



## Higher Human Biology

### Unit 4 Key Area 2 Pupil Notes

Microbes which manage to evade the non-specific immune system are then met with the next level of defence known as the **specific immune system**.

**Note:**

In case you get confused microbes (including cancer cells and transplanted cells) can all be thought of as the same in terms of the immune system as they all carry antigenic markers (foreign proteins) on their surface which are recognised as being non-self and trigger an immune response.

To reduce confusion we will use the term 'microbes' which include viruses, bacteria and fungi.

The specific immune response is brought about by **lymphocytes**. Lymphocytes are made from stem cells in bone marrow. Some lymphocytes pass to the thymus and develop into T lymphocytes (T cells). Others remain in the bone marrow and develop into B lymphocytes (B cells).

### Immune surveillance

A range of white blood cells move around the body in the circulatory system.

If tissues are damaged or invaded by a microbe, phagocytes of the non-specific immune system release cytokines (cell signalling protein molecules) which as well as attracting more phagocytes stimulate the specific immune system.

The phagocytes which engulf the foreign microbe present foreign **antigenic fragments** on their surface which also alert the specific immune system. These antigenic markers on the surface of the microbe attract the lymphocytes which make up the **specific immune system**.

The body has an enormous number of lymphocytes which can be broken down into two main groups **T Cells and B Cells**.

**T - Cells are made in the Thymus and fall into 2 classes:-**

a) Helper T cells

Helper T cells secrete cell signalling molecules called cytokines which activate immune cells such as phagocytes, cytotoxic T cells and B cells.

b) Cytotoxic T cells

These destroy infected cells by inducing apoptosis (cell death).

**More about Helper T Cells**

After a phagocyte has done its job of digesting a microbe, it presents fragments of the microbe on its surface. Helper T cells bind to the surface of this 'antigen-presenting' cell/phagocyte. When this happens, the helper T cell becomes 'activated' and multiplies forming a clone of the activated helper T cells and of memory helper T cells.

**The clone of activated helper T cells secrete cytokines which stimulate cytotoxic T cells and attract B lymphocytes plus more phagocytes.**

**More about Cytotoxic T Cells**

- Cytotoxic T cells have antigen receptors which bind to the surface of an antigen-presenting phagocyte
- This results in the cytotoxic T cell becoming 'activated'
- Activated cytotoxic T cells move to the site of infection
- Cytotoxic T cells bind to infected cells
- Chemicals from the **cytotoxic T cells perforate the membrane of the infected cell**
- Infected cell undergoes **apoptosis (cell death)** as cells are induced to commit suicide through the release of self-destructive enzymes

In order to ensure the immune system responds more quickly if re-infected with the same microbe, both a **clone of activated cytotoxic T cells** and a clone of **memory cytotoxic T cell** is formed.

## Cancer cells

Other cytotoxic T cells recognise antigens on the surface of cancer cells and attack them. Lysis (bursting) of the cancer cells occurs

## B lymphocytes (B cells)

### Remember -

After a phagocyte has done its job of digesting a microbe, it presents fragments of the microbe on its surface. Helper T cells bind to the surface of this 'antigen-presenting' cell/phagocyte.

Each lymphocyte has specific antigen receptors on its surface and is able to become attached to one type of antigen - the lymphocyte is said to have been 'selected' by the antigen.

The Lymphocyte responds to selection by dividing repeatedly to form a clonal population - this is called 'clonal selection'. When this happens, the helper T cell becomes 'activated', it multiplies forming a clone of activated helper T cells and a clone of memory helper T cells

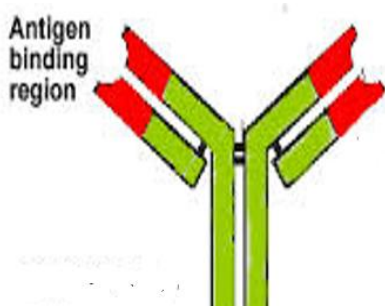
The clone of **activated helper T cells** secrete cytokines which **activate B cells**.

**B lymphocytes produce free antibodies** which are specific to the antigenic markers on the surface of the microbe.

Antibodies recognise and bind with antigens.

**Did you know** - An antibody is a Y-shaped protein molecule.

Each of its 'arms' bears a receptor (binding site) specific to a particular antigen.



Antigen-antibody complexes formed. This complex inactivates the microbe which is then engulfed by phagocytes.

Clones of memory B cells are also made to ensure a more rapid response by the immune system in the case of re-infection.

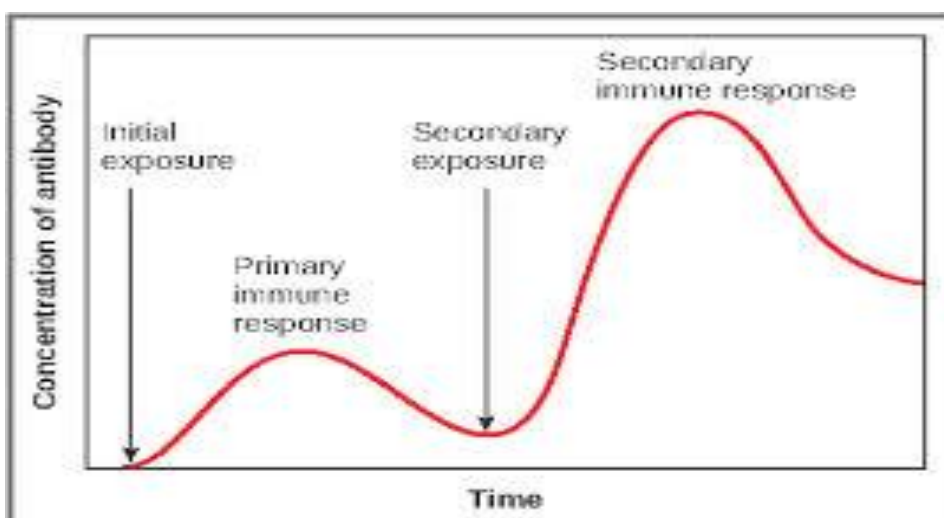
This ability to 'remember' and 'respond' quickly in the event of re-infection is called **Immunological Memory**.

### **More about - Immunological memory**

Some T and B lymphocytes survive as memory cells.

Exposure to a disease causing organism brings about a Primary Response. Exposure at later date brings about a Secondary Response. This time the disease is usually prevented -

- Antibody production is much more rapid.
- Concentration of antibodies produced reaches a higher level.
- Concentration of antibodies is maintained for a longer period of time.



## Antigen signature

Body cells have cell surface proteins unique to that person, their 'antigen signature'. It is critical that a person's lymphocytes do not regard these cell surface proteins as antigens.

T cells are able to distinguish between the body's own cells and cells with 'foreign' molecules on their surface.

## Autoimmunity

The body no longer tolerates the antigens that make up the 'self' message on cell surfaces and T lymphocytes attack the body's own cells. This causes Autoimmune Diseases e.g, M.S. rheumatoid arthritis and type1 diabetes.

## Allergy

This happens when the immune system over-reacts, with B lymphocytes responding to harmless substances. Such substances include pollen, dust, feathers, Penicillin.

## Allergic reaction

- Certain B cells are stimulated
- Antibodies are produced
- Antibodies become attached to 'mast' cells
- Mast cells secrete histamine
- Runny nose, constriction of bronchioles etc.