Components of the innate immune system

Ali Al Khader, MD
Faculty of Medicine
Al-Balqa’ Applied University
Email: ali.alkhader@bau.edu.jo
Before our discussion about innate immunity...
Differences between innate and adaptive systems:

- **Innate immune system** = “natural” = “native”
  - Germline: prepared before exposure
  ...the defense is direct or just needs some activation after exposure

  - Mainly against microbes

  - With repetition...the response is the same

  - Identify groups of related microbes...not distinguishing fine differences
  ...limited diversity
Before our discussion about innate immunity...

Differences between innate and adaptive systems:

• Adaptive immune system = “acquired” = “specific”

• It adapts: performance with repetitive exposure...the ability to remember

• High specificity... distinguishing fine differences...the specific target molecules = antigens

• Large diversity... by somatic recombination of gene segments

• Immunoglobulins...by B lymphocytes
Components of the innate immune system

• Physical barriers

• Biochemical “weapons”.. including chemicals that are:
  - Secreted from cells locally
  - Blood proteins
  - Cytokines...messenger molecules

• Biological barriers

• Cells
Physical barriers

- Skin
- Mucous membranes
Skin..epidermis

- Static: Cornified layer (=stratum corneum)
  - Watertight barrier..prevents dehydration
  - Dry..unsuitable for microbes

- Dynamic: continuous proliferation and shedding..
  removing microbes
Mucous membranes

• Lining of body cavities

• In GI and respiratory tract: goblet cells....excessive amount of mucus daily

• In respiratory tract: mucus traps bacteria, fungi and particles

• In GI: *mucus -protects from HCL and digestive enzymes
  -movement of ingested materials
  -environment for molecular exchange
  -isolation of microbes
  *sloughing and renewal
Respiratory tract...more features

- Hair in nostrils...particles >1cm
- Cilia...move secretions with trapped microbes or particles..coughing/sneezing

Smoking & alcohol affect their function..

**Cystic fibrosis:  🤔 -Which gene is affected?
-What does it encode?
-Why is the patient more prone to infections?
Urinary tract...special features
Urination...externally directed fluid pressure
...disrupted by urinary catheter
...nosocomial UTI

Vagina...special features
-Acidic secretions...biochemical
-Microbicidal molecules...biochemical
Biochemical "weapons"

- pH
- Microbicidal molecules
- Enzymes, esp. lysozyme in mucus, saliva, macrophages, neutrophils...etc.
- Blood proteins
- Cytokines...messenger molecules
pH

-Skin: 5.5...sebum, sweat and the fatty acids secreted by normal flora

-Stomach: 1-3...very few bacteria can live there

-Vagina: 4.4-4.6...Lactobacilli
Microbicidal molecules

• Defensins...alpha or beta

• Cathelicidins...special action against lipopolysaccharides in Gram (-) bacteria

**Defensins + cathelicidins = antimicrobial peptides
  ...also activate leukocytes

• Reactive oxygen species by activated neutrophils and macrophages
Microbicidal molecules & enzymes in specific tissues

• Skin
  - Alpha-defensins
  - Beta-defensins
  - Cathelicidin
Other molecules from the skin

• Fatty acids from commensal microbes

• Enzymes...
  - lysozyme in sweat...breaks down peptidoglycan
  - RNases and DNases

• Salts in sweat
Respiratory tract
• Beta defensins
• Cathelicidin
...Microbicidal and activation of leukocytes

GI
• Alpha defensins...the main producer: Paneth cells, these are called: crypticidins
• Digestive enzymes, esp. lysozyme in saliva
• Cathelicidin
Eye

Lacrimal secretions...lysozyme
Circulating proteins

• Complement system...will be discussed later

• Mannose-binding lectin... = collectin
  - Opsonization
  - Activation of complement

• C-reactive protein... of pentraxin family of proteins
  - Opsonization
  - Activation of complement
Biological barriers

= Commensal microbes = normal flora

**What do you know about?**
- Vaginal candidiasis
- Pseudomembranous colitis
Leukocytes

Pluripotent hematopoietic stem cell

Myeloid lineage

Granulocytes
  Mast cells
  Eosinophils
  Basophils
  Neutrophils

Agranular phagocytic cells
  Monocytes
  Macrophages
  Dendritic cells

Lymphoid lineage

B cells...Plasma cells

T cells

NK cells

Innate system
Agranular leukocytes

- We will not talk about lymphoid lineage (mainly adaptive immunity)
  ...However:
  - NK cells (Non-phagocytic lymphoid-derived cells) have roles in innate and adaptive immune system.
  ...special function against virus-infected cells
  - Intraepithelial lymphocytes are of the innate system...of T and B-1 subsets

- Agranular phagocytic cells:
  - Monocytes in blood
  - Macrophages in tissues
  - Dendritic cells: -branchlike cytoplasmic processes
    -both myeloid and lymphoid origins...mainly myeloid
Monocytes

- 1-2 days in circulation...short half-life in blood
- Settle in tissues for months as: macrophages
- Phagocytosis \(\rightarrow\) enzymatic degradation and bactericidal activities
Dendritic cells

• Phagocytosis

• A special type called plasmacytoid dendritic cells: special actions against viruses

• Important in adaptive immunity...antigen presentation for T lymphocytes
Granulocytes

- Neutrophils
- Basophils and mast cells
- Eosinophils
Neutrophils

- The most numerous of leukocytes
- 60% of peripheral blood WBCs
- = PMN cells (2-5 lobes)
- Half-life: 7 hours
- ↑ in acute inflammation
- When exhausted.. ↑ Immature forms in peripheral blood
Neutrophils...types of granules

**Enzymatic + bactericidal activities

**2 types of granules:
• **Specific granules:**
  - Enzymes: lysozyme, collagenase,..etc
• **Azurophilic granules:**
  - Enzymes & microbicidal substances (defensins and cathelicidins)
    → esp. elastase and cathepsin G, and also: lysozyme
Basophils and mast cells

• Granules contain amines...basophilic

• Vasoactive amines, e.g., histamine
  ...smooth muscle contraction: bronchoconstriction

• Tissue-resident form: mast cells

• Action: degranulation

• Allergic reactions
Eosinophils

• Innate and adaptive immunity

• Special function against helminths

• Have roles in allergic reactions
Thank You