



# Cardiovascular system II

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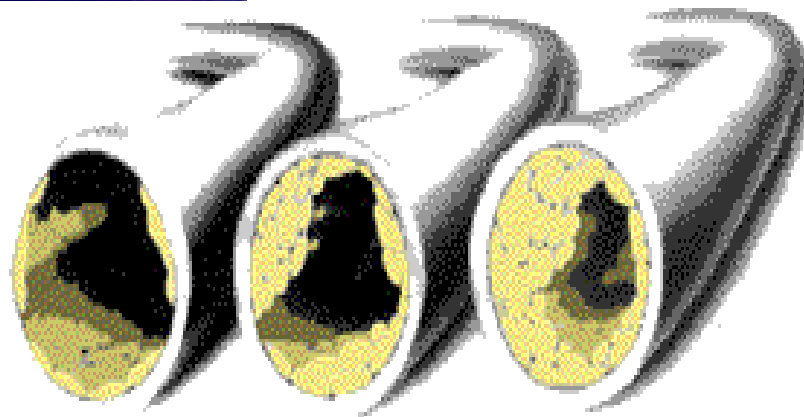
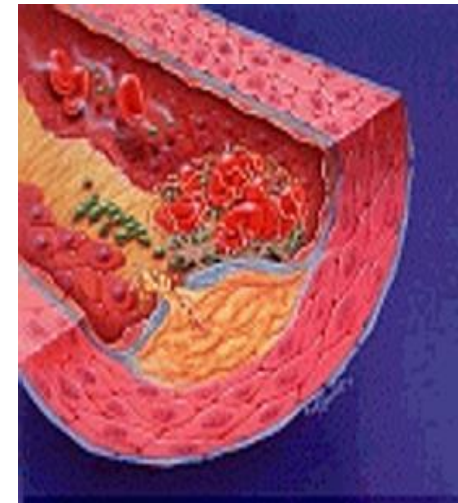
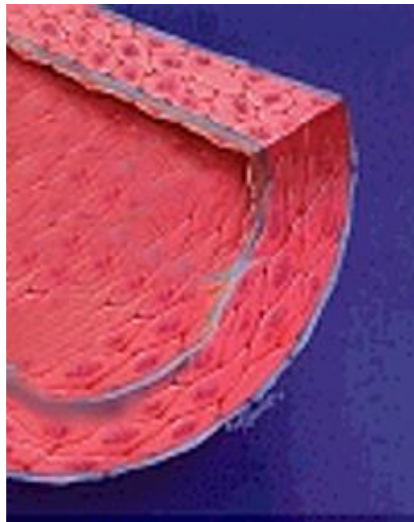


# Cardiovascular diseases

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- Hypertension
- Atherosclerosis
- Coronary artery disease
  - Angina pectoris
  - Acute myocardial infarction
- Heart failure
- Stroke

# Atherosclerosis



**The effect of Atherosclerosis  
on an artery over time**



# Atherosclerosis

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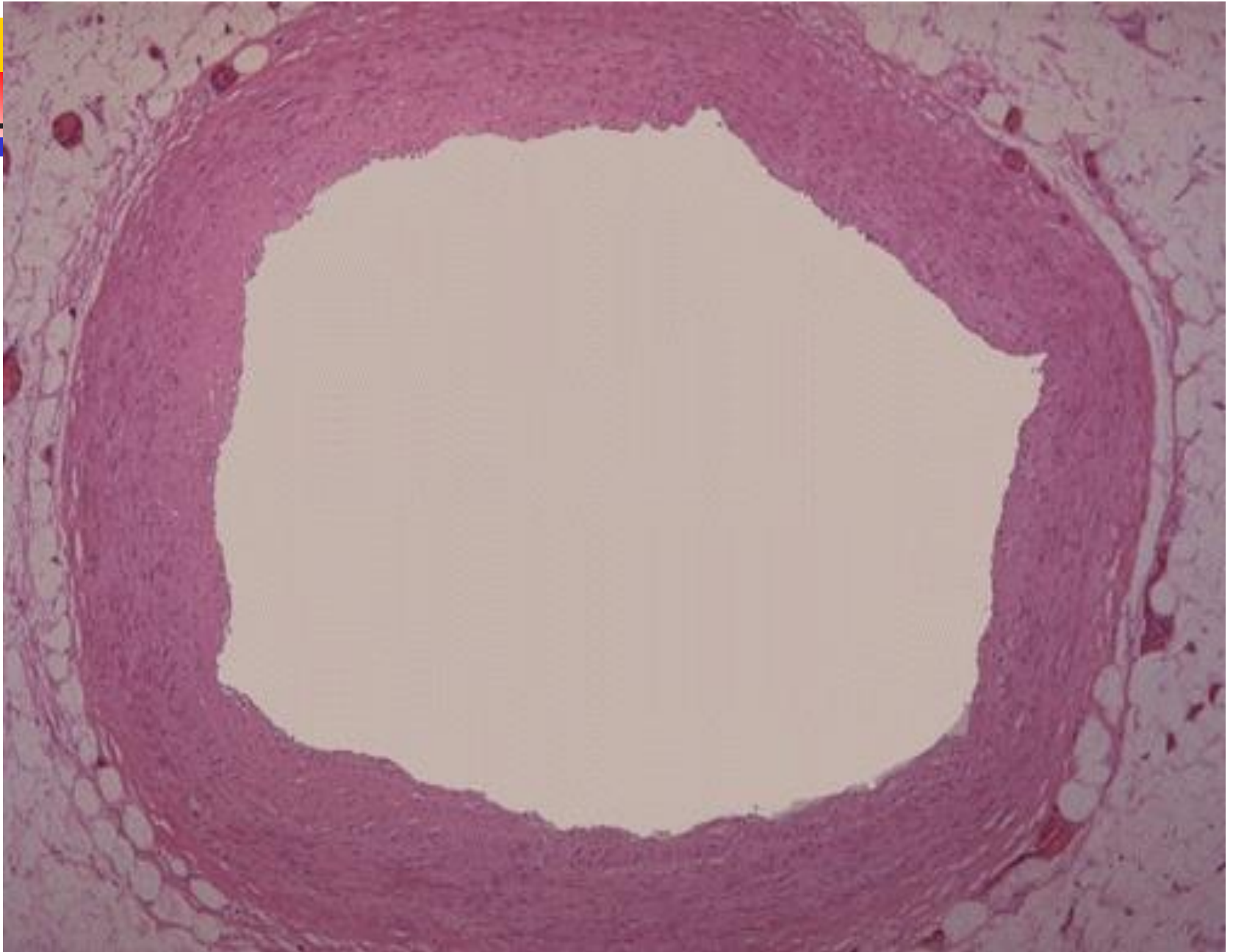
- Disease of muscular vessels – arteries
  - Not veins
  - Coronary, cerebral
- Progressive deposition of cholesterol and its derivatives in the subendothelial space
- Coronary artery disease, stroke



# Atherosclerosis

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- LDL, macrophages
- oxLDL, foam cells
  
- Lipid plaques
- Fibrous plaques
  
- Necrotic core
- Fibrous cap







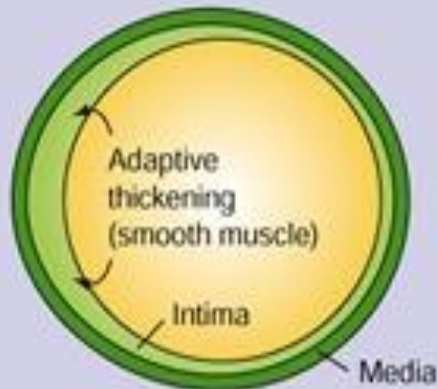
# Atherosclerosis

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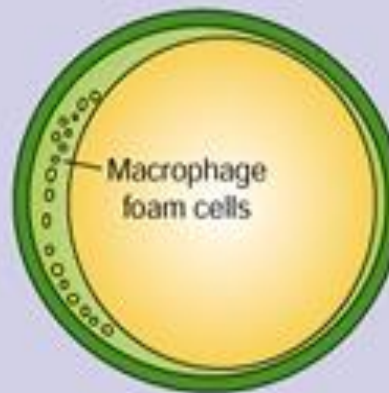
- Narrowing of the vessel lumen
- Decrease in the blood flow
- Calcification – rigidity of the vessel wall
- Decreased compliance
- Bleeding or rupture
- Embolisation

## Types of atherosclerotic lesions

Coronary artery at lesion-prone location



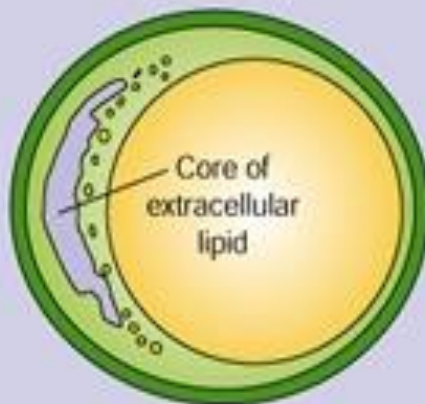
Type II lesion



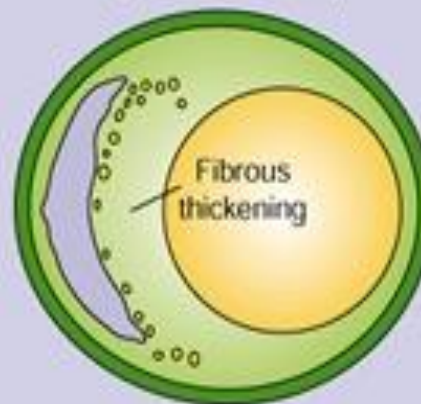
Type III (preatheroma)



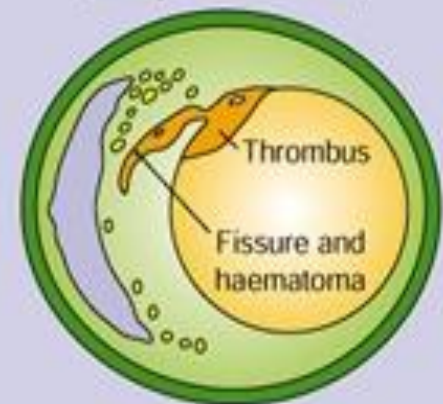
Type IV (atheroma)



Type V (fibroatheroma)



