Immunity

↳ "the protection against disease provided by the body's immune system"

EXTERNAL DEFENCE SYSTEM

→ eg. epithelia of airways, HCl in stomach, blood clotting.

INTERNAL DEFENCE SYSTEM

→ LEUCOCYTES
- phagocytes
  - neutrophils
  - macrophages (monocyte)
- lymphocytes
  - B-lymphocytes (B cells)
  - T-lymphocytes (T cells)

↳ recognise pathogens by molecules that cover their surface eg. proteins, glycoproteins, waste etc.

→ Features of immune system => distinguish between:
- ↳ self antigens (eg. cell surface antigens)
  - → molecule produced by the body that immune system does not recognise as foreign
- ↳ non-self antigens
  - → protein that is foreign to the body which stimulates immune response

→ Antigen => any molecule which the body recognises as foreign

→ Antibodies => glycoprotein molecules that act against specific antigens.

→ Immune response => the response of lymphocytes to the presence of a foreign antigen.

PHAGOCYTES

→ produced throughout life in the bone marrow.
→ stored there before being distributed around blood.
→ NEUTROPHILS
- ↳ travel throughout the body
- ↳ squeeze through walls of capillaries to 'patrol' tissues.
- ↳ during infection, released in large numbers.
- ↳ short lived.

→ MACROPHAGES
- ↳ larger than neutrophils
- ↳ found in organs
- ↳ in blood = monocytes, once enter organ develop into macrophage.
- ↳ long-lived
- ↳ cut up pathogens to display antigens

PHAGOCYTOSIS

→ cells under attack release histamine
→ histamine + chemicals by pathogen attract neutrophils => chemotaxis
→ pathogens covered with antibodies
→ neutrophils have receptor proteins on surface that recognise antibody molecules.
→ neutropil attach, engulf pathogen into phagocytic vacuole => endocytosis
→ lysosome fuse with vacuole
→ digestive enzyme destroy pathogen.
→ neutrophil die, forms pus.

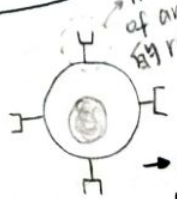
LYMPHOCYTES

→ large nucleus that fills most of cell.
→ produced before birth in bone marrow
→ B-LYMPHOCYTES (B CELLS)
- ↳ remain in bone marrow until mature
- ↳ then spread throughout, concentrating in lymph nodes & spleen, & liver

→ T-LYMPHOCYTES (T CELLS)
- ↳ leave bone marrow, mature in thymus.

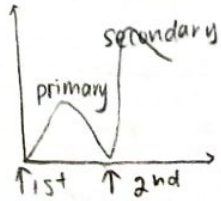
→ only mature lymphocytes carry out immune response.
→ circulate between blood & lymph
- ↳ ensures they are distributed so they come into contact with pathogens & each other.

B-LYMPHOCYTES



→ as they mature, gain ability to make 1 antibody molecule. (because genes that code for antibodies change to code for diff. antibodies.)
→ each divides => group of identical cells called a clone.
→ antibody molecules do not leave but remain in cell surface membrane.
→ forms antibody receptor (glycoprotein receptor)

→ when antigen enters body, B cells with complementary antibody receptors bind with antigen
→ stimulated => mitosis → clonal selection. → then large number of B cells produced → clonal expansion
→ some become plasma cells, secrete antibodies (they both do not live long)
→ some become memory cells → basis of Immunological memory
- ↳ if same antigen reintroduced, memory cells divide rapidly into (plasma c. + memory c.)



→ primary response = slow ∵ few B cells that are specific
→ secondary response = fast ∵ → many memory cells that divide into plasma c.
∴ → clone of B cells that are selected ↑

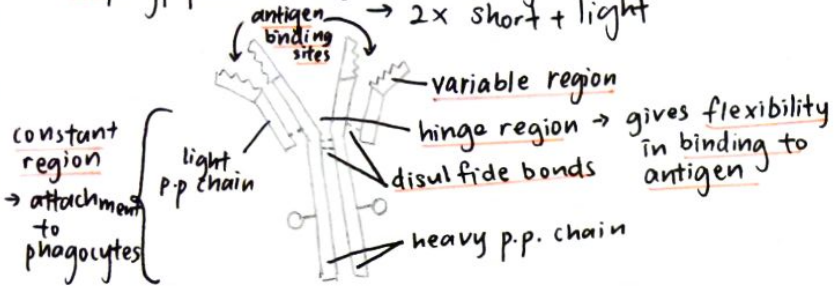
→ primary response must occur before become immune.

