ISCHEMIC HEART DISEASE

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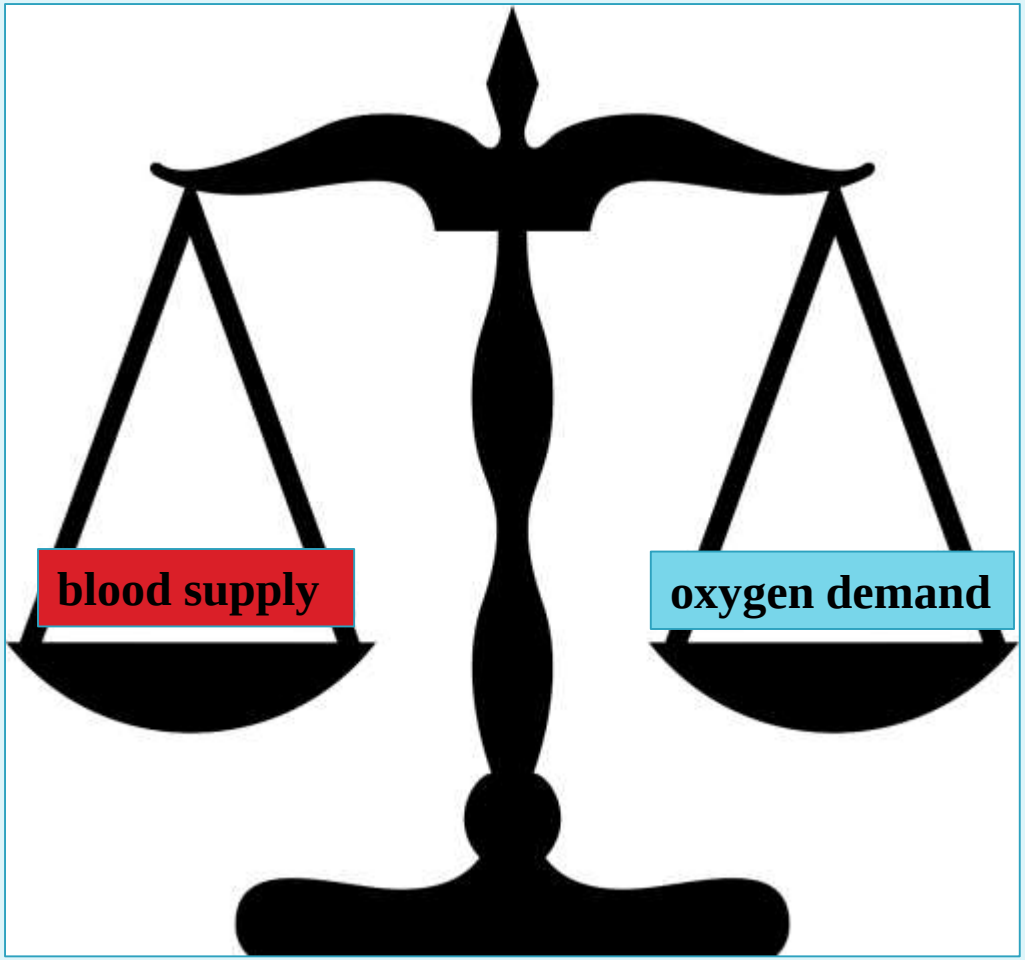
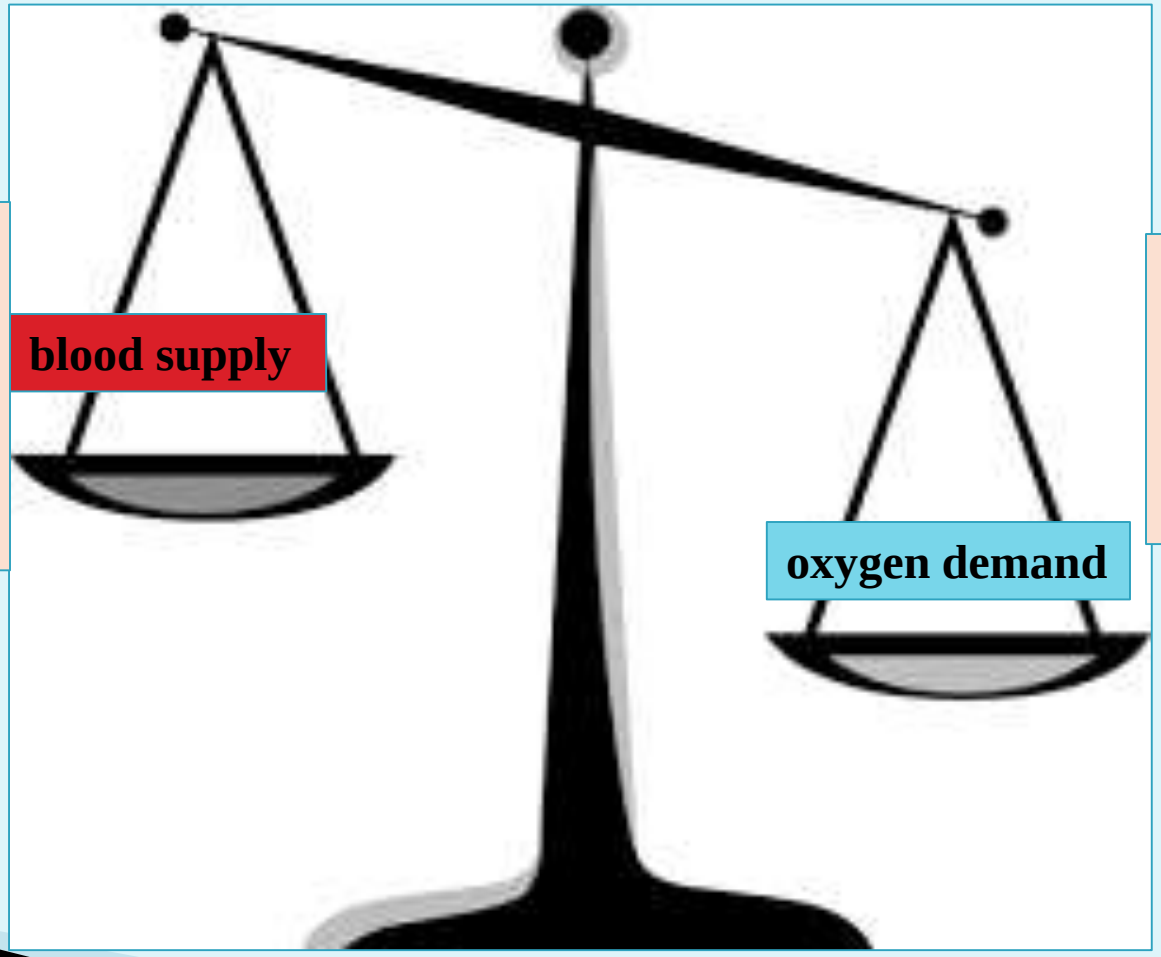
- **Heart disease is the leading cause of morbidity and mortality worldwide**

Normally …



myocardial *ischemia occurs when:*

Examples:
-Atherosclerosis
-Coronary Vasospasm
-Hypovolemia
-Shock



Examples:
-exertion
-hypertension
-stress
-tachycardia

ISCHEMIC HEART DISEASE (IHD)

- a group of related syndromes resulting from myocardial *ischemia* (**an imbalance between cardiac blood supply (perfusion) and myocardial oxygen demand)**
- IHD ≈ coronary artery disease (CAD)

Ischemia can result from:

1- reduction in coronary blood flow atherosclerosis (90 % of cases)

2- increased demand (e.g., tachycardia or hypertension)

3-diminished oxygen-carrying capacity (e.g., anemia, CO poisoning)

There are four basic clinical syndromes of IHD:

1-Angina pectoris

ischemia causes pain but is insufficient to lead to death of myocardium

2-Acute myocardial infarction (MI)

the severity or duration of ischemia is enough to cause cardiac muscle death

3-Chronic IHD

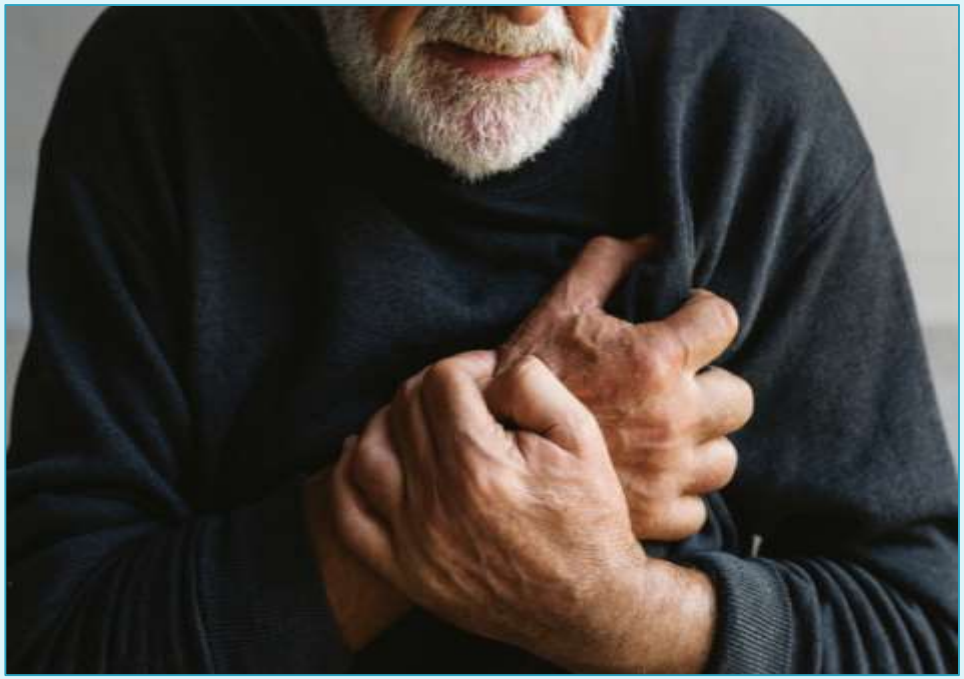
progressive cardiac decompensation (heart failure) following MI