Type VI (complicated lesion)



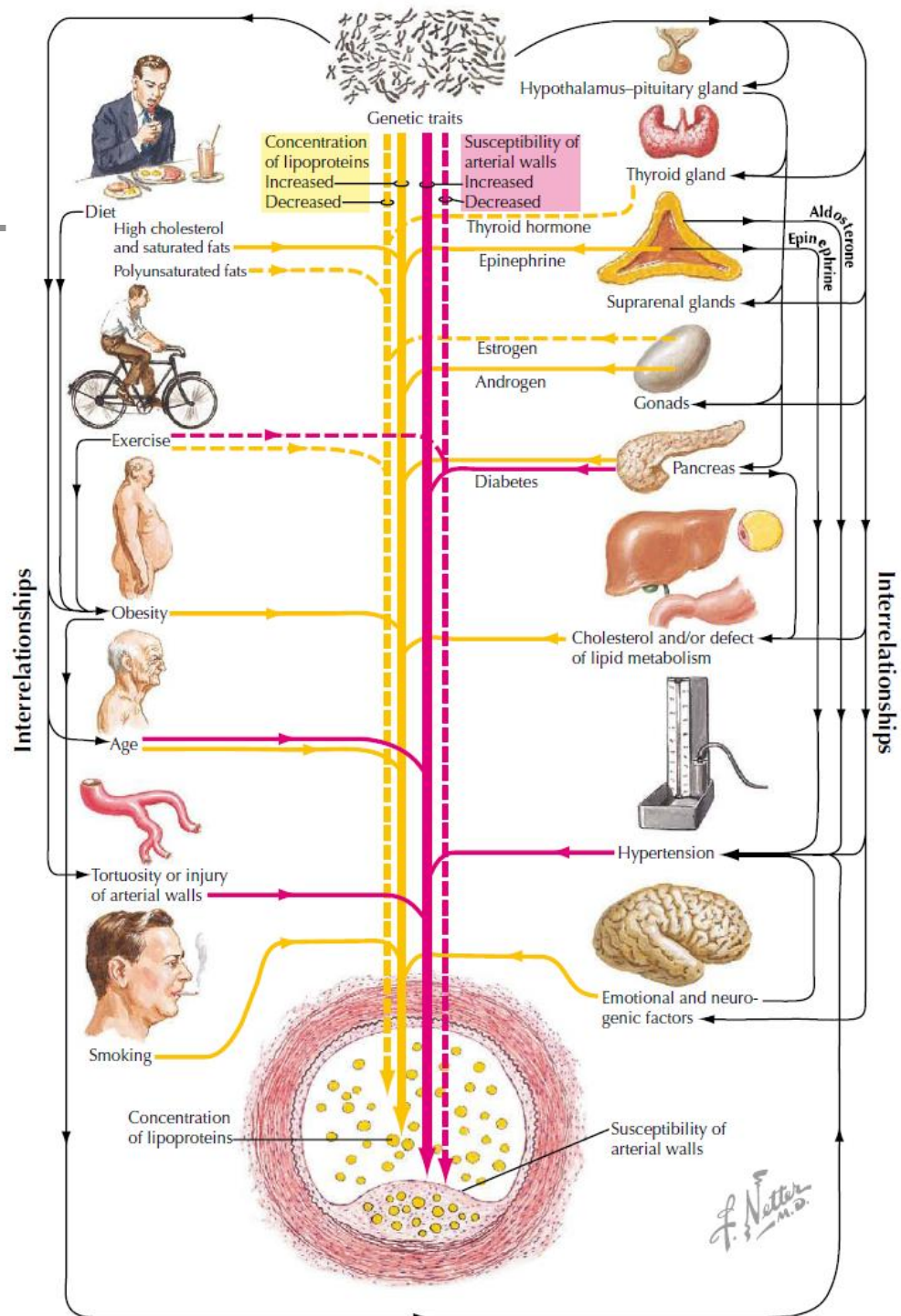


# Risk factors

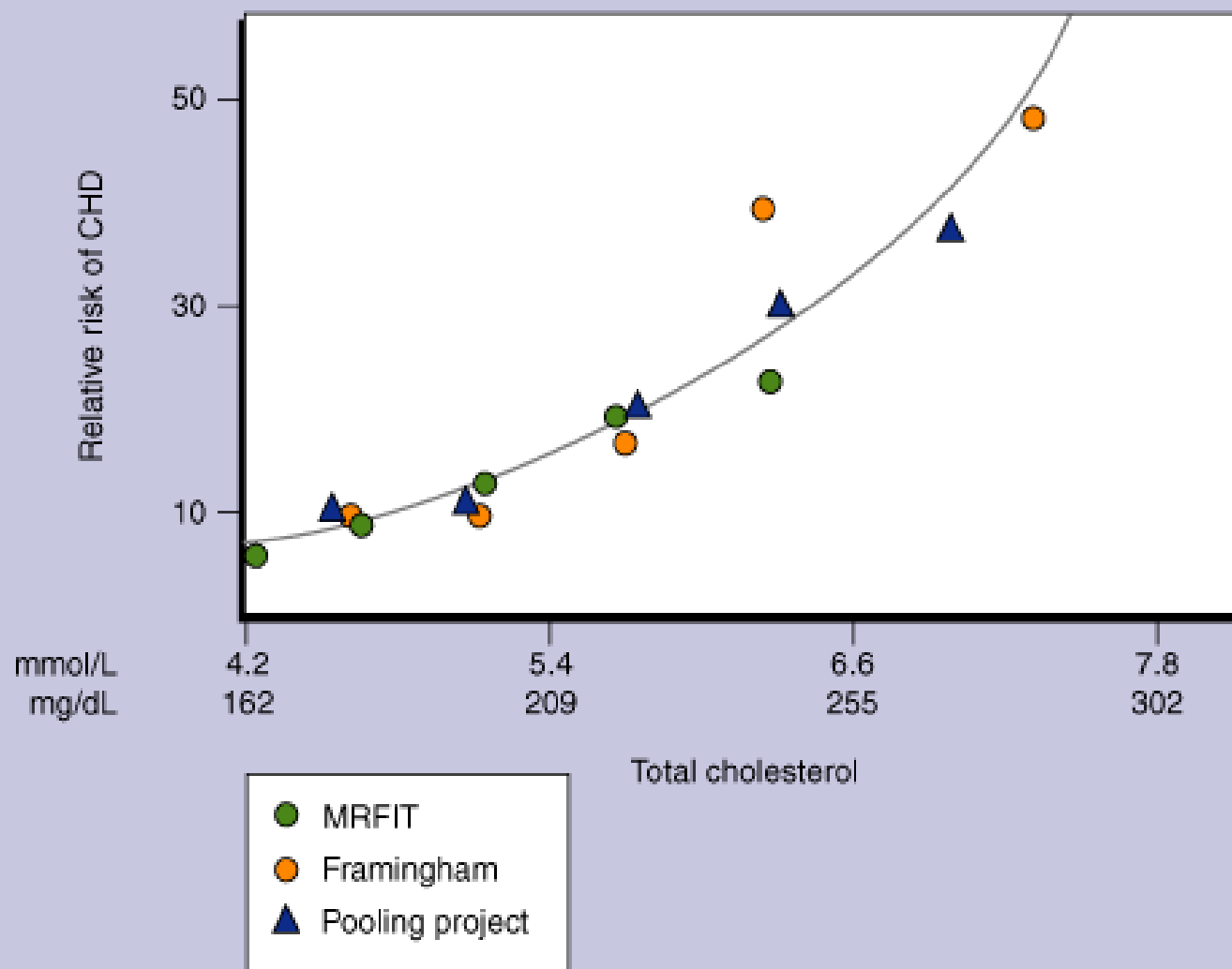
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- Hyperlipidemia
  - LDL vs. HDL
- Smoking
- Hypertension
- Diabetes mellitus
- Chronic inflammation

# Risk factors



## Relative risk for CHD at various levels of total cholesterol





# Atherosclerosis

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- Infectious disease?
  - Herpes viruses
  - CMV
  - Chlamydia
- Chronic inflammation
  - CRP

