Spring 2003 Immunology Exam #1 - Chapters 1 - 4

There is no time limit on this test, though I have tried to design one that you should be able to complete within 3 hours, except for typing. You are not allowed to use your notes, or any books, any electronic sources, nor are you allowed to discuss the test with anyone until all exams are turned in at 8:30 am on Friday February, 7. **EXAMS ARE DUE AT CLASS TIME ON FRIDAY FEBRUARY 7**. The **answers to the questions must be typed on a separate sheet of paper** unless the question specifically says to write the answer in the space provided. If you do not write your answers on the appropriate pages, I may not find them unless you have indicated where the answers are. There is one question where you will have to use the internet. For this question only, you may use a browser but you may only go to the one site indicated in this test.
There are 3 pages to this exam, including the cover sheet.
When you are ready to take the exam, send me an email with the subject line of Immunology Test. This will generate an automated email telling you how to download the exam.

-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):

Average = 79.7%
Range = 46-100%
Points added = 12

Write out the full pledge and sign:
"On my honor I have neither given nor received unauthorized information regarding this work, I have followed and will continue to observe all regulations regarding it, and I am unaware of any violation of the Honor Code by others."

How long did this exam take you to complete (excluding typing)?

30 pts.

I. Define these terms: 3 pts each. First define the terms and then provide a specific example to further 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. If you do not know a real example, make up one that is very similar to a real one, but be sure to indicate when you are making up a hypothetical example.

naïve lymphocyte – B or T cell that is mature but has not been activated or bound to its antigen/peptide. An example is a BCR that could bind to anthrax but you have not been exposed.
combinatorial diversity – the capacity to increase TCR or BCR variation of binding potential by mixing and matching gene segments within one gene or proteins from different genes (H + □ or □). For example, V1-V2-J1-J2 could combine to produce 4 different light chains.
innate immunity – ability to fight off pathogens without adaptive immune response, using germline genes without any recombination. There is no memory in innate system. Uses leukocytes, complement, epithelium and antimicrobial peptides. An example is a bacterial that is bound by C3 convertase and tagged for opsinization by macrophage.
TNF-□ □ cytokine that induces inflammation locally or systemically, depending on the type of infection. Secreted by macrophages, this small protein can help recruit other leukocytes and seal off the area to prevent the pathogen from entering the blood.
attack complex – terminal product of the complement cascade, this product produces holes in the surface of bacteria. It is composed of C5b, C6-C9.
diapedesis – one step in extravasation, this is the step where a leukocytes physically squeezes through the blood vessel wall. An example is a neutrophil that binds to endotherlial cells and passes between these cells and then digests the basement membrane.
allotype – genetic variations within a population due to allelic differences at a polymorphic locus. This is not restricted to antibody constant regions of a particular isotype, though this is a good example.
anchor residue – particular amino acids on a peptide that create non-covalent bonds with MHC I and MHC II. The anchor residues for MHC I are better understood. A picture would help provide an example.
coding joint – result after somatic recombination in T or B cells. This is where two coding segments are joined. A picture provides a good example.
isotype – different constant regions of the Heavy chains of immunoglobulins. Examples are G, A, M, E, D.

