HSC Biology
Core 3 – Search for Better Health

Focus 5

- *MacFarlane Burnet's work in the middle of the twentieth century contributed to a better understanding of the immune response and the effectiveness of programs.*

Identify the components of the immune response.

- **Antibodies.**
- **T cells.**
- **B cells.**

Name	What Is It	What It Does
Antibodies (immunoglobins)	- Proteins produced by the body when antigen detected. - Made in lymph nodes. - By 'B cells'. - Each antigen stimulates production of unique antibody.	- Protein binds with antigen. - Antigen-antibody complex activates production of proteins. - Bacteria ingested, destroyed. - Macrophages. - Histamine released. - Inflammatory response.
B cell	- Special lymphocyte differentiated in bone marrow. - Thus 'B cell'. - Control humoral (blood) response. - B cells, lymph activated by antigen.	- B cell recognises antigens, activated. - Divides repeatedly to produce mass of identical cells. - Cells differentiate. - Plasma cells: - Send antibodies into blood. - Memory cells.

T cell	- Another type of lymphocyte. - Differentiate in thymus gland. - Thus 'T cell'. - Remain inactive in blood & lymph until they detect an antigen. - Antigen binds to T cell, activating cloning mechanism.	- T cells control cell-mediated response. - Various types of T cells destroy antigen / foreign cell. - *Cytotoxic T cells*: - Carry antigens. - Remove foreign proteins from body. - Anything recognised as 'non self'. - Bacteria. - Transplants. - *Natural killer cells*: - Special cytotoxic T cells. - Destroy abnormal host cells. - **Eg.** Cancer cells, viruses. - Also produce interferon. - *Helper T cells*: - Secrete *interleukins*. - Regulate cytotoxic T cell & B cell functions. - *Inducer T cells, suppressor T cells*: - Regulate T & B cells. - Start & stop production and action. - *Memory T cells*: - Recognise antigen when reappearing. - Have helper T cell function. - Quick supply of antibody to antigen.

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.**

- Antigen enters body.
  - Travels via blood to lymphoid tissue (lymph node or spleen).
  - Ingested, processed by macrophage.
    - Displays fragments of antigen on outer membrane.
    - Recognised by helper T cells & B cells.
  - Interact through cytokines.
      - Polysaccharides / proteins secreted by T cells & macrophages.
    - Signal other cells to initiate immune response.
    - **Eg.** B cell to transform into plasma cell.

  - Interaction between B & T lymphocytes:
    - Attack same antigen.
    - *'Helper T cells'* stimulate B & T cells to clone.

- 2 proposed mechanisms for interaction of B & T cells:
  - <u>Mechanism 1:</u>
    - T cell produces soluble factor after interaction with antigen.
    - B cell reacts with factor & specific antigen.
    - B cell becomes functional antibody producing cell.
  - <u>Mechanism 2:</u>
    - Based on cell contact between T & B cell.
    - Contact arises from interaction with antigen.
    - Contact allows T cell to signal B cell to become functional.
      - Antibody producing cell.

- Different cells collaborate because:
  - Close to each other.
  - Regulated by cytokines.

- Proteins/polysaccharides.
- Secreted by T cells & macrophages.
- Signal other cells to initiate immune response.

Mechanisms allowing interaction of B & T lymphocytes:
- T lymphocytes help B lymphocytes.
  - *Helper T cells (T_h cells)*.
- If B cell has antigen on surface, risk that T cell will recognise antigen & attack it & B cell.
  - T cell able to recognise 'self' molecules.

Type of T cell	Function
Cytotoxic T cells	- Destroys cells carrying antigens. - Removes foreign proteins recognised as non self.
Natural killer cells	- Special cytotoxic cells. - Destroy abnormal host cells.
Helper T cells	- Secrete chemicals. - Interleukins. - Regulate cytotoxic T cell & B cell functions.
Inducer T cells & suppressor T cells	- Regulate T & B cells. - Initiate response when antigen detected. - Stop response when antigen destroyed.
Memory T cells	- Recognise antigen on reappearance. - Have helper T cell functions. - Producing large amounts of antibody.

