

Introduction to Immune System

Learning outcome

- You will be able to understand, at a fundamental level, the STRUCTURES and FUNCTIONS of cell surface and soluble molecules involved in recognition of foreign antigens

And

- You will be able to understand the way in which the DIFFERENT CELL TYPES expressing these molecules INTERACT during the immune response.

Introduction to the Immune System

- Innate and adaptive immunity
- Humoral and cell-mediated immunity
- Cells of the immune system

More commonly used terms

Antigen

Antibody

Affinity/Avidity

Cellular immunity

Complement

Chemotaxis

Cytokine

Humoral immunity

Hypersensitivity

Immunoglobulin

Inflammatory

MHC restriction

Opsonisation

Processing

Endogenous & Exogenous

Pathogen

Diversity

Epitope

Naive and memory

Tolerance

Ig (IgD, IgM, IgG, IgA, IgE)

TCR

MHC (HLA)

TLR

PRR

PAMP

Th1/Th2/Th17

Treg

MALT

1. What is the main function of the Immune System?
2. What are the most important features of the Immune System?

Primary function of the Immune System:

To protect individuals against infection

***- must be able to distinguish
‘self’ from ‘non-self’***

Dysfunctions: Immunodeficiency
 Allergy
 Autoimmunity

What does the Immune System protect against?

Potentially pathogenic organisms

- Bacteria: Extracellular / (intracellular)
- Viruses: Obligate intracellular parasites
- Fungi: Mostly extracellular
- Parasites: Extracellular or intracellular

Features of the Immune System (1)

Specificity

Immunised against	Protected against:		
	Polio	Measles	Diphtheria
Polio	+	-	-
Measles	-	+	-
Diphtheria	-	-	+

Features of the Immune System (2)

Memory ذاكرة

- Advantage to recognise antigen more rapidly and efficiently on second exposure.

Redundancy وفرة

- If one mechanism fails or is circumvented, another can take over.

Complementarity متكامل

- Different mechanisms operate at different times or locations.

Co-operation التعاون

- Between different cells and molecules of adaptive and innate systems.

Innate and Adaptive Immune Systems

Innate

Rapid, first line of defence against infection

Adaptive

Later, more specific response

Innate vs. adaptive immune systems

Response	Kinetics	Specificity	Memory
Innate	Rapid (early)	+	-
Adaptive	Slow (late)	+++	+++

