↑	No. cells ↑	Replacement one adult cell with another	abnormal size, shape, and appearance.
Results of	Disuse Insufficient blood flow Malnutrition Denervation Reduce endocrine stimulation	Increased workload	Increased workload Hormonal stimulation Decreased tissue	Inflammation Irritation	
pathological upnormal		edema			
physiological normal	Ageing	Body Building	-Growth -pregnancy		Cancer



## Memory jogger

To remember the four causes of cell injury, think of how the injury tipped (or **TIPD**) the scale of homeostasis:

- ① Toxin or other lethal (cytotoxic) substance <sup>سام للخلية</sup>
- ② Infection <sup>ممرضات</sup>
- ③ Physical insult or injury
- ④ Deficit, or lack of water, oxygen, or nutrients. <sup>نقص</sup>

Degeneration occurs in the cytoplasm of the cell; the nucleus remains unaffected.



شیر حسیت  
A type of nonlethal  
cell damage known  
as degeneration

Pathophysiology made incredibly easy!.—5th ed

# Degeneration

- back to normal
1. **Degeneration** is the early stage of cell damage where the cell is injured but not dead yet. If the damage is mild, the cell may recover. If it worsens, it can lead to cell death.
  2. **Necrosis** is uncontrolled cell death due to space injury (like lack of oxygen or toxins). The cell bursts, releasing its contents and causing inflammation. It often follows degeneration if the damage continues.
  3. **Apoptosis** is programmed cell death, meaning the cell actively destroys itself in a clean and controlled way, without causing inflammation. It's a normal part of growth and tissue maintenance.

## Relationship:

- **Degeneration** can either heal or progress to **necrosis** if the damage is severe.
- **Apoptosis** is a separate process that happens when the body **intentionally removes cells**, not because of direct injury like in necrosis.

So, degeneration is a warning sign, necrosis is messy accidental death, and apoptosis is clean planned death. Does that clear it up?



- **Necrosis happens when the injury is severe, sudden, or overwhelming**, like a lack of oxygen (ischemia), toxins, infections, or trauma. The cell **loses control**, swells, bursts, and spills its contents, causing **inflammation** and damage to surrounding tissue.
- **Necrosis is more dangerous** because it damages nearby cells and triggers inflammation, which can lead to further injury.

- **Apoptosis happens when the cell detects it's mildly or irreversibly damaged but still functional enough to die in a controlled way.** It's often triggered by DNA damage, aging, or signals from the body. The cell **shrinks, fragments neatly, and gets cleared away without inflammation.**

- **Apoptosis is safer** because it removes damaged cells without harming the surrounding tissue.

## How to distinguish between them:

- **Necrosis:** Swelling, bursting, inflammation, and tissue damage. Happens in conditions like heart attacks, infections, or burns.
- **Apoptosis:** Shrinking, controlled breakdown, no inflammation. Happens in normal processes like immune system regulation or removing old cells.

# # Degeneration

→ long lysosomes.

When changes within cells are **identified**, degeneration may be slowed or cell death prevented through **prompt** treatment. An **electron microscope** makes the identification of changes within cells easier.

When a disease is diagnosed before the patient complains of any symptoms, it's termed **subclinical identification**. Unfortunately, many cell changes remain unidentifiable even under a microscope, making early detection impossible.



# Cell aging

---

- During the normal process of cell aging, cells lose structure and function. Lost cell structure may cause a decrease in size or wasting away, a process called atrophy.

## **In's and out's of cell aging**

Factors that affect cell aging may be intrinsic or extrinsic, as outlined here.

### **Intrinsic factors**

- Psychogenic
- Inherited ورثية
- Congenital خلقية
- Metabolic ميتابوليزم
- Degenerative →
- Neoplastic → ورم
- Immunologic مناعية
- Nutritional غذائية

### **Extrinsic factors *Physical agents***

- Force
- Temperature
- Humidity رطوبة
- Radiation اشعاع
- Electricity
- Chemicals

### ***Infectious agents***

- Viruses
- Bacteria
- Fungi
- Protozoa
- Insects
- Worms

# HOMEOSTASIS

- The body is constantly striving to maintain a dynamic, steady-state of internal balance called homeostasis. Every cell in the body is **involved** in maintaining homeostasis, both on the cellular level and as part of an organism.
- Any change or damage at the cellular level can affect the entire body. When an **external stressor** disrupts homeostasis, **illness** may occur. A few examples of external stressors include injury, lack of nutrients, and invasion by parasites or other organisms. Throughout the course of a person's life, many external stressors affect the body's internal equilibrium.

Every cell in the body is involved in maintaining homeostasis, a dynamic, steady state of internal balance.

## Maintaining the balance

Three structures in the brain are responsible for maintaining homeostasis:



1

the **medulla oblongata**, the part of the brain stem that's associated with vital functions, such as respiration and circulation (AR-BH)



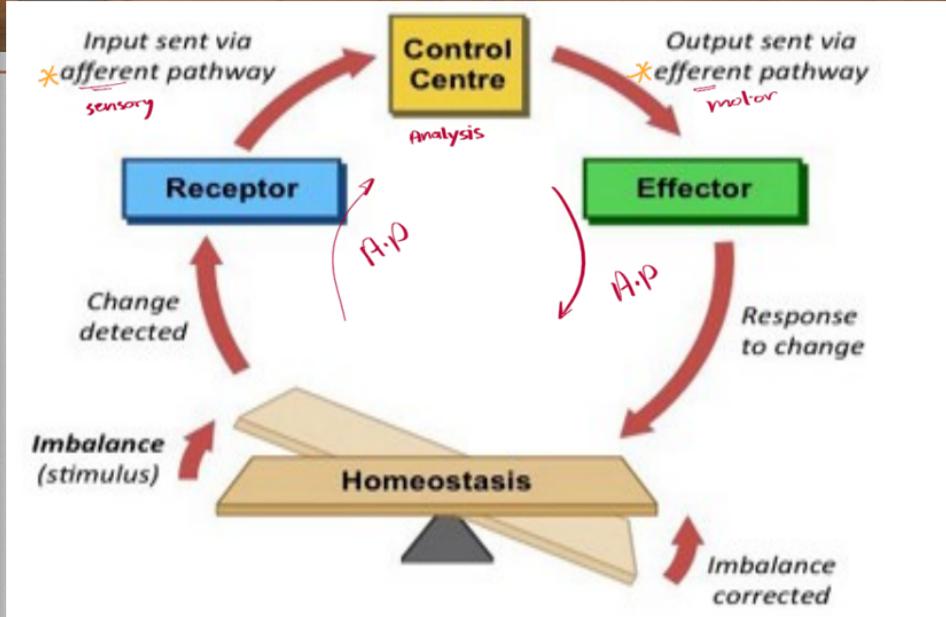
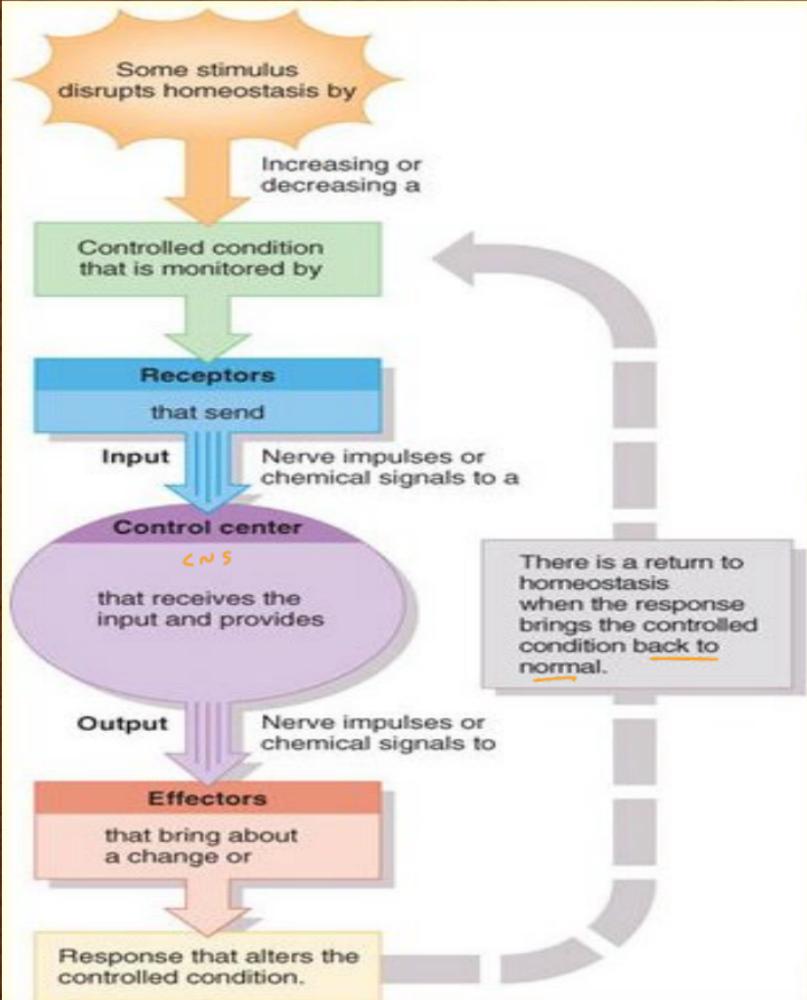
2

the **pituitary gland**, which regulates the function of other glands and thereby a person's growth, maturation, and reproduction



3

the **reticular formation**, a group of nerve cells or nuclei that form a large network of connected tissues that help control vital reflexes, such as cardiovascular function and respiration.



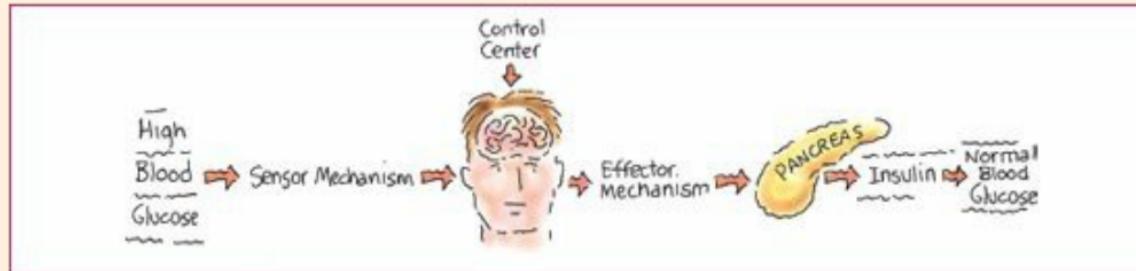
Group of receptors and effectors communicating with their control center forms a feedback system

Negative feedback  
cancels out the  
original response.  
Positive feedback  
exaggerates it.

*most*

## Negative feedback, positive result

This flowchart shows how a negative feedback mechanism works to restore homeostasis in a patient with a high blood glucose level.



# POSITIVE FEEDBACK SYSTEM

## ...and the positive

The positive feedback mechanism is far from positive. It takes the original response and **exaggerates** it. It's said to be positive because the change that occurs proceeds in the same direction as the initial disturbance, causing a further deviation from homeostasis. A positive feedback mechanism is responsible for intensifying labor contractions during childbirth.

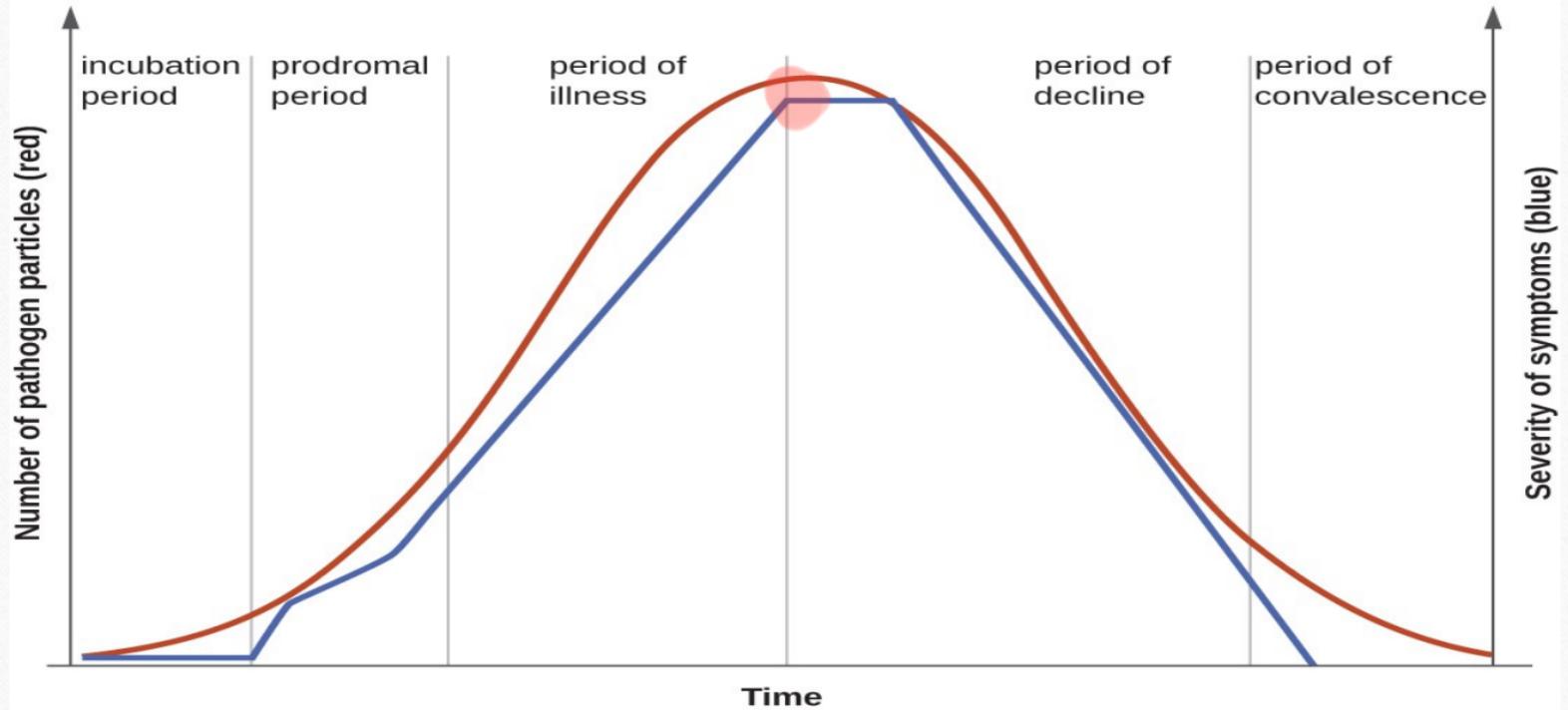
# DISEASE AND ILLNESS

Diagnosed ←

→ symptoms but  
not diagnosis

- Disease occurs when homeostasis isn't maintained.
- One aspect of the disease is its cause (the fancy term is **etiology**).
- Diseases with no known cause are called **idiopathic**. unknown cause
- A disease's development is called its **pathogenesis**.

