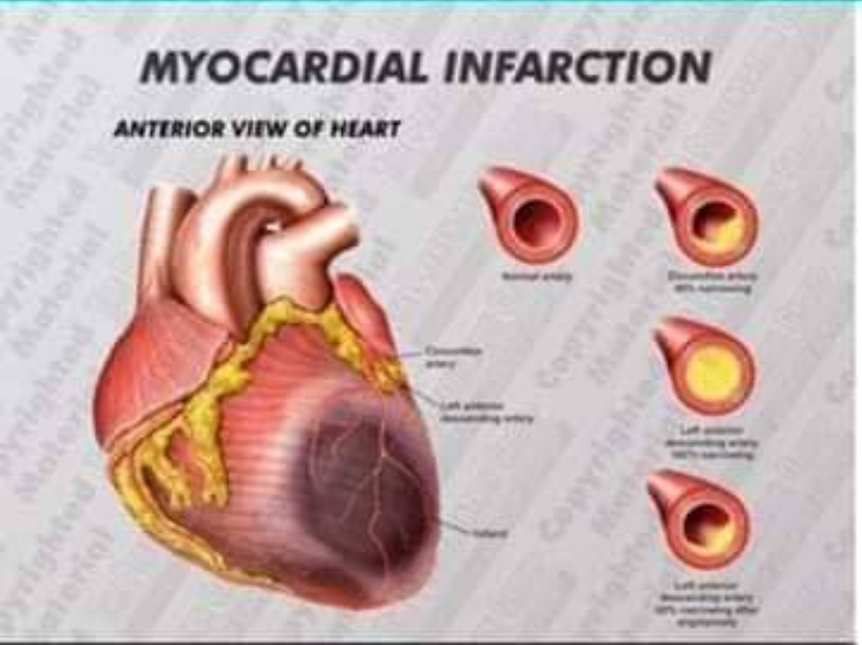
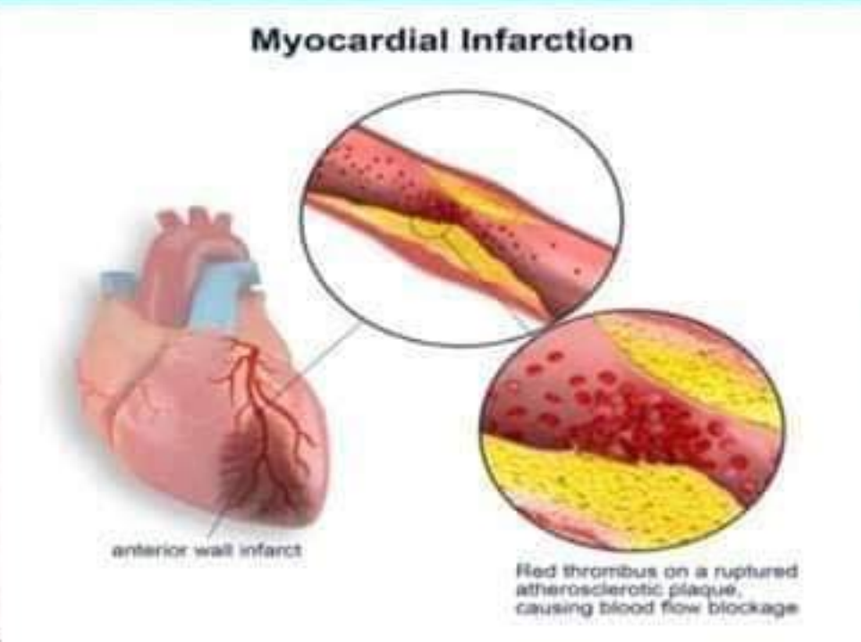
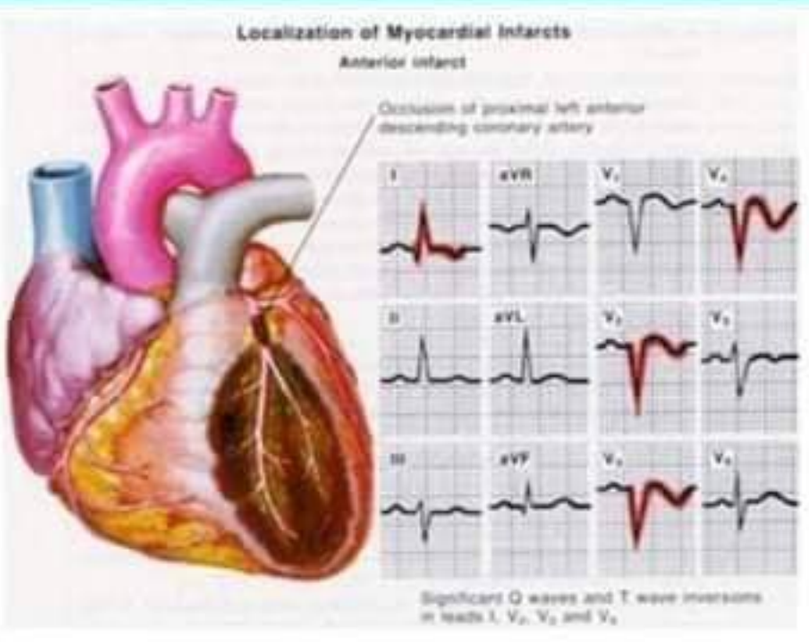
Myocardial Infarction

@MD,Sun Bunlorn Page





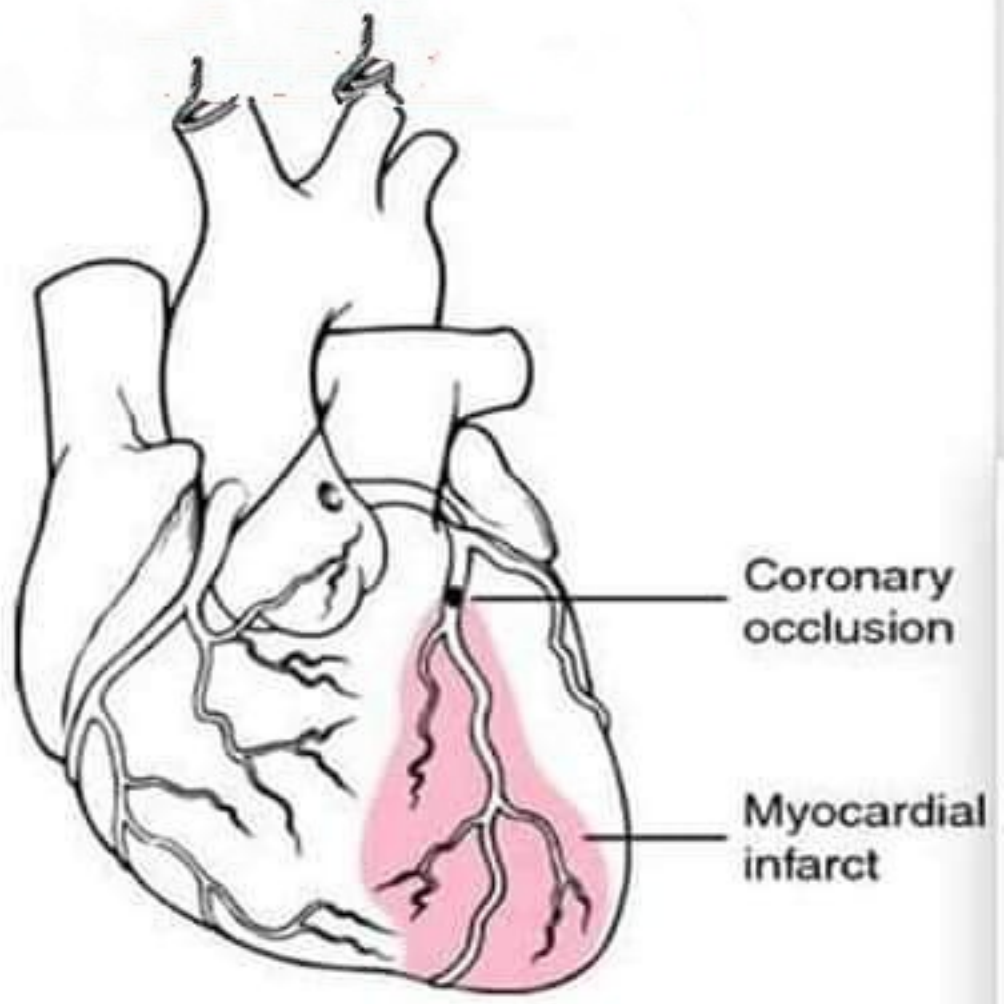


CONTENT:

- Introduction
- Causes and pathogenesis of IHD
- Angina pectoris
- Myocardial infarction
  - Etiopathogenesis
  - Morphology
  - Lab diagnosis
  - Complications