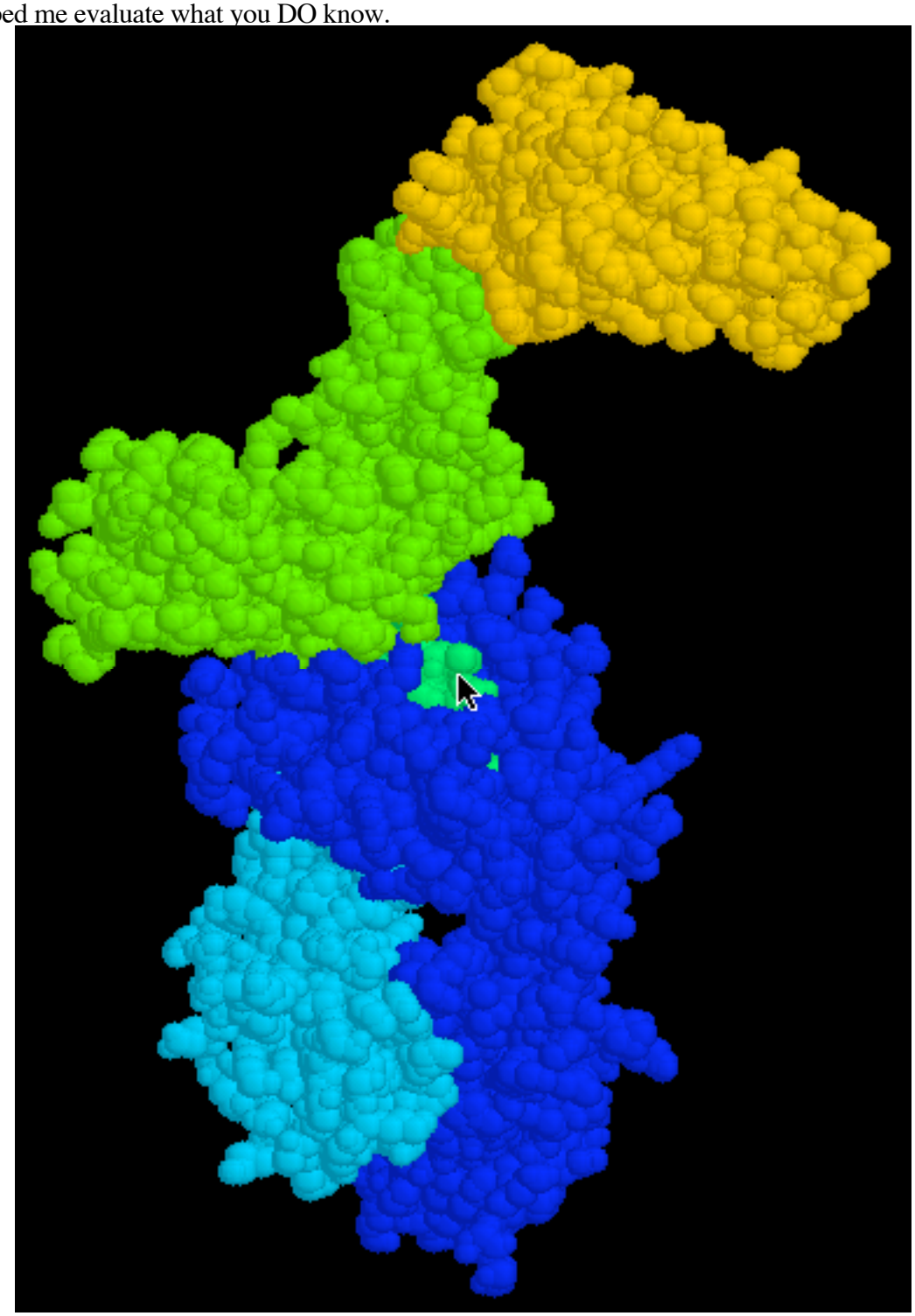
Part II

8 pts.

1) Imagine that yesterday you got a splinter in your big toe. Today the area is looks inflamed. Answer these questions:
a) List the symptoms that indicate the area is inflamed?
heat, swelling, tenderness, red (depends on skin tone)
b) What prevents this area of inflammation from spreading all over your big toe?
blood clots form downstream to blot pathogen escape
c) How did your immune system know to generate an inflammation response at this site?
cytokines such as TNFa from leukocytes OR complement fragments C2a, 4a and 5a
d) What cells cause the pus to form?
dead and dying neutrophils

8 pts.

2) Go to this URL <www.bio.davidson.edu/courses/Immunology/Exams/2003/examq.pdb> and describe what is shown. This particular image is a challenging question. You may not recognize it completely so be sure to describe the parts you do know and then the parts you don't know. It may be worthwhile telling me what your unknown parts *cannot* be as one way of demonstrating what you know. For example, you might say "It has feathers so it is probably a bird but I am sure it is not a badminton birdie." By indicated what the unknown is not, you have helped me evaluate what you DO know.



