Immunology Principles

Objectives

- Immunology Principles
  - Describe the innate immune system
  - Describe the adaptive immune system
  - Identify characteristics & types of each system
  - Identify accessories to these systems

Immunology & Public Health

- Study of immunology closely linked to practice of medicine
  - Transplants, treatments, & vaccines
- Increasing importance to public health
  - Infectious diseases, malnutrition, & tropical medicine
  - Worldwide a large immuno-compromised population
- Spread of disease!

Immunology

Definition:
The study of the organs, cells, and molecules of the immune system & accessory systems

- Recognition and disposal of foreign (non-self) materials (also know as antigens – Ag)
- How the systems respond and interact
- Desirable and/or undesirable consequences of their activity
- The ways these activities can be advantageously increase or decreased.

Immune System

Purpose: Prevent Infection

- Responsiveness to a diverse range of environmental information
- Responses are usually adaptive & specific to the stimulus
- Complex internal regulatory networks
- Capacity to respond to unexpected stimuli
- Self-referential & self-protective
Innate and Acquired Immunity

- Innate immunity
  - Natural immunity
  - No specificity
  - Defense through skin, macrophages, etc
- Acquired immunity
  - Adaptive immunity
  - Highly specific, leads to memory
  - Defense through lymphocytes – T and B cells

Mission Near Impossible

- For an organism to cause an infection, it must first colonize the host
- Pathogens must complete the following tasks:
  - Penetrate barriers (skin)
  - Resist physical removal (cilia)
  - Compete against normal flora
  - Defuse chemical defenses
  - Avoid stimulating inflammation
  - AND, escape acquired immunity

Antigen (Ag)

- Antigens will be described in more detail in Block Four, but for now ...
- They are non-self particles that have gained access to the body (such as a microbe or pollen)
- They are recognized by the immune system as foreign (by both innate & adaptive systems) & targeted for removal.

Antibody (Ab)

- Antibodies will be described in more detail in Block Three, but for now ...
- They are proteins that are produced by B cells to a specific pathogen or antigen
- Antibodies can attach to the pathogen & neutralize it, or target it for removal by other immune cells
- Integral component of the acquired defense

Resistance

- Innate (non-adaptive) or Constitutive “immunity”
- Not specific for any given pathogen or Ag
- Does not improve with successive exposures to the same pathogen or antigen – no memory
- Accessories to the adaptive immune system; complement, phagocytes, enzymes work to enhance adaptive response

Adaptive Immune System

- Purpose: must recognize self vs. non-self
  - Mostly recognizes pathogens
  - Many times innocuous particles (pet dander)
  - Sometimes self (autoimmunity)
- Components:
  - Antigen (substance capable of eliciting immune response)
  - Cellular limb – T and B cells (cell mediated)
  - Humoral limb – antibodies (ab mediated)
Adaptive Immunity

- Also called Acquired immunity
- Specific response to a given pathogen or antigen (antigens are non-self to the body)
- Improves with successive exposures to the same pathogen or Ag – memory
- Works together with accessories to protect against pathogens or to exert other effects such as immunopathology

Acquired Immunity

- Can be antibody or cell-mediated – usually both!
- Which type of immune response is effective is determined primarily by the site of the infection and type of pathogen involved
  - Extracellular, intracellular, persistent, etc.
- Immune responses are intimately connected to all other systems in the body

Types of Acquired Immunity

- Acquired Naturally
  - Active: exposure to pathogen with resulting disease & immune response made
  - Passive: transplacental Ab to fetus, no immune response made
- Acquired Artificially
  - Active: exposure to Ag (tetanus toxoid vaccine) with immune response made
  - Passive: injection of Ab (tetanus antitoxin), no immune response made

Examples of Innate Resistance & Acquired Immunity

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Accessories to the Immune System

- Complement: a set of ~20 proteins, present in the body fluids in inactive form, that can be sequentially activated in a controlled sequence (zymogens)

Complement membrane attack complexes (above) punch holes in the membranes of microbial invaders.
Functions of Complement

• Plays an essential role in inflammation
• Assists Abs in effector functions (Antibody Dependent Cell-mediated Cytotoxicity – ADCC)
• Assist in clearing immune complexes
• Deficiencies can result in severe inflammation
• Opsonization and facilitation of phagocytosis
• No Ag specificity

Accessories to the Immune System

• Inflammation: the body’s nonspecific reaction to invasion by pathogen, antigenic challenge or physical damage
• Acute Inflammation: short-lived response to transient injury
  • Cardinal signs: redness, heat, swelling, pain & immobility
  • Response is exudative in nature – neutrophils
  • Major goal: allow products of the immune response to enter area of infection or damage

Accessories to the Immune System

• Chronic Inflammation: sustained reaction to persistent injurious stimulus or Ag
  • May follow acute inflammatory response
  • Response is proliferative in nature – mononuclear cells, granuloma formation
  • Major goal: containment of injurious stimulus or Ag
• Acute and Chronic are different!

Immunopathology

• The immune system can be the cause of disease or other undesirable consequences – two-edged sword
  • Autoimmunity: inappropriate reaction to self as foreign
  • Immunodeficiency: ineffective immune responses, congenital & acquired
  • Hypersensitivity: overactive immune response to harmless Ags
  • Inconvenient responses: graft rejection, blood transfusions, reactions to drugs

In Summary

• Important components of the immune response:
  • Innate vs. acquired
  • Complement
  • Inflammation
  • Antibody
  • Antigen
  • Immunopathology
• These topics will be covered in more detail in upcoming units...

Keep in mind ...

• Our immune systems are always on watch for intruders & ready to respond immediately!
Self-Test Questions: Principles

• Which type of immunity improves after specifically recognizing antigen?
• What is an antibody? An antigen?
• Give 2 types of acquired immunity & examples of each.
• What is complement? Inflammation?
• Name & describe 2 types of inflammation.