Introduction

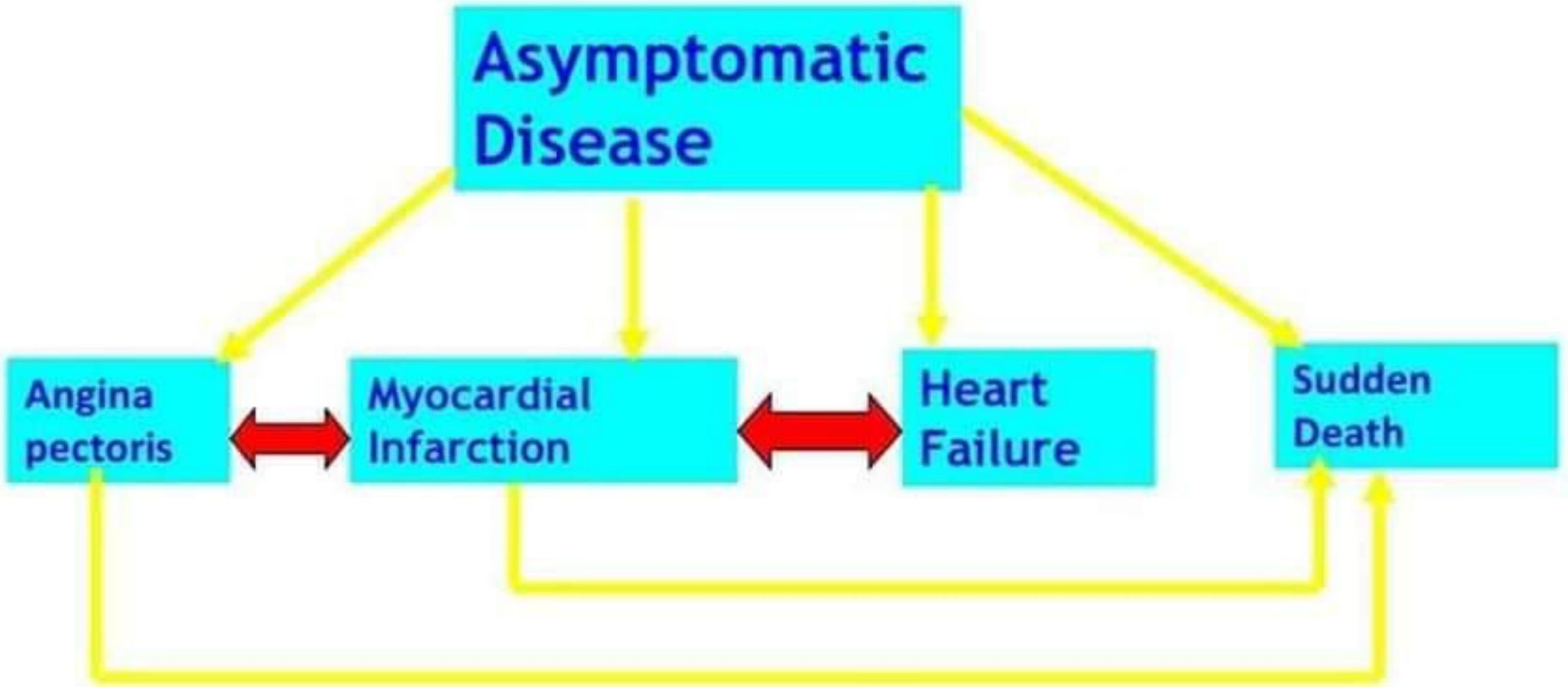
- Leading cause of death.
- Myocardial ischemia.
- Ischemia versus hypoxia.
- Coronary atherosclerosis- 90%



IHD presenting clinical syndromes:

- Myocardial infarction.
- Angina pectoris.
- Chronic IHD with heart failure.
- Sudden cardiac death

Ischemic Heart Disease (IHD)



Etiology:

1. Reduced coronary blood flow.

2. Increased myocardial metabolism.

3. Decreased oxygen transport

CAUSES OF ISCHEMIC HEART DISEASE

- Obstructed blood flow
  - Atherosclerosis
  - Thrombosis
  - Coronary spasm

- Reduced oxygen availability
  - Anemia

- Increased demand for oxygen
  - Hypertension
  - Hyperthyroidism
  - Fever

Pathogenesis :

- Chronic atherosclerosis.
- Acute plaque change.
- Consequences of myocardial ischemia.

Chronic atherosclerosis:

- More than 90% of patients with IHD have atherosclerosis of one or more of the epicardial coronary arteries.

- stenosis ("fixed" obstructions) , acute plaque disruption with thrombosis.
- single major coronary epicardial trunk may be affected, two or all three. 1. LAD, 2.LCX, and 3. RCA.

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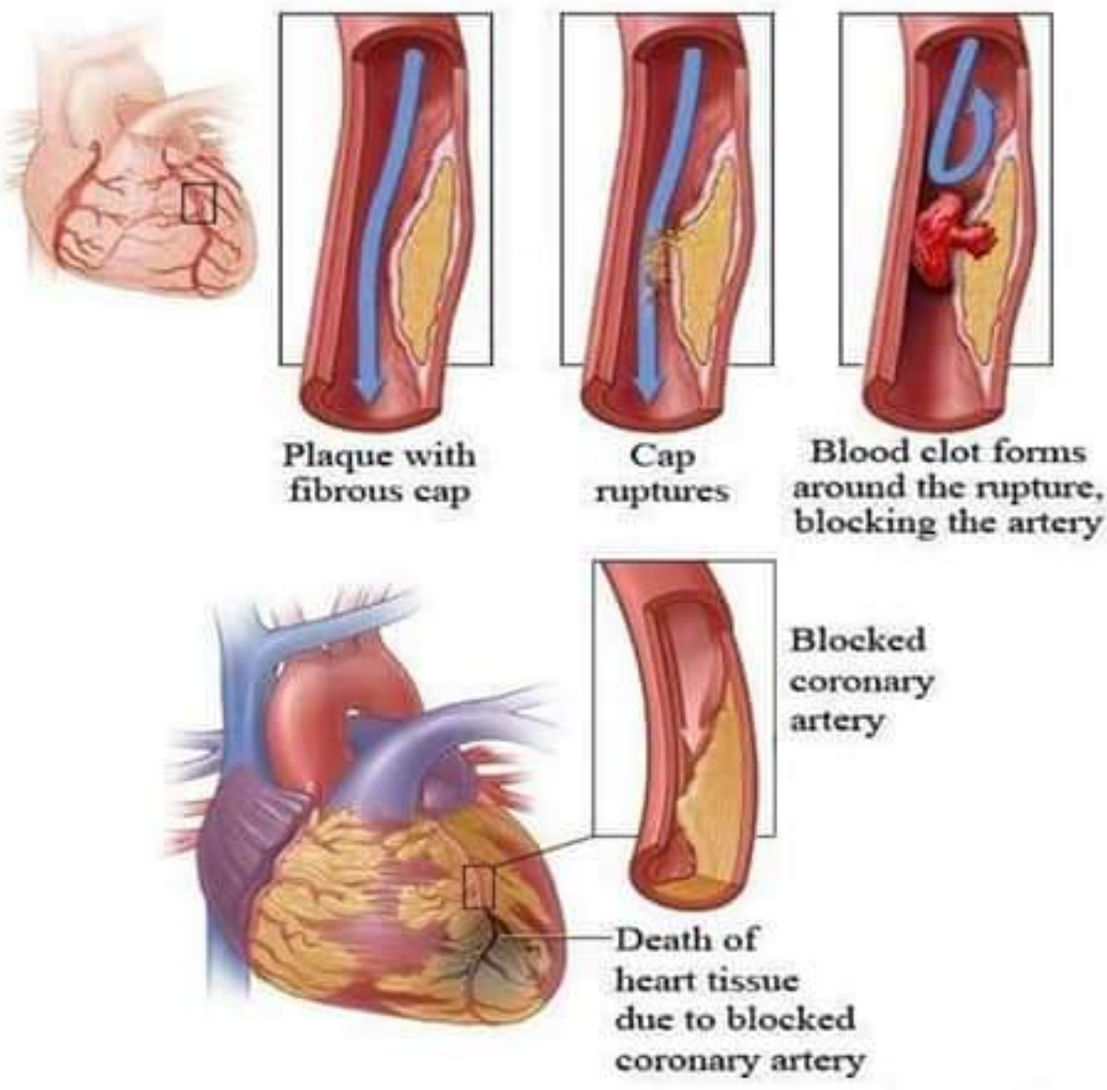
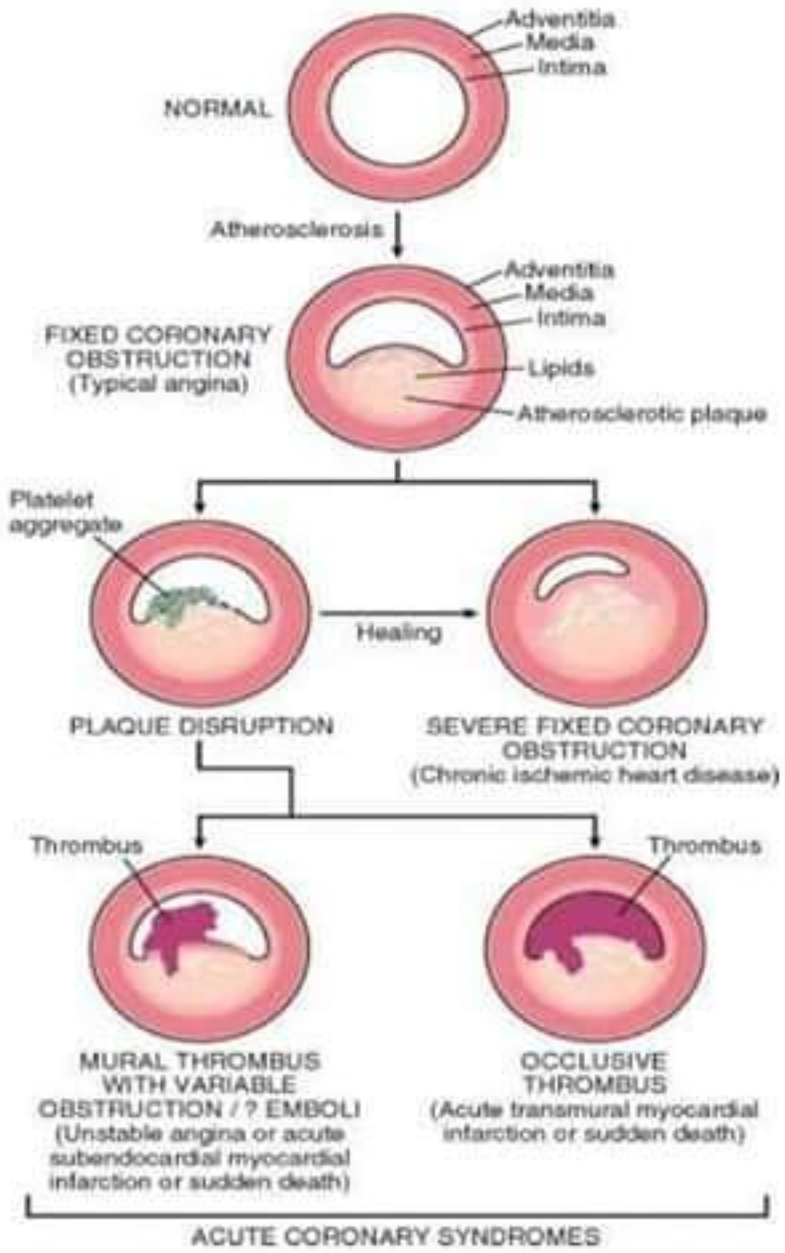
Acute Plaque Change:

