

HLS BIOCHEMISTRY

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- The following statement is TRUE regarding hemoglobin:
- a. Each heme molecule can bind to two oxygen molecules.
- b. Heme group is attached to the surface of hemoglobin.
- c. Hemoglobin has a high affinity to oxygen at peripheral tissues.
- d. Proximal histidine is non-covalently bound to the iron of heme.
- e. Distal histidine interacts with the bound oxygen.
- Answer: e

- This mutation results in reduction of both the stability of hemoglobin protein and its oxygen carrying capacity.
- a. Glu to Val at codon 6.
- b. Glu to Lys at codon 26.
- c. Glu to Lys at codon 6.
- d. Asn (G4) to Thr.
- e. His to Leu at codon 143.
- Answer: b

- Mutating the internal Phe (at codon 42) to Ser in beta hemoglobin results in:
 - a. Inability to reduce iron once oxygen is released.
 - b. Stabilization of the T state of hemoglobin.
 - c. Protein denaturation
 - d. Inability to release oxygen.
 - e. Unstable binding of heme to the protein.
- Answer: e

- One of the following is TRUE in regard to carbon monoxide (CO) binding to heme/hemoglobin:
 - a. The affinity of oxygen binding to hemoglobin increases when CO is bound to at least one heme of hemoglobin.
 - b. CO can form carbamates with hemoglobin.
 - c. The affinity of binding of CO to hemoglobin becomes less than that of oxygen's when heme is part of hemoglobin.
 - d. Proximal histidine forces CO to form a bent bond with heme.
 - e. CO influences the pKa of His146 of the beta chain of hemoglobin.
- Answer: a

- Although carbon dioxide (CO₂) is generated in metabolically active tissues resulting in formation of protons (H⁺), pH is not altered greatly due to a phenomenon known as isohydric shift. This is because:
- a. Excess protons are taken up by surrounding cells like endothelial cells.
- b. Hemoglobin acts as a buffer.
- c. Excess CO₂ molecules bind to hemoglobin forming carbamates.
- d. Chloride ions balance out the increased protons in tissues.
- e. The bicarbonate system is very efficient inside red blood cells.
- Answer: b

- A single point amino acid change from His143 in HbA to serine in fetal hemoglobin (HbF) results in higher affinity of HbF to oxygen. This is because:
 - a. Reduced formation of carbamates
 - b. Stabilization of R form of hemoglobin
 - c. Reduced chloride shift
 - d. Reduced binding to 2,3-bisphosphoglycerate
 - e. Reduced Bohr effect
- Answer: d

- In the T state of hemoglobin :
- a. heme group is planar with ferrous ion within the plane of the heme group.
- b. weak interactions between alpha and beta chains form.
- c. weak ionic and hydrogen bonds between alpha-beta dimers form.
- d. o₂ binds with high affinity to hemoglobin.
- e. strong hydrophobic interactions between alpha-beta dimers form.
- Answer: c

- G6PD Mediterranean is characterized by:
- a. Reduced stability of the enzyme.
- b. Reduced expression, stability, and activity of the enzyme.
- c. Reduced activity of the enzyme.
- d. Reduced expression of the enzyme.
- e. Reduced stability and activity of the enzyme.
- Answer: c

- 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

- Mutation of distal histidine into tyrosine results in:
- a. Inability to bind to methemoglobin reductase.
- b. Inability to release oxygen.
- c. Oxidation of iron.
- d. Attraction of carbon monoxide.
- e. Stabilization of the R form of hemoglobin.
- Answer: c

- 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.
- Answer: a

- 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

- 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: a

- An increase in the P50 of the oxygen- hemoglobin dissociation curve occurs with:
- a. A decrease in hydrogen ions.
- b. A decrease in the PCO₂.
- c. A decrease in diphosphoglycerate ions.
- d. Exercise.
- e. A decrease in temperature.
- Answer: d

- 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

- which of the following doesn't happen in gene expression regulation in hemoglobin:
- a. LCR as an enhancer for multiple genes.
- b. promoter for each gene.
- c. chromatin looping.
- d. adding organic groups on genes.
- e. protein ubiquitination.
- Answer: e

- Which of the following shifts HB saturation curve to the left:
- a. 2.3 BPG ↑
- b. CO₂ ↑
- c. 2.3 BPG ↓
- d. Temperature ↑
- e. H⁺ ↑
- Answer: c

- wrong about allosteric regulation :
- a. low PH decrease the affinity of hemoglobin towards oxygen.
- b. the major effect of CO₂ is form carbamate.
- c. 2,3BPG does its reaction by increasing electrostatic interactions.
- d. the bohr effect is caused by electrostatic interactions between His and negatively charged amino acid in the same chain.
- Answer: b

- In blood transfusion, some components are "rejuvenated" because:
- a. hemoglobin affinity towards oxygen decreased.
- b. hemoglobin loses its ability to carry oxygen.
- c. to repair the PH.
- d. the hemoglobin can't release oxygen because 2,3BPG is broken.
- Answer: d

- 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 tyrosine
 - e. The N-termini of the alpha chains of fetal hemoglobin are acetylated.
- Answer: b

