ISCHEMIC HEART DISEASE

ETIOLOGY AND PATHOPHYSIOLOGY

- *Ischemia* refers to a lack of oxygen due to inadequate perfusion, which results from an imbalance between oxygen supply and demand.
- The most common cause of myocardial ischemia is atherosclerotic disease of epicardial coronary arteries.

Ischemic heart disease (IHD)

- is the most common, serious, chronic, life-threatening illness in the Moldova, Europe, United States, where more than 40 million persons have IHD.
- This condition causes more deaths and disability and incurs greater economic costs than any other illness in the developed world.

Causes of IHD

- atherosclerosis - By reducing the lumen of the coronary arteries it reduces myocardial perfusion when the demand for flow is augmented, as occurs during exertion or excitement.
- spasm,
- arterial thrombi,
- rarely, coronary emboli as well as by ostial narrowing due to luetic aortitis.
- Congenital abnormalities,

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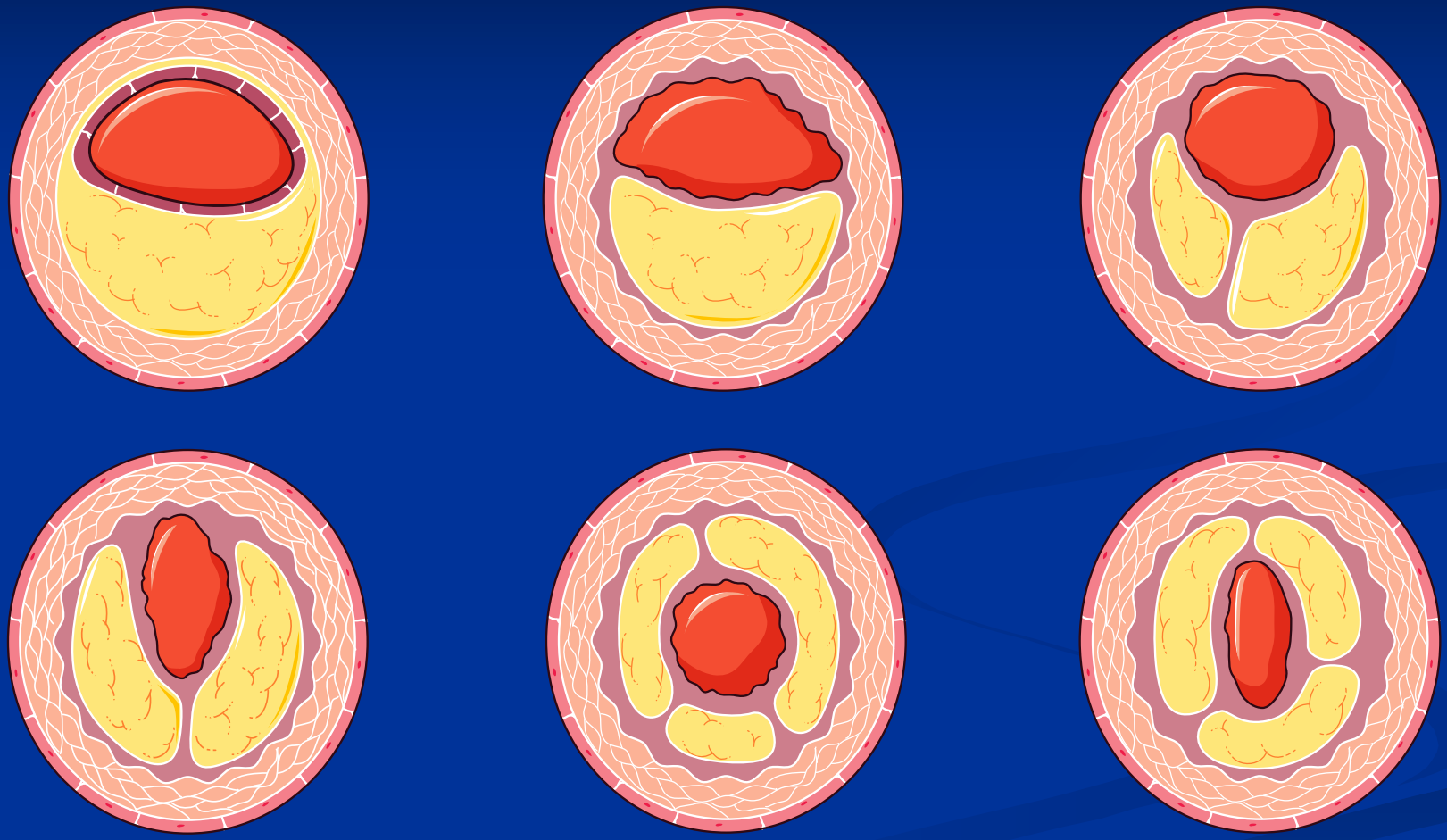

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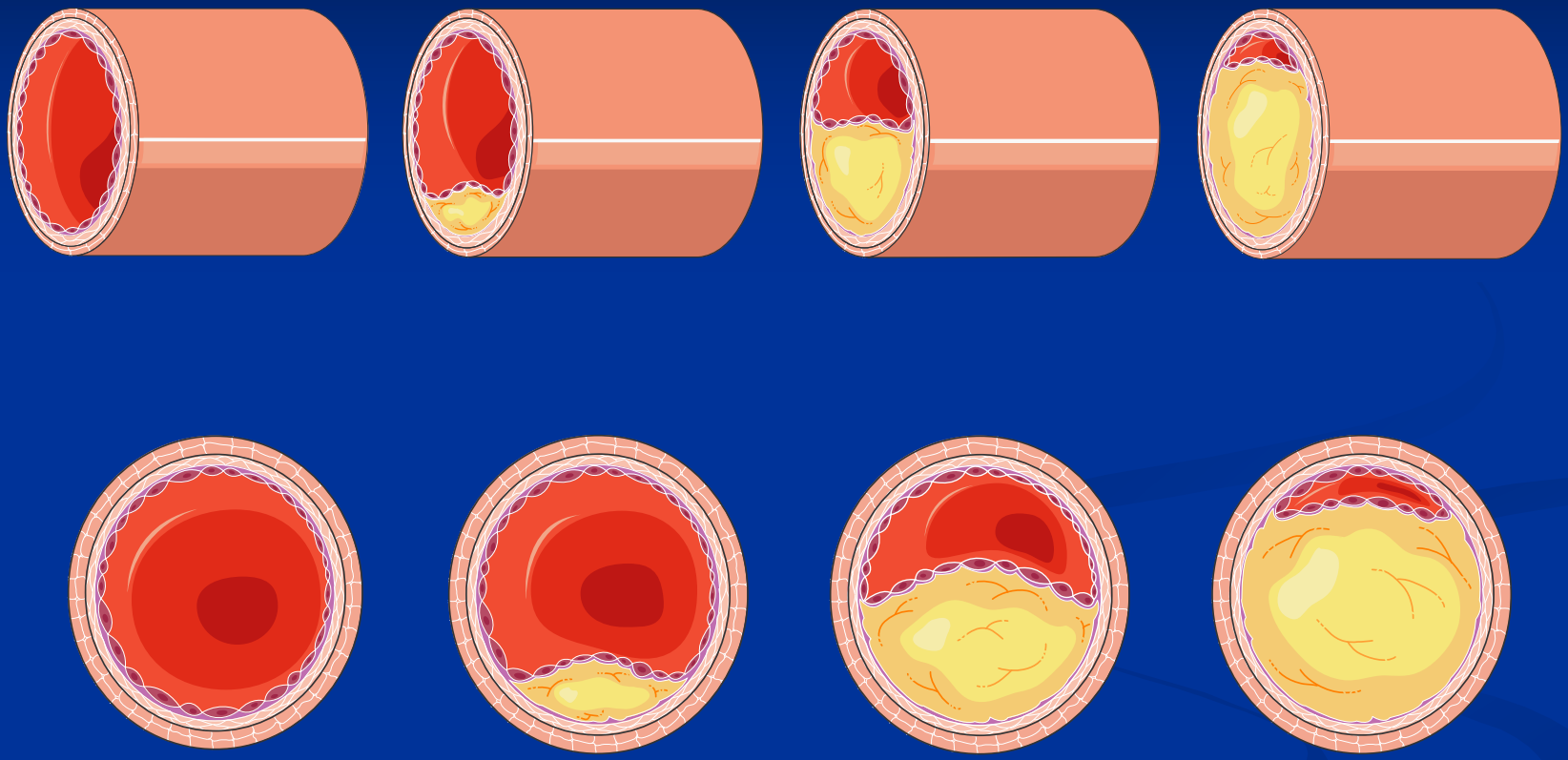

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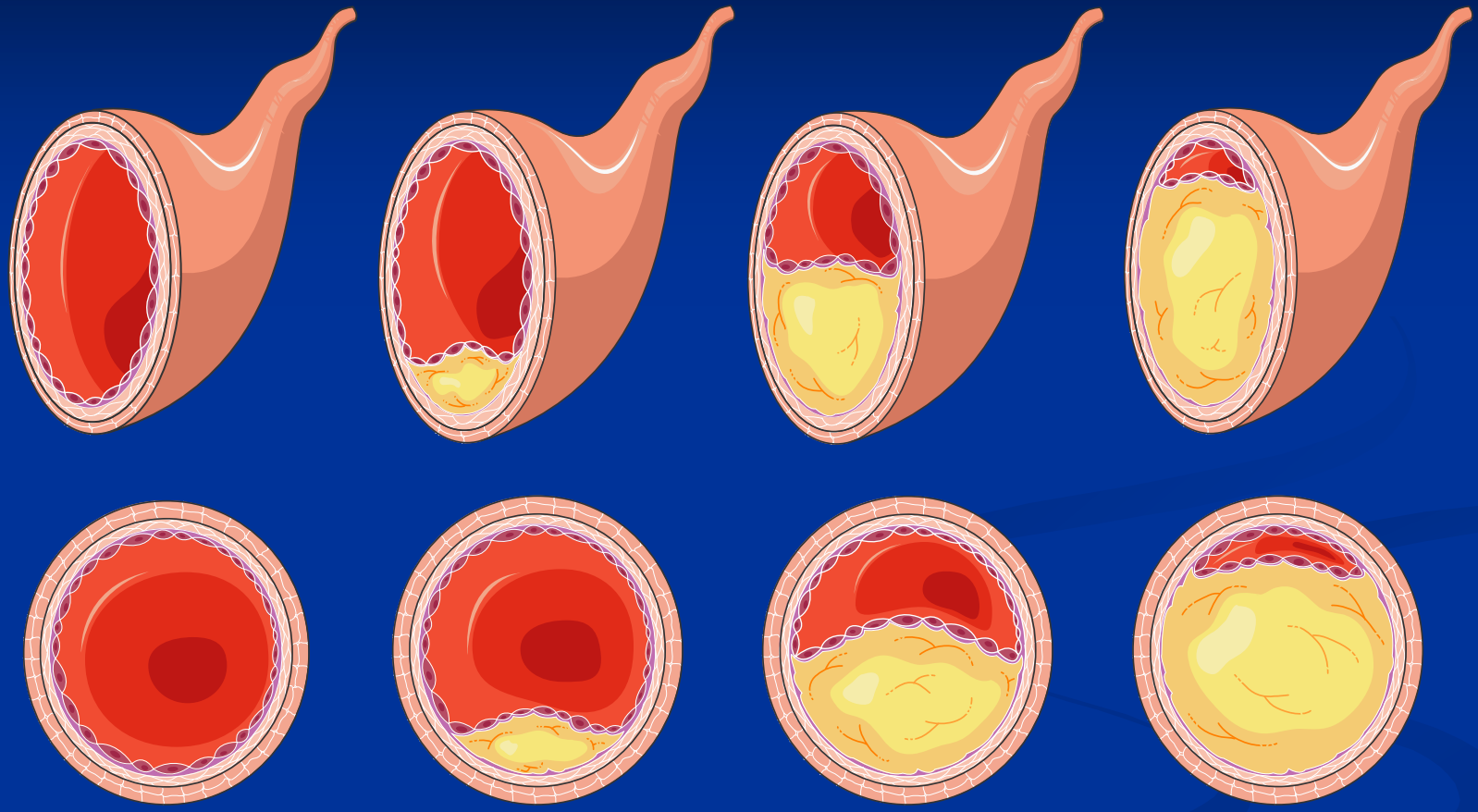
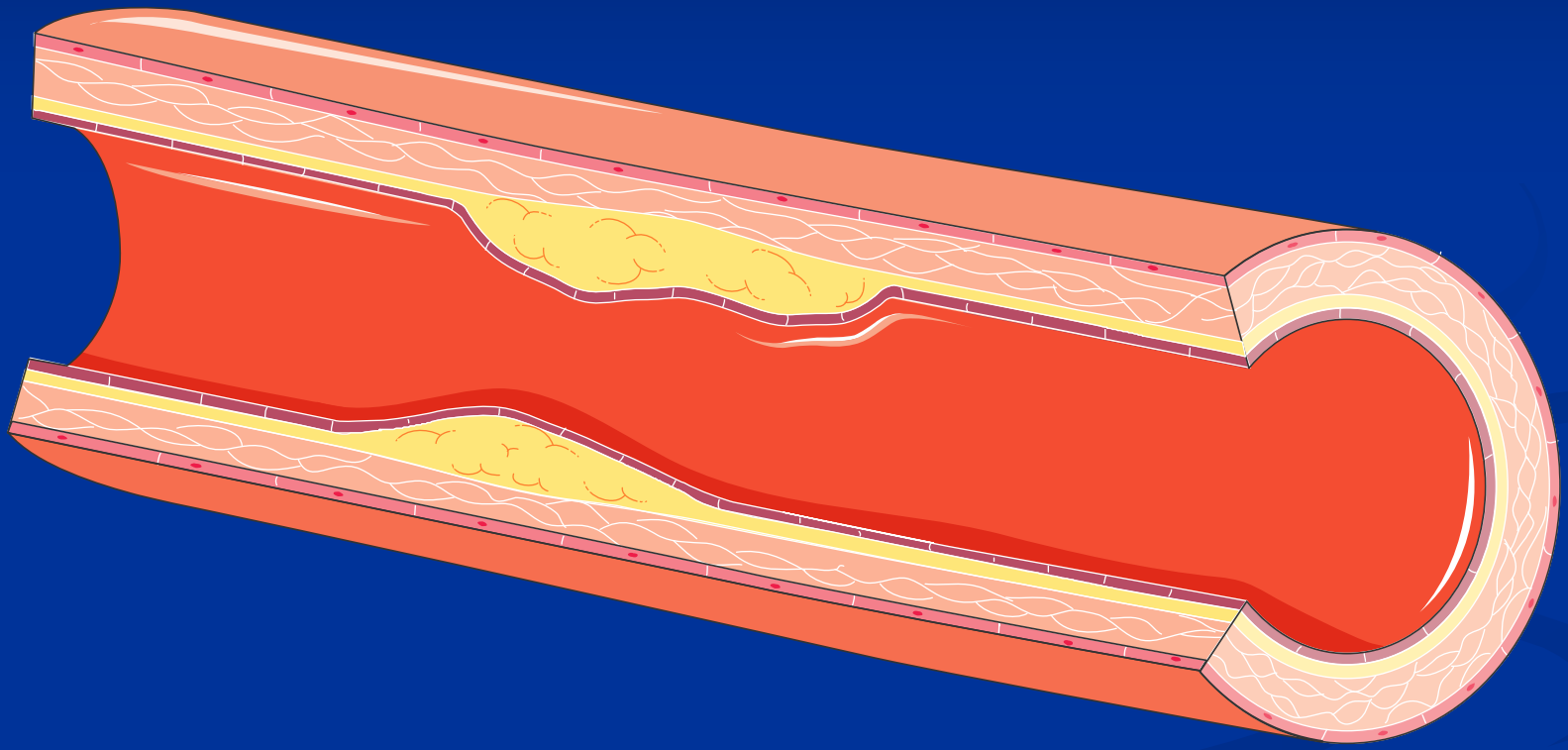