- Number, Distribution, Structure, and Degree of obstruction of atheromatous plaques.

- Stable atherosclerotic plaque to an unstable atherothrombotic lesion through rupture, superficial erosion, ulceration, fissuring, or deep hemorrhage.

- Formation of a superimposed thrombus that partially or completely occludes the affected artery.





Angina pectoris

- A symptom complex of IHD characterized by paroxysmal attacks of chest pain, usually substernal or precordial, caused by myocardial ischemia that falls short of inducing infarction. There are several patterns

Variants of Angina

- **1. Stable angina (typical)** - paroxysms of pain related to exertion and relieved by rest or vasodilators. subendocardial ischemia with ST-segment depression
- **2. Variant or Prinzmetal's angina** - angina that classically occurs at rest and is caused by reversible spasm in normal to severely atherosclerotic coronary arteries. ST-segment elevation or depression maybe seen during attacks.

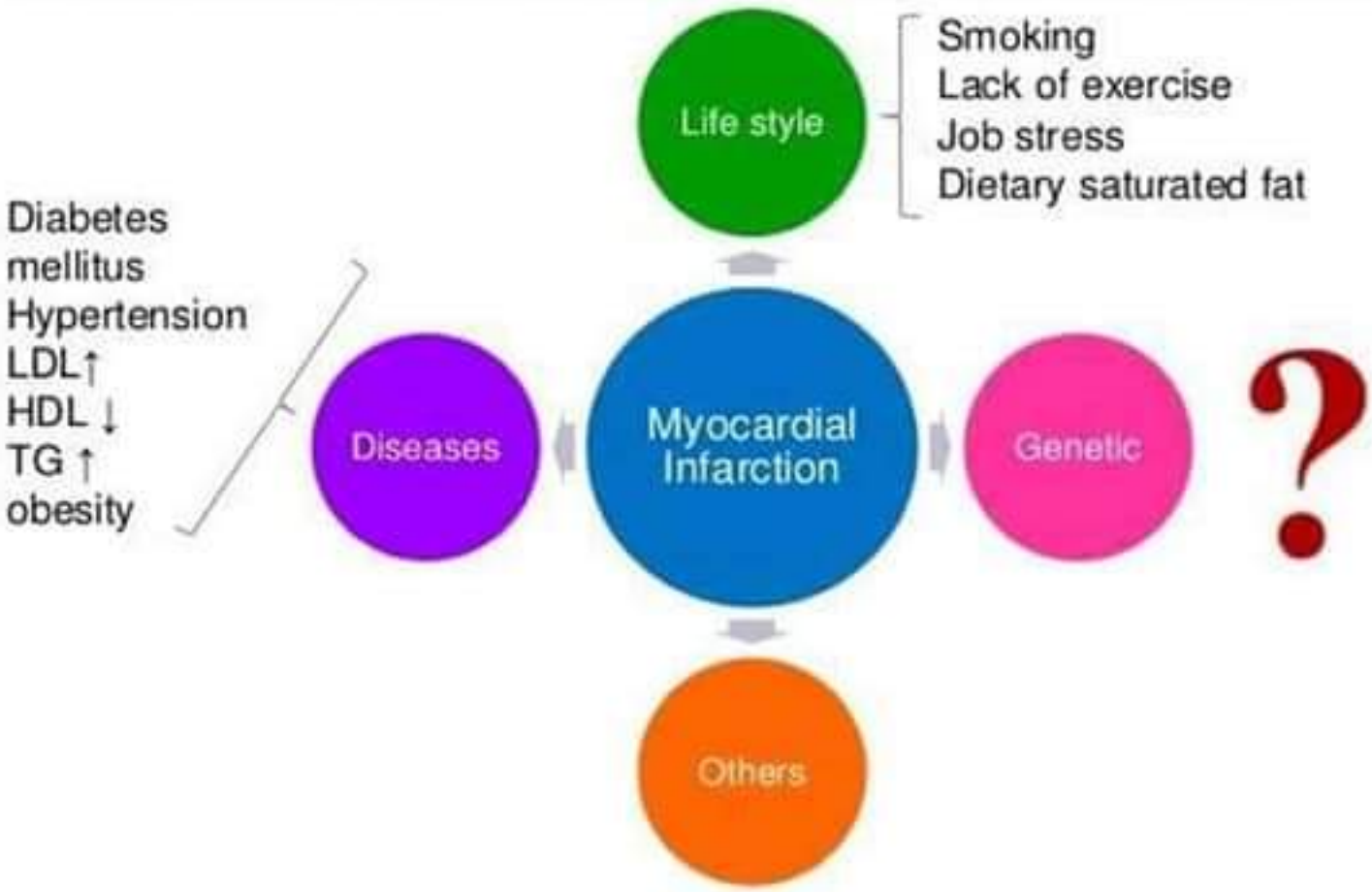
Variants of Angina

- **3. Unstable angina** - prolonged pain, pain at rest in a person with stable angina, or worsening of pain in stable angina. ST-segment depression (usually) and ST-segment elevation.
- .

Myocardial infarction

- Is the death of heart muscle following ischaemic heart disease

Causes of Myocardial Infarction



Pathogenesis-MI

- **Coronary artery occlusion-**
- Sudden change in the morphology of the plaque
- Adhesion,aggregation, activation and release of potent platelet aggregators including thromboxane A2,serotonin,platelet factor 3 & 4
- Vasospasm
- Activation of extrinsic pathway of coagulation
- Thrombus completely occludes vessel lumen

Pathogenesis (contd)

- Other mechanisms-

- Emboli-from lt. atrium,paradoxical emboli
- Unexplained-diseases of small intra-mural coronary vessels like vasculitis,haemoglobinopathies,amyloid deposition in vessel walls,other unusual disorders like vascular dissection and inadequate protection during cardiac surgery.

Pathogenesis -contd

- **Myocardial response-**Coronary artery occlusion leads to loss of critical blood supply to the myocardium,producing profound functional,biologic and morphologic consequences.
- Results in cell death in the area of supply,seen in sub-endocardium.Outcome depends on duration and severity of flow deprivation

Pathogenesis -contd

- Early biochemical change-switch from aerobic to anaerobic glycolysis within seconds→inadequate production of high energy phosphates(creatine phosphate and adenosine triphosphate)
- Accumulation of lactic acid
- Within 60 secs of onset of ischaemia-loss of contractility occurs→acute heart failure(myofibrillar relaxation,glycogen deposition,cell and mitochondrial swelling)
- These changes are reversible and cell death is not immediate

