Module: Infection & Immunity
Semester: 5
Session: 2
Lecture Duration: 1h.

Lecture Title: Infection model

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This Lecture was loaded in blackboard and you can find the material in:
Jawetz, Meinik & Adelberg's MEDICAL MICROBIOLOGY, 27 th Edition

For more detailed instructions, any question, or you have a case you need help in, please post to the group of session

Learning Objectives (LO)

1. Reference to the classification of microbes described in Week 1 you should start to accumulate names and key characteristics of some common microbes.

2. Understand the model of infection.

3. Understand how to apply the model of infection to a specific illness.

Classification of Microbes

LO-1

- Bacteria (*E. coli*)
- Viruses (*Influenza virus*)
- Fungi (*Candida albicans*)
- Parasites (*Plasmodium, Ascaris*)
- Prions (transmissible spongiform encephalopathy)

• Based on pathogenicity:

- True pathogens (*Mycobacterium tuberculosis*)
- Opportunistic pathogens (*Pseudomonas aeruginosa*)

Virulence factors

LO-1

- Bacterial toxins: there are two general types:

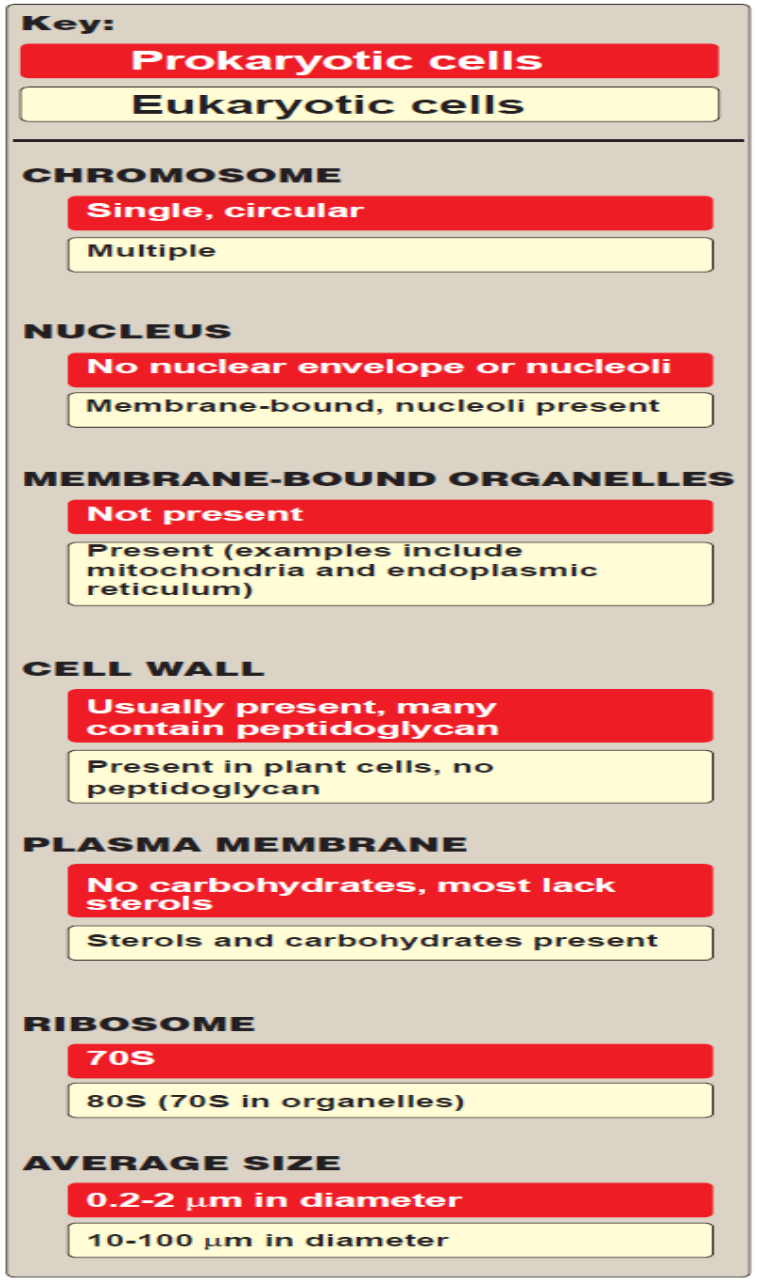
1. The exotoxins, which are proteins, are secreted by both gram-positive and gram-negative bacteria.
2. The endotoxins, which are lipopolysaccharides, are not secreted, but instead are integral components of the cell walls of gram-negative bacteria.

- Bacteria that have an outer polysaccharide capsule have a better chance of surviving the primary host defenses (phagocytosis).

Comparison of prokaryotic and eukaryotic cells.

LO-1

- All prokaryotic organisms are classified as bacteria
- Eukaryotic organisms include fungi, protozoa, and helminths, as well as humans.



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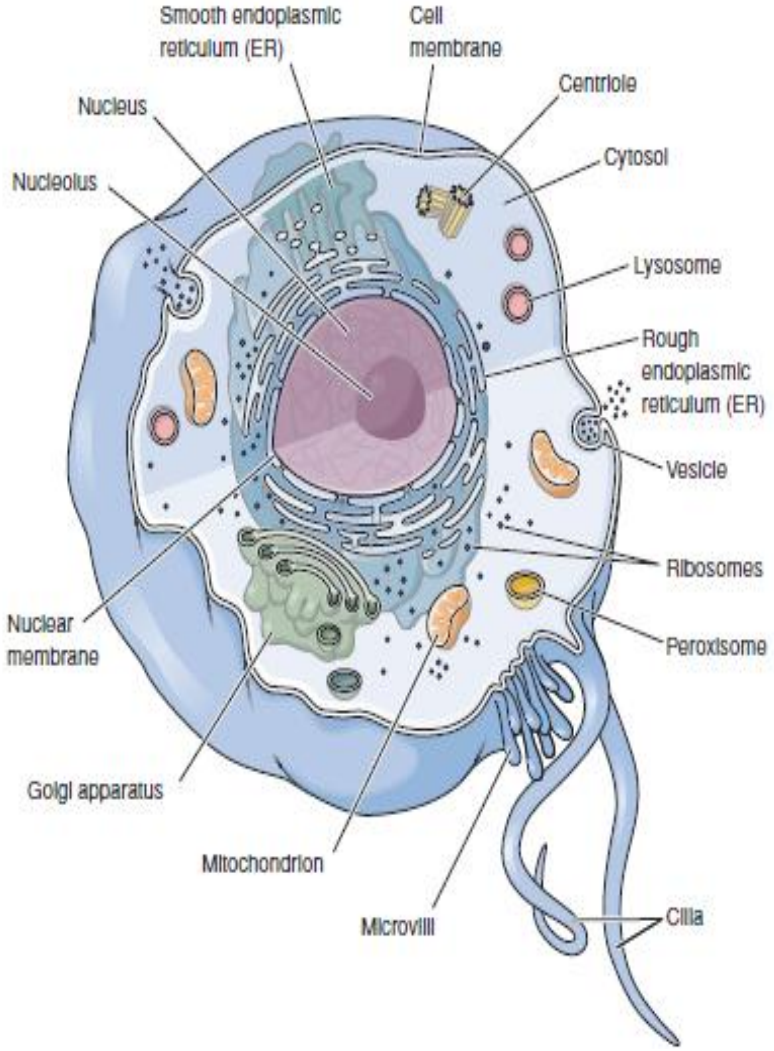
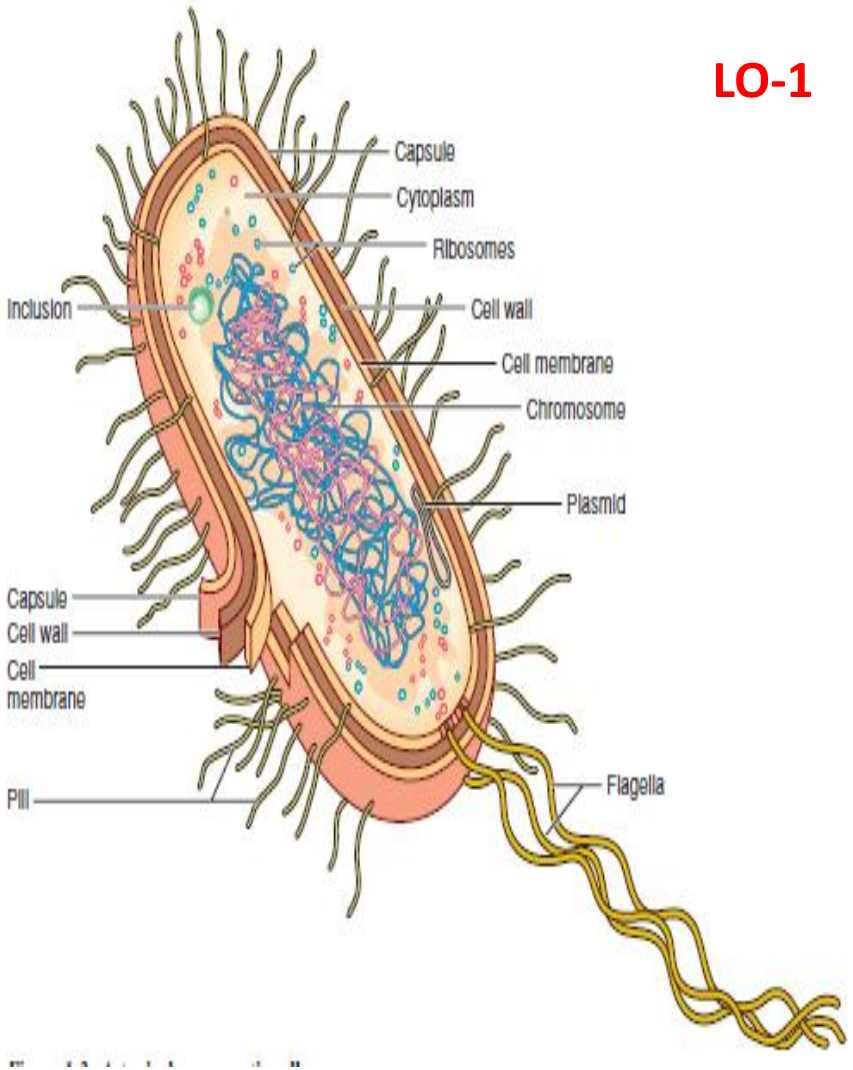