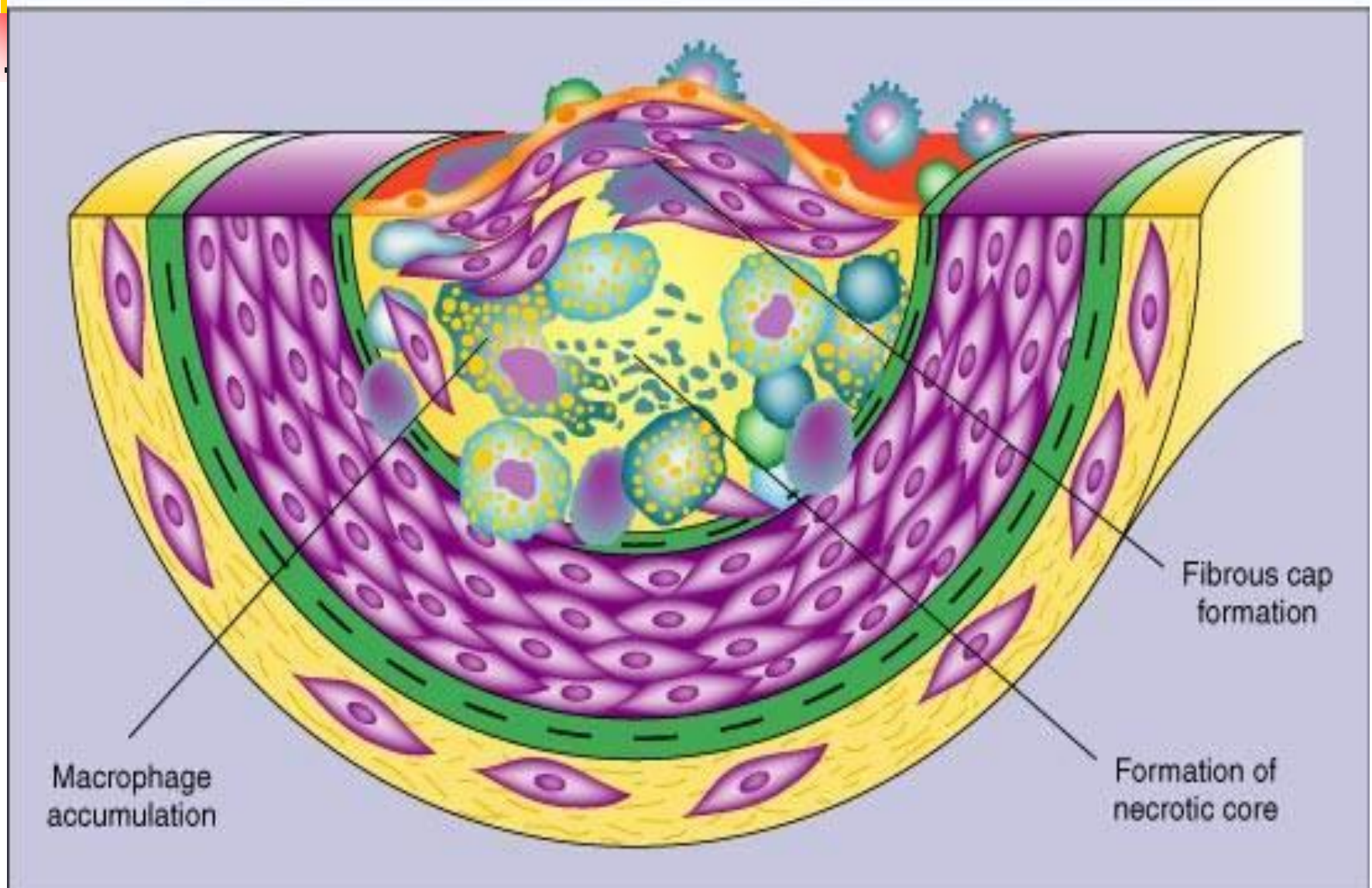


# Pathogenesis

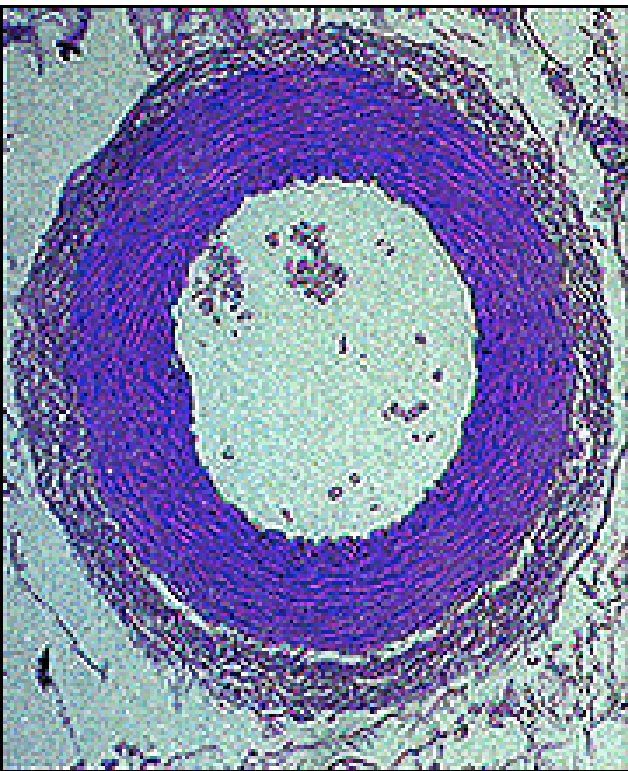
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- LDL
  - Oxidized LDL; LDL/HDL ratio
- Endothelial dysfunction
  - Injury (hypoxia, mechanical...)
- Immune system
  - VCAM, TNF-alfa, MCP

## *Formation of an advanced, complicated lesion of atherosclerosis*



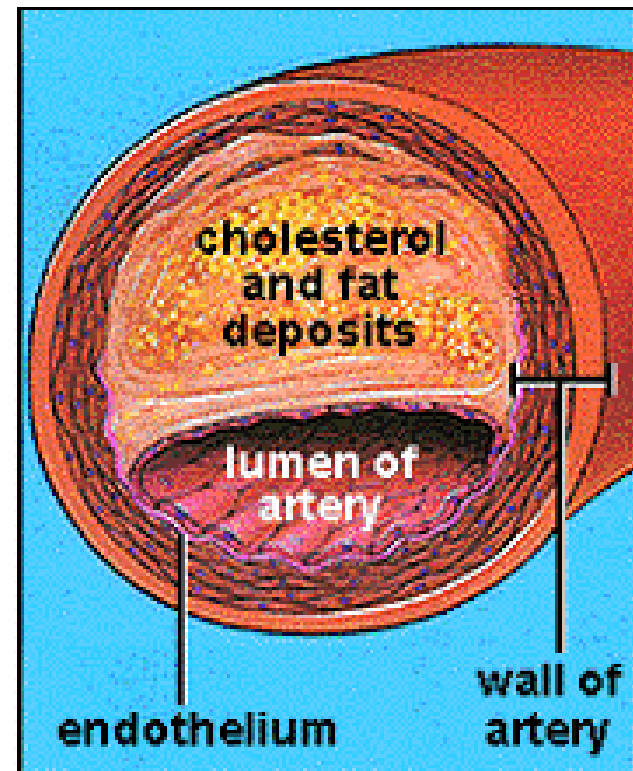
# Atherosclerosis



normal artery

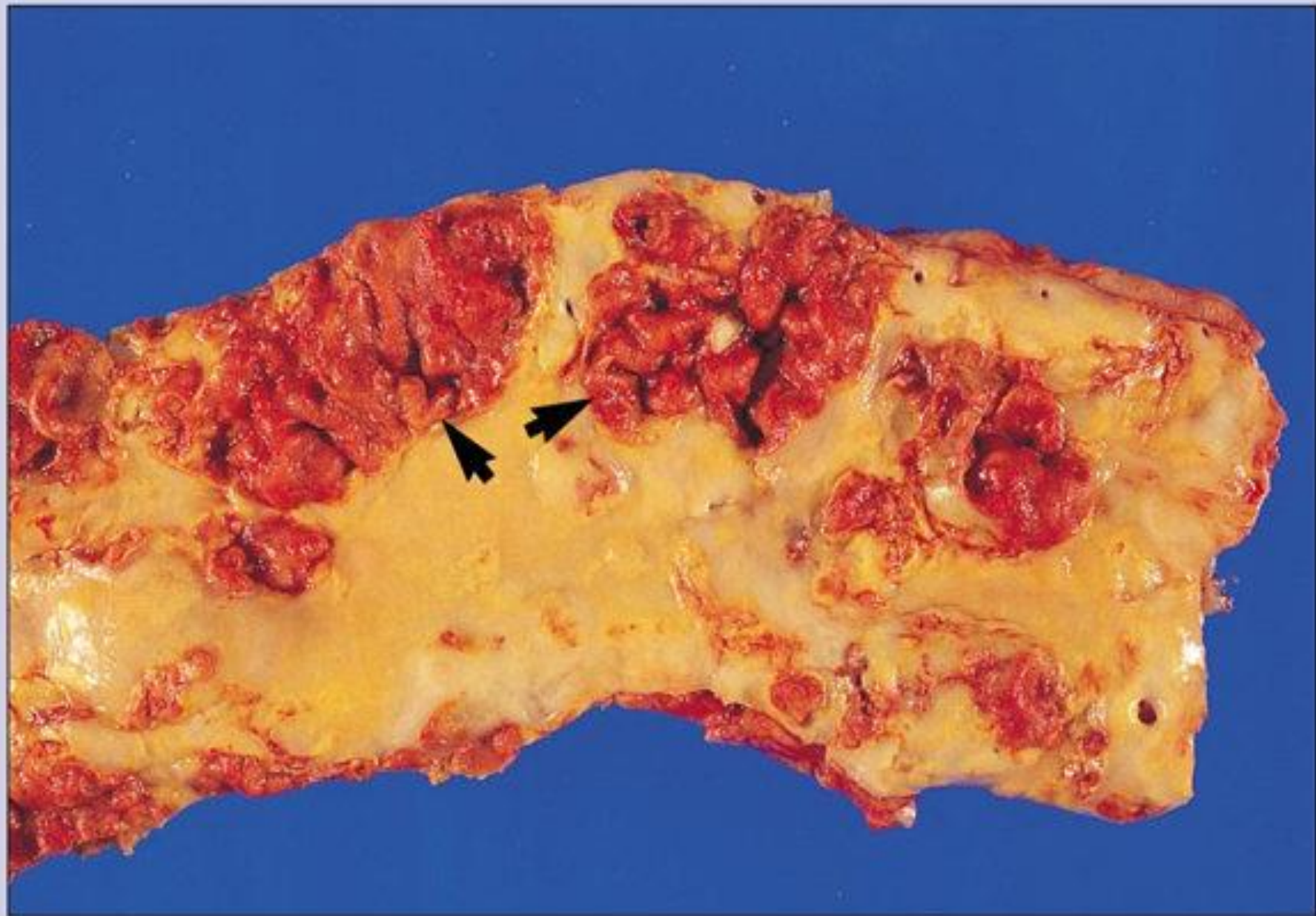


partially obstructed  
artery



atherosclerotic plaque

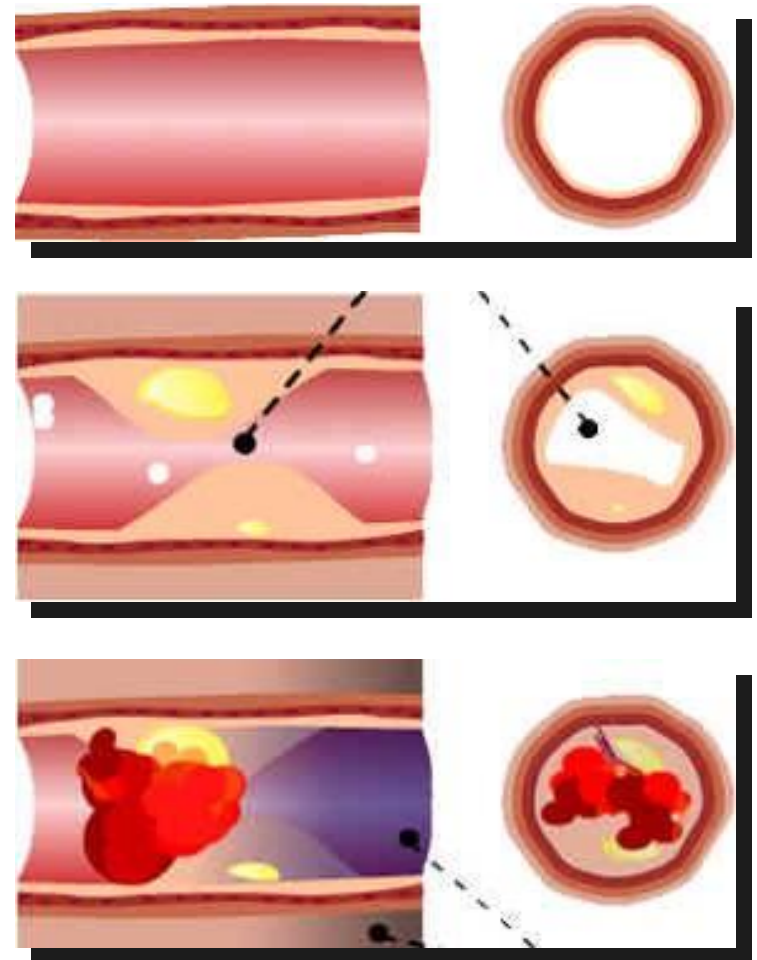
*Multiple complicated aortic atherosclerotic lesions*