少量时 => clonal selection
大量时 => clonal expansion

Immunity

ANTIBODIES

- globular glycoproteins with quartenary structure.
- form the group of plasma protein ⇒ immunoglobulins
- 4 polypeptide chains → 2× long + heavy
  → 2× short + light



- FUNCTIONS
  - combine with viruses & bacterial toxins to prevent them entering / damaging cells.
  - attach to flagella => make them less active & easier to engulf.
  - antibodies with multiple antigen binding sites cause agglutination of bacteria
    => reduce spreading.
  - 'punch' holes in cell walls of bacteria ⇒ burst when osmosis
  - coat bacteria ⇒ easier for phagocytes to ingest.
    ⇒ phagocytes have receptors for heavy p.p. chains.
  - combine with toxins to neutralise & make them harmless ⇒ called antitoxins.

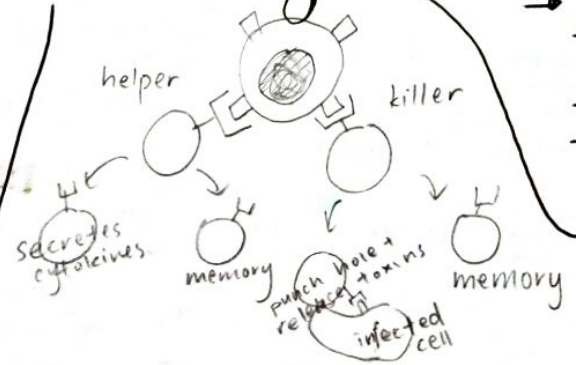
T-LYMPHOCYTES

- have T cell receptors
- activated when they encounter on host's cell
  ↳ eg. macrophage that cut up pathogen
  ↳ eg. body cell invaded & displaying 'help' signal
  ↳ antigen presentation.
- T cell < helper T cells / killer T cells

- HELPER T CELLS
  - release cytokines that stimulate B cells to divide into plasma c. & secrete antibodies.
  - secrete cytokines that stimulate killer T cells to divide & differentiate by producing vacuoles of toxins.
  - secrete cytokines that stimulate macrophages to carry out phagocytosis more vigorously.
- KILLER T CELLS → 'punch' holes
  - search the body for invaded cells displaying foreign antigens
  - attach to surface of infected cells, secrete toxic substances to kill the body cell & pathogen inside.
- memory helper T cells & memory killer T cells produced.
  → more than B cells.

NUMBER OF WBC

- Bacterial infections
  → neutrophils ↑
- viral infections
  → lymphocytes ↑
- HIV invades helper T cells & causes their destruction.
- all WBC from stem cells in bone marrow
- myeloid stem cells → neutrophils
  → monocytes
  → platelets
- lymphoid stem cells
  → B & T lymphocytes
- Leukaemias
  → cancers of these stem cells.
  → cells divide uncontrollably giving many cells that do not differentiate properly ∴ disrupt production of normal blood cells



[redacted] ACTIVE IMMUNITY

- immunity developed after contacting pathogens inside the body
- long term immunity
- NATURAL ACTIVE IMMU.
  → when lymphocytes are activated by antigens on pathogens during an infection
  → makes own antibodies.
- ARTIFICIAL ACTIVE IMMU.
  → when immune response is activated artificially
  → by injecting antigens into body.
  → vaccination.

PASSIVE IMMUNITY

- immunity provided by antibodies or antitoxins provided from outside the body.
- NATURAL PASSIVE IMMU.
  → antibodies from mother cross placenta & remain in infant for few months
  → Colostrum contains antibodies
- ARTIFICIAL PASSIVE IMMU
  → injection of antibodies / antitoxin
  → Immediate but temporary
  → the antibodies foreign ∴ removed by pathogens.

