

بِسْمِ اللَّهِ الرَّحْمَنِ الرَّحِيمِ
(وَفَوْقَ كُلِّ ذِي عِلْمٍ عَلِيمٌ)



HLS BioChemistry | MID

Past Papers



Written by : DST
RST

Reviewed by : Layan Abu-Sheha
Mousa Al-Neimat

بسم الله الرحمن الرحيم،

نرجو منكم الدعاء لزميلنا في الدفعة
عون العدوان، الذي وافته المنية.

اللهم ارحمه واغفر له، وأسكنه فسيح جناتك، وأنر قبره وأنس وحشته، واجعل قبره روضةً من رياض الجنة.

اللهم اجبر قلوب أهله وذويه، وارزقهم الصبر والسلوان، وألهمهم جميل الصبر وحسن العزاء.

رحمه الله رحمةً واسعةً وأسكنه الفردوس الأعلى من الجنة...

Hemoglobin

Overview

Q1: A medical student is reviewing the structure of hemoglobin. Which of the following statements best describes the relationship between the heme molecule and the globin protein in hemoglobin?

- A) The heme molecule is non-covalently attached to the globin protein.
- B) The heme molecule is covalently attached to the globin protein.
- C) The heme molecule is loosely associated with the globin protein without any specific bonds.
- D) The globin protein wraps around the heme molecule without direct attachment.

Q2: Which one of the following statements concerning hemoglobin is correct?

- A) HbA is the most abundant hemoglobin in normal adults.
- B) Fetal blood has a lower affinity for oxygen than adult blood because HbF has an increased affinity for 2,3- biphosphoglycerate.
- C) The globin chain composition of HbF is $\alpha_2\delta_2$.
- D) HbA1c differs from HbA by a single, genetically determined amino acid substitution.
- E) HbA2 appears early in fetal life.

Q3: Which of the following best describes the role of the heme group in hemoproteins?

- A) It is an amino acid chain essential for the protein's structure.
- B) It is a non-peptide unit required for the biological function of the protein.
- C) It is a sugar molecule that assists in energy storage.
- D) It is a lipid molecule that aids in the solubility of the protein.

Q4: Which of the following is wrong about the structure of heme?

- A) Contains vinyl and methyl groups
- B) Iron can form six bonds
- C) porphyrin consists of four rings (designated A-D) called pyrrole rings
- D) Four of the pyrrole rings have a propionate group

Q5: A 30-year-old female is suspected of having a hemoglobinopathy. Genetic testing reveals a mutation in a gene encoding one of the amino acids involved in the electrostatic interactions that stabilize the T-form of hemoglobin. This mutation would most likely result in which of the following?

- A) Decreased oxygen affinity of hemoglobin.
- B) Increased oxygen delivery to tissues.
- C) A shift in the oxygen dissociation curve to the right.
- D) Stabilization of hemoglobin in the R-state.

Q6: In the context of hemoglobin's ability to bind oxygen, which of the following best describes the T-state and R-state of hemoglobin?

- A) The T-state has a high affinity for oxygen, while the R-state has a low affinity.
- B) The T-state has more hydrogen bonds and electrostatic interactions than the R-state.
- C) The R-state is stabilized by the presence of more hydrogen bonds and electrostatic interactions.
- D) Transition from the R-state to the T-state is associated with oxygen release.

Q7: Which of the following statements regarding heme structure and abnormalities is correct?

- A) Heme consists of a tetrapyrrole ring with 4 methyl, 2 propionate and 2 vinyl groups.
- B) Structural changes in the heme are the most common cause in abnormal hemoglobin.
- C) Heme iron in aqueous solution will be present in the ferrous state.
- D) The distal histidine of heme is involved in the binding to ferrous iron.

Answer: A

Q8: Which of the following statements about the R and T forms of hemoglobin is true?

- A) The R form binds protons when oxygen binds.
- B) The R form has a lower affinity for oxygen than the T form.
- C) The T form is stabilized by increased CO_2 and H^+ concentration.
- D) The T form binds oxygen more tightly than the R form.
- E) The R form represents the deoxygenated state of hemoglobin.

Q9: The R form of hemoglobin is stabilized by:

- A) Electrostatic interaction between Asp of beta chain with His within the same chain.
- B) Electrostatic interaction between carboxylate of His146 with Lys of alpha chain.
- C) Electrostatic interaction between His146 of beta chain with Asp of the alpha chain.
- D) Hydrogen bond between Asn of beta chain with Asp within the same chain.
- E) Hydrogen bond between Asn of beta chain with Asp of alpha chain.

