



لجان الرفعات

# PATHOPHYSIOLOGY

MORPHINE ACADEMY

welcome back ☆

Ischemic Heart Disease

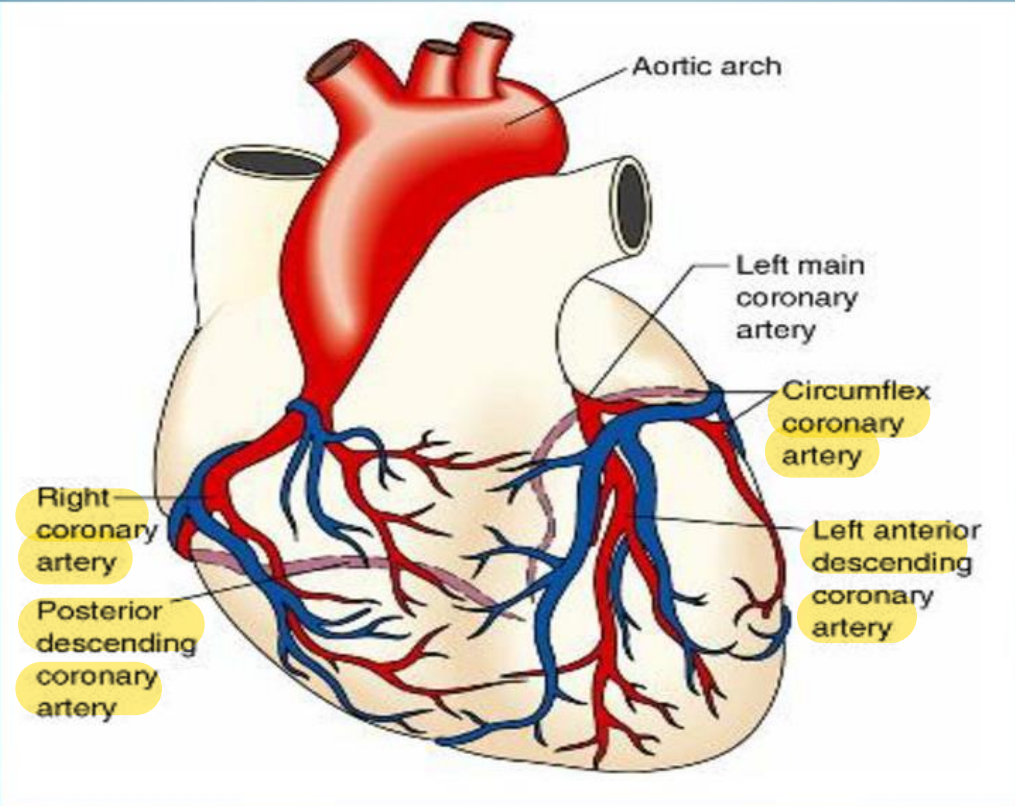
<https://youtu.be/2BcaALrQ3PU?si=1Si3-Uug9KhUhdun>

↳ easy  
explanation

# Normal coronary blood flow

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

## HEART PERFUSION



# Heart Perfusion



**Systole**  
*(pumping)*

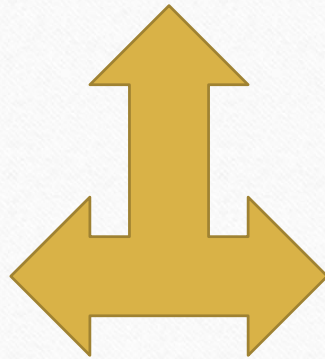


**Diastole**  
*(filling)*

[https://en.wikipedia.org/wiki/Cardiac\\_cycle](https://en.wikipedia.org/wiki/Cardiac_cycle)

