

CLC Study Group

Week 1



HAI Prevention Program

Agenda

- Review
 - Chapter 21: Risk Factors Facilitating Transmission of Infectious Agents
 - Chapter 22: Microbial Pathogenicity and Host Response
 - Chapter 23: The Immunocompromised Host
- Next week's assignments

Chapter 21

Risk Factors Facilitating Transmission of Infectious Agents

Key Concepts:

Transmission Pathways: the different ways infectious agents can be transmitted, including direct contact, indirect contact, droplet transmission, airborne transmission, and vector-borne transmission.

Risk Factors in Healthcare Settings: specific risk factors that facilitate the transmission of infections in healthcare environments, such as inadequate hand hygiene, improper use of personal protective equipment (PPE), and insufficient cleaning and disinfection practices.

Patient Factors: how certain patient factors, such as immunocompromised states, chronic illnesses, and invasive procedures, can increase susceptibility to infections and complicate their control.

Environmental Factors: how the physical environment, including the cleanliness of facilities, ventilation, and the presence of contaminated surfaces, plays a role in infection transmission.



Key Concepts (continued):

Procedural Factors: how medical procedures, especially invasive ones, can create opportunities for infections to spread. It also discusses the importance of adhering to infection control protocols during such procedures.

Behavioral Factors: how human behaviors, including adherence to infection control practices and proper use of PPE, impact the likelihood of infection transmission.

Microbial Factors: the characteristics of infectious agents, such as their virulence, mode of transmission, and resistance to treatment, influence their ability to spread.

Preventive Measures: strategies for mitigating risk factors and preventing the transmission of infectious agents, including rigorous infection control policies, education and training for healthcare workers, and ongoing monitoring and evaluation.

Why is this important?

To prevent the spread of these microorganisms in various health care settings and help determine the need for additional interventions when patients colonized or infected with these microorganisms.

General Key Terms

Transmission: The process by which infectious agents are spread from one person or surface to another.

Pathogen: A microorganism (bacteria, virus, fungus, or parasite) that can cause disease.

Vector: An organism, often an insect or arthropod, that carries and transmits pathogens from one host to another.

Fomite: Inanimate objects or surfaces that can carry and transfer pathogens, such as doorknobs, bed linens, and medical equipment.

Droplet Transmission: Spread of infectious agents through respiratory droplets generated by coughing, sneezing, or talking.

Airborne Transmission: Spread of infectious agents via tiny particles or droplets that remain suspended in the air for extended periods and are inhaled.

Direct Contact: Transmission of infectious agents through physical contact between an infected person and a susceptible host.

Indirect Contact: Transmission of infectious agents through contact with contaminated objects or surfaces.

Healthcare-associated Infections (HAIs): Infections that patients acquire while receiving treatment for other conditions within a healthcare setting.



General Key Terms

Immunocompromised: A state where an individual's immune system is weakened or impaired, making them more susceptible to infections.

Personal Protective Equipment (PPE): Equipment worn to protect healthcare workers from exposure to infectious agents, such as gloves, masks, gowns, and face shields.

Hand Hygiene: The practice of cleaning hands to prevent the spread of infectious agents, including handwashing and the use of hand sanitizers.

Disinfection: The process of cleaning surfaces and objects to destroy or reduce the number of pathogens to a safe level.