Pathogenesis -contd

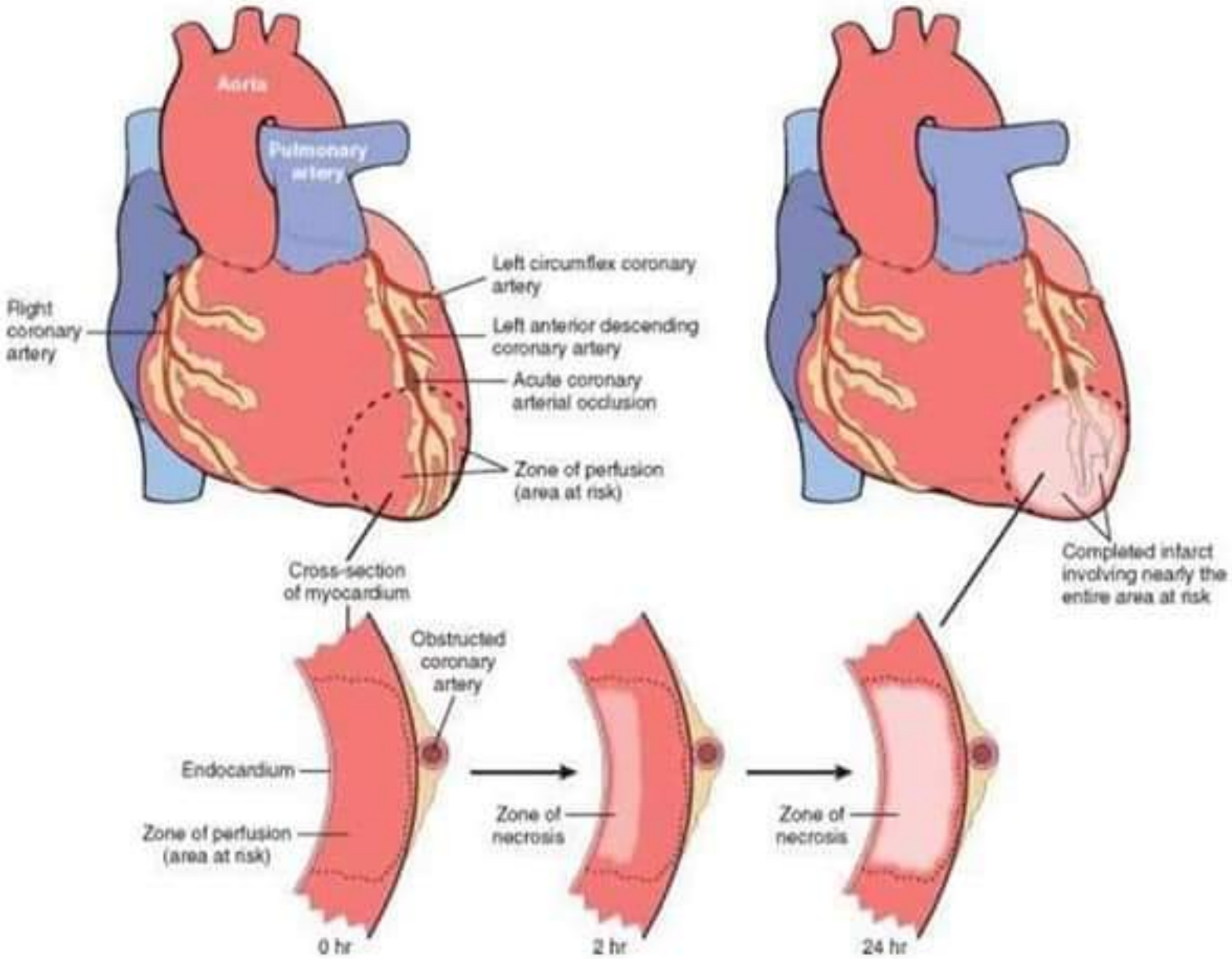
- Severe ischaemia lasting 20-40 mins leads to irreversible necrosis of some cardiomyocytes(primary structural defects in sarcolemmal membrane)
- With prolonged ischemia injury to micro-vasculature follows
- Arrhythmias occur through poorly understood mechanism
- Sudden cardiac death
- "Wavefront"of myocardial ischaemia

Gross morphology -MI

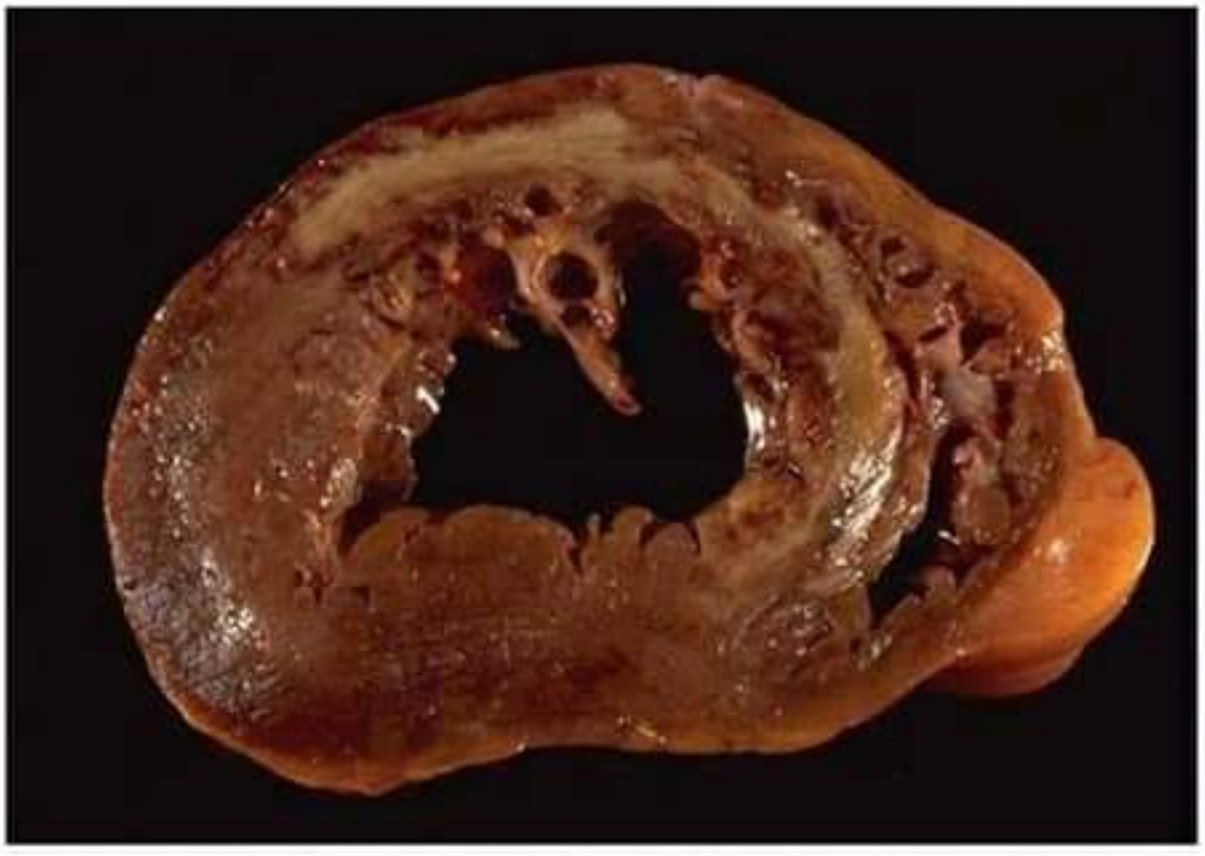
Patterns include:

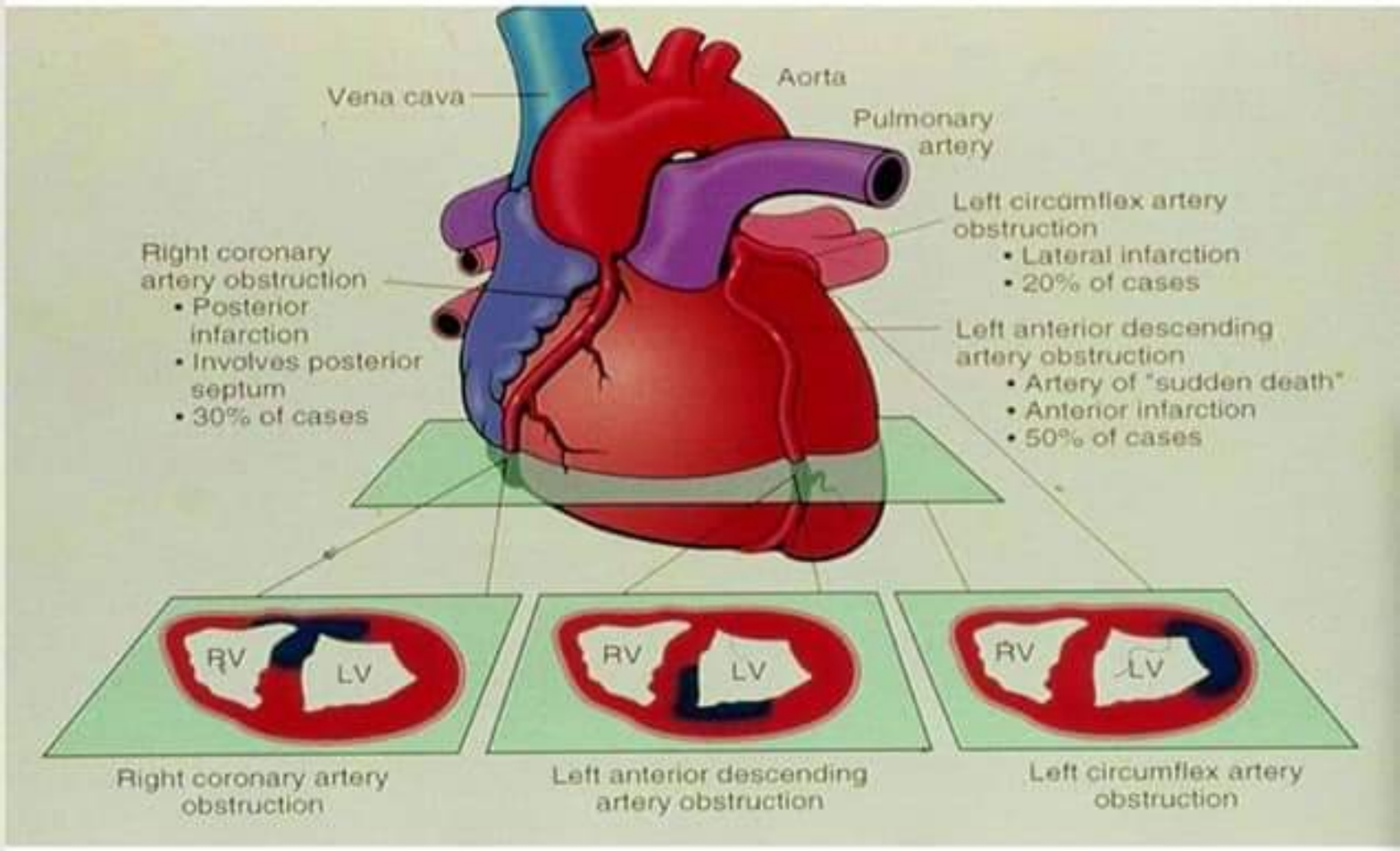
- **Transmural infarct** - involving the entire thickness of the left ventricular wall from endocardium to epicardium, usually the anterior free wall and posterior free wall and septum with extension into the RV wall in 15-30%. Isolated infarcts of RV and right atrium are extremely rare.