From Atheroma To Thrombus (1)



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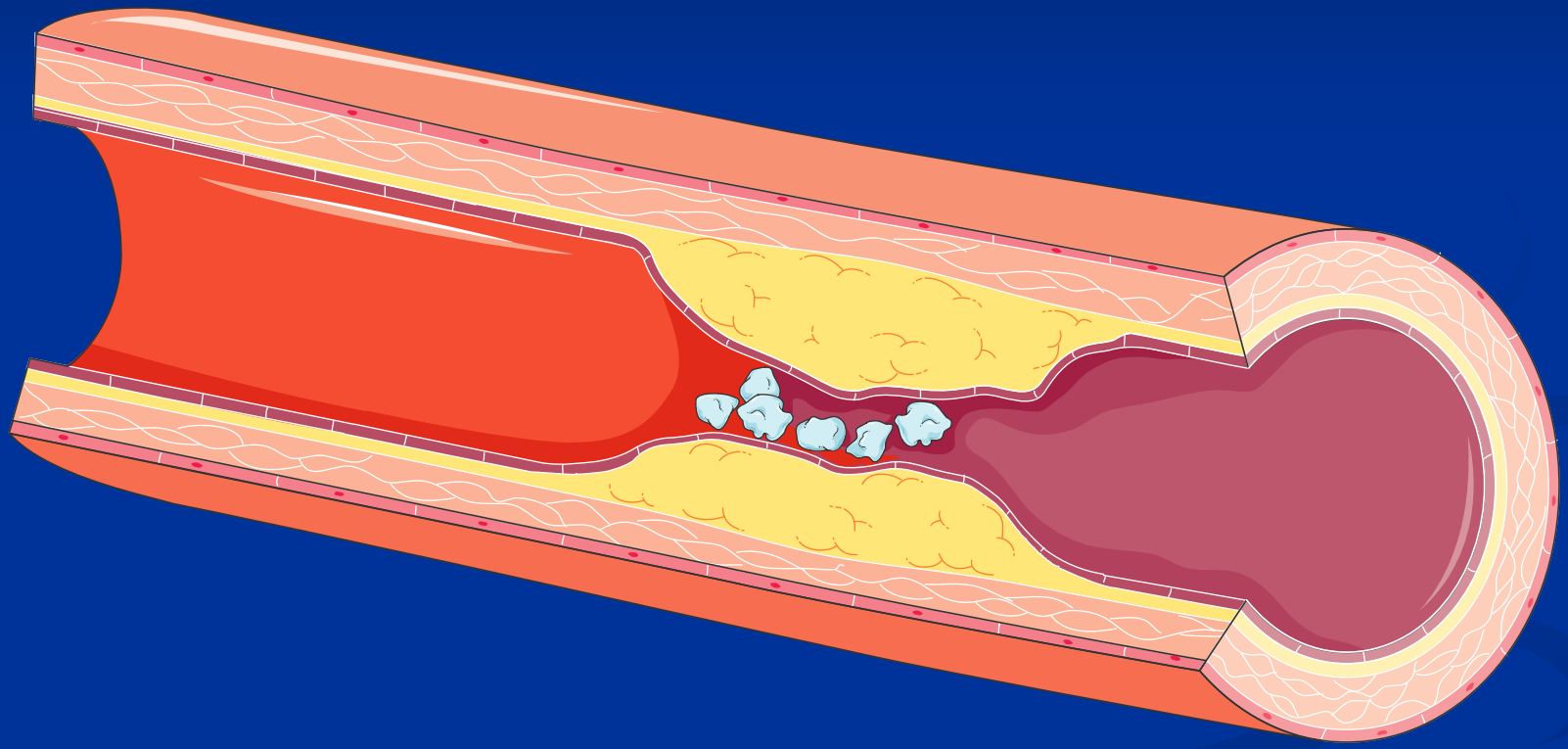

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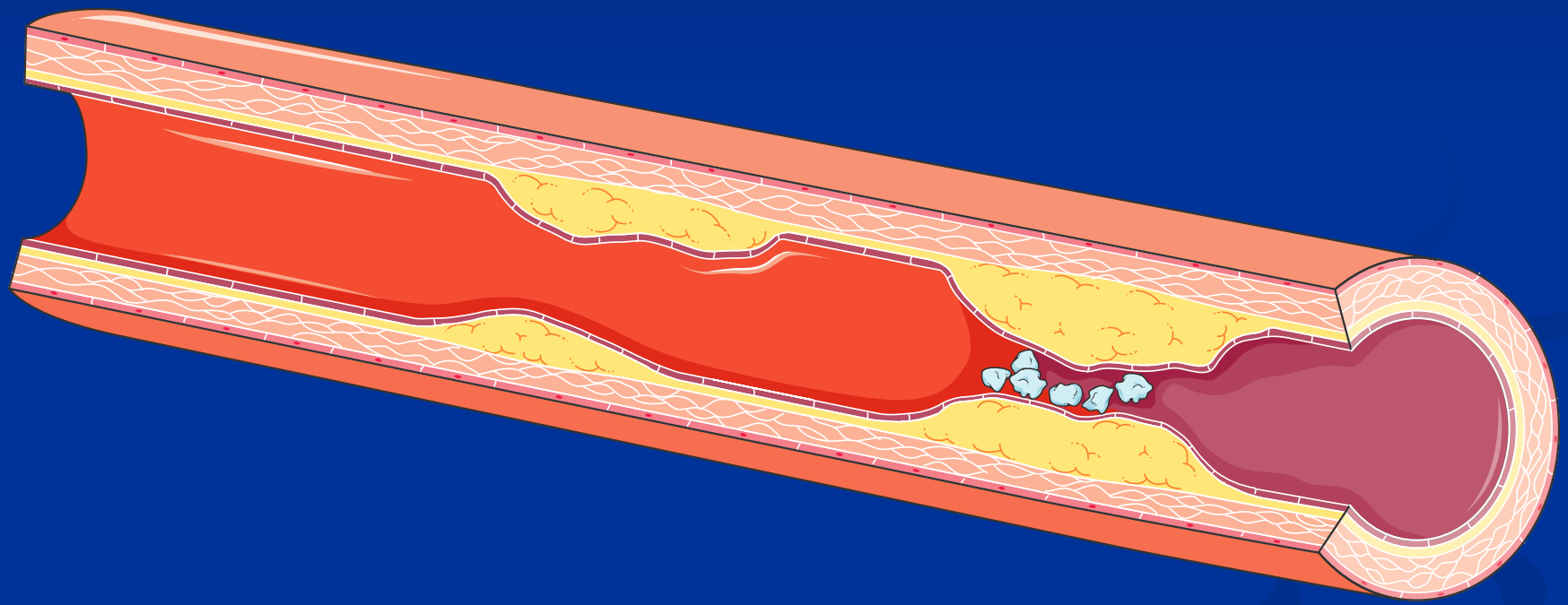

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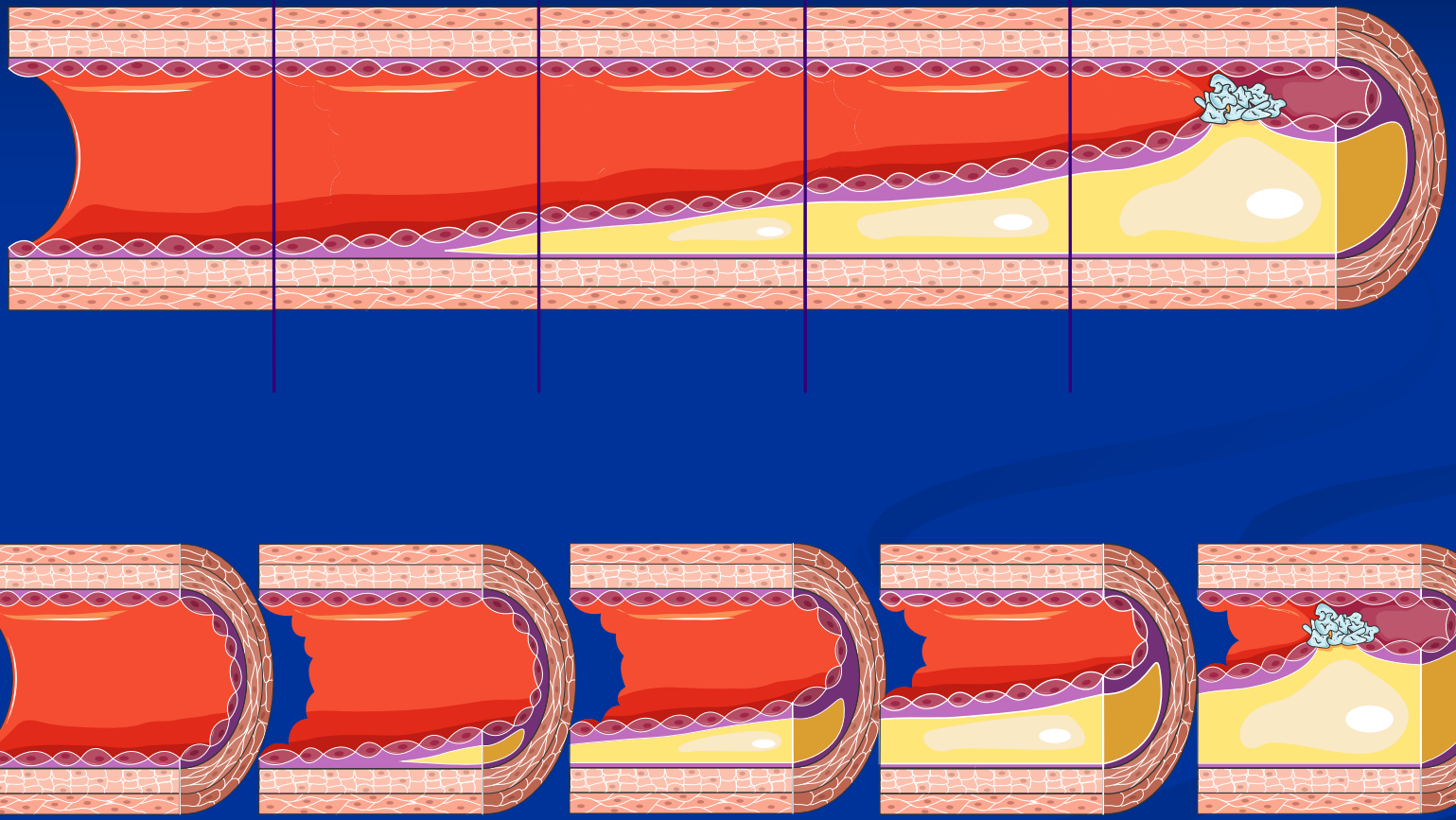
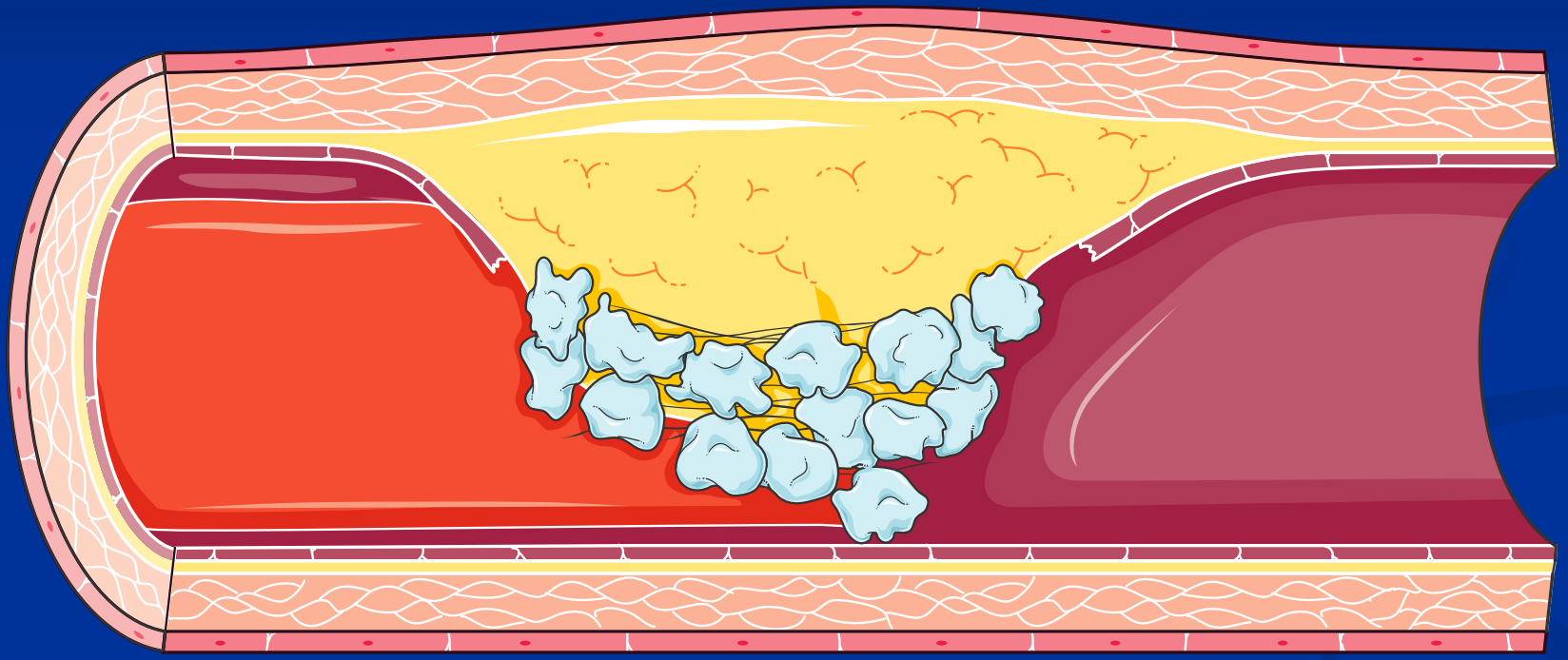


