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Questions

1. Explain the role of the Immune system

Each of the different types of white blood cells have a special role in the immune system, and many are able to transform themselves in different ways. The following descriptions help to understand the roles of the different cells.

Neutrophils are by far the most common form of white blood cells that you have in your body. Your bone marrow produces trillions of them every day and releases them into the bloodstream, but their life span is short -- generally less than a day. Once in the bloodstream neutrophils can move through capillary walls into tissue. Neutrophils are attracted to foreign material, inflammation and bacteria. If you get a splinter or a cut, neutrophils will be attracted by a process called chemotaxis. Many single-celled organisms use this same process -- chemotaxis lets motile cells move toward higher concentrations of a chemical. Once a neutrophil finds a foreign particle or a bacteria it will engulf it, releasing enzymes, hydrogen peroxide and other chemicals from its granules to kill the bacteria. In a site of serious infection (where lots of bacteria have reproduced in the area), pus will form. Pus is simply dead neutrophils and other cellular debris.

Eosinophils and basophils are far less common than neutrophils. Eosinophils seem focused on parasites in the skin and the lungs, while Basophils carry histamine and therefore important (along with mast cells) to causing inflammation. From the immune system's standpoint inflammation is a good thing. It brings in more blood and it dilates capillary walls so that more immune system cells can get to the site of infection.

Of all blood cells, **macrophages** are the biggest (hence the name "macro"). Monocytes are released by the bone marrow, float in the bloodstream, enter tissue and turn into macrophages. Most boundary tissue has its own devoted macrophages. For example, alveolar macrophages live in the lungs and keep the lungs clean (by ingesting foreign particles like smoke and dust) and disease free (by ingesting bacteria and microbes). Macrophages are called langerhans cells when they live in the skin. Macrophages also swim freely. One of their jobs is to clean up dead neutrophils -- macropghages clean up pus, for example, as part of the healing process.

The **lymphocytes** handle most of the bacterial and viral infections that we get. Lymphocytes start in the bone marrow. Those destined to become B cells develop in the marrow before entering the bloodstream. T cells start in the marrow but migrate through the bloodstream to the thymus and mature there. T cells and B cells are often found in the bloodstream but tend to concentrate in lymph tissue such as the lymph nodes, the thymus and the spleen. There is also quite a bit of lymph tissue in the digestive system. B cells and T cells have different functions.

- **B cells**, when stimulated, mature into plasma cells -- these are the cells that produce antibodies. A specific B cell is tuned to a specific germ, and when the germ is present in the body the B cell clones itself and produces millions of antibodies designed to eliminate the germ.
- **T cells**, on the other hand, actually bump up against cells and kill them. T cells known as Killer T cells can detect cells in your body that are harboring viruses, and when it detects such a cell it kills it. Two other types of T cells, known as Helper and Suppressor T cells, help sensitize killer T cells and control the immune response.

2. Describe the two types of immunity

1. Innate (Natural or Nonspecific) Immunity:

Innate immunity (also called nonspecific or natural immunity) refers to the inborn-ability of the body to resist, and is genetically transmitted from one generation to the next. This immunity offers resistance to any microorganism or foreign material encountered by the host.

- It includes general mechanisms inherited as part of the innate structure and function of each vertebrate, and acts as first line of defence. Innate immunity lacks immunological memory, i.e., it occurs to the same extent each time a microorganism or foreign material is encountered.

Types of Innate Immunity

Innate immunity can be divided into species, racial, and individual immunity.

(i)Species Immunity: Species immunity (species resistance) is that in which a disease affecting one species does not affect the other species. For convenience, humans do not contract cattle plague, chicken cholera, hog cholera, infectious horse anaemia, etc., while animals are not affected by many human diseases such as enteric fever, scarlet fever, syphilis, gonorrhoea, measles, etc.

(ii) Racial Immunity: Racial immunity (racial resistance) is that in which various races (breeds) show marked differences in their resistance to certain infectious diseases. A well-known example is that Brahman cattle are resistant to the protozoan parasite responsible for tick fever in other breeds of cattle. Similarly, Black Africans affected by sickle cell anaemia, a genetic disease, are resistant to malaria while malaria affects other human races.