- **Subendocardial infarct** - multifocal areas of necrosis confined to the inner 1/3-1/2 of the left ventricular wall. These do not show the same evolution of changes seen in a transmural MI.



Transmural infarction



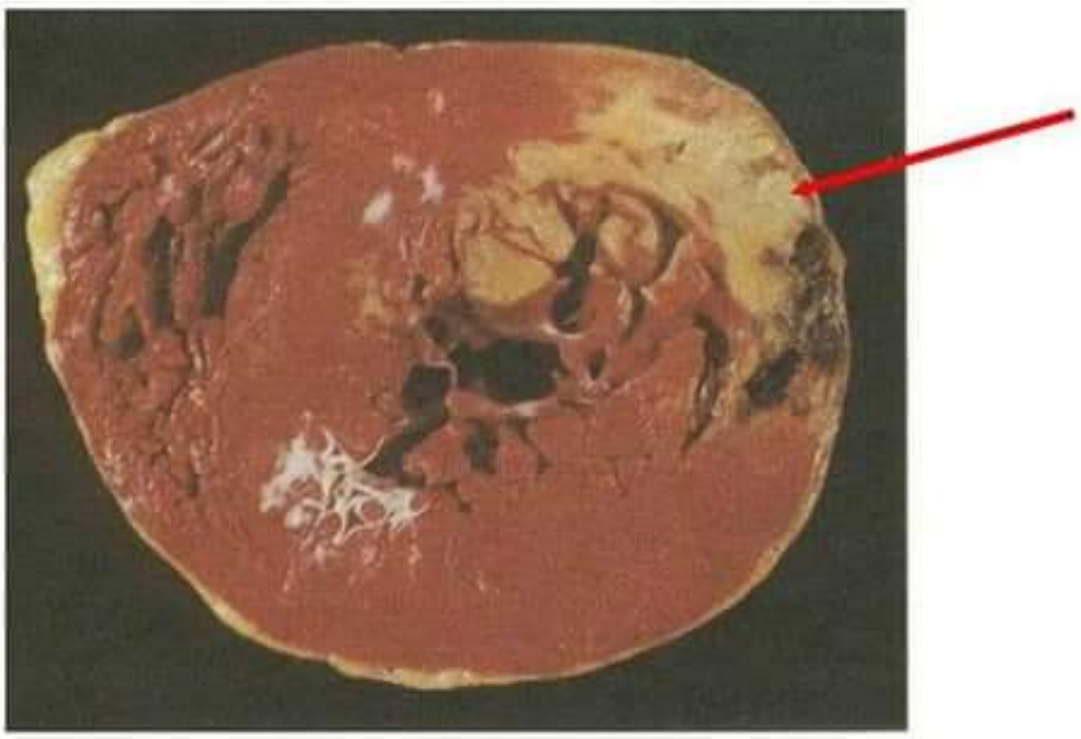


Irreversible injury

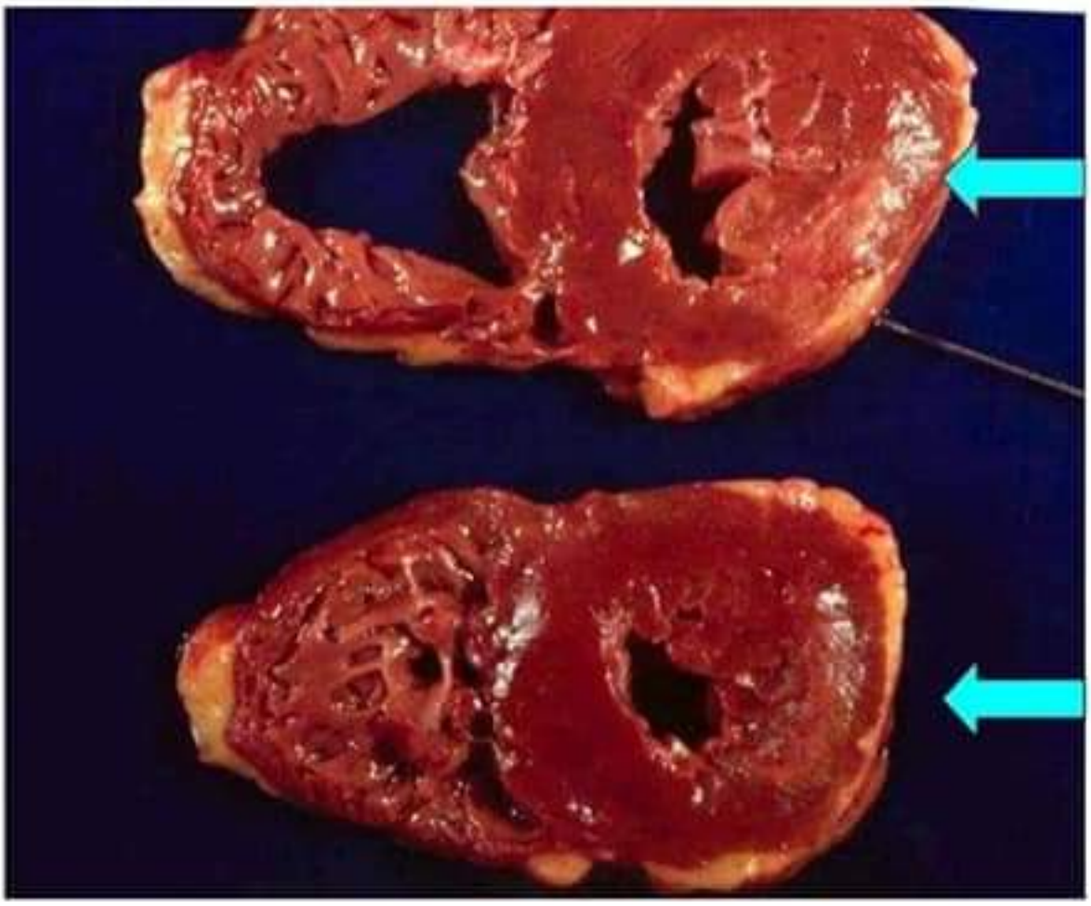
Time	Gross features	Light microscopy
½–4 hr	None	Usually none; variable waviness of fibers at border
4-12 hrs	Dark mottling (occasional)	Early coagulation necrosis; edema; hemorrhage
12–24 hr	Dark mottling	Ongoing coagulation necrosis; pyknosis of nuclei; myocyte hypereosinophilia; marginal contraction band necrosis; early neutrophilic infiltrate
1–3 days	Mottling with yellow-tan infarct center	Coagulation necrosis, with loss of nuclei and striations; brisk interstitial infiltrate of neutrophils
3–7 days	Hyperemic border; central yellow-tan softening	Beginning disintegration of dead myofibers, with dying neutrophils; early phagocytosis of dead cells by macrophages at infarct border

Time	Gross features	Light microscopy
7–10 days	Maximally yellow-tan and soft, with depressed red-tan margins	Well-developed phagocytosis of dead cells; early formation of fibrovascular granulation tissue at margins
10–14 days	Red-gray depressed infarct borders	Well-established granulation tissue with new blood vessels and collagen deposition
2–8 wk	Gray-white scar, progressive from border toward core of infarct	Increased collagen deposition, with decreased cellularity
>2 mo	Scarring complete	Dense collagenous scar

