

Immunology

Innate immunity

Adaptive immunity

Interaction with pathogens

Mammalian immune system

Physical barrier: Skin, mucus, low gastric pH

Innate as well as adaptive immune system

Innate: Quick response, not long-lasting

Adaptive: Slower response, long-lasting, memory

Innate immune system dominant system in plants, lower animals

Both innate and adaptive immune systems contain humoral and cell-based components

Comparison of innate and adaptive immunity

	Innate	Adaptive
Response time	Minutes to hours	Days
Specificity	Limited and fixed	Highly diverse, adapts to improve during the course of response
Response to repeat infection	Same each time	More rapid and effective with each subsequent exposure
Major components	Barriers, phagocytes, pattern recognition molecules	T and B lymphocytes, antibodies

Components of innate immune system

Cell-based

Macrophages

Natural killer cells

Dendritic cells

Polymorphonuclear lymphocytes

Granulocytes

Mast cells

Humoral

Complement system

Interferons

Cytokines

Initial recognition of pathogens

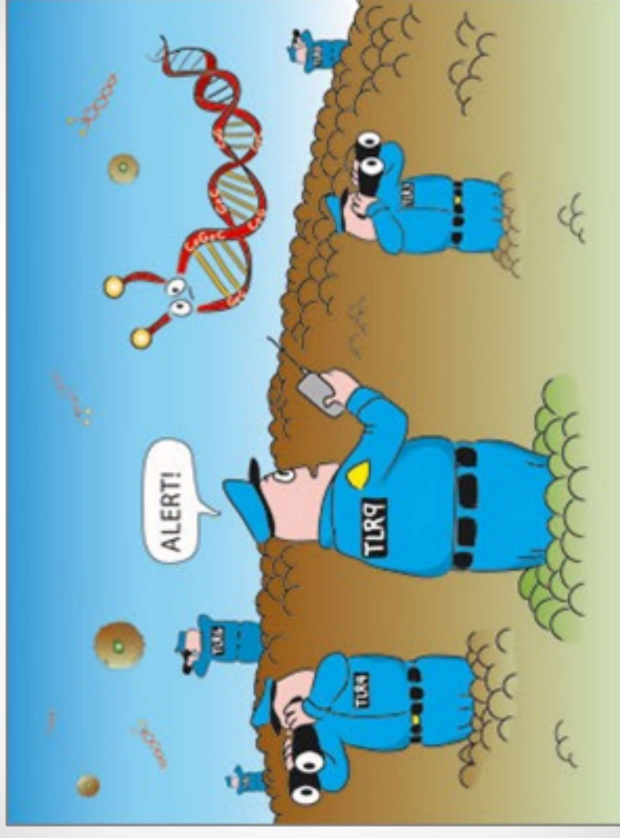
Recognition of Pathogen-Associated Molecular Patterns (PAMPs)

Cell wall components of bacteria (Lipopolysaccharides, Lipoteichoic acid, Peptidoglycan, Lipoteichoic acid, Lipoteichoic acid)

Double-stranded RNA in viruses

Recognized by Pattern recognition receptors (PRRs)

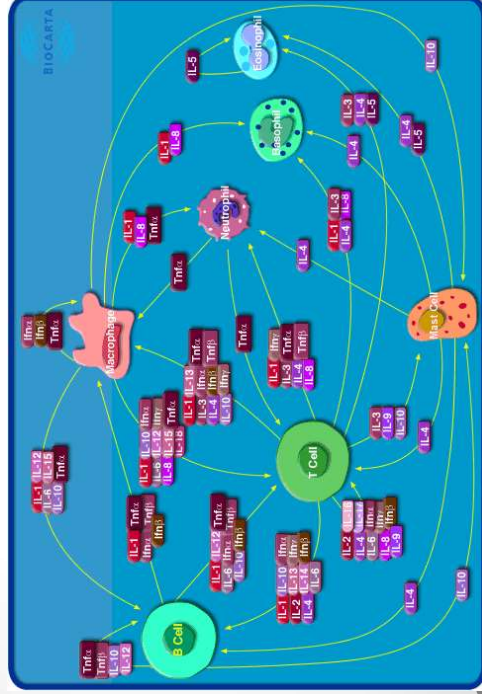
Toll-like-receptors (TLRs)