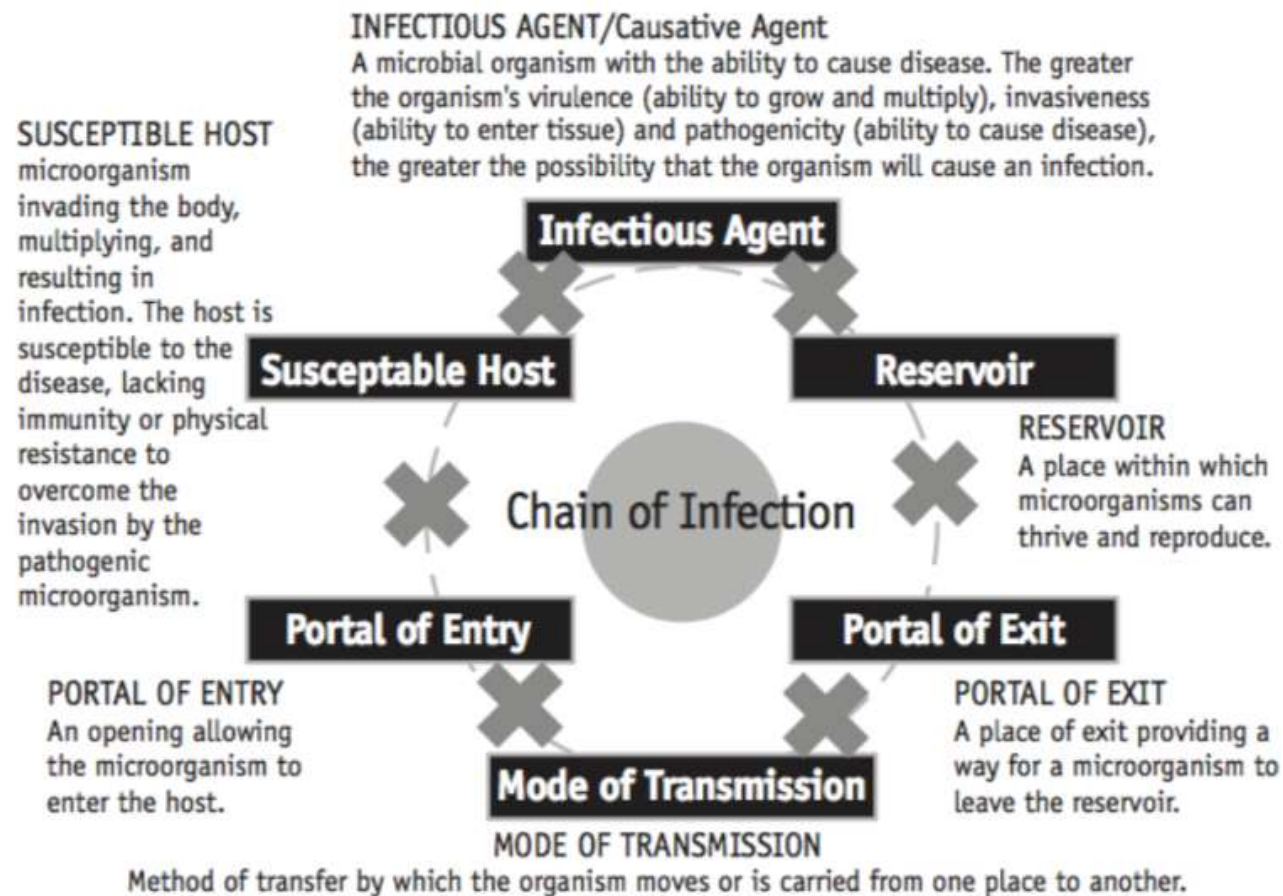
Sterilization: The process of completely eliminating all microorganisms, including spores, from surfaces and equipment.

Surveillance: The ongoing systematic collection, analysis, and interpretation of health data for the purpose of preventing and controlling infections.

Contamination: The presence of pathogens on surfaces, equipment, or hands that can lead to infection.

Invasive Procedures: Medical procedures that involve entering the body, such as surgery or catheter insertion, which can increase the risk of infection.

Figure 21-1.



Chain of Infection (continued)