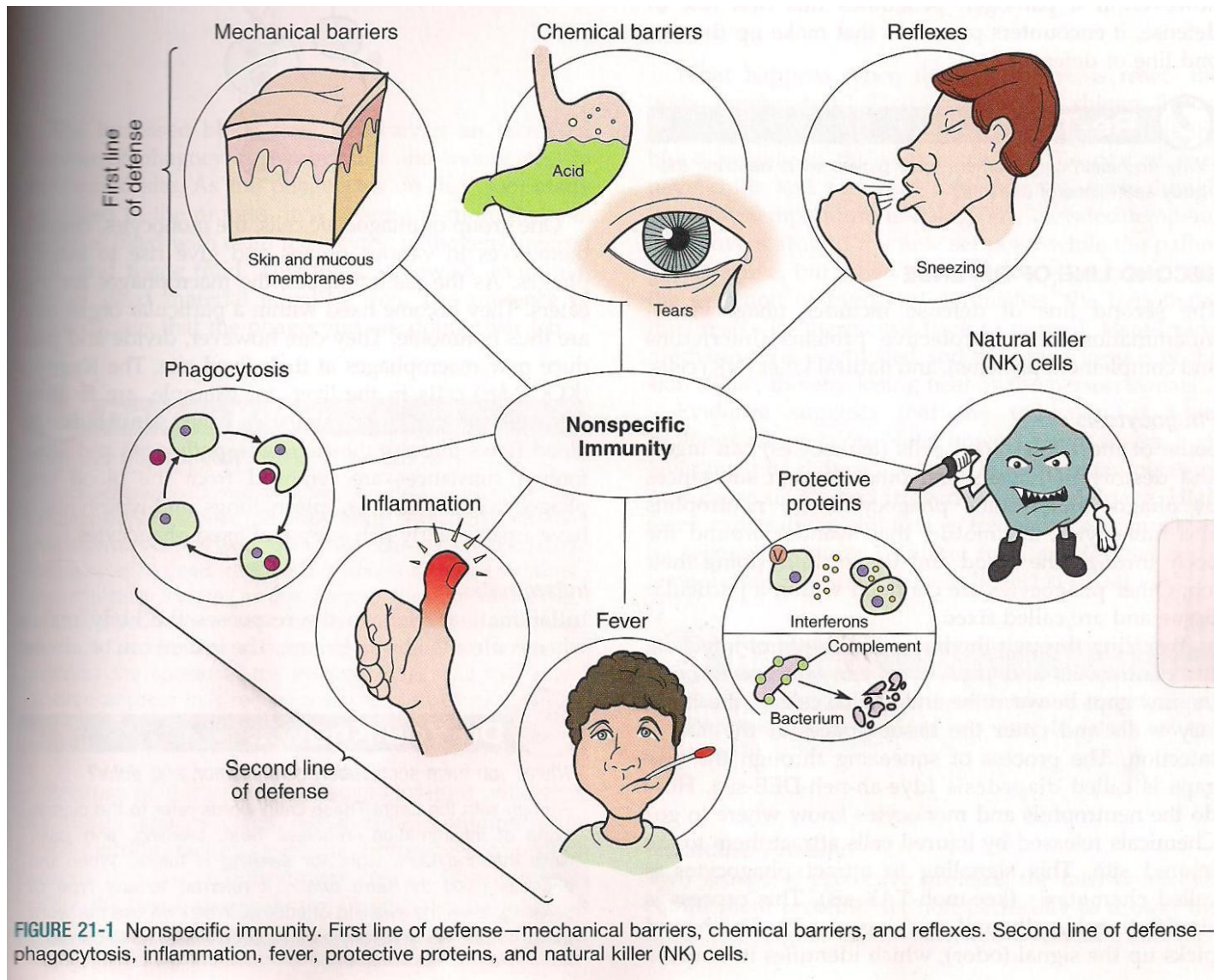


FIGURE 21-1 Nonspecific immunity. First line of defense—mechanical barriers, chemical barriers, and reflexes. Second line of defense—phagocytosis, inflammation, fever, protective proteins, and natural killer (NK) cells.

The Innate Immune System (1)

