5.2 Describe and explain the immune response in the human body in terms of:

- **Interaction between B and T Lymphocytes**
- **The Mechanisms that allow Interaction between B and T Lymphocytes**
- **The Range of T Lymphocyte Types and the difference in their Roles**

INTERACTION BETWEEN B AND T LYMPHOCYTES:

1. **Macrophages detect antigens that enter the body & destroy them (phagocytosis)**
2. **The macrophage displays fragments of the antigen on its cell surface, becoming an antigen presenting cell (APC). It then moves towards nearby lymph nodes**
3. **In the lymph nodes, the receptors (antigen-specific) of helper T cells recognise the antigen fragments as foreign, and thus become activated.**
4. **B-cells can also activate helper T cells. When a B-cell encounters a foreign antigen that is specific to its surface antibodies, it produces an antibody-antigen complex, and processes the antigen, attaching it to its surface molecules before presenting it to the helper T cell**
5. **Activated T cells release chemical signals (cytokines) to activate:**
   i. **More helper T cells that recognise the same antigen**
   ii. **Production of clones of B cells to make more antibodies specific for the antigen**
   iii. **Production of clones of cytotoxic T cells that have the particular antigen receptor on their surface**
6. **The activated T cells and B cells differentiate and work together to destroy other identical antigens in the blood or tissues**
7. **Once all antigens have been destroyed by the immune response, suppressor T cells suppress the activity of the B cells and cytotoxic T cells**

THE MECHANISMS THAT ALLOW INTERACTION BETWEEN B AND T LYMPHOCYTES:

Clonal Selection (THE WORK OF MACFARLANE BURNETT):

- **There are many types of lymphocytes in the body before an antigen enters the body**
- **The entry of an antigen causes the selection of only ONE type of lymphocytes → the one that has the binding site that matches the antigen**
- **This lymphocyte clones itself into large numbers of itself to produce large numbers of antibodies that match the specific antigen**
- **This selection means that all the lymphocytes that are produced in the response (all the T-Cells and B-Cells) are all specific ONLY to that antigen**
- E.g. Cytotoxic T-Cells for Influenza bacteria cannot kill the Pneumonia bacteria
- **Macrophages engulf and kill all foreign cells → Lymphocytes only act against the antigens that they specifically match! (i.e. macrophages are not specific, but lymphocytes are!)**
- **Clonal Selection → the t and b-cells only clone for one specific antigen – which corresponds to their specific receptor**

Cytokines & Interleukins (Signalling Chemicals):

- **CYTOKINES are a group of signalling compounds that are made of proteins or polysaccharides and are used for communication between cells (they are like co-factors – they need to be present to help communication between T and B cells)**
- **Cytokines coordinate the functions of cells so that they can act together as a whole e.g. in the immune system**
- **INTERLEUKINS are a type of cytokine that are secreted by Helper T-Cells and Macrophages**
- **When these cells secrete interleukins, they are signalling or stimulating the other cells to differentiate in response to an antigen** → such as a B-Cell changing into a Plasma B-Cell
- **This is the main mechanism that is used for intercellular interaction**

THE RANGE OF T LYMPHOCYTE TYPES AND THE DIFFERENCE IN THEIR ROLES:

There are 4 Types of T-Cells:

1. **Helper T-Cells (Th Cells):**
    - **Release interleukins (chemicals) that activate the cloning of Cytotoxic T-Cells and B-Cells and increase macrophage activity after the antigen has been recognised**
    - Each one has a receptor protein that recognises only one type of antigen
    - A particular antigen activates them and they thus release cytokine chemicals (Interleukin-2) that activate cytotoxic T-Cells & B-Cells specific for this antigen
    - Other cytokine chemicals that stimulate the activity of macrophages are released
2. **Cytotoxic T-Cells (Tc Cells):**
    - **Move to the site of infection and release chemicals that destroy infected cells**
    - They produce many clones of themselves when activated by Helper T-Cells and when there are antigens on their own surface with the same surface receptor protein
    - This army of identical Cytotoxic T-Cells move to the site of infection, bind with infected cells and release chemicals that destroy the infected cell
3. **Memory T-Cells:**
    - **Remain in the body to respond to future infections by the same antigens**
    - Produced at same time as Tc Cells and remain in body so that the body can respond more quickly to future invasions by the same antigen
4. **Suppressor T-Cells:**
    - **Supress the immune response when the infection has been defeated**
    - They stop the immune response once infection has been defeated

5.3 Outline the way in which vaccinations prevent infection –

- **Vaccination (Immunisation) is the process of making people resistant to infection caused by a pathogen → process of giving people an injection or oral dose of a vaccine**
- **Vaccines can be: live viruses, killed or harmful strains of pathogen, inactivated toxins or antibodies from blood of laboratory animals**
- **They are injected into body to provide immunity to diseases without giving the symptoms**
- **Vaccination slows down disease outbreaks (prevention rather than cure approach)**
- **Vaccines can give either ACTIVE or PASSIVE immunity**

Active Immunity:

- **This is gained through injecting the antigen of the pathogen in the vaccine**
- **This stimulates the whole immune response, including antibodies with T and B Memory Cells that are specific to that antigen, without the symptoms of the infection**
- **The production of memory cells has 2 implications:**
    1. **If the pathogen does enter the vaccinated individual, the memory cells initiates a quick immune response such that the individual does not experience an 'infection'**
    2. **It provides a long-term protection since memory cells last a long time**
- **E.g. Measles Vaccine**

Passive Immunity:

- **Involves injecting antibodies directly into individual in response to infection by a pathogen**
- **The antigens come from other organisms**
- **It by-passes the whole immune system → immediate protection**
- **Gives protection from diseases the body has never been infected by**
- **No memory cells are produced → hence protection is only short-term**
- **May bring the risk of a reaction against foreign blood proteins**
- **E.g. Tetanus Serum**

5.4 Outline the reasons for the suppression of the immune response in organ transplant patients –

- **A transplanted organ is recognised as foreign tissue by the immune system**
- **Suppression of the immune system is needed to prevent the body from rejecting the organ**
- **Without suppression, the immune system would create antibodies and cytotoxic T-Cells to try and destroy the organ**
- **The chances of rejection is reduced by matching the transplant organ tissue with the tissue of the patient, and by providing the immunosuppression drugs**
- **The danger of this therapy is the inability of the patient to fight off any infections, since the immune system is suppressed → hence the benefits of immunosuppression has to be balanced against the chance of life threatening infection**