Leads to production of cytokines

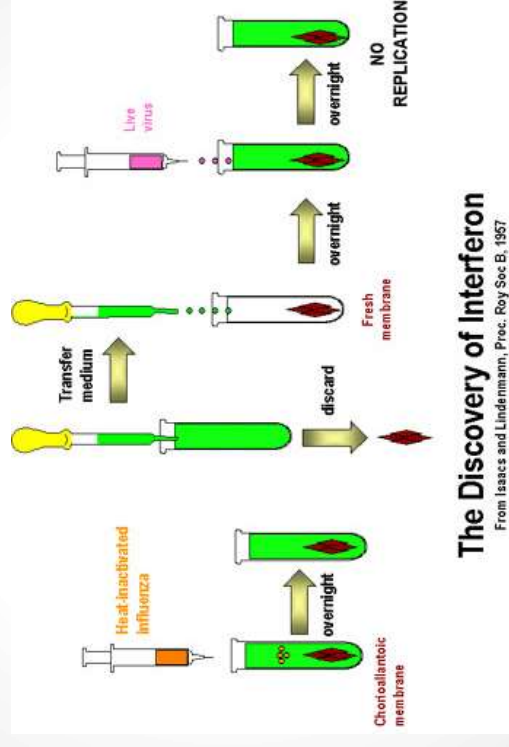
Role of cytokines

Cytokines - Proteins/peptides that stimulate/inhibit inflammation, promote tissue repair, activate cells of immune system



Source:biocarta.com

Interferons set up anti-viral state



The Discovery of Interferon

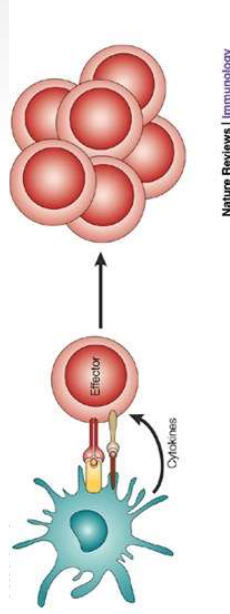
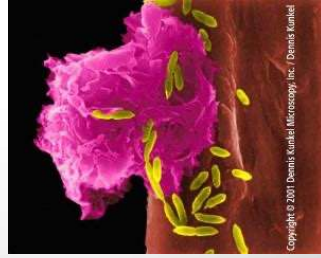
From Isaacs and Lindenmann, Proc. Roy Soc. B, 1957

Cellular components of innate immune system

Macrophages, PMNL, Natural Killer cells

Can engulf bacteria/infected cells

Macrophages/dendritic cells present foreign antigens to B/T lymphocytes- Antigen presentation



Components of adaptive immune system

Cell-based

B-lymphocytes (produce antibodies)
T-lymphocytes (helper and cytotoxic)

Humoral

Antibodies

Recognition of invading pathogen through “antigen”

Immune response tailored to suit the assault

Antigen - not only infectious material

Any “foreign” material

Distinction between “self” and “non-self”

Paul Ehrlich “Selective theory”

Modelle und Chemotherapie (Paul Ehrlich 1900)



One B or T cell makes one type of receptor
Antigen binds one receptor, helps in proliferation

Source: post.queensu.ca

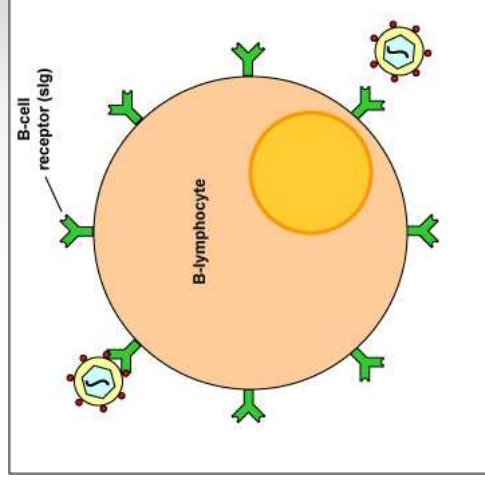
Components of adaptive immune system

B-lymphocytes

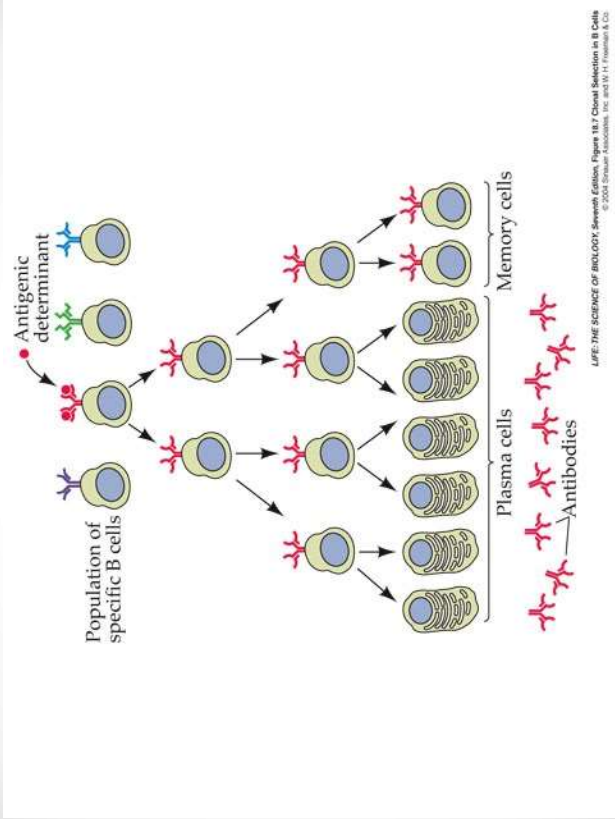
Produce antibodies

Each lymphocyte produces one type of antibody or “receptor”