Atherothrombosis



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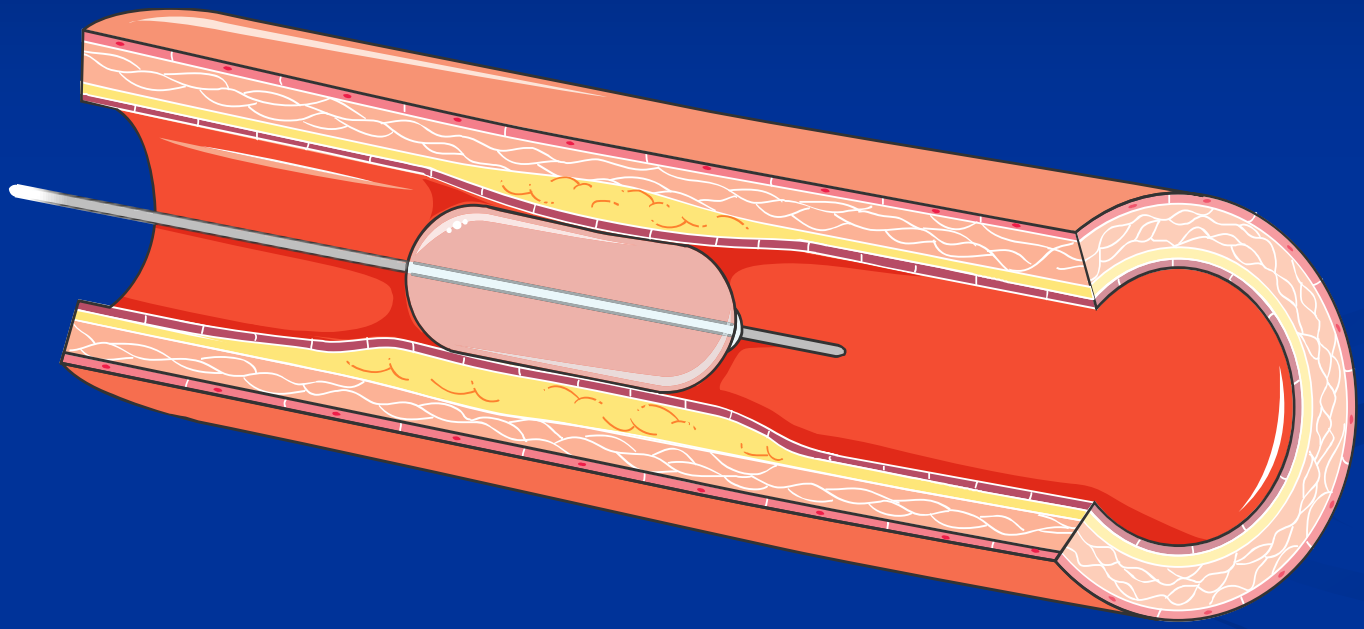

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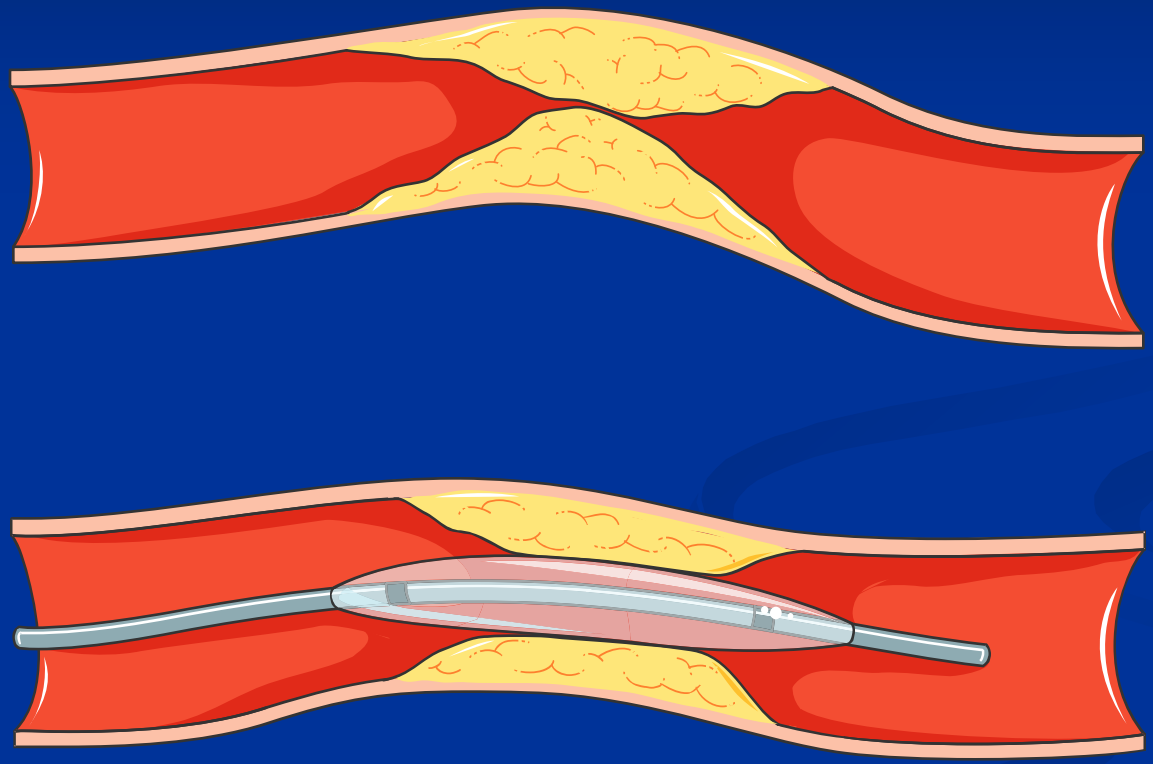

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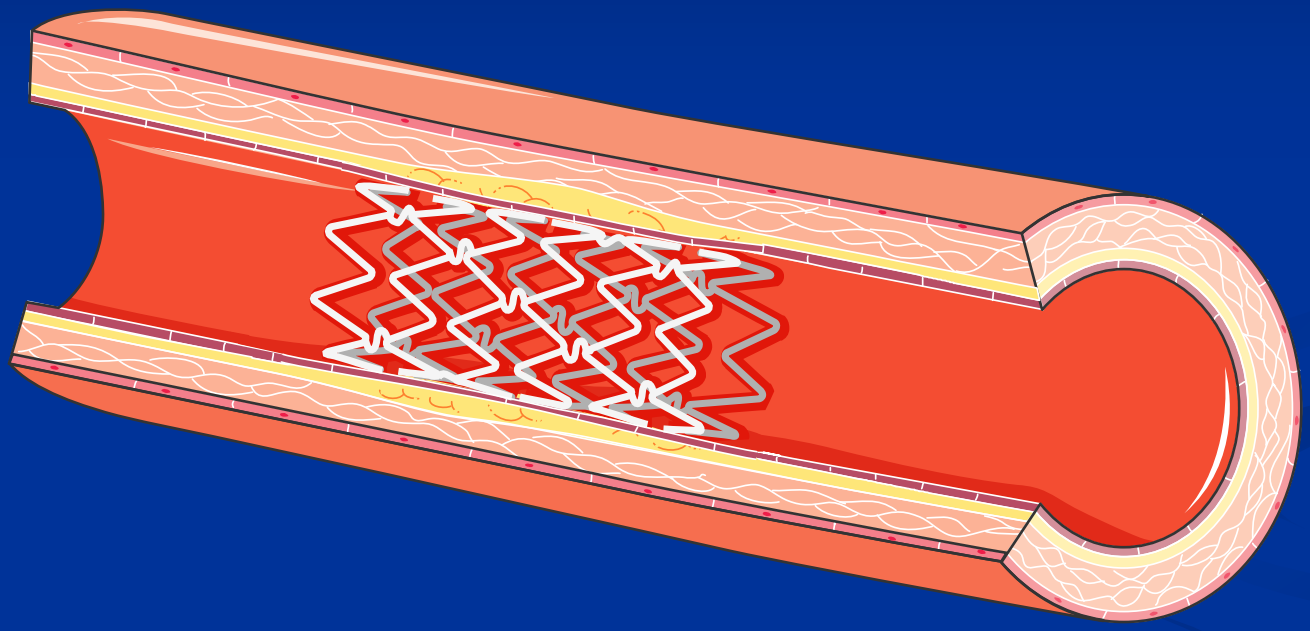

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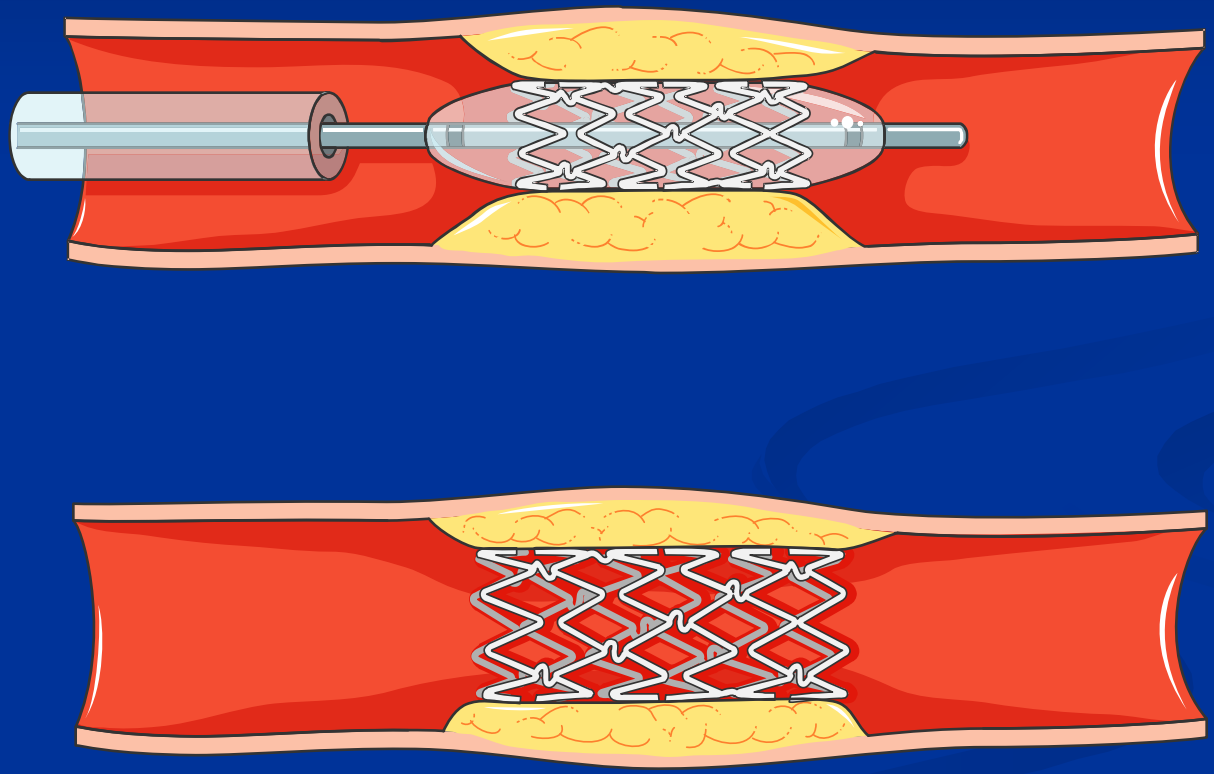