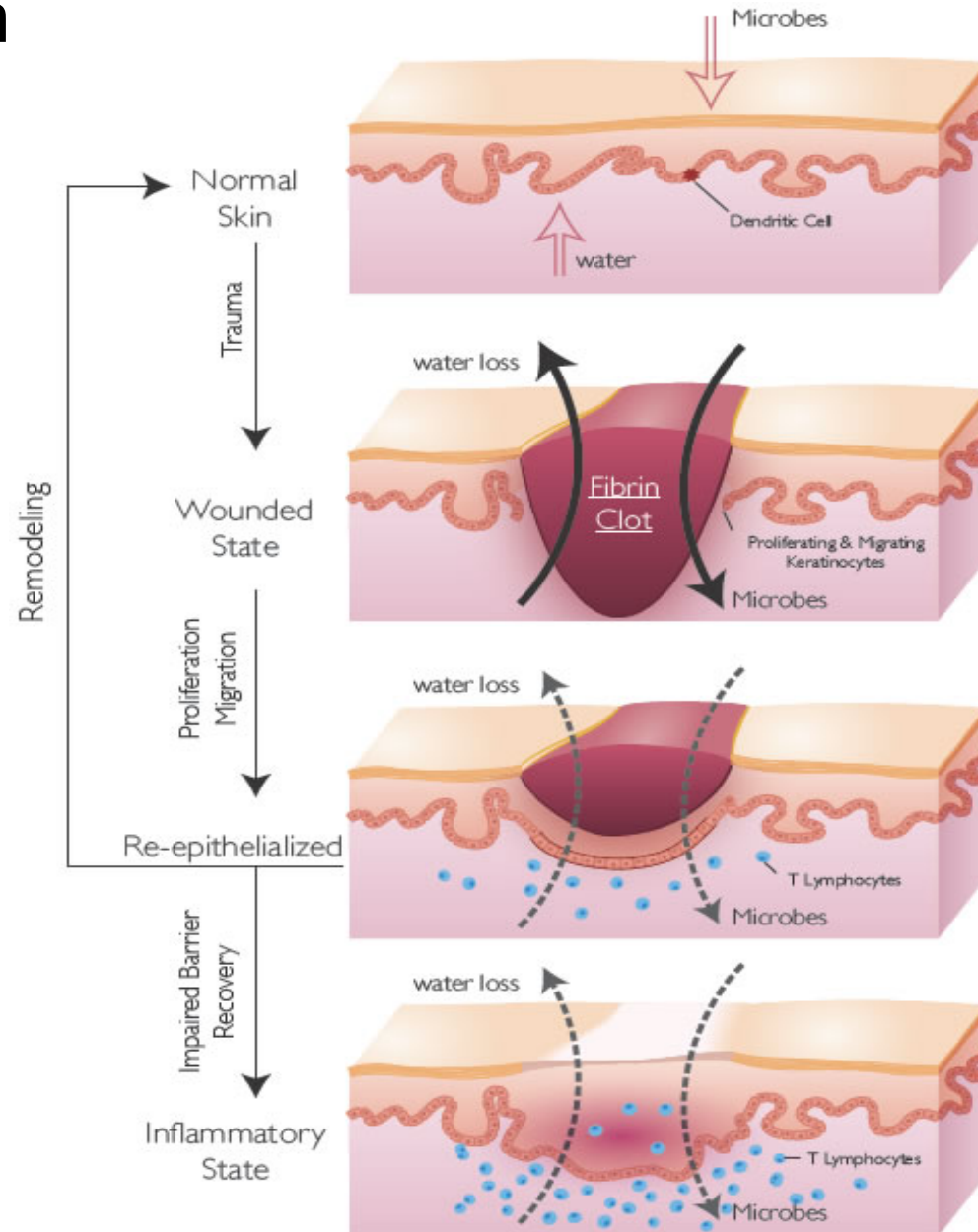
Skin/epithelia

- physical barrier to infection

Mucous membranes

- low pH
- peristaltic flow/cilia
- dilution and flushing
- mucus trapping
- normal flora

The Skin



The Innate Immune System (2)

Soluble proteins

- bactericidal
- opsonising

Leucocytes

- phagocytic cells
- cytotoxic cells (NK cells)

Cells of the Immune System

Granulocytes	-	Neutrophils
	-	Eosinophils
	-	Basophils

Mast Cells

Macrophage/Monocytes

Natural Killer (NK) Cells

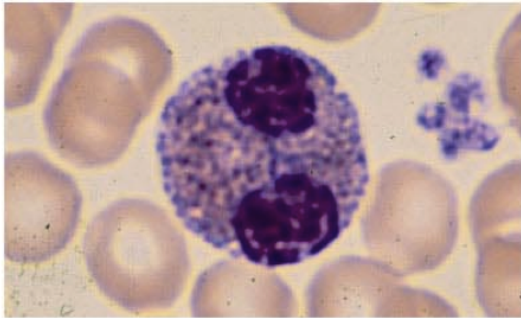
Adaptive:

B Lymphocytes

T Lymphocytes

Leukocytes or (WBCs)