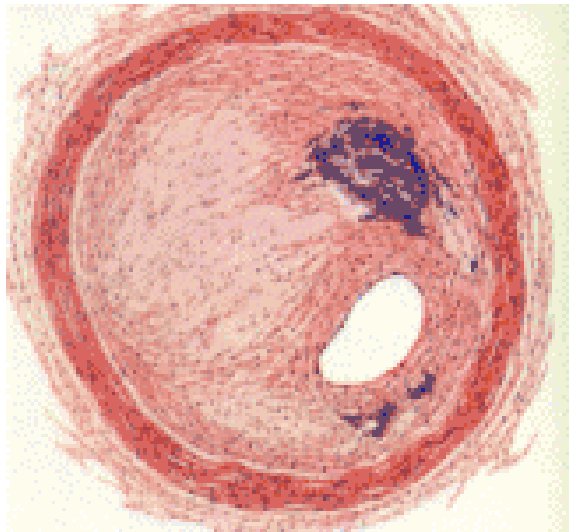


# Atherosclerosis

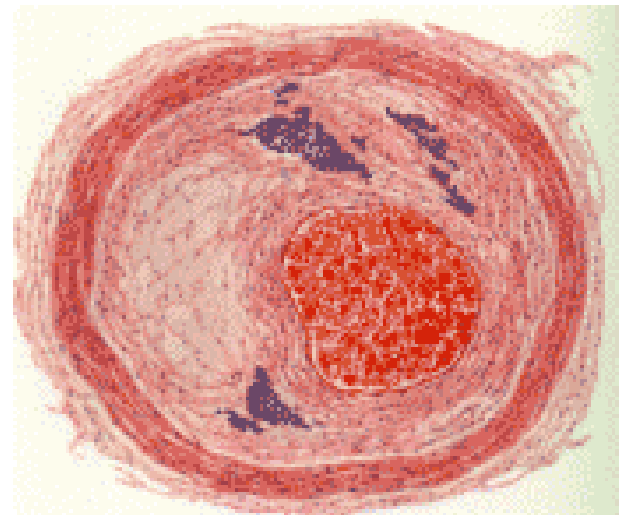
- Atherosclerosis
- Plaque rupture
- Platelet aggregation
- Thrombus formation
- Vessel occlusion
- Reactive vasospasm
- Distal ischemia



# Microscopy

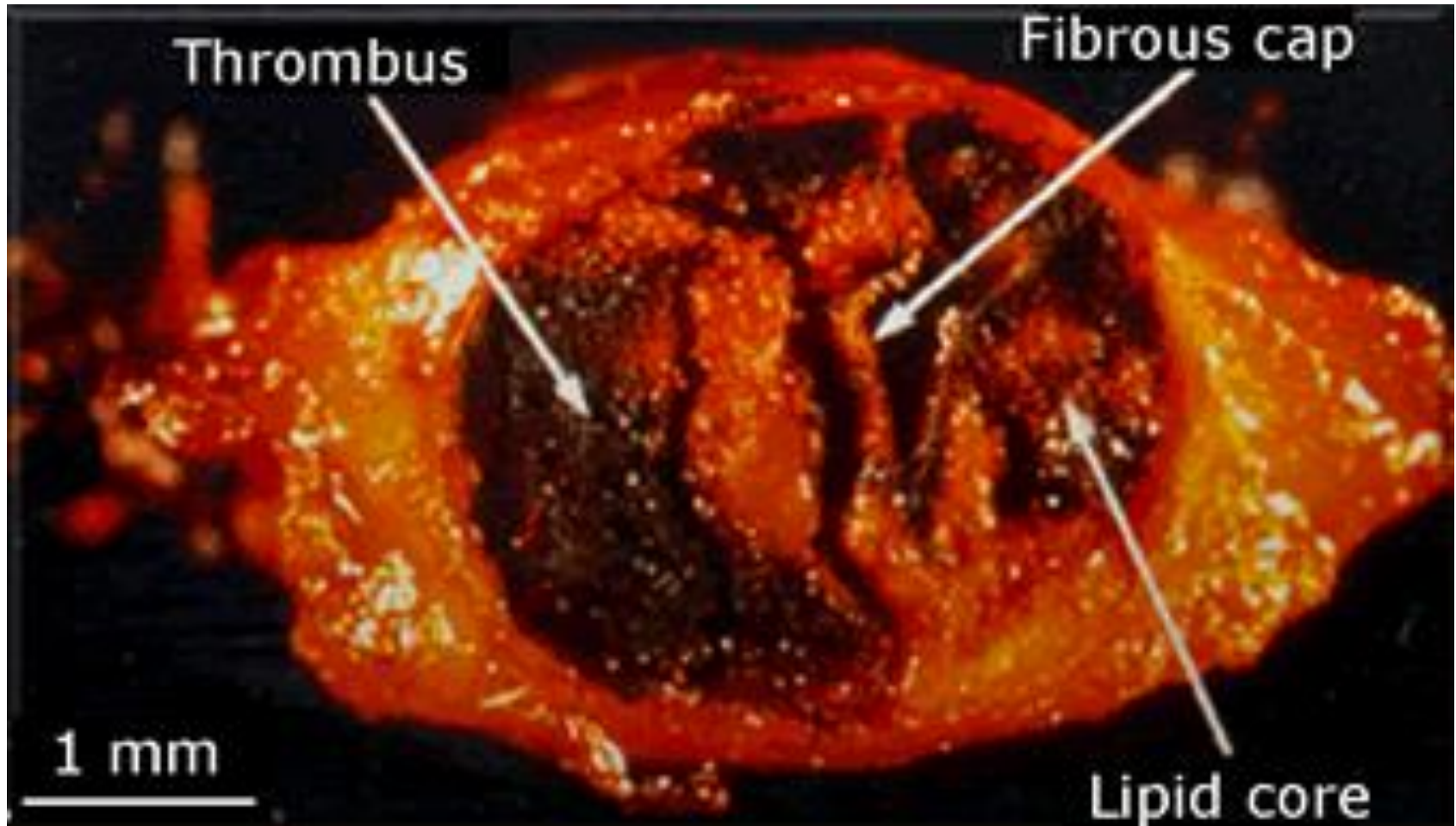


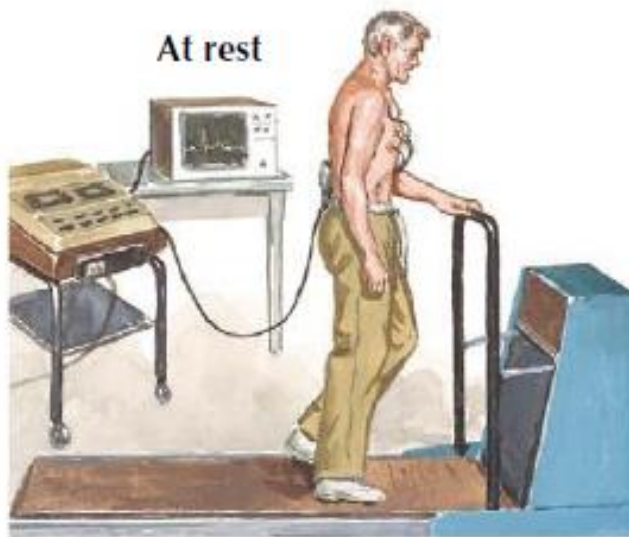
Almost Complete Occlusion  
of Arterial Lumen by Intimal  
Atherosclerosis with Calcium  
Deposition



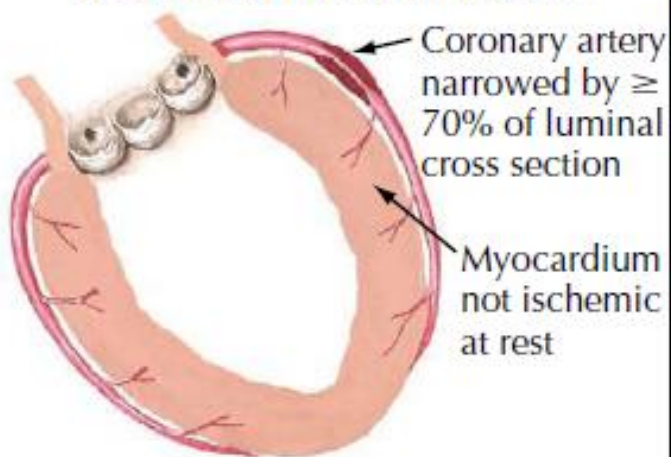
Complete Occlusion  
by Thrombus in Arterial Lumen