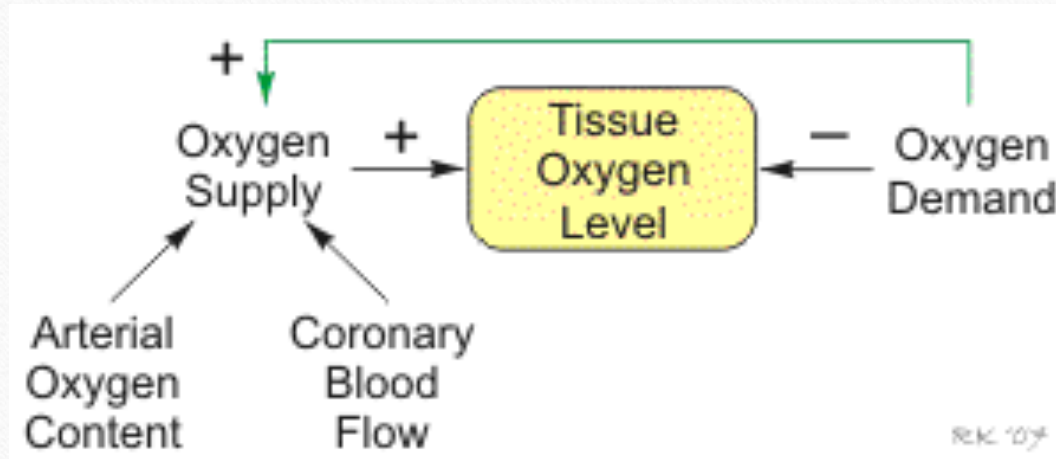
# Control of coronary blood flow

Metabolic regulation



Nervous control

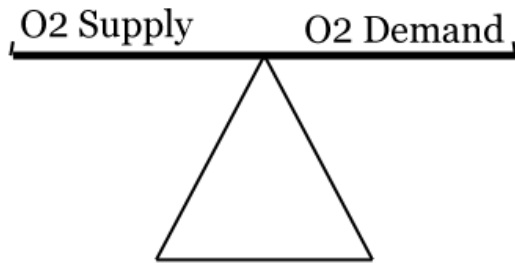
# Oxygen balancing act



O<sub>2</sub> ↓ MI

# Etiology of ischemic heart disease

## Myocardial Oxygen Supply and Demand



coronary blood flow

oxygen availability

- heart rate
- contractility
- preload
- afterload

❑ Lack of oxygen due to inadequate perfusion of the myocardium causes an imbalance between oxygen supply and demand.

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

↘  
cell death

## **2. The imbalance in Ischemic Heart Disease refers to a mismatch between:**

- A. Oxygen supply and carbon dioxide removal in the lungs
- B. Myocardial oxygen supply and myocardial oxygen demand
- C. Blood glucose supply and myocardial energy demand
- D. Atrial and ventricular contraction rates

**Answer: B. Myocardial oxygen supply and myocardial oxygen demand**

# Coronary atherosclerosis

✓ The most common cause of myocardial ischemia.

✓ Epicardial coronary arteries are the major site.

معرف

✓ 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.

معدل الإصابة  
measures  
new cases  
of disease  
and is expressed  
person-time unit

# 1. What is the most common underlying cause of Ischemic Heart Disease (IHD)?

Coronary artery vasospasm

Atherosclerosis

Coronary artery embolism

Congenital coronary anomalies

# Coronary atherosclerosis

✓ Risk factors:

➤ Modifiable:

- Cigarette smoking.
- DM. *diabetes mellitus*
- Hypertension.
- Hyperlipidaemia.

➤ Non-modifiable: *can't change them!*

- Age.
- Family history.
- Sex.

Question 27 / 40

young 100% family history

A 27 old female was presented to the emergency with severe chest pain and dyspnea. The cardiologist decided to do catheterisation (examination with catheter). After examination, a stenosis in the epicardial coronary artery was found. Which of the following risk factors does this patient most probably have?

- Young age not a risk factor
- Type 2 diabetes
- Gender
- Family history
- All the above

# Vascular endothelium

## ❖ The normal function of **vascular endothelium:**

- Local control of vascular tone.
- Maintenance of an anticoagulant surface.
- Defence against inflammatory cells.

## ❖ Endothelial dysfunction:

- Inappropriate constriction.
- Luminal clot formation.
- Abnormal interactions with blood monocytes & platelets.

permeability ↑  
inflammation ↑  
adhesion molecules ↑

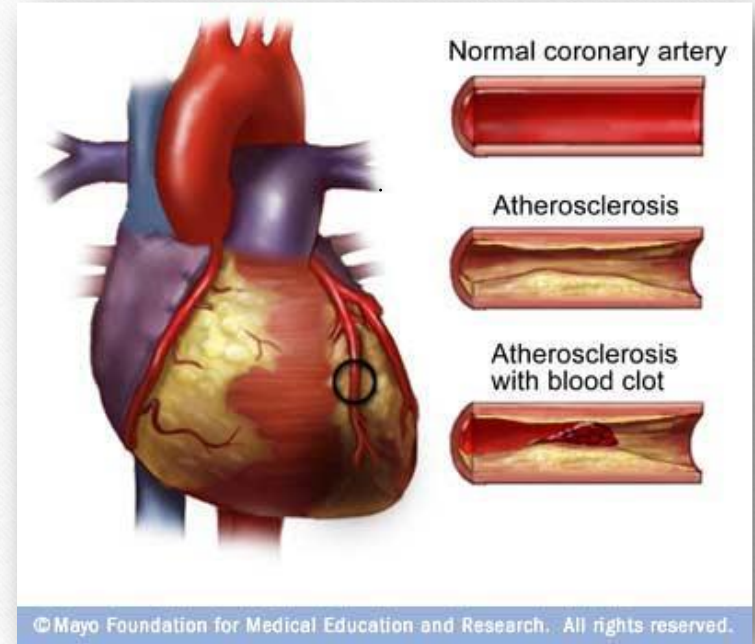
### Question 3 / 40

Which of the following is **CORRECT** about endothelial dysfunction?