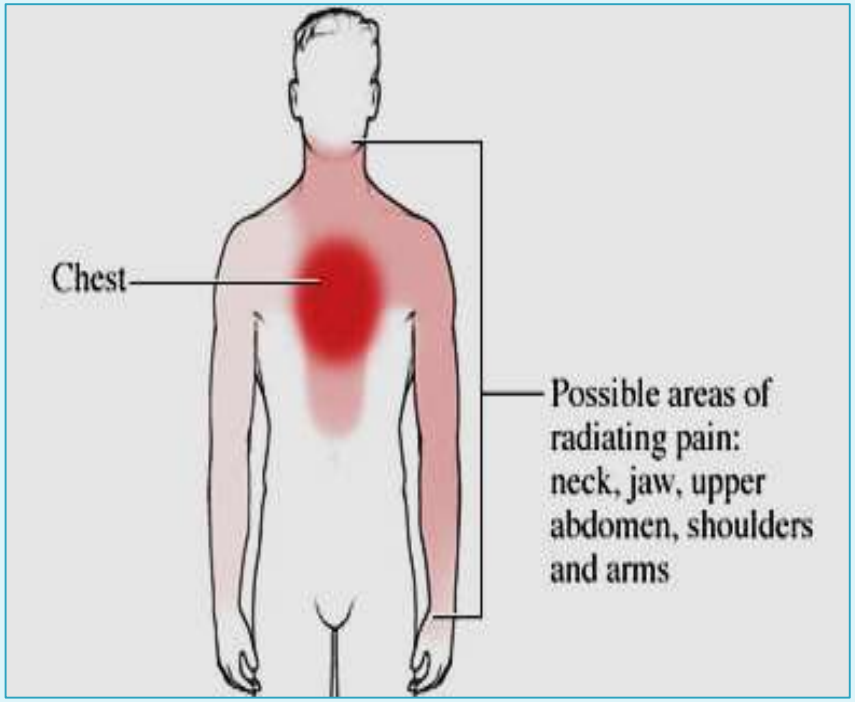
4-Sudden cardiac death (SCD)

can result from a lethal arrhythmia following myocardial ischemia.

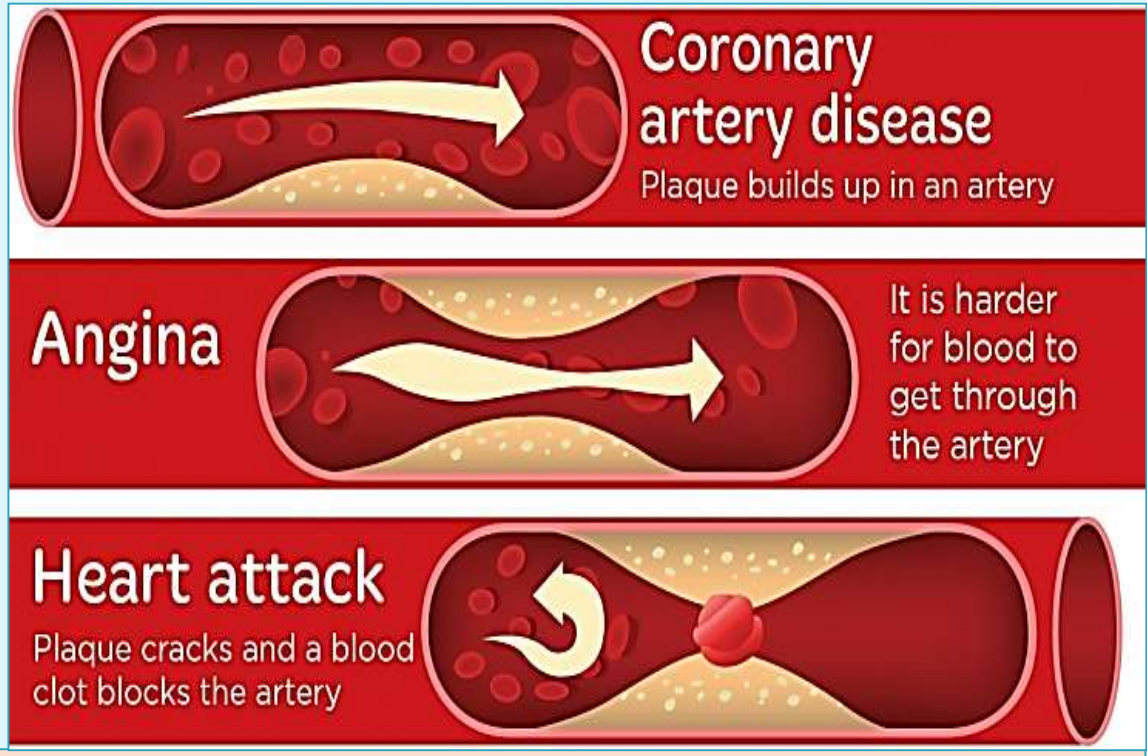
Angina pectoris

Angina pain: **A crushing or squeezing substernal pain**





Angina pectoris vs MI

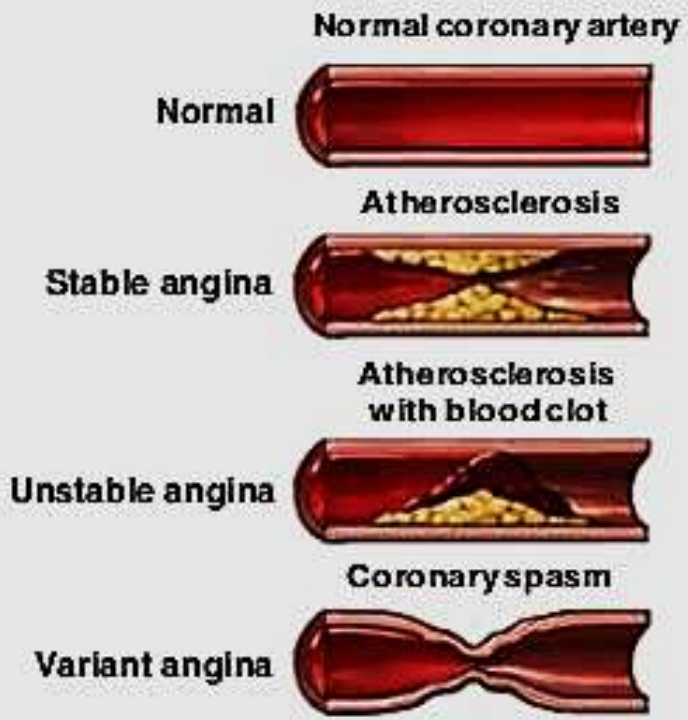


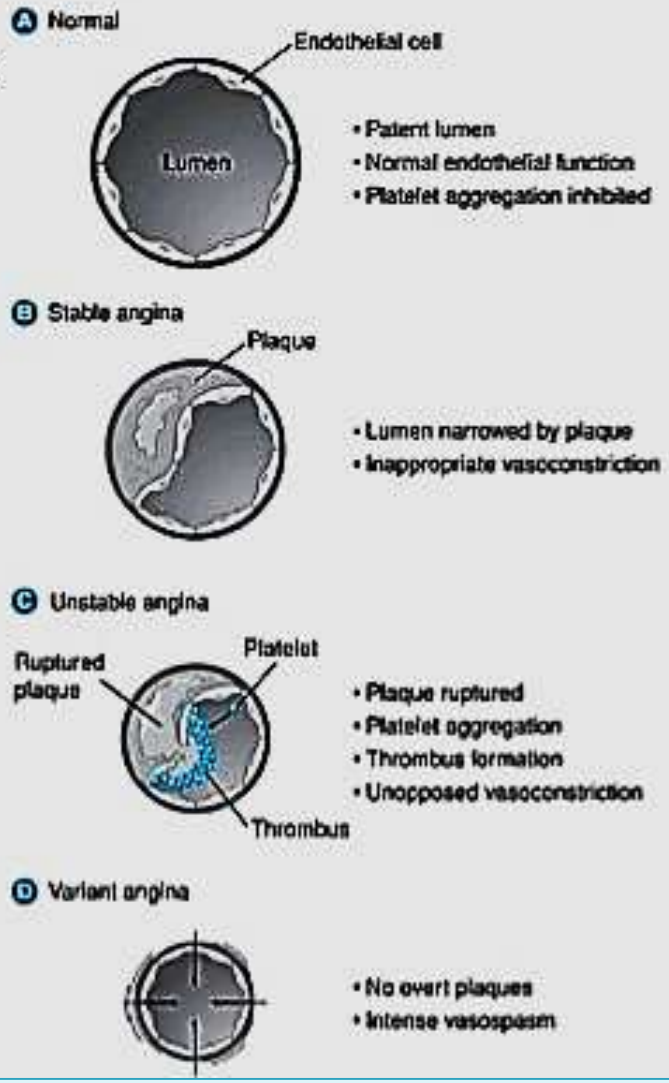
angina causes intermittent chest pain caused by transient reversible myocardial ischemia (**ischemia causes pain but is insufficient to lead to death of myocardium)**

- **angina** pectoris: pain < 20 minutes and relieved by rest or nitroglycerin
- **MI**: pain lasts > 20 minutes to several hours and is not relieved by nitroglycerin or rest.