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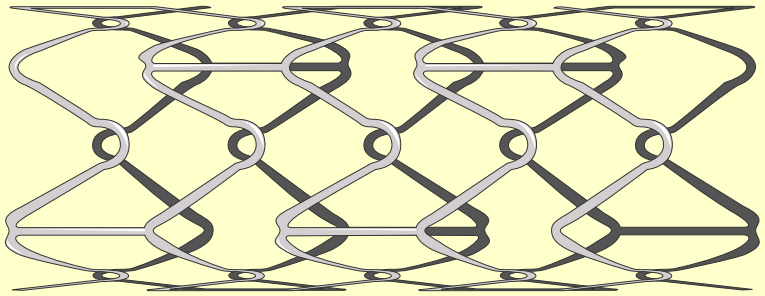

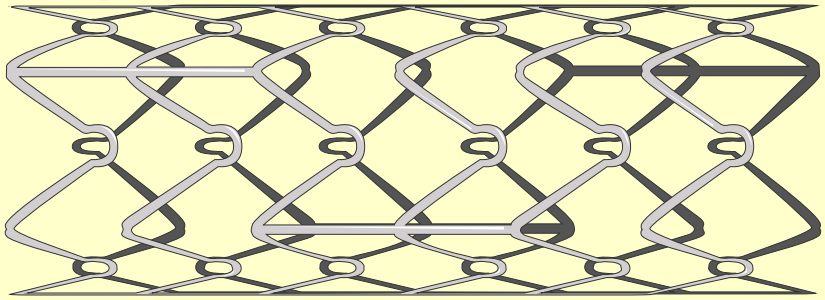

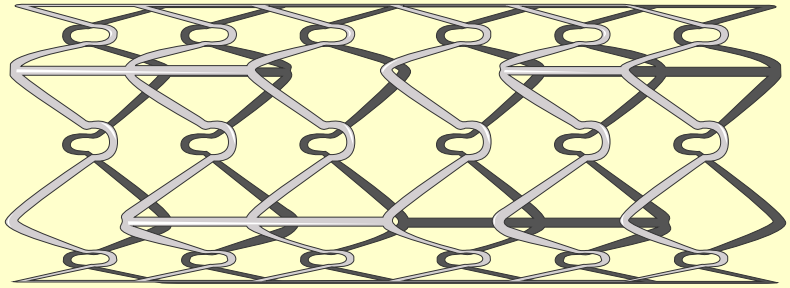

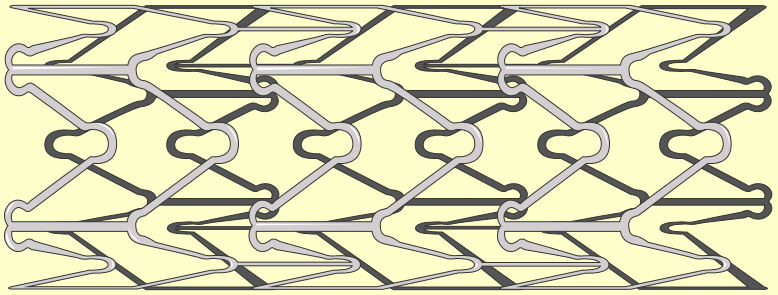

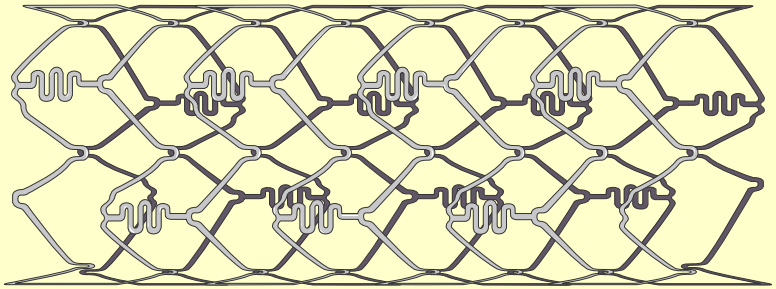

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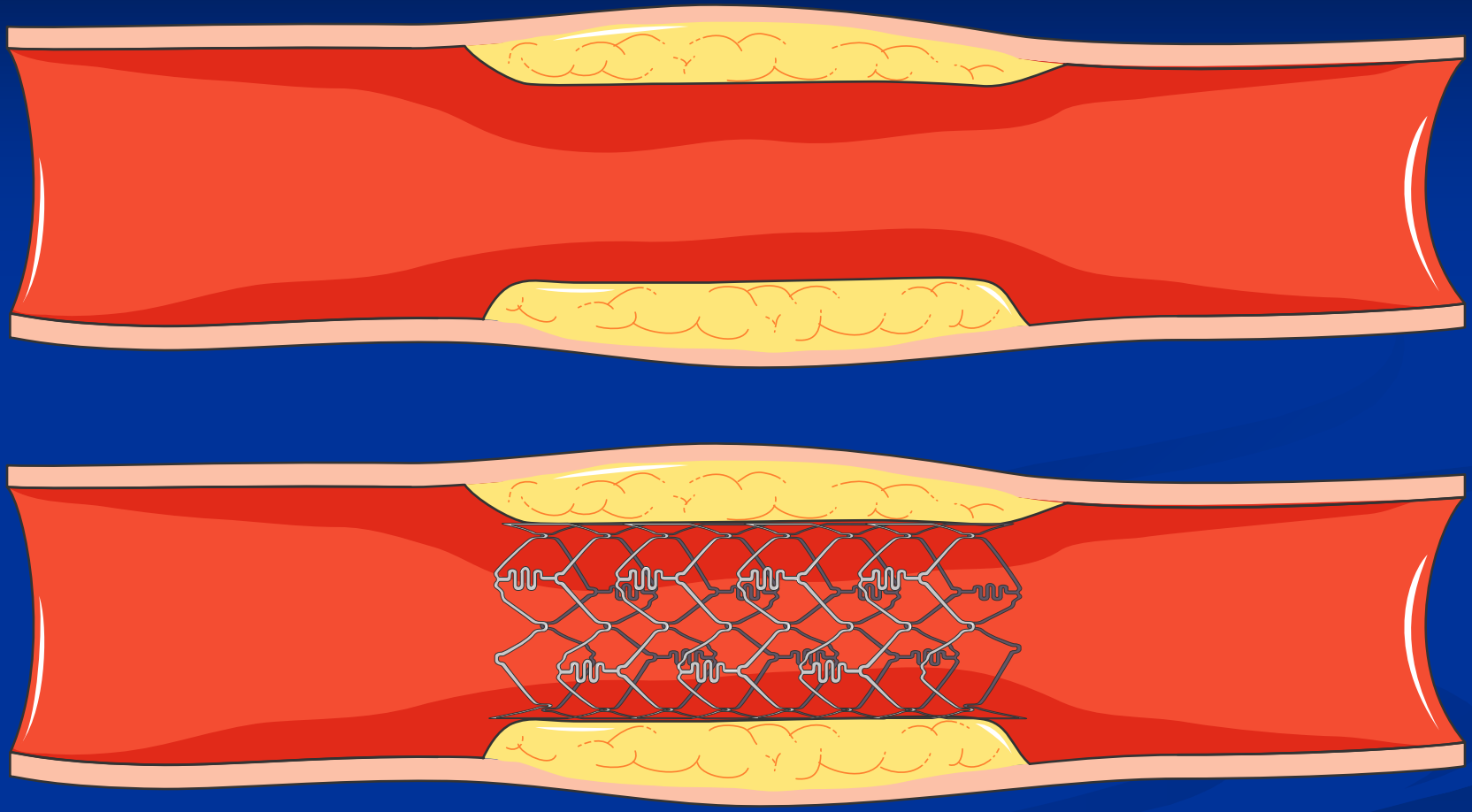
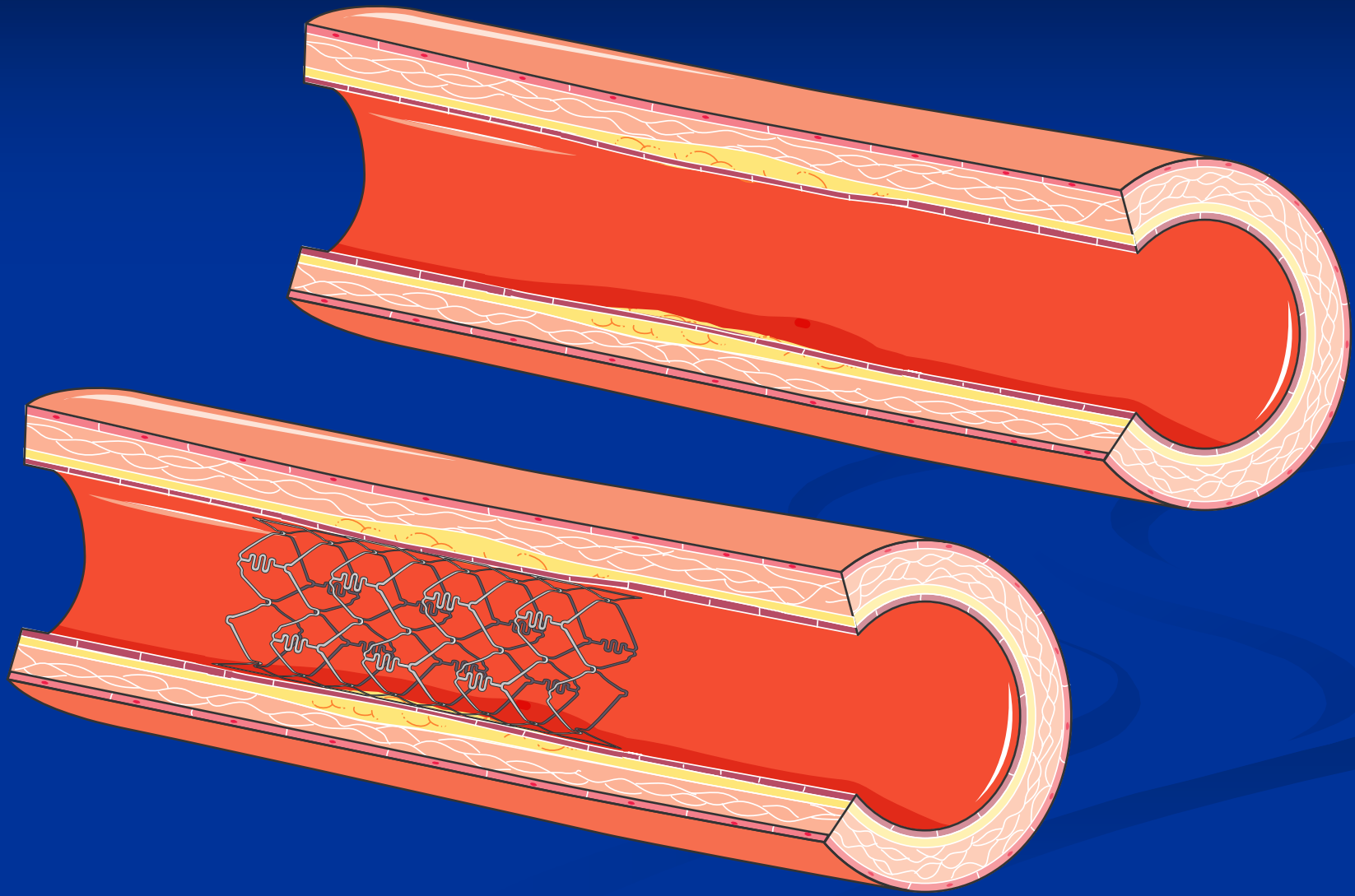
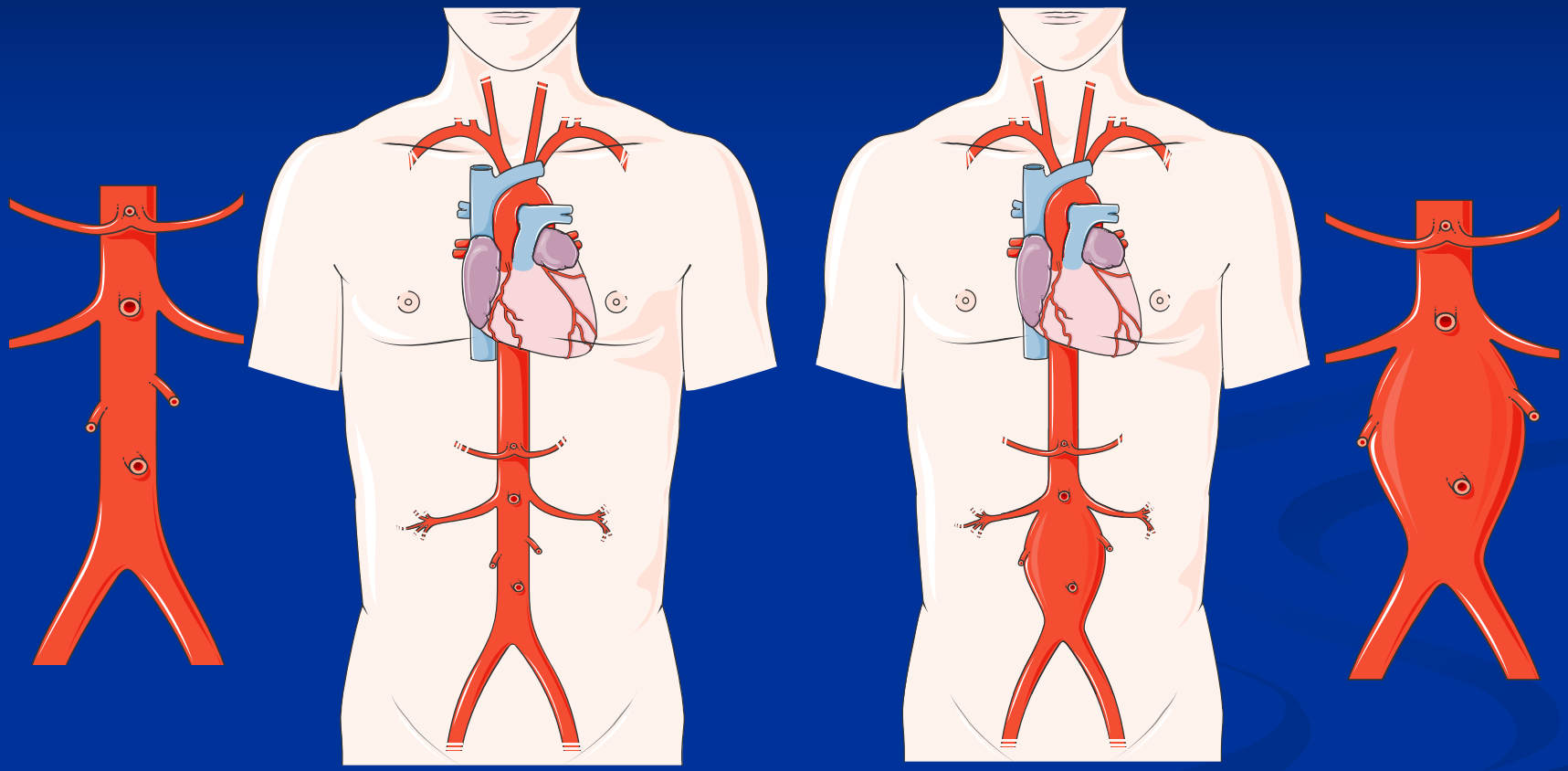


