University Of Fallujah
College Of Medicine
Medical Biochemistry

Lecture 5: Cardiac Biomarkers

Stage: 2nd Year

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Department: Medical Biochemistry

Date: 21 / 4 / 2026

Learning Objectives

By the end of this session, students should be able to:

- Define **cardiac biomarkers** and explain their role in diagnosing myocardial infarction (MI)
- Differentiate between **cardiac proteins (troponin, myoglobin)** and **enzymes (CK, AST, LDH)**
- Describe the **biochemical basis, source, and function** of major cardiac biomarkers
- Compare biomarkers based on **onset, peak, duration, sensitivity, and specificity**
- Identify the **most sensitive and most specific markers** for myocardial injury
- Interpret **CK isoenzymes (CK-MB, CK-MM, CK-BB)** and their clinical significance
- Explain the **diagnostic role of LDH isoenzymes (LDH_1 vs LDH_2 reversal)**
- Recognize **pre-analytical factors** affecting laboratory results (e.g., hemolysis, sample type)

Cardiac Biomarkers

Cardiac biomarkers are used to diagnose:

- Acute myocardial infarction (primary use)
- Myocardial injury (ischemic and non-ischemic)
- Risk assessment in ACS

A. Cardiac protein:

1. Myoglobin.

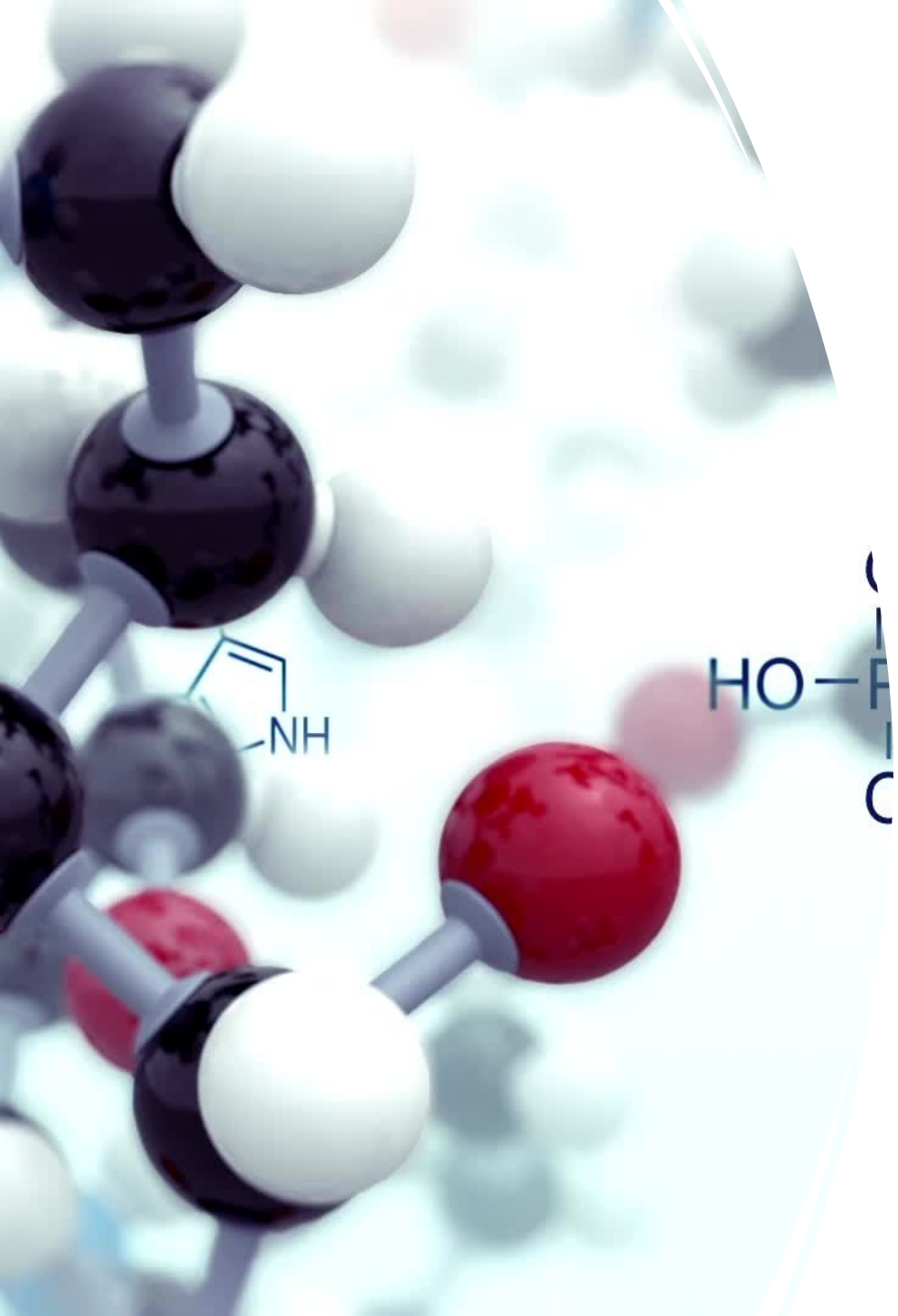
2. Cardiac Troponin I & T.