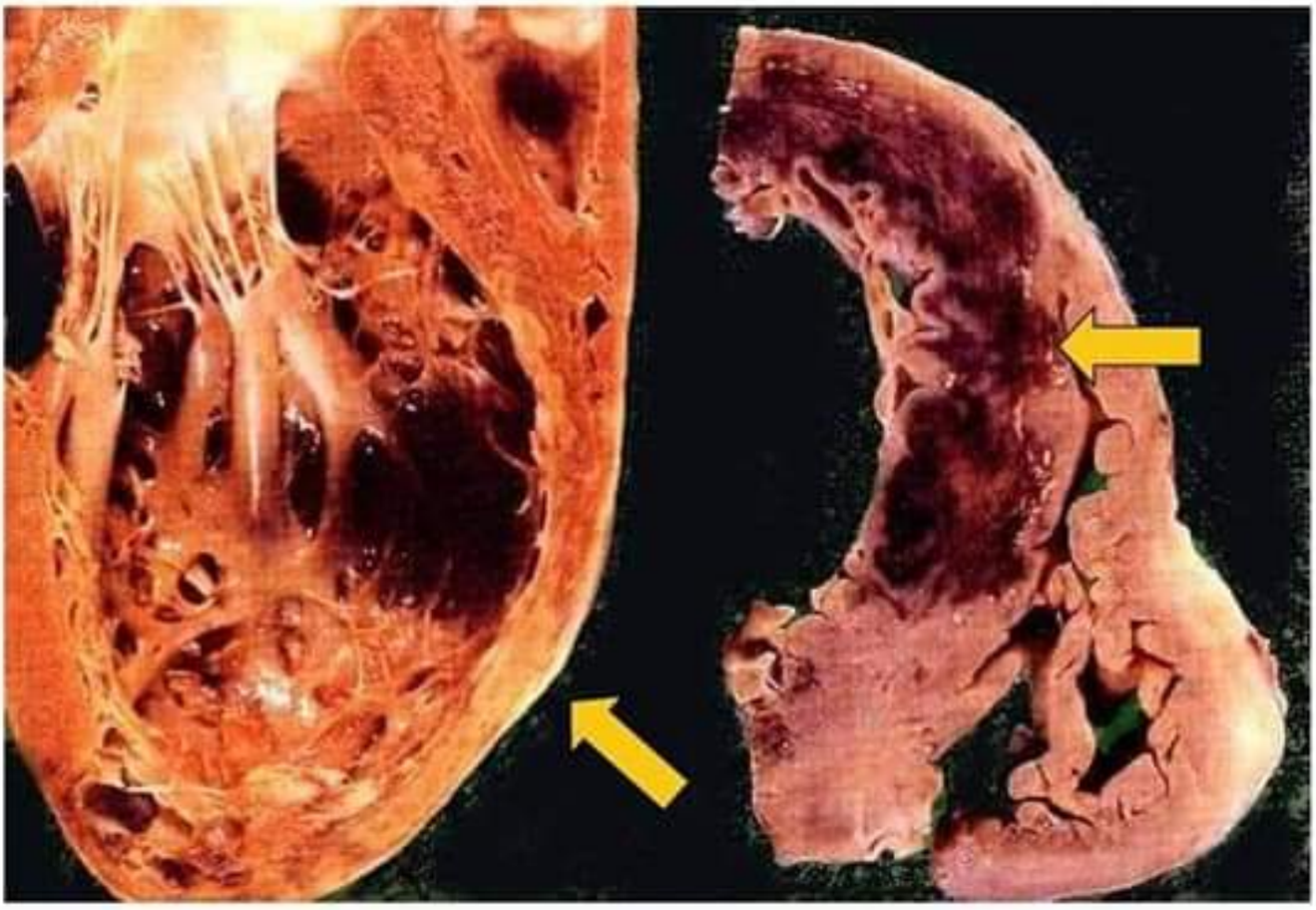
MI demonstrated histochemically by the lack of staining with triphenyl tetrazolium chloride in the areas of necrosis