MHC I is dark blue. □2 microglobulin is light blue. The peptide is a shade of green and pointed to by the cursor.

The two remaining proteins cannot be TCR since they don't work together to bind peptide + MHC. They cannot be CD8 because it binds too close to the peptide. The only option left is the NK KIR protein. If you got this right, you got +1. If you ruled out TCR and CD8, you missed zero points.

12 pts.

3) Compare and contrast the MHC I and MHC II. To facilitate grading, please number your similarities and differences. Here are two silly examples to illustrate what I want:

1) MHC I has one Roman number I while MHC II has two.
2) Both start with the letter M.

1) Both have similar overall structures.
2) MCH I is made of a large alpha and a small B2 microglobulin while MHC II is composed of two approximately equal sized alpha and beta subunits.
3) Both present peptides to TCR.
4) MHC I binds smaller peptides derived from proteins made in the cell's cytoplasm while MHC II binds larger peptides derived from proteins produced outside this cell.
5) MHC I is found on the PM of all cells with nuclei while MHC II is found only on APCs.
6) MHC I binds CD8 while MHC II binds CD4.
7) Both are unstable without a bound peptide.
8) MHC I binds to cytotoxic T cells while MHC II binds to helper T cells.

8 pts.

4)

a) Draw a picture of an IgA that has all its binding sites occupied with antigen (for fun, draw a microscopic gummy bear). In your diagram, neatly label all the protein chains, as well as the individual parts of the protein that physically touch the gummy bear.

see figure 4.23 in the book

b) List all the places this gummy bear could be in your body if it is bound by IgA.

tears, milk, saliva

6 pts.

5) Explain to a Bio111 student how your immune system accomplishes transplant rejections, and why.

Your immune system is trained to recognize anything different that appears in your body so a transplanted organ from another person fits this bill. Therefore, your immune system is trying to get rid of something that is new and could be harmful. To accomplish this task, your Tc cells bind to the new MHC I molecules and become activated to kill what they do not recognize. It may be possible that NK cells participate as well, but the major role is conducted by Tc. MHC I is a polymorphic protein which means the human species has many different alleles and it is difficult to find two people with identical alleles at this locus.

8 pts.

6) Why is it impossible to have a Ig heavy chain that is composed of VJ variable regions. You must draw a diagram to support your answer.

You needed to invoke the 12/23 rule but mention that some times recombination can accommodate a 12/12 recombination. Once you hade this, you needed a figure similar to 4.5 in the book. The figure was worth the most points.

6 pts.

7)

a) What role does TdT play in antibody production?

TdT increases antibody diversity by introducing random nucleotides at a coding joint after the hairpin loop is cut open. These N nucleotides are not coded for and thus differ every time somatic recombination takes place.

b) What role does RAG1/2 play in antibody production?

RAG1/2 also produces diversity when it cuts the hairpin loop at a random place. This produces random number and sequence of P nucleotides at a coding joint. As with TdT, this also takes place at the hypervariable regions of the heavy and light chains. In addition, RAG1/2 cuts the RSS and leads to the production of the hairpin loop in the first place, just outside the coding gene segments.

8 pts.

8) a) What is the overall consequence for your immune system after it accomplishes somatic hypermutations?

You produce antibodies with higher affinity (affinity maturation) due to random mutations in the variable regions. Only B cells with the highest affinity survive and produce more antibodies.

b) Which cells can perform somatic hypermutations?

Activated B cells.

6 pts.

9)

a) Describe the mechanism/s that prevent your T cells from producing □:□ and □:□TCR on the same cells.

The delta gene is located within the alpha gene so that if alpha undergoes somatic recombination, the delta gene is deleted. If the delta gene is utilized, somehow the alpha gene is silenced.

b) Given what we know so far in this semester, describe any unexplained issues that remain to be resolved given your answer to part 9a.

Everyone got this correct since I meant to say 9a instead of 8a. The nagging question is why don't cells produce alpha:gamma or beta:delta TCR? This mechanism has not been addressed. In addition, a question in class was also a good one. Why can't alpha V segments recombine with delta J segments?