11.E: Innate Immunity (Exercises)

These are homework exercises to accompany Kaiser's Microbiology TextMap. Microbiology is the study of microorganisms, which are defined as any microscopic organism that comprises either a single cell (unicellular), cell clusters or no cell at all (acellular). This includes eukaryotes, such as fungi and protists, and prokaryotes. Viruses and prions, though not strictly classed as living organisms, are also studied.

11.1: The Innate Immune System: An Overview

Study the material in this section and then write out the answers to these questions. Do not just click on the answers and write them out. This will not test your understanding of this tutorial.

1. Describe what is meant by the following:
   a. innate immunity (ans)
   b. adaptive (acquired) immunity (ans)

2. Define the following:
   a. antigen (ans)
   b. pathogen-associated molecular patterns or PAMPs (ans)
   c. epitope (ans)

3. Multiple Choice (ans)

11.2: Defense Cells in the Blood: The Leukocytes

Study the material in this section and then write out the answers to these questions. Do not just click on the answers and write them out. This will not test your understanding of this tutorial.
1. What is the difference between a CBC and a leukocyte differential count? \(\text{ans}\)

2. A person has an elevated white blood cell count with an elevated number of band-form neutrophils. What is the significance of this? \(\text{ans}\)

3. Match the following descriptions and functions with the type of leukocytes:

   _____ Important phagocytes; 54%-75% of the leukocytes; granules stain poorly; produce enzymes for the synthesis of bradykinins and prostaglandins that promote inflammation. \(\text{ans}\)

   _____ Capable of phagocytosis but primarily kill microorganisms and parasitic worms extracellularly; 1%-4% of the leukocytes; large granules stain red; secrete leukotriens and prostaglandins to promote inflammation. \(\text{ans}\)

   _____ Not important in phagocytosis; large granules stain a purplish blue; 0%-1% of the leukocytes; release histamine, leukotriens, and prostaglandins to promote inflammation. \(\text{ans}\)

   _____ Important in phagocytosis and aid in the adaptive immune responses; produce cytokines; 4%-8% of the leukocytes; differentiate into macrophages and dendritic cells when they leave the blood and enter the tissue. \(\text{ans}\)

   _____ Mediate humoral immunity (antibody production); have B-cell receptors (BCR) on their surface for antigen recognition; differentiate into antibody-secreting plasma cells. \(\text{ans}\)

   _____ Regulate the adaptive immune responses through cytokine production; have CD4 molecules and TCRs on their surface for antigen recognition. \(\text{ans}\)

   _____ Carry out cell-mediated immunity; have CD8 molecules and TCRs on their surface for antigen recognition; differentiate into cytotoxic T-lymphocytes (CTLs). \(\text{ans}\)

   _____ Lymphocytes that lack B-cell receptors and T-cell receptors; kill cells to which the antibody IgG has attached as well as human cells lacking MHC-I molecules on their surface. \(\text{ans}\)
   
   a. B-lymphocytes
   b. T4-lymphocytes
   c. T8-lymphocytes
   d. NK cells
   e. basophils
   f. neutrophils
   g. eosinophils
   h. monocytes

4. State what type of cell monocytes differentiate into when they enter tissue. \(\text{ans}\)

5. **Multiple Choice** \(\text{ans}\)
11.3: Defense Cells in the Tissue: Dendritic Cells, Macrophages, and Mast Cells

Study the material in this section and then write out the answers to these questions. Do not just click on the answers and write them out. This will not test your understanding of this tutorial.

1. State 3 different functions of macrophages in body defense.
   a. (ans)
   b. (ans)
   c. (ans)

2. Name the cells in the tissue whose primary function is to present antigen to naive T-lymphocytes. (ans)

3. Name the cells in the tissue whose primary function is to present antigen to effector T-lymphocytes. (ans)

4. State the primary function of mast cells in body defense. (ans)

5. Multiple Choice (ans)

11.3: Immediate Innate Immunity

11.3A: Antimicrobial Enzymes and Antimicrobial Peptides

Study the material in this section and then write out the answers to these questions. Do not just click on the answers and write them out. This will not test your understanding of this tutorial.

1. Matching

   _____ Found in in tears, mucous, saliva, plasma, tissue fluid, etc.; breaks down peptidoglycan. (ans)

   _____ A protein produced by skin and mucosal epithelial cells. The two peptides produced upon cleavage of this protein are directly toxic to a variety of microorganisms. (ans)

   _____ An enzyme that penetrates the bacterial cell wall and hydrolizes the phospholipids in the bacterial cytoplasmic membrane. (ans)

   _____ Short cationic peptides that are directly toxic by disrupting the cytoplasmic membrane of a variety of microorganisms causing leakage of cellular needs. They also activate cells for an inflammatory response. (ans)

      a. lysozyme
      b. phospholipase A2
      c. defensins
      d. cathelicidins
      e. lactotransferrin and transferrin

11.3B: The Complement System
Study the material in this section and then write out the answers to these questions. Do not just click on the answers and write them out. This will not test your understanding of this tutorial.

