Immune System

microbes attack our body → 2 types of immunity : Innate + Adaptive

Innate immunity (no memory)

1st line of defense = skin, mucous membranes, resident microbes

2nd line of defense

Phagocytes (neutrophils, eosinophils, dendritic cells, macrophages)

Natural Killer cells, inflammation, fever, antimicrobial chemicals

Early warning system

TLR toll like receptors = protein receptors in the plasma membranes of defense cells

↳ attaches to **PAMPs** which cause release of Cytokine proteins

Cytokines recruit macrophages + dendritic cells to isolate + DESTROY microbes

Cytokines activate T cells and B cells

Skin = epidermis + dermis + sebum (oil)

sweat = Lysozyme (kill bacteria cell walls)

mucous membrane have epithelial layer

lacrimal apparatus makes + drains tears

gastric juices

vaginal secretions

urine

Epithelial cells (endothelial cells)

line blood + lymphatic vessels

Adaptive Immunity

3rd line of defense = Lymphocytes (T cells & B cells, antibodies)

slow to respond

Blood erythrocytes, leukocytes, platelets

[Leukocytes]

- Granulocyte differ based on stain colour: neutrophils, basophils, eosinophils
  - neutrophils have ability to enter infected tissue and DESTROY microbe
  - basophils release histamine for inflammation + allergy response
  - eosinophils make toxic proteins to kill parasites
- Agranulocyte
  - monocytes ⟹ Macrophages
  - dendritic cells (skin, mucous, thymus, lymph nodes)
    - function = DESTROY microbes by Phagocytosis and initiate immune response

Lymphocytes (Natural Killer Cells, T cell, B cell)

NK cells able to kill a variety of infected cells, tumor cells

chemicals = perforin (⇒ lysis), granzymes (= apoptosis)

T and B cells

stem cell bone marrow OR liver → bone marrow - adults → B Cells → lymph nodes / spleen

stem cell bone marrow OR liver → thymus → T Cells → lymph nodes / spleen

Lymphatic System = vessels, structures, organs (tissues), bone marrow

* spleen has lymphocytes + macrophages * thymus site for T cells

Phagocytosis (WBC)

• infection • → neutrophils eosinophils dendritic cells + monocytes ⇓ macrophages

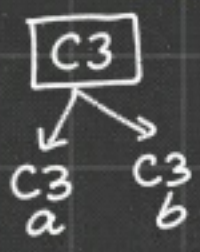
multiply + dominate in the blood in early stages

later stages Macrophage dominate and phagocytize bacteria

stages = Chemotaxis, Adhesion (PAMPs TLR, Opsonization)
Ingestion, Digestion, Elimination

Complement System (liver produced proteins) not adaptive but innate immune

DESTROY microbes by lysis, inflammation + phagocytosis



uppercase 'C' active when split

C1 → C9 proteins activated proteins 'a' and 'b'

one reaction triggers another

Classical pathway = antibodies bind to antigens (microbes)

Alternative pathway = Complement protein contacts a pathogen

Lectin pathway = macrophage eats pathogen then releases Cytokines
lectin protein binds Carbohydrates

Interferons (cytokine family of antiviral proteins)

block virus multiplication host/cell specific

types = alpha (IFN-α), Beta (IFN-β), Gamma (IFN-γ)