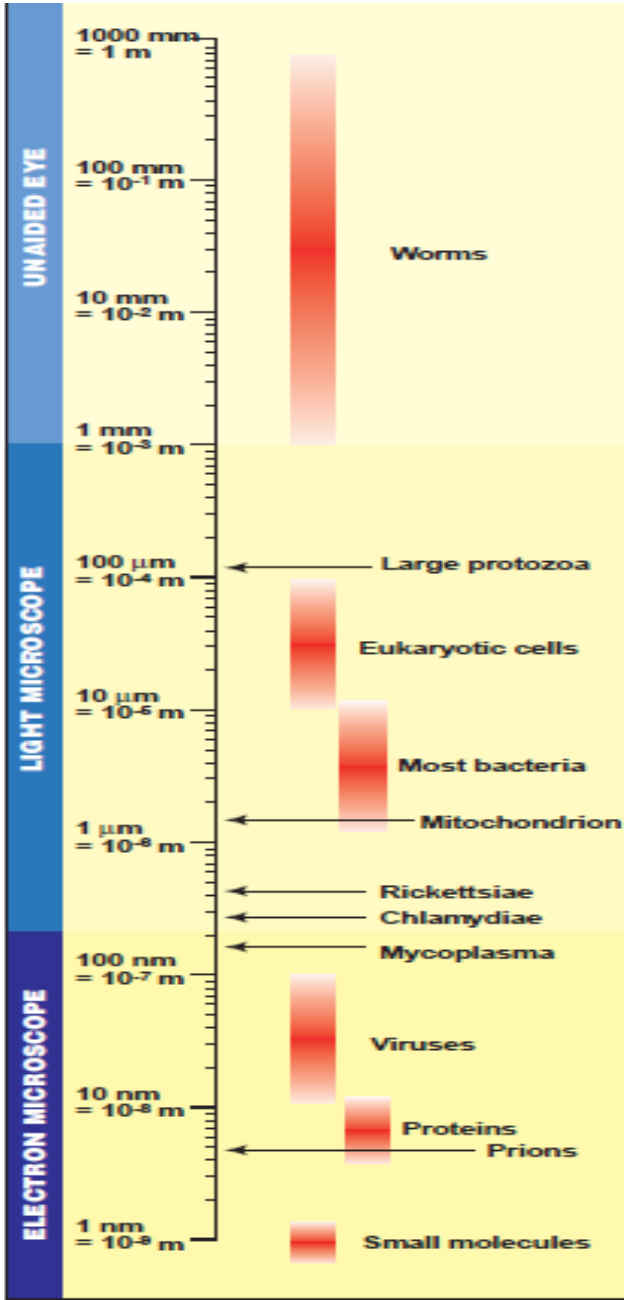
A typical eukaryotic cell



A typical prokaryotic cell

LO-1

Relative size of organisms and molecules.



LO-1

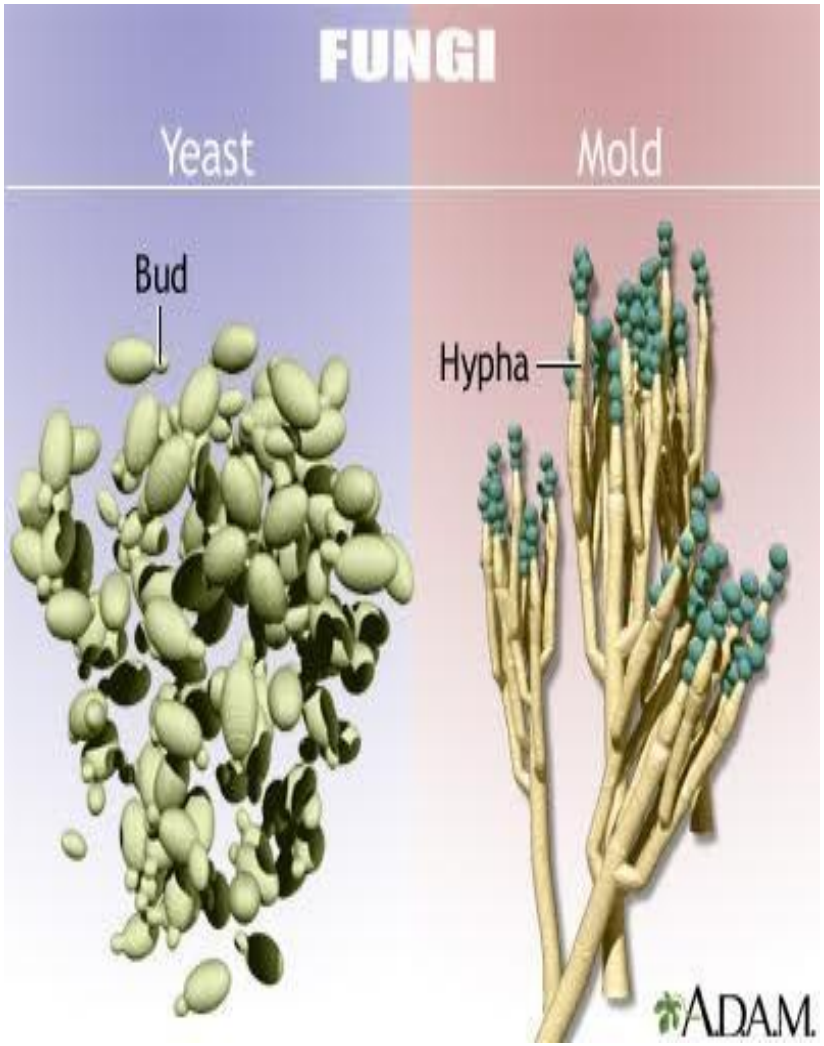
Bacteria

- Most bacteria have shapes that can be described as either a rod, sphere, or spiral.
- All bacteria, with the exception of the mycoplasma, have a rigid cell wall surrounding the cell membrane that determines the shape of the organism.
- The cell wall also determines whether the bacterium is classified as gram-positive or gram-negative.
- External to the cell wall may be flagella, pili, and/or a capsule.
- Bacterial cells divide by binary fission.

