Introduction to the Patient-Oriented Problem-Solving (POPS) System

The fundamental purpose of all activities in the health-care professions is to help other people. Like all behaviors, helping behavior becomes more effective and natural with practice. This exercise enables you to practice by helping your fellow students to learn basic science. Your skill at helping your fellow students should relate to your ability to help your patients in the future.

This is a Patient-oriented Problem-Solving activity. Its purposes are:

1. To help you learn how to apply your basic science knowledge to the solution of clinical problems
2. To help you learn how to better use sources (i.e., textbooks and peers) that will be available to you throughout your career
3. To help you work with your fellow students and thus:
   a. increase your ability to evaluate your colleagues’ opinions, thought processes, and diagnoses
   b. increase communications skills
   c. get to know your classmates better

This activity consists of four phases. First, you will review the attached set of objectives, do background reading on the topics to be covered, and complete the pretest on your own. In the second phase, you will join three other students and review the pretest answers in an "open-book" discussion. In the third phase, the group will solve patient-oriented problems. Information exchange and group interaction are keys to the success of this phase. This process will allow you to teach your fellow students and, at the same time, learn from them. Finally, you will take a posttest, individually, which will enable you to assess your progress.
Objectives

There are several antigenic systems in humans that show individual variation within the species. These are known as alloantigens and include, among others, the ABO blood group antigens, the HLA antigens, and the immunoglobulin allotypes. There is a variety of ways in which individuals may respond to these antigens, some spontaneous, such as females becoming sensitized to fetal antigens during pregnancy, some medically-induced, such as blood transfusion or organ transplantation. Because of their genetic transmission, alloantigens used to be the basis for the investigation of paternity, but in this instance they have been replaced by DNA analysis. In this POPS activity you will investigate the possible involvement of immunological mechanisms as a cause of neonatal jaundice.

The concepts learned in this activity extend far beyond the scope of materno-fetal incompatibility. In fact, these same procedures are used to type and crossmatch blood, which is the most frequently transplanted tissue in humans.

When you have completed this activity, you should be able to

1) define and contrast the terms isotype, idiootype, allotype, genotype, and phenotype.
2) list the genotypes and associated phenotypes of the ABO, Rh, MN, and Ss red blood cell (RBC) surface antigens.
3) compare and contrast the mechanisms of inheritance and expression of the above alloantigens (e.g., codominant alleles, dominant and recessive alleles, multiple alleles).
4) interpret hemagglutination (HA) assays, especially the direct and indirect Coombs test.
5) decide, based upon HA data, which RBC antigens are present on the RBC surface. You should also be able to state the limitations of these assays for determining genotypes.
6) describe the clinical problems associated with incompatibilities in blood types during transfusions or pregnancy.
7) state the reason why different results may be obtained when testing for isoagglutinins at ten minutes and at nine months after birth.

If you have participated in previous POPS sessions, you should have identified some of your own strengths and weaknesses in helping your classmates learn. In your next group meeting, why not focus on a strategy to utilize your greatest strength or to eliminate your greatest weakness? Two common student strengths are the ability to ask penetrating questions and to support discouraged colleagues. Two common weaknesses are (1) impatience with classmates perceived to be slow and (2) not listening to classmates.

When you have become familiar with the objectives, complete the pretest beginning on the next page.
PRETEST

Instructions: Please mark your answers to the following questions on this exam to facilitate later discussion and review. If your instructor has provided a separate answer form, please be sure to fill in the identification section; then answer the questions both on the form and on this exam.

Choose the one correct or most appropriate answer. If you do not know an answer, leave it blank. Do not guess. Health professionals who think they know something, but don’t, can do real harm. Those who know they don’t know something can get help.

Don’t be upset if you don’t know all the answers. The purpose of the pretest and objectives is to alert you to important concepts. The posttest will be similar to the pretest.

1. A pair of codominant alleles controls the MN antigens of red blood cells (RBCs). A pair of codominant alleles at another locus also controls the Ss antigens of RBCs. For these two antigen systems, which of the following are possible genotypes (with correct phenotypes in parentheses)?

   (A) MMNN (MN)
   (B) MNNS (MNS)
   (C) MSSS (MSS)
   (D) NNss (NNss)
   (E) MNSs (MNSs)

The following data apply to questions 2 and 3:

A couple, both blood type 0-, brought their 12-year-old child to a hematology lab for blood typing. Results of a hemagglutination (HA) assay is given below. (Assume there was no laboratory errors.) The patterns represent test tubes viewed from above.

