Spring 2006 Immunology Exam Answer Key #3 - Chapters 8 - 10

There is no time limit on this test, though I have tried to design one that you should be able to complete within 4 hours. You are not allowed to use your notes, any books, any electronic sources, nor are you allowed to discuss the test with anyone until all exams are turned in at 9:30 am on Thursday March 30. **EXAMS ARE DUE AT CLASS TIME ON THURSDAY MARCH 30**. Turning in an exam late will cost you a letter grade for each 24 hours. The **answers to the questions must be typed** unless the question specifically says to write/draw the answer in the space provided. If you do not type your answers on the appropriate pages, I may not find them unless you have indicated where the answers are. You will need *black, blue, and red* ink pens, as well as a regular pencil to answer at least one question on this exam.

There are 3 pages to this exam, including the cover sheet.

-3 pts if you do not follow this direction.
Please do not write or type your name on any page other than this cover page. Staple all your pages (INCLUDING THE TEST PAGES) together when finished with the exam.
Name (please print here):

Write out the full pledge and sign:

How long did this exam take you to complete?

24 pts.

I. Define these terms: 2 points each. Define the terms and demonstrate your knowledge. These terms can be define succinctly, so using a lot of words is not the best way to demonstrate your fluency with these terms. You may combine words with pictures if this helps, but don't hand write the words unless you print VERY neatly.

priming
activation and proliferation of a T cell upon *first* antigen recognition

HEVs
High Endothelial Venules: blood vessles for naïve lymphocyte entry into lymph node

CD40
on APCs, binds CD40L on T cells, makes APCs present more B7s, B cells induced to undergo cell division and isotype switching and somatic hypermutation

cross priming
virus engulfed by macrophage or dendritic cell can present viral peptides in MCH I instead of the expected MHC II

IL-2
cytokine produced by activated (primed) T cells and causes the same T cells to progress from G1 → S phase of the cell cycle and onwards through mitosis as a part of cell proliferation

perforin
protein secreted by CD8+ T cells and NK cells, makes holes in plasma membrane of target cells, let's granzymes into cells for apoptosis induction

dark zone
centroblast B cells that have been activated and reside in a crowded portion of the germinal center of a lymph node; cells are rapidly dividing and have low BCR on their surfaces

poly-Ig receptor
surface protein that binds IgA dimers and moves them from the basolateral cell surface (e.g. M cells) to the apical surface (transcytosis); clipped and helps keep IgA bound to mucus.

H1N5 (Should have been H5N1)
Avian flu virus that could cause a pandemic since humans have not seen this version and it is 50% lethal in the known human infections. It is only a matter of time before it covers every country in the world.

immune complexes
antibodies bound to soluble antigens that cross link so much they fall out of solution; can bind complement

proteins and these bind to complement receptor on RBCs for cleaning in the liver

commensal bacteria
beneficial symbionts that live in the human gut (as one example) that help us digest foods and out compete possible pathogenic microbes.

SMAC
SupraMolecular Adhesion Complex – collection of cell surface proteins that form a tight seal around a central area that forms the "immunological synapse"; site of activated T cell secretion

Part II
These questions encourage you to synthesize a lot of specific information. I decided to see how you can integrate this information rather than breaking it up into smaller unrelated questions.
There are many possible answers. I am providing some key points that I was looking for.
10 pts.
1) Explain why many autoimmune diseases are associated with infections of particular pathogens. To get full credit, you must explain two parts:
a. the infection part and
infection leads to inflammation which leads to more B7 production on APCs. This could result in self-antigen being presented by MHC and binding to TCR with costimulatory molecule also present.
b. the particular pathogen part.
Some pathogens may have peptides that are very similar to our own proteins. This could be adaptive for the pathogen since most TCR would have been negatively selected, but if a BCR bound to the pathogen's protein and then through somatic hypermutation bound to a self-peptide better, this could explain why certain pathogens are associated with particular autoimmune diseases.