Virulence

- The ability to grow and multiply

Infectivity

- The ability to enter tissue

Pathogenicity

- The ability to cause disease

Duration of exposure

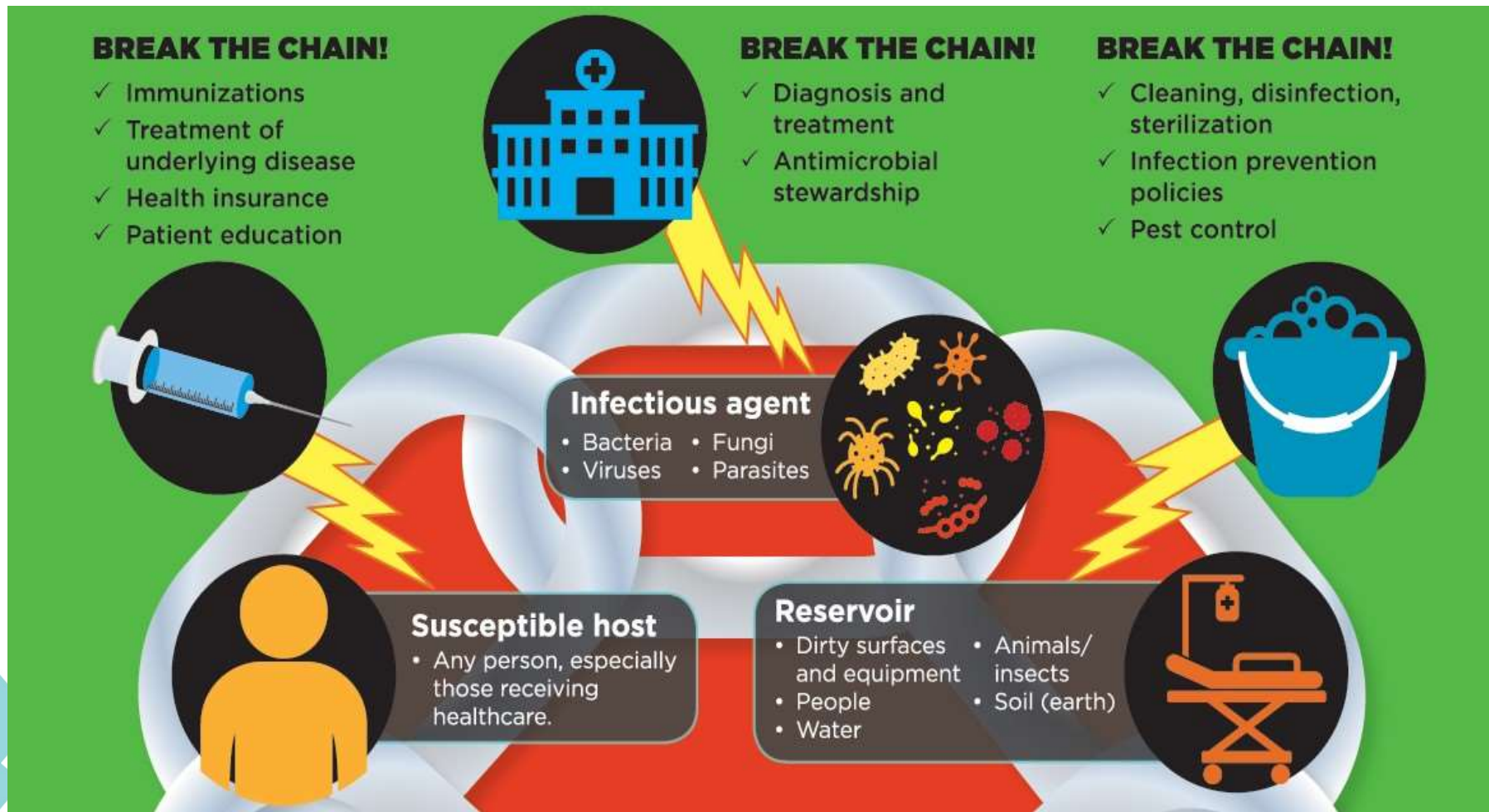
- The length of time an individual is exposed to an organism