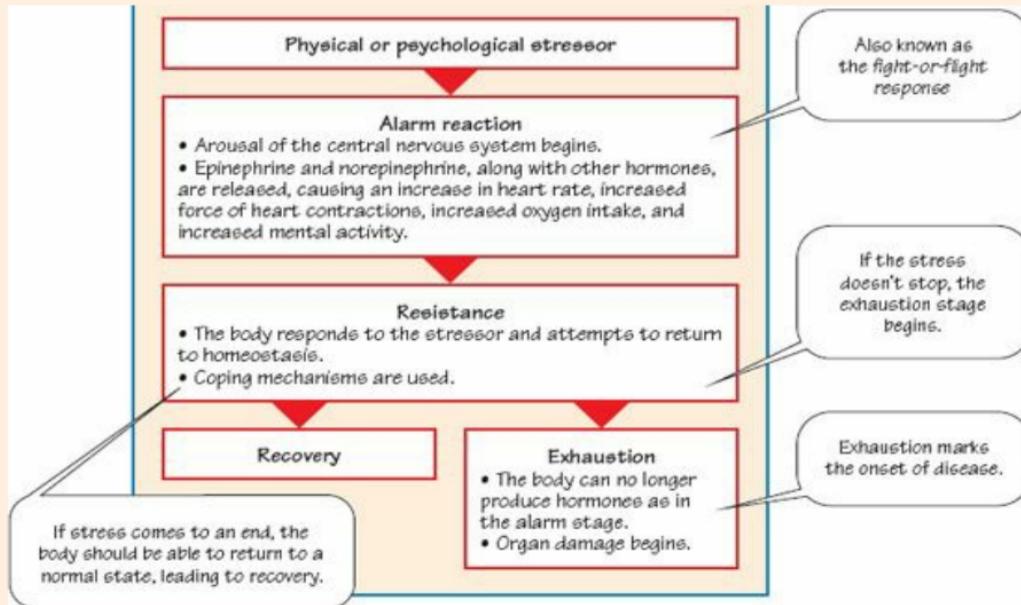
## Periods of Disease



<https://courses.lumenlearning.com/microbiology/chapter/characteristics-of-infectious-disease/>

## When stress strikes

According to Hans Selye's General Adaptation Model, the body reacts to stress in the stages depicted below.



# Quick quiz

1. The organelle that contains the cell's DNA is the:

- A. mitochondria.
- B. Golgi apparatus.
- C. ribosome.
- D. nucleus.

2. When a cell gets injured, the first sign is:

- A. a biochemical lesion.
- B. an area of hyperplasia.
- C. a chromatid.
- D. cellular necrosis.

**Question 2: When a cell gets injured, the first sign is...**

- (A) A biochemical lesion (✓ Correct) → The earliest sign of cell injury occurs at the molecular and biochemical level before any visible structural damage.
- (B) An area of hyperplasia (✗ Incorrect) → Hyperplasia is an increase in the number of cells due to increased cell division, not an immediate response to injury.
- (C) A chromatid (✗ Incorrect) → Chromatids are part of chromosomes during cell division and have nothing to do with cell injury.
- (D) Cellular necrosis (✗ Incorrect) → Necrosis is an advanced stage of cell death that occurs after severe and prolonged injury, not the first sign.

**Question 3: An extrinsic factor that can cause cell aging and death is...**

- (A) Down syndrome (✗ Incorrect) → Down syndrome is a genetic disorder (intrinsic factor), not an external cause of cell aging.
- (B) Sickle cell anemia (✗ Incorrect) → Sickle cell anemia is a hereditary disease caused by a genetic mutation, making it an intrinsic factor.
- (C) Ultraviolet (UV) radiation (✓ Correct) → UV radiation is an extrinsic factor that accelerates cell aging by damaging DNA and increasing oxidative stress.
- (D) A person's advanced age (✗ Incorrect) → Aging is an intrinsic factor because it is a natural biological process rather than an external cause of damage.

3. An extrinsic factor that can cause cell aging and death is:

A. Down syndrome.

B. sickle cell anemia.

C. ultraviolet radiation.

D. person's advanced age.

4. Homeostasis can be defined as:

A. a steady, dynamic state.

B. a state of flux.

C. an unbalanced state.

D. an exaggeration of an original response.



## Pathophysiology-Review of CVS

Faculty of Pharmaceutical Sciences

Dr. Amjaad Zuhier Alrosan, Dr. Abdelrahim Alqudah

## ➤ As we learned before:

---

- ✓ **Physiology** is the science, which is related to studying mechanics, characteristics, and features of the body that makes it function the right way.
- ✓ **Pathophysiology** studies abnormal physiology.

## THE CARDIOVASCULAR SYSTEM: THE HEART

- The **heart contributes to homeostasis** by **pumping blood** through blood vessels to the tissues of the body to deliver oxygen and nutrients and remove wastes.
- The cardiovascular system consists of the blood, the heart, and blood vessels.

**Table 12–1** The Cardiovascular System

<b>Component</b>	<b>Function</b>
<i>Heart</i>	
Atria	Chambers through which blood flows from veins to ventricles. Atrial contraction adds to ventricular filling but is not essential for it.
Ventricles	Chambers whose contractions produce the pressures that drive blood through the pulmonary and systemic vascular systems and back to the heart.
<i>Vascular system</i>	
Arteries	Low-resistance tubes conducting blood to the various organs with little loss in pressure. They also act as pressure reservoirs for maintaining blood flow during ventricular relaxation.
Arterioles	Major sites of resistance to flow; responsible for the pattern of blood flow distribution to the various organs; participate in the regulation of arterial blood pressure.
Capillaries	Major sites of nutrient, metabolic end product, and fluid exchange between blood and tissues.
Venules	Sites of nutrient, metabolic end product, and fluid exchange between blood and tissues.
Veins	Low-resistance conduits for blood flow back to the heart. Their capacity for blood is adjusted to facilitate this flow.
<i>Blood</i>	
Plasma	Liquid portion of blood that contains dissolved nutrients, ions, wastes, gases, and other substances. Its composition equilibrates with that of the interstitial fluid at the capillaries.
Cells	Includes erythrocytes that function mainly in gas transport, leukocytes that function in immune defenses, and platelets (cell fragments) for blood clotting.

"Little loss of pressure" means that as a fluid (such as air, water, or gas) moves through a system (like a pipe, tube, or artery), it experiences only a small reduction in pressure. This usually indicates smooth flow with minimal resistance, turbulence, or friction. It is desirable in systems where maintaining pressure is important, such as in efficient plumbing, respiratory systems, or hydraulic systems.

# Components of blood

## Plasma



Transports nutrients, hormones, and proteins. It is a yellow liquid that makes up about 55% of the body's blood volume.

## Platelets



Form clots to stop bleeding. Platelets make up less than 1% of blood.



## Red blood cells



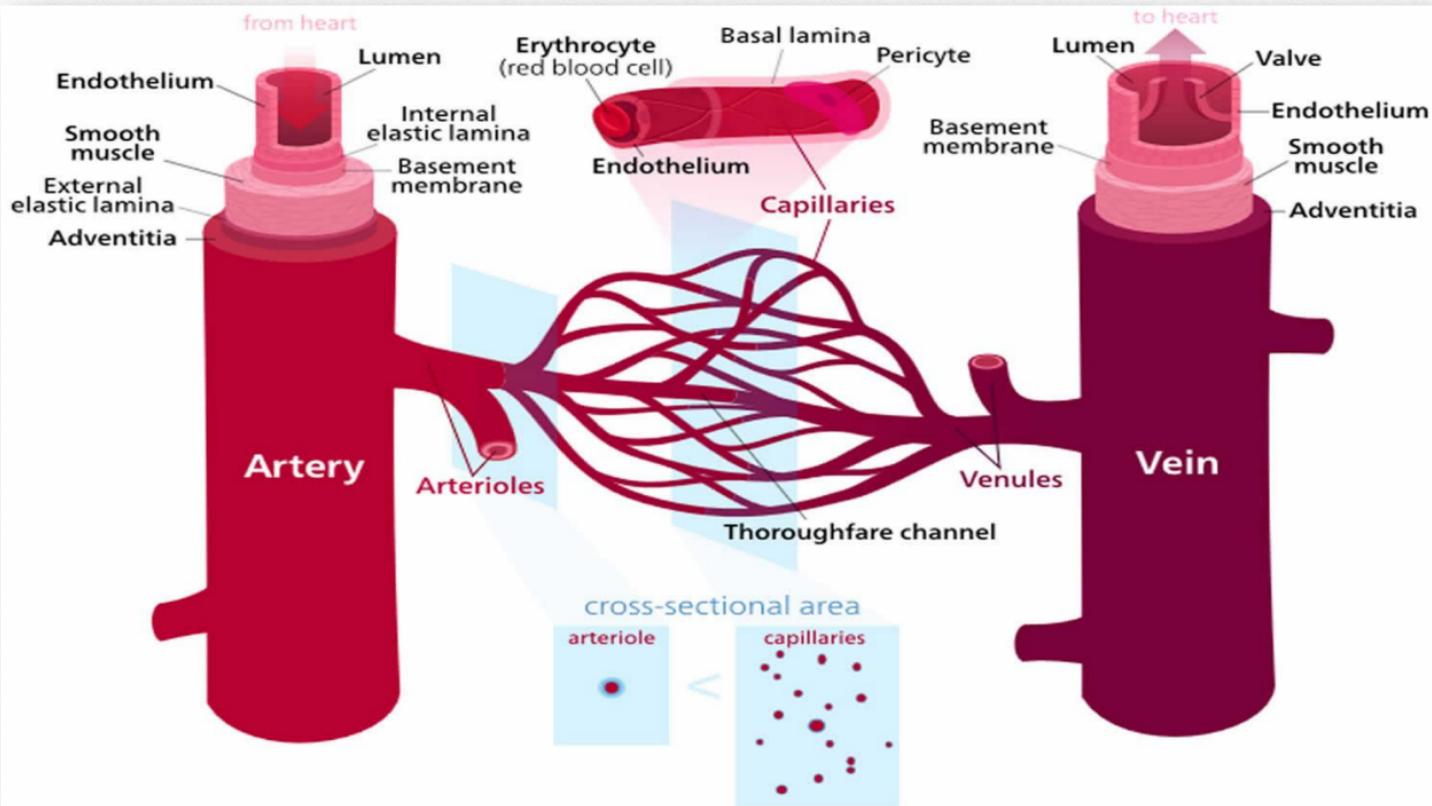
Carry fresh oxygen through the body and remove carbon dioxide. Red blood cells make up about 40 to 45% of blood.

## White blood cells



Part of the body's immune system, detect and fight viruses and bacteria. There are five major types of white blood cells, and they make up less than 1% of blood.

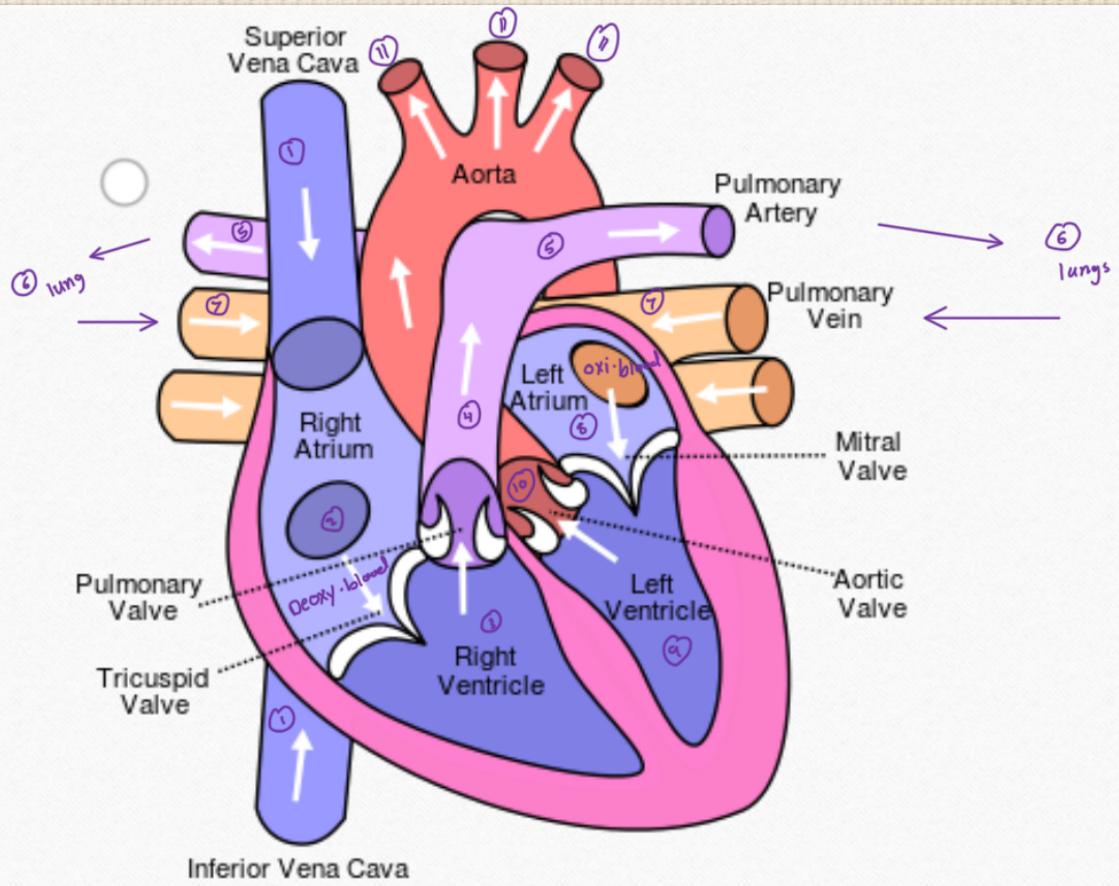




**Table 1. Five blood vessel types**

Vessel type	Function
Arteries	Transport high-pressure blood from the heart to smaller arteries and arterioles
Arterioles	Connect arteries and capillaries
Veins	Act as reservoir of blood and transport low-pressure blood from venules to heart
Venules	Connect capillaries and veins
Capillaries	Allow gas exchange, nutrient transfer and waste removal between blood and tissue fluid