Hemoglobin function

Regulation

Q10:2,3-bisphosphoglycerate binds weakly to fetal hemoglobin than adult hemoglobin because:

- A) The heme pocket is less hydrophobic.
- B) Fetal hemoglobin has a serine instead of a histidine 143 residue.
- C) Fetal hemoglobin has a narrower core.
- D) The lysine residue within the core of hemoglobin is replaced by a tyrosine.
- E) The N-termini of the alpha chains of fetal hemoglobin are acetylated.

Q11: A pregnant woman is found to have a higher affinity of her fetal hemoglobin (HbF) for oxygen compared to her adult hemoglobin (HbA). Which of the following changes in the fetal hemoglobin is responsible for this increased affinity?

- A) Increase in CO₂ concentration
- B) Increase in 2,3-BPG binding
- C) Histidine is replaced by Valine
- D) Presence of Chloride ions
- E) Histidine is replaced by Serine

Q12: All of the following regarding to 2,3BPG are correct except?

- A) decrease the oxygen binding capacity of hemoglobin.
- B) decrease some effects of sickle cell anemia.
- C) Binds to the pocket situated between the two beta globin chains.
- D) raises the P50 of hemoglobin.
- E) All of the above are correct.

Q13:A27 years old firefighter is brought to the emergency room after being exposed to smoke during a training exercise. He looks ill and has labored breathing. He is clutching his head and exhibits an altered mental status. On examination, you note that he appears red, and his pulse oximetry reads 100%. You suspect carbon monoxide toxicity. What is true of the oxygen saturation curve during carbon monoxide toxicity?

- A) The oxygen saturation curve is shifted to the left.
- B) The oxygen saturation curve is shifted to the right.
- C) The effect of carbon monoxide on hemoglobin is similar to that of having increased levels of 2,3 bisphosphoglycerate.
- D) The effect of carbon monoxide on hemoglobin is similar to that of a low pH state.
- E) The effect of carbon monoxide on hemoglobin is similar to that of an increased temperature state

Q14: A medical student is studying the binding of various molecules to hemoglobin. She learns that one molecule binds to hemoglobin with an affinity that is 20,000–40,000 times greater than that of oxygen. Which of the following molecules is she studying?

A) CO₂

B) 2,3-BPG

C) O₂

D) CO

E) Cl

Answer: D

Q15: Which of the following is wrong about allosteric regulation?

- A) Low P_{H_2O} decreases the affinity of hemoglobin towards oxygen.
- B) The major effect of CO_2 is form of carbamate.
- C) 2,3-BPG does its action by increasing electrostatic interactions.
- D) Bohr effect works by electrostatic interaction between His with negatively charged amino acid on the same chain.

Q16: Which one of the following statements concerning the binding of oxygen by hemoglobin is correct?

- A) The Bohr effect results in a lower oxygen affinity at higher pH values.
- B) Carbon dioxide increases the oxygen affinity of hemoglobin by binding to the C terminal groups of the polypeptide chains.
- C) The oxygen affinity of hemoglobin increases as the saturation percentage increases.
- D) The hemoglobin tetramer binds four molecules of 2,3-bisphosphoglycerate
- E) Oxyhemoglobin and deoxyhemoglobin have the same affinity for protons

Q17: A 28-year-old man recently moved to a city at a high altitude. He is not acclimatized to the altitude, and as a result, the oxygen dissociation curve of his hemoglobin has shifted. Which of the following conditions most likely represents the initial compensatory mechanism that shifts the curve, indicating a decreased affinity of hemoglobin for oxygen in response to the altitude change?

- A) Decrease in temperature
- B) Presence of fetal hemoglobin
- C) Decreased 2,3-BPG concentration
- D) Decreased CO₂ concentration
- E) Increased 2,3-BPG concentration

Q18:β-Lysine 82 in HbA is important for the binding of 2,3-bisphosphoglycerate. In Hb Helsinki, this amino acid has been replaced by methionine. Which of the following should be true concerning Hb Helsinki?

- A) It should be stabilized in the taut, rather than the relaxed form
- B) It should have increased oxygen affinity and consequently decreased oxygen delivery to tissues.
- C) Its oxygen-dissociation curve should be shifted to the right relative to HbA.
- D) It results in anemia

Q19:A 25-year-old male patient presents to the emergency room with dizziness, confusion, and headache. He mentions that he was working in his garage for several hours with the door closed. On examination, his oxygen saturation is 94%, but his arterial blood has a cherry-red appearance. Which of the following is most likely responsible for his symptoms?

- A) High levels of 2,3-BPG
- B) Hyperventilation
- C) Carbon monoxide exposure
- D) Allosteric regulation
- E) Chloride shift

Answer: C

Q20: Which of the following statement is false?

- A) BPG forms salt bridges with lysine, a histidine and in both beta chains.
- B) BPG increases the energy needed to transform hemoglobin from T to R state.
- C) Both Mb & Hb are affected by 2,3-BPG.
- D) None of the above.