Size of inoculum

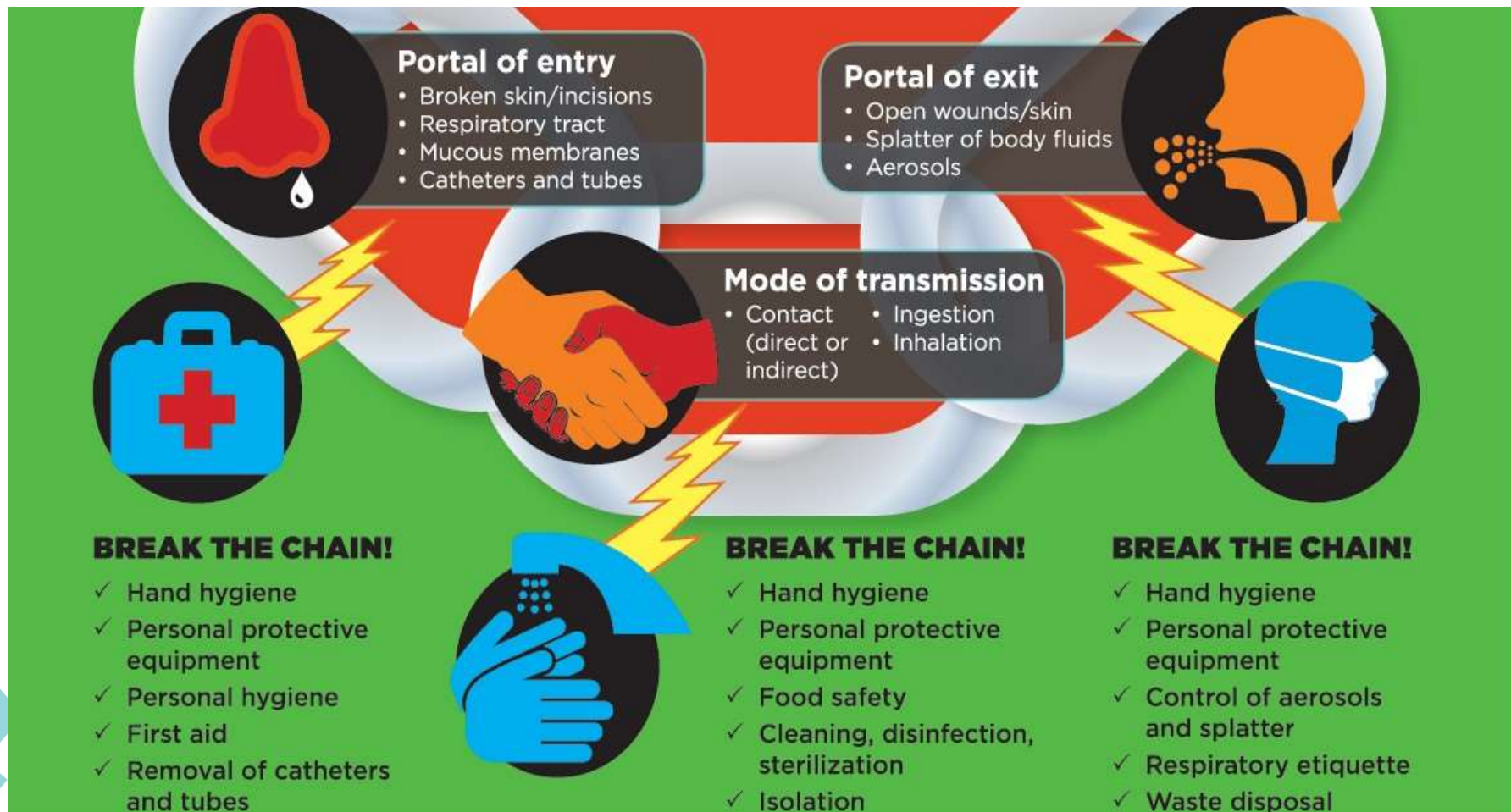
- The number of organisms needed to cause disease



Chain of Infection



Chain of Infection, Cont.



Source: <https://infectionpreventionandyou.org/protect-your-patients/break-the-chain-of-infection/>

Medical Interventions That Increase Risk

- Exposure to antibiotics or total parenteral nutrition (TPN)
 - Length of hospitalization
 - Staffing ratios
- Presence of invasive devices:
- Intravascular access
 - Indwelling urinary catheters
 - Mechanical ventilation
 - Intracranial monitoring
 - Extracorporeal membrane oxygenation (ECMO)

Patient Factors That Increase Risk of Transmission of Infectious Agents

- Immunosuppressive diseases and disorders
- Malignant disorders
- Patients APACHE Score
- Poor nutritional status
- Age
- Pregnancy
- Travel History
- Occupation
- Residence
- Contact with certain pets or animals
- Extensive burn wounds
- Trauma
- Diabetes

Infection Risk Reduction: Personnel Practices

- Immunization of personnel may be required and should be available.
- Restriction of HCP with a communicable disease or infectious process.
- Assignment of patients to be cared for by immune HCP.
- Protocols should be created for evaluation and follow-up of employee exposure to infectious disease.