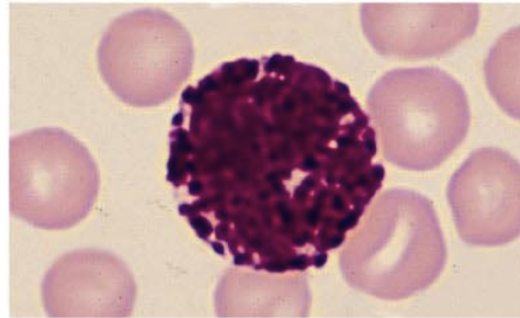
Granulocytes



Basophil 0.5–1%

LM

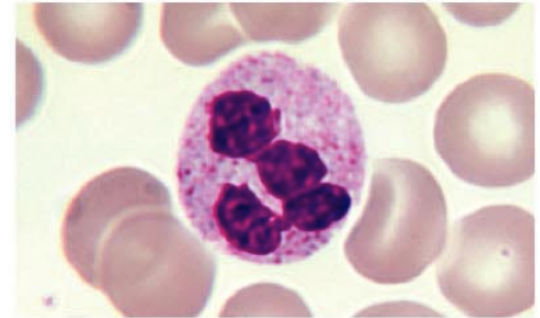
7.5 μ m



Eosinophil 2–4%

LM

7.5 μ m



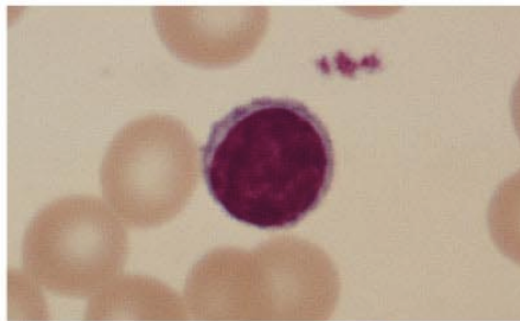
Neutrophil 60–70%

LM

7.5 μ m

(a)

