Effector functions of antibodies essay sample

Antibodies also known as immunoglobulins are secreted by plasma cells and B lymphocytes from the bone marrow and the lymphoid organs. The effector functions of antibodies are determined by the constant regions of the heavy chain. There are five different isotypes known in mammals to perform different roles and to direct a specific immune response for the antigen encountered. The binding of antigens to the variable regions will trigger the effector functions. Antibodies are only able to perform their functions upon entering the blood and the peripheral sites of infection. They prevent the entry of potential microbes through the epithelia. Antibodies are produced as early as the first week of vaccination or infection. Vaccination aims to produce long-lived plasma cells and memory cells.

During the primary response to a microbe, plasma cells help to secrete small amounts of antibodies for a long period of time. If there is a repeated attack to the antigen, there will be a more effective defence against the infection as memory cells differentiate into antibody producing cells. Antibodies have both antigen-binding (Fab) regions and Fc regions to carry out different functions. The Fab region binds to the microbe and toxins to block the harmful effects. The Fc regions consist of heavy chain constant regions and binds to phagocytes and complement. However, it requires the antigen recognition by the Fab region. Isotype switching and affinity maturation occur in antibodies produced by antigen-stimulated B lymphocytes in response to protein antigens. Isotype switching causes the production of antibodies with distinct Fc regions with different effector functions. IgG carries out neutralization of toxins and microbes, activates the classical pathway of the complement and opsonisation of antigens for phagocytosis.

It is the only class of immunoglobulin involved in neonatal immunity where it goes through the placenta and the gut to transfer the maternal antibodies. There are four subclasses which varies in the hinge region flexibility and glycosylation sites. There are some that respond to T-independent antigens like IgG2 and IgG4. IgM acts as the best complement-activating antibody and the first antibody to be made in response to the antigen. It activates the classical pathway of the complement and expressed on the surface of mature B cells. IgA is expressed in mucosal immunity such as gastric fluid and tears. It is where IgA is being secreted into the lumens of the respiratory and gastrointestinal tracts. It is involved in neutralization of microbes and toxins. It is a monomer in the serum and on mucosal surfaces, it acts as a dimer consisting of two four-chain units linked by the joining (J) chain. IgD does not have significant functional properties however it is expressed on surface of mature B cells and have a similar antigen-specificity with IgM.

IgE antibodies are essential to destroy helminthic parasites and diseases associated with allergies. The IgE antibody binds to the worms and FceRI which is the high-affinity Fc receptor for IgE aids in the attachment of eosinophils. Eosinophils kill helminths by releasing their granule contents after being activated. Mast cells may also be activated to secrete cytokines to attract leukocytes to destroy the worms. Antibodies help to neutralize microbial infectivity and toxins with host cells. Neutralization prevents microbes from gaining entry and infecting the host. It also prevents the spread of infection when microbes manage to enter host cells and infect neighbouring cells. Endotoxins or exotoxins bind to specific receptors and are responsible for the harmful effects. Opsonisation is the process where

antibodies coat microbes for phagocytosis. Opsonins are the molecules involved in phagocytosis. For certain isotypes such as IgG1 and IgG3, the Fc regions of antibodies will bind to CD64 which is expressed on macrophages and neutrophils. The binding activates phagocytes.

There are massive substances such as nitric oxide, proteolytic enzymes in the lysosomes of the activated neutrophils or macrophages to kill the ingested microbe. Antibody dependent cellular cytotoxicity is a process whereby Natural killer cells are activated after expressing CD16, an Fc receptor to discharge their granules to kill the antibody coated cells. The complement system contains cell membrane and circulating proteins in defending the body against antimicrobial activity of antibodies. It may be activated by both the innate and adaptive immunity.

It is a series of cascading enzymatic events which leads to opsonisation, phagocytosis, lysis of microbe and stimulates inflammation. After activation of complement, complement proteins become cleaved and C3b proteins get attached to the surfaces. Cytolytic membrane attack complex occurs as one of the last stages of complement activation. Cell surface and circulating regulatory proteins are expressed by mammals to prevent inappropriate complement activation. Microbes have several mechanisms to evade humoral immunity.

Mutations of antigenic surface molecules allows many such bacteria and viruses to evade antibodies in infections. An example is antigenic variation in viruses such as human immunodeficiency virus (HIV). Due to the variants of the major antigenic surface glycoprotein called gp120 present in HIV,

vaccines could not work for protecting people against this HIV infection. The antibodies cannot protect against other HIV isolates. Bacteria such as Escherichia coli can alter the antigens in the pili to evade antibodies. Other ways in which microbes evade humoral immunity is by resisting phagocytosis and inhibit complement activation.

References:

1. Abbas A. K., Lichtman A. H. (2010) Basic Immunology: Functions and Disorders of the Immune System, 3rd edition, Saunders Elsevier, California 2. Coico R., Sunshine G., Benjamini E. (2003)Immunology : A short course, 5th edition, John Wiley & Sons, Inc, New Jersey