1. Briefly describe how the classical complement pathway is activated. (ans)
2. Match the following:
   _____ Complement proteins that trigger inflammation (ans)
   _____ Complement proteins that chemotactically attracting phagocytes to the infection site. (ans)
   _____ Complement proteins that promote the attachment of antigens to phagocytes (enhanced attachment or opsonization. (ans)
   _____ Complement proteins that cause lysis of Gram-negative bacteria and human cells displaying foreign epitopes. (ans)
      a. the membrane attack complex (MAC)
      b. C5a, and to a lesser extent, C3a and C4a.
      c. C3b, and to a lesser extent, C4b.
      d. C5a
3. Briefly describe how the lectin complement pathway is activated. (ans)
4. Briefly describe how the alternative complement pathway is activated. (ans)
5. Multiple Choice (ans)

11.3C: Anatomical Barriers to Infection, Mechanical Removal of Microbes, and Bacterial Antagonism by Normal Body Microbiota

Study the material in this section and then write out the answers to these questions. Do not just click on the answers and write them out. This will not test your understanding of this tutorial.

1. Describe what is meant by anatomical barriers to infection. (ans)
2. List 4 ways in which the body can physically remove microorganisms or their products. (ans)
3. Describe how bacterial antagonism by normal microbiota acts as a nonspecific body defense mechanism. (ans)
4. Multiple Choice (ans)

11.4: Early Induced Innate Immunity

11.3A: Pathogen-Associated Molecular Patterns (PAMPs) and Danger-Associated Molecular Patterns (DAMPs)

Study the material in this section and then write out the answers to these questions. Do not just click on the answers and write them out. This will not test your understanding of this tutorial.

1. State the function of pathogen-associated molecular patterns as they relate to innate immunity. (ans)
2. Name at least 5 PAMPS associated with bacteria. (ans)
3. Name at least 2 PAMPS associated with viruses. \((\text{ans})\)

4. Define DAMP. \((\text{ans})\)

5. **Multiple Choice PAMPs and DAMPs** \((\text{ans})\)

**11.3B: Pattern-Recognition Receptors (PRRs)**

Study the material in this section and then write out the answers to these questions. Do not just click on the answers and write them out. This will not test your understanding of this tutorial.

1. State the function of the following as they relate to innate immunity.
   a. pathogen-associated molecular patterns \((\text{ans})\)
   b. pattern recognition receptors \((\text{ans})\)
   c. endocytic pattern recognition receptors \((\text{ans})\)
   d. signaling pattern recognition receptors \((\text{ans})\)
   e. danger-associated molecular patterns
   f. danger recognition receptors \((\text{ans})\)
   g. inflammasome \((\text{ans})\)

2. Briefly describe the major difference between the effect of the cytokines produced in response to PAMPs that bind to cell surface signaling PRRs and endosomal PRRs. \((\text{ans})\)

3. **Multiple Choice (PRRs)** \((\text{ans})\)

**11.3C: Cytokines Important in Innate Immunity**

Study the material in this section and then write out the answers to these questions. Do not just click on the answers and write them out. This will not test your understanding of this tutorial.

1. Match the following:

   _____ Cytokines that promote inflammation by enabling white blood cells to adhere to the inner surface of blood vessels, migrate out of the blood vessels into the tissue, and be chemotactically attracted to the injured or infected site. \((\text{ans})\)

   _____ Cytokines that prevent viral replication, activate a variety of cells important in body defense, and exhibit some anti-tumor activity. \((\text{ans})\)

   _____ A wide variety of intercellular regulatory proteins produced by many different cells in the body that ultimately control every aspect of body defense. Cytokines activate and deactivate phagocytes and immune defense cells, increase or decrease the functions of the different immune defense cells, and promote or inhibit a variety of nonspecific body defenses. \((\text{ans})\)

   a. lysozyme
   b. chemokines
   c. cytokines
   d. interferons
   e. human beta-defensins
2. Describe specifically how type-I interferons are able to block viral replication within an infected host cell. (ans)

3. Multiple Choice (ans)

11.3D: Harmful Effects Associated with Abnormal Pattern-Recognition Receptor Responses, Variations in Innate Immune Signaling Pathways, and/or Levels of Cytokine Production

Study the material in this section and then write out the answers to these questions. Do not just click on the answers and write them out. This will not test your understanding of this tutorial.

