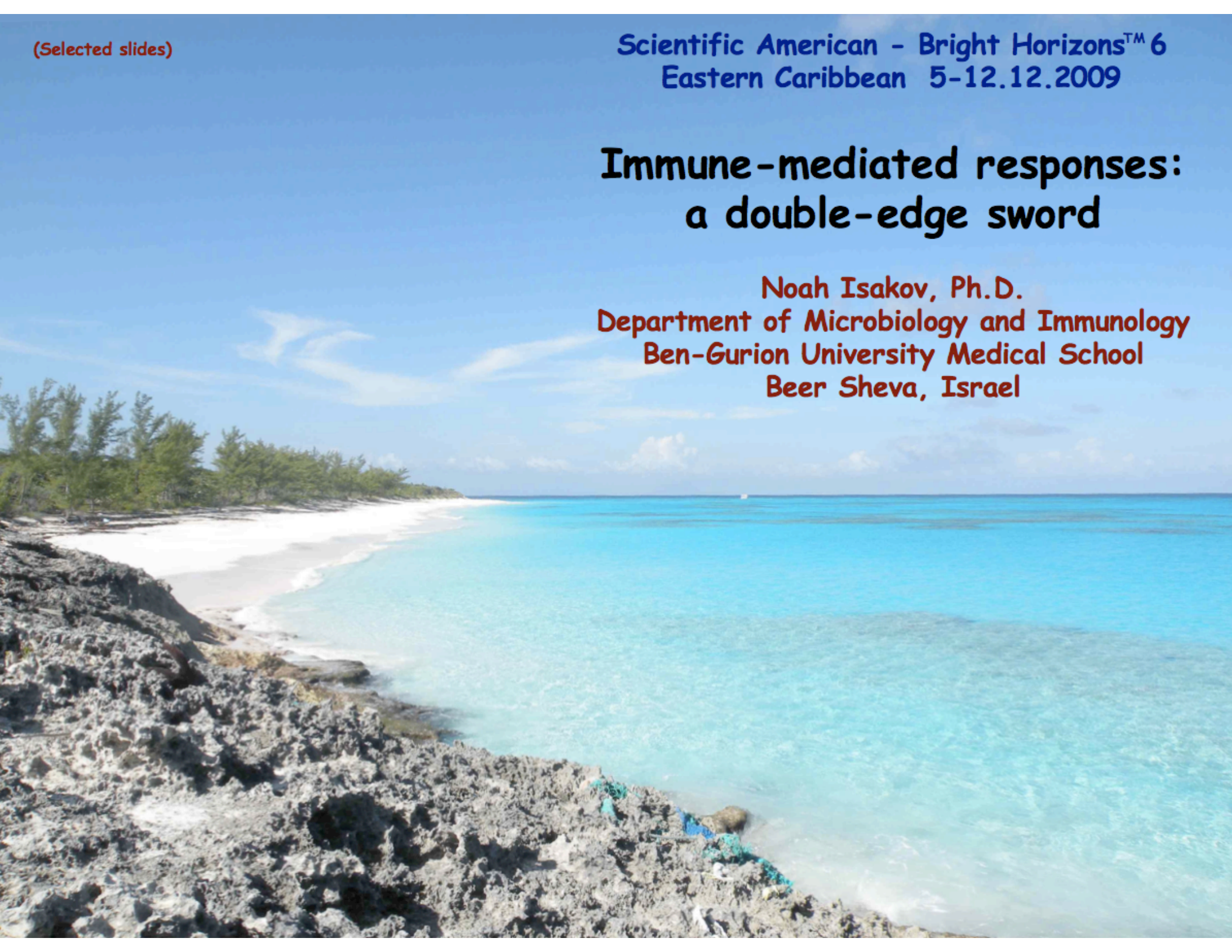


(Selected slides)

Scientific American - Bright Horizons™ 6
Eastern Caribbean 5-12.12.2009

Immune-mediated responses: a double-edge sword

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Immunology

Immunology is a branch of biomedical science that covers all aspects of the immune system in health and disease.