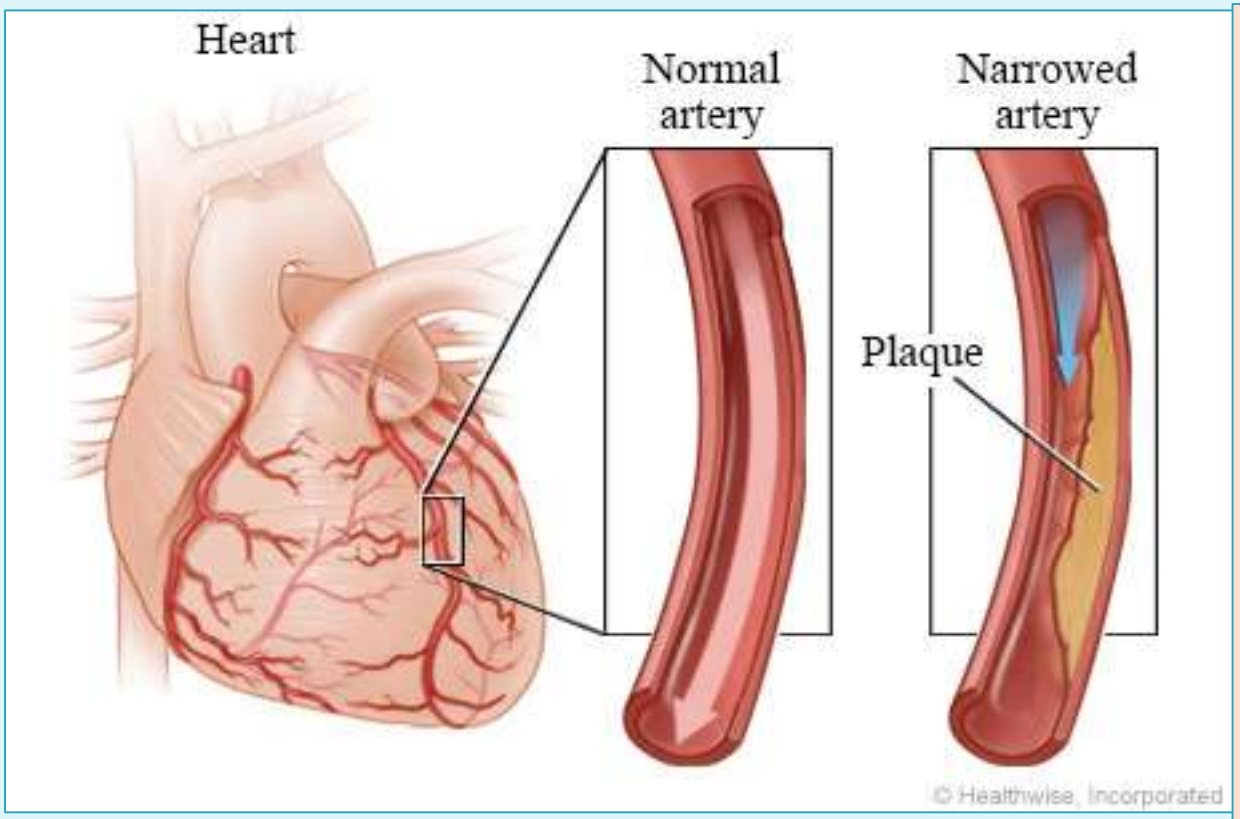
Three types of angina

- **Stable angina**/Classic angina/Effort angina
- **Unstable angina**/Crescendo angina
- **Variant angina**/Prinzmetal angina



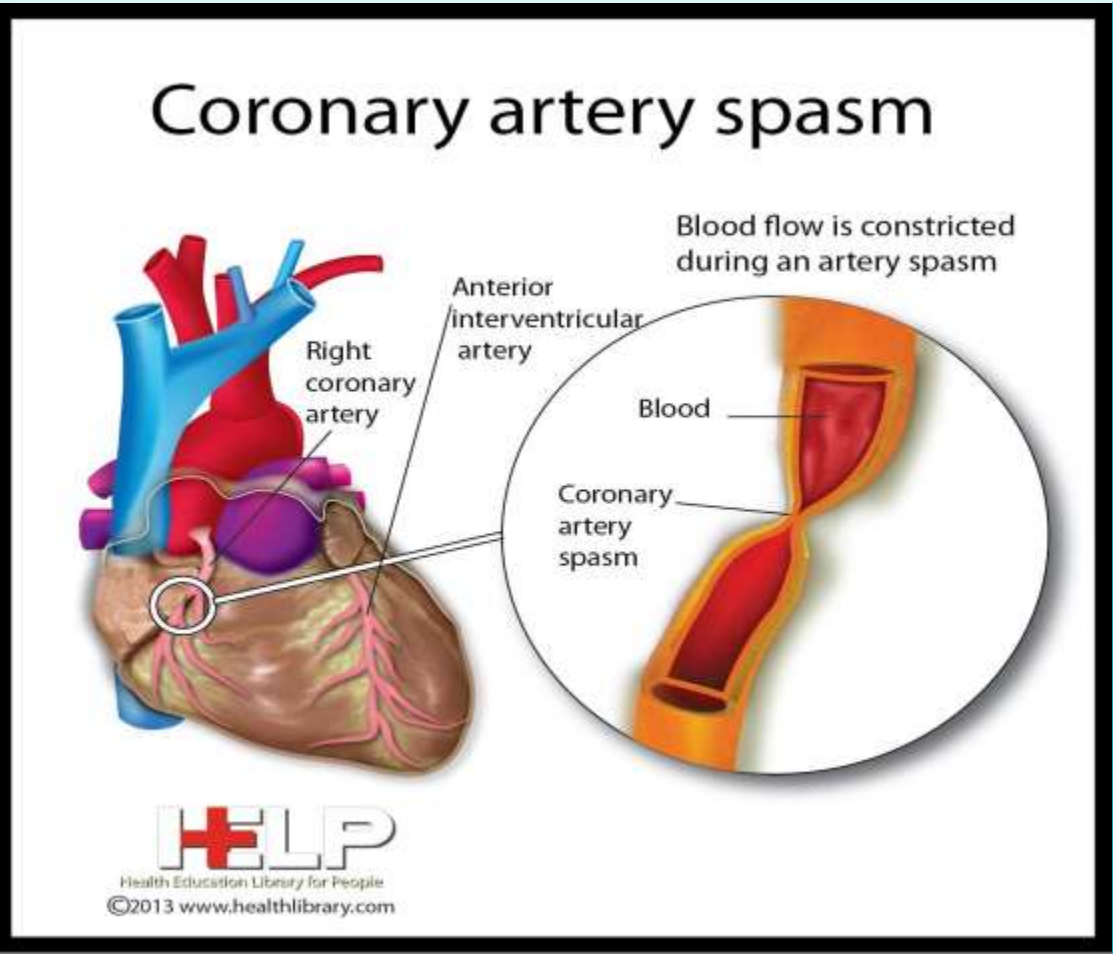


Pathogenesis of stable angina: critical coronary stenosis



-episodic pain only <u>with increased demand</u>
-forms of ↑ myocardial oxygen demand (e.g. exertion; tachycardia; hypertension; fever; anxiety; fear)
-associated with critical atherosclerotic narrowing
-relieved by rest (reducing demand) or by drugs (e.g. nitroglycerin)

Pathogenesis of Prinzmetal angina: severe coronary vasospasm



- **occur at rest or sleep**
- **Vessels without atherosclerosis can be affected**
- **Etiology not clear**
- **Treatment: vasodilators (nitroglycerin or calcium channel blockers)**

Pathogenesis of unstable angina

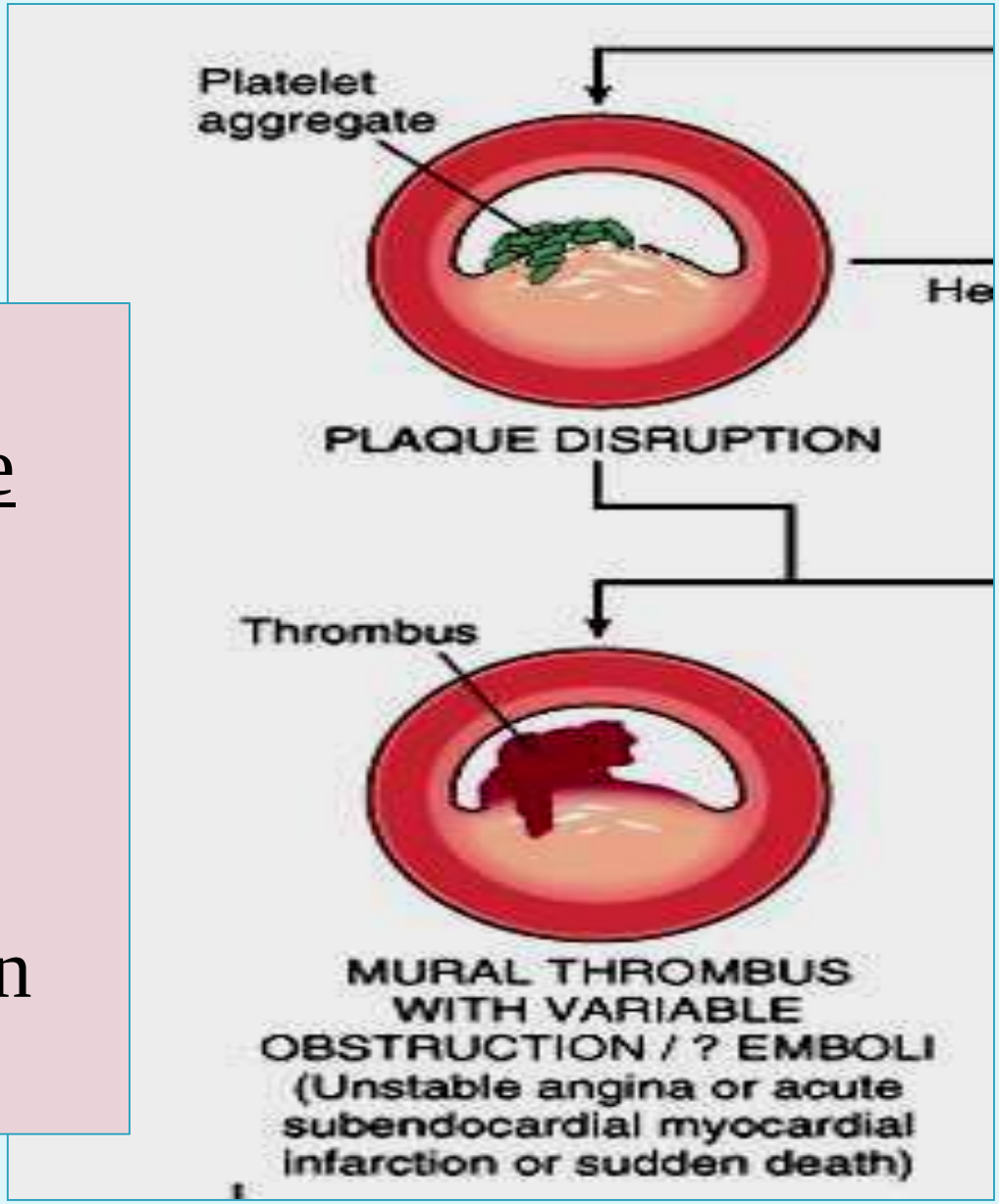
critical stenosis with **superimposed** Acute Plaque Change:

1-plaque disruption

2- partial thrombosis (non-occlusive)

3- distal embolization

4-vasospasm



Unstable angina (crescendo angina)

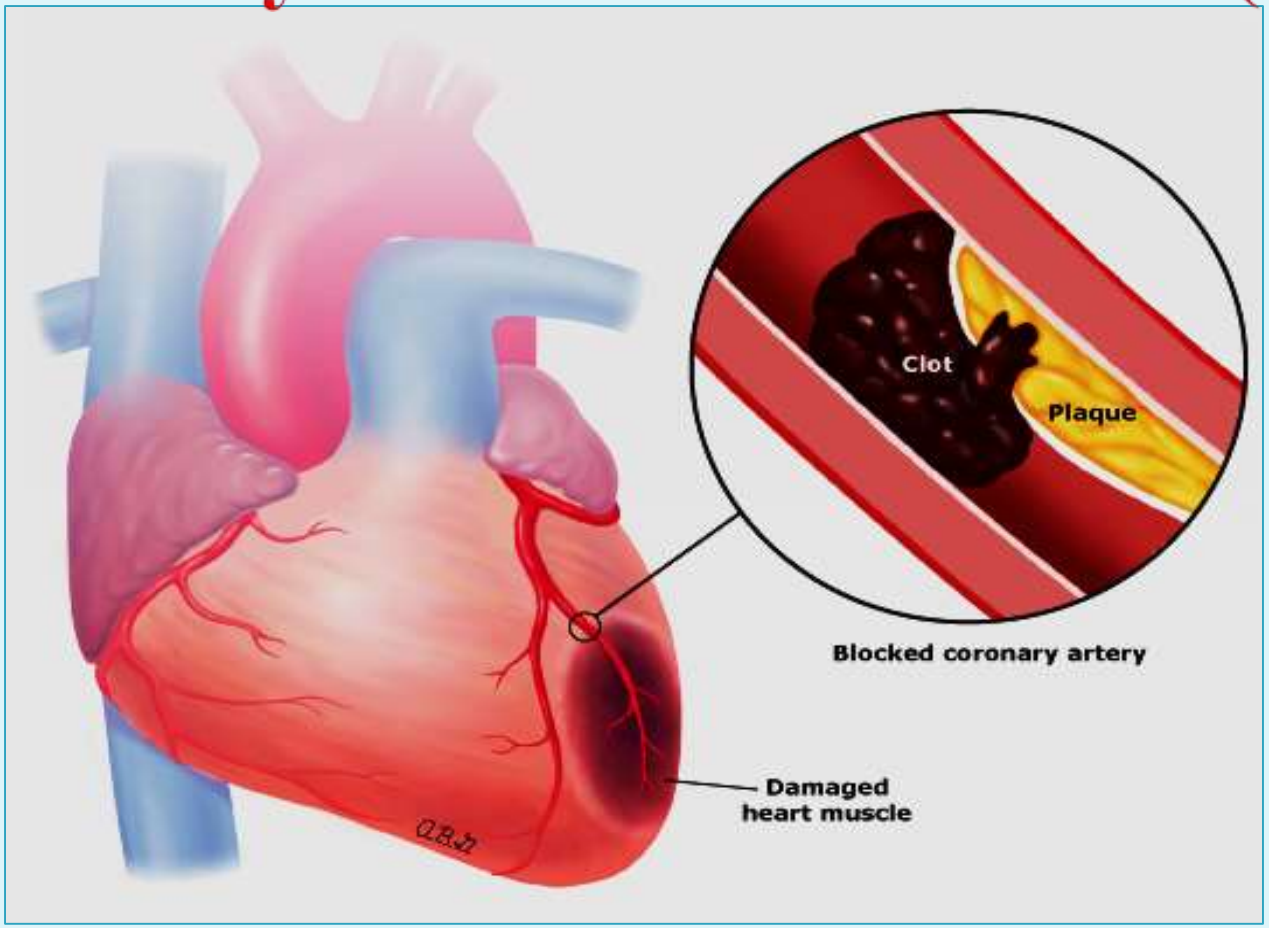
- **increasing frequency** of pain, precipitated by **less** exertion.
- more **intense** and **longer** lasting than stable angina

- Causes: plaque disruption; superimposed partial thrombosis; distal embolization; vasospasm**.**

- Usually precedes more serious, potentially irreversible ischemia, thus it is c**alled***: pre-infarction angina*

Acute Myocardial Infarction

Acute Myocardial Infarction (MI)



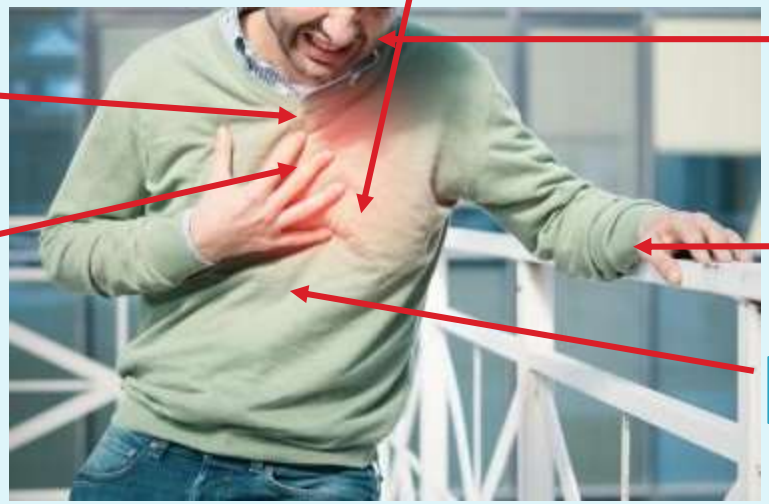
- MI = *heart attack.*
- *Necrosis of heart muscle due to ischemia.*
- A significant cause of death worldwide.

Clinical Features of acute MI

Severe, crushing substernal chest pain that radiates to neck, jaw, epigastrium, or left arm

dyspnea (if pulmonary congestion and edema)

cardiogenic shock (in massive MIs >40% of left ventricle)



Dizziness; sweating

rapid and weak pulse

nausea (in posterior MI)

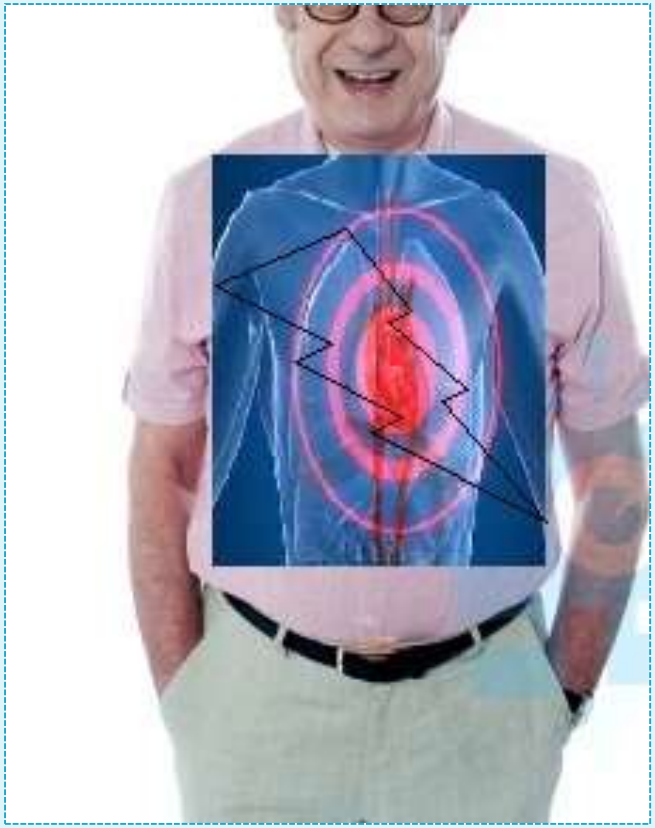
Sometimes: No typical symptoms (silent infarcts)

Silent infarcts:

- A variable percentage of MIs are asymptomatic
- Confirmed only on ECG and lab workup.
- particularly in:

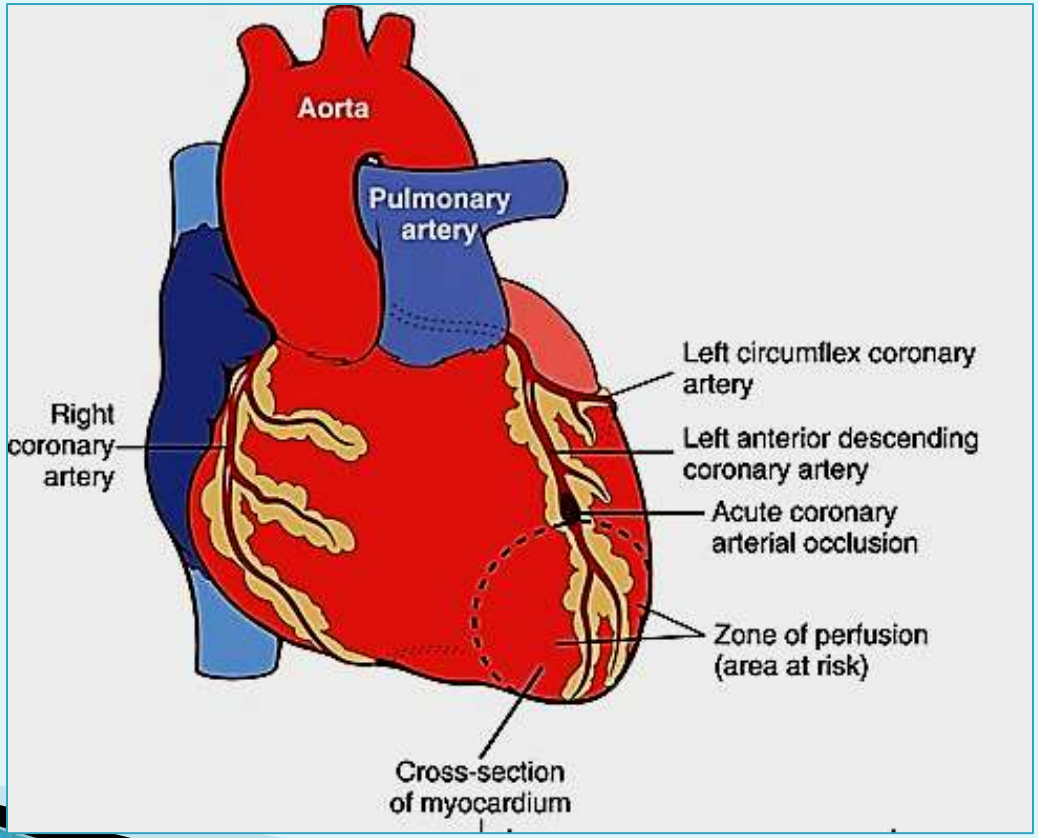
1- DM (peripheral neuropathies)

2- the elderly

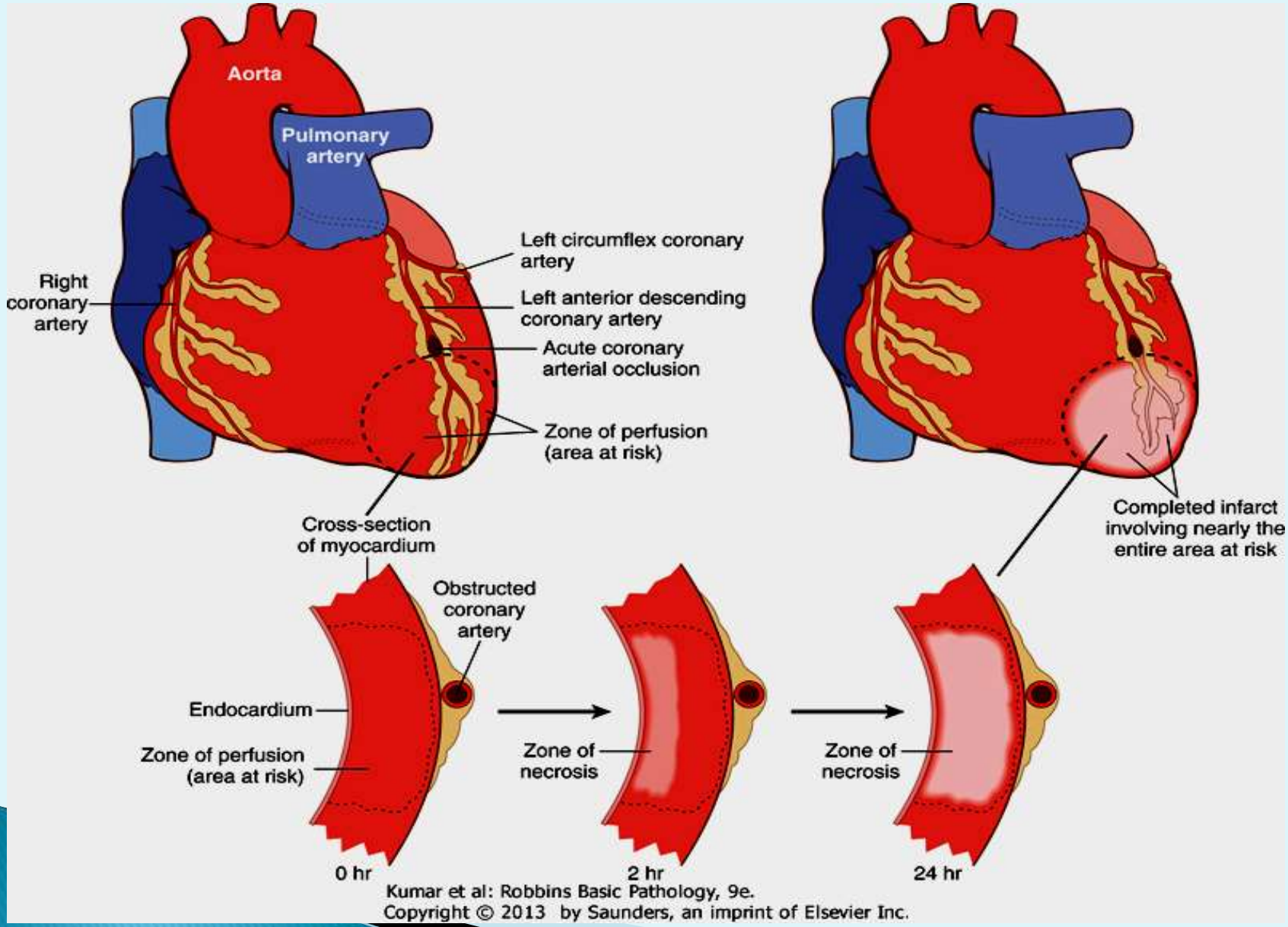


MI- Causes:

- Acute occlusion of the proximal left anterior descending (**LAD**) artery is the cause of *40% to 50% of all MI cases*

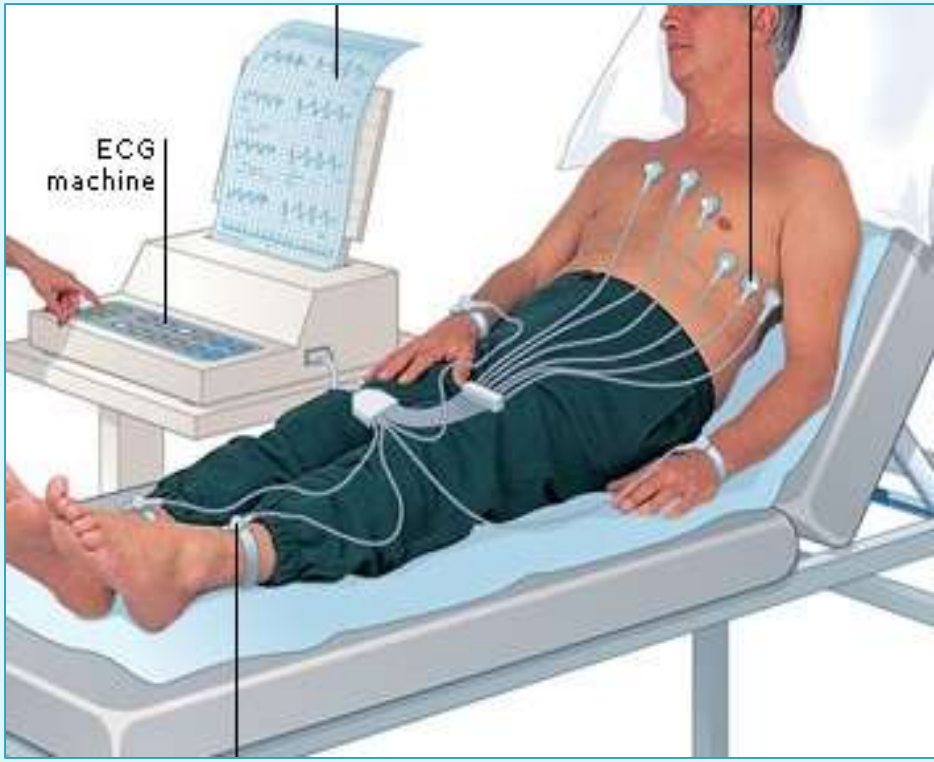


MI- Evolution



Evaluation of MI

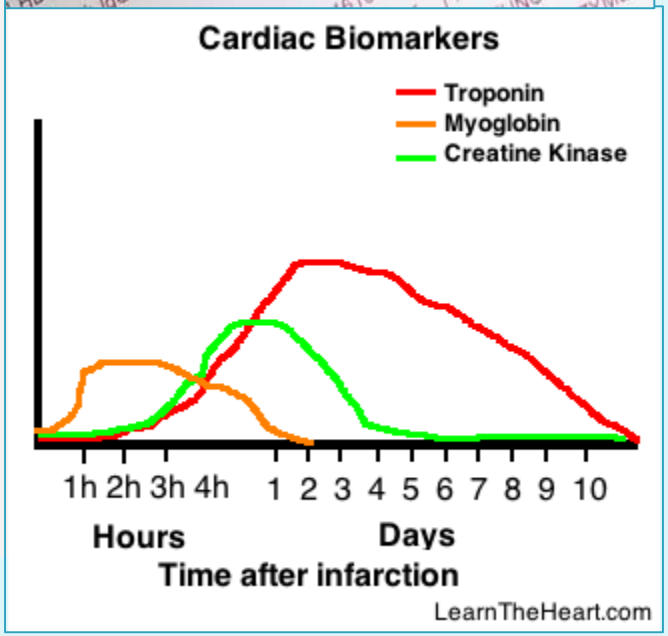
- *Clinical signs and symptoms*
- ***Electrocardiographic (ECG)** abnormalities*
- ***Laboratory evaluation:*** blood levels of intracellular macromolecules that leak out of injured myocardial cells through damaged cell membranes.