1.  Endothelial permeability is reduced.
2.  Adhesion molecules are downregulated.
3.  Inflammation is reduced.
4.  Monocyte's migration to subendothelial layer is increased.
5.  B&D

# Acute coronary occlusion

- **Thrombosis.** *localized*
- **Embolism.** *moveable*
- All MIs have a central area of **necrosis** or **infarction** surrounded by an area of injury. 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.**



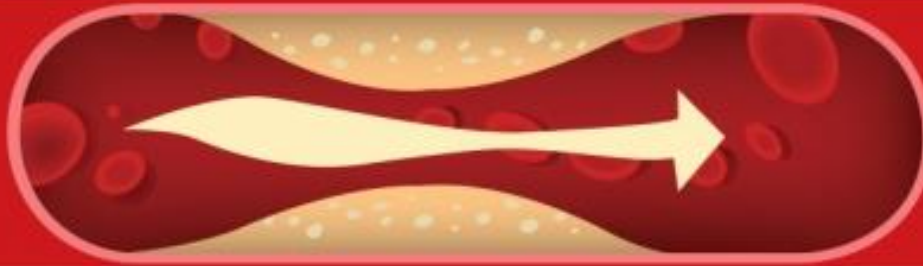


## Coronary artery disease

Plaque builds up in an artery

## Angina

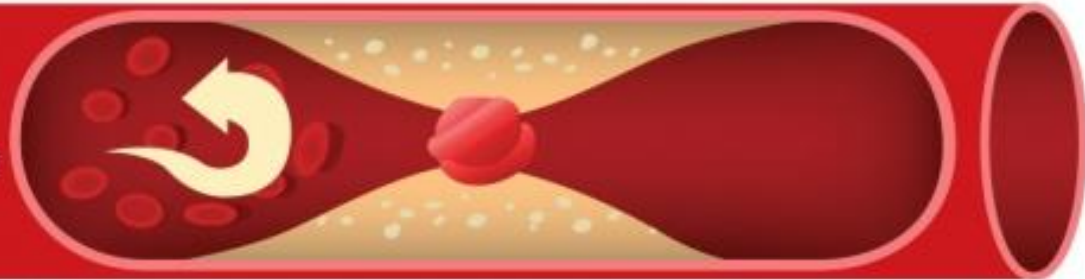
*chest pain*



It is harder for blood to get through the artery

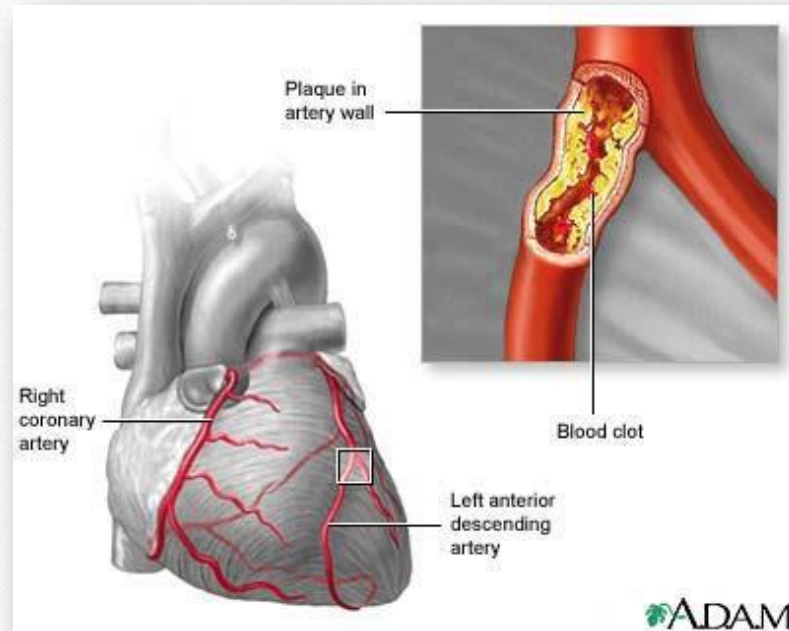
## Heart attack

Plaque cracks and a blood clot blocks the artery



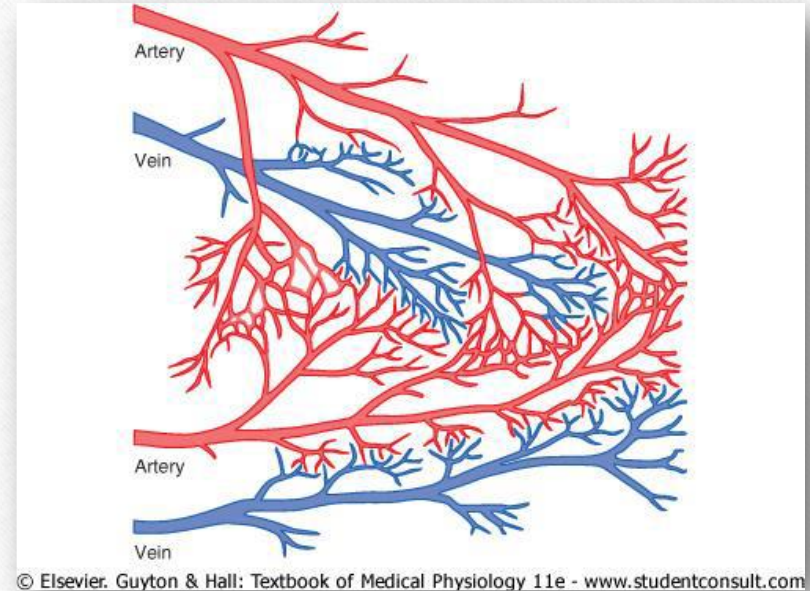
# Location of the obstruction

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



## ❖ Collateral circulation:

- With sudden occlusion.
- With gradual developing atherosclerosis.