Fungi

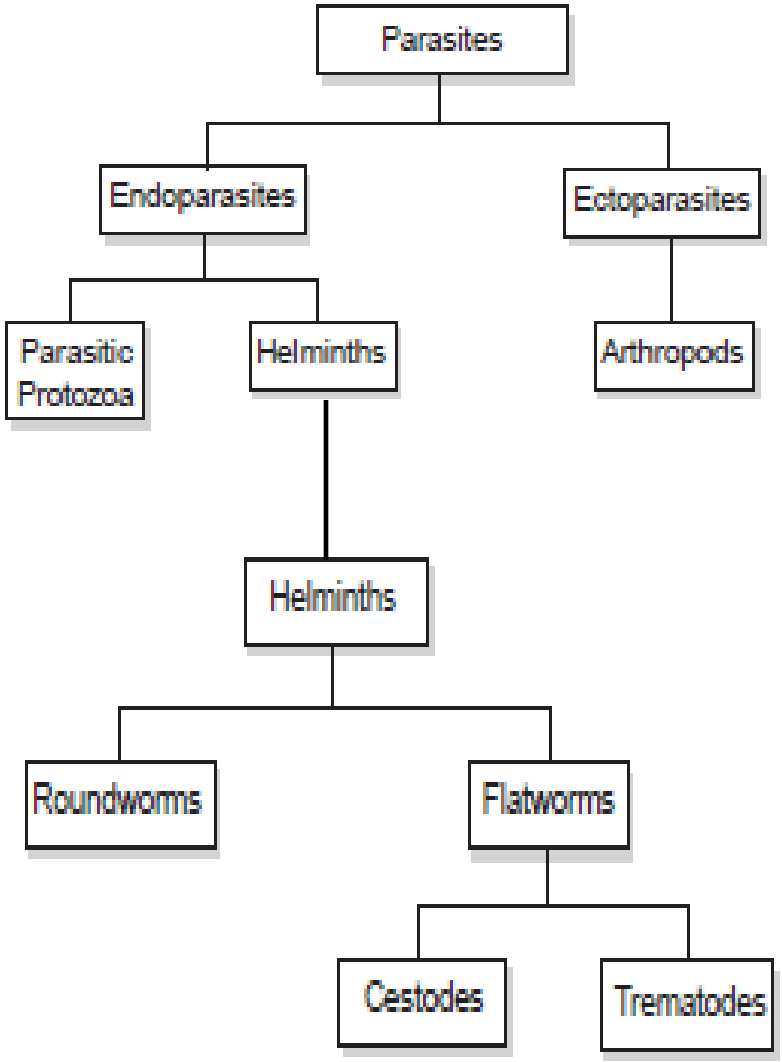
LO-1

- Fungi are eukaryotic organisms.
- Some fungi are filamentous, and are called molds, whereas others—the yeasts—are unicellular.
- Pathogenic fungi can cause diseases, ranging from skin infections (superficial mycoses) to serious, systemic infections (deep mycoses).



LO-1

Parasites classification



Parasites

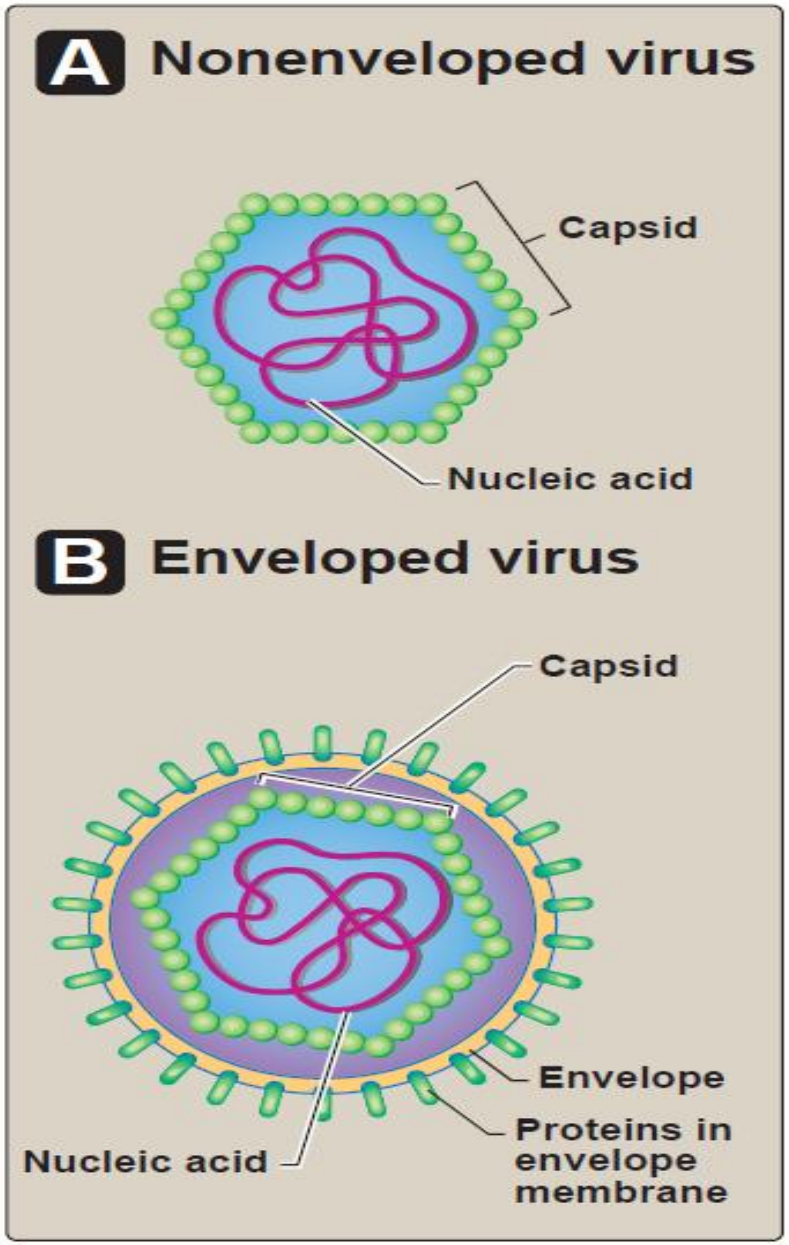
LO-1

Class	Definition	Types
Protozoa	Single-celled organisms that can exist free-living or as a parasite	Amoeba, Plasmodium, Giardia, Cryptosporidium and more
Helminths	Multi-celled organisms that can exist free-living or as a parasite	Flukes, Tapeworms, Roundworms, Hookworms, Ringworms and more
Ectoparasites	Multi-celled organisms that live or feed off skin, usually attaching to or burrowing under the skin	Mosquitos, Fleas, Ticks, Lice, Mites