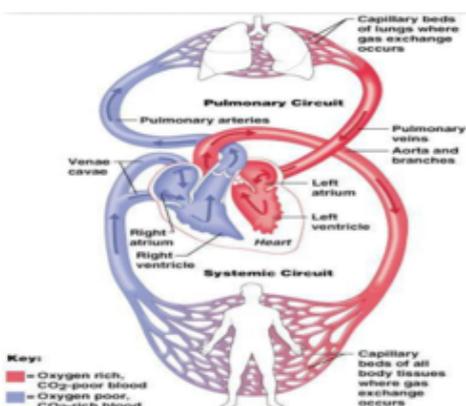
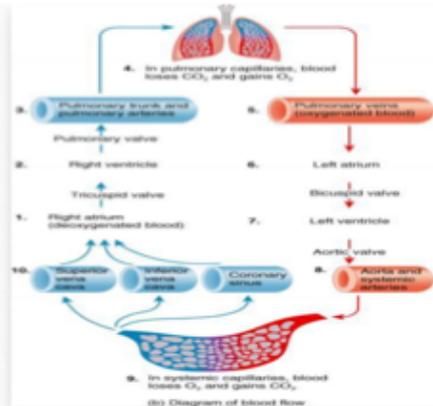




# Circulation

## Two Sets of Pumping Chambers in Heart:

- **Right atrium:** Receives systemic blood.
- **Right ventricle:** Pumps blood to lungs (pulmonary).
- **Left atrium:** Receives blood from lungs.
- **Left ventricle:** pumps blood to organ systems (systemic).

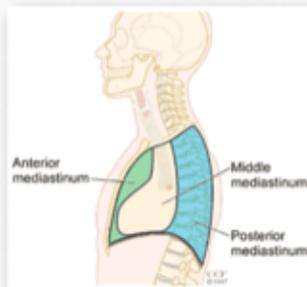


## Heart Pumps Blood into Two Circuits in Sequence :

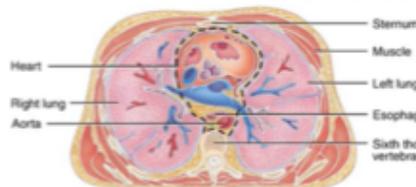
- **Pulmonary circuit:** To and from the lungs.
- **Systemic circuit:** To and from the rest of the body.

## Location of the heart

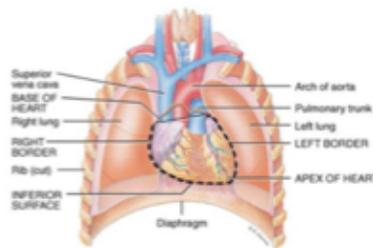
- The heart is located in the thoracic cavity, it is located in the **mediastinum**.
- Area from the sternum to the vertebral column and between the lungs.
- The ascending of the aorta is located in the middle mediastinum. The apex of the heart is located in the inferior of the mediastinum. The base is located in the superior mediastinum.



## Heart Location

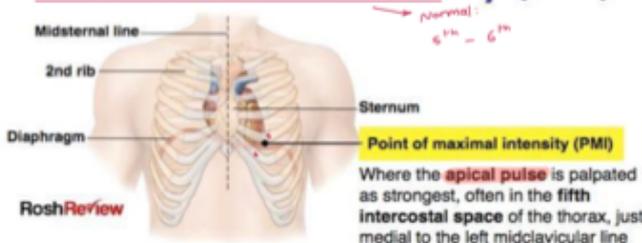


- Heart is located in the **mediastinum** - area from the sternum to the vertebral column and between the lungs



- Apex - directed anteriorly, inferiorly and to the left
- Base - directed posteriorly, superiorly and to the right
- Anterior surface - deep to the sternum and ribs
- Inferior surface - rests on the diaphragm
- Right border - faces right lung
- Left border (pulmonary border) - faces left lung

## Point of Maximal Intensity (PMI)



Where the **apical pulse** is palpated as strongest, often in the **fifth intercostal space** of the thorax, just medial to the left midclavicular line

# Layers of heart wall =

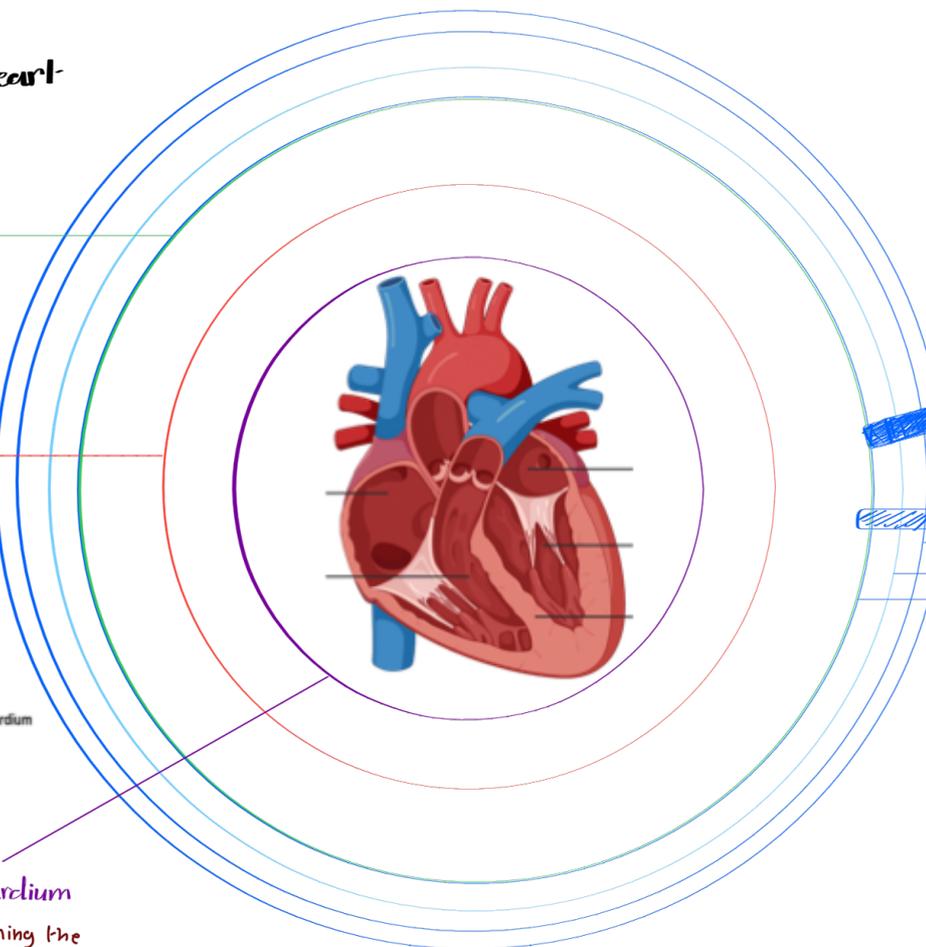
① epicardium

② myocardium

- ↳ on the chambers from outside
- muscle → contraction of chambers
- Differ. thickness from chamber to another (thickest L.V)

③ endocardium

- ↳ lining the chambers from inside
- keep the blood inside the chambers
- smooth



حلاف القلب :-

pericardium

① fibrous

② serous

a partial

b visceral

Fluid

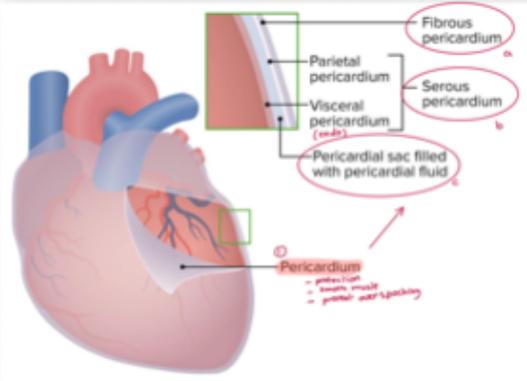
- ↳ - smooth muscle
- elasticity: prevent overexpansion of heart muscle
- protection

الغشاء الجداري للقلب (fibrous pericardium) هو الغشاء الخارجي للقلب الذي يمنع تضخم القلب المفرط ويمنح القلب مرونة كافية.  
 الغشاء الجداري للقلب (serous pericardium) هو الغشاء الداخلي للقلب الذي يمنع تضخم القلب المفرط ويمنح القلب مرونة كافية.

Note:-  
visceral same as epicardium

Myocardium هو الطبقة العضلية القلبية المسؤولة عن ضخ الدم

## Pericardial Layers of the Heart



- **Pericardial Cavity:**
- ✓ Surrounds the heart.
- ✓ Lined by the pericardium.
- ✓ Two layers:
- Visceral pericardium (epicardium):
- Covers heart surface
- Parietal pericardium:
- Lines pericardial sac that surrounds the heart.

## # مقارنه Cardiac Muscle Cells

- ✓ Shorter than skeletal muscle fibers.
- ✓ Have a single nucleus.
- ✓ Have striations (sarcomere organization).
- ✓ Depend on aerobic metabolism.
- ✓ Connected by intercalated discs
- Desmosomes transmit tension.
- Gap junctions transmit action potential.

pericardial wall:  
 1. Endothelium  
 2. Myocardium  
 3. Epicardium

### Properties of Cardiac Muscle Fibers

1. **Autorhythmicity:** The ability to initiate a heart beat continuously and regularly without external stimulation
2. **Excitability:** The ability to respond to a stimulus of adequate strength and duration (i.e. threshold or more) by generating a propagated action potential
3. **Conductivity:** The ability to conduct excitation through the cardiac tissue
4. **Contractility:** The ability to contract in response to stimulation

### Autorhythmic Fibers: The Conduction System

- ✓ An inherent and rhythmical electrical activity is the reason for the heart's lifelong beat.
- ✓ The source of this electrical activity is a network of specialized cardiac muscle fibers called **autorhythmic fibers** because they are self-excitabile.
- ✓ Autorhythmic fibers repeatedly generate action potentials that trigger heart contractions.

## \* جدار القلب The Heart Wall

1. ✓ Epicardium (visceral pericardium):
  - o Outermost layer.
  - o Serous membrane.
2. ✓ Myocardium:
  - o Middle layer.
  - o Thick muscle layer.
3. ✓ Endocardium.
  - o Inner lining of pumping chambers.
  - o Continuous with endothelium

muscle type	Cardiac	skeletal
controlling	involuntary	sup-voluntary
Fibers length	shorter	longer
The needs for ATP	needs more ATP → has more mitochondria	less energy
Ca <sup>2+</sup> ions	more ↳ also more SR (store Ca ions)	less
synapses	electrical → no transmitters very fast ↓ through gap junction	chemical → needs transmitter slower ↓
Nucleus	one	multi

# Valves

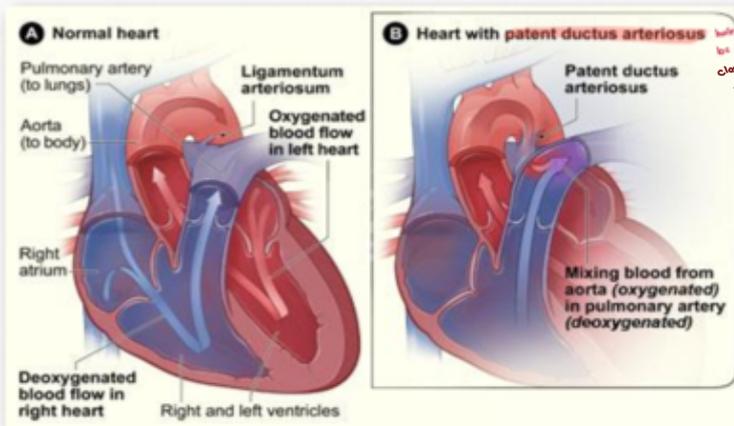
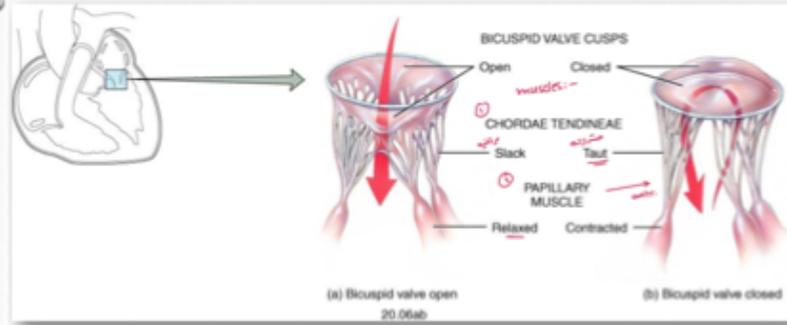
## Atrioventricular Valves

A-V valves open and allow blood to flow from atria into ventricles when ventricular pressure is lower than atrial pressure:

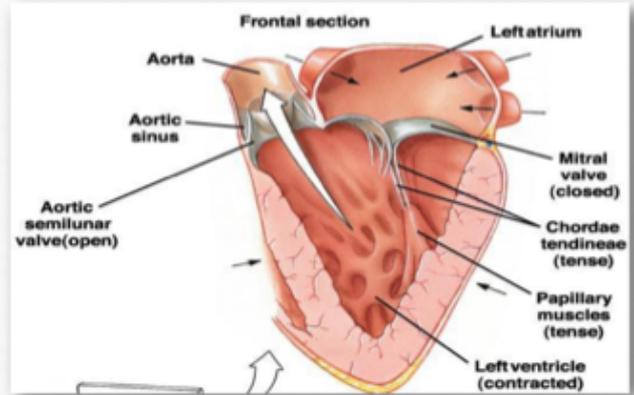
- occurs when ventricles are relaxed, chordae tendineae are slack and papillary muscles are relaxed.