Visitor Risk Reduction

- Identify dedicated areas where visitation is allowed.
- Post precautions visitors must take if visiting a patient in a high-risk area or isolation.
- Provide warning signs for exclusion of visitors with communicable diseases, and, possibly, implement additional visitor restrictions during times of increased community illness.

Concept Check

The IP wants to calculate the surgeon-specific rate of infections associated with spinal fusion surgeries in the facility. Which one of the following data elements will he need?

1. Number of spinal fusion procedures within the designated time frame
2. Number of spinal fusion SSIs within the designated time frame
3. Number of spinal fusion surgeries performed by each surgeon within the designated time frame
4. Number of spinal fusion infections for each surgeon within the designated time frame

a) 1, 2

b) 1, 4

c) 2, 3

d) 3, 4

Chapter 22

Microbial Pathogenicity and Host Response

Principles of Microbial Pathogenicity

Pathogenicity: The ability of a microorganism to cause disease. This is influenced by factors such as the pathogen's virulence, its ability to evade the host immune system, and its capacity to cause damage to host tissues.

Virulence Factors: Specific traits or molecules produced by pathogens that enhance their ability to cause disease. These can include toxins, adhesions, enzymes that break down host tissues, and mechanisms to evade the host immune response.

- ★ The initial element of virulence is the ability of an organism to survive in the external environment during transit between hosts.
- ★ The second element in virulence is a mechanism for transmission to a new host.

Principles of Microbial Pathogenicity

- **Infection Cycle:** The process by which a pathogen establishes an infection. This includes entry into the host, colonization, invasion, and dissemination within the host.
- **Toxin Production:** Some pathogens produce toxins that can directly damage host tissues or interfere with normal cellular functions. Examples include exotoxins and endotoxins.

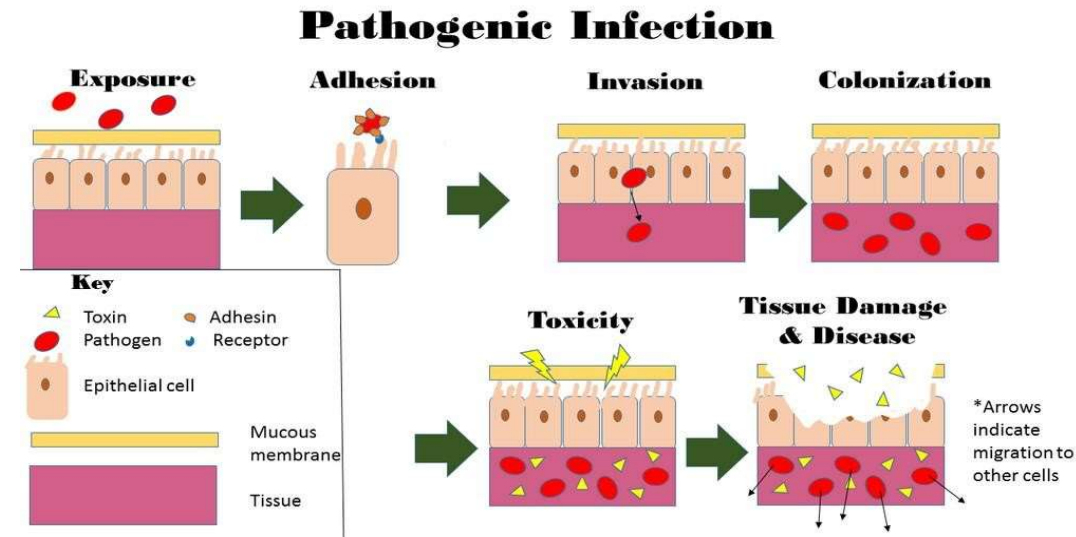
Infection vs. Colonization

- Colonization

Occurs when microorganisms inhabit a specific body site (such as the skin) but do not cause signs and symptoms

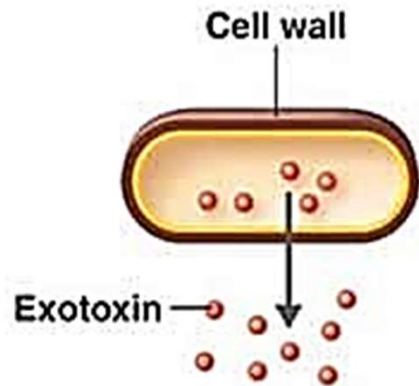
- Infection

Clinical signs of illness or inflammation (e.g., localized pain/tenderness, redness, warmth, swelling, pus, fever) present due to tissue damage caused by invading microorganism.