Viruses

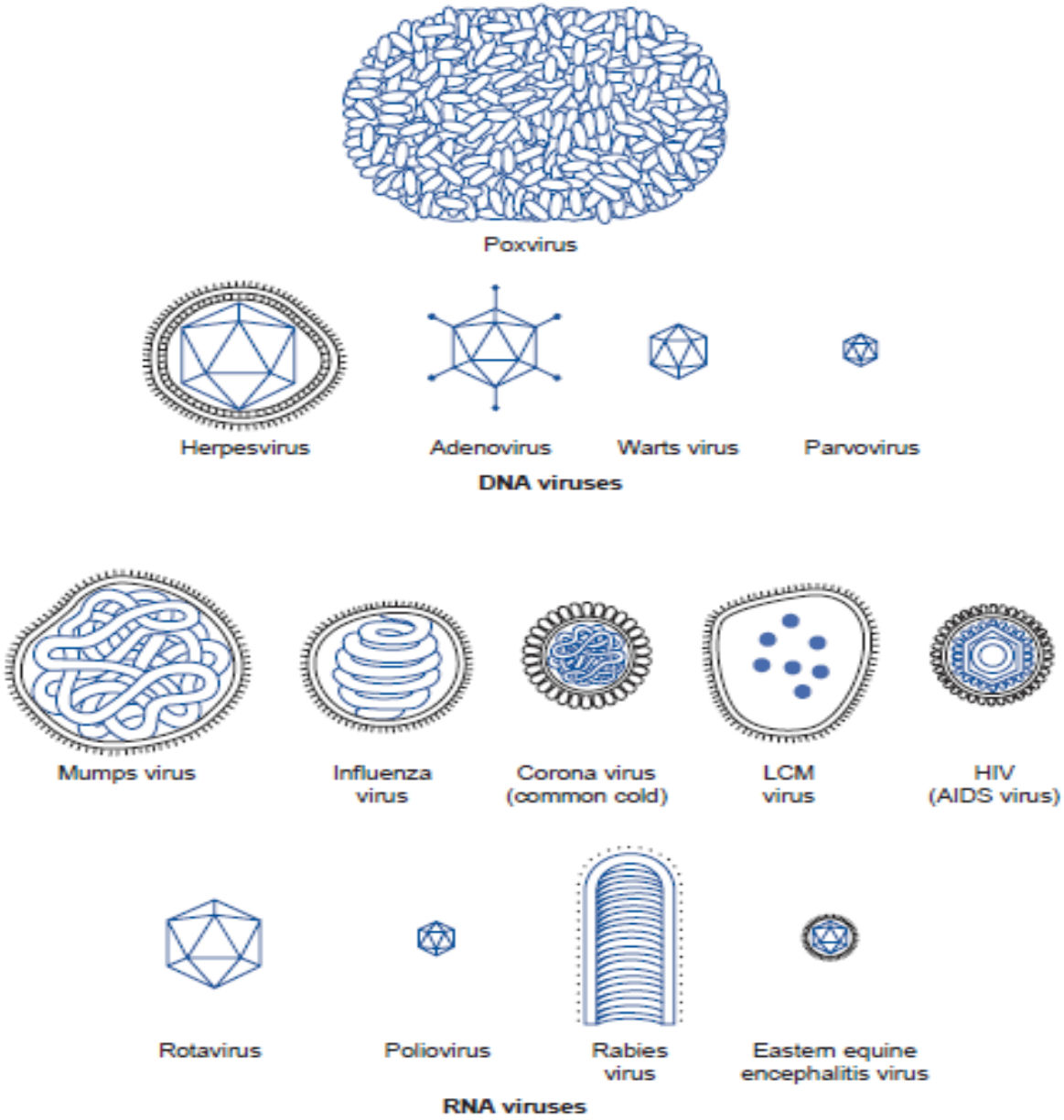
LO-1

- Viruses are obligate intracellular parasites.
- A virus consists of molecule of DNA (DNA virus) or RNA (RNA virus), but not both, surrounded by a protein coat.
- A virus may also have an envelope.
- Viruses cause a broad spectrum of diseases.



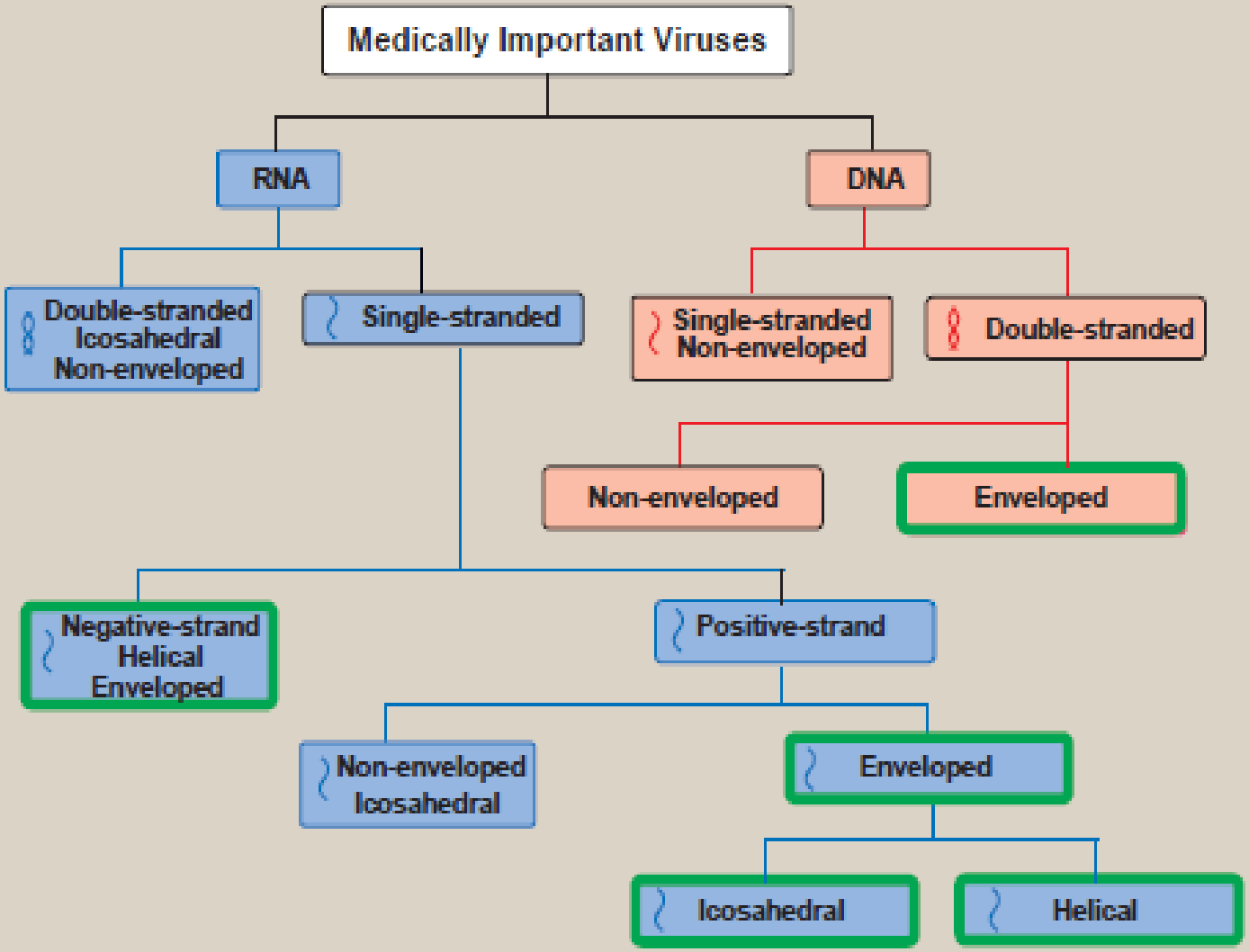
LO-1

Morphology of selected viruses



Classification of medically important virus families

LO-1



The infectious process

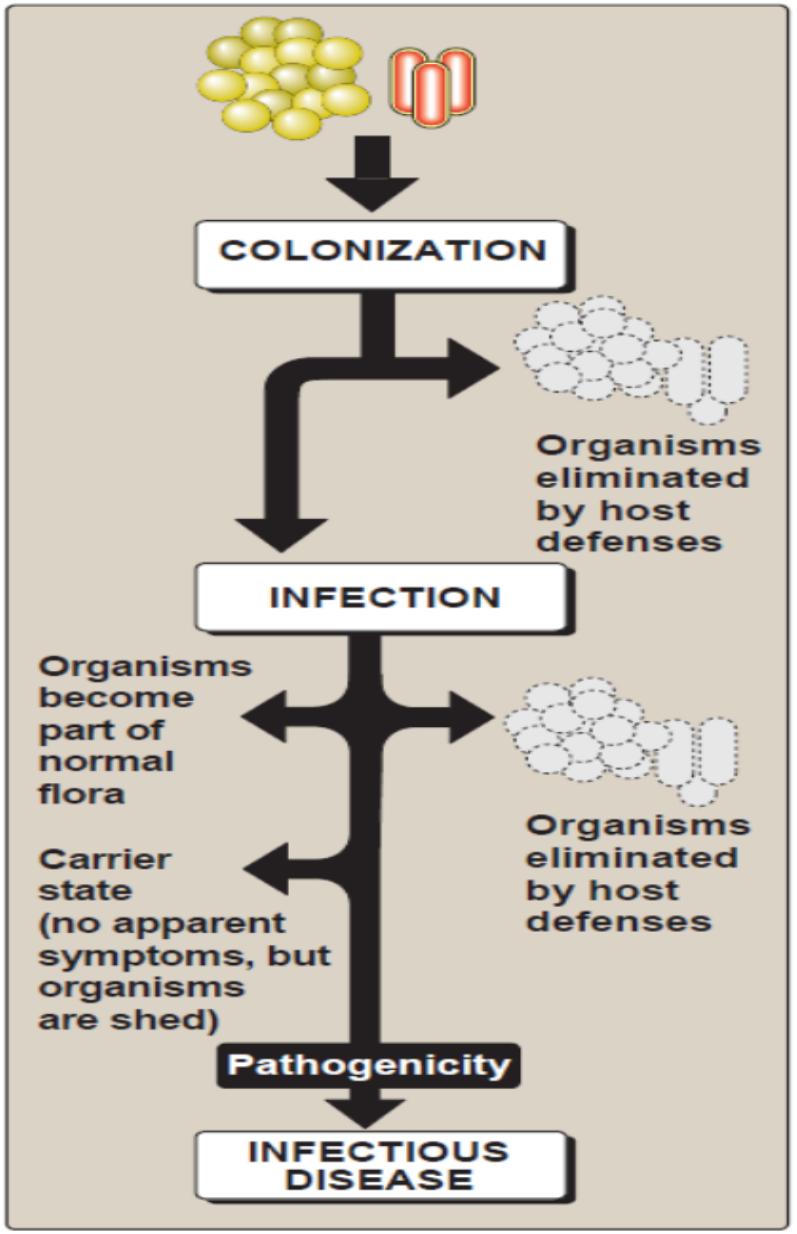
LO-1

The infectious process can be divided into several stages:

1) Entry of the microorganism into the host (respiratory, gastrointestinal, urogenital, skin)
2) Adhesion of the microorganism to host cells
3) Invasion & Spread (enzymes, toxins)
4) Evasion of host defenses (capsules, antigenic variation)
5) Host tissue damage: Direct cytotoxicity, Toxin production, Immune-mediated damage

LO-1

Possible outcomes following exposure to microorganisms



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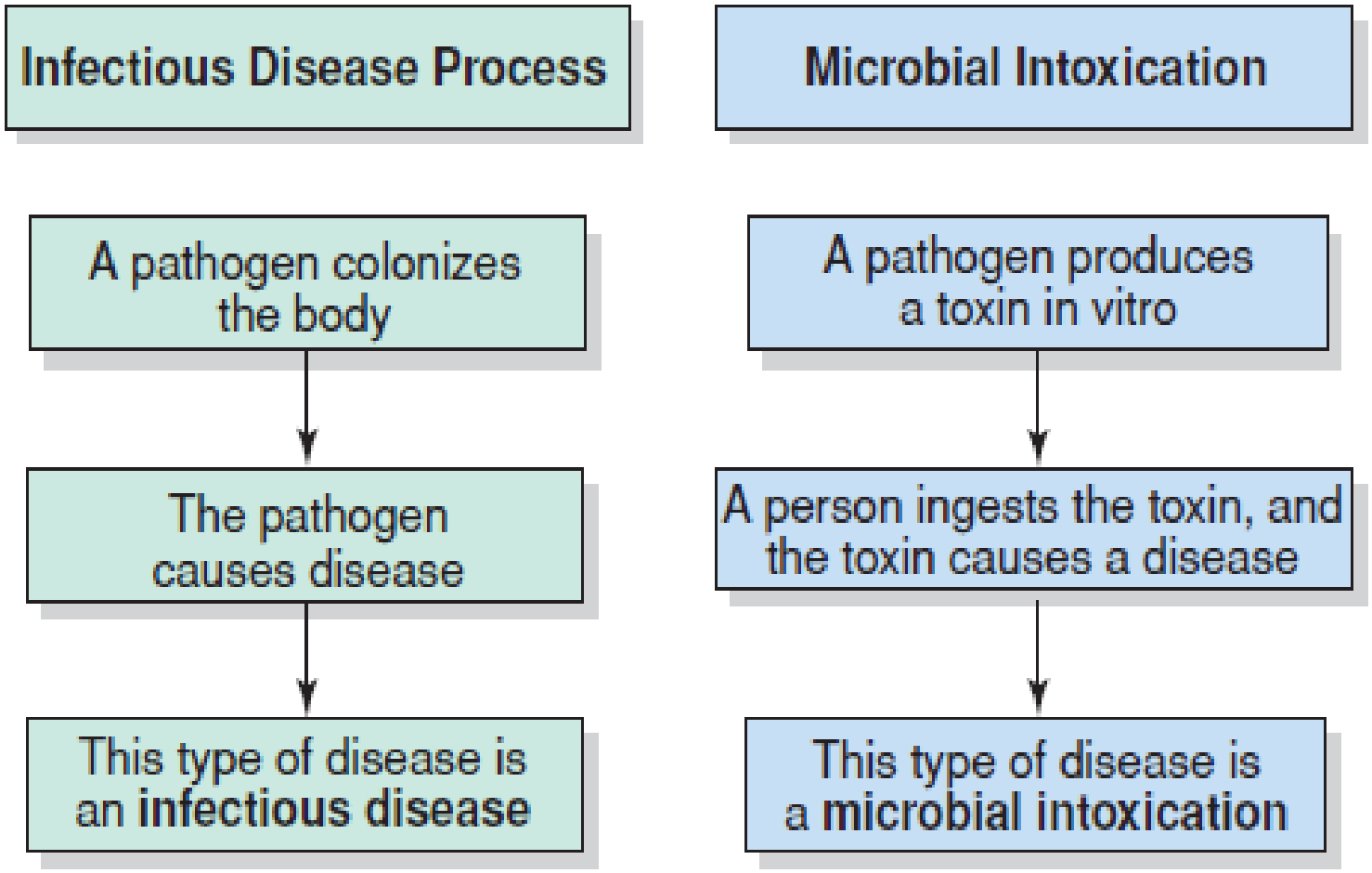


The two categories of diseases caused by pathogens

Normal Flora

LO-1

- **Microorganisms inhabiting skin, mucosa, and other body sites.**

Examples:

Skin: *Staphylococcus epidermidis*

Gut: *E. coli, Bacteroides, Lactobacillus*

Vagina: *Lactobacillus*

- **Functions:**

Protection against pathogens

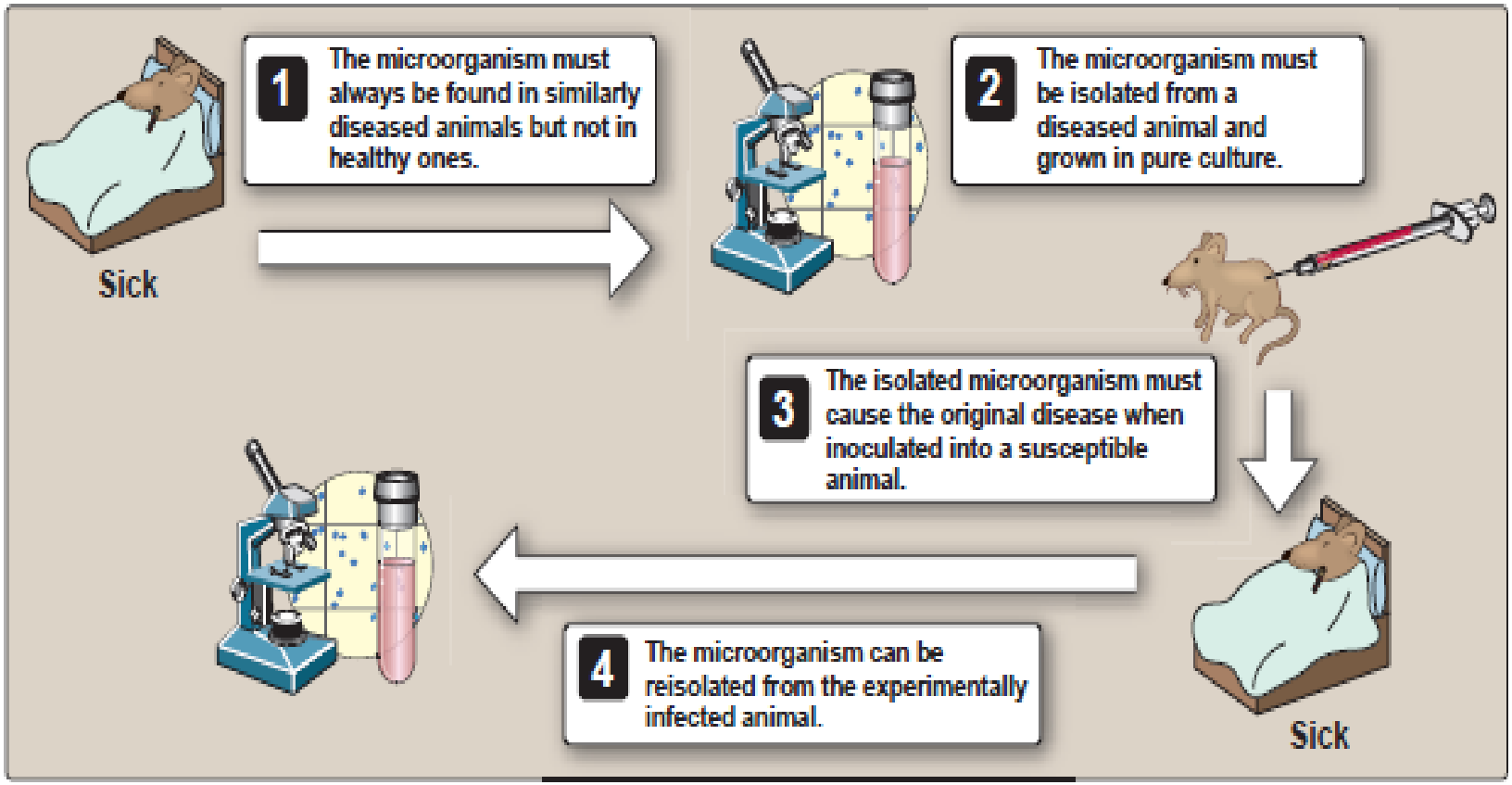
Immune stimulation

Nutritional (vitamin K, B)

- **Can cause opportunistic infections if balance is disturbed.**

Which is the pathogen?