- Memory cells:
  - Cloned & differentiated T & B cells remain in body.
  - Lymphocytes have receptors.
    - Recognise antigens.
    - Provide ready defence against subsequent invasions.

- Rapid elimination of antigen.
  - Before symptoms appear.

Outline the way in which vaccinations prevent infection.

- Vaccination / immunisation:
  - The process of making people resistant to infection caused by a pathogen.
  - Giving injection or oral dose of a vaccine.
    - Produces immunity actively or passively.

- Vaccine:
  - Preparation of live, attenuated or dead infective micro organism.
  - Injected into body.
    - Intention of producing immunity without symptoms.
  - Some last for short time, some for life.
    - Booster injections given at intervals to provide longevity.

  - *Active immunisation*:
    - Injection of antigen in form of a vaccine.
    - Stimulates production of antibodies, T & B memory cells.

  - *Passive immunisation*:
    - Injection of antibodies produced by another organism in response to infection.
    - **Not** provide long term immunity.
    - Risk of stimulating reaction to foreign blood proteins in vaccine.
    - Provides instant immunity for people with no immune system.

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

- New organs recognised as ‘non self’.
  - Immune response to remove ‘non self’ cells.
  - Only identical twins or closely inbred strains share identical proteins.

- Immune system suppression prevents rejection of new organ.
  - Blood drains from rejected organ, into recipient’s circulation.
  - Body recognises foreign tissue cells.
  - Produces antibodies in response.
    - Destroys new organ.
  - T cells mainly responsible for rejection.
    - Cytotoxic T cells, natural killer cells, macrophages & B cells can cause serious reactions, destroying organ.

- Rejection reduced by:
  - Closely matching transplanted tissue proteins with recipient’s protein.
  - Drugs.
    - Antilymphocyte globulin (ALG).
      - Suppresses immune response.

  - Patient’s immune system unable to respond to infection.
  - Also suffer from renal impairment, diabetes.
    - Given antibiotics.

Process, Analyse and Present information from secondary sources to evaluate the effectiveness of vaccination programs in preventing the spread and occurrence of once common diseases, including small pox, diphtheria and polio.

- Vaccines:
  - Cheapest & safest method of preventing disease.
  - Early immunisation has potential to save 6-8 million lives of children each year (3rd undeveloped countries).
  - Vaccination programs in developed countries stopped spread & occurrence of once common diseases.

- **Smallpox:**
  - Used to be one of the most dreaded diseases.
  - In 1700s:
    - 1 in 3 who caught it died.
  - Jenner developed vaccine in 1796.
  - 1960s:
    - WHO developed worldwide immunisation program.
  - 1980:
    - WHO declared world smallpox free.

- **Diphtheria:**
  - Bacterial infection transmitted by close physical contact / respiratory contact.
  - Commonly infected young children in temperate climates.
  - Vaccine released in 1923.
  - By 1940s:
    - Limited to occasional, low intensity outbreaks.
  - Vaccine injected usually:
    - DTP.
      - Prevents diphtheria, tetanus, pertussis (whooping cough).
  - 1974:
    - Goal was to immunise all children against diphtheria, polio & t.b. by 1990.
      - 80% of children vaccinated by 1990.
  - Since 1990s, epidemics and outbreaks occurred in;

- Soviet Union.
- Iraq.
- Mongolia.
- P.N.G.
- Thailand.

- Current global vaccination rate:
  - 74%

- **Polio:**

- Mainly a disease of young children.
  - Results in paralysis & death.
- Poliomyelitis virus enters through mouth, attacks nerves.
  - Leg nerves most affected.
  - Nerves in brain may be attacked.
- 1955:
  - Vaccine introduced.
- By 1960s, polio brought under control.
- Polio now eradicated from most parts of the world.