B. Cardiac enzymes:

1) Creatine kinase (CK)= Creatine phosphokinase (CPK).

2) Aspartate transaminase (AST).

3) Lactate dehydrogenase (LDH).



Myoglobin

- Myoglobin is a low molecular-weight haem-containing protein found in both skeletal and cardiac muscle.
- Small-sized heme protein mainly assists in ***oxygen transport***
- It is rapidly released from the myocardium upon damage, and a typical rise occurs within 2–4 h after the onset of acute myocardial infarction.
- Unfortunately, myoglobin is not cardiac-specific.
- Myoglobin has ***high sensitivity*** but ***poor specificity.***
- It may be useful for the **early detection** of myocardial infarction.

- **The normal ranges: 90 µg/L for males and 75 µg/L for females**

Cardiac Troponin

Troponin is a ***protein*** released from **myocytes** when irreversible myocardial damage occurs.

Troponin is a ***superior marker*** for myocardial injury.

Troponin is a complex of **three** regulatory proteins.

Troponin C binds to **calcium ions**, Troponin T binds to **tropomyosin, and Troponin** I binds to **actin** in thin myofilaments.

Cardiac troponin is slightly different from skeletal troponin serve **as a potent specific marker for cardiac disease**

Cardiac Troponin I and T are the most ***sensitive*** and ***specific*** tests for ***myocardial damage.***

Troponin I and T are of equal clinical value.

Troponin levels may not be detectable for six hours after the onset of myocardial injury.

Specimen Requirements:

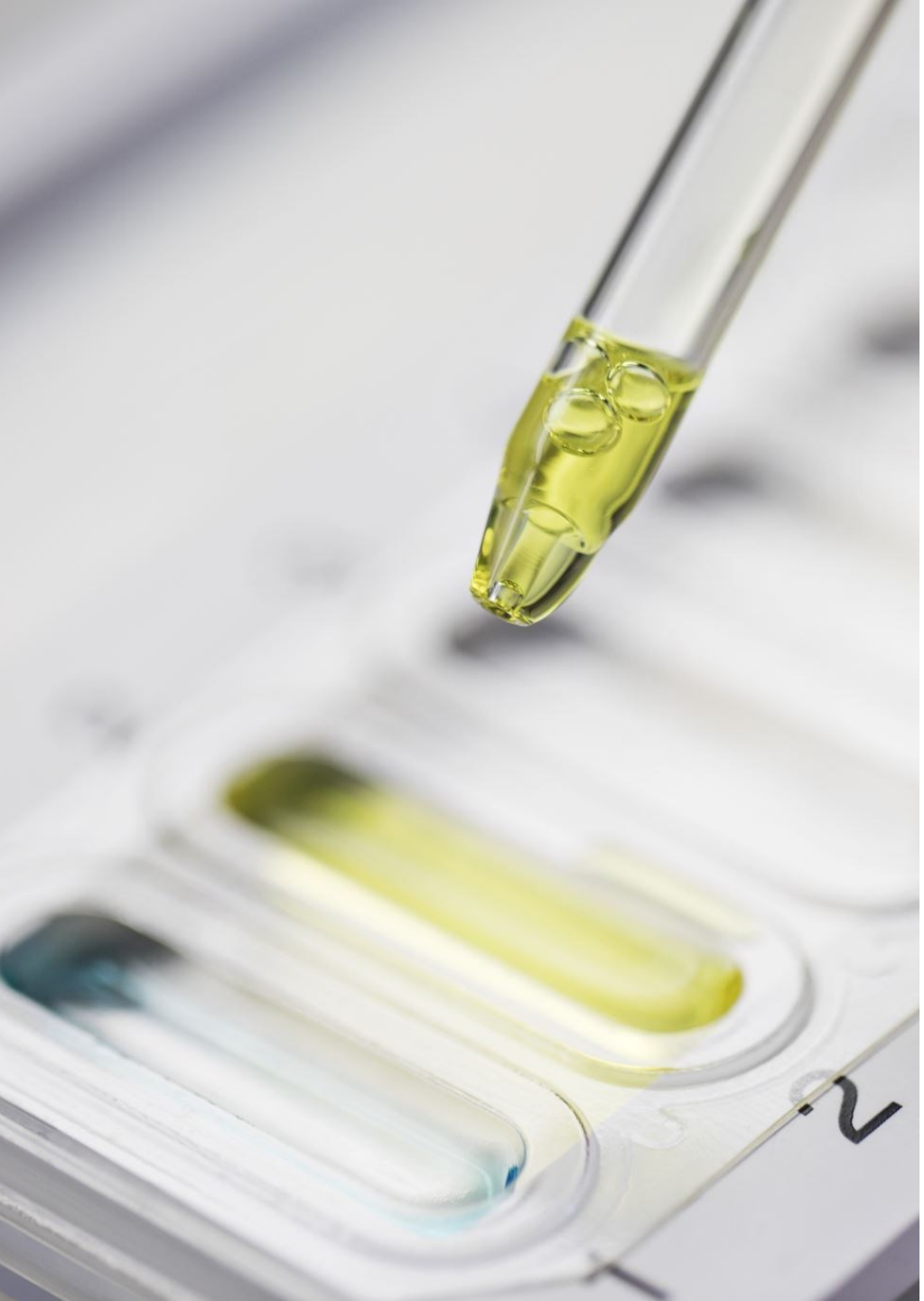
- Anticoagulated whole blood or plasma appears to be the optimal specimen for rapid processing and testing.
- Both EDTA and heparin are known to interfere with cTnI and cTnT antibody-binding affinity.