•A-V valves close preventing backflow of blood into atria :

- occurs when the ventricles contract, pushing valve cusps closed, chordae tendineae are pulled taut, and papillary muscles contract to pull cords and prevent cusps from everting.



## Left ventricle



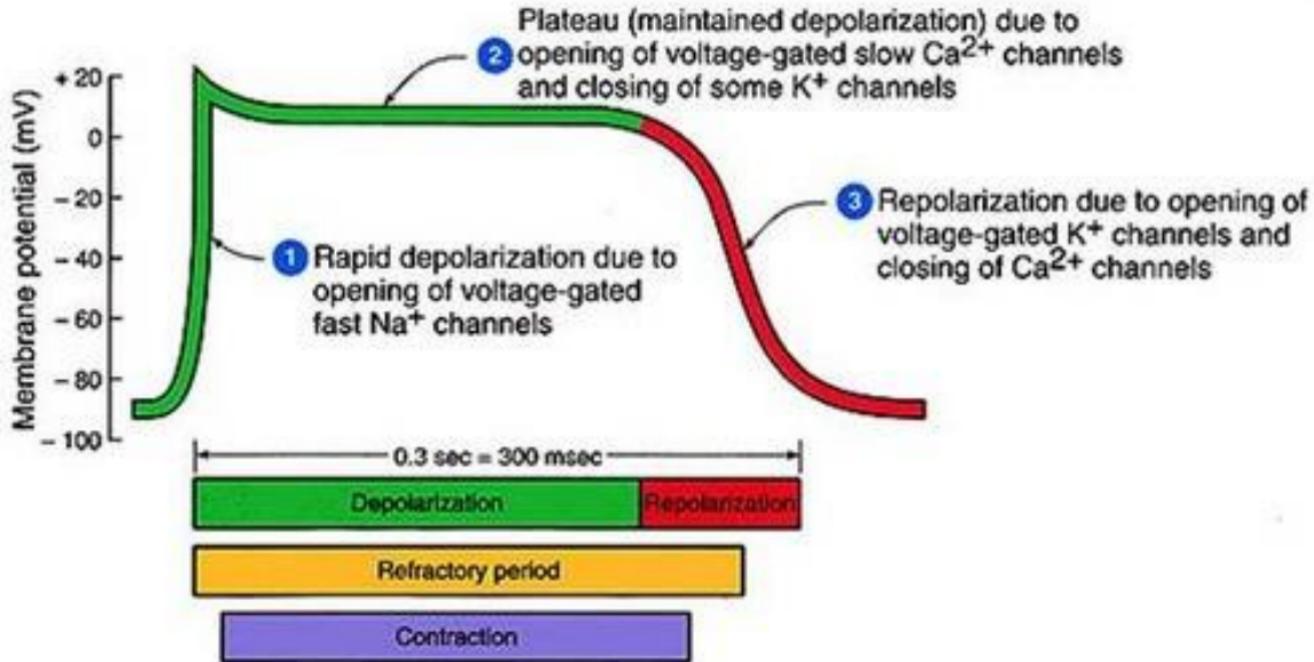
## Semilunar valves

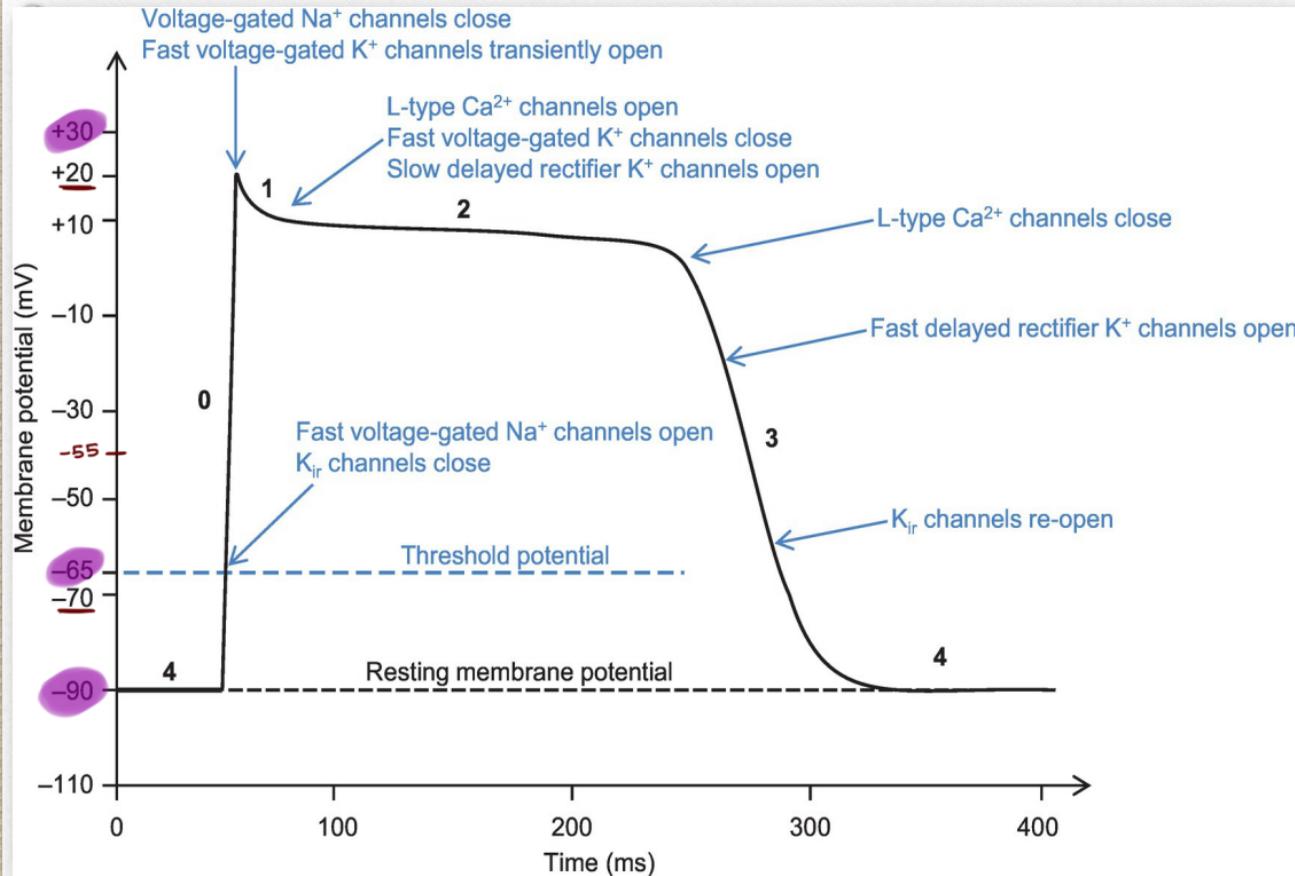


## Atrioventricular valves



# Action Potential and Contraction of Contractile Fibers





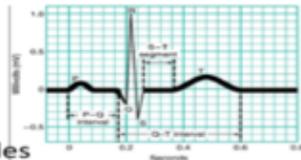
## Action Potential and Contraction of Contractile Fibers

# ELECTROCARDIOGRAM

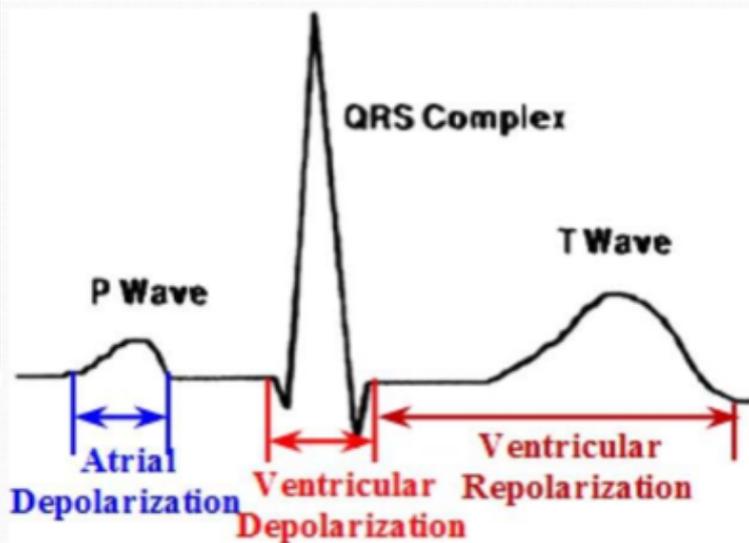
## The Electrocardiogram

- The major deflections and intervals in a normal ECG include:

- P wave - atrial depolarization
- P-Q interval - time it takes for the atrial kick to fill the ventricles
- QRS wave - ventricular depolarization and atrial repolarization
- S-T segment - time it takes to empty the ventricles before they repolarize (the T wave)

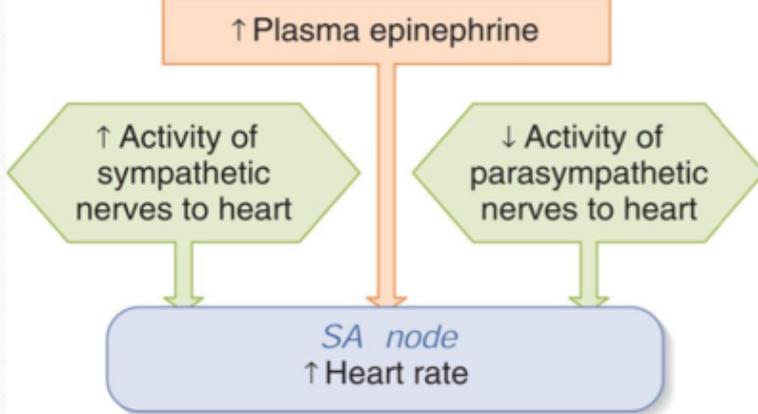


- Analysis of an ECG also involves measuring the time spans between waves, which are called intervals or segments.
- P-Q interval** is the time from the beginning of the P wave to the beginning of the QRS complex. It represents the conduction time from the beginning of atrial excitation to the beginning of ventricular excitation.
- The **S-T segment**, which begins at the end of the S wave and ends at the beginning of the T wave, represents the time when the ventricular contractile fibers are depolarized during the plateau phase of the action potential.
- The **Q-T interval** extends from the start of the QRS complex to the end of the T wave. It is the time from the beginning of ventricular depolarization to the end of ventricular repolarization.



# Control of the Heart by the Sympathetic and Parasympathetic Nerves

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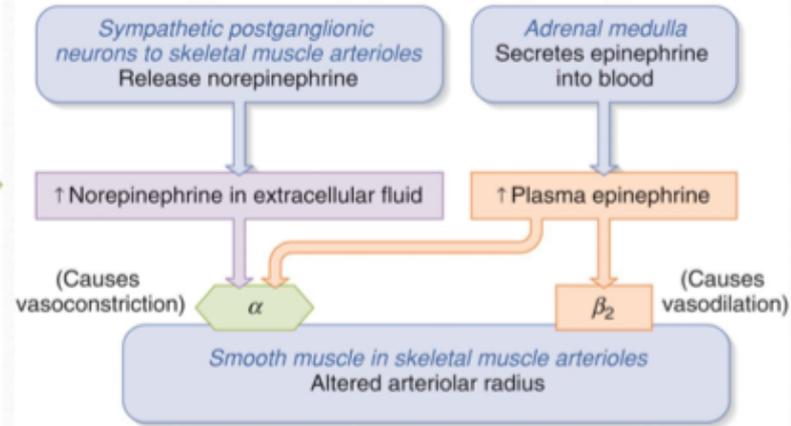
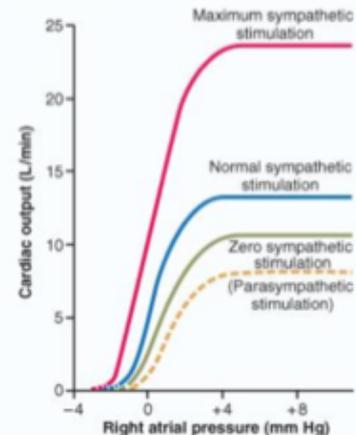


Table 12-3 Effects of Autonomic Nerves on the Heart

Area Affected	Sympathetic Nerves (norepinephrine on $\beta$ -adrenergic receptors)	Parasympathetic Nerves (ACh on muscarinic receptors)
SA node	Increased heart rate	Decreased heart rate
AV node	Increased conduction rate	Decreased conduction rate
Atrial muscle	Increased contractility	Decreased contractility
Ventricular muscle	Increased contractility	No significant effect <i>(the only diff)</i>



- 
- **Parasympathetic stimulation** (acetylcholine) doesn't affect **beta receptors** because acetylcholine primarily interacts with **muscarinic receptors** on the heart, which mainly influence the heart rate and conduction but not the contractility (force of contraction).
  - **Sympathetic stimulation** (norepinephrine), on the other hand, acts on **beta-1 adrenergic receptors** on the cardiac muscle. When norepinephrine binds to these receptors, it triggers a cascade that increases **calcium ion influx** into the cardiac muscle cells, enhancing the strength of contraction (inotropy).

So, the key difference is that **sympathetic stimulation** directly influences **contractility** by affecting calcium influx through **beta-1 adrenergic receptors**, while **parasympathetic stimulation** has no significant effect on contractility because it doesn't interact with those receptors.