Question 24 / 40

Collateral circulation might be newly formed blood vessels or already existing blood vessel which become active in response to ischemia?

1.  True
2.  False

Next

(blei pexjib ptaesi) ↩

# Effect of ischemia

## 1) Mechanical function:

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

## 2) Biochemical function:

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

PH ↓  
acidosis

# Effect of ischemia

## 3) Cell membrane function:

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.

Question 10 / 40

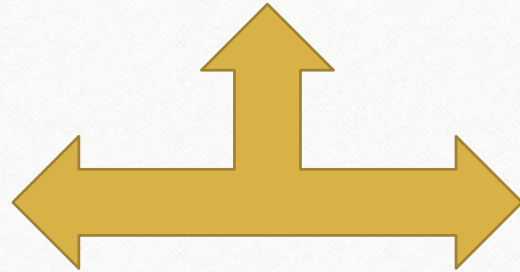
A 46 old male was presented to the hospital suffering from severe chest pain. After investigation, this patient was diagnosed with ischemia in coronary artery. What do you expect the conduction to the left ventricle will be in this case?

1.  Decrease ventricular contraction rate
2.  Ventricular bradyarrhythmia
3.  Ventricular fibrillation
4.  No effect on ventricle rhythm
5.  None of the above

# Ischemic heart disease

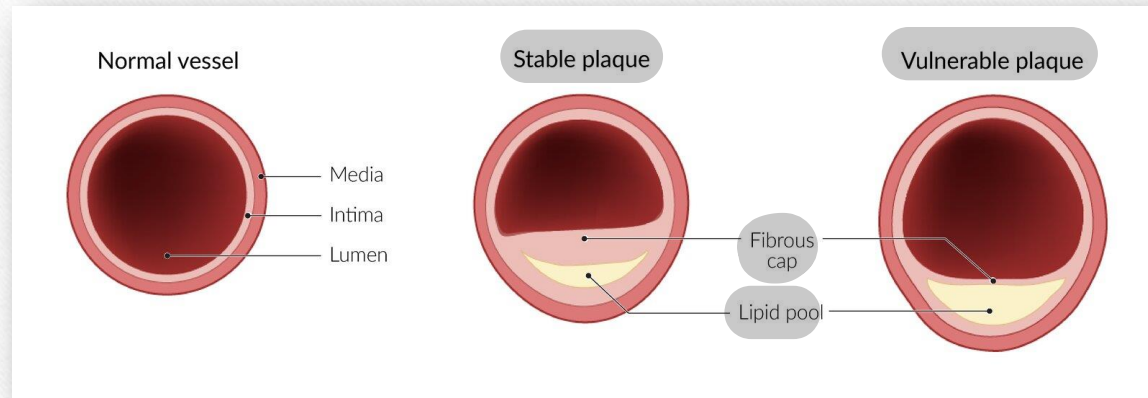
Stable Angina

(Coronary artery  
disease)



Acute coronary syndrome

- Unstable angina
- Acute MI



## partial occlusion

- stable angina
- unstable angina
- NSTEMI (include myocardial necrosis) Troponin ↑