Theoretically able to bind any ligand

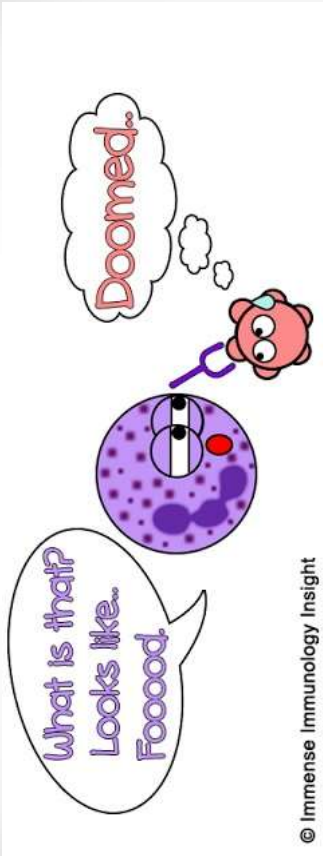


Clonal selection theory: Humoral Immunity (antibodies)



Source: course1.wilona.edu

Components of adaptive immune system

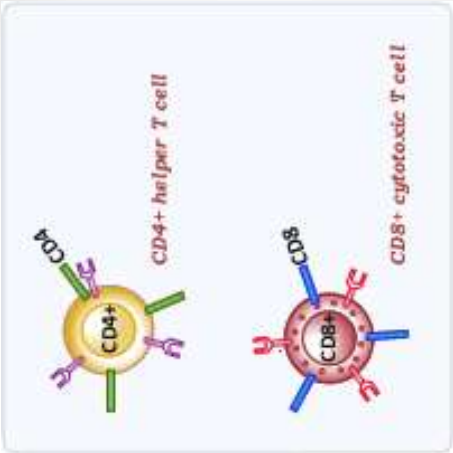


Antibody binds to antigens on pathogen surfaces

Attracts phagocytic cells

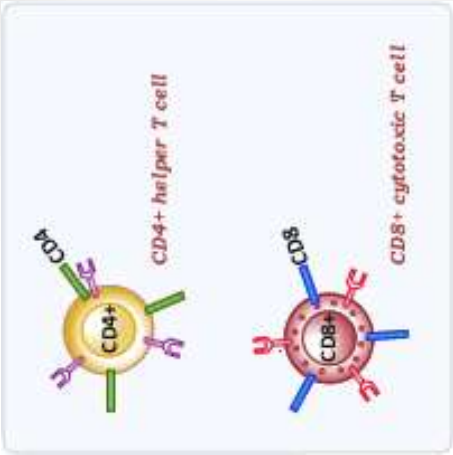
Pathogen engulfed

Components of adaptive immune system



Source: lookfordiagnosis.com

Components of adaptive immune system



Source: lookfordiagnosis.com

T-lymphocytes

1. CD8+/Cytotoxic T cells

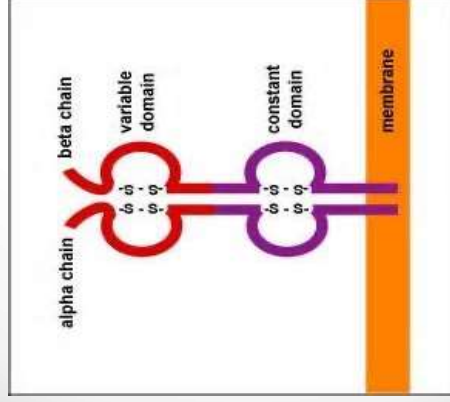
Kills infected cells
Major defense against viruses/
intracellular bacteria