1. Briefly describe two specific examples of how an improper functioning PRR can lead to an increased risk of a specific infection or disease.
   A. (ans)
   B. (ans)

11.3E: Phagocytosis

Questions I

Study the material in this section and then write out the answers to these questions. Do not just click on the answers and write them out. This will not test your understanding of this tutorial.

1. Briefly describe the role of the following as they relate to phagocytosis:
   a. inflammation (ans)
   b. lymph nodules (ans)
   c. lymph nodes (ans)
   d. spleen (ans)

2. Multiple Choice (ans)

Questions II

1. Describe the following steps in phagocytosis:
   a. activation (ans)
   b. chemotaxis (ans)
   c. attachment (both unenhanced and enhanced) (ans)
   d. ingestion (ans)
   e. destruction (ans)

2. State what happens when either phagocytes are overwhelmed with microbes or they adhere to cells to large to be phagocytosed. (ans)
3. Most of the tissue destruction seen during microbial infections is due to ______________________. (ans)

4. **Multiple Choice** (ans)

### 11.3F: Natural Killer Cells (NK Cells) and Invariant Natural Killer T-Lymphocytes (iNKT Cells)

Study the material in this section and then write out the answers to these questions. Do not just click on the answers and write them out. This will not test your understanding of this tutorial.

1. **Matching**
   - _____ Recognize stress induced molecules such as MICA and MICB on the surface of tumor cells or infected cells. (ans)
   - _____ Recognize MHC-I molecules usually present on all nucleated cells of the body. (ans)
   - _____ Mechanism by which NK cells kill tumor cells and infected cells. (ans)
     A. Apoptosis, a programmed cell suicide
     B. Killer-activating receptors
     C. Killer-inhibitory receptors

2. Epitopes of glycolipid antigens are recognized by iNKT lymphocytes by way of their _______. (ans)

3. iNKT cells promote both innate and adaptive immunity and may also regulate immune responses by way of the ______________ they produce once activated. (ans)

4. **Multiple Choice** (ans)

### 11.3G: Inflammation

Study the material in this section and then write out the answers to these questions. Do not just click on the answers and write them out. This will not test your understanding of this tutorial.

1. Describe the following in terms of inflammation:
   - a. mechanism for inflammation (ans)
   - b. benefits of plasma leakage (ans)
   - c. benefits of diapedesis (ans)
   - d. healing (ans)

2. Briefly describe the process of diapedesis, indicating the role of the following:
   - a. P-selectins (ans)
   - b. integrins (ans)
   - c. adhesion molecules (ans)

3. Briefly describe the problems that arise from chronic inflammation. (ans)

4. **Multiple Choice** (ans)
11.3H: Nutritional Immunity

Study the material in this section and then write out the answers to these questions. Do not just click on the answers and write them out. This will not test your understanding of this tutorial.

1. State three different ways the body deprives microorganisms of iron.
   a. (ans)
   b. (ans)
   c. (ans)

11.3I: Fever

1. Describe the mechanism behind fever. (ans)
2. State 2 benefits of fever.
   a. (ans)
   b. (ans)

11.3J: The Acute Phase Response

Study the material in this section and then write out the answers to these questions. Do not just click on the answers and write them out. This will not test your understanding of this tutorial.

1. Briefly describe the mechanism behind the acute phase response. (ans)
2. An acute phase protein that binds to phospholipids in microbial membranes, sticks the microbe to phagocytes, and activates the classical complement pathway is ___________________. (ans)
3. An acute phase protein that binds to mannose in microbial walls, sticks the microbe to phagocytes, and activates the lectin pathway is ___________________. (ans)
4. Multiple Choice (ans)

11.3K: Intraepithelial T-lymphocytes and B-1 cells

Study the material in this section and then write out the answers to these questions. Do not just click on the answers and write them out. This will not test your understanding of this tutorial.

_____ These cells have a limited diversity of antigen receptors that initially produce a class of antibody molecule called IgM against common polysaccharide and lipid antigens of microbes and against PAMPs of bacteria that invade body cavities. (ans)

_____ These cells have a limited diversity of antigen receptors that recognize molecules associated with epithelial cells but expressed only when those cells are stressed or infected. They kill those cells by inducing apoptosis, a programmed cell suicide. (ans)
   a. gamma:delta T-lymphocytes
   b. alpha:beta T-lymphocytes
   c. B-1 cells
   d. marginal zone B cells