(iii) Individual Immunity:

Having the same racial background and opportunity for exposure, some individuals of the race experience fewer or less severe infections than other individuals of the same race. For convenience, children are more susceptible to diseases such as measles and chicken pox, while aged individuals are susceptible to other diseases like pneumonia.

2. Acquired (Specific or Adaptive) Immunity:

Acquired immunity (also called specific or adaptive immunity) refers to an immunity that is developed by the host in its body after exposure to a suitable antigen or after transfer of antibodies or lymphocytes from an immune donor.

Characteristics of Acquired Immunity:

Acquired immunity is highly adaptive and is capable of specifically recognizing and selectively eliminating foreign microorganisms and macromolecules, i.e., antigens.

It exhibits the following four characteristic features that distinguish it from nonspecific (innate) immunity:

(i) Specificity:

Acquired immunity is extremely antigenic specific as it acts against a particular microbial pathogen or foreign macromolecule and immunity to this antigen usually does not confer resistance to others.

(ii) Diversity:

The acquired immune system generates tremendous diversity in its recognition molecules. As a result, it is able to specifically recognize billions of different structures on foreign antigens.

(iii) Memory:

Once the acquired immune system has recognized and responded to an antigen, it is able to respond this antigen more quickly and strongly following a subsequent exposure. This is due to the constitution of immunologic memory that makes the basis for long-term immunity in the body of the host.

(iv) Discrimination between "Self' and "Nonself":

The immune system almost always recognizes self and nonself antigens and responds only to nonself antigens. This ability to recognize self antigens from nonself ones is critical for normal functioning of the immune system. Sometimes this feature fails and, as a result, there develops autoimmune disease in the host.

3. Explain the different types of antibodies and their roles

There are five immunoglobulin classes of antibody molecules found in serum: IgG, IgM, IgA, IgE and IgD. They are distinguished by the type of heavy chain they contain.

IgG antibody structure and function
Immunoglobulin G (IgG) antibodies are large globular proteins with a molecular weight of about 150 kDa made of four peptide chains. It contains two identical γ (gamma) heavy chains of about 50 kDa and two identical light chains of about 25 kDa, thus a tetrameric quaternary structure.
IgG provides long term protection because it persists for months and years after the prescence of the antigen that has triggered their production. IgG protect against bacteria, viruses, neutralise bacterial toxins, trigger compliment protein systems and bind antigens to enhance the effectiveness of phagocytosis.

IgM antibody structure and function
Immunoglobulin M (IgM) antibodies are constructed of five or six units (i.e. mostly as pentamers but also hexamers occur) which are each comprised of two heavy-chains (μ-chains) and two light chains, bound together by disulfide bonds and a so-called J-chain.
IgM is involved in the ABO blood group antigens on the surface of RBCs. IgM enhance ingestions of cells by phagocytosis.

IgA antibody structure and function
Immunoglobulin A (IgA) antibodies consist of heavy (H) and light (L) chains. Each H chain is comprised of the constant region (Cα1, Cα2, Cα3), hinge region and the Variable (V) region. Light chains consists of the CL and Vκ or Vλ elements.
Main function of IgA is to bind antigens on microbes before they invade tissues. It aggregates the antigens and keeps them in the secretions so when the secretion is expelled, so is the antigen. IgA are also first defense for mucosal surfaces such as the intestines, nose, and lungs.

IgE antibody structure and function
Immunoglobulin E (IgE) antibodies have only been found in mammals. IgE is synthesised by plasma cells. Monomers of IgE consist of two heavy chains (ε chain) and two light chains, with the ε chain containing 4 Ig-like constant domains (Cε1-Cε4).
IgE bind to mast cells and basophils which participate in the immune response. Some scientists think that IgE's purpose is to stop parasites.

IgD antibody structure and function
Immunoglobulin D (IgD) antibodies are expressed in the plasma membranes of immature B-lymphocytes. IgD is also produced in a secreted form that is found in small amounts in blood serum. IgD plays a role in the induction of antibody production.