11.7A: Antibody Proteins and Antigen Binding

A region at the tip of the antibody protein is very variable, allowing millions of antibodies with different antigen-binding sites to exist.

Learning Objectives

• Describe the general function and structure of an antibody

Key Points

• An antibody (Ab), also known as an immunoglobulin (Ig), is a large protein produced by B-cells that is used by the immune system to identify and neutralize foreign objects, such as bacteria and viruses. The antibody recognizes a unique part of the foreign target, called an antigen.

• Each tip of the “Y” of an antibody contains a paratope that is specific for one particular epitope (analogous to a lock and key) on an antigen, allowing these two structures to bind together with precision. Using this binding mechanism, an antibody can tag a microbe or an infected cell.

• The general structure of all antibodies is very similar: The Ig monomer is a Y-shaped molecule that consists of four polypeptide chains: two identical heavy chains and two identical light chains connected by disulphide bonds.

• Antibodies can occur in two physical forms, a soluble form that is secreted from the cell, and a membrane-bound form that is attached to the surface of a B-cell and is referred to as the B-cell receptor (BCR).

Key Terms

• Hypervariable region: In antibodies, hypervariable regions form the antigen-binding site and are found on both light and heavy chains. They also contribute to the specificity of each antibody. In a variable region, the 3 HV segments
of each heavy or light chain fold together at the N-terminus to form an antigen binding pocket.

An antibody (Ab), also known as an immunoglobulin (Ig), is a large Y-shaped protein produced by B-cells that is used by the immune system to identify and neutralize foreign objects, such as bacteria and viruses. The antibody recognizes a unique part of the foreign target, called an antigen. Each tip of the “Y” of an antibody contains a paratope (a structure analogous to a lock) that is specific for one particular epitope (similarly analogous to a key) on an antigen, allowing these two structures to bind together with precision. Using this binding mechanism, an antibody can tag a microbe, or an infected cell, for attack by other parts of the immune system, or can neutralize its target directly; for example, by blocking a part of a microbe that is essential for its invasion and survival. The production of antibodies is the main function of the humoral immune system.

Antibody Functions

Antibody functions include the following:

- Combine with viruses/toxins to prevent them from invading cells
- Attach to flagella of bacterium, restricting their movement
- Multi-bind to many bacteria at once, causing them to accumulate and prevent movement around the body
- Burst bacteria cell walls
- Attach to bacteria, making it easier for phagocytes to ingest them

Antibody Structure

Antibodies are heavy (~150 kDa) globular plasma proteins. They have sugar chains added to some of their amino acid residues; in other words, they are glycoproteins. Antibodies are typically made of the same basic structural units, each with two large heavy chains and two small light chains.

Heavy and light chains, variable and constant regions of an antibody

There are several different types of antibody heavy chains, and several different kinds of antibodies, which are grouped into different isotypes based on which heavy chain they possess. Five different antibody isotypes are known in mammals, which perform different roles, and help direct the appropriate immune response for each different type of foreign object they encounter.
Figure: **Basic Antibody Structure**: Heavy and light chains, variable and constant regions of an antibody

The general structure of all antibodies is very similar. The Ig monomer is a Y-shaped molecule that consists of four polypeptide chains: two identical heavy chains, and two identical light chains connected by disulphide bonds. Each chain is composed of structural domains called immunoglobulin domains. These domains contain about 70-110 amino acids and are classified into different categories according to their size and function; for example, variable or IgV, and constant or IgC. The constant region determines the class of an immunoglobulin. All chains have a characteristic immunoglobulin fold in which two beta sheets create a “sandwich” shape, held together by interactions between conserved cysteines and other charged amino acids.

![Basic Antibody Structure](https://bio.libretexts.org/Bookshelves/Microbiology/Book%3A_Microbiology_(Boundless)/11%3A_Immunology/11.07%3A_Anti...)

Figure: **Antigen Binding Fragment**: Scheme of an IgM/IgE with its constant (C) and variable (V) regions: 1) antigen binding fragment 2) Fab region 3) Fc region

blue: heavy chains
yellow: light chains

However, a small region at the tip of the protein is extremely variable, allowing millions of antibodies with slightly different tip structures, or antigen binding sites, to exist. This region is known as the hypervariable region. Each of these variants can bind to a different antigen. This enormous diversity of antibodies allows the immune system to recognize an equally wide variety of antigens. The large and diverse population of antibodies is generated by random combinations of a set of gene segments that encode different or paratopes, followed by random mutations in this area of the antibody gene, which create further diversity. The paratope is shaped at the amino terminal end of the antibody monomer by the variable domains from the heavy and light chains. The variable domain is also referred to as the FV region, and is the
most important region for binding to antigens. More specifically, variable loops of β-strands, three each on the light (VL) and heavy (VH) chains are responsible for binding to the antigen.

Antibodies can occur in two physical forms, a soluble form that is secreted from the cell, and a membrane-bound form that is attached to the surface of a B cell and is referred to as the B cell receptor (BCR). The BCR is only found on the surface of B cells and facilitates the activation of these cells and their subsequent differentiation into either antibody factories called plasma cells, or memory B cells that will survive in the body and remember that same antigen so the B cells can respond faster upon future exposure. In most cases, interaction of the B cell with a T helper cell is necessary to produce full activation of the B cell and, therefore, antibody generation following antigen binding.