   Saline + child's RBC  → ⊗
   Anti-A + child's RBC  → ⊗
   Anti-B + child's RBC  → ⊗
   Anti-D + child's -RBC → ⊗
   Child's serum + A RBC  → ⊗
   Child's serum + B RBC  → ⊗
   Child's serum + D RBC  → ⊗

2. The child’s blood type is

   (A) O-
   (B) O+
   (C) AB+
   (D) AB-
   (E) None of the above

3. What conclusions are valid about the child's parentage?

   (A) The child is the natural offspring of this couple.
   (B) The mother could be the natural mother, but the father could not be the natural father.
   (C) The father could be the natural father, but the mother could not be the natural mother.
   (D) Neither the father nor the mother could be the natural parents.
   (E) None of the above
4. Naturally occurring antigens found in food and intestinal bacteria are the immunogenic stimuli for the so-called natural antibodies produced in normal humans. These ubiquitous antigens are responsible for antibody production to which of the following RBC antigens?

(A) A B  
(B) O  
(C) Rh  
(D) MN  
(E) Ss

5. During delivery of a baby, fetal RBCs often enter the maternal circulation. These RBCs can be immunogenic for the mother. Which of the following RBC antigens almost never stimulate antibody production in the mother?

(A) AB  
(B) O (H antigen)  
(C) Rh (D antigen)  
(D) MN  
(E) Ss

6. The most likely combination for producing erythroblastosis fetalis (a hemolytic disease of the newborn) is

(A) Rh+ mother, Rh- father, Rh- child.  
(B) Rh- mother, Rh- father, Rh+ child.  
(C) Rh- mother, Rh+ father, Rh+ child.  
(D) A Rh+ mother, B Rh+ father, B Rh+ child.  
(E) O Rh+ mother, O Rh- father, O Rh- child.

7. A child that is Rh incompatible with its mother may elicit in the mother the production of anti-Rh antibody. This can lead to erythroblastosis fetalis (hemolytic disease of the newborn). Which ONE of the following statements is true?

(A) Erythroblastosis is caused by more than one class of antibody.  
(B) IgM anti-Rh is produced by the mother, crosses the placenta, and causes the disease.  
(C) IgG anti-Rh is produced by the baby and causes the disease.  
(D) IgG anti-Rh is produced by the mother, crosses the placenta, and causes destruction of the baby's RBCs  
(E) 11S IgA anti-Rh is produced by the mother, crosses the placenta, and causes destruction of the baby's RBCs.

8. A 34-year-old man comes to your office complaining of tiredness and a rapid heart rate with any exertion. On physical exam you note pallor of the conjunctiva and nail beds. Blood examination reveals a hematocrit of 25% (normal is 40% to 54%) and a hemoglobin of 7 (normal is 14 to 18 gm/100 ml). You realize the anemia could be due to one of three primary causes- blood loss, failure of blood formation, or destruction of blood cells within the body (hemolytic anemia). Which of the following statements is true?

(A) A positive direct Coombs test would support a diagnosis of anemia due to loss of blood.  
(B) Positive indirect Coombs test would support a diagnosis of aplastic anemia (failure to form RBCs  
(C) A positive direct Coombs test would support a diagnosis of anemia due to RBC destruction within the body  
(D) A negative indirect Coombs test would rule out anemia due to blood loss.  
(E) These three causes are not all-inclusive; therefore, the patient's anemia could have a different etiology
9. Rabbit anti-sheep red cell antibodies of several different isotypes were isolated and mixed with sheep red cells and guinea pig complement. Five minutes later the amount of free hemoglobin in each tube was measured. Which antibody was most likely added to the tube with \textit{maximal} amount of free hemoglobin?

(A) IgA  
(B) IgE  
(C) IgG3  
(D) IgG4  
(E) IgM

10. A human myeloma protein (IgG $\lambda$) is used to immunize a rabbit. The resulting antiserum is then absorbed with a large pool of IgG purified from normal human serum. Following this absorption, the antiserum is found to react only with the particular IgG myeloma protein used for immunization; it is now defined as an anti-idiotypic antiserum. With what specific portion(s) of the IgG myeloma protein would this antiserum react?

(A) Constant region of the $\gamma$ chain  
(B) Constant region of the $\lambda$ chain  
(C) Variable regions of $\gamma$ chain  
(D) Variable regions of $\lambda$ chain  
(E) Variable regions of $\gamma$ and $\lambda$ chains

When you have completed the pretest, consult your study materials. Try to identify the correct answers and understand the concepts that make them correct. The list of objectives may be used as a guideline for your studies. When your group meets, you will have the responsibility of explaining some of the correct pretest answers to the others. \textit{Please bring your pretest and textbook to the group meeting.}