LO-1



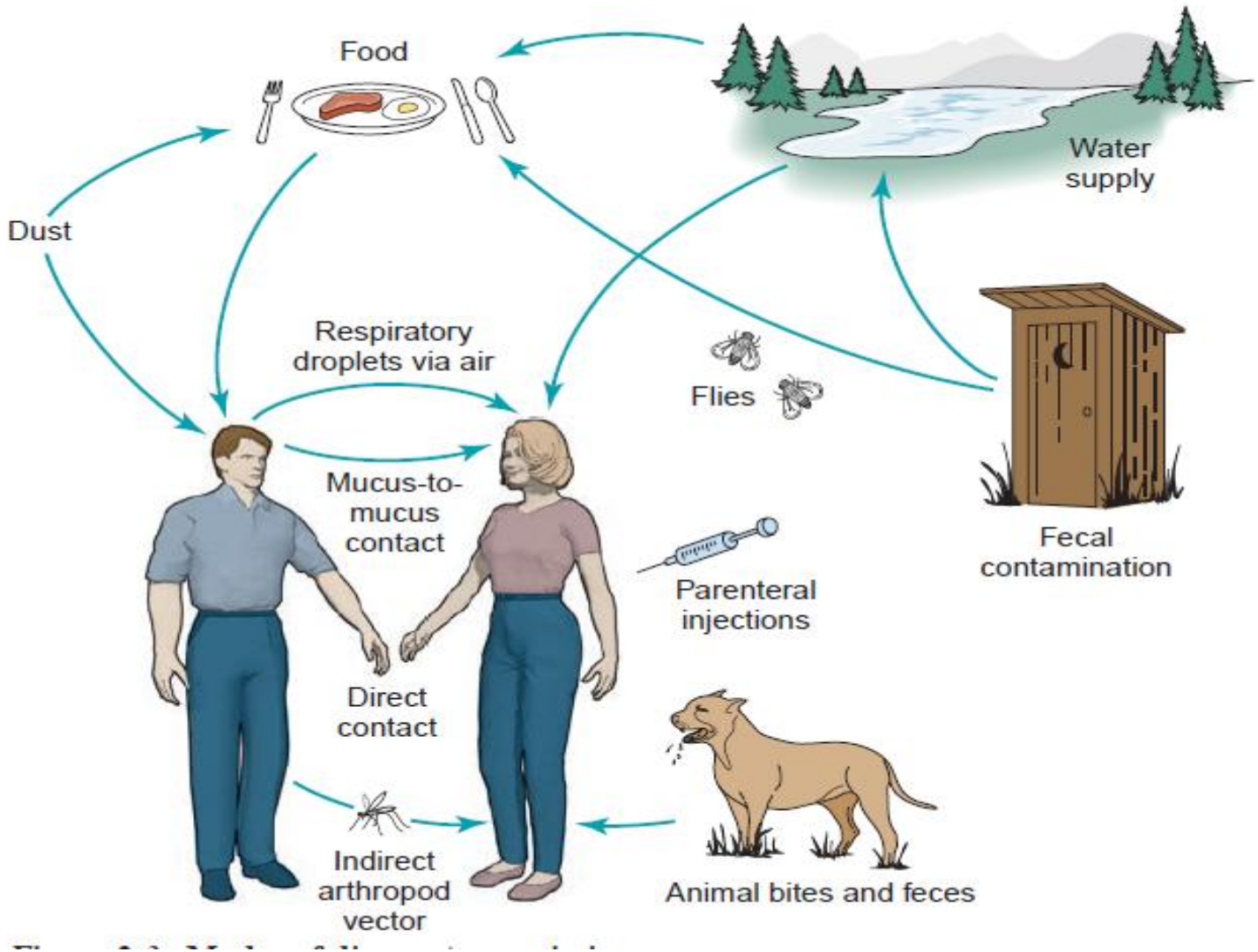
Koch's postulates by which the identity of the causative microbial agent of a disease can be confirmed.

Infections in human populations

LO-2

- **Bacterial diseases may be communicable from person-to-person or noncommunicable. For example, cholera is highly communicable (the disease-causing organism, Vibrio cholerae, is easily spread), whereas botulism is noncommunicable because only those people who ingest the botulinum exotoxin are affected.**
- **Highly communicable diseases, such as cholera, are said to be contagious**
- **Epidemics in which the disease frequency is higher than normal. When an epidemic becomes worldwide, it is called a pandemic.**

