Acquired immunity refers to resistance against a specific pathogen or its products that is developed by a host organism (Tortora et al. Figure 17.1)
- Immunity maybe acquired either either actively or passively
  = Immunity is acquired actively when an organism, exposed to particular antigens, responds by stimulating specialized lymphocytes and antibody proteins
  = Immunity is acquired passively if an organism acquires the antibodies without exposure to the antigens
- Naturally acquired active immunity is obtained by natural exposure to antigens, which provokes an immune response and production of antibodies
  = Naturally acquired immunity is life-long for some diseases, short-lived for others
  = Although we usually associate such immunity with recovery from infectious disease, active immunity can also be naturally acquired from subclinical (inapparent) infections
- Naturally acquired passive immunity refers to vertical transmission of antibodies
  = Some antibodies will pass across the placenta, and can thus be acquired by a developing fetus
  = Colostrum also contains some antibodies, which may protect an infant from some gastrointestinal pathogens
  = Passive immunity lasts only as long as the antibodies remain active, which is usually a few months (but those are a critical few months!)
- Artificially acquired active immunity is what is sought from vaccination
  = A vaccine is a preparation of microorganisms or their products (e.g., toxins) that have lost their pathogenicity but still serve as antigens to stimulate an active immune response
  = Vaccines may be killed microorganisms, attenuated (weakened) microorganisms or inactivated toxins (toxoids)
- Artificially acquired passive immunity can be provided by administration of antibodies
  = The antibodies are taken from a person or animal that has acquired (naturally or artificially) immunity to a particular antigen
  = Antibodies used in passive immune therapies are found in the gamma globulin fraction of whole serum
  = Like naturally acquired passive immunity, artificially acquired passive immunity is short-lived

The human immune system has two components, the humoral immune system and the cell-mediated immune system
- The humoral immune system involves antibodies found in extracellular fluids
  = Antibodies are found in a variety of fluids, including blood, lymph, saliva, and mucus secretions
  = Antibodies are secreted into extracellular fluids when specialized lymphocytes called B cells are exposed to antigens
- The cell-mediated immune system involves the activities of specialized lymphocytes called T cells
  = T cells are located in both blood and lymphoid tissues
  = T cells have T cell receptors on their surface that cause them to react to specific antigens on the surface of cells
  = T cells do not secrete antibody in response to antigen (as B cells do), but instead produce lymphokines
The majority of antigens are proteins, nucleoproteins, lipoproteins, glycoproteins or large polysaccharides
- Such macromolecules may be components of invading microorganisms (e.g., viral capsid proteins, bacterial capsule polysaccharides)
- Not all antigens are found on microorganisms
  - For example, if you get hay fever, it's because your immune system responds to antigens on the surface of pollen grains
  - Antigens are also found on our own cells, although our immune systems usually don't respond to these "self" antigens (why this is will be discussed later)
- Generally, antibodies do not respond to a whole antigen molecule
  - Antibodies recognize specific antigenic determinants on an antigen's surface (Tortora et al., Figure 17.3)
  - Individual antibodies recognize different antigenic determinants on an antigen
- Most natural antigens are macromolecules; however, small molecules can serve as antigenic determinants if they are combined as haptens with a "carrier" macromolecule (Tortora et al., Figure 17.4)

Antibodies belong to the class of proteins called immunoglobulins
- Each immunoglobulin has at least two identical antigen-binding sites that bind to antigenic determinants
- A typical immunoglobulin contains four polypeptide chains (Tortora et al., Figure 17.5a)
  - There are two identical heavy chains and two identical light chains
  - The heavy and light chains are covalently joined by disulfide bonds to give a "Y-shaped" macromolecule
- The antigen-binding sites of an immunoglobulin are formed from the variable (V) regions of one heavy chain and one light chain
  - The amino acid sequences of these V regions vary from one immunoglobulin to another, which is why different antibodies bind to different antigenic determinants
  - Binding of antibody to antigen is a result of chemical interaction between an antigen-binding site and an antigenic determinant (Tortora et al., Figure 17.5b)
- The constant (C) regions of an immunoglobulin's heavy and light chains determine how cells, recognizing the immunoglobulin's Fc region, respond to an antibody molecule that is bound to antigen

There are five classes of immunoglobulins - IgG, IgM, IgA, IgD, and IgE (Tortora et al., Figure 17.6), which differ mainly in the amino acid sequence of the constant region of their heavy chains
- The different classes of immunoglobulin serve different functions in an immune response (Tortora et al., Table 17.2)
- IgG, "serum immunoglobulin", accounts for 80-85% of all antibodies in serum
  - IgG has the "classic" antibody structure shown in Tortora et al., Figure 17.5
  - IgG molecules can cross the placenta, and are among the antibodies of naturally acquired passive immunity
- IgM has a pentamer structure, in which five IgG-like monomers are held together by a J chain protein
  - IgM antibodies are the first to appear in response to an antigen (Tortora et al., Figure 17.7)
  - Because IgM appears early in an infection, and is relatively short-lived, it is valuable for diagnosis
- IgA, "secretory immunoglobulin", has a dimer structure in which two immunoglobulin monomers are connected by a J chain
  - IgA is dominant in secretions such as saliva and secretions of the gastrointestinal tract
  - The main function of of IgA appears to be blocking adherence of microorganisms to epithelial tissues
  - IgA molecules are found in colostrum, where they may help to protect an infant's gastrointestinal tract from infection
- Most IgD molecules are found on the surface of B cells; their function remains something of a mystery, although they may be involved in initiating an immune response
- IgE molecules bind tightly by their Fc ends to mast cells and basophils
  = When an IgE molecule binds antigen, it stimulates a response by the cell that it is bound to, which may include release of histamine or other bioactive compounds
  = IgE may be especially important in defending against parasitic infections

Both B cells and T cells develop from stem cells in bone marrow; T cells migrate to and mature in the thymus (hence the "T" designation), while B cells mature in the bone marrow itself (Tortora et al. Figure 17.6)
- Mature B cells, which display antibody on their surface, migrate to lymphoid tissues, where they encounter antigen
- When a B cell encounters antigen that is recognized by its surface immunoglobulin, it is activated to proliferate into a large clone of cells
  = Some of these progeny cells develop into short-lived plasma cells, which secrete free immunoglobulin molecules
  = Other of the progeny cells develop into memory B cells which, like the original B cell, are capable of responding to the antigen
- Often, B cell activation requires cooperation of helper T cells ("T_H cells") (Tortora et al., Figure 17.11)
  = Antigens that require T helpers are known as T-dependent antigens
  = T-dependent antigens are "processed" by macrophages and other antigen-presenting cells (APC) (see Tortora et al., Figure 17.12)
  = T_H cells interact with a complex of antigen fragment and major histocompatibility complex (MHC) protein on the surface of APCs
- Certain T-independent antigens are capable of activating B cells without the participation of helper T cells; most such antigens consist of repeating antigenic determinants