Stent (5)



Abdominal Aortic Aneurysm



- Myocardial ischemia can also occur if myocardial oxygen demands are markedly increased, as in severe ventricular hypertrophy due to aortic stenosis.

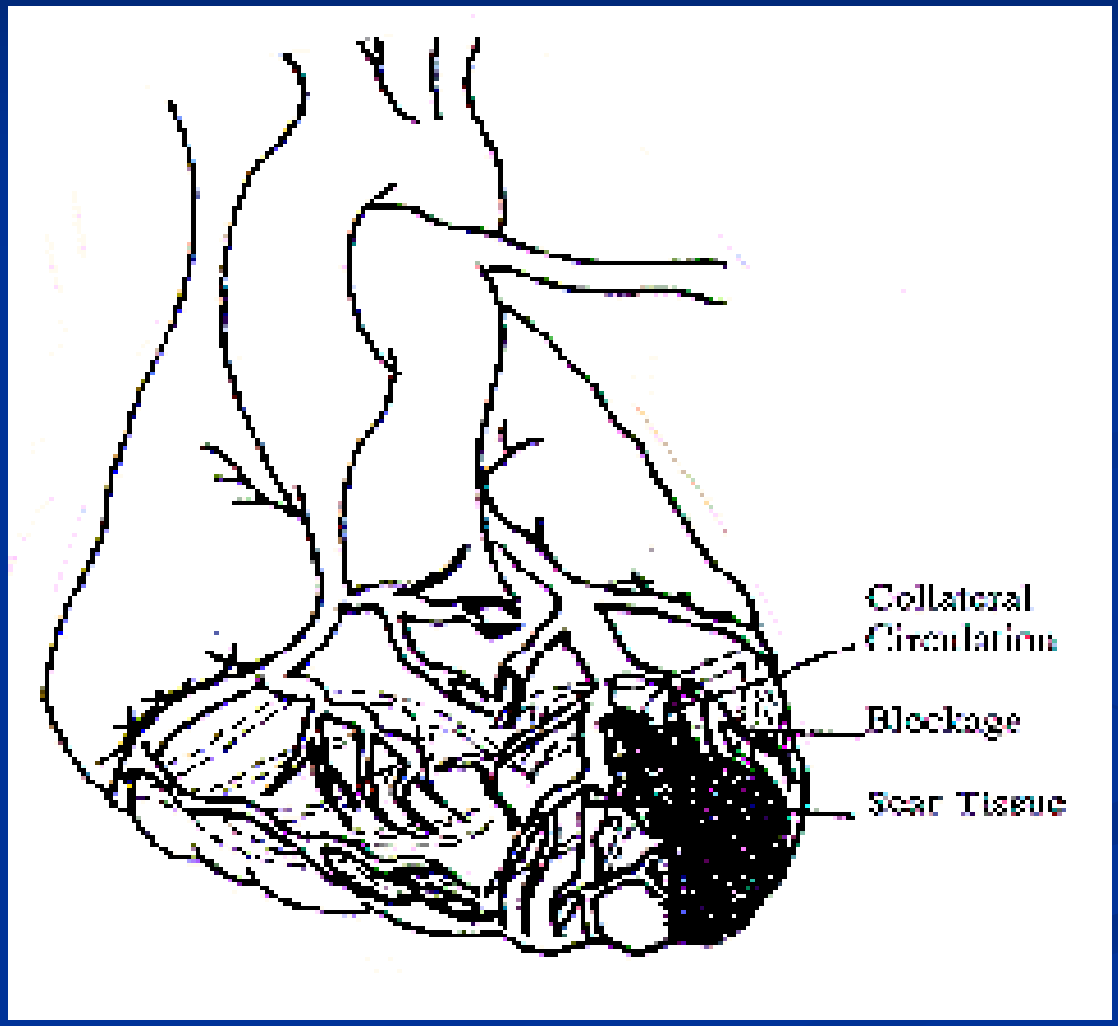
- the large epicardial coronary arteries are capable of constriction and relaxation, in healthy persons they are referred to *conductance vessels*,
- the intramyocardial arterioles normally exhibit striking changes in tone and are therefore referred to as *resistance vessels*.
- Abnormal constriction or failure of normal dilation of the coronary resistance vessels can also cause ischemia. When it causes angina this condition is referred to as *microvascular angina- X syndrome*.

Risk factor is something that increases your chance of getting a disease or condition. IHD:

- Sex: Male
- Age: 45 and older for men; 55 - for women
- Heredity
- Diabetes
- Obesity and overweight
- Smoking

- High blood pressure
- High blood cholesterol (specifically, high LDL cholesterol, and low HDL cholesterol)
- Sedentary lifestyle
- Stress
- Excessive alcohol use

- Atherosclerosis is characterized by an abnormal thickening and hardening of the walls of arteries, with a resulting loss of elasticity.


Collateral
Circulation
Blockage
Scar Tissue

Classification of the IHD (WHO)

1. Sudden coronary death
2. Angina pectoris

- Stable angina pectoris
- Unstable angina pectoris
- Angina pectoris *de novo*
- Prinzmetall angina pectoris
- Progressive angina pectoris

Classification of the IHD (WHO)

3. Myocardial infarction
   - Acute
   - Transmural MI
   - Intramural MI (subendocardial, subepicardial)
   - Chronic (old MI)
4. Cardiac failure in IHD
5. Arrhythmias

1. Sudden death

- – is a coronary death in 2 hours that happens suddenly, without serious previous cardiac diseases.

- *Etiology of Sudden death* - usually the course of it is ventricular tachy- arrhythmias.

2. Angina pectoris

- – its main clinical symptoms are attacks of retrosternal pain due to acute but transient disorder in the coronary circulation – Ischemia

Etiology of Angina pectoris

- the atherosclerosis of the coronary arteries of the heart
- coronary spasms.

Angiography

- is the most commonly used diagnostic tool used to view blood vessels.
- contrast material is injected into the coronary arteries, to diagnose blockages in the blood vessels

Clinical picture

Symptoms

Angina – intermittent chest pain that often has a squeezing or pressure-like feeling, which may radiate into the shoulder(s), arm(s),etc.

Angina usually lasts for about 2 to 10 minutes, not more than 20 min, and is often relieved with rest.

Angina can be triggered by:

- Exercise or exertion
- Emotional stress
- Cold weather
- A large meal

- If angina is unrelieved by rest or nitroglycerin, is severe, begins at rest (with no activity), or lasts more than 20 minutes, these are warning signs of unstable angina or a heart attack.

Accompanying symptoms may include:

- Shortness of breath
- Sweating
- Nausea
- Weakness

Objective examination

- During the attack, the pulse is usually slow, rhythmical, may be tachycardia, slightly increasing of the arterial pressure.
- Palpation, percussion and auscultation cannot reveal any abnormalities.

Instrumental and laboratory examinations

Tests may include:

1. Blood Tests – to look for certain substances in the blood; helps the doctor determine if you are having angina or an acute myocardial infarction .

- Blood tests during a myocardial infarction will show elevated Creatinine kinase (CK), Troponin level, or LDL level, AsT level.

2. Electrocardiogram (ECG, EKG)

- EKG shows characteristic abnormalities of ST segment or T waves:

- ST elevations > 1 mm or depression of the ST segment > 1 mm (below isoelectrical line)
- T wave inversions (negative T wave) or T wave may be – "high, positive, sharp"
- It may also show evidence of an old heart attack, i.e. Q waves or poor R wave progression.
- When the attack is abated the ECG soon normalizes.

3. Echocardiogram – uses high-frequency sound waves to examine the size, shape, and motion of the heart; gives information about the structure and function of the heart

4. **Tests with physical effort:**

- cycloergometria - physical effort on bicycle with permanently taking the ECG
- treadmill – running road with permanently taking the ECG

5. Exercise Stress Test – records the heart's electrical activity during increased physical activity
6. **Holter monitorization** – is a method of taking ECG during 3-6-24 hours, when electrodes are placed on the patient's body and he is acting as usual.

- 7. Stress Echocardiogram -- this is where stress treadmill is combined with Echocardiogram before and after exercise. It is also about 90% sensitive for detecting heart disease.
- 8. Thallium Stress Test – thallium is used to scan the myocardium, the muscle layer of the heart
- 9. Nuclear Scanning – radioactive material is injected into a vein and observed as it is absorbed by the heart muscle

- 10. Electron-beam CT Scan – a type of x-ray that uses a computer to make pictures of the inside of the heart
- 11 .Coronary Angiography –
- 12. Cardiac catheterization -- this is the gold standard, allows for exact determination of blockages. Heart function and valve function may also be assessed at the same time.

Preventive Blood Testing

- Lipid profile (this includes total cholesterol, LDL, HDL, and triglyceride levels)
  - Homocystine level -- this blood test seems to correlate with increased reactivity of the lining of the artery walls to atherosclerosis formation
  - C-reactive protein -- this is an inflammatory marker. This is useful for predicting which patients will respond to aspirin as a preventative in the case of an ischemic event, such as a heart attack.