The term **Immunity** describes the state of having sufficient biological defenses to avoid infection, disease, or other unwanted biological invasion.

The immune system was originated as a result of the basic need of cells of a multicellular organisms to communicate with each other.

This led to the development of recognition mechanisms (cell surface markers, and appropriate receptors) that allow cells to recognize and interact with each other in order to set up symbiotic household functions for the benefit of the entire organism.

This basic characteristic was developed into a mechanism, which enables cells of the immune system to distinguish self from non-self, and respond only when needed.

The Enemies

(Pathogens)

There are many different pathogens that can cause myriad of diseases. In general, pathogens can be divided into four major classes:

- Viruses
- Bacteria
- Fungi
- Parasites

Viruses

Pathogenic viruses can cause many different diseases, including,

Infectious Disease

AIDS (Acquired immune deficiency syndrome)

Common cold

Ebola hemorrhagic fever

Hepatitis A

Herpes simplex

Human papillomavirus infection

Mononucleosis (Mono)

Influenza (flu)

Measles (Rubeola)

Mumps

Poliomyelitis

Rabies

Rubella

Smallpox (Variola)

Causative Agent

HIV (Human immunodeficiency virus)

Rhinoviruses and coronaviruses

Ebolavirus (EBOV)

Hepatitis A Virus

Herpes simplex virus (HSV-1 and HSV-2)

Human metapneumovirus (hMPV)

Epstein-Barr Virus (EBV)

Orthomyxoviridae family

Measles virus

Mumps virus

Poliovirus

Rabies virus

Rubella virus

Variola major or Variola minor

Bacteria

Pathogenic bacteria cause many different diseases, including,

Infectious Disease

Anthrax

Cholera

Diphtheria

Legionellosis (Legionnaires' disease)

Leprosy

Pneumococcal infection

Salmonellosis

Shigellosis

Staphylococcal infection

Syphilis

Tetanus (Lockjaw)

Tuberculosis

West Nile Fever

Causative Agent

Bacillus anthracis

Vibrio cholerae

Corynebacterium diphtheriae

Legionella pneumophila

Mycobacterium leprae

Streptococcus pneumoniae

Salmonella genus

Shigella genus

Staphylococcus genus

Treponema pallidum

Clostridium tetani

Mycobacterium tuberculosis

West Nile virus

Fungi

Fungal infections (mycoses) are classified according to the degree of tissue involvement and mode of entry into the host.

They include four major categories, including,

1. Superficial infection - localized to the skin, hair, and the nails.
2. Subcutaneous infection - confined to the dermis and subcutaneous tissue.
3. Systemic infection - deep infections of internal organs.
4. Opportunistic infection - occurs only in immune compromised individuals.

Selected diseases caused by pathogenic fungi:

Infectious Disease

Aspergillosis

Candidiasis

Cryptococcosis

Histoplasmosis

Causative Agent

Aspergillus genus

Candida albicans

Cryptococcus neoformans

Histoplasma capsulatum

Parasites

Pathogenic parasites Parasites enter your body, through food and water intake, or transmitting agent, such as a mosquito, through sexual conduct, or via the nose and skin. Among the more common parasitic diseases are:

Infectious Disease

Ascariasis

Babesiosis

Brucellosis

Chagas Disease

Echinococcosis

Giardiasis

Histoplasmosis

Hookworm infection

Leishmaniasis

Leptospirosis

Malaria

Scabies

Schistosomiasis

Causative Agent

Ascaris lumbricoides

Babesia genus

Brucella genus

Trypanosoma cruzi

Echinococcus genus

Giardia intestinalis

Histoplasma capsulatum

Ancylostoma duodenale

Leishmania genus

Leptospira genus

Plasmodium genus

Sarcoptes scabiei

Schistosoma genus

Advantages of the immune system

- Infectious diseases
- Cancer diseases
- Non-infection-induced inflammation

Major milestones in the history of immunology

- 430 B.C. - Thucydides observed that people who recovered from plague could nurse the sick because they were protected from re-infection.
- 1798 - *Active immunization*: Dr. Edward Jenner inoculated a child with pus from a cowpox, challenged him with smallpox and observed full immunity. First example of active immunization.
- 1880 - Louis Pasteur showed that injection of live attenuated bacteria induces immunity (Chicken cholera, anthrax, rabies).
- 1890 - *Passive immunization*: Emil von Behring and Shibasaburo Kitasato independently, showed that immunity to diphtheria and tetanus could be obtained by serum (antibodies) transfer from immune host. First example of passive immunization.

There are three major mechanisms of 'inappropriate' immunity

- Autoimmunity, when tolerance breaks, and the immune system respond against 'self' molecules.
- Immunodeficiency, when one or several immune mechanisms fail to respond properly, resulting in lack (or decreased) immune responses, concomitantly with frequent infections by opportunistic pathogens.
- Hypersensitivity, an undesirable (damaging, discomfort-producing and sometimes fatal) normal or exaggerated response of the immune system.

Autoimmune diseases

Hashimoto's thyroiditis

Pernicious anemia

Insulin-dependent diabetes mellitus

Goodpasture's syndrome

Myasthenia gravis

Pemphigus vulgaris

MS, multiple sclerosis

Idiopathic thrombocytopenic purpura

Autoimmune hemolytic anemia

Ulcerative colitis

Atherosclerosis

Sjogren's syndrome

RA, rheumatoid arthritis

Scleroderma

SLE, systemic lupus erythematosus

Immunity (resistance) is the sum of all naturally occurring defense mechanisms that protect humans from infectious diseases

Two major lines of defense

1. Innate immunity (Non-specific immunity)

- Elie Metchnikoff (1908): Pathogens can be ingested and digested by phagocytic cells (i.e., macrophages).
- Combat microorganisms without prior exposure.

2. Acquired immunity (Specific or adaptive immunity)

- ___ - Only occurs after exposure to pathogens.
- Lifelong protective immunity to reinfection.

Innate Immunity

(Vertebrates and Invertebrates)

- Resistance mechanisms are germline encoded - all elements exist throughout life span.
- First line of defense - acting within a very short notice (minutes/hours) to protect the host.
- Immunity which is not affected by prior exposure to infectious agents - No "memory"-stereotypic response.
- Antigen-"non-specific": Broadly recognize molecules possessed by various classes of microbes (*bacterial cell wall components, bacterial DNA, glycoproteins/lipids*).

Acquired (or Adaptive) Immunity

(Exist only in Vertebrates)

- A more specialized type of immunity, which supplements the innate system.
- Individuals are born with the capacity to mount an immune response to a foreign antigen, but specific immunity is **acquired** by contact with the invader.
- Contact with a foreign agent (**immunization**) triggers a chain of events leading to **lymphocyte** activation, which directly or indirectly react against the foreign agent.
- Immunity can be induced against microorganisms, and their products, but also against enumerable natural and synthetic compounds.
- The compound to which the acquired immune response is induced is termed an **antigen (antibody generating)**.

Major properties of the innate and adaptive immune systems

<i>Property</i>	<i>Innate</i>	<i>Adaptive</i>
Characteristics	<ul style="list-style-type: none">Antigen nonspecificRapid response (min/hrs)No memory	<ul style="list-style-type: none">Antigen specificSlow response (days)Memory
Immune components	<ul style="list-style-type: none">Natural barriers (e.g., skin)PhagocytosisSoluble mediators (e.g., complement)Pattern-recognition molecules	<ul style="list-style-type: none">LymphocytesAntigen-recognition molecules (B cell and T cell responses)Secreted molecules (e.g., antibody)