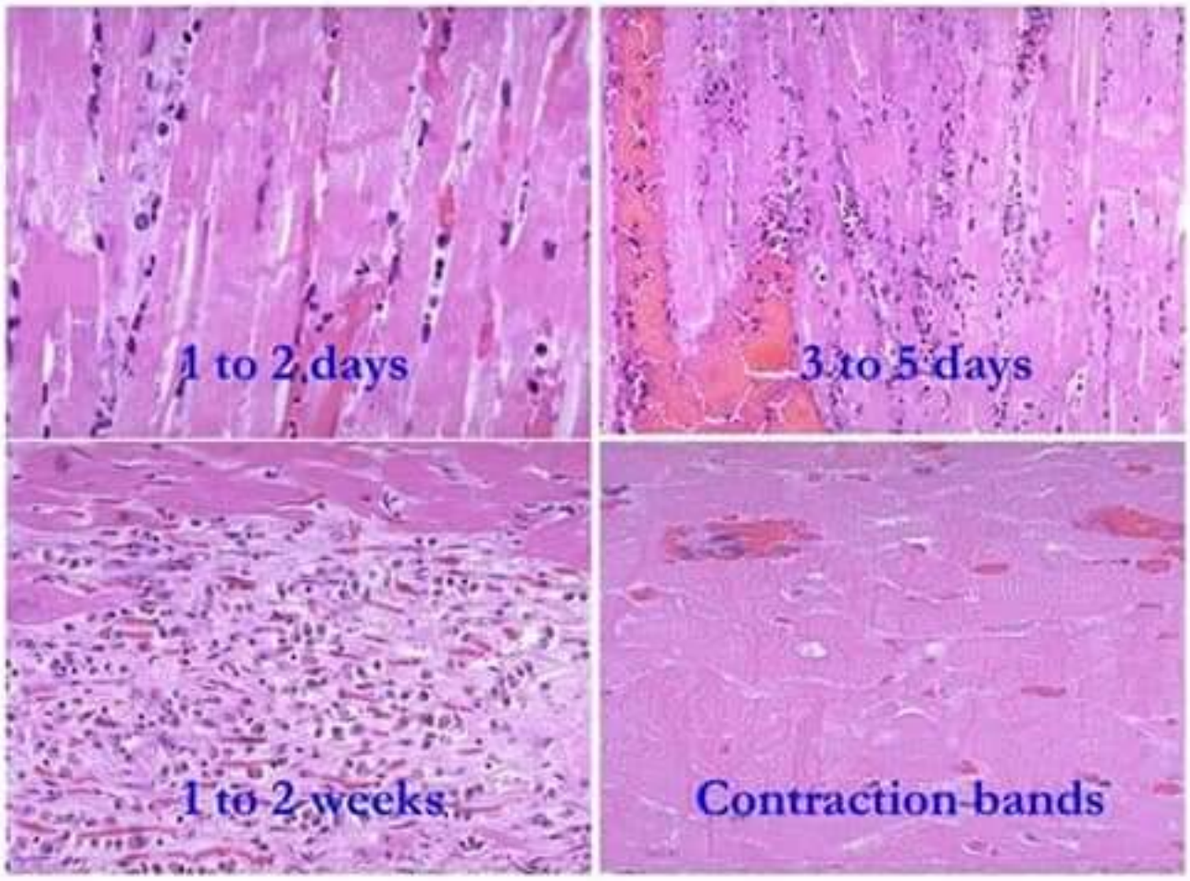
Myocardial Infarction – 1 week



Myocardial Infarction - 2week

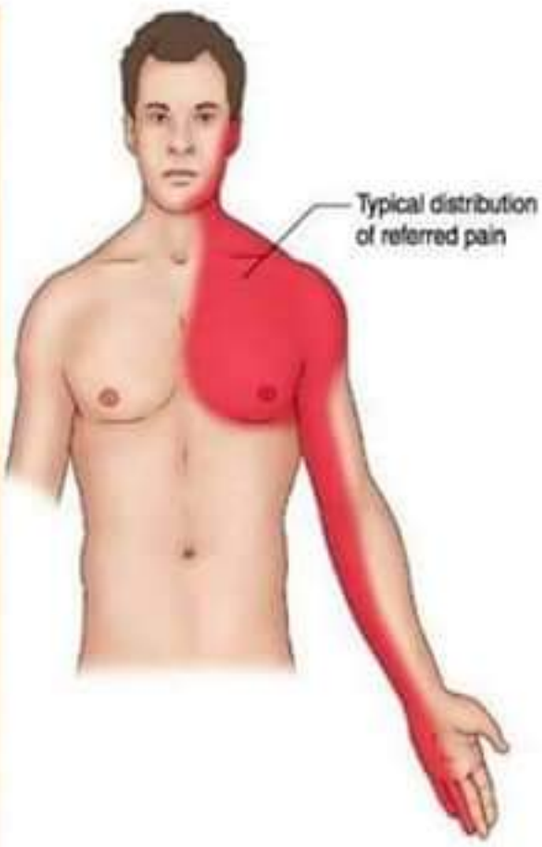


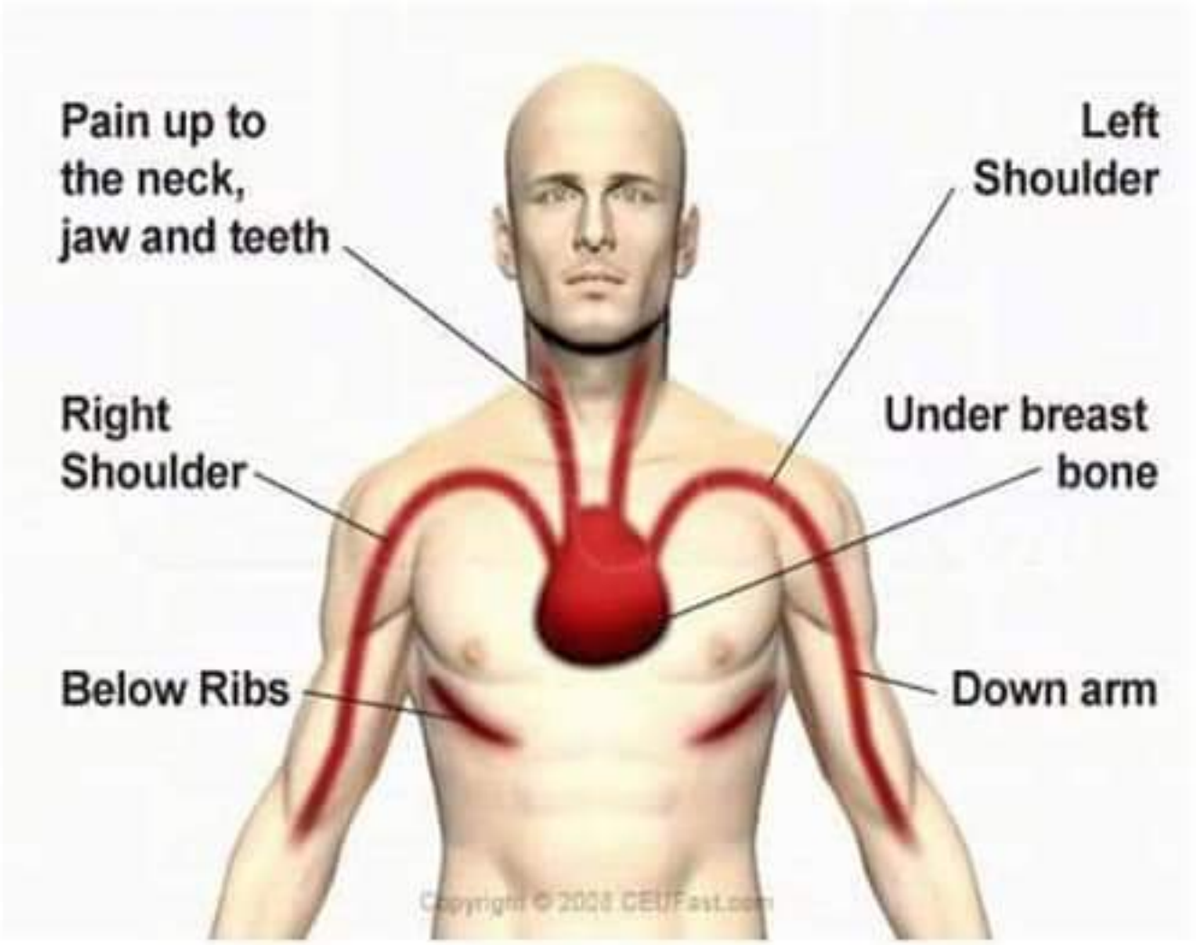
Morphological changes in MI



Signs and symptoms

- prolong cardiac pain radiating to chest, arms, throat and back.





Diagnosis Of MI

- Clinical features-diaphoresis,dyspnoea,pulmonary congestion and oedema
- Clinical laboratory-CK-MB

  Elevated at 2-4 hrs, lasts 72hrs

  Troponin I 2-4 hrs & lasts 7-10 days

  Troponin T
- ECG
- Radiologic (angiography)

Creatine Kinase -Total

- The total CK is a simple and inexpensive test that is readily available using many laboratory instruments.
- However, an elevation in total CK is not specific for myocardial injury,
- because most CK is located in skeletal muscle, and elevations are possible from a variety of non-cardiac conditions.

Creatine Kinase

- Three isoenzymes
  - CK – MM (heart & skeletal muscle)
  - CK – BB (brain, lung & other tissues)
  - CK – MB (Principally myocardium, variable amounts in skeletal muscle)
- CK – MB rises within 2 – 8 hours of MI, peaks at 18 hours and disappears by 48 to 72 hours
- An absence of a change in levels in CK – MB during the first 2 days of chest pain essentially excludes MI

CK-MB

- Is a very good marker for acute myocardial injury, because of its excellent specificity, and it rises in serum within 2 to 8 hours of onset of acute myocardial infarction.
- Serial measurements every 2 to 4 hours for a period of 9 to 12 hours after the patient is first seen will provide a pattern to determine whether the CK-MB is rising, indicative of myocardial injury.
- The CK-MB is also useful for diagnosis of reinfarction or extension of an MI because it begins to fall after a day, dissipating in 1 to 3 days, so subsequent elevations are indicative of another event.

Troponin I and T

- Troponin I and T are structural components of cardiac muscle.
- They are released into the bloodstream with myocardial injury.
- They are highly specific for myocardial injury – more so than CK-MB – and help to exclude elevations of CK with skeletal muscle trauma.
- Troponins will begin to increase following MI within 2 to 12 hours, about the same time frame as CK-MB. However, the rate of rise for early infarction may not be as dramatic as for CK-MB.

Troponins

- Troponins will remain elevated longer than CK--up to 5 to 9 days for troponin I and up to 2 weeks for troponin T.
- This makes troponins a superior marker for diagnosing myocardial infarction in the recent past--better than lactate dehydrogenase (LDH).
- However, this continued elevation has the disadvantage of making it more difficult to diagnose reinfarction or extension of infarction in a patient who has already suffered an initial MI.
- Troponin T lacks some specificity because elevations can appear with skeletal myopathies and with renal failure.

Myoglobin

- Is a protein found in skeletal and cardiac muscle which binds oxygen.
- It is a very sensitive indicator of muscle injury. The rise in myoglobin can help to determine the size of an infarction.
- A negative myoglobin can help to rule out myocardial infarction. It is elevated even before CK-MB.
- However, it is not specific for cardiac muscle, and can be elevated with any form of injury to skeletal muscle.

LDH

- The LDH has been supplanted by other tests. It begins to rise in 12 to 24 hours following MI, and peaks in 2 to 3 days, gradually dissipating in 5 to 14 days.
- Measurement of LDH isoenzymes is necessary for greater specificity for cardiac injury.
- There are 5 isoenzymes (1 through 5). Ordinarily, isoenzyme 2 is greater than 1, but with myocardial injury, this pattern is "flipped" and 1 is higher than 2.
- LDH-5 from liver may be increased with centrilobular necrosis from passive congestion with congestive heart failure following ischemic myocardial injury.

Infarct modification by reperfusion

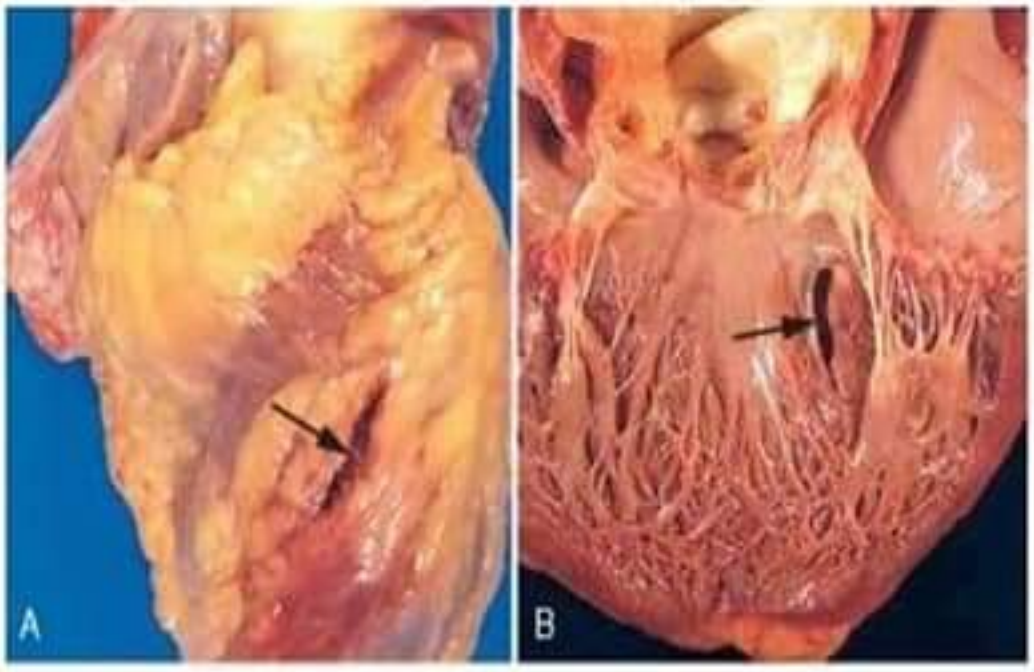
- Restoration of coronary flow→salvage ischaemic myocardium.To be established in 3-4 hrs.Within 15-20 mins-prevents all necrosis
- Contraction bands-occurs in lethally injured cells on reperfusion
- Reperfusion injury-Leukocytes in the reperfused blood→apoptosis of myocytes and microvascular injury→haemorrhage,endothelial swelling→occludes capillaries→prevents local reperfusion-no reflow

Complications

Complicated(80%)

- Contractile dysfunction,pump failure,cardiogenic shock(15%)
- >40% ventricular wall involved
- Arrhythmias and conduction defects, with possible "sudden death" (85%)
- Myocardial rupture-3-7 days,mid-ventricular wall
- Risk factors-female gender,older than 60 yrs,pre-existing hypertension,lack of lt ventr hypertrophy
- Myocardial wall rupture, with possible tamponade (1-2%)
- Papillary muscle rupture, with possible valvular insufficiency
- Rupture of Ventricular septum-L→R shunt(1-2%)