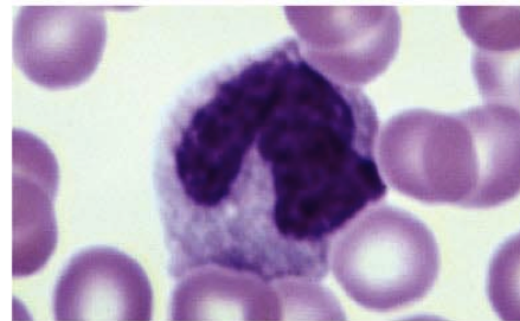
Agranulocytes



Lymphocyte 20–25%

LM

7.5 μ m



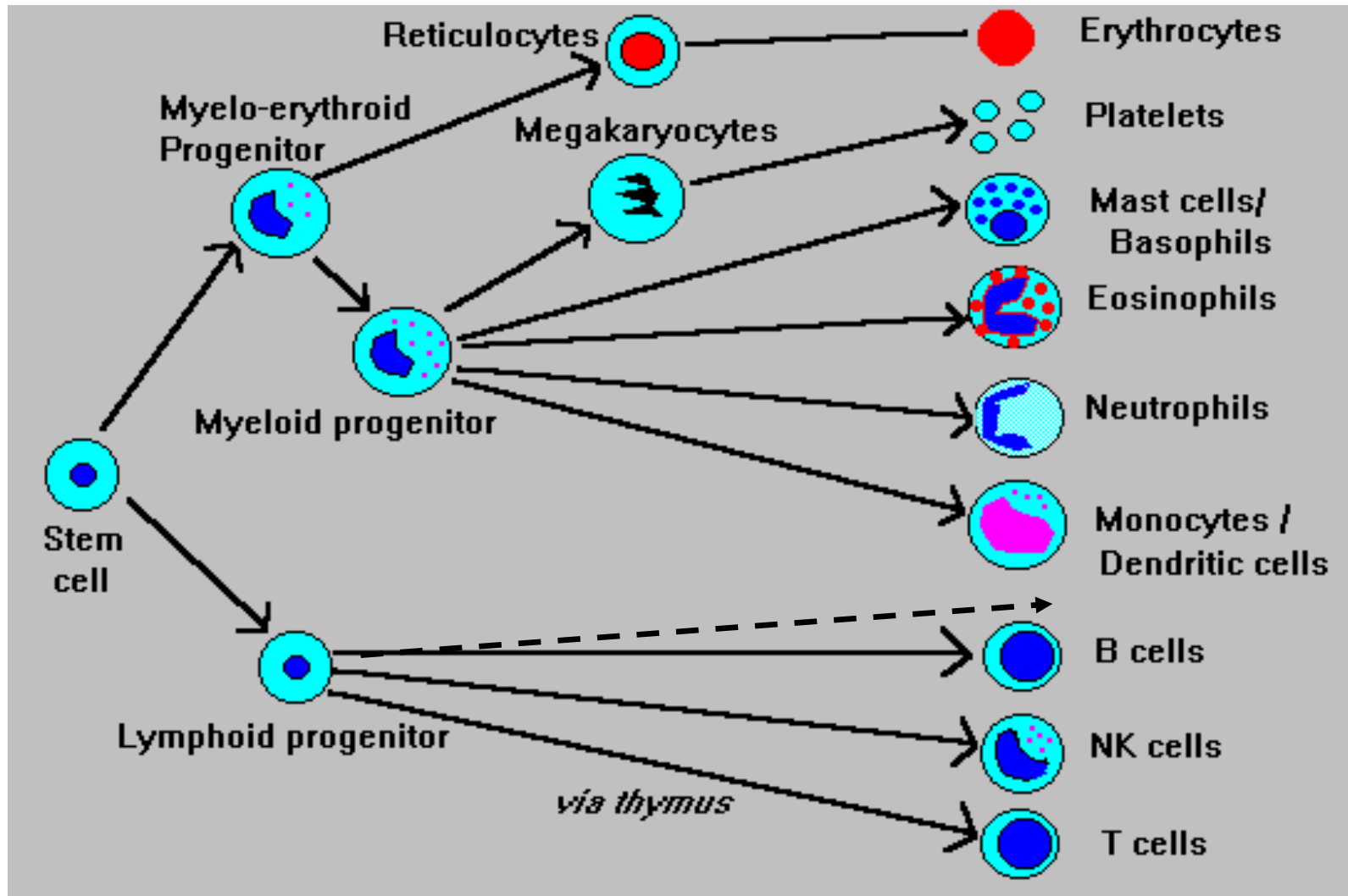
Monocyte 3–8%

LM

7.5 μ m

(b)

Haematopoietic Cell Lineages



Haematopoiesis

تكوين خلايا الدم

- Almost exclusively takes place in bone marrow
- All haematopoietic cells derived from a common bone marrow stem cell
- Regulated by cytokines which act on early or later stages of differentiation

Phagocytes of the Innate Response

Monocyte/macrophages

Neutrophils (PMN)

