Host Response To Disease

Chris Chase
Department of Veterinary and Biomedical Sciences
South Dakota State University
Brookings SD

Credits
- Patricia LeFleur HHMI
- Kuby Immunology
- Immunobiology, 6th edition
- David Topham, University of Rochester

Topics
- Herd Immunity
- Immunology
Herd Immunity

- A situation in which a sufficient proportion of a population is immune to an infectious disease (through vaccination and/or prior illness) to make its spread from person to person unlikely. Even individuals not vaccinated (such as newborns and those with chronic illnesses) are offered some protection because the disease has little opportunity to spread within the community. Also known as community immunity.

- Synonyms: Community Immunity; Coverage

- Cocooning- herd immunity within a household

- http://www.vaccinestoday.eu/vaccines/what-is-herd-immunity/

Herd Immunity

Sustained transmission

Transmitting case ←→ Susceptible case ←→ Transmitting case ←→ Susceptible case

Transmission terminated

Transmitting Case (A) ←→ Immune (B) ←→ Susceptible (C) (Indirectly Protected)
Herd Immunity

Basic reproduction number

\[ R_0 = 3 \]
What is the immune system?
- The body’s defense against disease causing organisms, cancer cells, and foreign particles

Think of the body as a hollow plastic tube...

The food is digested within the hole in the tube, but it never actually enters into the solid plastic material.

Escherichia coli is common and plentiful in all of our digestive tracts. Why are we all not sick?
- These bacteria are technically outside the body and aid in digesting material we cannot
- Only if E. coli are introduced in an unnatural manner can they break through the first line of defense and harm us
Immune responses

1st Line of Defense
Barriers
- mucous, tears, gastric pH,
- saliva, skin

2nd Line of Defense
Cellular and humoral defenses
- interferon, cytokines (pro-inflammatory and T stimulatory), complement proteins,
- phagocytosis, NK cells

3rd Line of Defense
Cellular and humoral defenses
- Antibodies, cytokines, T helper cells, cytotoxic T cells

Epithelial Cells and First Line of Defense
- Decrease water intake- dehydration barrier

Epithelial Barriers
Microbiota (Microflora)

- The collection of organisms found in and on our body—very location specific and individual specific (genetic component)
- Gastrointestinal microbiota is the most diverse and has the largest interaction both with mucosa and ingesta—"superorganism"
Commensal Organisms

- $10^{14}$ organisms—eukarya, archae and bacteria
- $10^{12}$ commensal bacteria/ml- 10X higher than the combined somatic and stem cells in man
- Commensals are essential for immune development
- Composition of commensal bacteria influenced by the host immune status

Commensal Bacteria-Inhibit proinflammatory responses
• Innate Immunity - 2nd Line of Defense
  the troops are called to battle...
  – injury & infection
  – macrophages are on patrol
  – cytokine chemicals attract other “troops”

Inflammatory Response

IL-1 Proinflammatory cytokines

Recruitment
Toll-like Receptors

Pathogen-associated molecular patterns (PAMPs)
Toll-like Receptors - Pathogen Recognition Receptors (PRRs)

Activation of Receptors and Antigen Presentation

The Second Line of Defense ~White Blood Cells~
- If invaders actually get within the body, then white blood cells (WBCs) begin their attack.
- WBCs normally circulate throughout the blood, but will enter the body’s tissues if invaders are detected.
- These white blood cells are responsible for eating foreign particles by engulfing them.
**Second Line of Defense**

**Phagocytosis**

Neutrophil Chemotaxis and Phagocytosis

**2nd Line of Defense**

**Acute Inflammatory Response-Pathogens**

- Hypothalamus
- Pituitary
- Adrenal cortex
- Complement
- Inflammation
- White blood cells

Dendritic Cell

- Toll like receptors
- Pathogen-associated microbial patterns (PAMPs)
- Pathogen Recognition Receptors (PRRs)
Dendritic Cells

Why Dance Longer?

Why Dance Longer?

Primary Immune Response

- Acquired Immune response = T cell (CD4) + Dendritic Cells
- The Occurrence of the Specific Acquired Response is a Numbers Game-
- What is the chance that a T cell will react with APC expressing its antigen???
  - Number of Naïve T cells Fixed: 1:5000-1:10,000
  - APC is the variable cell - affect the number of APC and how much antigen they express

Getting a Vaccine Response

Generating Memory Response.

Each new cell is identical to the parent cell.
Getting a Better Vaccine Response

Adjuvant and/or delivering in APC (Dendritic cell) areas increases APC and MHC II expression.

Animated Short

Immune Response - T cell (CD4) + Dendritic Cells
How does TLR work for Antigen Presentation

Linking Innate and Adaptive Immunity

Activation of the Acquired Immune Response- Threshold T Cell Population- Multiplication
Balancing Act

- Just enough to prevent/control disease
- Too much of a good thing- immune pathology
- Too little response- pathogen wins
- Immune response is not always a good thing

The Third Line of Defense

~Acquired or Adaptive Immunity~

- Most infections never make it past the first and second levels of defense
- Those that do trigger T and B cells and the production and release of antibodies
  - Each antibody binds only to one specific binding site, known as an antigen

The host immune response to infection
Humoral Immune System

Cellular Immune System
- helper T cells
- cytotoxic T cells

Active Immunity
- The production of T cells, B cells and antibodies against a specific disease by the immune system.
- Naturally acquired through disease
- Artificially acquired through vaccination
  - Vaccines include inactivated toxins, killed microbes, parts of microbes, and viable but weakened microbes.
- Active immunity is usually permanent

3rd Line of Defense
"mucosal immune system"
Secretory IgA is the most important Immunoglobulin for Mucosal Immunity
Review of danger and activation of the acquired immune response

Humoral response
- B cell
- Antigen
- Plasma cell
- Antibodies

Cell mediated response
- T helper cell
- Cytokine production

Th1
- IL-2
- IFN-γ
- Innate
- IL-1β
- TNFα
- INFα/β

Th2
- IL-4
- IL-5

Antigen

Harvey Dunn (1884–1952) Prairie is My Garden, South Dakota
Art Museum