The Immune System

Definitions:

- Immunity - can be defined as the capacity to recognise the intrusion of material foreign to the body and to mobilise cells and cell products to remove that sort of foreign material with great speed and effectiveness.
- Pathogen - a disease causing micro-organism.
- Reservoir - The place where the pathogen is usually found.
- Endemic - is a disease which is always present at low levels.
- Epidemic - when the number of cases of a disease increase significantly.
- Vectors - organisms which carry pathogens between other organisms.
- Infectious - a disease which can be passed between hosts.

Defence Mechanisms

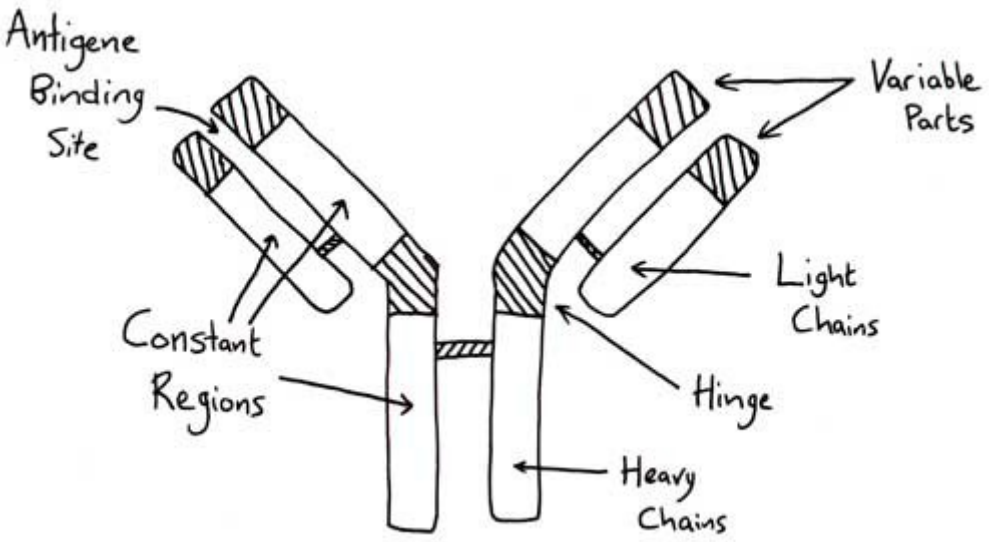
- Natural Barriers - Skins, Mucus Linings and Blood Clotting.
- The human body is an idea incubator for micro organisms. Many live in or on our bodies (comensals) causing no harm and benefiting. Pathogens are disease causing micro organisms and enter in two ways, either through the skin or natural openings.
- The skin is an effective barrier due to its think continuous carotonised layer.
- Micro organisms can be washed off easily and skin can flake off which helps to prevent a build up of bacteria.
- Lysozyme in the eyes breaks down bacteria cell walls.
- Invasion only occurs when skin is broken.

Antigens

An antigen is any substance that when introduced into the blood or tissue induces the production of antibodies. Most cells possess antigens in their cell surface membrane which act as markers enabling cells to recognise each other.

Antigens are usually large complex molecules such as proteins or glycoproteins, although any complex can be antigenic. The body can then distinguish between local and foreign cells but only usually make antibodies in response to foreign antigens.

Antibodies



An antibody is a protein produced by lymphocytes in the presence of a specific, usually foreign, antigen. As seen from the diagram above, antibodies are Y-shaped and are made up from polypeptide chains. When an antibody encounters a foreign antigen it can then join with the specific antigen and neutralise, inhibit or destroy it.

Types of Immunity

- Naturally Acquired

- Passively - This could be due to the transfer of antibodies from the mother to the fetus across the placenta. No memory cells involved so it's a short term solution.
- Actively - Usually when the body is exposed to an infection it will manufacture its own antibodies to combat the infection, along with memory cells. Because of these memory cells the response time when exposed to the same infection again decreases.

- Artificially Acquired

- Passively - Again no memory cells are made so it's only a short term solution. It usually occurs when ready made antibodies are injected into the body to combat certain infections like tetanus, and is a help against diseases which are hard to build an immune response to.
- Actively - This is achieved by a vaccine being given to a healthy human, the body is stimulated into producing antibodies and memory cells against this vaccine and thus building an immunity to the disease.

Immune System Responses

There are two systems of immunity in mammals, cell-mediated immune response and humoral immune response. Both use lymphocytes produced from stem cells in the bone marrow.