LO-2



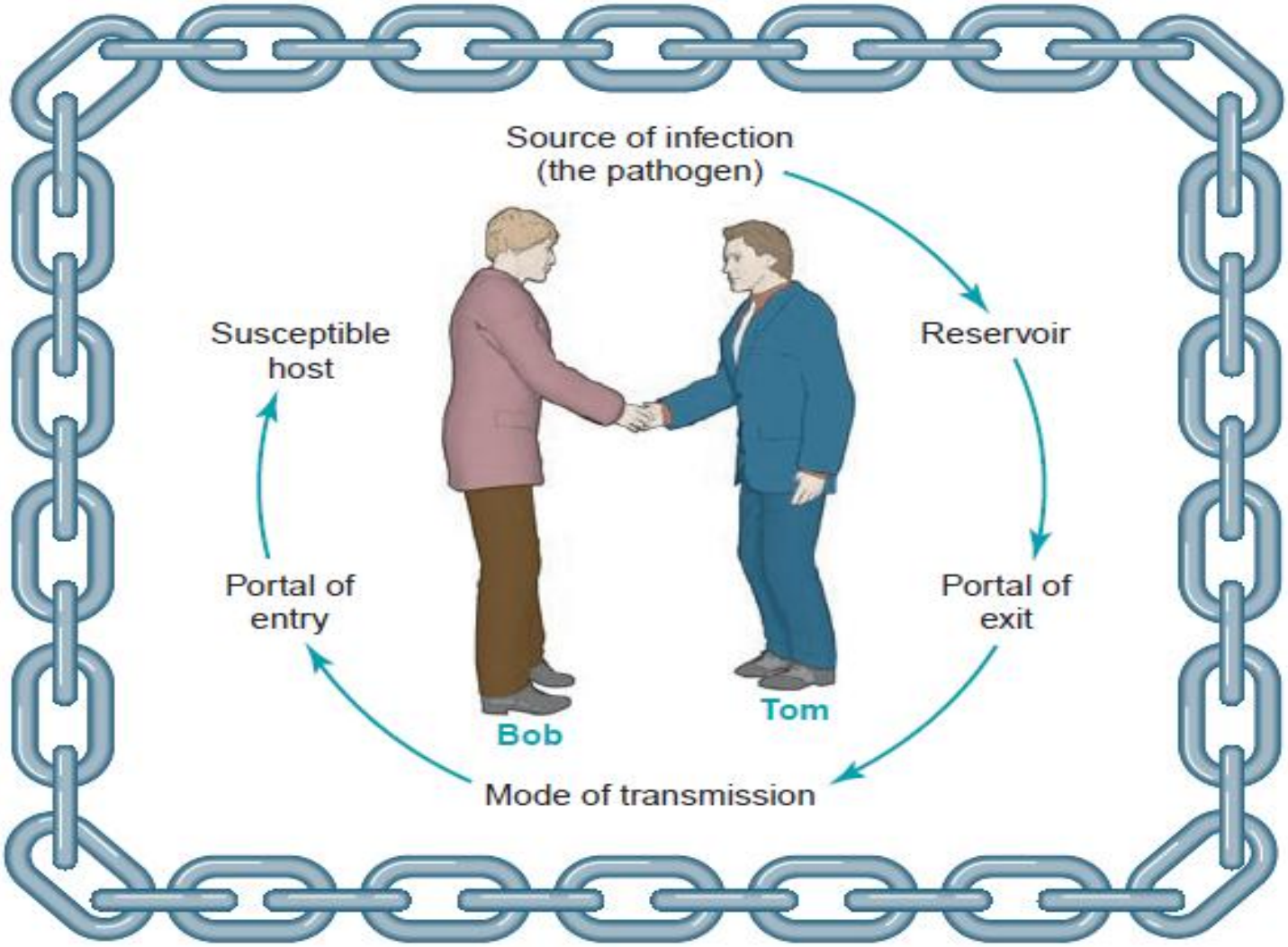
Modes of disease transmission

Common Routes of Transmission of Infectious Diseases

LO-2

Route of Exit	Route of Transmission or Entry	Diseases Transmitted in This Manner
Skin	Skin discharge → air → respiratory tract	Chickenpox, common cold, influenza, measles, staphylococcal and streptococcal infections
	Skin to skin	Boils, eczema, impetigo, syphilis, warts
Respiratory	Aerosol droplet inhalation Nose or mouth → hand or inanimate object → nose	Chickenpox, common cold, influenza, mumps, measles, pneumonia, tuberculosis
Gastrointestinal	Stool → hand → mouth Stool → soil → food or water → mouth	Amebiasis, cholera, gastroenteritis, giardiasis, hepatitis, salmonellosis, shigellosis, typhoid fever
Salivary	Direct salivary transfer	Herpes labialis (cold sores/fever blisters), infectious mononucleosis, strep throat
Genital secretions	Urethral or cervical secretions	Chlamydial infection, genital herpes, gonorrhea
	Semen	AIDS, cytomegalovirus infection, syphilis, warts
Blood	Transfusion or needlestick injury	AIDS, cytomegalovirus infection, hepatitis B, malaria
	Insect bite	Malaria, relapsing fever
Zoonotic	Animal bite	Rabies
	Contact with animal carcasses	Anthrax, tularemia
	Arthropod	Lyme disease, malaria, plague, Rocky Mountain spotted fever, typhus, viral encephalitis, yellow fever

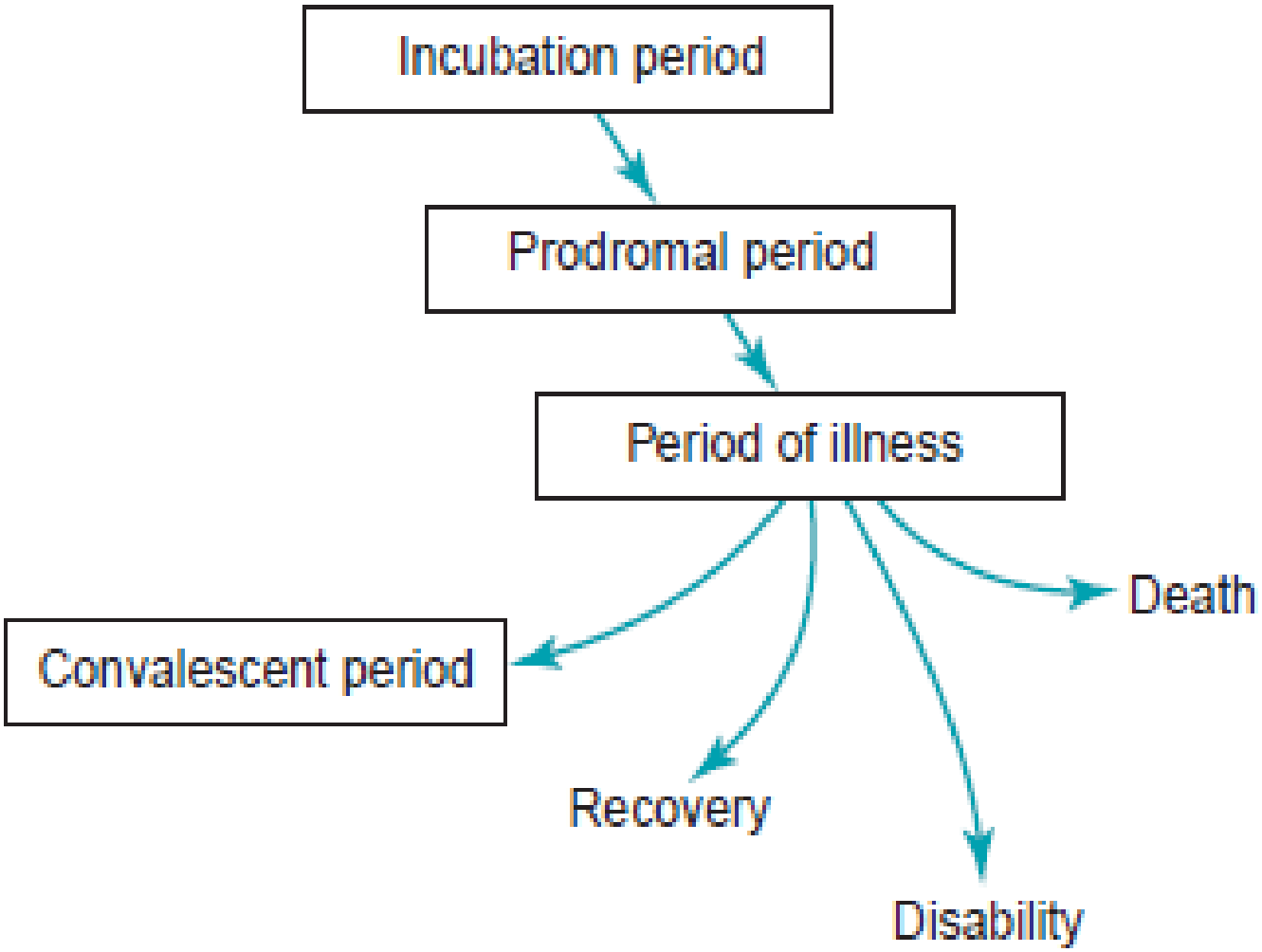
LO-2



The chain of infection

The course of an infectious disease

LO-2



Factors that influence the development of an infectious disease LO-2

Factors relating to the pathogen	Factors relating to the host	Factors relating to the environment
Virulence of the pathogen (virulence as a measure or degree of pathogenicity; some pathogens are more virulent than others)	Health status of the host (e.g., hospitalization, any underlying illnesses, invasive procedures, prosthetic devices, or catheterization)	Physical factors such as geographic location, climate, heat, cold, humidity, season of the year
Is there a way for the pathogen to enter the body?	Nutritional status of the host	Availability of appropriate reservoirs, intermediate hosts, and arthropod vectors
Number of organisms that enter the body (infectious dose)	Other factors pertaining to the susceptibility of the host (e.g., age, lifestyle [behavior], socioeconomic level, travel, hygiene, substance abuse, immune status, etc.)	Sanitary and housing conditions; adequate waste disposal. Availability of potable (drinkable) water

LO-3

Management of Patients

- Diagnosis: history, examination, lab tests
- Treatment:

  Antimicrobials (specific treatment)

  Supportive treatment
- Prevention:

  Vaccination

  Infection control (hand hygiene, sterilization)

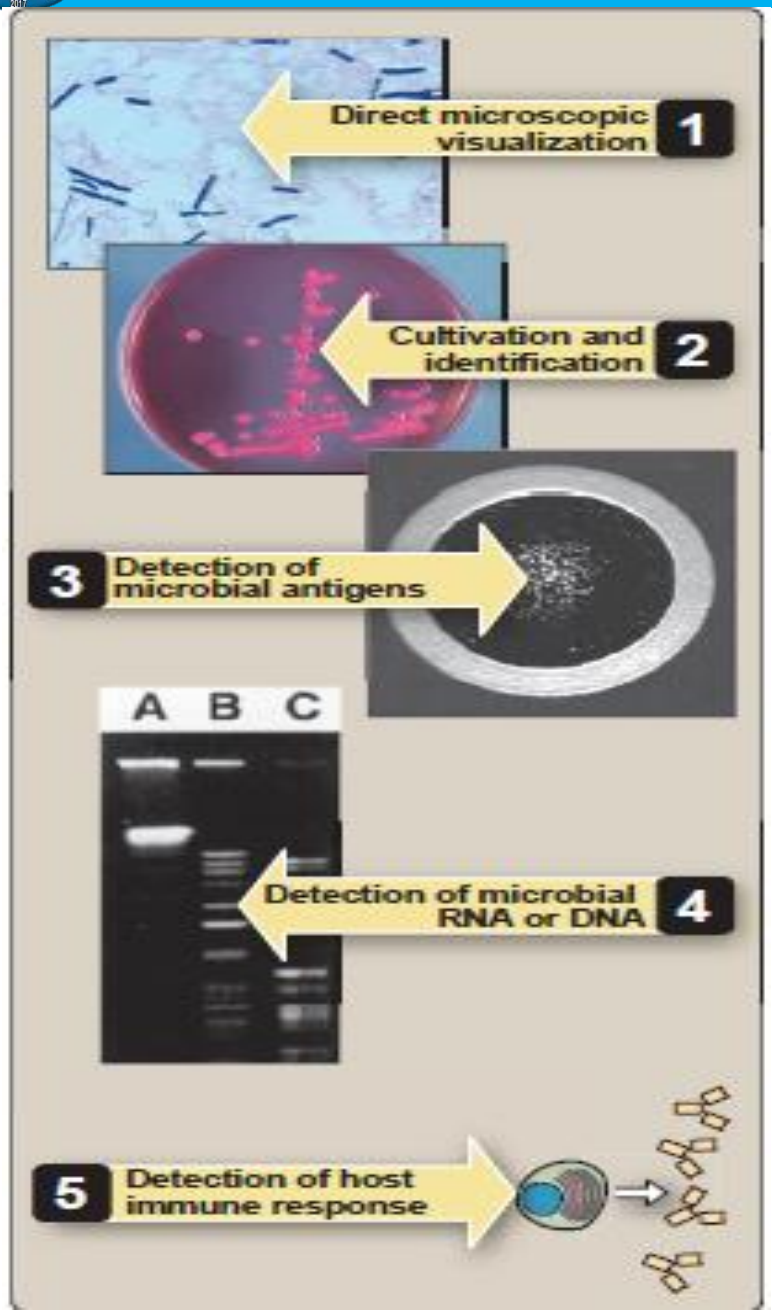
Patient history and physical examination