T-lymphocytes

1. CD4+/Helper T cells

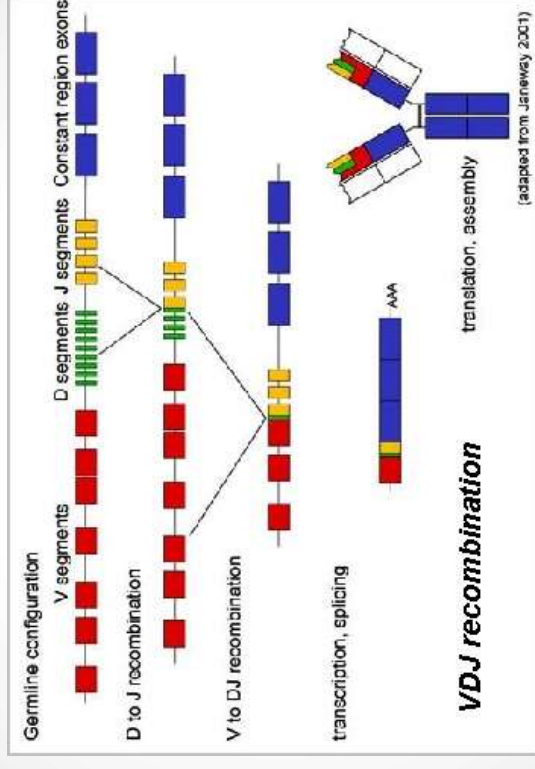
Activates CD8+ cells
B-lymphocytes
Macrophages

“Generation of Diversity” in B and T lymphocyte receptors



Source: faculty.ccbcmd.edu
jenabioscience.com

“Generation of Diversity” in B and T lymphocyte receptors



Tonegawa, 1976

“Generation of Diversity” in B and T lymphocyte receptors

Rearrangement and editing of genomic DNA

Happens in primary lymphoid organs (B cells - bone marrow, T cells - thymus)

Many B and T cells do not survive the recombination or quality control

Tolerance: Self-correction to ensure that “self” is not recognized as “non-self”

B and T lymphocytes are screened to ensure there is no recognition of “self”

Surviving cells move into circulation

Binding of antigen triggers clonal selection

B-cell receptors in secreted forms = Antibodies

T-cell receptors = no secreted forms

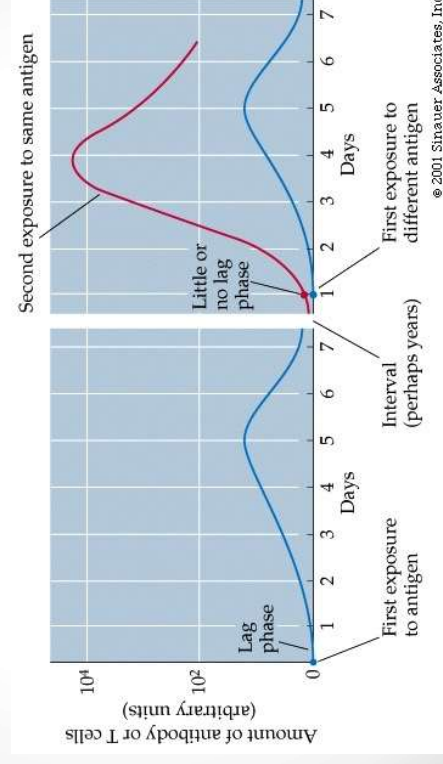
Required for recognition of “foreign” material presented by infected cells

Immunologic “memory”

Adaptive immune system generates “memory of antigen”

Can respond much more swiftly on subsequent exposures

No memory component of innate immunity



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Source: lookfordiagnosis.com

Dysfunctional immune response

Hypersensitivity (Allergy etc.) : Attack on common, benign but foreign antigens

Autoimmune disease: Targeting of self by immune cells
Multiple sclerosis, Crohn's disease

Immune deficiency: Insufficiency of immune system to protect against pathogens
SCID, AIDS

Robust self-tolerance leads to ignorance of cancerous cells

Immune system and bacterial infections

Innate immune response

Recognition of molecular patterns

Lipopolysaccharide/lipoteichoic acid stimulate production of cytokines
Activates tissue macrophages

Innate immune cells present antigens to adaptive immune system

Extracellular bacterial infection leads to production of antibodies

Antibody-bacteria/antibody-toxin complexes phagocytosed

Cells infected with intracellular bacteria engulfed by CD8+ T-cells

Bacterial evasion of immune response

1. Alteration of surface antigens
2. Inhibition of cytokine/complement/antigen presentation
3. Blocking phagocytic cells/antibodies/T-cells

Immune system and viral infections

Barrier Immunity

Innate immunity - Involvement of Toll-like receptors
Recognition of ds RNA

Interferon generation, antiviral state

Adaptive immunity - Antibodies may bind to key viral structures
Interfere with ability of virus to enter host cells

Cell-mediated immunity is essential
T cell activity peaks after 7-10 days of infection
Eliminate sources of new virus

Viral evasion of immune response

- 1. Alteration of surface antigens**
- 2. Inhibition of cytokine/complement/antigen presentation**
- 3. Blocking phagocytic cells/antibodies/T-cells**
- 4. Immunosuppression and latency**