ImO Immunology Overview

Learning Objectives

The student will

- Use aseptic techniques in the safe inoculation of various forms of media.
- Follow oral and written instructions and manage time in the lab efficiently.
- Explain how immunological tests can be used to identify microbes and determine a person's blood type.
- Use agglutination and ELISA to detect the presence of specific proteins in a sample.

Background/Theory

Immunology is the study of the complex ways that humans and other animals respond to invasion by bacteria and other pathogenic organisms. It includes nonspecific innate defenses as well as specific adaptive defenses. Antibodies are large proteins also called immunoglobulins (Ig), involved in the **specific adaptive defense** against pathogens. Any substance that elicits the production of antibodies is called an **antigen** (short for antibody generating). Microbiologists not only study how these molecules are produced and how they interact with chemicals and cells in vertebrates but also use antibodies to detect organisms or other molecules with high specificity.

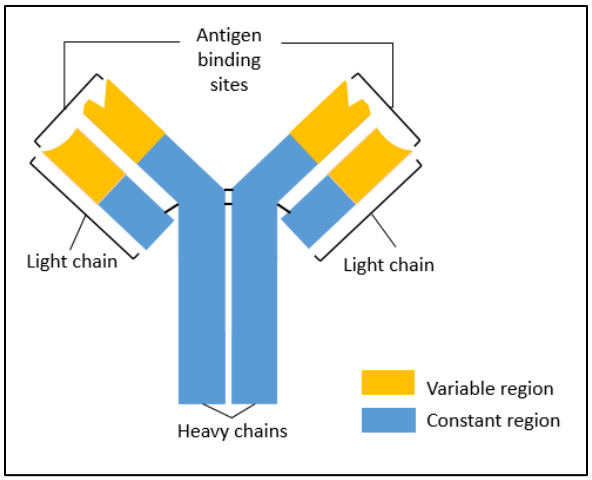

Figure 1 Structure of Immunoglobulin Monomer

Antibodies are composed of one or more units or **monomer**s. Each monomer is composed of four polypeptide chains arranged in a basic Y-shaped structure held together by disulfide bonds. See figure 1. Two heavy chains and two light chains. Each of the four chains has a constant region and a variable region. Note that the variable regions of all four chains are arranged so that they line up at one end of the y-shaped structure. The variable regions form the antigen binding site. Each immunoglobulin subunit has two antigen binding sites, in other words, it is **bivalent**. The specific part of the antigen that interacts with the antigen binding site is called the **epitope**.

Immunoglobulins are grouped into several **classes**. IgD, IgE and IgG classes are monomers, composed of a single Y-shaped structure. IgA is a dimer containing two Y-shaped molecules connected at the constant regions. The IgM, a pentamer, is the largest of the classes. The constant region is the same for all immunoglobulin molecules of a given class in a given organism. The variable region is highly variable within a given Ig class. This variability is what allows the immune system to recognize and respond to pathogenic organisms. Figure 2 shows the basic structures of each of the classes. In this course, we will be dealing with IgG and IgM.

IgG is a monomer that is by far the most abundant antibody in human blood, accounting for about 80% of total serum antibody. IgG penetrates efficiently into tissue spaces, and is the only antibody class with the ability to cross the placental barrier, providing passive immunity to the developing fetus during pregnancy. IgG is also the most versatile antibody class in terms of its role in the body's defense against pathogens. (OpenStax CNX, 2018)

In IgM, the ten available antigen binding sites make it an important antibody in the body's arsenal of defenses. IgM is the first antibody produced and secreted by B cells during the primary and secondary immune responses, making pathogen-specific IgM a valuable diagnostic marker during active or recent infections. (OpenStax CNX, 2018)

