بسم الله الرحمن الرحيم

Biochemistry

MID | Past Papers

﴿ وَقُل رَّبِّ أَدْخِلْنِي مُدْخَلَ صِدْقٍ وَأَخْرِجْنِي مُخْرَجَ صِدْقٍ وَاجْعَل لِّي مِن لَّدُنكَ سُلْطَانًا نَّصِيرًا ﴾

ربنا آتنا من لدنك رحمة وهيئ لنا من أمرنا رشدًا

Lecture 1-3

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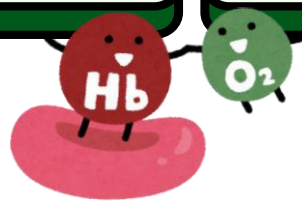
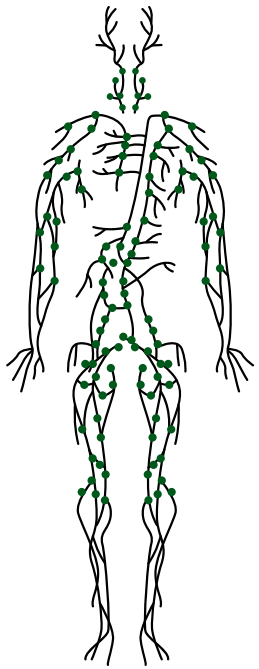




LEC 1

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.

Answer: A

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- bisphosphoglycerate.

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.

Answer: A

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.

Answer: B

Q4: Which of the following is wrong about HbA1c:

A) Measurement of glucose bound to valine on Beta hemoglobin chains.

B) The patient should be fasting to undergo testing.

C) According to IFCC 100mmol/mol indicates a normal reading.

D) A less than 5.7% DCCT value indicates a normal reading.

E) Both B and C are false.

Answer: E

100mmol/mol = 11.3%

Q5: 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

Answer: D

Q6: A 45-year-old male with a history of diabetes presents to the clinic for a routine check-up. Laboratory findings reveal elevated levels of glycosylated hemoglobin (HbA1c). What is the primary significance of this finding?

A) The patient has been compliant with his insulin regimen.

B) The patient's blood glucose levels have been well-controlled over the

past 2-3 months.

C) The patient's blood glucose levels have been consistently elevated over

the past 2-3 months.

D) The patient likely has an unrelated hemoglobinopathy.

Answer: C

Q7: 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.

Answer: D

Q8: 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.

Answer: B+D

Q9: 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 is found 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

Q10: 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.

Answer: C

Q11: 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.

Answer: E

Q12: Prediabetes is characterized by having these lab results of glucose:

A) 155 mg/dL or 7%.

B) 212 mg/dL or 11.8 mmol/L.

C) 120 mg/dL or 40mmol/mol.

D) 9% or 11.8 mmol/L.

E) 8% glycosylated glucose or 64 mmol/mol.

Answer: C

40mmol/mol = 5.8%

LEC 2

Q13: 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.

Answer: B

Q14: 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

Answer: E

Q15: 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.

Answer: B

Q16: 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

Answer: A

Q17: 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

Q18: Which of the following is wrong about allosteric regulation?

A) Low Ph decreases the affinity of hemoglobin towards oxygen.

B) The major effect of CO2 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.

Answer: B

Q19: 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

Answer: C

Q20: 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

Answer: E

Q21: 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

Answer: B

Q22: 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

Q23: 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.

Answer: C

Q24: 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.

Answer: A

Q25: Which of the following increases p50 of the curve of O_2 binding to Hb?

A) Decreased temperature.

B) Increased pH.

C) Living in high altitude.

D) Mutation at His146 of β-chain.

Answer: C

Q26: 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.

Answer: B

Q27: 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

Q28: A carbamate is formed between CO_2 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.

Answer: C

Q29: 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.

Answer: A

Q30: 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.

Answer: D

Q31: 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.

Answer: C

Q32: Which of the following shifts HB saturation curve to the left?

A) 2.3 BPG ↑

B) CO2 ↑

C) 2.3 BPG ↓

D) Temperature ↑

Answer: C

Q33: 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.

Answer: C

Q34: 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

Answer: A

I think that D is also correct

LEC 3

Q35: This hemoglobin variant is both a quantitative and a qualitative hemoglobinopathy:

A) Hb Hammersmith.

B) Hb Kansas.

C) HbS.

D) HbE.

E) HbC.

Answer: D

Q36: 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

Answer: B

Q37: 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

Answer: A

Q38: Which of the following is not true about thalassemia major?

A) HbA2 increases in B thalassemia

B) HbF increase in B thalassemia

C) Hb Bart's increase in a thalassemia

D) In thalassemia major 3 or 4 copies are mutated but in B thalassemia major 2 copies are mutated

Answer: D

Q39: 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

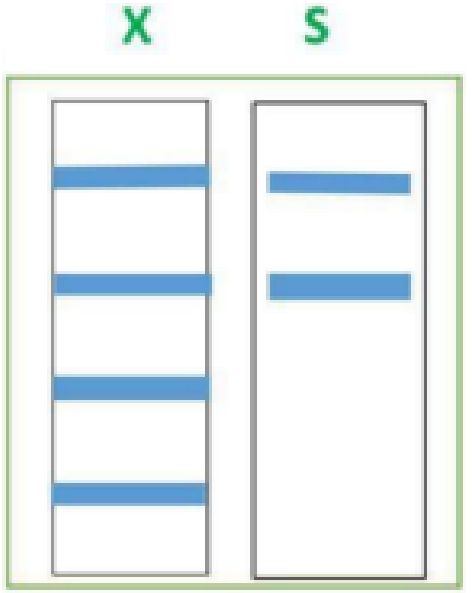
Q40: You have sample X and S in heme electrophoresis, what can you conclude about sample S? (in X you have HbA, HbC, HbS, HbF, NOT ORDERED)

A) HbS homozygous

B) HbS heterozygous

C) HbSC

D) A neonate 4 weeks before birth



Answer: D

Q41: Which of the following can't be present in beta thalassemia:

A) HbH

B) HbA

C) HbF

Answer: A

Q42: 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

Answer: C

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Corrections from previous versions:

Versions	Slide # and Place of Error	Before Correction	After Correction
V0 → V1	3 10 37 44	Answer: B Answer: B Answer: A	Answer: A Answer: B+D Answer: A I think that D is also correct Option E was deleted
V1 → V2			