---

# Effects of Potassium and Calcium Ions on Heart Function

if  $Na^+$  ↑ inside cell

## Sodium

Block  $Ca^{+2}$  channels  
 ↓  
 No plateau phase  
 (no maintaining to Dep)



\* المخروفين

لما نوصل لـ +30 تسبب قنوات الصوديوم وتفتح قنوات الكالسيوم عشان ال plateau بس لو زاد الصوديوم عن +30 يعني ضلن قنواته مفتوحه ← الضيق بدعا تعادل الايونات حابقدر تفتح الكالسيوم  $Ca^{+2}$  ← ما عن حافظه على ال Dep ← ما بصير Full contraction in Atrium  
 → R.A بضع دم

Decrease muscle contraction in the heart

contraction ↓

زيادة

## Calcium

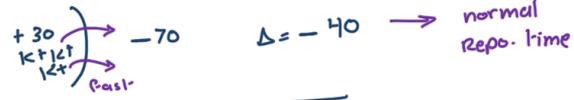
↓  
 contraction ↑  
 (strength of cont.)

زيادة

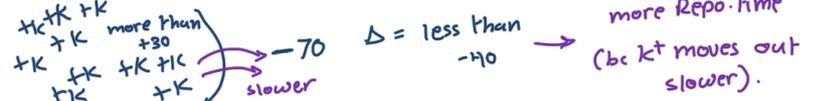
## Potassium

↓  
 Repolarization ↑  
 ↓  
 Relaxation time ↑  
 ↓  
 Contraction ↓

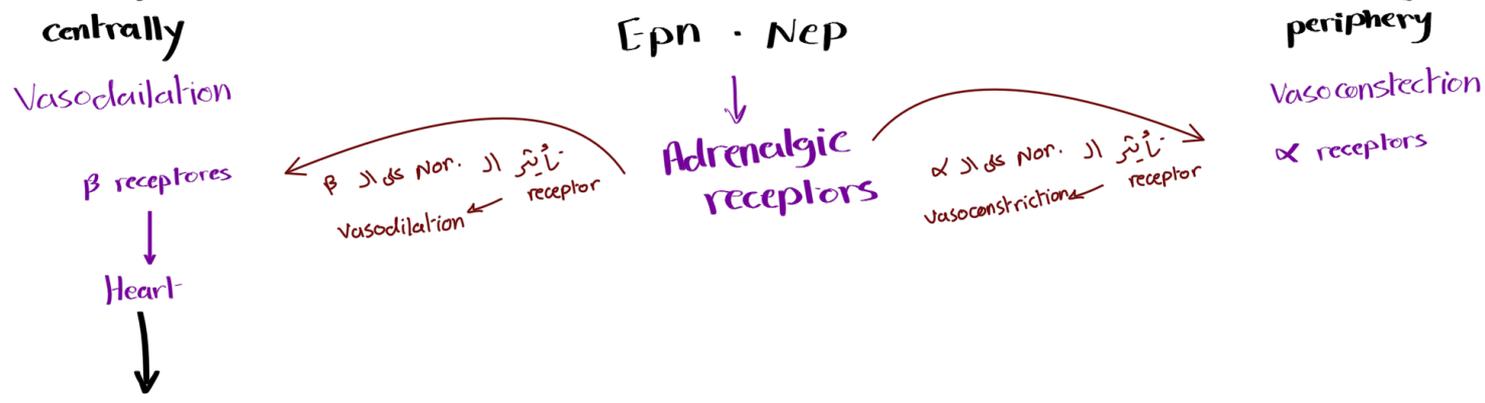
Normal



Hyperkalemia



# sympathatic effect-



Blood V in systimic circulation  
جزید

**CO = HR x SV, as follows.**  
The heart is the pump that moves the blood. Its activity can be expressed as “cardiac output (CO)” in reference to the amount of blood moved per unit of time.

**Mean arterial pressure**, which drives the blood, is the sum of the diastolic pressure plus one-third of the difference between the systolic and diastolic pressures.

**The autonomic system dynamically adjusts CO and MAP.**



**Pathophysiology-Ischemic Heart Disease**  
**Faculty of Pharmaceutical Sciences**

**Dr. Amjaad Zuhier Alrosan, Dr. Abdelrahim Alqudah**

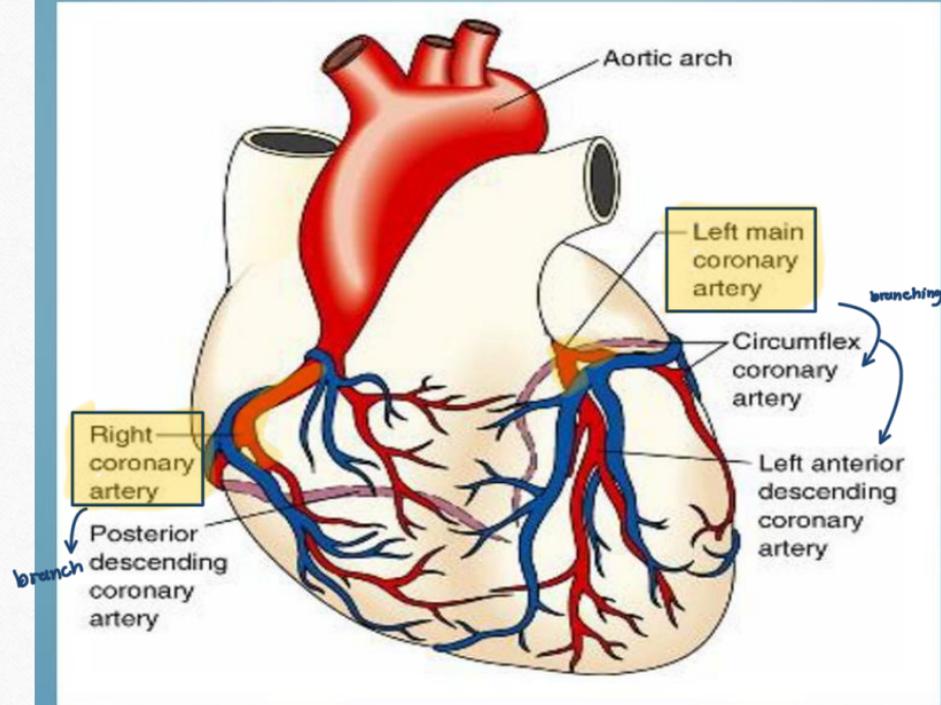
ACD : Acute coronary disease

signs of  
Coronary artery

# Normal coronary blood flow

- The resting coronary blood flow = 225 ml/min
- In strenuous exercise = increase three to four folds.

## HEART PERFUSION



Blood  
Flow

for the whole  
body

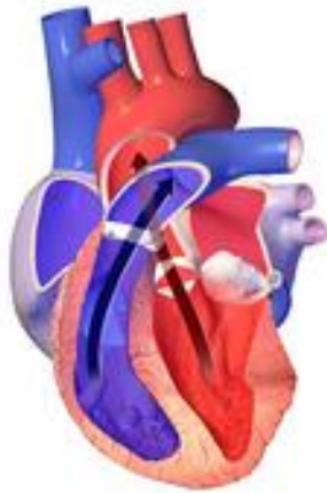
كمية الدم التي  
تخرج من القلب  
لكل الجسد

perfusion

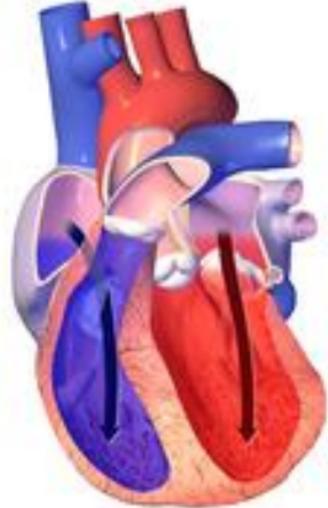
to specific  
organs

كمية الدم التي  
تأخذ كل كنية  
وتجده من كضو  
عجين

# Heart Perfusion



Systole  
(pumping)



Diastole  
(filling)

يعرفون من  
Diastole

نعم، هناك فرق بين هذه المصطلحات:

### 1. النوبة القلبية (Heart Attack - Myocardial Infarction - MI):

- تحدث عند انسداد أحد الشرايين التاجية التي تغذي القلب، مما يؤدي إلى نقص التروية وموت جزء من عضلة القلب بسبب عدم وصول الأكسجين.
- قد تكون مصحوبة بألم في الصدر، ضيق تنفس، غثيان، وتعرق.

### 2. السكتة القلبية (Cardiac Arrest):

- هي توقف مفاجئ لعمل القلب، مما يؤدي إلى توقف ضخ الدم إلى الجسم بالكامل.
- تحدث نتيجة اضطراب كهربائي شديد مثل الرجفان البطيني (Ventricular Fibrillation) أو بسبب نوبة قلبية حادة.
- المريض يفقد الوعي بسرعة وقد يتوقف التنفس.

### 3. الجلطة القلبية (Coronary Thrombosis):

- تعني تكوّن خثرة دموية (جلطة) في أحد الشرايين التاجية، مما يؤدي إلى انسداده جزئيًا أو كليًا.
- يمكن أن تؤدي الجلطة القلبية إلى نوبة قلبية إذا لم يتم علاجها بسرعة.

بالتالي، النوبة القلبية هي نتيجة انسداد الشريان، وقد تؤدي إلى سكتة قلبية إذا كان الضرر شديدًا وأثر على النظام الكهربائي للقلب. أما الجلطة القلبية فهي السبب الرئيسي لحدوث النوبة القلبية.

كل ما تحدثنا عنه—الجلطة (Thrombosis)، الذبحة الصدرية (Angina)، والاحتشاء القلبي (Myocardial Infarction - MI)—مرتبط بشكل أساسي بـ الإسكيميا (Ischemia) لأنها العامل الأساسي الذي يسبب هذه الحالات. إليك كيف:

### 1. الإسكيميا (Ischemia) هي المشكلة الرئيسية

• الإسكيميا تعني نقص التروية الدموية، أي أن الأنسجة لا تحصل على كمية كافية من الدم الغني بالأكسجين بسبب تضيق أو انسداد الشرايين التاجية.

### 2. كيف تؤدي الإسكيميا إلى الذبحة الصدرية والجلطة؟

• **الذبحة الصدرية (Angina):** تحدث عندما يكون هناك إسكيميا مؤقتة، أي أن تدفق الدم إلى عضلة القلب يقل ولكنه لا يتوقف تمامًا. وهذا يسبب ألمًا في الصدر لكنه لا يؤدي إلى موت خلايا القلب.

• إذا كانت الذبحة مستقرة (Stable Angina)، فالإسكيميا تحدث فقط أثناء الجهد وتحسن بالراحة.

• إذا كانت الذبحة غير مستقرة (Unstable Angina)، فالإسكيميا تزداد سوءًا وقد تحدث حتى في الراحة، مما يشير إلى خطر كبير للجلطة.

• **الجلطة (Thrombosis) واحتشاء عضلة القلب (MI):** إذا أصبح الانسداد كاملاً بسبب جلطة دموية (Thrombus)، فإن الإسكيميا تصبح شديدة ومستدامة، مما يؤدي إلى نقص الأكسجين تمامًا في جزء من القلب.

• هذا يؤدي إلى احتشاء عضلة القلب (Myocardial Infarction - MI)، أي موت خلايا القلب (Necrosis) لأن الدم لا يصل إليها نهائيًا.

### 3. دور الدورة الدموية الجانبية (Collateral Circulation)

• إذا كان الانسداد يحدث ببطء بسبب تصلب الشرايين المزمن، فقد تتشكل أوعية دموية جانبية تساعد في تقليل شدة الإسكيميا، وبالتالي تقلل من احتمالية حدوث الجلطة أو تقلل شدتها.

## الخلاصة

الإسكيميا هي الأساس لكل هذه الحالات: الذبحة الصدرية، الجلطة، واحتشاء عضلة القلب. إذا كانت الإسكيميا مؤقتة → ذبحة صدرية، وإذا استمرت وأدت إلى موت الأنسجة → احتشاء عضلة القلب (MI).

نقص التروية يحدث عندما لا يحصل النسيج على دم كافٍ. الأسباب الرئيسية تشمل **تصلب الشرايين** (تراكم الدهون في الشرايين)، **الجلطات الدموية** (التي تسد الشرايين)، **تشنجات الأوعية الدموية** (التي تقلل تدفق الدم)، **الضغط الخارجي أو الصدمات**، و **الأمراض المزمنة** مثل السكري وارتفاع ضغط الدم.

أعراض # ACD : Disease caused by a problem of coronary artery.

أحد هاتين الأعراض → our topic :

IHD Ischemic heart disease



# Angina

stable

ذبحه صدرية

- we have a clot inside the blood vessel but it's not fully blocked

unstable



# But, what's the cause for ischaemia?

it may happen as a result for

clot (خثرة)

→ close the lumen of the blood vessel

could cause

# Angina

الذبحة الصدرية (Angina Pectoris) تندرج تحت أمراض الشرايين التاجية (Coronary Artery Disease - CAD) وهي مختلفة عن النوبة القلبية لكنها قد تكون مؤشرًا على خطر حدوثها. الذبحة الصدرية تحدث عندما يكون نقص في التروية الدموية لعظمة القلب بسبب تضيق الشرايين التاجية وذلك دون حدوث موت لخلايا عظمة القلب كما في النوبة القلبية.

لحمي والتضيق الذبحة الصدرية أو "الذبحة" هي حالة تحدث عندما يكون هناك تضيق أو انسداد جزئي في الشرايين التاجية التي تزود القلب بالدم. لكن في هذه الحالة لا يكون هناك انسداد كامل أو "سد" تام. بل فقط تضيق جزئي أو خلل في تدفق الدم مما يقلل من كمية الأوكسجين الذي يصل إلى عظمة القلب.

هذا التضيق في تدفق الدم يؤدي إلى ما يُسمى "نقص التروية" (ischemia) والذي يسبب الشعور بالألم أو الضيق في الصدر. عادةً تتجلى كألم خفيف أو تورط خفيف يحدث بسبب أن عظمة القلب لا تحصل على كمية كافية من الأوكسجين الذي تحتاجه أثناء عملها بشكل طبيعي.