Long half life in blood

Short half life in blood

Chronic inflammation

Acute inflammation

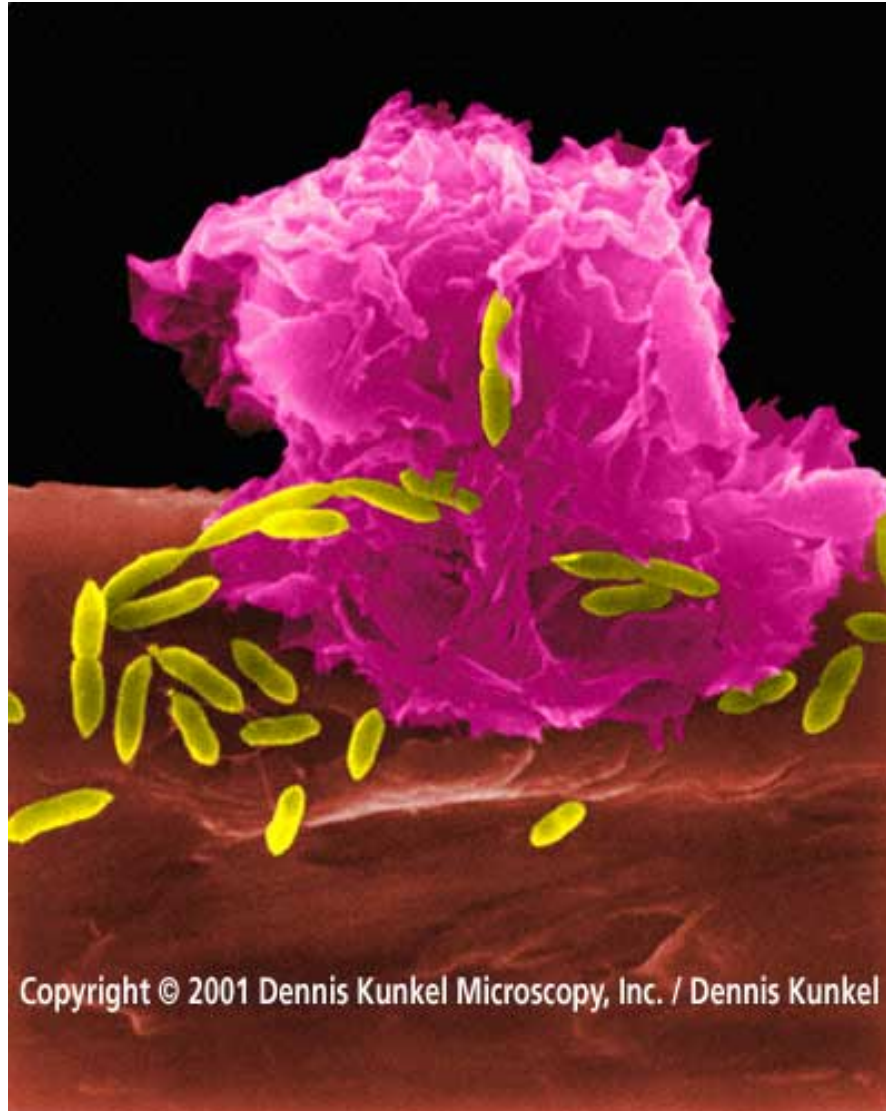
Resident tissue cells

Usually confined to blood

Both phagocytic for microbes

Both contain lytic granules

Phagocytosis of E.Coli



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Mononuclear Phagocyte Lineage

Blood:	Monocytes (Dendritic Cells)
Tissues:	Macrophages/Histiocytes/Dendritic Cells
Liver:	Kupffer Cells
Lung:	Alveolar Macrophages
Bone:	Osteoclasts
Brain:	Microglia
Synovium:	Type A synovial cells
Skin:	Langerhans cells
Lymphoid tissues:	Dendritic cells/Macrophages

Cytokines: Molecular messengers of the innate and adaptive immune responses

- Soluble protein mediators
- Produced by or act upon leucocytes
- Act via cell surface receptors
- Act in networks

The Complement System

A cascade of plasma proteins that provide rapid defence against infectious agents

- Classical pathway (antibody dependent)
- Alternate pathway (direct)
- Lectin pathway (soluble innate mediators)

Functions: Lysis, chemotaxis, opsonisation

Summary –

Functions of the Innate Immune Response

Soluble mediators

Bind to pathogens or their products, neutralise their function or aid their removal by phagocytic cells = opsonisation.

Phagocytic cells

Sequestration and elimination of pathogens.

Adaptive Immune Responses:

Humoral and Cell-Mediated Immunity

- Huge range of potential pathogens
- Susceptible to rapid genetic mutation
- May be intracellular or extracellular
- Need more than one mechanism of protection

Adaptive Immune Responses:

- 1- Antigenic Specificity (recognize different molecules)
- 2- Diversity (recognize different structure)
- 3- Immunologic memory (Second challenge)
- 4- Self/ Non-Self Recognition

Mediators of the Adaptive Immune Response

Antibodies Mainly against antigens in body fluids
Neutralisation of bacteria and viruses

T cells Exclusively against cell-bound antigens
Killing of virus-infected cells
Killing of intracellular bacteria (indirect)
Killing of tumour cells

T- Lymphocytes



Thymus



Cell – mediated immunity

B- Lymphocytes



Bursa at Fabricius



Humoral immunity

Interaction between Innate & Adaptive Immune Response

- Cooperative relationship
- Soluble mediators facilitate antigen uptake by antigen presenting cells (APC)
- Cell surface receptors also enhance uptake of antigen
- Triggers adaptive immune response

Homework assignment

1. Describe the different types of immune system?
2. How do they function?