10 pts.
2) Explain how it is possible that humans can be vaccinated for viruses to produce a humoral response. I am NOT asking what should be injected. Rather, I want you to explain how our immune systems work in these two cases:
a. live, attenuated oral polio vaccine ;
This is a real viral infection of a strain that is weakened. Therefore, cross priming can produce an antibody-mediated immune response, complete with memory B cells. Virus is presented by dendritic cell in MHC II, which binds to CD4+ TCR which becomes primed and activates the appropriate B cell. Being injested orally implies an IgA response, perhaps an IgE as well.
b. an injection for small pox. Think about what was used in the injection when I was a child, and could be used again if needed.
Edward Jenner used cow pox to vaccinate the first person ever; I was vaccinated with cow pox as well. The cow pox surface proteins are similar to small pox and thus cross reactivity of the antibodies and cross priming of the virus (see part a above) leads to a humoral response.

15 pts.

3) **Diagram** how a B cell that is specific for tetanus gets activated by a vaccine. Use colors effectively to highlight key components. Start when a person is first injected and finish with a high affinity IgG response. You may use more than one picture to show what happens, but you do NOT have to show the pathogen in a person and growing. Just focus on the immune **responses** to the vaccination.

INSERT SCANNED DIAGRAM

10 pts.

4) Choose and briefly explain an example that illustrates a positive feedback loop in immunology. A positive feedback loop is one in which an input produces more input to sustain the original signal.

11 pts.

5) There is a paradox that needs explaining. How can we develop a food allergy given the existence of oral tolerance? Explain this apparent contradiction using the rules we have learned so far. This question requires that you speculate, but to get full credit you must base your speculation on accepted immunological principles.

Similar to how commensal bacterial can cause an infection if the epithelium is breached, so too perhaps, can food cause an allergic reaction. If food enters the blood/tissue in an incompletely digested form, and/or the food can create a modified-self protein similar to the way penicillin can, then perhaps a new antigen would be seen by the immune system. Alternatively, the food particle might mimic a pathogenic antigen and thus be recognized by memory cells. It is important to remember that true food allergies are triggered by IgE and lead to isotype switching. Intollerance of food can be confused for allergy, but IgE-mediated responses stimulate mast-cell degranulation. Food allergies cannot be a loss of oral tolerance because this would lead to every food producing an allergy.

10 pts.

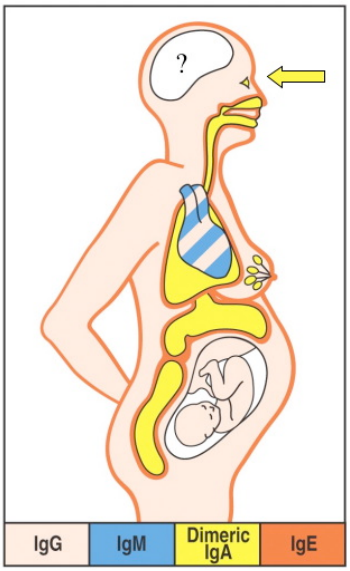
6) List 5 examples of how the immune system amplifies the signal of a small antigenic stimulus. Number your 5 examples 1 – 5 and use a complete sentence for each one, not just a phrase.

Many acceptable answers. Points taken off for restating the same example twice, or not clearly linking the stimulus with an amplified response.

10 pts.

7) Draw the outline of a human body (rectangles and circles are fine) and then use your colors to show where in the body each antibody isotype is used to produce its effect. Make sure you produce a color legend so I can be sure to understand your color code.

I got many entertaining human body drawings. I was looking for something similar to this diagram from the book. You had to have the fetus and the brain addressed in your drawing.



+2 pts.

Bonus Question: What is the most important immunological advice you could give to a new mother to help keep the infant healthy during the first month?

Breast feed your child, especially during the first 3 or so days for the antibody-rich colostrum.