- Normal levels: **< 14 ng/L**

Creatinine kinase (CK)

- **It catalyses the conversion of creatine to phosphocreatine, degrading ATP to ADP**
- **The CK enzyme consists of two subunits, B** (brain type) or **M** (muscle type), making **three** different isoenzymes:
- **CK-BB:** is of **brain** origin, found in blood only when the brain is damaged.
- **CK-MB:** highly specific for myocardial **origin**
- **CK-MM:** found primarily in skeletal **muscle**

- **Normal Range:** 5-25 U/L.



Sample type:

- Serum free of hemolysis.
- Hemolysis of serum samples may be a source of elevated CK activity.

- ***Plasma containing heparin, EDTA, citrate, or fluoride is not allowed.***

- Serum should be stored in a dark place because CK is inactivated by light.

Lactate Dehydrogenase (LDH)

- LDH is an enzyme that is found in almost all body tissues, but only a small amount of it is usually detectable in the blood.
- When cells are damaged or destroyed, they release LDH into the bloodstream.
- Hemolysis of serum samples may be a source of elevated LDH activity (*Erythrocytes contain an LDH concentration approximately 100 to 150 times that found in serum*).
- Both total and LDH 1 isoenzymes are elevated in myocardial infarction.

•Usually, LDH2 in blood is higher than LDH1.

•But in acute myocardial infarction, LDH 1 is more than LDH 2.

- Males: 135 – 225 (U/L). Females: 135 – 214 U/L.

Lactate Dehydrogenase (LDH) and Creatine Kinase (CK) Isoenzymes

Isoenzyme	Composition	Location	Diagnostic Importance *(Cause of Elevated Level)*
LDH_1	HHHH	Heart, RBC	Myocardial infarction
LDH_2	HHHM	Heart, RBC	Megaloblastic anemia
LDH_3	HHMM	Brain	Leukemia, malignancy
LDH_4	HMMM	Lung, spleen	Pulmonary infarction
LDH_5	MMMM	Liver, muscle	Liver diseases, Muscle damage/diseases
CK_1	BB	Brain	Neurological injury
CK_2	BM	Heart	Myocardial infarction
CK_3	Skeletal muscle	Skeletal muscle	Muscular dystrophies and myopathies

Marker	Myoglobin	Troponin	Creatine kinase MB	LDH-1	AST
Site	Cardiac muscle Skeletal muscle	Cardiac muscle only	Cardiac muscle	Cardiac muscle	Liver Cardiac muscle
Onset	1-2 hours	3 hours	4 hours	5 hours	12 hours
Peak	6 hours	24 hours	24 hours	24 hours	24 hours
Duration	24 hours	14 days	48 hours	7 days	5 days
Sensesivity	*Highly sensitive*	*Sensitive*	***Sensitive***	***Sensitive***	Not sensitive
Specificity	*Not specific*	*Highly specific*	***Specific***	***Specific***	Not specific

A trauma patient is present after a road accident with muscle injury.

Lab results:

- Myoglobin: elevated
- Troponin: normal

Questions:

- Why is myoglobin elevated?
- Why is it not specific for MI?

Thank you

Reminder

"You are not studying to pass the exam... You are studying for the day when you are the only one standing between the patient and the grave."