Some of the ways antibodies work are as follows

1. Antibodies may bind to a virus or toxic protein preventing it from binding to its target (neutralization).
2. Antibodies can tag a pathogen so that it can be recognized and consumed by a macrophage or neutrophil.
3. They activate the complement system, (OpenStax Biology, 2018)
4. They **agglutinate** several pathogenic cells creating large aggregates that are easier for phagocytes to ingest or for the kidneys and spleen to filter from the blood. (OpenStax CNX, 2018)

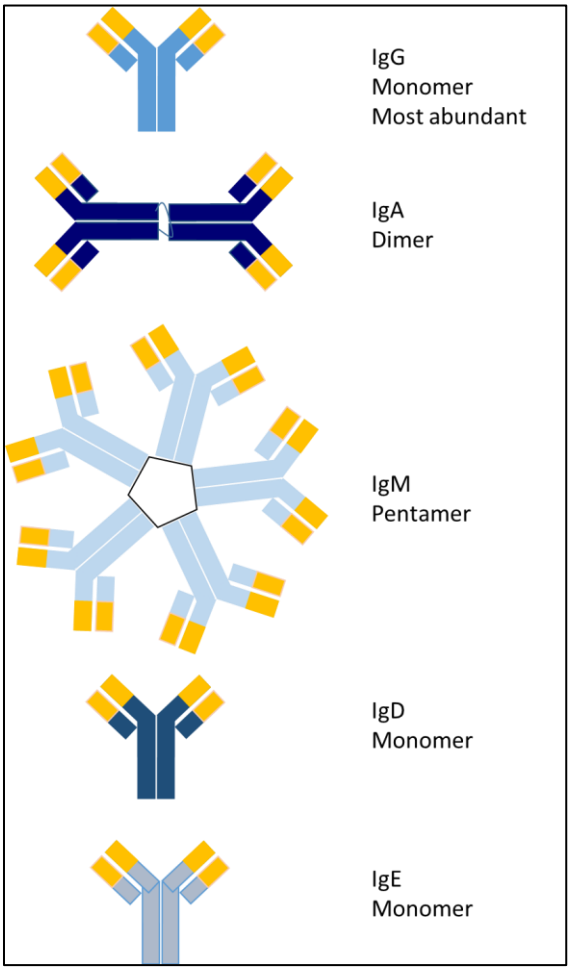

Figure 2 Five classes of antibodies

Scientists can take advantage of antibody specificity in diagnostic testing and research. Because the variable region will bind to only one epitope, antibodies can be used as probes for very specific organisms or antigens in a mixture. For example, if a bacterium displays the epitope that interacts with an IgM binding site, you can imagine up to 10 bacterial cells "sticking" to a single IgM. When each of these bacteria bind to other homologous IgM's and those IgM's complex with additional target cells, a large aggregate forms. This clumping is called **agglutination**. To be used in a test, these large aggregates must be observable. In **direct agglutination**, the antigen is naturally large enough that the resulting aggregate is visible to the human eye. Blood typing is an excellent example of a direct agglutination reaction. In **indirect agglutination**, the antigen is too small to be seen even in large aggregates. Visible clumping is artificially created by using large particles like latex beads.

Lab Report: Immunology Overview

Name _____
Lab Section _____

Post Lab Questions

1. Which region of the Ig molecule interacts with the antigen? What makes this region suited for this purpose?

2. The constant region is the same for all human IgG.
   a. Is the constant region of **human IgG** the same as the constant region of **human IgD**?

   b. Is the constant region of **chicken IgG** the same as the constant region of **human IgG**?

3. Which immunoglobin class plays a prominent role in agglutination of pathogens?

4. Which immunoglobin class is the most prevalent in humans?

References

OpenStax Biology. (2018, Sep 26). OpenStax Biology 2nd Edition, Biology 2e. Retrieved from http://cnx.org/contents/8d50a0af-948b-4204-a71d-4826cba765b8@14.24

OpenStax CNX. (2018, Mar 19). OpenStax Microbiology. Retrieved from http://cnx.org/contents/e42bd376-624b-4c0f-972f-e0c57998e765@4.24