جامعة الفرات الاوسط التقنية /المعهد التقني سماوة

قسم تقنيات صحة مجتمع

المحاضرة الخامسة

اسم المادة / وظائف اعضاء 1.

المرحلة الدراسية / الاولى

العام الدراسي / 2022 - 2023

استاذ المادة. م .م شيماء جبار حسين

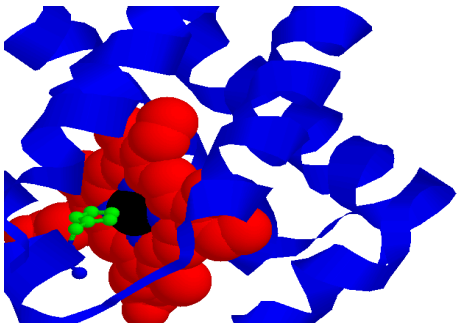
Lec5

Hemoglobin

Hemoglobin is the protein that carries oxygen from the lungs to the tissues and carries carbon dioxide from the tissues back to the lungs. In order to function most efficiently, hemoglobin needs to bind to oxygen tightly in the oxygen-rich atmosphere of the lungs and be able to release oxygen rapidly in the relatively oxygen-poor environment of the tissues. It does this in a most elegant and intricately coordinated way. The story of hemoglobin is the prototype example of the relationship between structure and function of a protein molecules

3-4 ***Hemoglobin Structure***

A hemoglobin molecule consists of four polypeptide chains: two alpha chains, each with 141 amino acids and two beta chains, each with 146 amino acids. The protein portion of each of these chains is called "globin". The a and b globin chains are very similar in structure. In this case, a and b refer to the two types of globin. Students often confuse this with the concept of a helix and b sheet secondary structures. But, in fact, both the a and b globin chains contain primarily a helix secondary structure with no b sheets



A heme group is a flat ring molecule containing carbon, nitrogen and hydrogen atoms, with a single Fe^{2+} ion at the center. Without the iron, the ring is called a

porphyrin. In a heme molecule, the iron is held within the flat plane by four nitrogen ligands from the porphyrin ring. The iron ion makes a fifth bond to a histidine side chain from one of the helices that form the heme pocket. This fifth coordination bond is to histidine 87 in the human α chain and histidine 92 in the human β chain. Both histidine residues are part of the F helix in each globin chain.

4-4 The Bohr Effect

The ability of hemoglobin to release oxygen, is affected by pH, CO_2 and by the differences in the oxygen-rich environment of the lungs and the oxygen-poor environment of the tissues. The pH in the tissues is considerably lower (more acidic) than in the lungs. Protons are generated from the reaction between carbon dioxide and water to form bicarbonate:

$$CO_2 + H_20 \text{ ----------> } HCO_3^- + H^+$$

This increased acidity serves a twofold purpose. First, protons lower the affinity of hemoglobin for oxygen, allowing easier release into the tissues. As all four oxygens are released, hemoglobin binds to two protons. This helps to maintain equilibrium towards the right side of the equation. This is known as the Bohr effect, and is vital in the removal of carbon dioxide as waste because CO_2 is insoluble in the bloodstream. The bicarbonate ion is much more soluble, and can thereby be transported back to the lungs after being bound to hemoglobin. If hemoglobin couldn't absorb the excess protons, the equilibrium would shift to the left, and carbon dioxide couldn't be removed.

In the lungs, this effect works in the reverse direction. In the presence of the high oxygen concentration in the lungs, the proton affinity decreases. As protons are shed, the reaction is driven to the left, and CO_2 forms as an insoluble gas to be expelled from the lungs. The proton poor hemoglobin now has a greater affinity for oxygen, and the cycle continue

1-5 Blood Groups

Blood groups are created by molecules present on the surface of red blood cells (and often on other cells as well).

2-5 *The ABO Blood Groups*

The ABO blood groups were the first to be discovered (in 1900) and are the most important in assuring safe blood transfusions.

The table shows the four ABO phenotypes ("blood groups") present in the human population and the genotypes that give rise to them.

Blood Group	Antigens on RBCs	Antibodies in Serum	Genotypes
A	A	Anti-B	*AA* or *AO*
B	B	Anti-A	*BB* or *BO*
AB	A and B	Neither	*AB*
O	Neither	Anti-A and Anti-B	*OO*

When red blood cells carrying one or both antigens are exposed to the corresponding antibodies, they agglutinate; that is, clump together. People usually have antibodies against those red cell antigens that they lack.

The antigens in the ABO system are O-linked glycoproteins with their sugar residues exposed at the cell surface. The terminal sugar determines whether the antigen is A or B.

The critical principle to be followed is that transfused blood must not contain red cells that the recipient's antibodies can clump. Although theoretically it is possible to transfuse group O blood into any recipient, the antibodies in the donated plasma can damage the recipient's red cells. Thus, when possible, transfusions should be done with exactly-matched blood. than "self".

3-5 The *Rh System*

Rh antigens are transmembrane proteins with loops exposed at the surface of red blood cells. They appear to be used for the transport of carbon dioxide and/or ammonia across the plasma membrane. They are named for the rhesus monkey in which they were first discovered.

There are a number of Rh antigens. Red cells that are "Rh positive" express the one designated D. About 15% of the population have no RhD antigens and thus are "Rh negative".

The major importance of the Rh system for human health is to avoid the danger of RhD incompatibility between mother and fetus.

During birth, there is often a leakage of the baby's red blood cells into the mother's circulation. If the baby is Rh positive (having inherited the trait from its father) and the mother Rh-negative, these red cells will cause her to develop antibodies against the RhD antigen. The antibodies, usually of the IgG class, do not cause any problems for that child, but can cross the placenta and attack the red cells of a subsequent Rh^+ fetus. This destroys the red cells producing anemia and jaundice.

The disease, called erythroblastosis fetalis or hemolytic disease of the newborn, may be so severe as to kill the fetus or even the newborn infant. It is an example of an antibody-mediated cytotoxicity disorder.

Other examples of antibody-mediated cytotoxicity disorders.

Although certain other red cell antigens (in addition to Rh) sometimes cause problems for a fetus, an ABO incompatibility does not. Why is an Rh incompatibility so dangerous when ABO incompatibility is not?

It turns out that most anti-A or anti-B antibodies are of the IgM **class and these do not cross the placenta. In fact, an Rh^-/type O mother carrying an Rh^+/type A, B, or AB fetus is resistant to sensitization to the Rh antigen. Presumably her anti-A and anti-B antibodies destroy any fetal cells that enter her blood before they can elicit anti-Rh antibodies in her.**

This phenomenon has led to an extremely effective preventive measure to avoid Rh sensitization. Shortly after each birth of an Rh^+ baby, the mother is given an injection of anti-Rh antibodies. The preparation is called Rh immune globulin (RhIG) or Rhogam. These passively acquired antibodies destroy any fetal cells that got into her circulation before they can elicit an active immune response in her.

Rh immune globulin came into common use in the United States in 1968, and within a decade the incidence of Rh hemolytic disease became very