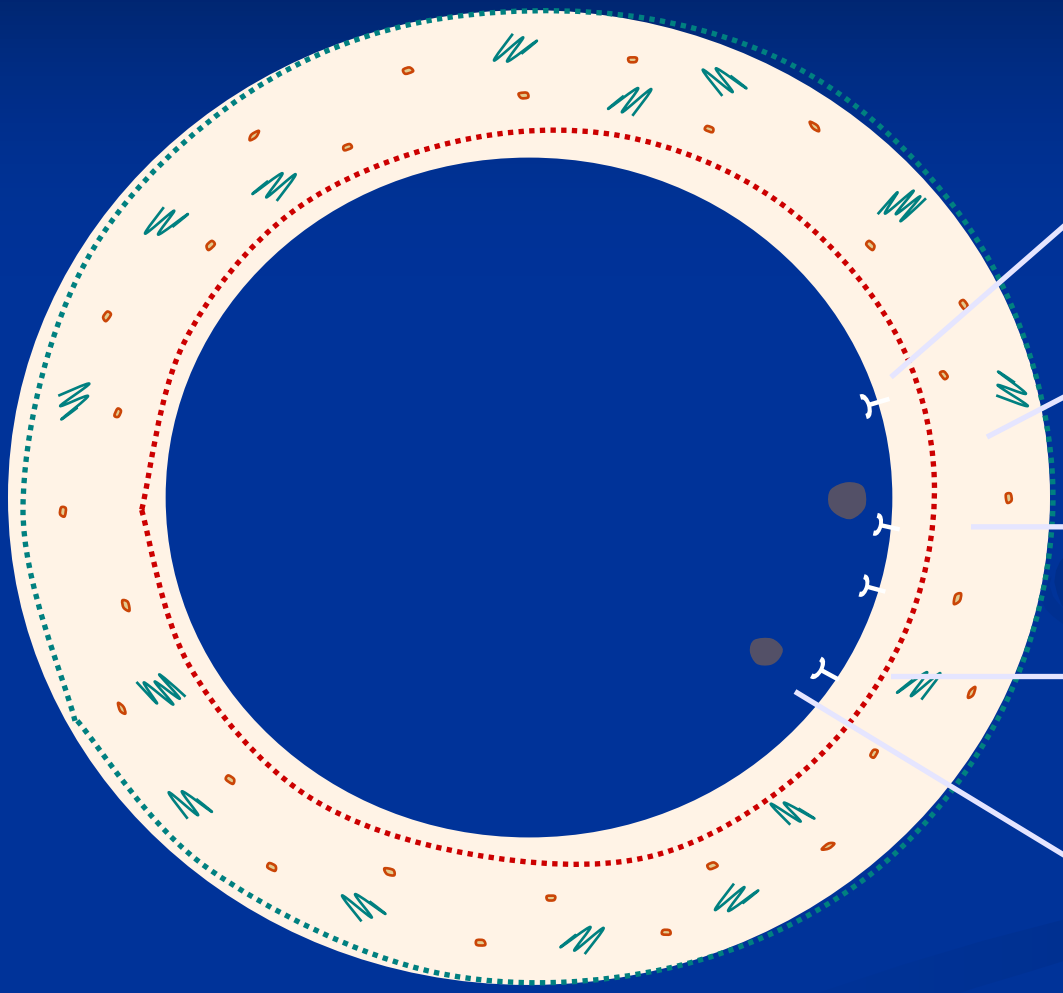
3. Acute myocardial infarction (AMI).

- is formation of a necrotic focus in the heart muscle due to upset coronary circulation.
- In survived patients necrosis is substituted in several weeks by a scar.

Etiology

- One of the main causes of the AMI (90-95%) is the rupture of the atherosclerotic plaque with the following thrombosis of the vessel, sometimes and spasm

Endothelial Dysfunction in Atherosclerosis



Upregulation of endothelial adhesion molecules

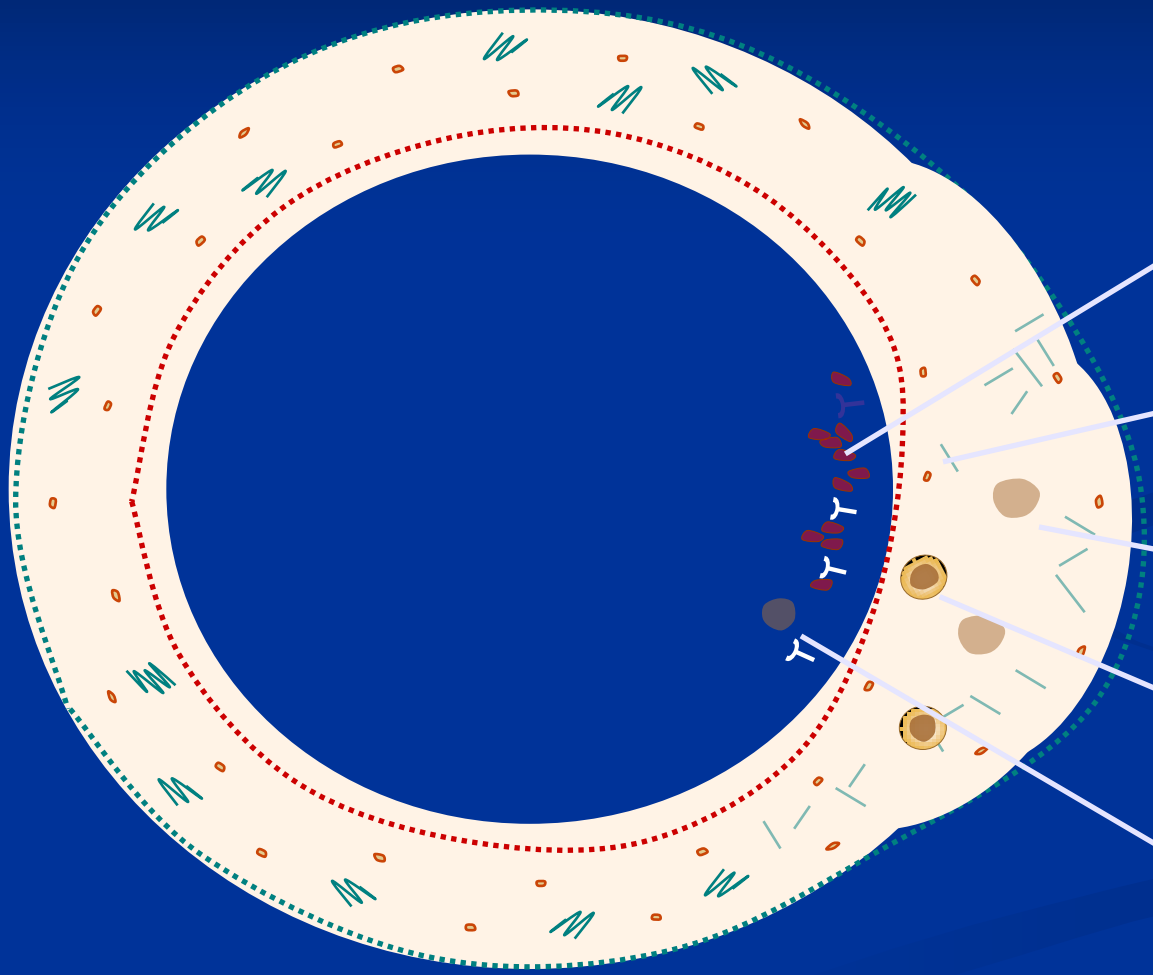
Migration of leucocytes into the artery wall