- Humoral immune response

- Uses B-lymphocytes produced in the bone marrow, where they also mature.
- There are many different types of B-lymphocytes.
- When an foreign antigen enters the blood it combines with a few B-lymphocytes which then divide rapidly through mitosis forming a clone of plasma cells. These then produce mainly antibodies but also memory cells. The memory cells can live for large periods of time, sometime even for life.

- Cell-mediated immune response

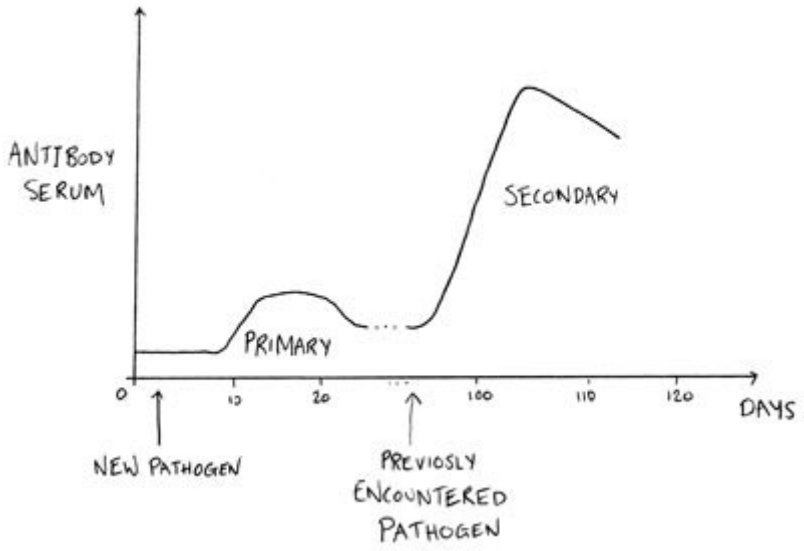
- Uses T-lymphocytes which are produced in the bone marrow and mature in the thymus gland.
- Once matured T-lymphocytes circulate the body in the blood until it meets an antigen it has the receptor site for. It is then stimulated to divide by mitosis many times forming clones.
- Three types of T-lymphocyte:
    - Killer cells - cause lysis of target cells, will destroy virus infected or cancer cells.
    - Helper cells - activate B-lymphocytes to produce antibodies.
    - Suppressor cells - turn off immune response, e.g. turning off antibody production.

Vaccines

Vaccines work by injecting small amounts antigens from a disease into the body. This triggers an immune response and antibodies are produced. This is the primary response to an intrusion.

As well as antibodies, memory cells are also produced to recognise similar antigens again. If there was a second intrusion with these antigens it would be vastly quicker due to the memory cells and the mammal might not even show any symptoms.

Below is a diagram showing the differences in response time between primary and secondary response.



As you can see from the graph when a new pathogen is introduced into a human it takes a while before antibodies are produced to combat the pathogen. But once the pathogen has been combated the first time (primary response) if it enters the same human again the immune system reacts a lot quicker and produces more antibodies (secondary response).

Monoclonal Antibodies

These are monospecific antibodies that are identical the each other because they are produced by one type of immune cell that are all clones of a single parent cell. Monoclonal antibodies are typically made from fusing myeloma cells with spleen cells from a mouse that has been immunitised with the desired antigen.

Uses for Monoclonal Antibodies

- Pregnancy Testing - Monoclonal antibodies can detect minute traces of hCG (human chorionic gonaotropin), a hormone produced after conception, in urine of the pregnant human. The monoclonal antibodies used in most pregnancy testing are molecules coated with a substance that bonds to the hCG, depending on whether it's present or not, will either blue or red.
- Drug Targeting - These act as 'magic bullets' linking anti-cancer drugs with monoclonal antibodies which are then attracted to cancer cells enabling drugs to be delivered to their desired destination.
- Treating a range of infection.
- In the diagnosis of diseases.

Antibiotics

Antibiotics are substances which inhibit the growth of micro organisms. These can be split up into two groups, broad spectrum antibiotics and narrow spectrum antibiotics. An example of a broad spectrum would be either chloramphenicol or tetracyclines. An example of a narrow spectrum would be penicillin. These two different groups also work in different ways, broad spectrum antibiotics work by affecting processes like protein synthesis. Narrow spectrum antibiotics on the other hand work by affecting the formation of the cell wall.

Antibiotic Resistance

- Resistance arises by mutations in the bacteria which in time can randomly have an advantage against the antibiotics.
- An example could be the enzyme penicillinase which renders penicillin unusable.