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 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:**
   - Suppress 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