An introduction to innate immunity

Hans-Peter Duerr

Department of Medical Biometry
University of Tübingen, Germany

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Motive: superinfection with helminths

Parasite establishment rate (PER)

\[
\text{established parasites per year}
\]

"Proportional" immune response (\(PER = 10^{-3} \cdot IR\))

Infection rate (IR)

\("offered" parasites per year\)

The problem with a proportionally acting immune response:

\(IR = 100, \ PER = 0.1 \rightarrow 99.9 \text{ parasites are eliminated by the immune response}\)

\(IR = 1000, \ PER = 1 \rightarrow 999 \text{ parasites are eliminated by the immune response}\)
Program

Part I: Biology of (innate) immunity

Part II: Observations & Hypotheses

Miscellaneous: Immunosenescence

Immunouppression
Relevance for modeling

- **immunity**
  - 684,341 publications

- "innate immunity"
  - 3,365 publications

- immun* & math* & model
  - 488 publications

- innate & immun* & math* & model
  - 13 publications
Pathogens

• Bacteria
• Viruses
• Parasites, Protozoa
• Fungi
• Proteins, Prions
• Cancer cells

"90% of infections are controlled by the innate immune response."
Innate & adaptive immunity

**Innate Immunity**
- is fast (hours)
- is genetically based and inheritable
- is nonspecific: All antigens are attacked pretty much equally
- no memory
- evolutionary "old"

**Adaptive Immunity**
- is slow, delayed (days)
- receptors are somatically encoded
- is highly specific via antibodies
- memory, can last life-long
- evolutionary "young"
First-line defense: Physical and chemical barriers

**Saliva, tears, nasal secretions**: contain lysozyme, destroys Gram positive bacterial cell walls.

**Lactoperoxidase**: enzyme found in mother’s milk.

**Lungs**: ciliary action; coughing and sneezing.

**Stomach**: hydrochloric acid (0.9 < pH < 3.0) and protein-digesting enzymes

**Hair follicles** secrete sebum ("Talg") that contains lactic acid and fatty acids: inhibit the growth of some pathogenic bacteria and fungi.

**Skin**: mechanical barrier, secretions inhibit growth of organisms.

**Sticky mucus** in respiratory and gastrointestinal tracts.
Second-line defense: Phagocytic cells & CK's

Granulocytes
(polymorphonuclear leukocytes, PML)

Natural killer cells

Makrophages

Cytokines (Interleukines, IFN, TNF):
messenger substances of the immune system
Interaction between innate and adaptive immune system

Dendritic cells

e.g. Macrophages

become

APCs

(antigen-presenting cells)

interact with

Lymphocytes

Innate

immune system

Adaptive

immune system
Hypotheses & observations

Evolutionary "old" pathogens:
- viruses
- protozoa

Evolutionary "young" pathogens:
- metazoa ("parasites")
Hypothesis on controlled superinfection

Legend
- Host protected against superinfection
- Host susceptible due to loss of immunity
- “Unsuccessful” parasite (becomes neutralised)
- “Successful” parasite (leads to infection)
Modifications of controlled superinfection

Magnitude of the immunological response diminishes over time
due to influences of suppressing or degenerating immunity (infection, age)

Threshold of susceptibility decreases with time
due to influences of suppressing or degenerating immunity (infection, age)

Legend
- Host protected against superinfection
- Host susceptible due to loss of immunity
- "Unsuccessful" parasite (becomes neutralised)
- "Successful" parasite (leads to infection)
Hypotheses & observations

→ Multiple (instable) equilibriae?
Outlook

DFG-Projekt:  
*Mathematische Modelle zum Infektionsprozess bei Filariosen und seine Bedeutung für die großen Bekämpfungsprogramme APOC und GPELF*

60-90 days
Hans-Peter Duerr
Universität Tübingen
Institut für Medizinische Biometrie