subendocardial ischemia

ST depression / T inversion

## complete occlusion

- STEMI
- MI

transmural injury

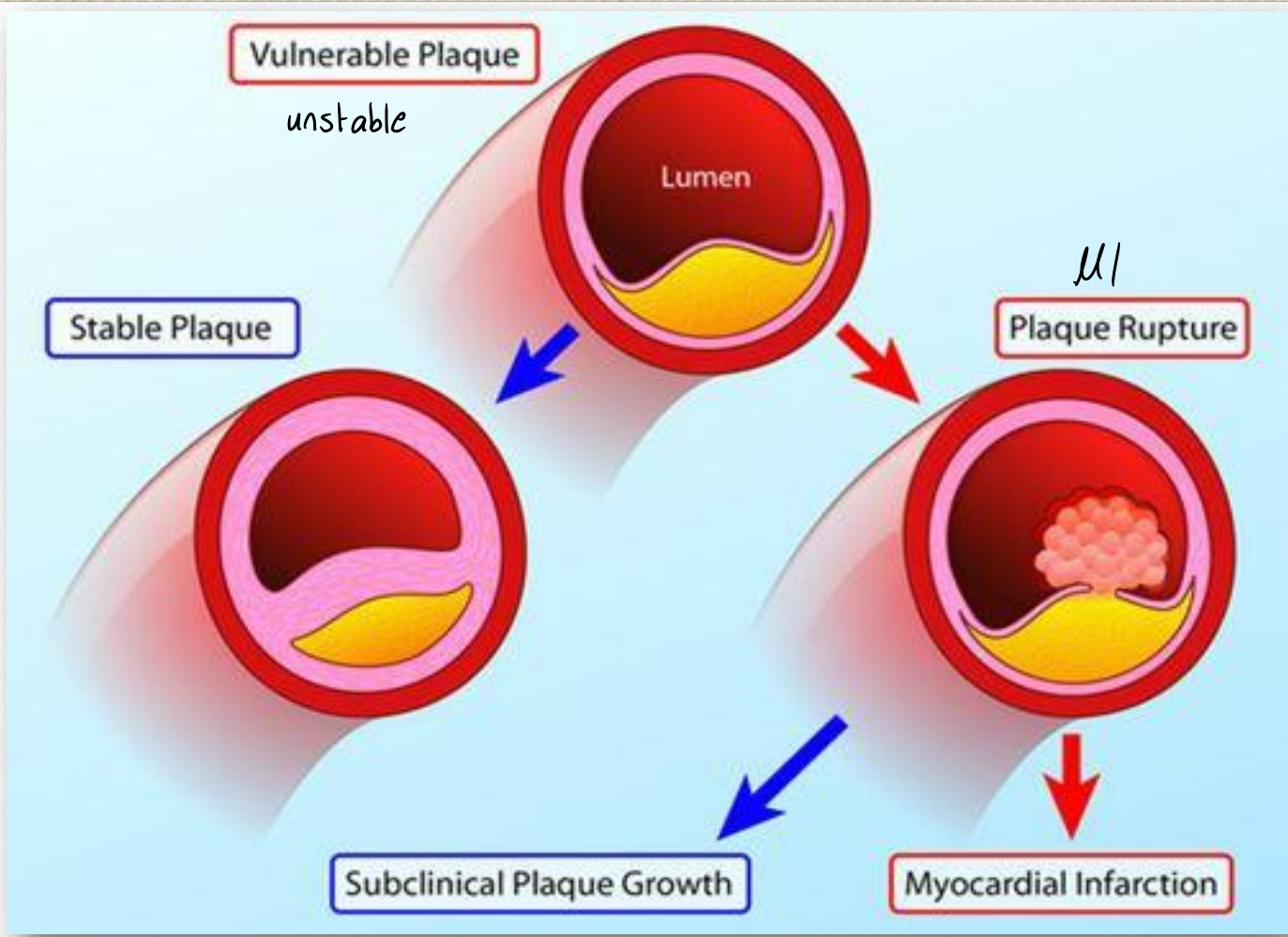
ST elevation

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.



تسد

➤ 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.

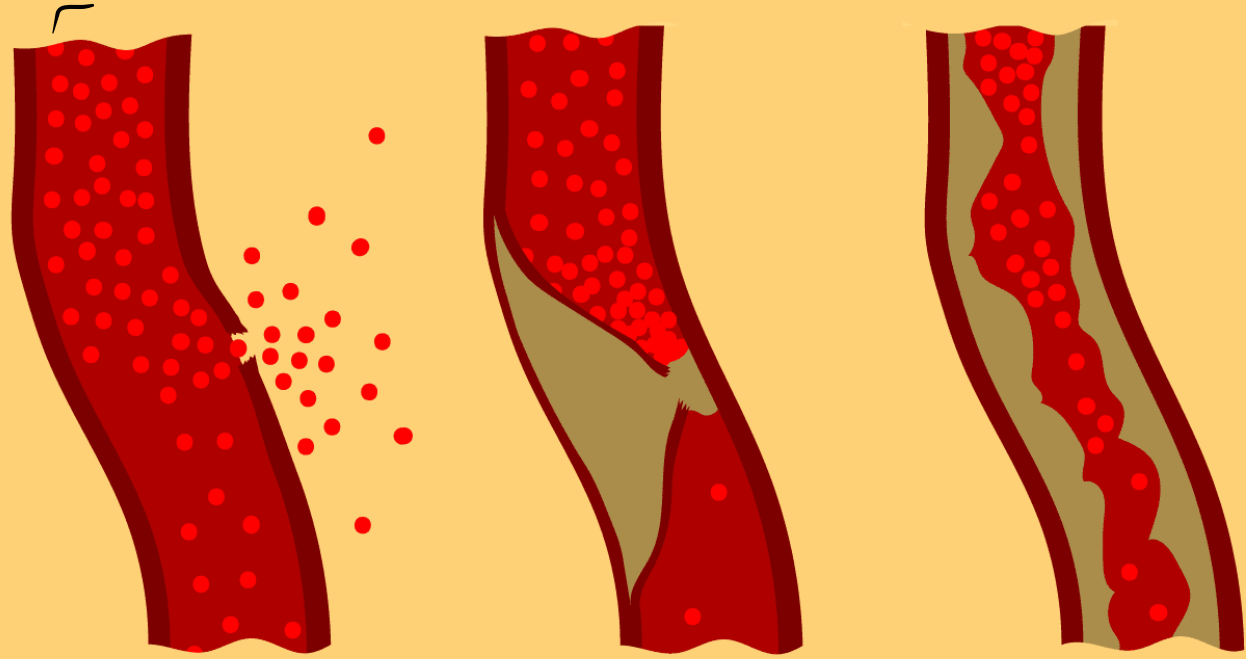
NSTEMI

✓ 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.