Immunity

VACCINES

- A preparation containing antigens used to stimulate an immune response artificially.
- may contain whole live pathogen / dead one/ harmless version / harmless form of toxin / preparation of surface antigens.
- good because immune system has met living organisms.
- **PROBLEMS**
  - Poor response
    - ↳ defective immune system ∴ do not develop necessary B & T cells
    - ↳ protein-enery malnutrition ∴ can't make antibodies/ clones of lymphocytes.
  - Live virus & herd immunity
    - ↳ vaccinated people may pass out pathogen in faeces
    - ↳ herd immunity → interrupts transmission
  - Antigenic variation
    - ↳ many different strains.
    - ↳ (influenza) virus mutates regularly to give diff antigens
    - ↳ antigenic drift can still recognise
    - ↳ antigenic shift can't recognise
  - No effective vaccines against protoctists
    - ↳ many genes ∴ many antigens on cell surface
    - ↳ (Plasmodium) each stage has its specific antigens.
- Antigenic concealment
  - ↳ pathogens inside host cells ∴ does not encounter immune system
  - ↳ difficult to develop vaccine cuz short time for immune response before pathogen 'hides'.

ERADICATION OF SMALLPOX

- variola virus, direct contact
- vaccination & surveillance
  - ↳ ring vaccination
    - ↳ protected everyone who could possibly come into contact
    - ↳ reduced chances of transmission
    - ↳ contained the disease
- **FEATURES OF VACCINE**
  - easy to administer
  - could be freeze-dried and kept @ high temp for 6 months
  - cheap to produce (?) (emergency point)
  - vaccine made from harmless strain of similar virus. ∴ effective cuz 'live' vaccine
- **FEATURES OF VIRUS**
  - did not mutate & change surface antigens
  - did not infect animals
  - did not linger in body after infection

PREVENTING MEASLES

- poor response to vaccine
  - → several children need boosters
- high birth rates & shifting population ∴ difficult to give boosters.
- migrants & refugees can form reservoirs of infection.

AUTOIMMUNE DISEASE

- when immune system attacks one or more self antigens
- during maturation of T cells, T cells with T cell receptors complementary to self-antigens destroyed.
- some evade destruction.
- **MYASTHENIA GRAVIS**
  - acetylcholine binds with receptor proteins on cell surface membranes of muscle fibres, sodium ions move through
  - T cells specific for the receptors stimulate clone of B cells to differentiate into plasma cells 比如 cell 上面有 "antigen"
  - antibodies bind to receptor ∴ block transmission of impulses.

MONOCLONAL ANTIBODIES

- identical antibodies
- problem: → B cells that divide by mitosis do not produce antibodies
  - → plasma cells that secrete antibodies do not divide.
- Hybridoma cell → cell produced by fusion of plasma cell & cancer cell.
  - → produces Mabs. (name of antibody)
- Production of hybridomas
  - → antigen injected into mouse
  - → mouse B cells recognise it & divide & differentiate into plasma cells.
  - → plasma cells collected from spleen & fused with cancer cells to form hybridomas that secrete the antibody (Mabs)

Mabs

→ ~~Hybridomas~~ in diagnosis
  → each antibody is attached to radioactive chemical that produces γ-rays.
  → labelled antibodies introduced into patient's blood.
  → mabs bind to antigen
  → γ-ray camera used to detect position of antibodies
→ Used in → identifying exact strain of virus / bacterium
  → blood typing
  → tissue typing
→ Mabs in treatment
  → trigger immune response ∴
    ↳ alter genes to code for human sequences of amino acids
    ↳ change type & position of sugar groups that are attached to the heavy chains to the arrangement found in human antibodies.
  → binds to cancer cells and marks them for destruction by immune system
  → binds to protein secreted by T cells that causes damge to cartilage in joints & blocks its action (rheumatoid athritis)
  → treat diseases in which there is an overproduction / inappropriate production of B cells (or other cells)