# Macroscopy

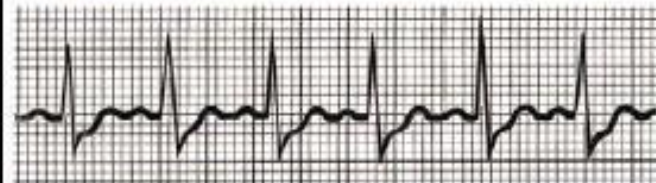
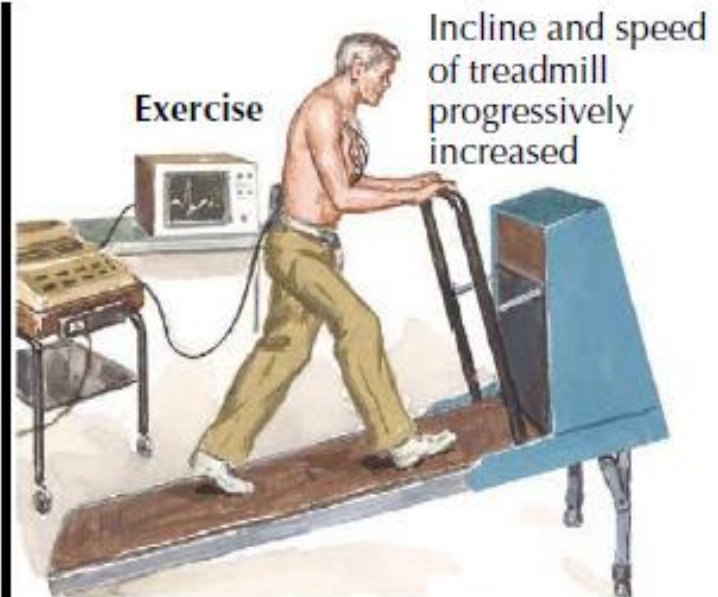




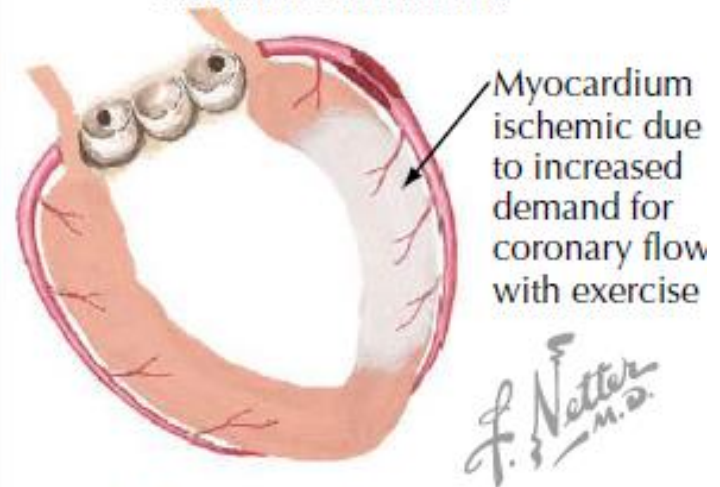
Heart rate normal for resting state



Normal ECG. No ST-segment depressions.

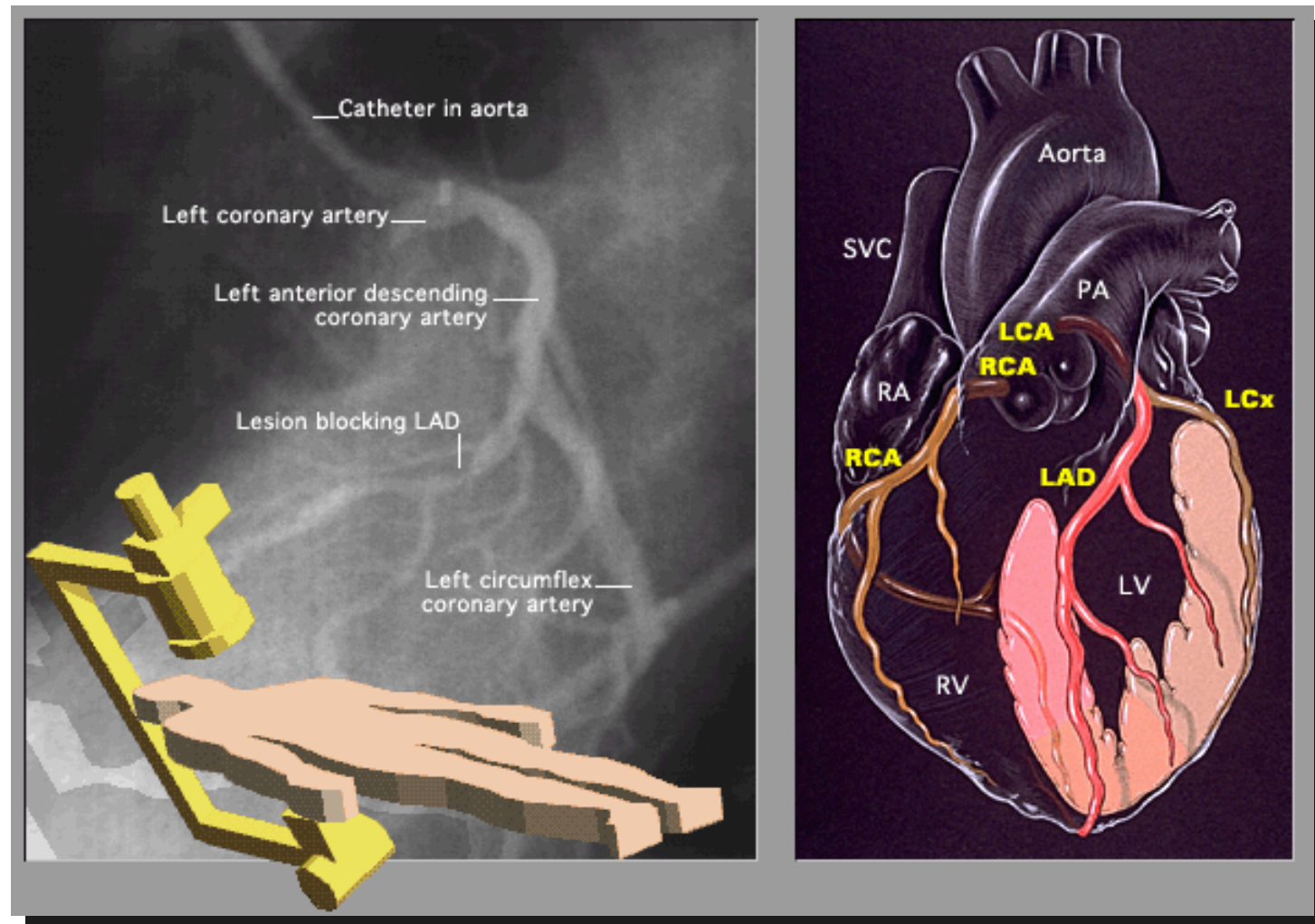


Heart rate accelerated



ST-segment depressions

# Angiography

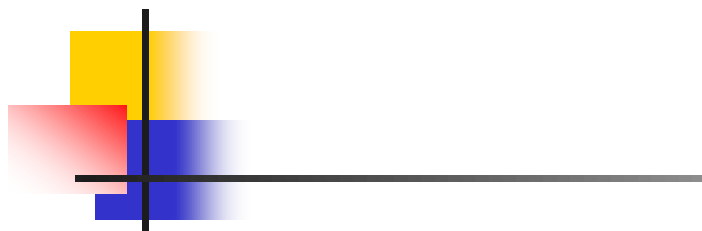




# Therapy

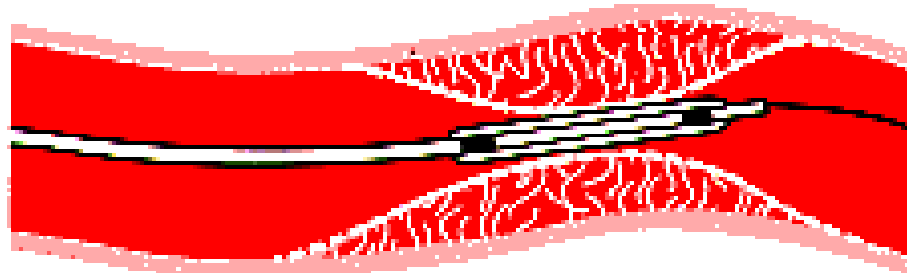
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- Pharmacological
- Interventional - surgery
  - PTCA
    - percutaneous transluminal coronary angioplasty
  - Bypass