STEMI

# Types of Acute Coronary Syndrome

unstable angina  
MI



ST depression

**Unstable angina**  
•partial rupture of an artery  
•does not cause permanent damage to the heart

**STEMI**

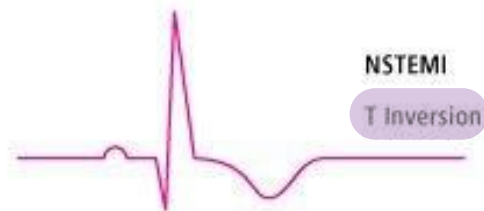
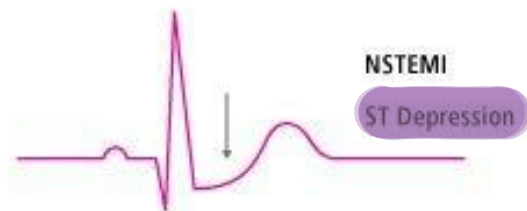
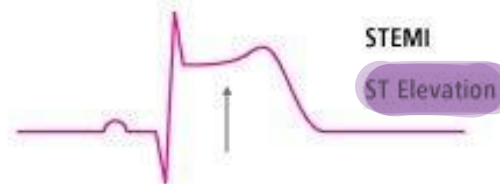
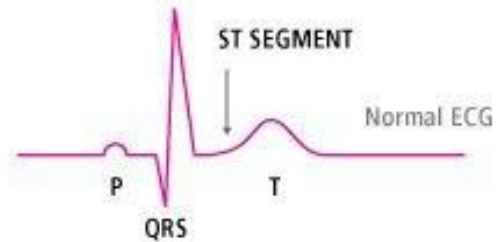
ST elevation

•“classic” heart attack  
•causes extensive heart damage

**NSTEMI**

ST depression

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



Non - ST -

**13. A patient with NSTEMI typically presents with elevated cardiac biomarkers and which of the following ECG findings?**

ST-segment elevation

ST-segment depression or T-wave inversion

Normal ECG

Pathological Q waves

# ❖ Stable angina

➤ An effort-related chest discomfort.

➤ **Characteristics:**

- Heaviness.
- Pressure.
- Squeezing.
- Smothering خانگی
- Choking pain

➤ **Causes:**

- **CAD**. coronary artery disease
- Other heart diseases:
  - **Aortic valve disease**.
  - **Hypertrophic cardiomyopathy**

# Stable Angina

## □ History:

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

## □ Physical examination:

- ✓ Atherosclerotic disease at other sites.
- ✓ Important risk factors:
  - Hyperlipidemia
  - DM. *diabetes mellitus*
- ✓ Left ventricular dysfunction.
- ✓ Conditions that may exacerbate angina:
  - Anemia.
  - Thyroid disease.

2. A 65-year-old man presents with chest pain that occurs with exertion and is relieved by rest. This is characteristic of:

Stable angina

Unstable angina

Prinzmetal's angina

Acute myocardial infarction

## Question 32 / 40

**Stable angina lasts for:**

1.  5 to 10 minutes
2.  30 to 60 minutes
3.  1 to 2 hours
4.  2 to 3 hours
5.  more than 3 hours

## ❑ Laboratory examination:

## Stable Angina

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

## ❑ *Other investigations:*

- ***Resting ECG:*** most important baseline investigation.
- ***Stress testing.***

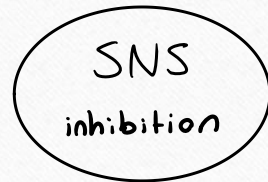
# Stable Angina

## □ *Management:*

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

# Stable Angina

14.)



low contraction  
low Ca<sup>+</sup>

Ca<sup>+</sup> blockers

## □ Drug therapy:

❖ Treatment for MI has three goals:

- ✓ to relieve chest pain
- ✓ to stabilize heart rhythm
- ✓ to reduce cardiac workload.

- Nitrates. vasodilation
- $\beta$ -adrenergic blockers.
- Calcium antagonist. (blocker)
- Antiplatelet drugs.  
like aspirin

**Question 6 / 40**

**Which of the following is one of the choices for stable angina treatment?**

1.  Alpha adrenergic agonists
2.  Alpha adrenergic antagonists
3.  Calcium channel agonists
4.  Beta adrenergic agonists
5.  Beta adrenergic antagonists

# Unstable angina

Angina pectoris is rapidly worsening.