أولاً، أنت صاغ هناك نقطة مهمة. الفرق بين الذبحة الصدرية المستقرة وغير المستقرة على سبب الأعراض لكن كمان في طريقة تكون الجلطات.

في الذبحة الصدرية المستقرة (Stable Angina)، عادةً ما يكون هناك تراكم بطيء للـ plaque (الذي يتكون من الدهون والكوليسترول) داخل الشرايين التاجية. هذا التراكم تضيق الشرايين ويقلل من تدفق الدم. لكن في الغالب لا يحدث انسداد كامل. الجلطات هنا قد تكون صغيرة أو لا تتشكل بشكل مفاجئ. بمعنى آخر، التضيق يحدث بشكل ثابت وثابت مع مرور الوقت.

أما في الذبحة الصدرية غير المستقرة (Unstable Angina)، الجلطات هنا أكثر خطورة. يحدث تضيق في الـ plaque أو أن هناك تفاعل مفاجئ يؤدي إلى تكوين جلطات كبيرة فجأة داخل الشرايين. الجلطات هنا قد تسبب انسداد جزئي أو كامل للشرايين بشكل مفاجئ. مما يؤدي إلى انخفاض مفاجئ في تدفق الدم إلى القلب. هذا النوع من الجلطات أكثر خطورة ويمكن أن يؤدي إلى نوبة قلبية.

إذن الفرق بينهما يكمن في طريقة تكون الجلطة وحجمها. في الذبحة المستقرة، التضيقات تكون أكثر تدريجية ومستقرة. بينما في الذبحة غير المستقرة، التضيقات تحدث بشكل مفاجئ مع جلطات قد تكون كبيرة وأكثر خطورة.

إذن، نعم، من الممكن أن يكون هناك تراكم ثابت للـ plaque ويظل الشخص يعاني من الذبحة الصدرية المستقرة لفترة طويلة، ولكن إذا حدث تضيق في الـ plaque أو تغيرات مفاجئة في التراكم، فسيؤدي ذلك إلى تحوّل الحالة إلى ذبحة غير مستقرة، مما يعني أن الأمور تصبح أكثر خطورة وفجائية.

# آخر نقطة : unstaBe Angina معنى تتحول إلى Myocardial infarction نوبة قلبية

blood vessel is fully blocked in this case

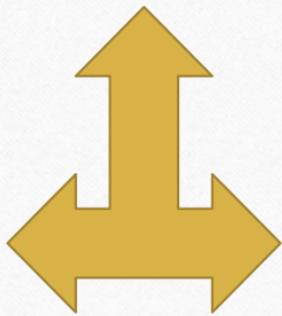
\* endothelial cells functions:

- ① smooth blood flow
- ② maintaining the vascular tone by releasing vaso {  
- constrictors  
- dilators
- ③ balance between vaso {  
- C  
- D
- ④ prevent → a. inflammation b. coagulation

# Control of coronary blood flow

**Metabolic regulation**

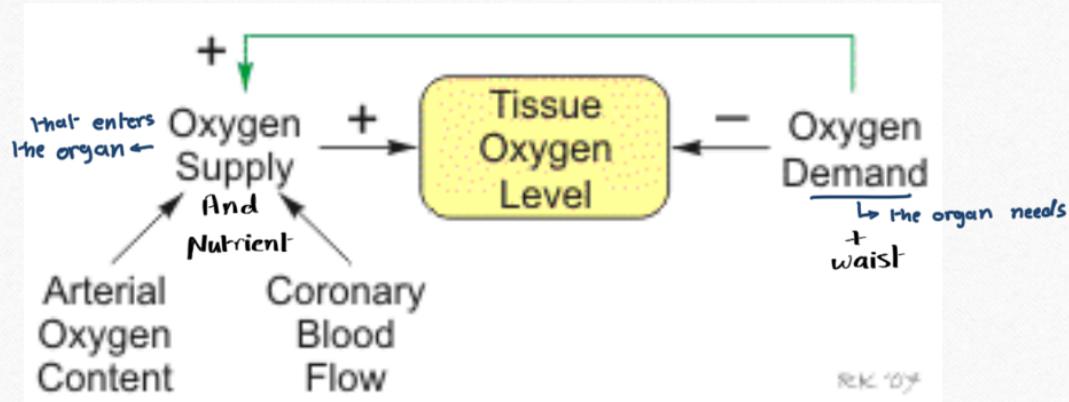
↳ endothelium cells → vaso {  
- constrict.  
- dilation



**Nervous control**

↳ sym. para

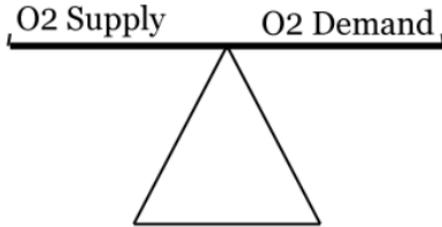
# Oxygen balancing act



# Etiology of ischemic heart disease

cause

## Myocardial Oxygen Supply and Demand



coronary blood flow  
oxygen availability

heart rate  
contractility  
preload  
afterload

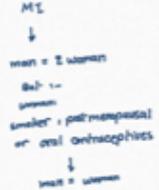
- ❑ Lack of oxygen due to <sup>inefficient</sup> inadequate perfusion of the myocardium causes an imbalance between oxygen supply and demand.

$O_2 \downarrow \xrightarrow{to} \text{myocardium} \rightarrow \text{imbalance } O_2 < \begin{matrix} \text{supply} \\ \text{demand} \end{matrix}$

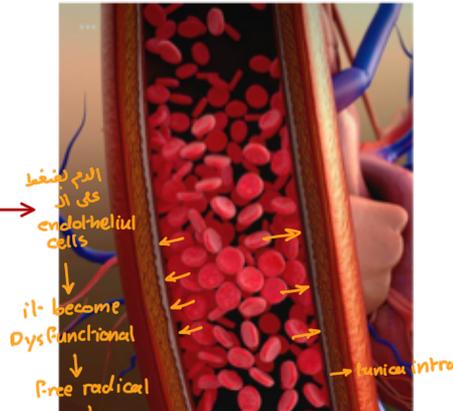
- ❑ MI, an acute coronary syndrome, results from reduced blood flow through one of the coronary arteries. This causes: myocardial ischemia, injury, and necrosis.

# Coronary atherosclerosis → تجمع دهنية (MHA) مؤكسدة

- ✓ The most common cause of myocardial ischemia.
- ✓ Epicardial coronary arteries are the major site.
- ✓ Men are more susceptible to MI than premenopausal women, although the incidence is increasing in women who smoke and take hormonal contraceptives. The incidence in postmenopausal women is similar to that in men.



- ✓ Risk factors:
  - Modifiable:
    - Cigarette smoking.
    - DM.
    - Hypertension.
    - Hyperlipidaemia.
  - Non-modifiable:
    - Age.
    - Family history.
    - Sex.



## TUNICA INTERNA (INTIMA)

- ✦ The tunica interna (intima) forms the inner lining of a blood vessel and is in direct contact with the blood as it flows through the lumen, or interior opening, of the vessel. Although this layer has multiple parts, these tissue components contribute minimally to the thickness of the vessel wall.
- ✦ Its innermost layer is called endothelium, is a thin layer of flattened cells that lines the inner surface of the entire cardiovascular system (heart and blood vessels). The endothelial cells are active participants in a variety of vessel-related activities, including physical influences on blood flow (secretion of locally acting chemical mediators that influence the contractile state of the vessel's overlying smooth muscle, and assistance with capillary permeability). In addition, their smooth luminal surface facilitates efficient blood flow by reducing surface friction.



## TUNICA INTERNA (INTIMA)

- ✦ The second component of the tunica interna is a basement membrane deep to the endothelium. It provides a physical support base for the epithelial layer. It appears to play an important role in guiding cell movements during tissue repair of blood vessel walls.
- ✦ The outermost part of the tunica interna, which forms the boundary between the tunica interna and tunica media, is the internal elastic lamina, is a thin sheet of elastic fibers with a variable number of window-like openings that facilitate diffusion of materials through the tunica interna to the thicker tunica media.



## TUNICA MEDIA

- ✓ In the tissue layer that displays the greatest variation among the different vessel types. In most vessels, it is a relatively thick layer comprising mainly smooth muscle cells and substantial amounts of elastic fibers.
- ✓ An increase in sympathetic stimulation typically stimulates the smooth muscle to contract, squeezing the vessel wall and narrowing the lumen. Such a decrease in the diameter of the lumen of a blood vessel is called vasoconstriction.
- ✓ In contrast, when sympathetic stimulation decreases, smooth muscle fibers relax. The resulting increase in lumen diameter is called vasodilation.

# Vascular endothelium

- ❖ **The normal function of vascular endothelium:**
  - Local control of vascular tone.
  - Maintenance of an anticoagulant surface. → معضاد للتخثر
  - Defence against inflammatory cells.
- ❖ **Endothelial dysfunction:** → permeability ↑ → contraction ↑
  - Inappropriate constriction.
  - Luminal clot formation.
  - Abnormal interactions with blood monocytes & platelets.

\* long story:-

- Dysfunctional endothelial cells  $\xrightarrow{\text{release}}$  Free radicals

Free radicals  $\xrightarrow{\text{oxidation}}$  of LDL to oxidised LDL



simulation  $\rightarrow$  immunity system



sends  $\rightarrow$  Monocytes (part of WBC)  $\rightarrow$  Dysfunctional endothelial  
 لما وصل بتشول

Monocytes  $\rightarrow$  Macrophage  
 خلية بلعمه

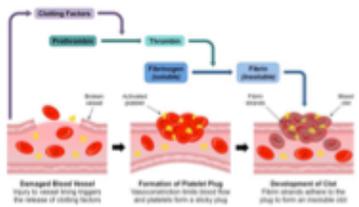
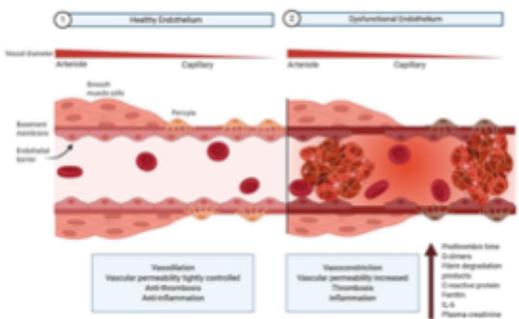
glp

OXIDISED LDL molecules

يعبر اسمها  $\rightarrow$  Foam cells or plack or streak  
 it gets bigger

المعروفه  $\rightarrow$  تطلب التترايين

arteriosclerosis  
 عبارة عن تجمع مجموعة من الدهنيان  
 المتؤسده (LDL) بالاعضاء



platelet + clotting factors

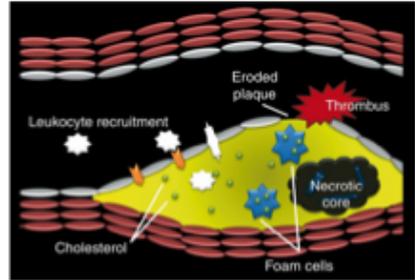
Rupture (explodes)

stable angina localized  $\rightarrow$  small rupture

clot =

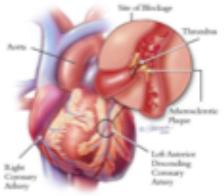
unstable angina impulsim (movement)  $\rightarrow$  big rupture

myocardium infarction  $\leftarrow$  could cause



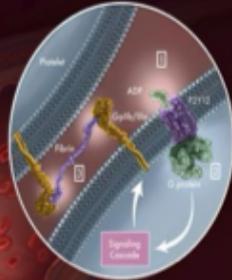
Foam cells keeps getting bigger

until it



# MYOCARDIAL INFARCTION

In the majority of acute myocardial infarcts, the causative factor is an occlusive intracoronary thrombus (blockage) due to atherosclerosis. Heart muscle downstream to the blockage becomes ischemic and eventually necrotic. Platelets play a key role in the formation of the block. They attach to the endothelial cells near the breach in the atherosclerotic vessel, where they begin to build a plug. Aggregates of platelets bind fibrin, creating a netlike framework that traps blood cells and keeps the growing clot in place.



## PLATELET AGGREGATION

1. On the platelet membrane, ADP binds to the P2Y<sub>1</sub> receptor.
2. The G protein of P2Y<sub>1</sub> is activated, which leads to a signaling cascade inside the platelet.
3. The GPIIb/IIIa protein is activated through the cascade, causing the platelet to bind fibrin. The fibrin molecule is bound by another platelet, causing aggregation.

## ANTI-PLATELET AGGREGATION

After a myocardial infarction, blood clotting can be managed with Plavix® (clopidogrel bisulfate). Converted to its active metabolite in the liver, clopidogrel travels through the blood stream and irreversibly binds to the P2Y<sub>1</sub> membrane receptor found on platelet membranes. This effectively prevents the signaling cascade leading to platelet aggregation, and can reduce the patient's risk of developing another life-threatening clot by up to 20 percent.

**Thrombosis** → إذا كانت جلطة دموية تتكون داخل الوعاء الدموي.

**Blood Clot** → تعني جلطة دموية بشكل عام.

**Embolism** → إذا كانت الجلطة أو أي مادة أخرى انتقلت من مكانها وسدت وعاء دموي آخر.

**Stroke** → إذا كانت الجلطة في الدماغ (سكتة دماغية).

**Heart Attack (Myocardial Infarction)** → إذا كانت الجلطة في شرايين القلب وسدت تدفق الدم للقلب.

مش بالضبط. التخثر (Thrombosis) و الانسداد (Embolism) هما مصطلحات تتعلق بتجلط الدم وحركته، لكن مش نفس الشيء زي الذبحة الصدرية المستقرة (Stable Angina) و الذبحة الصدرية غير المستقرة (Unstable Angina).

• الذبحة الصدرية المستقرة هي ألم في الصدر يحصل عادة مع المجهود أو التوتر، وغالبًا يكون بسبب تراكم الدهون في الشرايين (تصلب الشرايين)، لكن مش بالضرورة بسبب تجلط الدم.