Cardiac enzymes in MI

1-Myoglobin
2-Cardiac **Troponins** T and I (TnT, TnI)
3-Creatine kinase (CK); specifically the myocardial-specific isoform (CK-MB)
4- Lactate dehydrogenase

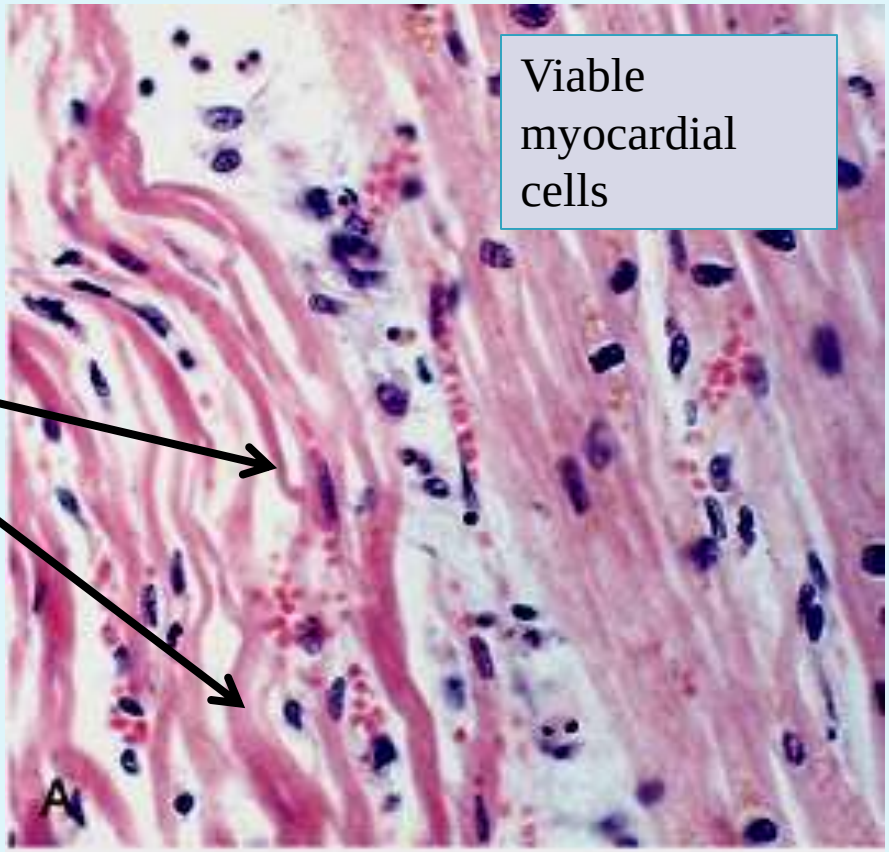
- Cardiac troponins T and I (TnT, TnI), are the best markers for acute MI.
- Creatine kinase CK-MB is the second best marker after the cardiac-specific troponins.



Microscopic features of myocardial infarction and its repair.

<24 hr:

coagulative **necrosis** and **wavy fibers** Necrotic cells are separated by edema fluid

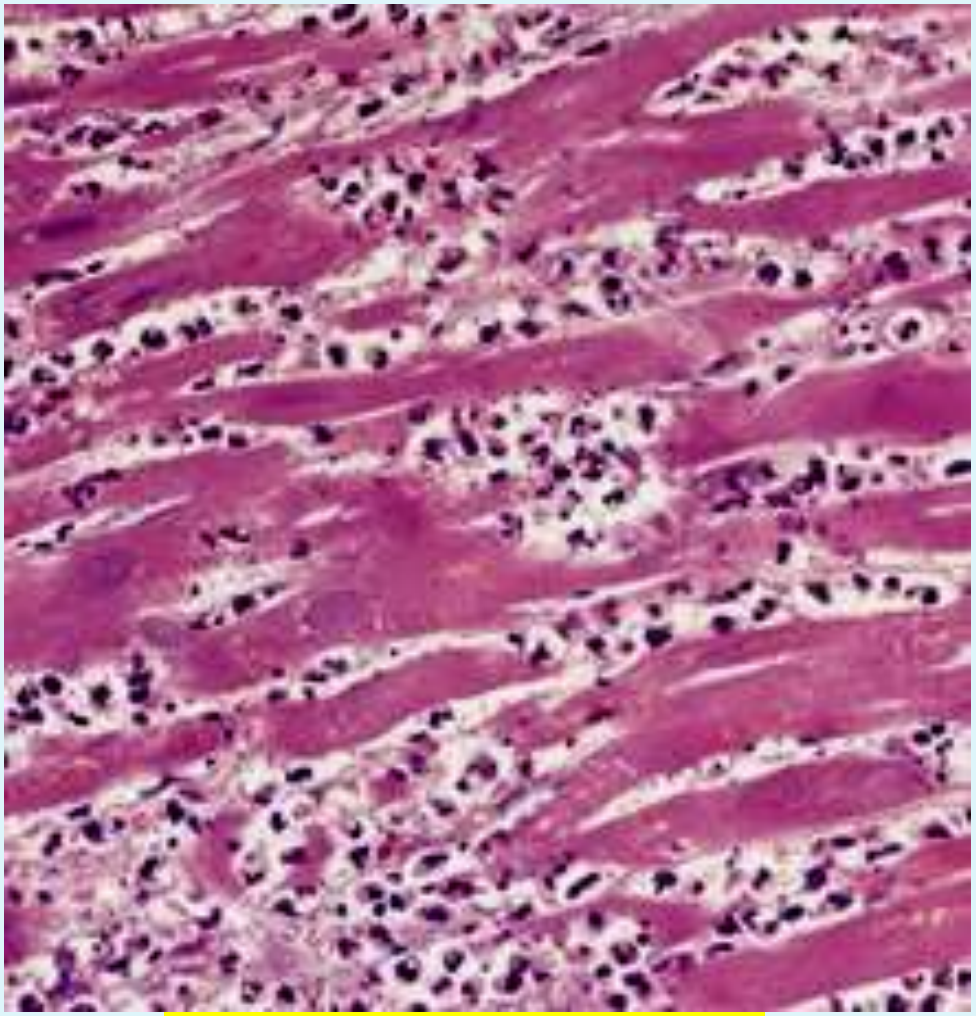


Stain: Hematoxylin & Eosin (H&E)

Microscopic features of myocardial infarction and its repair.

2 - 3 days:

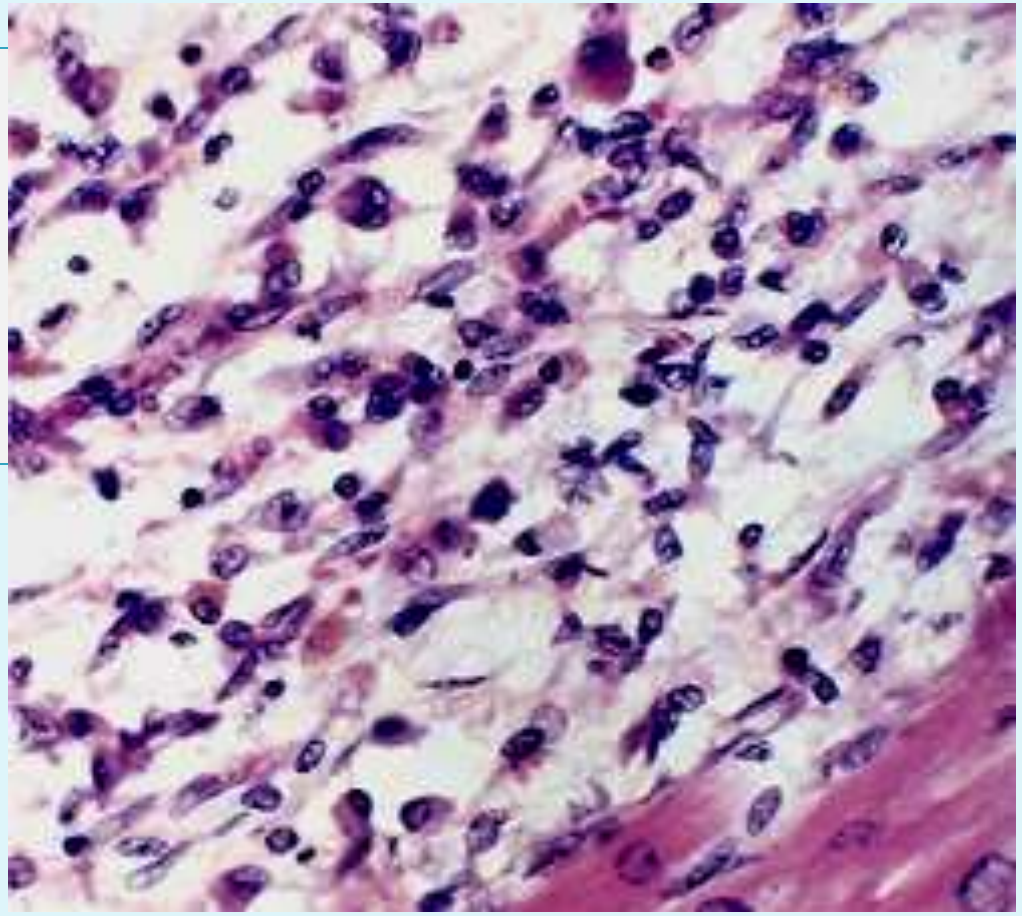
Dense **neutrophil** infiltrate



Stain: Hematoxylin & Eosin (H&E)

Microscopic features of myocardial infarction and its repair.