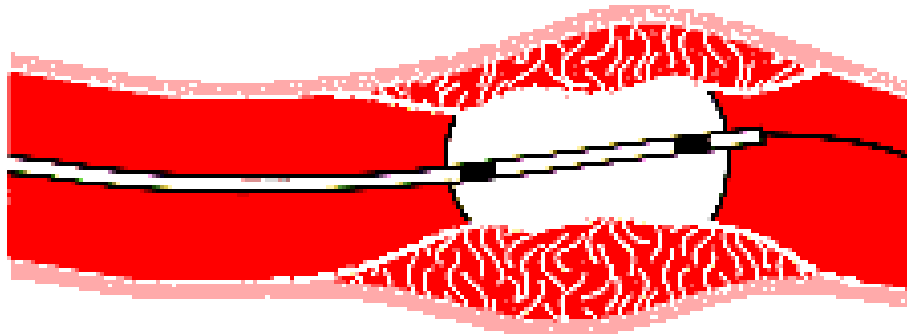


# Percutaneous Transluminal Coronary Angioplasty (PTCA)

**Cross-section of an artery showing how  
balloon angioplasty opens a blockage**



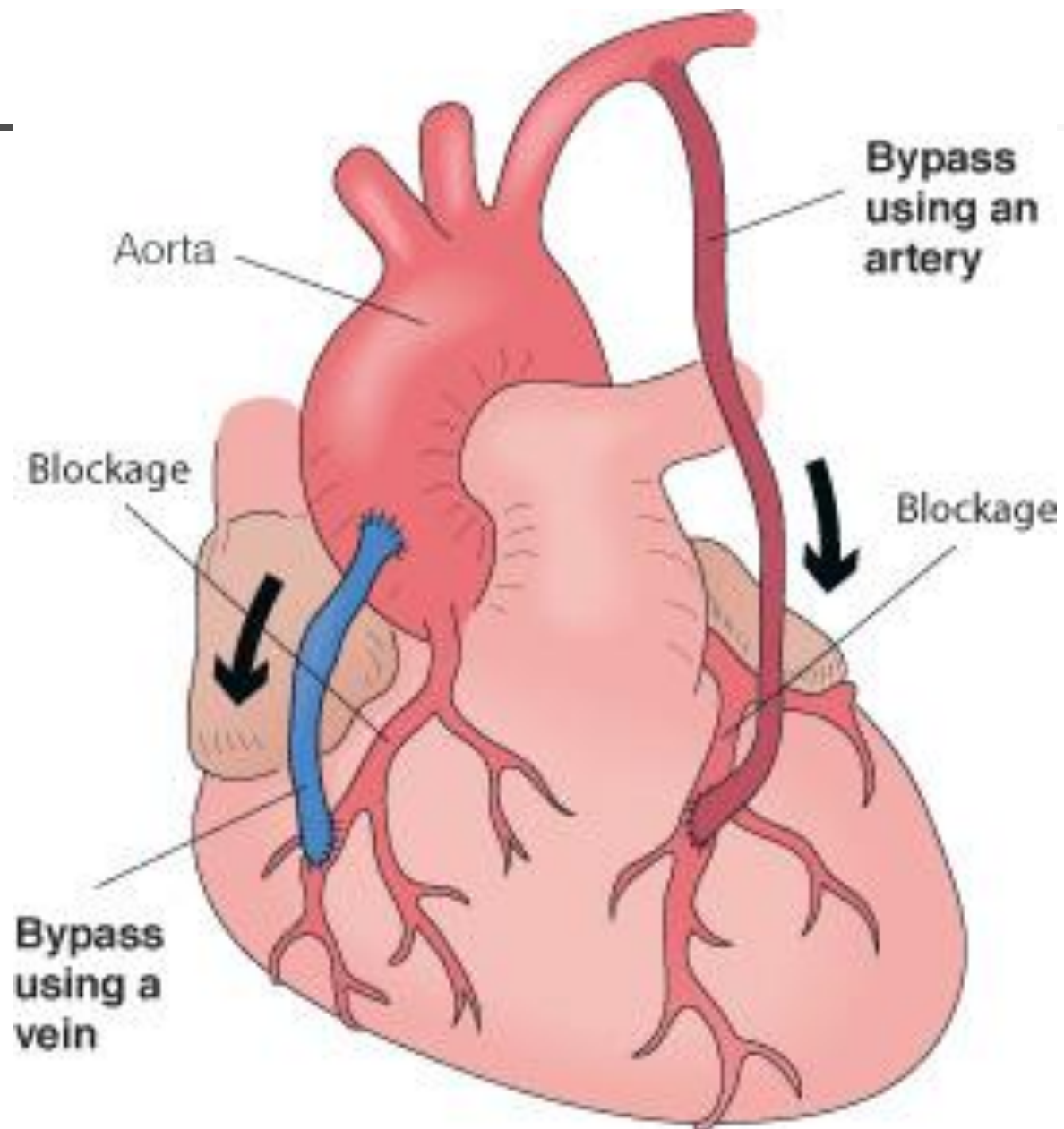
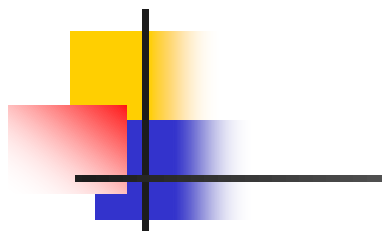
Balloon catheter placed in blocked area of artery



Balloon catheter inflated



Catheter removed, blocked  
area open





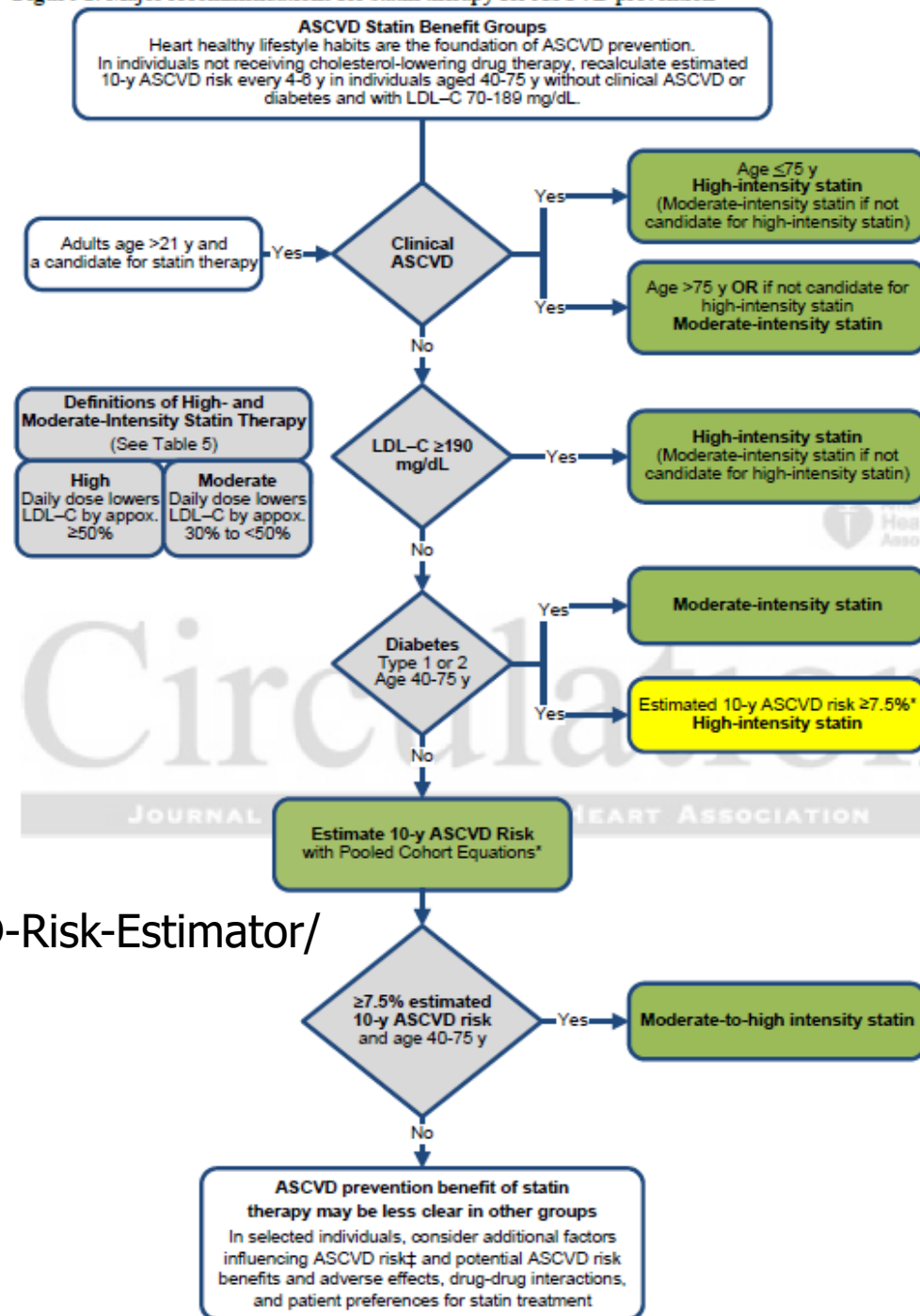
# Therapy

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## ■ Statins

- HMG-CoA-reductase inhibitors
- Inhibition of endogenous cholesterol production
- Simvastatin, Pravastatin, Atorvastatin
- EBM in primary and secondary prevention of CVS mortality
- Risk reduction by cca. 30%
- Costs

Figure 2. Major recommendations for statin therapy for ASCVD prevention



<http://tools.acc.org/ASCVD-Risk-Estimator/>



# Coronary artery disease

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- Inadequate coronary perfusion
- Ischemia vs. Hypoxia
- Frequency, contractility, wall tension
  
- Angina pectoris
  - stable, unstable, Prinzmetal
- Acute myocardial infarction
- Ischemic heart disease



## Stable AP

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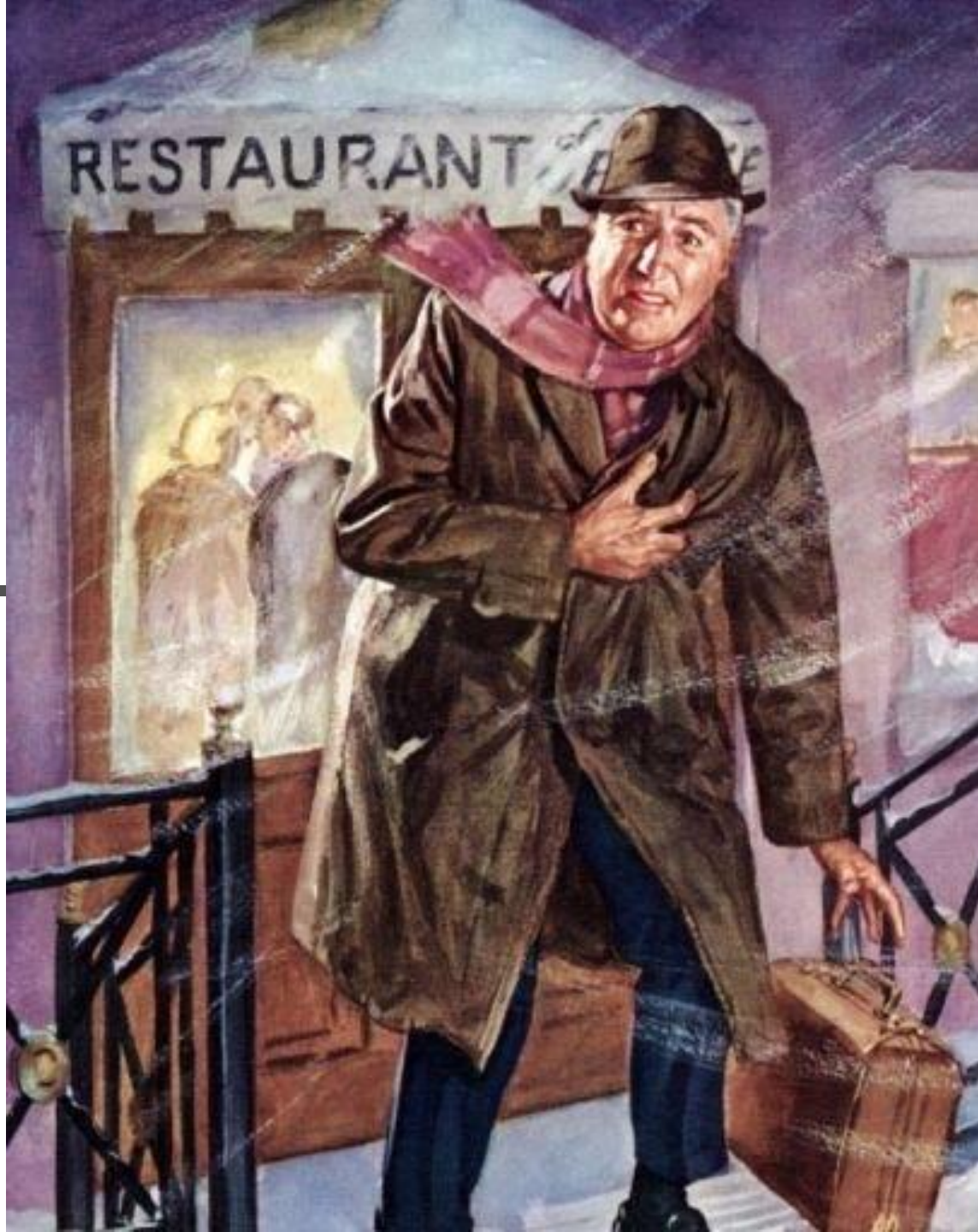
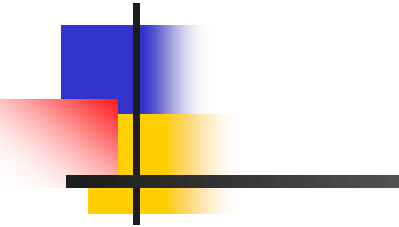
- Transient - <30 min
- Predictable and reproducible
- After physical activity or emotional stress
- Stable coronary lesion
- Not a thrombus!
- ECG