Q21: All of the following favor the transformation from the T form to the R form of hemoglobin except:

- A) Decreased PH.
- B) Decreased 2,3-BPG.
- C) Decreased temperature.
- D) All the above is correct.

Q22: Which of the following increases p_{50} of the curve of O₂ binding to Hb?

- A) Decreased temperature.
- B) Increased pH.
- C) Living in high altitude.
- D) Mutation at His146 of β -chain.

Q23:Regarding the binding of 2,3 BPG, it makes a cross-linking by which subunits?

- A) B1, A1 subunits.
- B) B1 , B2 subunits.
- C) B1 , A2 subunits.
- D) A1 , A2 subunits.

Q24:One of the following about hemoglobin is NOT true:

- A) In one hemoglobin molecule there are four hemes and four globins subunits.
- B) The term oxygenation is used for hemoglobin binding to oxygen not oxidation.
- C) One hemoglobin molecule can bind four oxygen molecules.
- D) Binding of four heme in the hemoglobin with oxygen doesn't occur at the same time, and the affinity of the fourth heme to oxygen is much greater than the first.
- E) Globins can't bind oxygen, but they bind CO, CO₂ and hydrogen.

Answer: E

Q25: A carbamate is formed between CO₂ and?

- A) Arg141 of the alpha chain.
- B) His146 of the beta chain Iron of heme.
- C) The N-terminus of the alpha chain.
- D) The carboxylate end of the beta group.

Q26: Chloride ions move through the membrane of red blood cells in association with the movement of:

- A) Bicarbonate ion in the opposite direction.
- B) Oxygen.
- C) Protons in the same direction.
- D) Bicarbonate ion in the same direction.
- E) Protons in the opposite direction.

Q27: In blood transfusion, some components are "rejuvenated" because ?

- A) Hemoglobin affinity towards oxygen decreased.
- B) Hemoglobin loses its ability to carry oxygen.
- C) The PH shift creates a buffer for Cl⁻ ions to diffuse.
- D) Hemoglobin can't release oxygen because 2,3BPG is broken.

Q28: Which of the following is wrong about HbF (Fetal hemoglobin)?

- A) It can bind 8 oxygen atoms.
- B) It has different affinity to myoglobin.
- C) It is only found in adults.
- D) It has higher affinity than adult hemoglobin.

Q29: Which of the following shifts HB saturation curve to the left?

A) 2,3 BPG $\uparrow$

B) CO₂ $\uparrow$

C) 2,3 BPG $\downarrow$

D) Temperature $\uparrow$

Answer: C

Q30: Why is 2,3-BPG concentration lower in fetal tissues?

- A) Fetal hemoglobin has a higher affinity for 2,3-BPG.
- B) Fetal tissues lack enzymes needed to synthesize 2,3-BPG.
- C) Since serine residue in Hemoglobin cannot form a salt bridge with 2,3-BPG.
- D) Fetal hemoglobin requires less oxygen binding capacity.
- E) Increased CO_2 inhibits 2,3-BPG formation.

Q31: Incorrect about the expression of alpha and beta globins:

- A) Both will be at their maximal level in the variable developmental stages
- B) It's affected by mother genetic background
- C) It's mediated by enhancer elements
- D) They are always expressed in equal amounts

Hemoglobinopathies

Q32: This hemoglobin variant is both a quantitative and a qualitative hemoglobinopathy:

A) Hb Hammersmith.

B) Hb Kansas.

C) HbS.

D) HbE.

E) HbC.

Q33: Which of the following is wrong about HbE?

- A) It is caused by mutation that affects B chain
- B) It is common in Africans
- C) It results in defected proteins
- D) A truncated (short) beta-chain is produced

Q34:Hb Cowtown where His 146 is replaced by Leucine, choose the correct statement:

- A) it stabilizes R state and increases affinity for oxygen
- B) it stabilizes T state and increases affinity for oxygen
- C) it stabilizes R state and decreases affinity for oxygen
- D) it causes degradation of protein

Q35: Which of the following is not true about thalassemia major?

- A) HbA₂ increases in β thalassemia
- B) HbF increase in β thalassemia
- C) Hb Bart's increase in α thalassemia
- D) In thalassemia major 3 or 4 copies are mutated but in β thalassemia major 2 copies are mutated

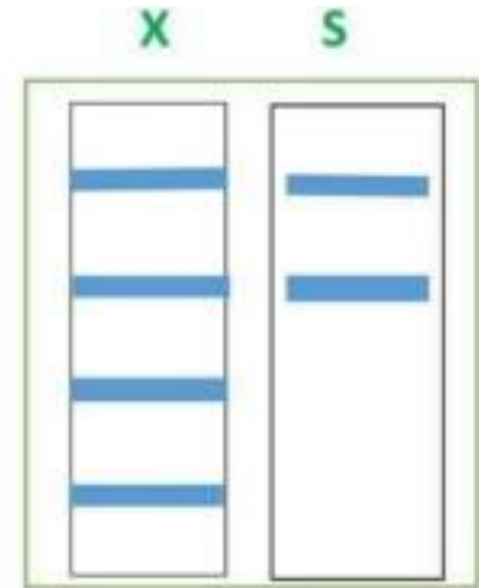
Q36: Hb Bart means that you have:

- A) 4 chains of gamma
- B) 4 chains of beta
- C) 3 chains of beta and 1 chain of alpha
- D) 2 chains of gamma and 2 chains of beta
- E) 2 chains of alpha and 2 chains of gamma

Answer: A

Q37: You have sample X and S in heme electrophoresis, what can you conclude about sample S? (in X you have HbA, HbC, HbS, HbF, NOT ORDERED)

- A) HbS homozygous
- B) HbS heterozygous
- C) HbSC
- D) A neonate 4 weeks before birth



Answer: D

Q38: Which of the following can't be present in beta thalassemia:

A) HbH

B) HbA

C) HbF

Answer: A

Q39:Hemoglobin H (HbH) disease is caused by:

- A) Deletion of one α -globin gene
- B) Deletion of two α -globin genes
- C) Deletion of three α -globin genes
- D) Deletion of all four α -globin genes
- E) Mutation in the β -globin gene

Iron Metabolism

Almost there

Q1: True about iron regulatory elements

- A) It stabilizes mRNA transcripts on the 3' UTR & occupied by iron regulatory proteins
- B) It degrades mRNA transcripts on the 5' UTR & occupied by iron regulatory protein.
- C) They are bound to iron bound iron regulatory proteins

Q2: What is responsible for iron transport into enterocytes:

- A) Ferroportin
- B) DMT1
- C) Transferrin
- D) Ferrireductase
- E) Ferroxidase

Q3: Which of the following is true about hepcidin

- A) Decreases iron absorption into intestines
- B) Decreases number of iron transporters
- C) Released in state of high iron load
- D) Decrease iron release from all cells
- E) all are true

Q4: We need Vitamin C for iron absorption in order to:

- A. Release iron from heme by heme oxygenase
- B. Open the ferroportin channel to efflux iron
- C. Activate the divalent metal transporter
- D. Transfer ferric into ferrous by ferric reductase

Q5: All the following increase the Hepcidin except:

- A. Over-expression of hemojuvelin.
- B. Stimulation of transferrin receptor
- C. Increased erythropoietin
- D. Increased release of bone morphogenetic protein

Q6: Which of the following regarding iron absorption is NOT TRUE:

- A) The daily iron intake is usually equal to daily iron requirement.
- B) Women have less stored iron than men.
- C) More than 65% of iron is present in hemoglobin.
- D) Iron absorption is mainly in the upper part of the jejunum.
- E) There is more iron absorption from meat and meat products than from vegetables.

Q7:Heme oxygenase's function is:

- A) Converting ferric to ferrous.
- B) Absorption of iron.
- C) Carries iron in blood.
- D) Release iron out of heme.
- E) Oxidation of iron molecules.

Q8: The following does not cause an increase in expression of hepcidin:

- A) Stimulation of transferrin receptor 2.
- B) Increased release of erythroferrone.
- C) Overexpression of hemojuvelin.
- D) Increased release of inflammatory cytokines.
- E) Increased release of bone morphogenetic protein 6.

Q9:One of the following about iron metabolism in the body is NOT true:

A) Iron is important for the formation of not only hemoglobin but also other essential proteins in the body.

B) The total iron quantity in the body averages 4–5 g.

C) There is heme iron and non-heme iron, non-heme iron is absorbed more efficiently than heme iron.

D) The amount of iron absorbed is normally about 3–6% of the ingested amount.

E) The average daily iron intake is about 20–30 mg.

Q10: Which of the following is a way of iron regulation in our body:

ANSWER: TFR2 binds HFE and sends intracellular signal

Q11: True about ferroportin:

ANSWER: It's found in different tissues

Q12: True about transferrin:

ANSWER: It binds with ferric iron

**Good
Luck**

**Wishing you all
the best.**

رسالة من الفريق العلمي:

أعوذ بك يا الله من فقدان الشغف، وسعي يستنزف الجهد والوقت بلا جدوى، وحياة بلا هدف. وأعوذ بك من طول التمني وحرمان الوصول، ومن العُسر بعد اليُسْر...
اللهم اني أعوذ بك من أن أجز إلى نفسي سوءًا او إلى أحد من خلقك...

For any feedback, scan the code or click on it.



Corrections from previous versions:

Versions	Slide # and Place of Error	Before Correction	After Correction
V0 → V1			
V1 → V2			