made by lymphocytes + leukocytes

antimicrobial peptides punch holes in cytoplasmic membrane = lysis

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Adaptive Immunity

antigens proteins of invading microbes

antibodies recognize antigens and their epitopes then bind to the antigen

↳ Immunoglobulins (Ig) classes = IgG, IgM, IgA, IgD, IgE

IgG = fight circulating bacteria + viruses, trigger the Complement System

IgM = #1 to respond to infection but short life in blood

IgA = most common in mucous membranes + body secretions

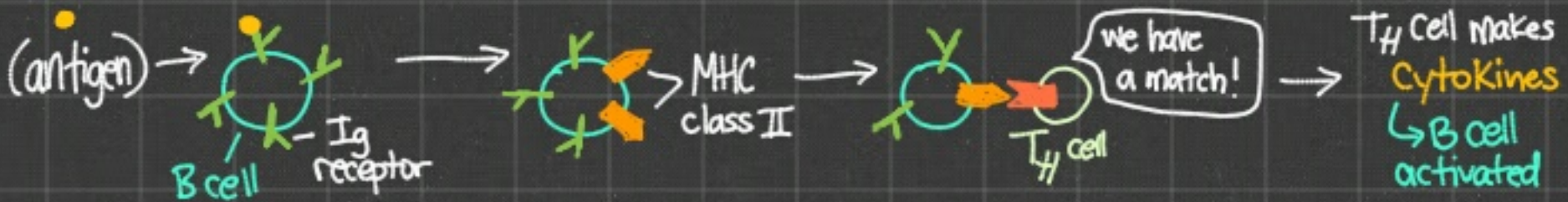
IgD = location of B cell surface, blood, lymph - unknown function -

IgE = fight allergic reactions

B Cells mostly have IgM + IgD which bind to the epitope, then B cell = Activated
an activated B cell then does proliferation and needs help from Helper T cells

Major Histocompatibility Complex = gene collection that encode molecules
AKA Human Leukocyte Antigen system

antigenic fragments + MHC displayed
on the B cell surface for T cell helpers to identify
MHC molecule ID's the host + prevents immune system from antibody attack



Antigen-Antibody Complex = antibody meets a specific antigen and binds to it
which tags the antibody for DESTRUCTION! (Phagocytosis)

- Agglutination = antibodies cause antigens to clump together
- Opsonization = antigen is coated with antibodies that aid in phagocytosis
- Neutralization = IgG antibodies block microbes from attaching to host cells

T Cells require that antigens be first processed by Antigen-Presenting Cells

Antigen-Presenting Cell = dendritic cells (skin, mucous, thymus, lymph nodes)

CD = cluster of differentiation = surface proteins

Classes: T Helper cells (T_H) $CD4^+$

(antigen) → dendritic cell (DC) → DC eats antigen → MHC II molecule put on surface → I_H has TLR and binds to MHC-antigen → Cytokines get made and T_H multiply

T_H cells can recognize an antigen on the surface of a macrophage and ACTIVATE → phagocytosis

T Cytotoxic cell (T_c) $CD8^+$

on their surface they wear fragments of endogenous antigens (virus/parasite)

$CD8^+$ recognizes antigens on target cell surface and MHC class I

T_c attaches to cell + releases perforin, Granzymes that kill the cell

T Regulatory (Suppressor) Cell function to fight autoimmune problems

T_H1 activate macrophages, T_c cells, NK cells

T_H2 stimulates production of eosinophils, IgM and IgE

T_c Lymphocyte
DESTROY target cells on Contact

NK cells attack and destroy target cells
ADCC

Natural killer Cell (lymphocyte)

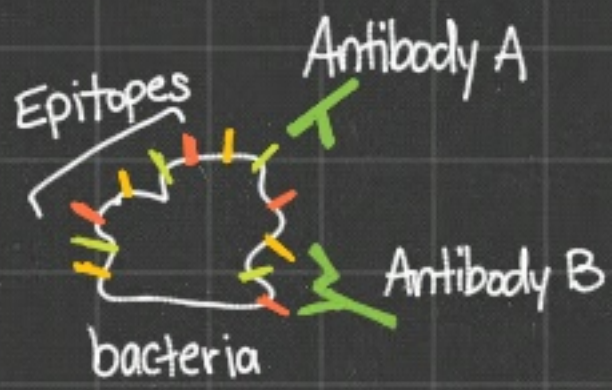
attack + DESTROY target cells no antigen required

Contact target → determine if it has MHC class 1 antigens

If NO = cell death by punching holes in the cell = lysis / apoptosis

Antibody - dependent cell mediated Cytotoxicity (ADCC)

organisms too big for phagocytosis So the body uses variety of cells to attack + kill


Epitopes
Antibody A
Antibody B
bacteria