

Johns Hopkins Engineering

Immunoengineering

Module 2/Lecture 2A

Immune Response to Pathogens: Introduction

Today's Learning Objectives

- List examples of pathogens and routes of infection
- Identify major cellular and protein components of the immune response to pathogens and their function
- Describe how information is communicated by the immune system
- Explain differences between the immune response to bacteria and viruses and explain how infection is resolved
- Define immunological memory and context with vaccines

If a country attacked you, list some things you would want going into war.
(think as a nation)

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- Food/Water/Nutrients
- Weapons
- Medicine
- Shelter
- Allies
- Army
- Transport
- Funding/support/propaganda
- Leadership
- Tanks/Ships
- Known target
- Spies
- Intelligence agency
- Fence/Barracks/Barrier
- Detector/Camera
- Sentinel
- Radars/communication
- Bases
- Engineering war department
- Computers
- Target missiles
- Special forces – Marine corp
- Way to detect an ally
- Ways to stop the war
- Learning from war

5 If a country attacked you, list some things you would want going into war (think as a nation)

- Detection
- Recognition
- Communication
- People: Soldiers, Leaders, Engineers, Doctors, etc.
- Transportation/Housing/Nutrition
- Weapons and Training

This is war!

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The immune system protects against four classes of pathogens		
Type of pathogen	Examples	Diseases
Extracellular bacteria, parasites, fungi	<i>Streptococcus pneumoniae</i> <i>Clostridium tetani</i> <i>Trypanosoma brucei</i> <i>Pneumocystis carinii</i>	Pneumonia Tetanus Sleeping sickness <i>Pneumocystis pneumonia</i>
Intracellular bacteria, parasites	<i>Mycobacterium leprae</i> <i>Leishmania donovani</i> <i>Plasmodium falciparum</i>	Leprosy Leishmaniasis Malaria
Viruses (intracellular)	Variola Influenza Varicella	Smallpox Flu Chickenpox
Parasitic worms (extracellular)	<i>Ascaris</i> <i>Schistosoma</i>	Ascariasis Schistosomiasis

Figure 1.24 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

Barriers to get in

	Skin	Gut	Lungs	Eyes/nose/ oral cavity
Mechanical	Epithelial cells joined by tight junctions			
	Longitudinal flow of air or fluid		Movement of mucus by cilia	Tears Nasal cilia
Chemical	Fatty acids	Low pH	Pulmonary surfactant	Enzymes in tears and saliva (lysozyme)
		Enzymes (pepsin)		
	β -defensins Lamellar bodies Cathelicidin	α -defensins (cryptdins) RegIII (lecticidins) Cathelicidin	α -defensins Cathelicidin	Histatins β -defensins
Microbiological	Normal microbiota			

Figure 2.6 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

How do they get in?

Routes of infection for pathogens				
Route of entry	Mode of transmission	Pathogen	Disease	Type of pathogen
Mucosal surfaces				
Mouth and respiratory tract	Inhalation or ingestion of infective material (e.g. saliva droplets)	Measles virus	Measles	Paramyxovirus
		Influenza virus	Influenza	Orthomyxovirus
		Varicella-zoster	Chickenpox	Herpesvirus
		Epstein-Barr virus	Mononucleosis	Herpesvirus
		<i>Streptococcus pyogenes</i>	Tonsillitis	Gram-positive bacterium
		<i>Haemophilus influenzae</i>	Pneumonia, meningitis	Gram-negative bacterium
	Spores	<i>Neisseria meningitidis</i>	Meningococcal meningitis	Gram-negative bacterium
		<i>Bacillus anthracis</i>	Inhalation anthrax	Gram-positive bacterium
Gastrointestinal tract	Contaminated water or food	Rotavirus	Diarrhea	Rotavirus
		Hepatitis A	Jaundice	Picornavirus
		<i>Salmonella enteritidis</i> , <i>S. typhimurium</i>	Food poisoning	Gram-negative bacterium
		<i>Vibrio cholerae</i>	Cholera	Gram-negative bacterium
		<i>Salmonella typhi</i>	Typhoid fever	Gram-negative bacterium
Reproductive tract and other routes	Sexual transmission/ infected blood	Hepatitis B virus	Hepatitis B	Hepadnavirus
		Human immunodeficiency virus (HIV)	Acquired immunodeficiency syndrome (AIDS)	Retrovirus
	Sexual transmission	<i>Neisseria gonorrhoeae</i>	Gonorrhea	Gram-negative bacterium
		<i>Treponema pallidum</i>	Syphilis	Bacterium (spirochete)

Figure 2.2 Janeway's Immunobiology, 8ed. (© Garland Science 2012)

How do they get in?

Opportunistic pathogens				
	Resident microbiota	<i>Candida albicans</i>	Candidiasis, thrush	Fungus
	Resident lung microbiota	<i>Pneumocystis jirovecii</i>	Pneumonia	Fungus
External epithelia				
External surface	Physical contact	<i>Trichophyton</i>	Athlete's foot	Fungus
Wounds and abrasions	Minor skin abrasions	<i>Bacillus anthracis</i>	Cutaneous anthrax	Gram-positive bacterium
	Puncture wounds	<i>Clostridium tetani</i>	Tetanus	Gram-positive bacterium
	Handling infected animals	<i>Francisella tularensis</i>	Tularemia	Gram-negative bacterium
Insect bites	Mosquito bites (<i>Aedes aegypti</i>)	Flavivirus	Yellow fever	Virus
	Deer tick bites	<i>Borrelia burgdorferi</i>	Lyme disease	Bacterium (spirochete)
	Mosquito bites (<i>Anopheles</i>)	<i>Plasmodium</i> spp.	Malaria	Protozoan

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