• الذبحة الصدرية غير المستقرة هي ألم شديد في الصدر يحصل فجأة، وغالبًا يكون بسبب تمزق جزء من الدهون المتراكمة في الشرايين وتكوين جلطة (تخثر) تسد الشريان. ده ممكن يحصل في حالة التخثر، لكن مش هو نفسه.

التخثر ممكن يسبب مشاكل في الذبحة الصدرية المستقرة أو غير المستقرة لو الجلطة سدت الشريان، لكن مش بيبطلق عليه اسم الذبحة الصدرية. و الانسداد بيحصل لما الجلطة تتحرك وتسد مكان تاني في الجسم، وده مش زي الذبحة الصدرية.

Blocked

# Acute coronary occlusion

الفرق بين منطقة الإصابة و حلقة الإقفار يكمن في شدة تقليص تدفق الدم وحالة الأنسجة:

انسداد

→  
يصنع الدم من الوصول الى اجزاء من القلب

تفتت

➤ Thrombosis.

Related to blood

clots and their movement

➤ Embolism.

انسداد

heart attack

من خطبة القلب نفسها

tissue death

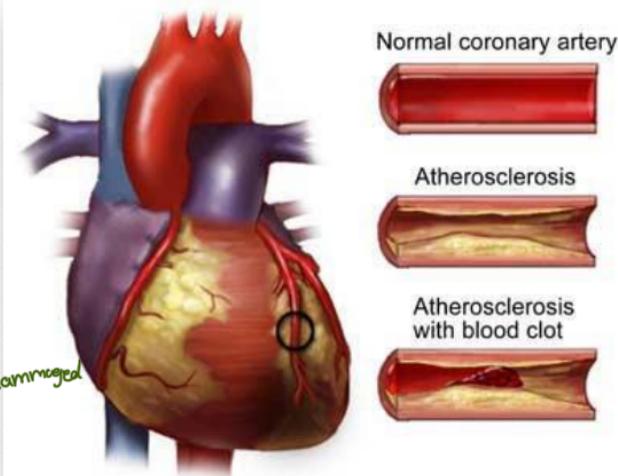
All MIs have a central area of **necrosis** or **infarction** surrounded by an area of **injury**.

more specific

→ damaged

The area of **injury** is surrounded by a ring of **ischemia**. Tissue regeneration doesn't occur after an MI because the affected myocardial muscle **is dead**.

→ not enough blood



**In short:** The **area of injury** is more **damaged** (tissue is at high risk of dying), while the **ring of ischemia** has **reduced blood flow** but is still in a less damaged state.

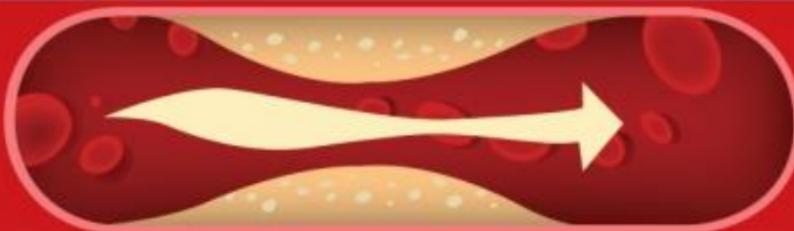
النسج الذي يحدث له تلف جزئي القلب



## Coronary artery disease

Plaque builds up in an artery

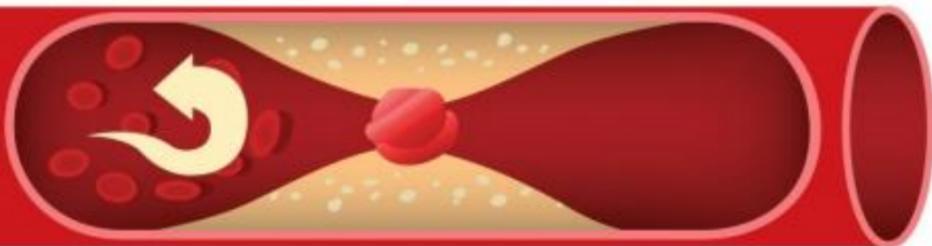
## Angina



It is harder for blood to get through the artery

## Heart attack

Plaque cracks and a blood clot blocks the artery

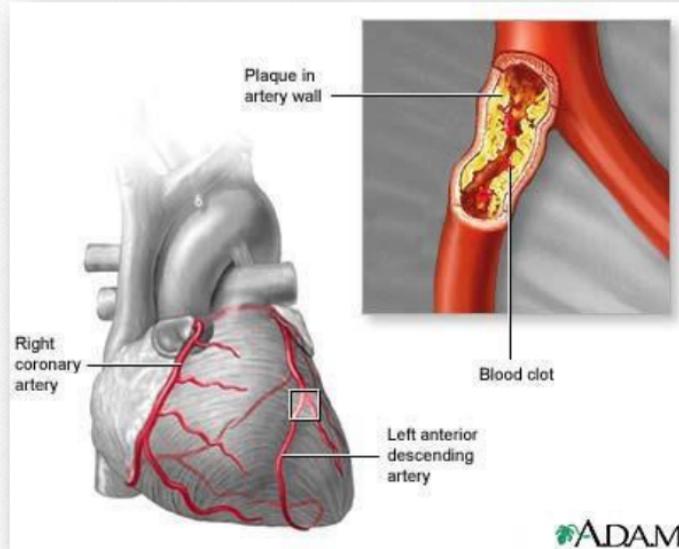


# Location of the obstruction

- ✓ Influence the quantity of myocardial ischemia.
- ✓ Determines the severity of the clinical manifestations.

صدر

الأعراض السريرية



## ❖ Collateral circulation:

التدفق البديل للدم من جهة اخرى عن تلك التي تضررت

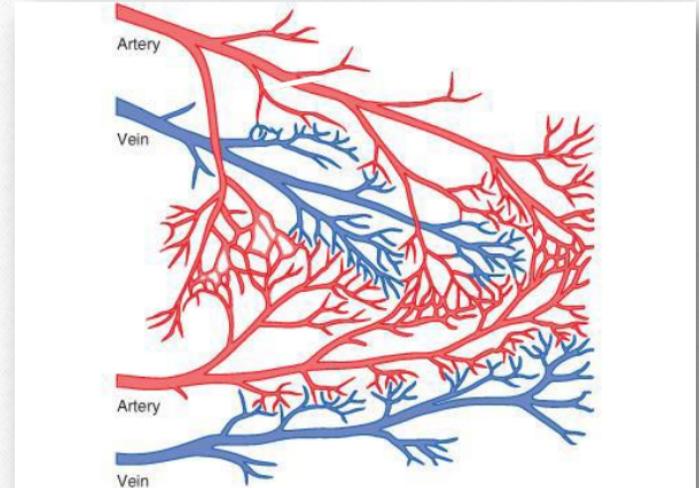
- With sudden occlusion.
- With gradual developing atherosclerosis.

### 1. مع الانسداد المفاجئ:

• عندما يتم انسداد الوعاء الدموي فجأة (مثل النوبة القلبية الحادة أو السكتة الدماغية)، فإن الدورة الدموية الجانبية تكون غير كافية عادةً، لأن الأوعية الدموية الجديدة لا تحصل على الوقت الكافي للتطور. هذا قد يؤدي إلى تلف شديد في الأنسجة أو تخرها.

### 2. مع تصلب الشرايين التدريجي:

• عندما يتطور تصلب الشرايين ببطء مع الوقت، يكون هناك فرصة أكبر لتشكّل الدورة الدموية الجانبية. يتكيف الجسم عن طريق توسيع الأوعية الدموية الصغيرة الموجودة أو تكوين أوعية جديدة لتجاوز التضيق، مما يساعد في إيصال الأكسجين إلى الأنسجة المصابة، وبالتالي تقليل شدة الأعراض ومنع موت الأنسجة بالكامل.



# Effect of ischemia

## 1) Mechanical function: (no vascular tone) لانزاد Endothelin عضويه

- Failure of normal muscle contraction & relaxation. ✓
- Ischemia of large portions of the ventricle; left ventricular failure. ✓

## 2) Biochemical function: (there is no enough O<sub>2</sub>)

- Fatty acid can't be oxidized.
- Glucose is broken down into lactate. نعمل على الجلوكوز للطاقة
- Reduced intracellular PH and ATP stores.

mus →  
constriction ← clot يدعي  
- vasodilators ← clot صاوي  
- antiplatelet  
- Beta and Alpha antagonists  
(I don't want sympathetic)

a better idea :-



## 3) Cell membrane function:

K<sup>+</sup> ↓ Na<sup>+</sup> ↓ Ca<sup>2+</sup> ↑ } bc I want contraction ↑

Leakage of potassium and uptake of sodium by myocytes.

## 4) Electrical function:

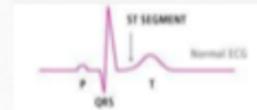
### ○ ECG changes:

Repolarization abnormalities.

Transient ST-segment depression.

### ○ Electrical instability:

Ventricular tachycardia and fibrillation.



# Types of infraction

## 1. Subendocardial Infarction (احتشاء تحت الإندوكاردي)

• الطبقة المتأثرة: الطبقة الداخلية (الإندوكارديوم) فقط.

• الوصف: يحدث عندما ينسد شريان تاجي جزئيًا أو يضيّق، مما يقلل من تدفق الدم إلى الطبقة الداخلية لعضلة القلب (تحت الإندوكارديوم).

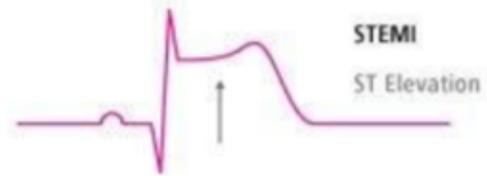


## 2. Transmural Infarction (احتشاء عبر الطبقات)

• الطبقات المتأثرة: تأثر جميع الطبقات القلبية (الإندوكارديوم، الميودكارديوم، والإيبيريكارديوم).

• الوصف: يحدث عندما ينسد الشريان التاجي بشكل كامل ويؤدي إلى نقص الدم الكلي في منطقة واسعة من عضلة القلب، فينتج عنها موت الأنسجة عبر جميع الطبقات.

• التأثير على ECG: يظهر ارتفاع ST في التموهات المرتبطة (مثل V1-V4 للأمامي أو aVF, III, II للسفلي) وقد يظهر موجة Q في التموهات المتأثرة.



نعم، عكس موجة T (T inversion) ليس دائمًا مرتبطًا بحالة معينة محددة، ولكن يمكن أن يحدث في عدة حالات طبيعية، مثل:

1. احتشاء عضلة القلب (Myocardial Infarction).
2. الذبحة الصدرية غير المستقرة (Unstable Angina).
3. الإقفار (Ischemia)، حيث يكون هناك نقص مؤقت أو طويل الأمد في التروية الدموية للقلب.
4. عدم انتظام ضربات القلب (Arrhythmias).
5. التوتر النفسي أو الإجهاد الشديد.



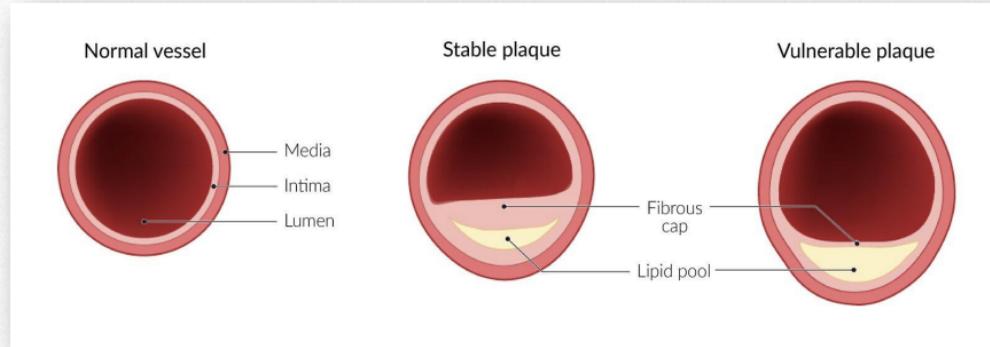
# Ischemic heart disease

Stable Angina

Acute coronary syndrome

(Coronary artery disease)

- Unstable angina
- Acute MI

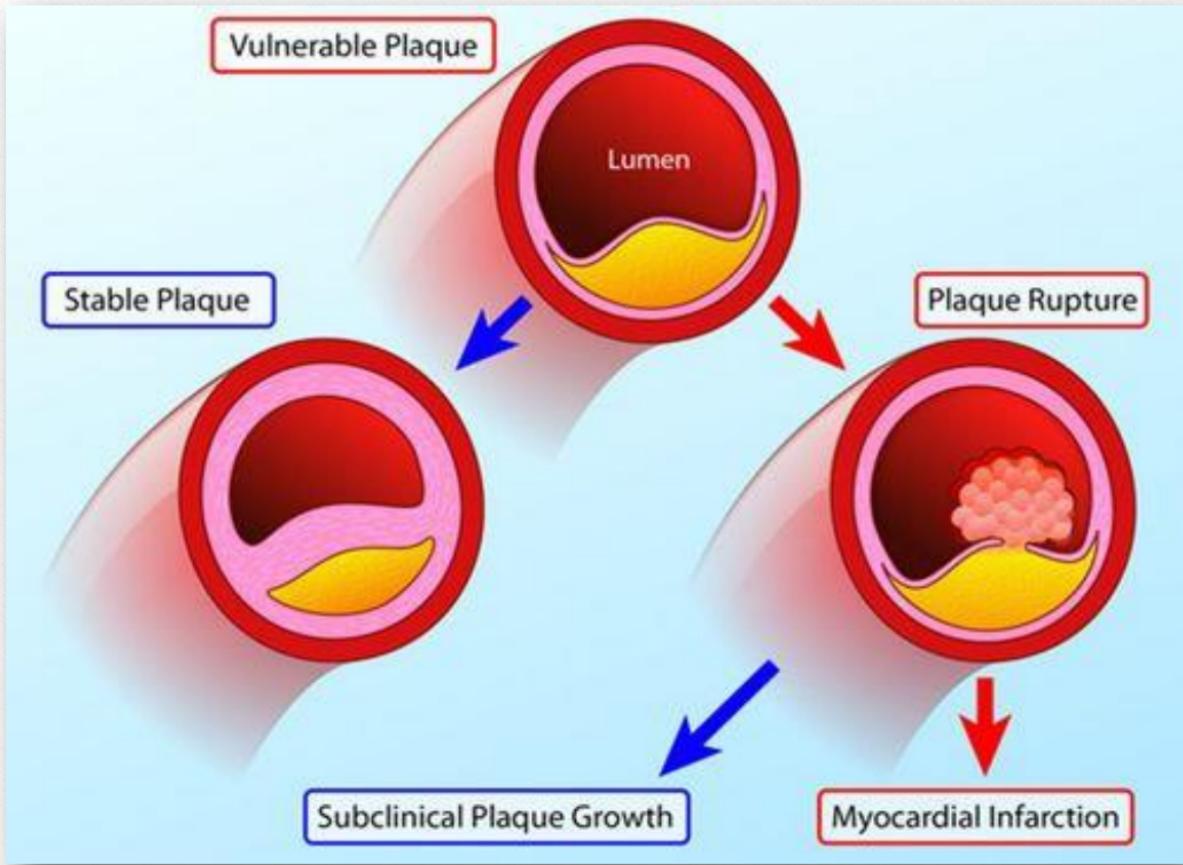


Angina is the classic sign of CAD. It usually occurs after physical exertion but can also follow emotional excitement, exposure to cold, or the consumption of a large meal.