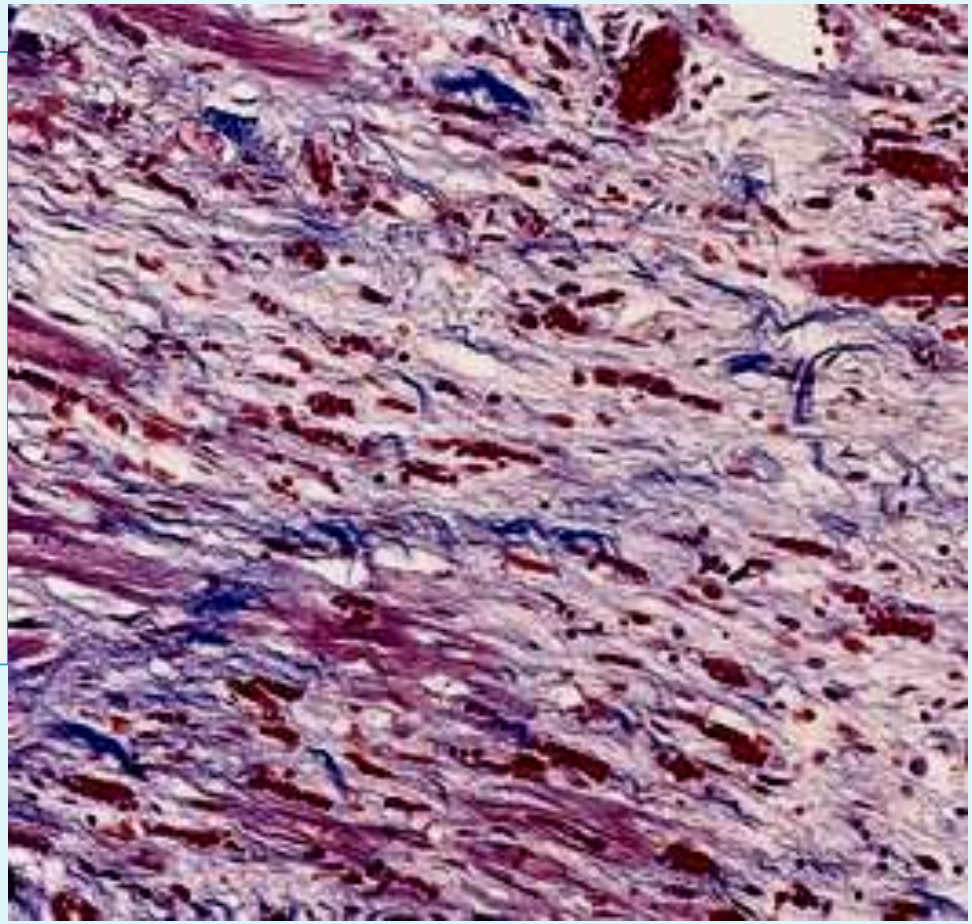
7 to 10 days:
complete removal of necrotic myocytes by **macrophages**



Stain: Hematoxylin & Eosin (H&E)

Microscopic features of myocardial infarction and its repair.

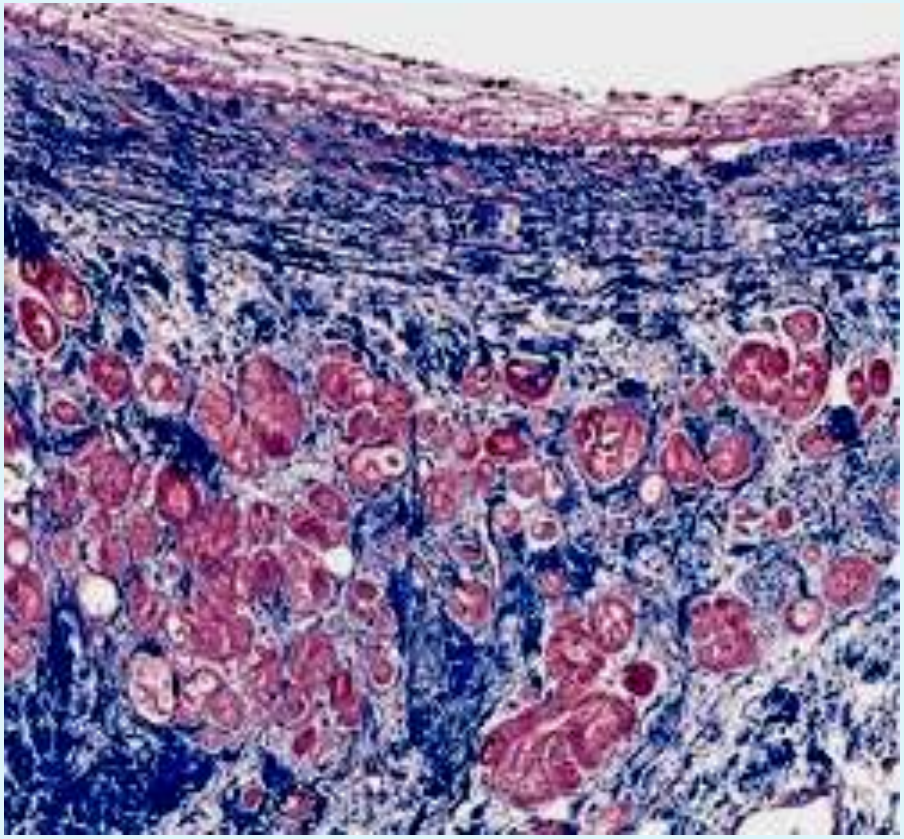
up to 14 days:
Granulation tissue
[loose connective tissue (blue) and abundant capillaries (red)]



Stain: Masson Trichrome (MT)

Microscopic features of myocardial infarction and its repair.

several weeks:
Healed infarct consisting of a dense collagenous **scar (blue)**



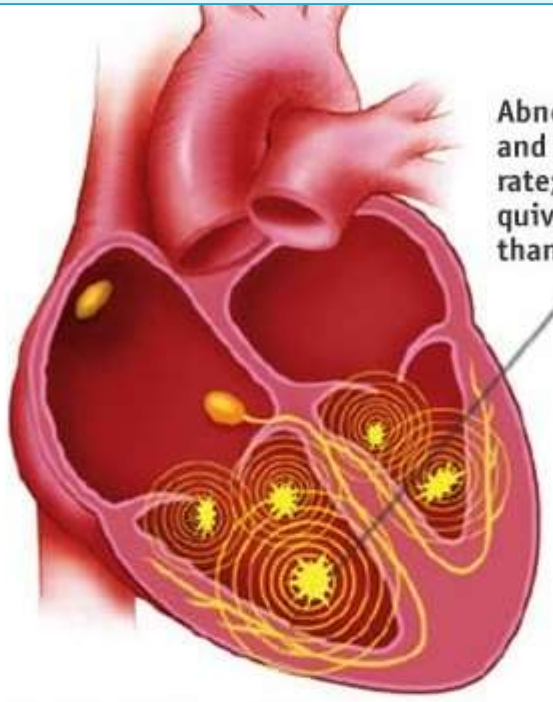
Stain: Masson Trichrome (MT)

Consequences & Complications of MI

1- Death:

- **50%** occur before reaching hospital (within 1 hour of symptom onset-usually as a result of lethal arrhythmias (Sudden Cardiac Death)

- **Arrhythmias are caused by electrical abnormalities of the ischemic myocardium and conduction system**
- With current medical care, patient outcome is better (*in-hospital death rate* has declined).