# Unstable AP

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- Transient - <30 min
- Angina pectoris at rest
- Unpredictable
- Every new AP
- Atherosclerotic lesion  $\pm$  thrombus
- ECG



# Symptoms of AMI

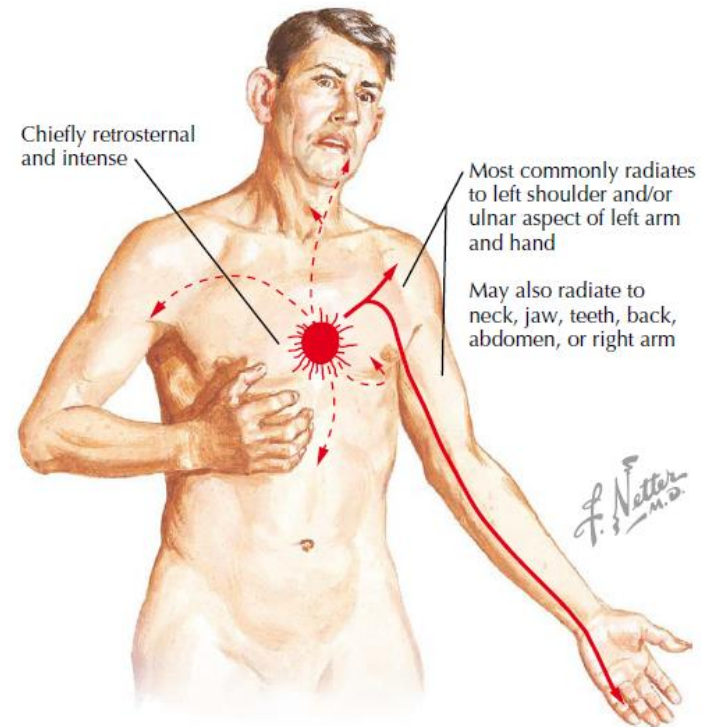
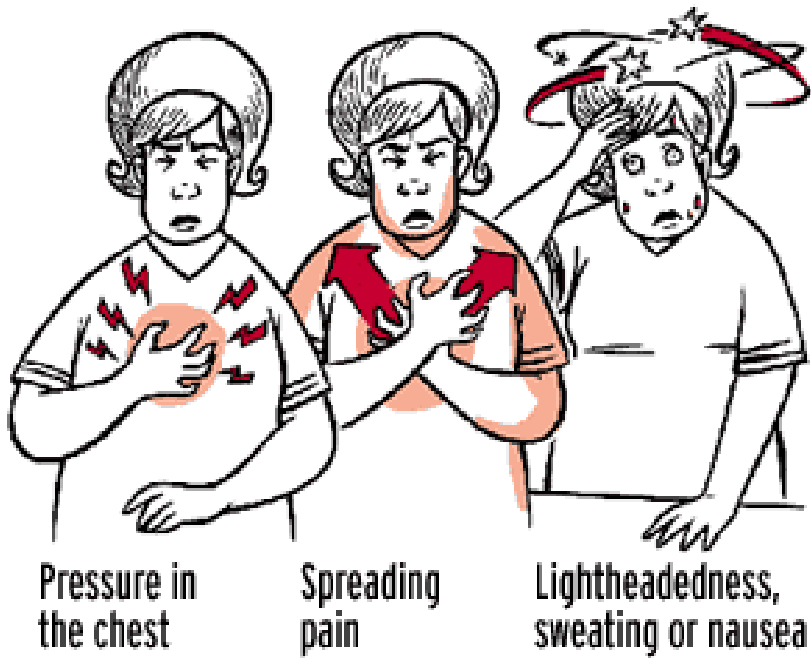


Figure 12-3 Pain of myocardial ischemia.