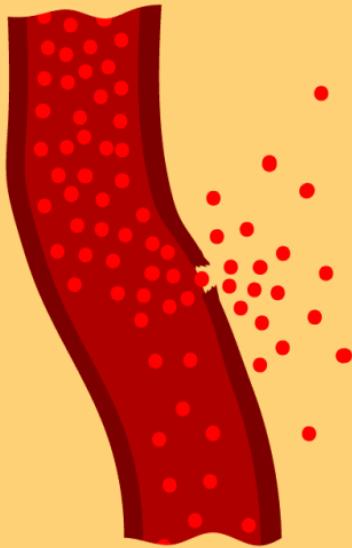
## When to label it stable or unstable

- ❖ If the pain is predictable and relieved by rest or nitrates, it's **called stable angina**. If it increases in frequency and duration and is more easily induced, it's called **unstable or unpredictable angina**. Unstable angina is classified as an acute coronary syndrome and is much more likely to progress to an **MI**. Unstable angina is thought to result from unstable plaque rupture that can lead to thrombus with an MI.



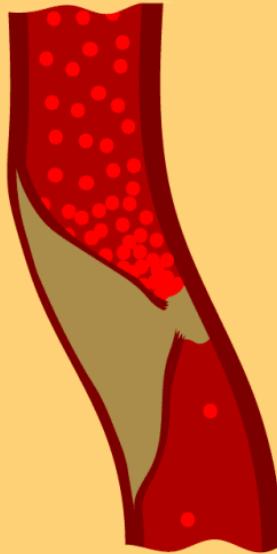
- A thrombus progresses and occludes blood flow, although an early thrombus doesn't necessarily totally block blood flow.
- ❑ Depending on the degree of occlusion, the effect is an imbalance in myocardial oxygen supply and demand.
- ✓ **If the patient has unstable angina**, a thrombus partially occludes a coronary vessel. This thrombus is full of platelets. The partially occluded vessel may have distal microthrombi that cause necrosis in some myocytes.
- ✓ **If smaller vessels infarct**, the patient is at higher risk for MI, which may progress to a non-ST elevation MI. Usually, only the innermost layer of the heart is damaged.
- ✓ If reduced blood flow through one of the coronary arteries causes **myocardial ischemia**, injury, and necrosis, **ST-segment elevation MI results**. The damage extends through all myocardial layers.

## Types of Acute Coronary Syndrome



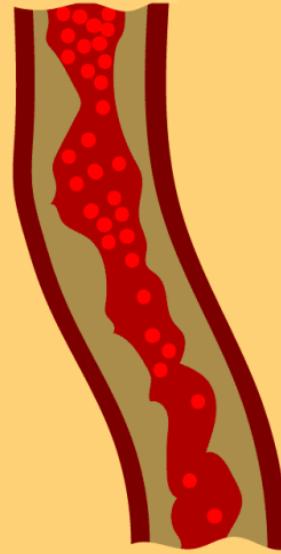
### Unstable Angina

- partial rupture of an artery
- does not cause permanent damage to the heart



### STEMI

- “classic” heart attack
- causes extensive heart damage



### NSTEMI

- intermediate form of ACS
- causes less extensive damage to the heart

# ❖ Stable angina

➤ An effort-related chest discomfort.

## ① ➤ Characteristics:

- Heaviness.
- Pressure.
- Squeezing.
- Smothering

## ② ➤ Causes:

• CAD.

• Other heart diseases:

• Aortic valve disease. → stenosis of Aorta

• Hypertrophic cardiomyopathy → cells: myocytes

→ thickness of myocardium ↑ chamber size

## ③ History:

- A man > 50 years.
- A woman > 60 years.
- Pain with physical & emotional exertion.
- Last to 5-10 min.

## ④ Physical examination:

- ✓ Atherosclerotic disease at other sites.
- ✓ Important risk factors:
  - Hyperlipidemia
  - DM. سكري
- ✓ Left ventricular dysfunction.
- ✓ Conditions that may exacerbate angina: تفاقم  
تزيد من سوء
  - ① Anemia.
  - ② Thyroid disease. → (metabolic rate)

## ⑤ Laboratory examination:

- Urine analysis (DM and renal disease).
- Full blood count.
- Measurements of:
  - a • Lipids.
  - b • Glucose.
  - c • Creatinine.
  - d • Hematocrit.
  - c • Thyroid function test.

## ⑥ Other investigations:

- **Resting ECG:** most important baseline investigation.
- **Stress testing.** (on treadmill)

## ⑦ Management:

- A careful assessment.
- Identification and control of aggravating conditions.
- Identifications of high-risk pts.
- Application of treatment to improve life expectancy.

## ⑧ Drug therapy:

- ❖ Treatment for MI has three goals:
  - ✓ to relieve chest pain
  - ✓ to stabilize heart rhythm
  - ✓ to reduce cardiac workload.
- Nitrates. → vasodilators
- β-adrenergic blockers.
- Calcium antagonist.
- Antiplatelet drugs.

# Unstable angina

Angina pectoris is rapidly worsening.

## 1 Characteristics:

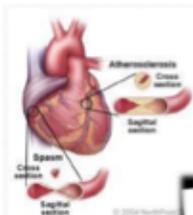
- Occurs at rest, usually lasting >10 min.
- Severe and of new onset.
- Crescendo pattern.

## 2 Causes:

- Shares common pathophysiological mechanisms with acute MI.
- Plaque rupture or erosion.
- Dynamic obstruction (coronary spasm).
- Rapidly advancing coronary atherosclerosis.

## 3 History:

- History of chronic stable angina.
- May present as new phenomena.
- Chest pain (substernal region, radiating to the neck, left shoulder and left arm).



## 4 Physical examination:

- Diaphoresis. → blue skin
- Pale cool skin. → yellow
- Sinus tachycardia. heart rate > 100
- 3rd or 4th heart sound.

## 5 Biochemical markers:

- Troponin I & T.
- Creatinine kinase isoenzyme.

## 6 ECG changes:

- 12 lead ECG is mandatory.
- ST elevation or depression.

## 7 Management:

- Urgent admission to hospital.
- Bed rest.
- Antiplatelet.
- $\beta$ -blockers (atenolol).
- IV or buccal nitrates. → vaso dilator  
حيه تحت اللسان
- Revascularization.

## Sinus Tachycardia

- QT interval
  - Within normal limits
    - 0.36 to 0.44 seconds
    - QT normally shortens with tachycardia



# Myocardial infarction

• Occurs when there is zero flow or so little flow that it can't sustain cardiac muscle function.

• Occlusive thrombus in a coronary artery.

## □ Clinical features:

- Pain (severe, lasts longer).
- Breathlessness.
- Vomiting.
- Collapse.
- Syncope.

## □ Investigations:

### ➤ ECG:

- Partial thickness infarction → ST/T wave changes.
- Transmural infarction → ST elevation and Q waves.

### ➤ Biochemical markers.

### ➤ Chest radiography.

### ➤ Cardiac US.

*ultra sound*

## □ Management:

- Immediate access to hospital.
- High-flow oxygen.
- ECG monitoring.
- I.V. analgesia and antiemetic.
- Detect and manage acute complications:
  - Arrhythmia.
  - Ischemia.
  - Heart failure.

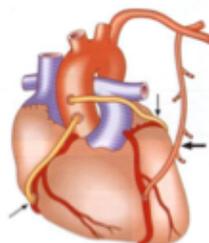
## □ Complications of infarction:

- Arrhythmia.
- Ischemia.
- Acute circulatory failure.
- Pericarditis. *inflammation of pericardium*
- Embolism.

## □ Causes of death in MI:

- Decreased Cardiac output (CO).
- Damming of blood in the pulmonary or systemic veins.
- Fibrillation.
- Rupture of the heart.

## Surgical treatment of coronary disease



- Aortic-coronary bypass surgery.
- Coronary angioplasty.



Abnormality	characteristic (clinical features)	Causes	History	Examination	Management	other
<b>stable angina</b> [effort-related chest discomfort]	<ul style="list-style-type: none"> <li>- Heaviness</li> <li>- pressure</li> <li>- squeezing</li> <li>- smothering</li> <li>- pain with phy &amp; emotional exertion</li> </ul>	<ul style="list-style-type: none"> <li>- CAD</li> <li>- heart diseases: aortic valve</li> <li>⊕ hyper-trophic cardiomyopathy</li> </ul>	man > 50 woman > 60 last: 5-10 min	ⓐ Physical: <ul style="list-style-type: none"> <li>alter. al. other sites</li> <li>Risk factors</li> <li>LV Dific. condition exerts</li> <li>Hypert lipid</li> <li>DM</li> <li>anemia</li> <li>Thyroid disease</li> </ul> ⓑ Laboratory: <ul style="list-style-type: none"> <li>urine analysis (DM, renal disease)</li> <li>Full blood count</li> <li>measurements of:               <ul style="list-style-type: none"> <li>lipids</li> <li>Glucose</li> <li>Creatinine</li> <li>hematoc</li> <li>Thyroid</li> </ul> </li> </ul> ⓒ other investigations: <ul style="list-style-type: none"> <li>ⓐ Resting ECG</li> <li>ⓑ stress testing</li> </ul>	<ul style="list-style-type: none"> <li>- careful assessment</li> <li>- identification and control of aggravating conditions</li> <li>- identification of high-risk pts.</li> <li>- application of treatment to improve life expectancy</li> </ul>	<ul style="list-style-type: none"> <li>- therapy goals:</li> <li>- relieve chest pain</li> <li>- stabilize heart rhythm</li> <li>- reduce cardiac workload</li> </ul>
<b>Unstable angina</b> [Angina pectoris rapidly worsening]	<ul style="list-style-type: none"> <li>- occurs at rest</li> <li>- last &gt; 10 min</li> <li>- crescendo pattern</li> </ul>	<ul style="list-style-type: none"> <li>- plaque rupture or erosion</li> <li>- Dynamic obstruction (coronary spasm)</li> <li>- Rapidly advancing coron. atheros.</li> </ul>	<ul style="list-style-type: none"> <li>- chronic stable angina</li> <li>- new pheno</li> <li>- chest pain</li> <li>↓</li> <li>substernal neck</li> <li>left shoulder</li> <li>left arm</li> </ul>	ⓐ Physical: <ul style="list-style-type: none"> <li>Diaphoresis</li> <li>pale cool skin</li> <li>Sinus tachycardia</li> </ul> ⓑ Bio chemical: <ul style="list-style-type: none"> <li>Troponin</li> <li>Creatinine kinase Isoenzyme</li> </ul> ⓒ ECG: <ul style="list-style-type: none"> <li>ST elevation or depression</li> </ul>	<ul style="list-style-type: none"> <li>- urgent admission to hospital</li> <li>- Bed rest</li> <li>- Anti-platelet</li> <li>- β blockers (atenolol)</li> <li>- IV, buccal nitra</li> <li>- Revascularization</li> </ul>	<ul style="list-style-type: none"> <li>we use:</li> <li>Nitrate</li> <li>β-blockers</li> <li>Ca<sup>2+</sup> antagonist</li> <li>Antiplatelet</li> </ul>
<b>Myocardial infarction</b> [zero flow or little flow] occlusive thrombus in coronary artery	<ul style="list-style-type: none"> <li>- pain (severe last longer)</li> <li>- Breathless</li> <li>- vomiting</li> <li>- collapse</li> <li>- syncope</li> </ul>	Causes of death: <ul style="list-style-type: none"> <li>MI:</li> <li>- CO ↓</li> <li>↓</li> <li>- Damming of blood in pulmonary or systemic veins</li> <li>- Fibrillation</li> <li>- Rupture of heart</li> </ul>	complications: <ul style="list-style-type: none"> <li>- Arrhythmia</li> <li>- Ischemia</li> <li>- Acute Failure</li> <li>- pericarditis (inflammation of pericardium)</li> <li>- Embolism</li> </ul>	ECG: <ul style="list-style-type: none"> <li>- partial thickness infarction → ST/T wave change</li> <li>- Transmural → ST elevation Q waves</li> </ul> chest radio Cardiac US	<ul style="list-style-type: none"> <li>- To hospital Right away</li> <li>- Flow oxygen ↑</li> <li>- ECG monitoring</li> <li>- IV analgesia</li> <li>- antiemetic</li> <li>- Detect the manage acute complications</li> </ul>	Treatment: <ul style="list-style-type: none"> <li>floric</li> <li>caro. bypass surgery</li> <li>- coronary angioplasty</li> </ul>