Ventricular Fibrillation ECG

Consequences & Complications of MI

- ***2- Cardiogenic shock.***
- 15% - In large infarcts (>40% of Left ventricle).
- 70% mortality rate - important cause of in-hospital deaths.
- ***3-Myocardial rupture***
- ***4-Pericarditis***
- ***5-Infarct expansion***
- ***6- Mural thrombus***
- ***7-Ventricular aneurysm***
- ***8-Progressive late heart failure***

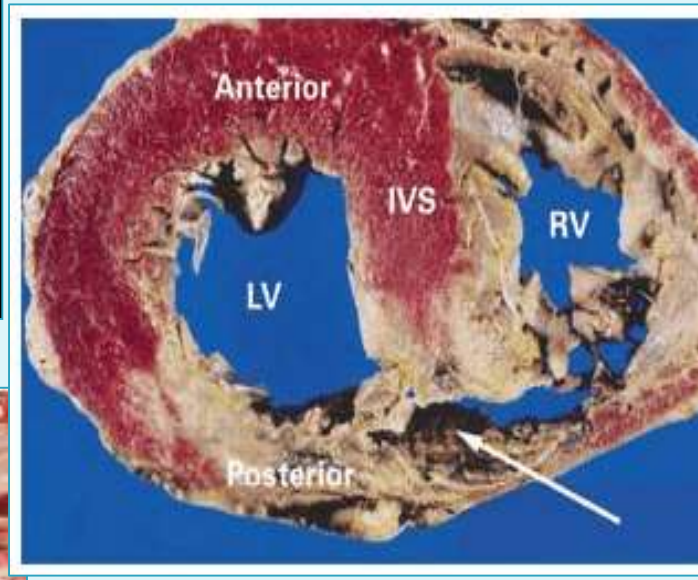
Complications of Myocardial Rupture Include:

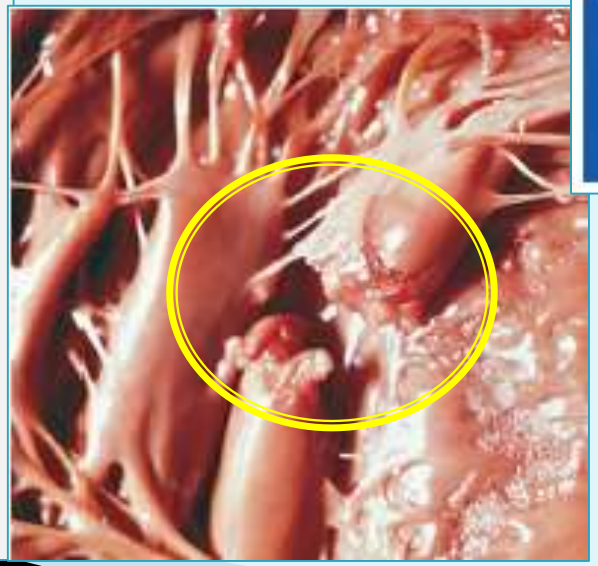
(1) rupture of the ventricular free wall: hemopericardium and cardiac tamponade (usually fatal)

(2) rupture of the ventricular septum: VSD and left-to-right shunt

(3) papillary muscle rupture:

severe mitral or tricuspid regurgitation





4-Pericarditis.

- 2 to 3 days post a transmural MI
- spontaneously resolves (immunologic mechanism)

5-Infarct expansion.

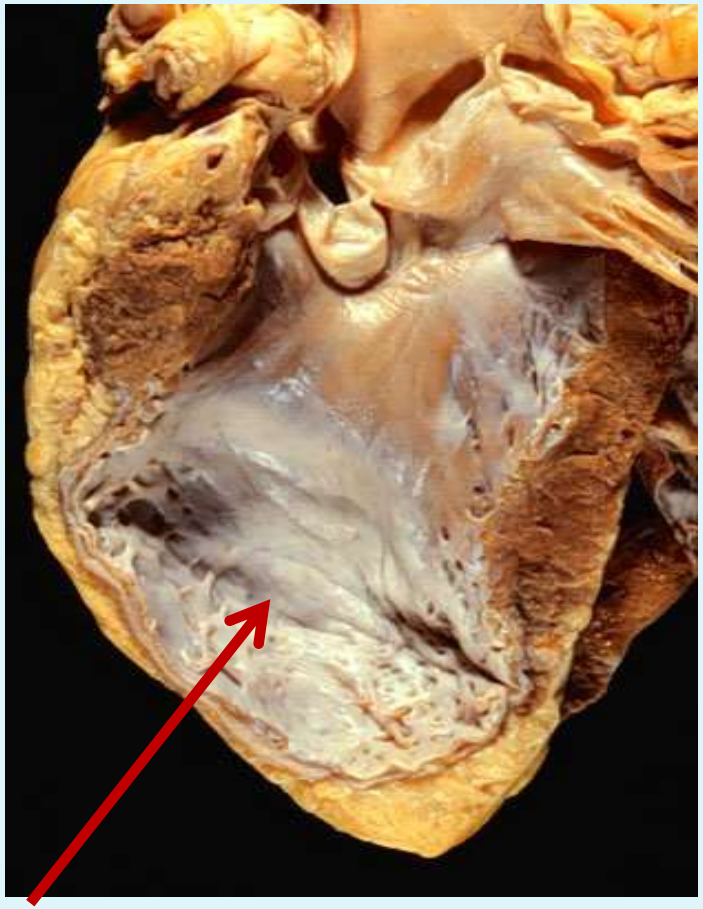
disproportionate stretching, thinning, and dilation of the infarct region (especially with anteroseptal infarcts)

6-Mural thrombus.

loss of contractility (causing stasis) + endocardial damage → ***thromboembolism***

7-Ventricular aneurysm.

- A late complication
- most commonly result from a large transmural anteroseptal infarct that heals with the formation of thin scar tissue



Complications of ventricular aneurysms include:

1-mural thrombus
2-arrhythmias
3-heart failure

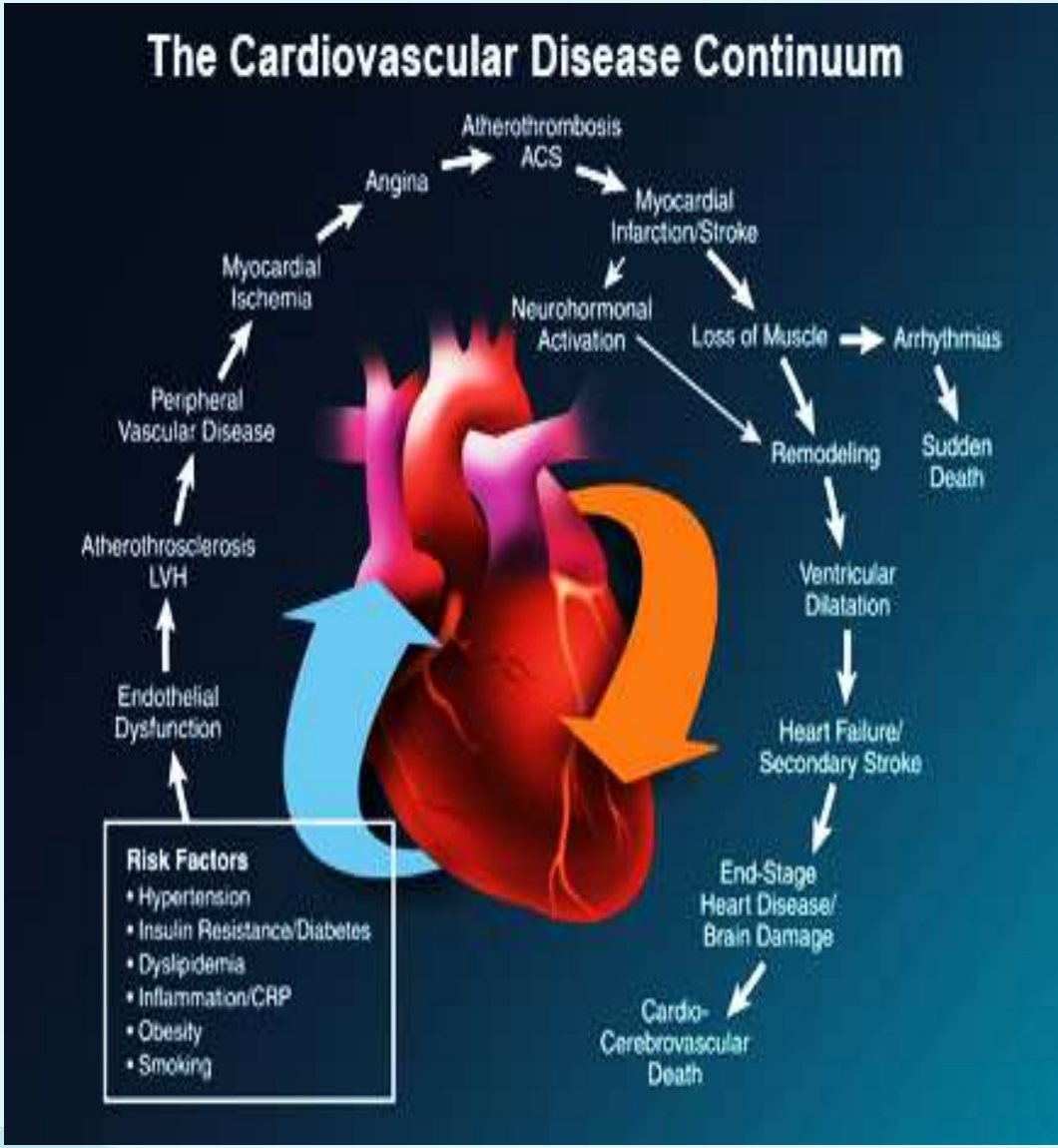
Long-term prognosis after MI

- depends on many factors: e.g. left ventricular function; severity of atherosclerosis in viable myocardium; etc...

- 1^{st} year mortality ≈ 30%.
- Thereafter, the annual mortality rate≈ 3%

Chronic Ischemic Heart Disease

- results from **post-infarction** cardiac decompensation that follows exhaustion of hypertrophic viable myocardium.
- **progressive heart failure**
- sometimes punctuated by episodes of angina or MI
- Arrhythmias are common



Sudden Cardiac Death (SCD)

- **Unexpected death from cardiac causes either without symptoms or < 24 hours of symptom onset**
- **CAD (atherosclerosis) is the most common underlying cause**
- **Lethal arrythmias (v. fibrillation) is the most common direct mechanism of death**
- With **younger** victims, other **non-atherosclerotic** causes are more common:

Non-atherosclerotic causes of SCD

- Congenital coronary arterial abnormalities
- Aortic valve stenosis
- Mitral valve prolapse
- Myocarditis
- Dilated/ hypertrophic cardiomyopathy
- Pulmonary hypertension
- Hereditary/ acquired abnormalities of cardiac conduction system
- ……