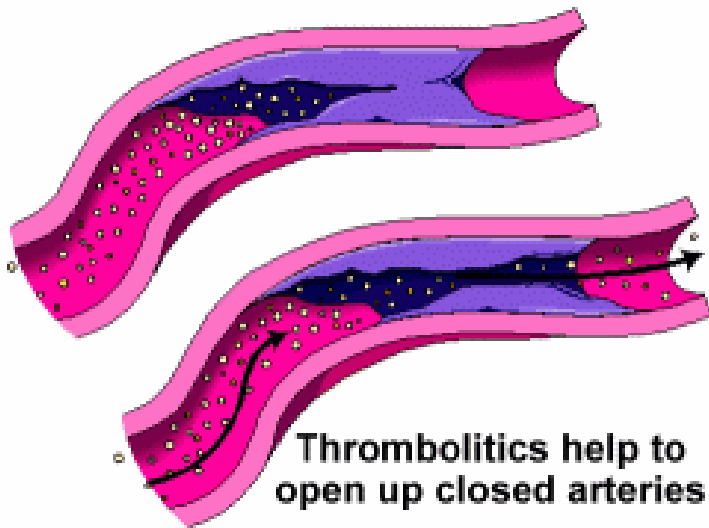
Normal coronary artery



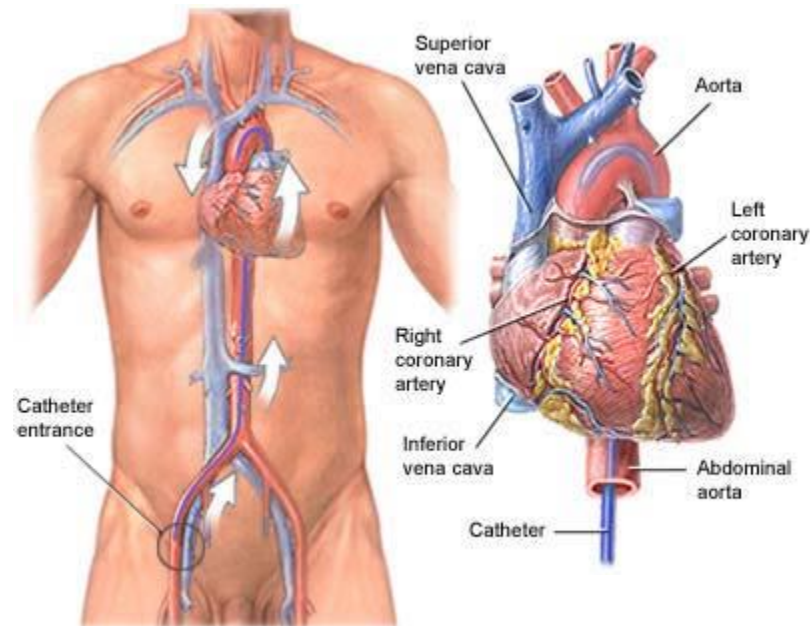
Atherosclerosis



Atherosclerosis with blood clot



**Thrombolytics help to open up closed arteries**

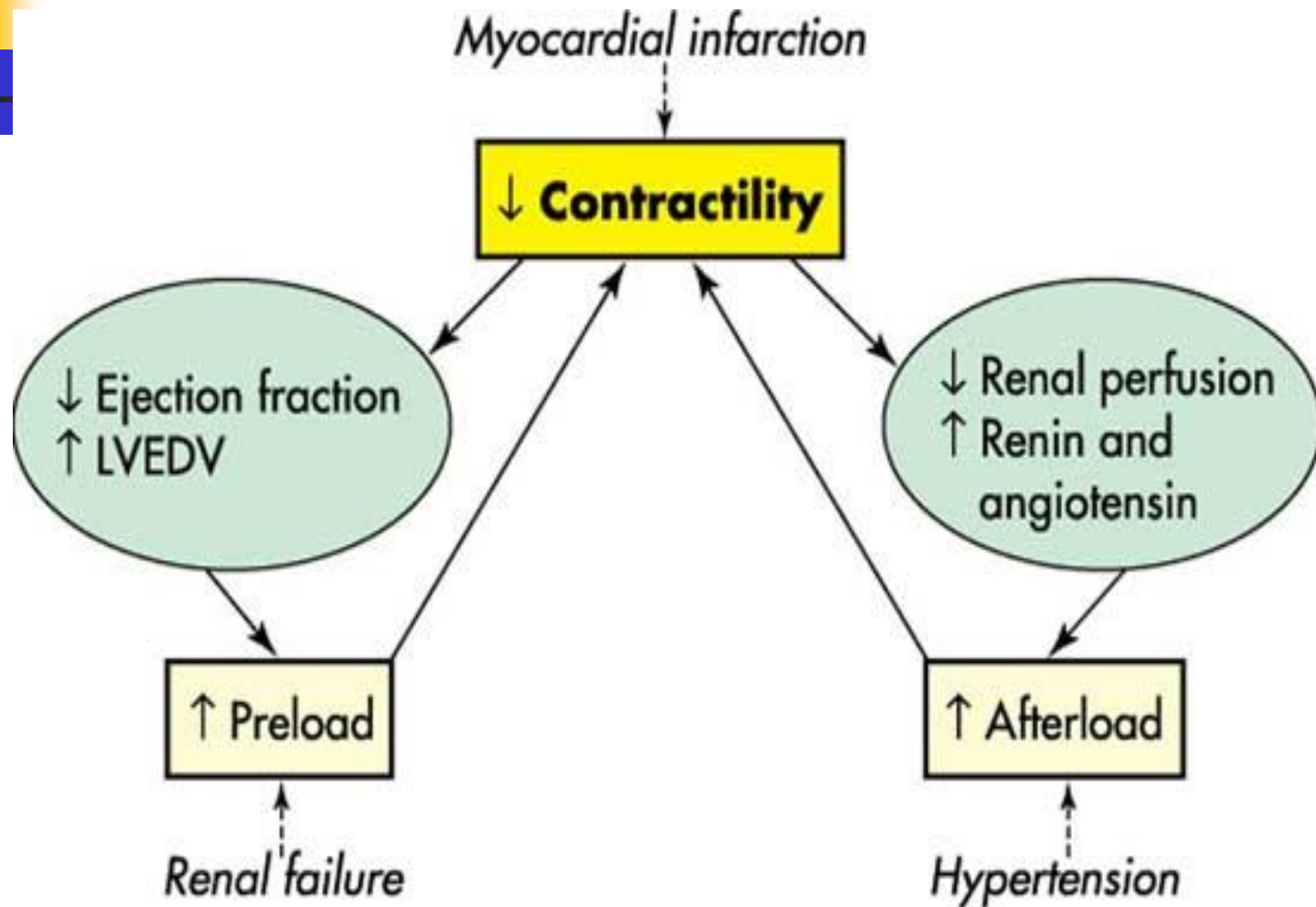
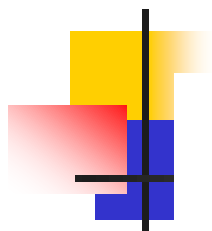


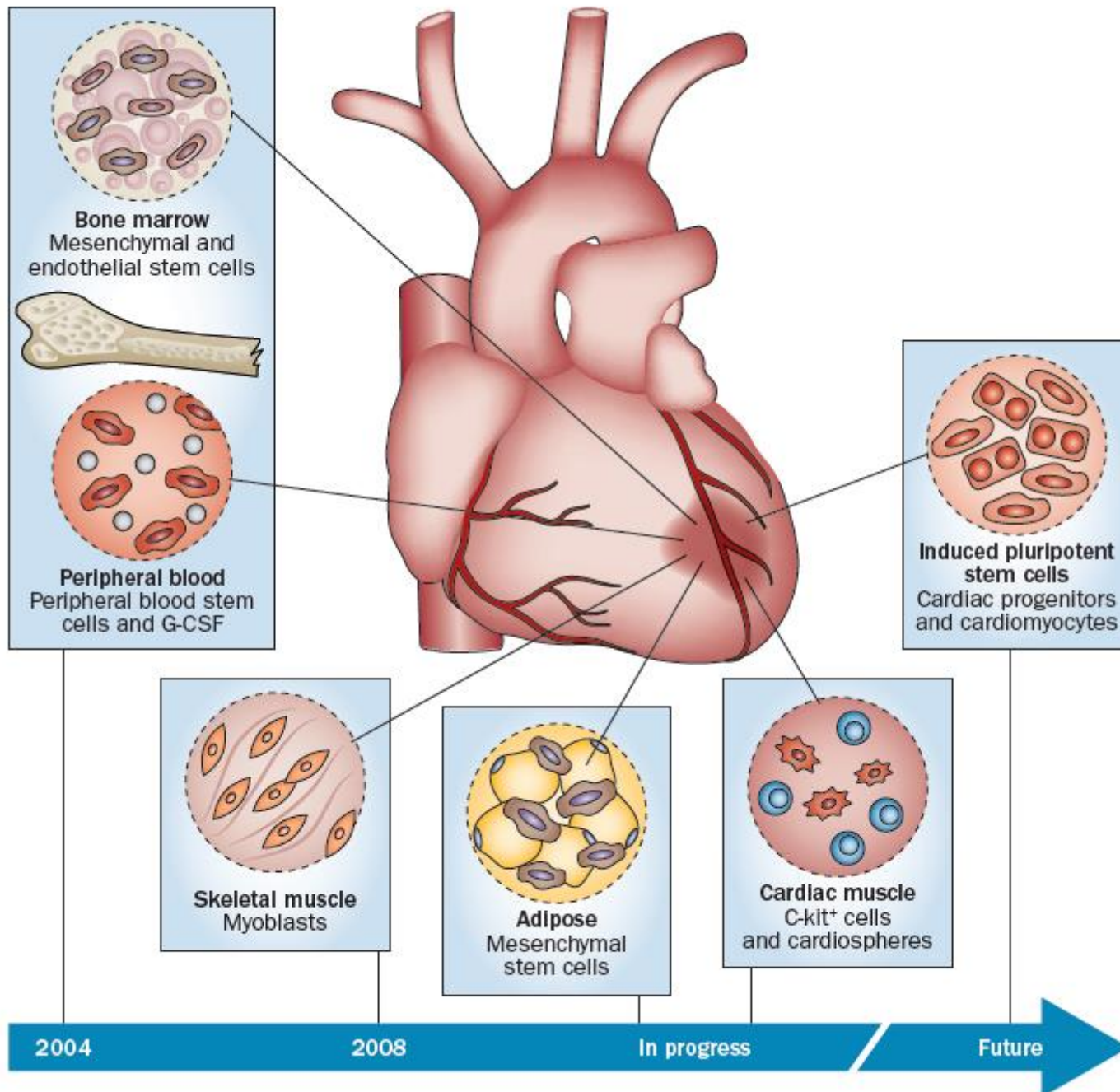


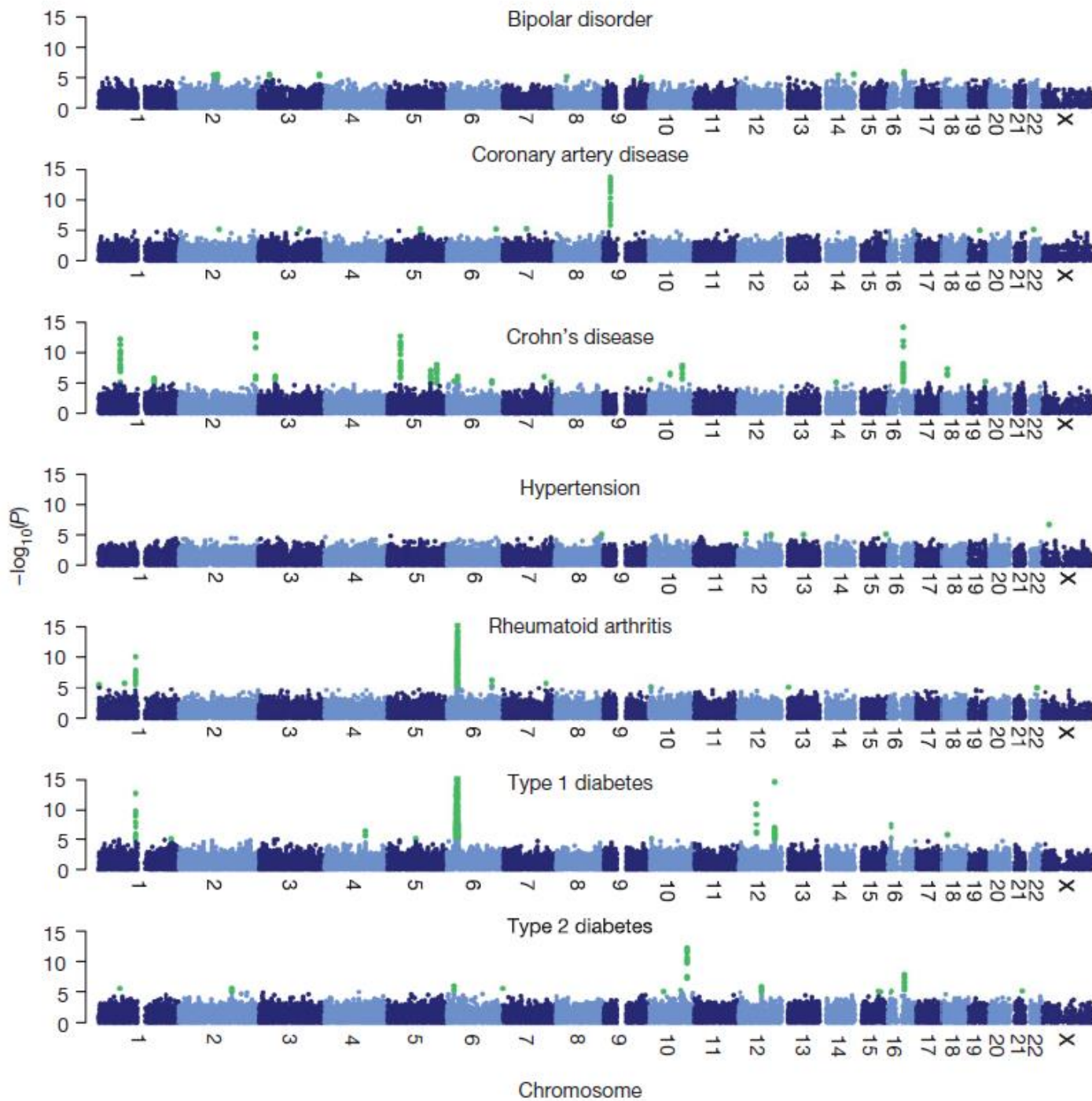
# Coronary artery disease

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- Ischemic-reperfusion injury
  - Ischemia
  - Metabolic changes
  - Reperfusion
  - Calcium and oxygen paradoxon
- Oxidative stress
- Carbonyl stress









# Animal models

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- ApoE<sup>-/-</sup>
- LDL receptor<sup>-/-</sup>
- Diet induced atherosclerosis
  - Western type diet
  - Palm oil diet
- Pressure overload – aortic constriction
- Coronary artery ligation
- IRI – Langendorff apparatus