Lipoprotein infiltration

Increased endothelial permeability

Leucocyte adhesion

Fatty Streak Formation in Atherosclerosis



Adherence and aggregation of platelets

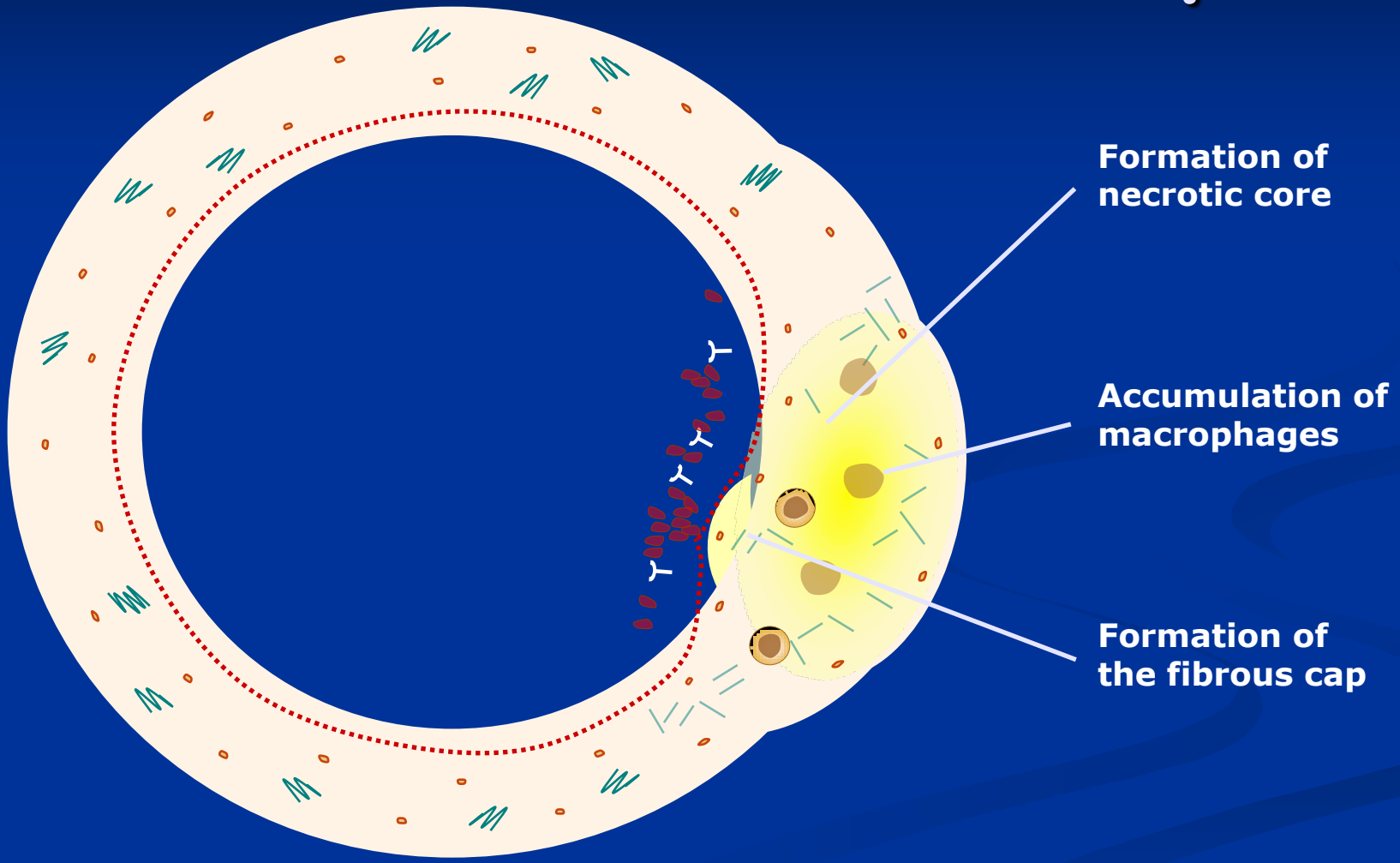
Migration of smooth muscle cells

Formation of foam cells

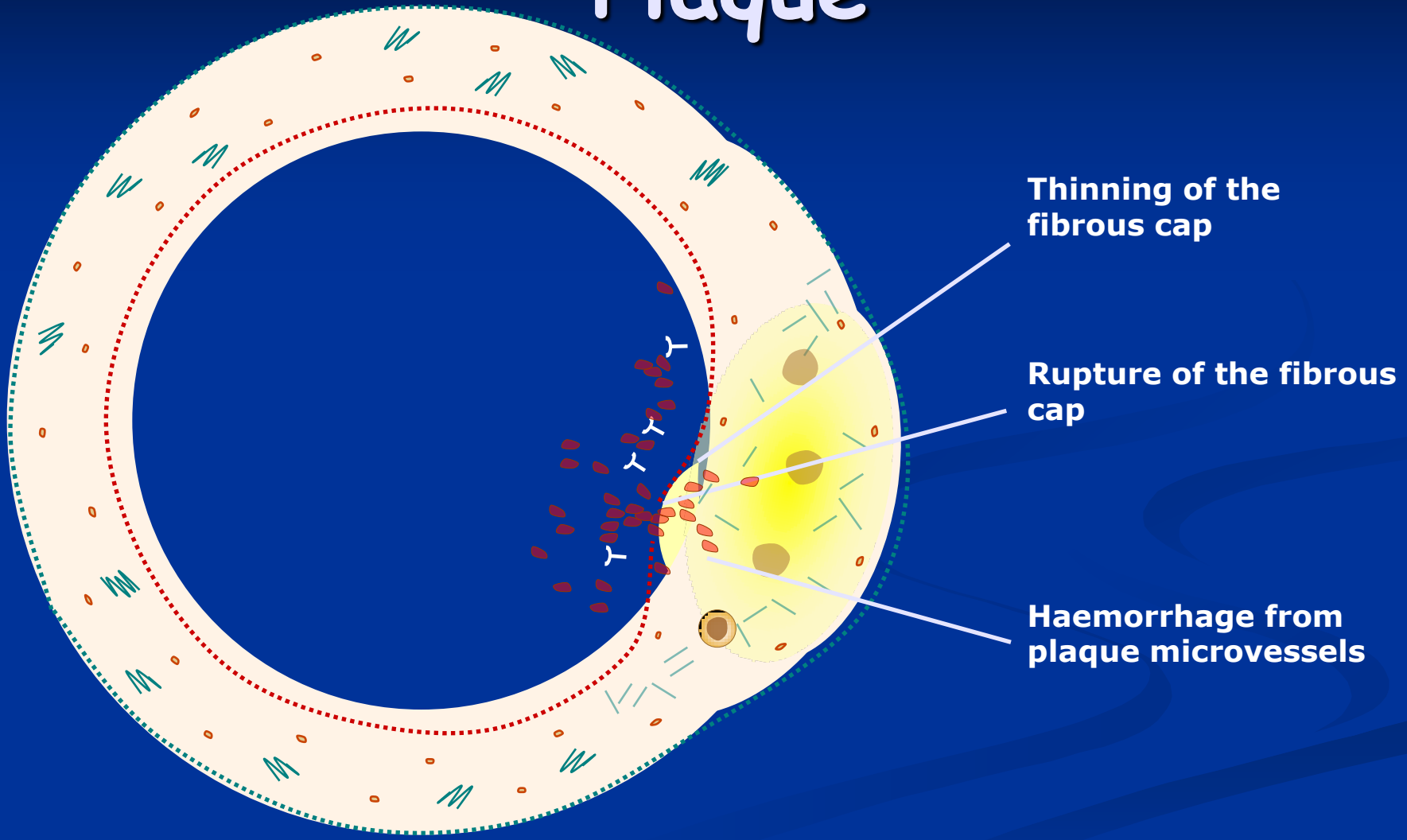
Activation of T cells

Adherence and entry of leucocytes

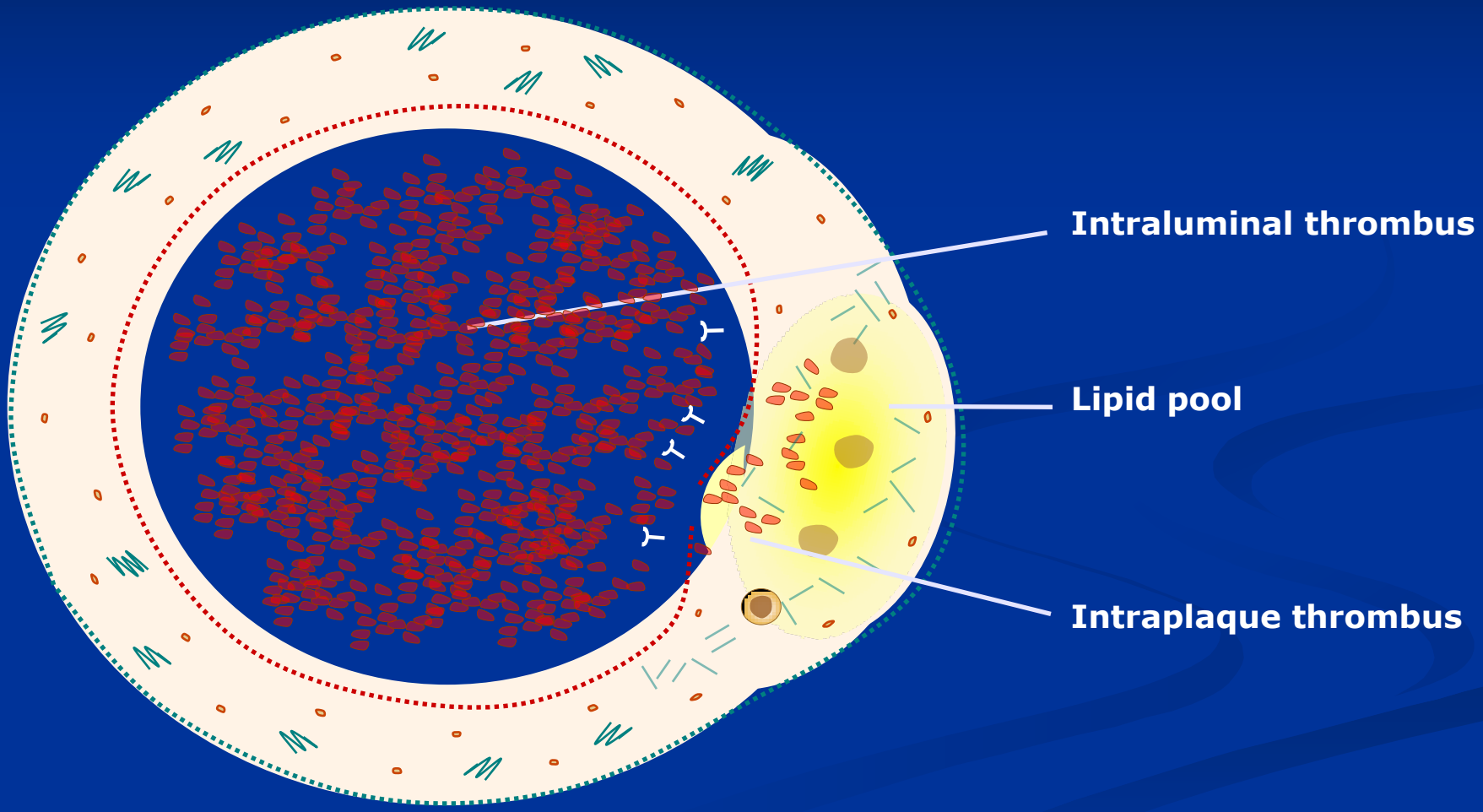
Formation of the Complicated Atherosclerotic Plaque



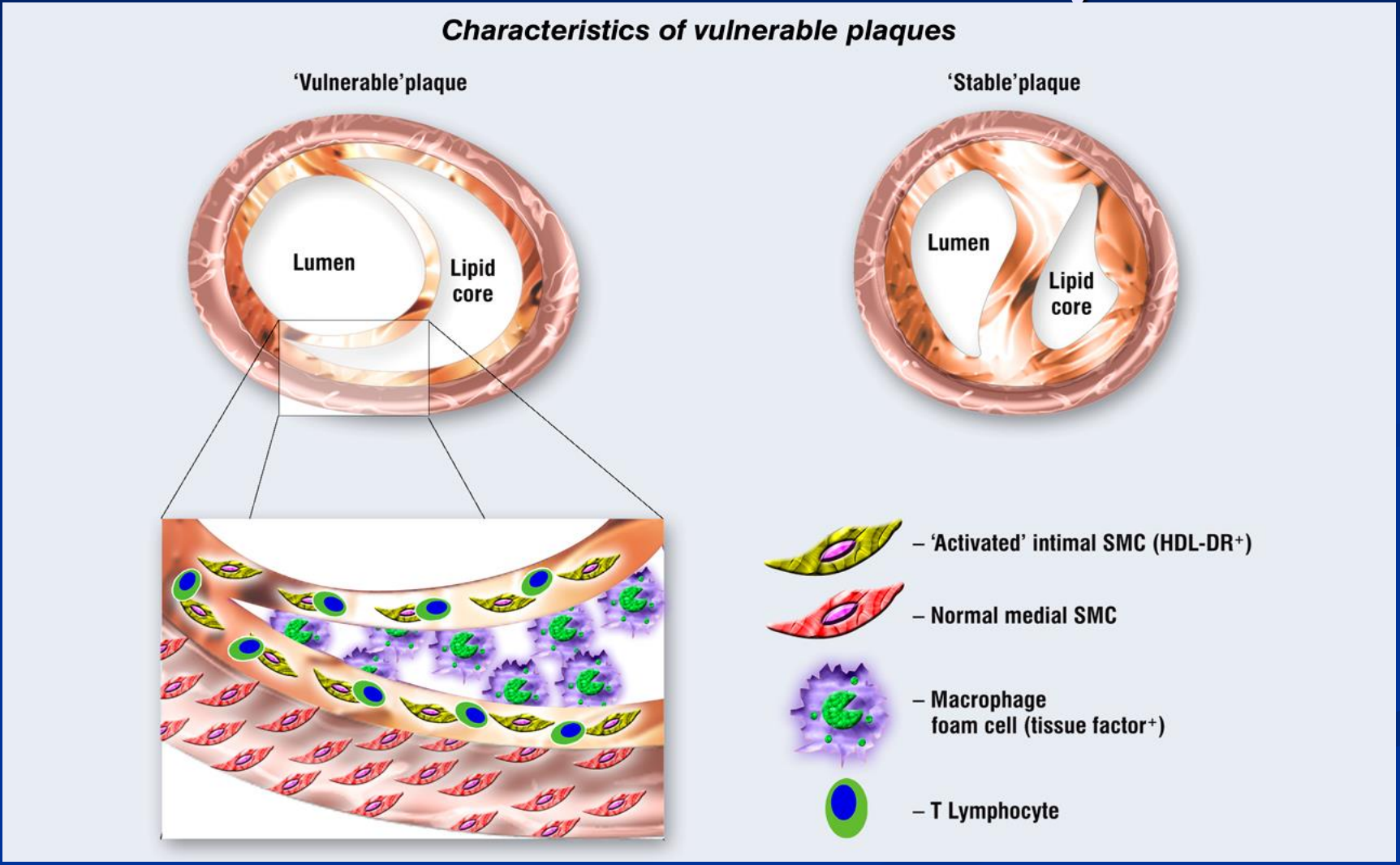
The Unstable Atherosclerotic Plaque



Atherosclerotic Plaque Rupture and Thrombus Formation



The Vulnerable Atherosclerotic Plaque



SMC – smooth muscle cell
HDL-DR – transplantation antigen indicating 'activation' of SMCs

Libby P. *Circulation* 1995;**91**:2844-2850.

The diagnosis of AMI is based on 2 from 3 signs:

- characteristic clinical picture
- characteristic ECG changes
- Characteristic blood serum analysis.

Clinical picture.

Typical form of AMI:

- anginous form (pain lasts more than 30 min)

Atypical forms of AMI:

- Asthmatic form – like an hit of bronchial asthma
- Abdominal form – like an acute abdomen, with a dyspeptic syndrome (often in old people)
- Cerebral form – like the symptoms in stroke
- Arrhythmic form – it begins with arrhythmias.

- As distinct from angina pectoris, pain in myocardial infarction is not removed by nitroglycerin and persists for a longer time (from 30 – 60 min to several hours).
- Sometimes AMI may begin with a sudden heart failure or collapse, various disorders in the cardiac rhythm or heart block, while the pain syndrome is absent or weak.

Cardiovascular system.

- Examination reveals enlargement of cardiac dullness and low auscultation sounds.
- Sometimes can be heard gallop rhythm.
- Pericardial friction is audible over restricted area on the 2nd or 3rd day after debut of AMI.
- Pulse in AMI is often small, accelerated, or arrhythmic.
- Arterial pressure increases during attack but then it falls.

- Depending on the localization of the AMI, circulation may be disordered by the left-ventricular or right-ventricular type.
- In the former case, congestive moist rales can be heard in the lungs.

General blood analysis - leucocytosis, elevation of ESR.

Blood serum analysis – elevated level of :

- lactic dehydrogenase (after 48 hours, 1-3 weeks)
- creatine phosphokinase – MB (is elevated after 6 hours from beginning of the MI) – 3-4 days
- myoglobine
- troponine fractions (is elevated after 3-4 hours from beginning of the MI).

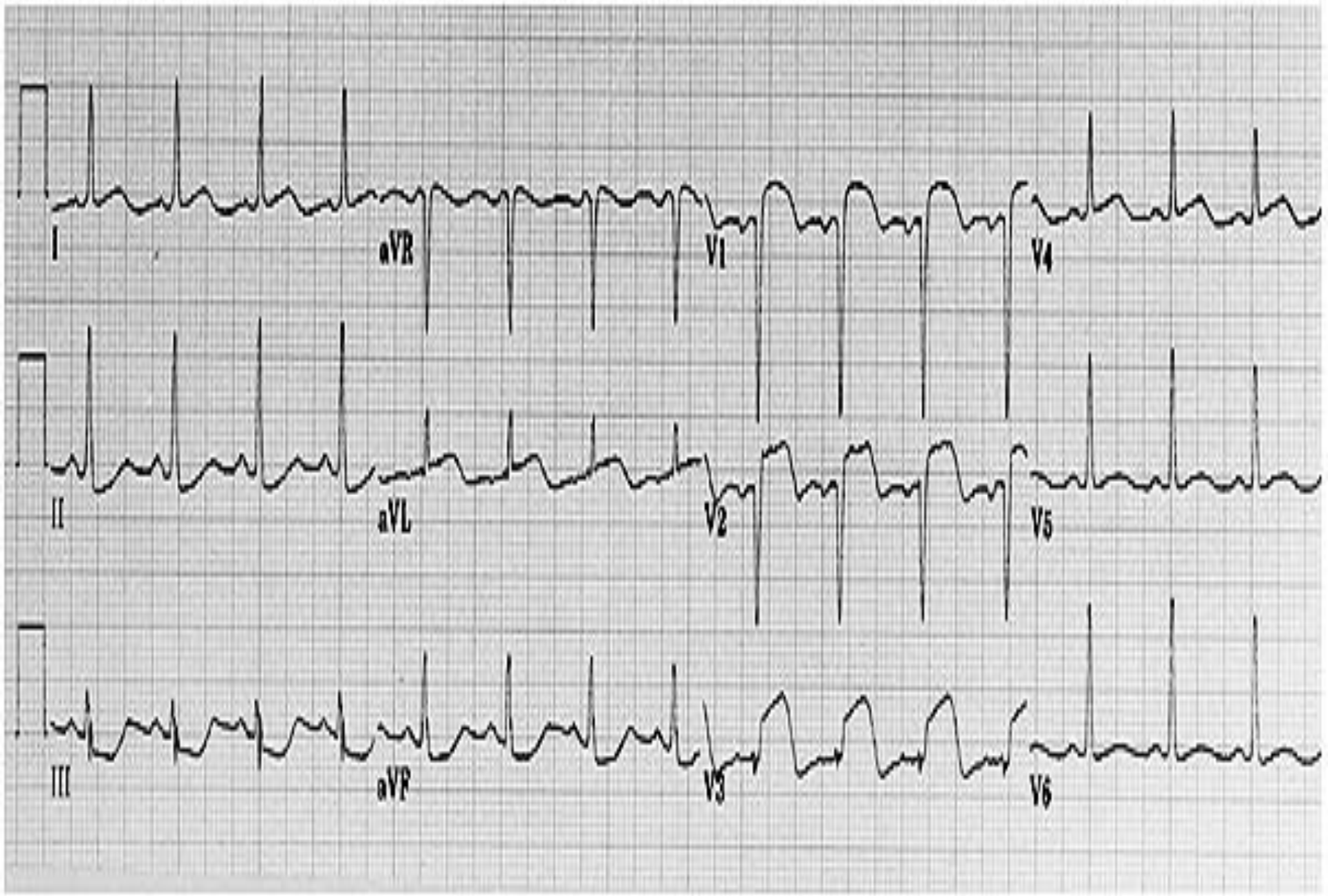
ECG investigation –

1. Acute phase:

- Initially acute phase – (3-6 hours) – progressive elevating of ST segment and T wave. Together they formed monophase curve.
- Acute defined phase – appearance of the pathological Q wave with concomitant slowly diminishing of the R wave. ST segment becomes to the isoelectric line to the 10-15 day