## □ Characteristics:

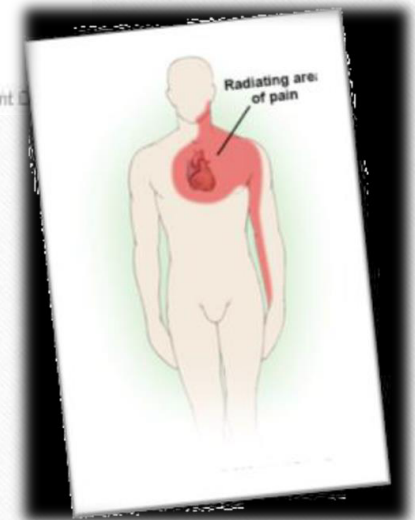
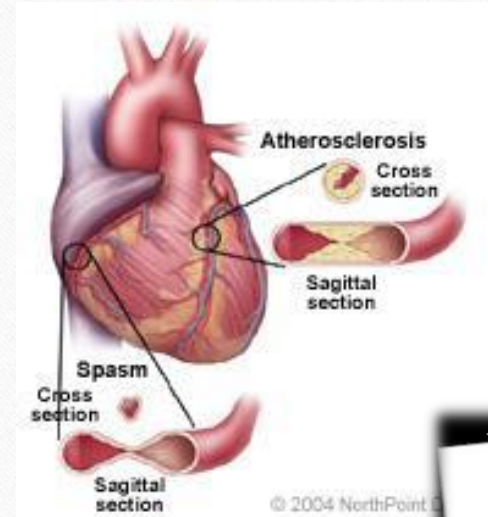
- Occurs at rest, usually lasting >10 min.
- Severe and of new onset.
- Crescendo pattern.

رَاصِد

# Unstable angina

## □ Causes:

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



# Unstable angina

## □ History:

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



# Unstable angina

## Physical examination:

- Diaphoresis. (excess sweating)
- Pale cool skin.
- Sinus tachycardia.
- 3<sup>rd</sup> or 4<sup>th</sup> heart sound.

*unstable angina*

## Biochemical markers:

- ★ • Troponin I & T.
- ★ • Creatinine kinase isoenzyme.

*CK - MB*

## ECG changes:

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

2 enzymes <sup>peal</sup>

# HEART ATTACK VIA MYOCARDIAL INFARCTION (MI)

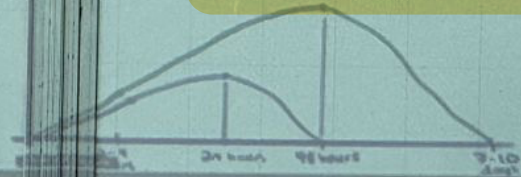
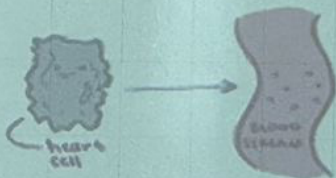
↳ COMPLETELY BLOCKED CORONARY ARTERY

DIAGNOSIS ~ LAB

TROPONIN I  
TROPONIN T  
CK-MB (Creative Kinase M-B)

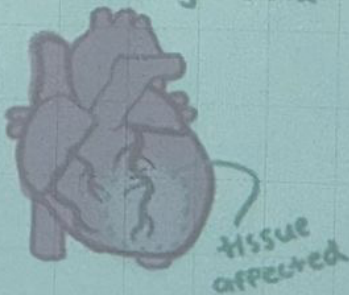
stay

last only 48h



## COMPLICATIONS

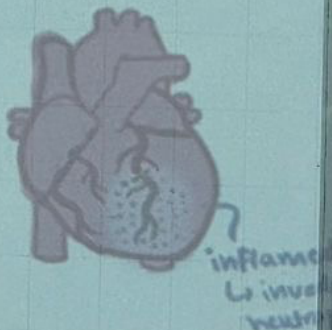
- Arrhythmias  
↳ disrupted signals
- Cardiogenic Shock  
↳ can't pump enough blood



0-24 hours

## COMPLICATIONS

- Pericarditis  
↳ Inflammation of pericardium

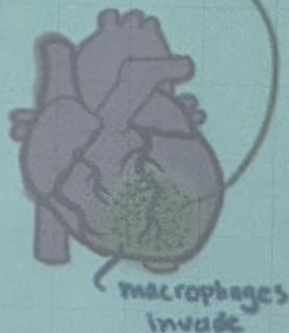


1-3 days

## COMPLICATIONS

Myocardial rupture

Granulation tissue (yellow + soft)