- 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.
- Answer: c

- One of the following statements about Hb-O₂ relationship is FALSE:
- A. When plotted (%) saturation against P_{o2}, the curve will always be the same whatever the Hb concentration is, if other factors remain the same.
- B. The (%) saturations of Hb with O₂ is dependent on P_{o2} as well as the Hb concentration.
- C. The (%) saturation of Hb with O₂ is dependent on P_{o2} and totally independent of Hb concentration.
- D. The quantity of O₂ carried in volume of blood is dependent on the P_{o2} as well as the Hb concentration.
- E. If O₂ content is plotted against P_{o2}, the level of the curve will be dependent on the Hb concentration of the sample of the blood.
- Answer: B

- 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 many times that of the first.
- e. Globins can't bind oxygen but they bind CO, CO₂ and hydrogen.
- Answer: e

- 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

- All of the following regarding 2,3 BPG are correct EXCEPT:
- a. Decreases the oxygen-binding capacity of hemoglobin.
- b. Decreases some of the effects of sickle cell anemia
- c. Binds to the pocket situated between the two β globin chains.
- d. Raises the P50 of hemoglobin
- e. all the above are correct.
- Answer: b

- Which of the following regarding heme structure and abnormalities is CORRECT:
- a. Heme consists of a tetrapyrrole ring, with 4 methyl, 2 vinyl and 2 propionate groups.
- b. Structural changes in the heme are the most common cause of abnormal hemoglobin.
- c. Heme iron if found in an aqueous solution will be present in the ferrous (Fe^{2+}) state.
- d. The distal histidine of heme is involved in the binding to ferrous iron.
- Answer: a

- 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

- A compensatory mechanism to allow adequate oxygen delivery to the tissues at high altitudes, where oxygen concentrations are low, is which one of the following:
 - a. An increase in 2,3-BPG synthesis by the erythrocyte.
 - b. A decrease in 2,3-BPG synthesis by the erythrocyte.
 - c. An increase in hemoglobin synthesis by the erythrocyte.
 - d. A decrease in hemoglobin synthesis by the erythrocyte.
 - e. Decreasing the blood pH.
- Answer: a

- A critical histidine side chain in an enzyme's active site displays a pKa value of 8.2, Which of the following best describes the effect of local environment in which this histidine residue resides:
- a. A loss of quaternary structure of the hemoglobin molecule.
- b. An increase in oxygen binding to hemoglobin.
- c. A gain of ionic interactions, stabilizing the "T" form of hemoglobin.
- d. An increase in hydrophobic interactions between deoxyhemoglobin molecules.
- e. An alteration in hemoglobin secondary structure leading to loss of the " α " helix.
- Answer: c

- 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

- An amino acid substitution in one of chains of hemoglobin could lead to hemoglobinopathy (hemoglobin with abnormal function) for any of the following reasons EXCEPT:
 - a. An increase in the 2,3-BPG binding affinity.
 - b. A change in the affinity of subunits contact.
 - c. A change in the solubility properties of reduced hemoglobin.
 - d. An increase in the hydrophilic property of heme-pocket.
 - e. An increase tendency of the heme iron to exist in the reduced state.
- answer: e

- Which of the following regarding glutathione and G6PD deficiency is NOT CORRECT:
- a. Glutathione is a tri-peptide that consists of (gly-cys-glu).
- b. G6PD production of NADPH is required to maintain glutathione in a reduced state.
- c. G6PD A variant (class III) is associated with 80% enzyme activity in reticulocyte cells.
- d. In cells such as the liver, G6PD is not the only way for the production of NADPH.
- e. G6PD deficiency is associated with non-sense and frameshift mutations.
- answer: e

- 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

- Your diabetic patient has a hemoglobin A1c (HbA1c) of 8.8. HbA1c differs from unmodified hemoglobin by which one of the following.
- a. Amino acid sequence.
- b. Serine acylation.
- c. Valine glycosylation.
- d. Intracellular location.
- e. Rate of degradation.
- Answer: c

- Mutation of distal histidine into tyrosine results in:
- a. Inability to bind to methemoglobin reductase.
- b. Inability to release oxygen.
- c. Oxidation of iron.
- d. Attraction of carbon monoxide.
- e. Stabilization of the R form of hemoglobin.
- Answer: c

- The reason why liver is not affected by deficiency of pyruvate kinase is:
 - a. ATP and NADH are compensated by other metabolic pathways.
 - b. The enzyme is not regulated.
 - c. Reduced activity is compensated by increased expression.
 - d. Reduced activity is compensated by alternative expression of pyruvate kinase M1.
 - e. Reduced pyruvate level is compensated by increase uptake of pyruvate.
- Answer: c

- 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

- Which of the following is wrong about HbF (Fetal hemoglobin):
- a. It can bind 8 oxygen atoms
- b. It has similar affinity to myoglobin
- c. It is only found in adults
- d. It has higher affinity than adult hemoglobin
- Answer: c

- The concerted and sequential models explain:
- a. How binding of Oxygen to one Heme molecule leads to cooperativity
- b. Structural changes that occur as Oxygen binding leads to cooperativity
- c. The degree of cooperativity as multiple Oxygen molecules bind one Heme molecule
- Answer: b

- What is the percentage of CO (Carbon monoxide) in heavy smokers:
- a. 1%
- b. 10%
- c. 25%
- d. 40%
- e. 60%
- Answer: b

- 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 Asn102 of β -chain
- Answer: c

- Which of the following is correct regarding HbA₂:
- a. It is found in fetuses in albeit low amounts
- b. Percentage of this hemoglobin increases in β -thalassemia carriers
- c. Its blood levels increase if overexpression of LCR (locus control region) occurs
- d. It can bind 10 oxygen molecules
- Answer: b

THE END