ECG investigation

2. *Subacute phase* – (few weeks or months) – ST segment is on the isoelectric line, T wave becomes positive.
3. *Chronic phase* – presence of the QS complex, T wave is positive, absence of the R wave (or R wave is very small).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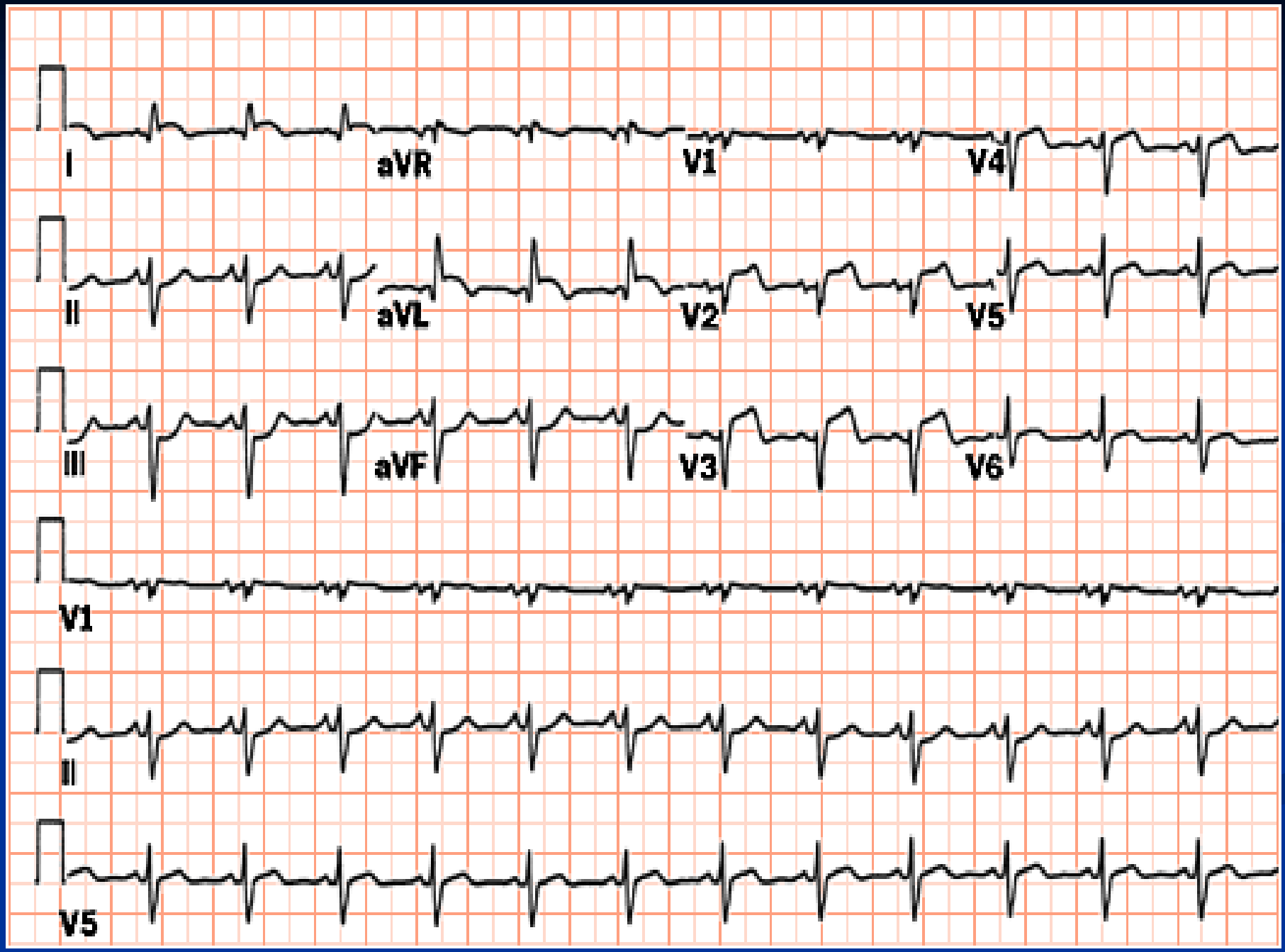
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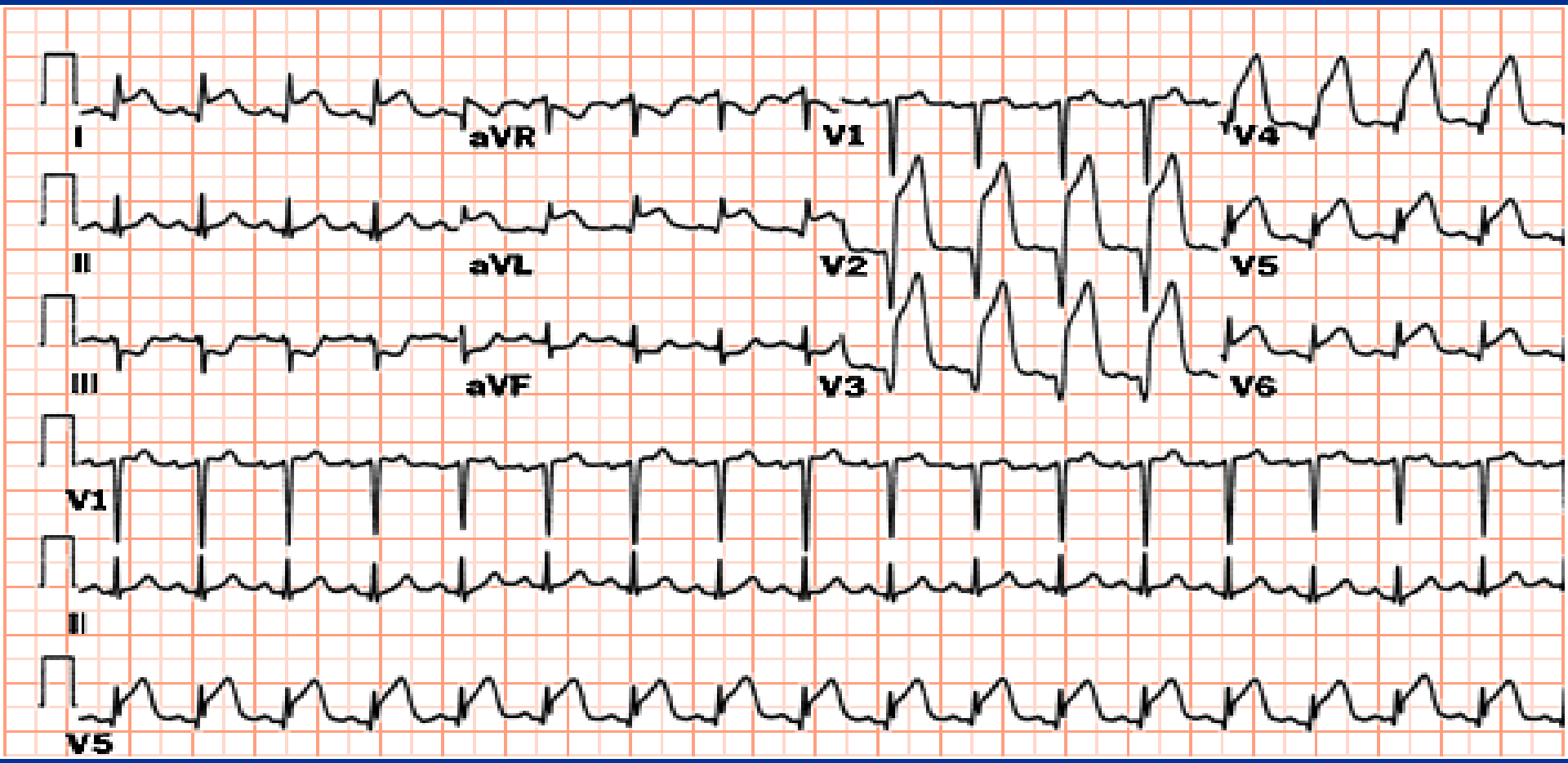
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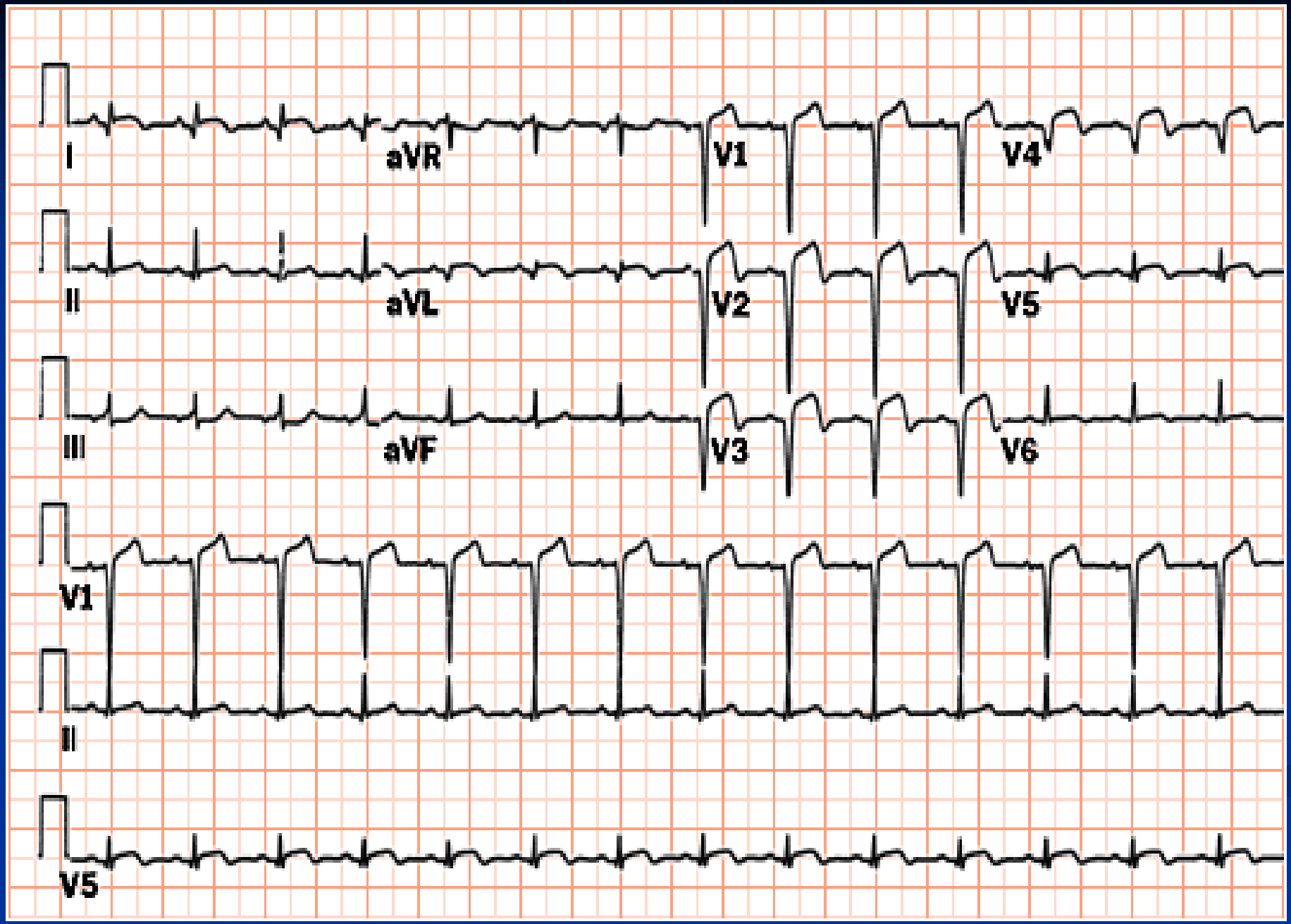
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- **Ecocardiography** – is revealing the presence of the hypokinetic or akynetic zones, anevrism of the heart muscle.
- **Coronarography** – presence of the occlusions of the arteries, zones of necrosis.
- Radionuclide method with Tl 99 can be helpful in diagnosing of the AMI.