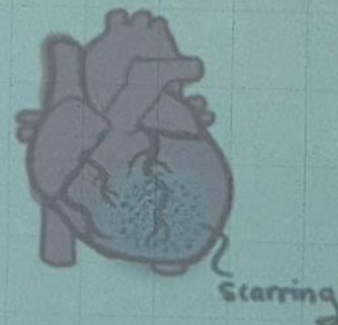


2-10 days

## COMPLICATIONS

Heart Failure

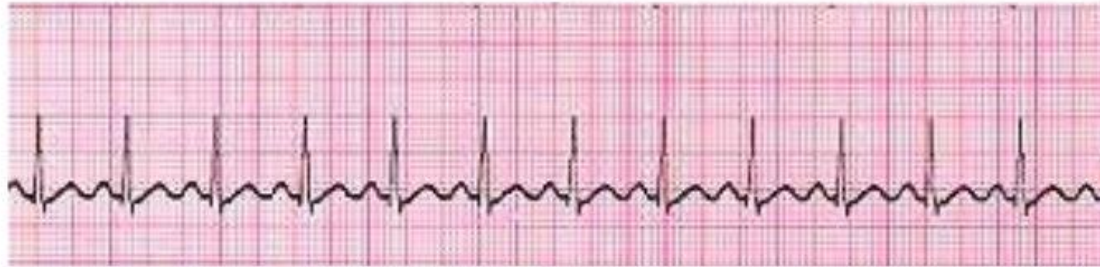
- ↳ remaining muscle grows / changes shape
- ↳ ultimately fails



after 2 weeks

# Sinus Tachycardia

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



# Unstable angina

## □ Management:

- Urgent admission to hospital.
- Bed rest.
- **Antiplatelet.**
- **$\beta$ -blockers (atenolol).**
- IV or buccal nitrates.
- Revascularization.

# 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.

# Myocardial infarction

## □ Clinical features:

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

# Myocardial infarction

## ▣ Investigations:

### ➤ ECG:

▣ Partial thickness infarction → ST/T wave changes.

★ Transmural infarction → ST elevation and Q waves.

### ➤ Biochemical markers.

STEMI

### ➤ Chest radiography.

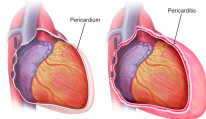
### ➤ Cardiac US. (ultra sound)

} يعطون مورتيك

## □ Management:

- Immediate access to hospital.
- High-flow oxygen.
- ECG monitoring.
- I.V analgesia and antiemetic. <sup>دھندلانا اور قہقہے</sup>
- Detect and manage acute complications: of MI <sup>مسکنات الم</sup>
  - Arrhythmia.
  - Ischemia.
  - Heart failure.

## ❑ Complications of infarction:

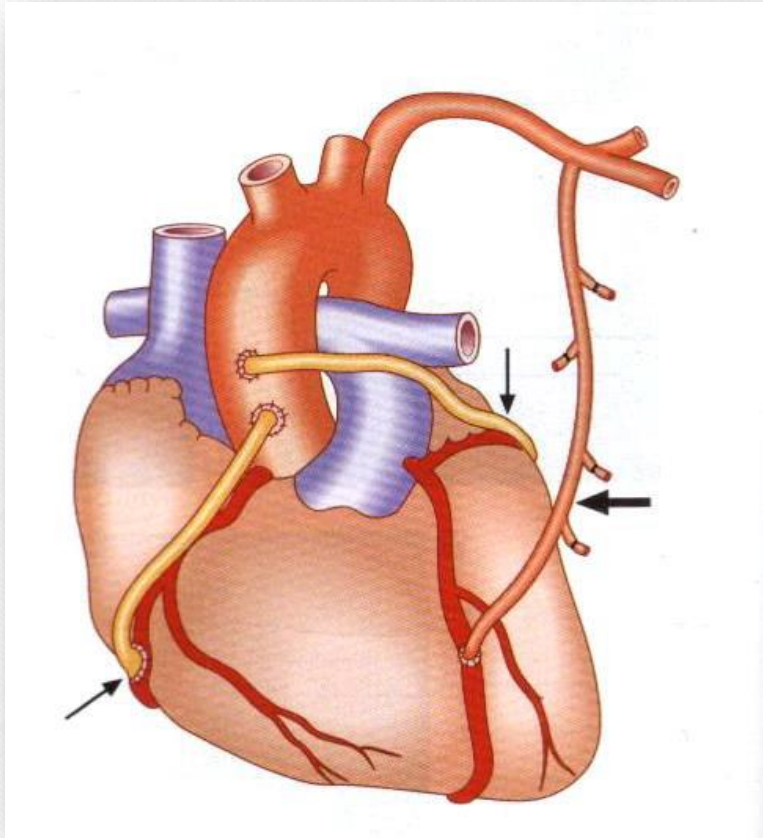
- Arrhythmia.
- Ischemia.
- Acute circulatory failure.
- Pericarditis. 
- Embolism. *obstruction of an artery*

CO ↓

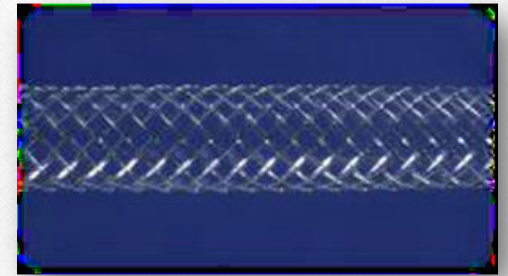
## □ Causes of death in MI:

- 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.



Question 49 / 49

Coronary angioplasty is the most common technique for myocardial infarction treatment.

1.  True

2.  False