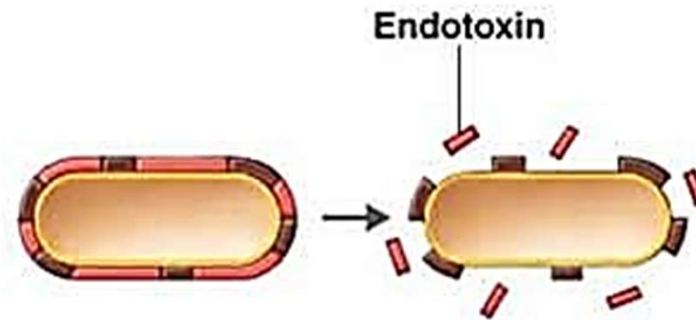
(Image 2: Difference between colonization and infection Web source <https://www.differencebetween.com/difference-between-colonization-and-vs-infection/>)

Exotoxins vs. Endotoxins



(a) Exotoxins are proteins produced inside pathogenic bacteria, most commonly gram-positive bacteria, as part of their growth and metabolism. The exotoxins are then secreted or released into the surrounding medium following lysis.

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(b) Endotoxins are the lipid portions of lipopolysaccharides (LPSs) that are part of the outer membrane of the cell wall of gram-negative bacteria (lipid A; see Figure 4.13c). The endotoxins are liberated when the bacteria die and the cell wall breaks apart.

(Image 3: Differences Between Exotoxins and Endotoxins Web source <https://microbiologyinfo.com/differences-between-exotoxins-and-endotoxins/>)

Exotoxins vs. Endotoxins, Cont.

Table 22-5 Selected Classes of Exotoxins and Their Specific Target Activities

CATEGORY	EXAMPLE	PATHOGEN	MECHANISM AND DISEASE
Intracellular-targeting toxins	Cholera toxin	<i>Vibrio cholerae</i>	Activation of adenylate cyclase in intestinal cells, causing increased levels of cyclic adenosine monophosphate (cAMP) and secretion of fluids and electrolytes out of cells, causing diarrhea
	Tetanus toxin	<i>Clostridium tetani</i>	Inhibits the release of inhibitory neurotransmitters in the central nervous system, causing spastic paralysis
	Botulinum toxin	<i>Clostridium botulinum</i>	Inhibits release of the neurotransmitter acetylcholine from neurons, resulting in flaccid paralysis
	Diphtheria toxin	<i>Corynebacterium diphtheriae</i>	Inhibition of protein synthesis, causing cellular death
Membrane-disrupting toxins	Streptolysin	<i>Streptococcus pyogenes</i>	Proteins that assemble into pores in cell membranes, disrupting their function and killing the cell
	Pneumolysin	<i>Streptococcus pneumoniae</i>	
	Alpha-toxin	<i>Staphylococcus aureus</i>	
	Alpha-toxin	<i>Clostridium perfringens</i>	Phospholipases that degrade cell membrane phospholipids, disrupting membrane function and killing the cell
	Phospholipase C	<i>Pseudomonas aeruginosa</i>	
	Beta-toxin	<i>Staphylococcus aureus</i>	
Superantigens	Toxic shock syndrome toxin	<i>Staphylococcus aureus</i>	Stimulates excessive activation of immune system cells and release of cytokines (chemical mediators) from immune system cells. Life-threatening fever, inflammation, and shock are the result
	Streptococcal mitogenic exotoxin	<i>Streptococcus pyogenes</i>	
	Streptococcal pyrogenic toxin	<i>Streptococcus pyogenes</i>	

Concept Check

This leukocidin allows the staphylococcus in MRSA to spread rapidly through tissue like streptococci, creating an entirely new clinical syndrome for staphylococcal infections.