LO-3

- A clinical history is the most important part of the evaluation of patients. For example, a history of cough points to the possibility of respiratory tract infection; dysuria suggests urinary tract infection.
- Patient occupations may suggest exposure to certain pathogens, such as brucellosis in a butcher.
- A history of travel to endemic area may implicate exotic organisms such as malaria
- A physical examination often provides confirmatory clues to the presence and extent (localized or disseminated) of disease
- Clues to the presence of bacteremia may include chills, fever, or cardiovascular instability heralding septic shock.
- Physical signs of pulmonary consolidation suggest pneumonia.

Laboratory techniques that are useful in diagnosis of microbial diseases

LO-3



Treatment

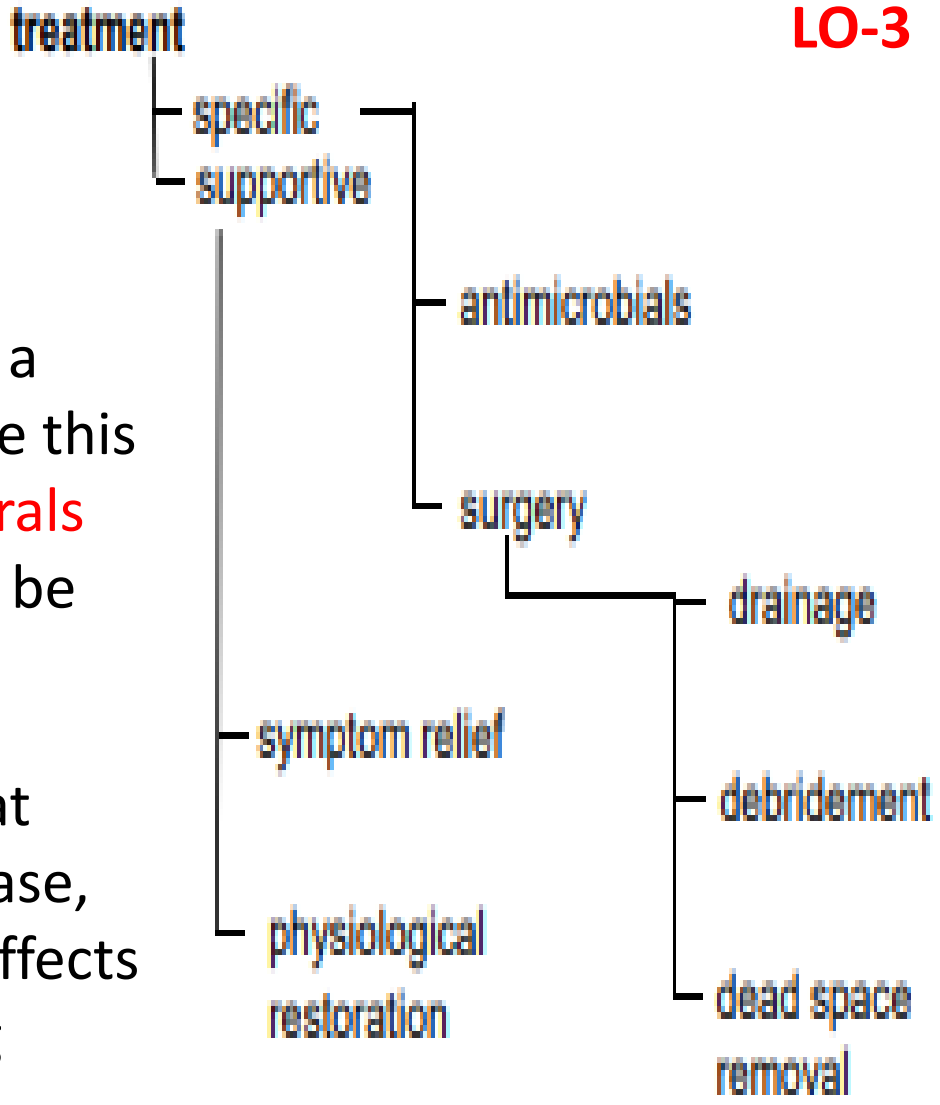
LO-3

There are two broad types of treatment: **specific** and **supportive**

- **Specific** treatment focuses on treating the underlying cause of a disease. For an infectious disease this involves giving antibiotics/antivirals which the pathogen is known to be susceptible to.

- **Supportive** treatment is aimed at treating the symptoms of a disease,

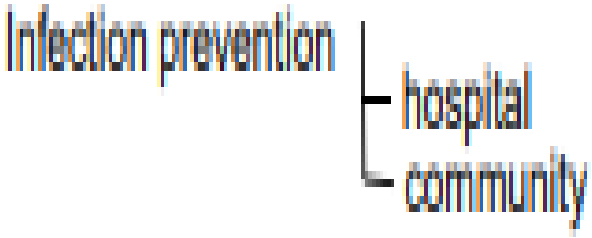
- lessening the impact of the side effects of treatment and overall improving patient comfort.



Infection prevention

LO-3

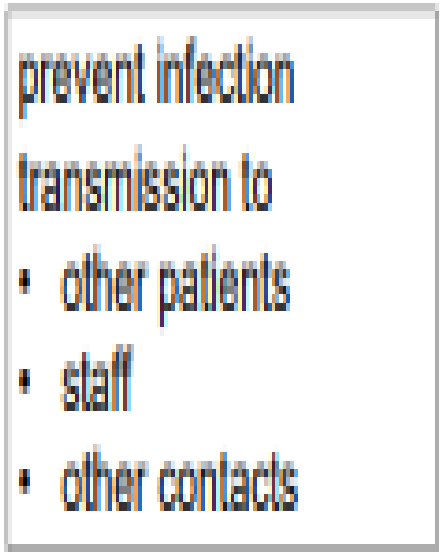
Infection prevention involves stopping an infection spreading from one patient to another in a patient or community setting.



The **4 main** areas of infection prevention can be remembered as **4 P's:**

1. Patient- minimize patients risk factors for infection by

- Optimizing health and Controlling interaction with visitors and other patients e.g. by isolation in side rooms/ negative pressure rooms.
- Use of prophylactic antibiotics



Infection Prevention--cont

LO-3

2. Pathogen– prevent the pathogen from causing infections. This can be achieved by minimizing inappropriate antibiotic use to limit resistance and ensuring good levels of vaccination within the general population. Healthcare workers should also be fully vaccinated and healthy.

3. Practice- modify healthcare worker activity to prevent iatrogenic spread of disease. This includes effective hand hygiene and professional dress standards

4. Place- this includes the environment in which the patient is in and the equipment used. This includes sterilization and disinfection of equipment and the ward environment to eliminate reservoirs of infection.

Vaccines

LO-3

operate on the concept of herd immunity. Immunizing one individual removes them from the pool of susceptible individuals who may catch the pathogen.

If enough people are vaccinated ("the herd"), then the microorganism does not have enough susceptible people.

This concept also helps protect those who cannot be immunized including; immunosuppressed individuals and children who are too young to be.

Immunization

LO-3

- Protection of individuals from disease by immunization can take two forms:

1. **Passive immunization** is achieved by injecting a recipient with preformed immunoglobulins directed against an already present infection
2. **Active immunization** involves injection of modified or purified pathogens or their products.

“ We always work together as a team ”