- Extension of infarction, or re-infarction
- Congestive heart failure (pulmonary edema) (60%)
- Pericarditis-2-3 days
- Right ventricular infarction
- Infarct expansion-Stretching,thinning and dilatation of infarct region as with mural thrombus
- Mural thrombosis, with possible embolization (30%)
- Ventricular aneurysm formation-late complication,rarely undergoes rupture
- Papillary muscle dysfunction
- Progressive late heart failure
- **Uncomplicated (20%)**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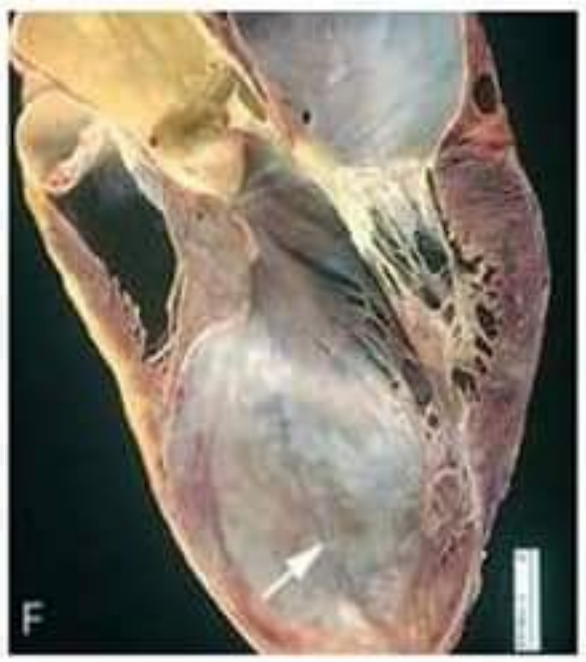
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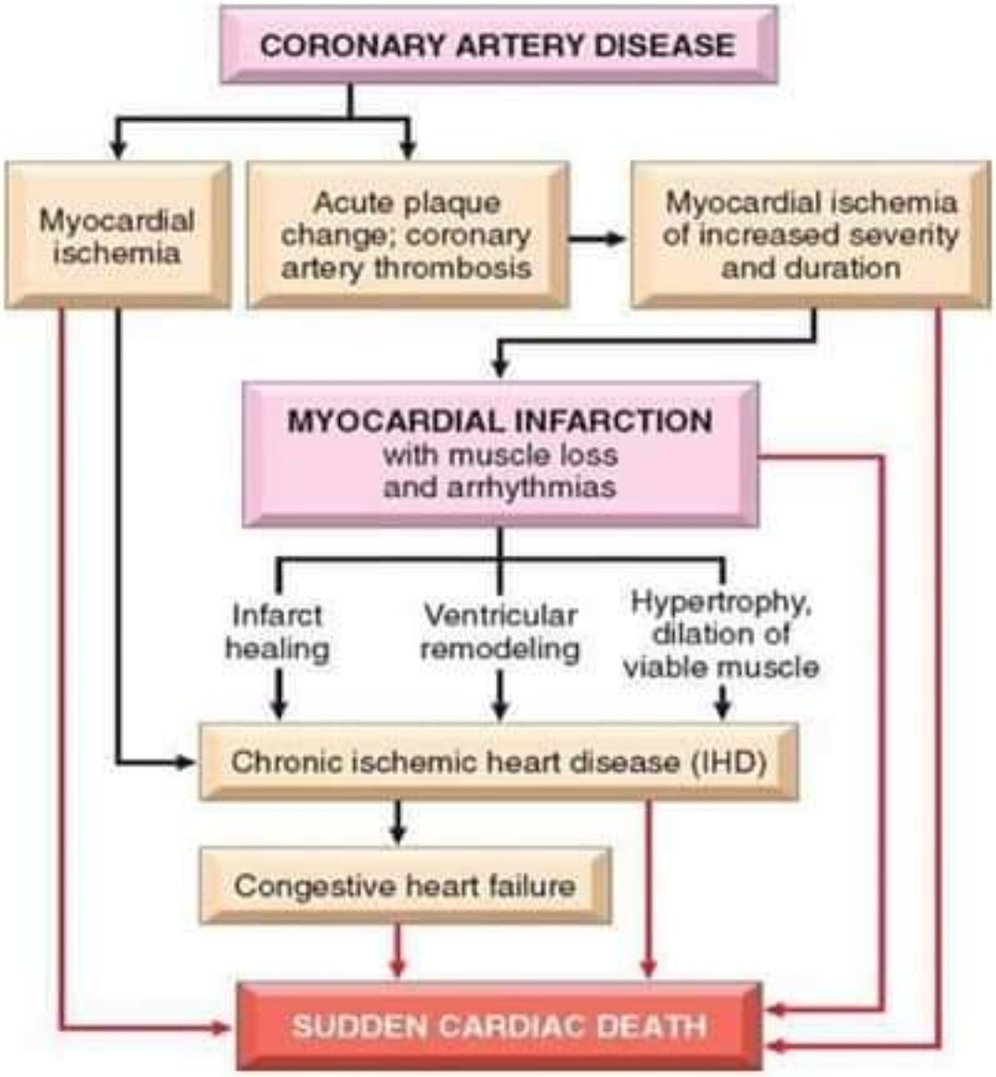

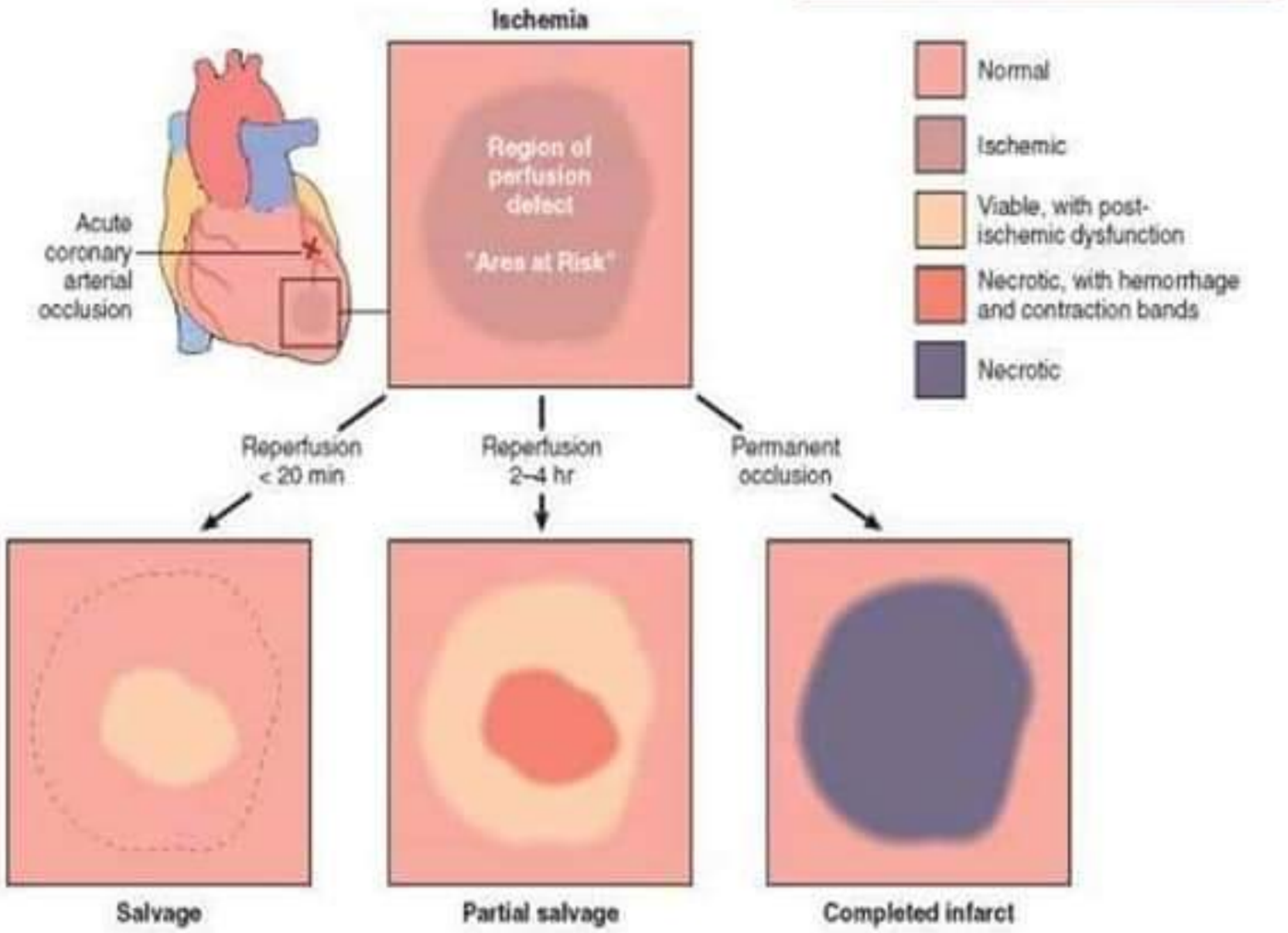

Myocardial Infarction Treatment:

ON AM (I am ON fire in the AM as I am a morning person)

O Oxygen 

N Nitroglycerine 

A ASA (Aspirin) 

M Morphine