The Panton-Valentine leukocidin

Concept Check

What are the three mechanisms used for transmission to a new host?

1. Vectors
2. Fomites
3. Motility mechanisms
 - Example: *E. coli*

Principles of Host Response

- **Immune System:** The body's defense mechanism against infections. It consists of innate and adaptive components.
- **Innate Immunity:** The body's first line of defense, which includes physical barriers (like skin), phagocytic cells (such as macrophages and neutrophils), and innate immune responses like inflammation.
- **Adaptive Immunity:** A more specialized immune response involving lymphocytes (T cells and B cells) that recognizes specific pathogens and improves over time with exposure. It includes the production of antibodies and the activation of cytotoxic T cells.
- **Inflammatory Response:** A complex biological response to harmful stimuli, such as pathogens or damaged cells. It includes the release of signaling molecules (cytokines), recruitment of immune cells to the site of infection, and the eventual resolution or continuation of inflammation.
- **Immunological Memory:** The ability of the immune system to remember and mount a stronger response to previously encountered pathogens. This is the basis for vaccine-induced immunity.

The Cellular Immune System

Cell-mediated immune (CMI) system:

- Induced, mediated or regulated by T-lymphocytes and mononuclear phagocytes.
- Interacts with the antibody-mediated humoral immune system via effects of CD4 T-lymphocytes, B-lymphocytes and granulocytes.

Antibody-mediated humoral immune system:

- Gain the ability to recognize virus-infected cells and adhere to and kill them.
- CD4, CD8 (cytotoxic or suppressive) and B cells.
- Also known as the innate immune system and adaptive immune system

The Cellular Immune System, Cont.

Cytokines- substances that have specific structures and biological activities

- IL-1, IL-2, IL-4, IL-6, IL-12, IL-16, the interferons (IFNs), lymphotoxin, granulocyte macrophage colony-stimulating factor (GMCSF) and monocyte colony-stimulating factor.
- May possess various physiological properties such as:
 - Priming and stimulating antibody production
 - Stimulating reproduction of cell lines
 - Fever induction
 - Interference with intracellular virus reproduction
 - Involution and death of tumor cells

Immunoglobulins

IgM

- ❖ the largest of all the immunoglobins, the first immunoglobulin to react in an adaptive immune response to an infection and is generally produced for no more than 6 months after the onset of the infection.

IgG

- ❖ the major circulating and interstitial antibody, late-occurring in an immune response, and it is the longest lived.

Immunoglobulins

IgD

- ❖ an immunoglobulin present principally on the surface of lymphocytes, where it serves to bind specific antigens.

IgE

- ❖ the principal allergy-inducing immunoglobulin, known as reagin.

IgA

- ❖ the principal secretory antibody in humans.

Concept Check

The most immediate postoperative surgical site infections, beginning in less than 24 hours from incision are caused by:

- a) *Staphylococcus aureus*
- b) *Streptococcus pneumoniae*
- c) *Streptococcus pyogenes*
- d) *Escherichia coli*

Concept Check

Which immune marker represents past exposure to disease?

- a) IgM
- b) IgE
- c) IgA
- d) IgG

Chapter 23

The Immunocompromised Host

Basic Principles of the Immunocompromised Host

Categories associated with impaired resistance

- Defects in the cutaneous barrier to invasion of endogenous or acquired organisms
- Mucous membrane barrier defects
- Conditions that cause obstruction of a natural body passage
- Abnormal number or function of granulocytes
- Abnormalities of cell-mediated immunity
- Abnormalities of humoral immunity
- Patients with defects in multiple arms of immunity

Preventing Infection in Immunocompromised Host

Augmentation of host resistance

- Gastric acidity
- Immunizations

Reduction of exposure to pathogens

- Isolation
- Hand hygiene (HH)
- Prophylactic antimicrobials
- Visitors

Week 2 Assignments

Action Items

Assigned chapter readings:

- Chapter 24 Microbiology Basics
- Chapter 25 Laboratory Testing and Diagnosis
- Chapter 26 Antimicrobial Resistance

Choose two chapters to read from the “Additional Chapters” reading list