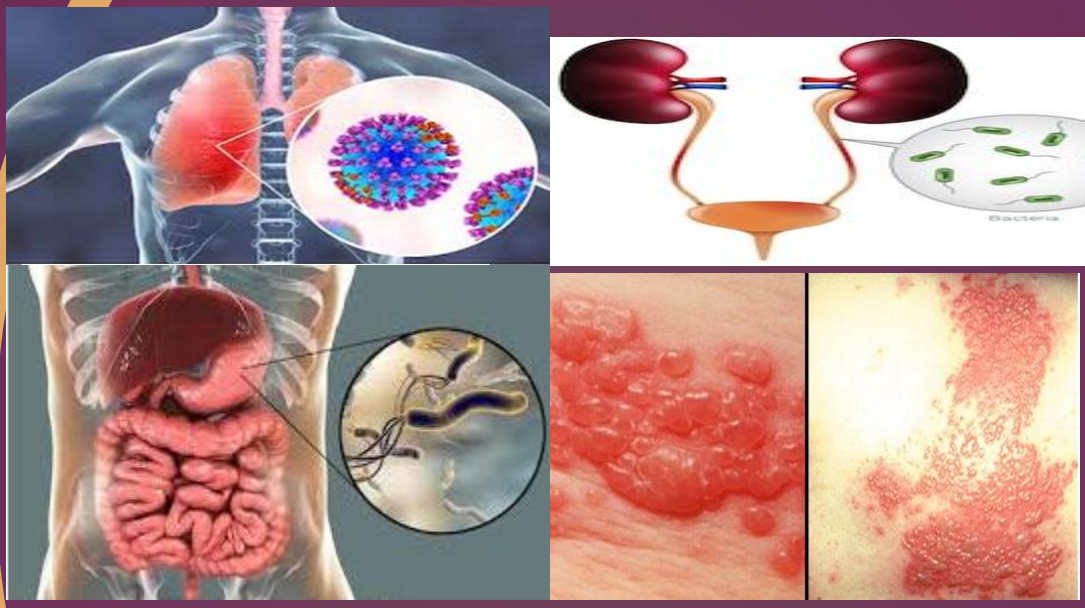
Microbiology and Infection Control



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First Year

2018/2019

Acknowledgments

This two-year curriculum was developed through a participatory and collaborative approach between the Academic faculty staff affiliated to Egyptian Universities as Alexandria University, Ain Shams University, Cairo University , Mansoura University, Al-Azhar University, Tanta University, Beni Souef University , Port Said University, Suez Canal University and MTI University and the Ministry of Health and Population(General Directorate of Technical Health Education (THE). The design of this course draws on rich discussions through workshops. The outcome of the workshop was course specification with Indented learning outcomes and the course contents, which served as a guide to the initial design.

We would like to thank **Prof.Sabah Al- Sharkawi** the General Coordinator of General Directorate of Technical Health Education, **Dr. Azza Dosoky** the Head of Central Administration of HR Development, **Dr. Seada Farghly** the General Director of THE and all share persons working at General Administration of the THE for their time and critical feedback during the development of this course.

Special thanks to the **Minister of Health and Population Dr. Hala Zayed and Former Minister of Health Dr. Ahmed Emad Edin Rady** for their decision to recognize and professionalize health education by issuing a decree to develop and strengthen the technical health education curriculum for pre-service training within the technical health institutes.

Contents

Course Description:

This is course aims at provide the students with the knowledge and practice about microbiology and infection control

Core Knowledge

By the end of the course every student will be able to:

A.1. Identify important infectious diseases.

A.2. Describe the common transmission mechanisms for infectious diseases.

A.3.Recognize methods of prevention for infectious diseases.

A.4.Describe the interaction between host and parasite.

A.5. Explain the different components of immune system.

A.6.Describe the complications of antimicrobial therapy.

A.7. Understand the principles of health care associated infections.

Core Skills

By the end of this course, students should be able to:

B.1. Discuss the appropriate specimen and processing method needed to diagnose a suspected causative pathogen causing infection.

B.2. Interpret results of microbiological tests.

B.4.Discuss the components of chain of infection.

B.5.Discuss the standard and transmission based precautions.

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Terminology

Antibodies Substances produced by B cells that react with antigens and prepare them for destruction.

Antigen A substance that triggers an immune response.

Antimicrobial is any substance of natural, semisynthetic or synthetic origin that kills or inhibits the growth of microorganisms but causes little or no damage to the host. It includes all agents that act against all types of microorganisms – bacteria (antibacterial), viruses (antiviral) and fungi (antifungal).

Bacteremia: Transient presence of bacteria in the bloodstream, there may be symptoms and signs of local infection.

Bundle: Grouping of best practices. A group of processes needed by patients undergoing certain risky treatments.

Catheter associated urinary tract infection (CAUTI) is a UTI that occurs in a patient who had an indwelling urethral urinary catheter in place within the **48hour** period before the onset of the UTI.

Cleaning: It is a process that uses detergent and water to remove visible contamination. It does not necessarily destroy microbes. Effective cleaning is essential before disinfection or sterilization.

Colonization: It is the process of multiplication of an organism on a body surface of the host, with no tissue invasion and not causing a disease.

Disinfection: It is a process that uses chemical agents or heat to eliminate many or all pathogenic microorganisms on inanimate objects, with the exception of bacterial spores.

Encephalitis is inflammation of the brain.

Gastroenteritis is an inflammation of the stomach and /or intestines caused by the presence of microorganisms or their toxins

Infection: The entry and multiplication of infectious agents in the tissues of the host with tissue invasion or damage.

Meningitis is an acuteinflammation of the protective membranes covering the brain and spinal cord, known collectively as the meninges

Pneumonia is an inflammation of the lung parenchyma.

Septicemia or sepsis: Presence of bacteria in the bloodstream associated with signs of shock, including tachycardia and reduced blood pressure

Sterilization: This is the complete elimination or destruction of all forms of microbial life, including bacterial spores.

Surgical site infections (SSI) Infection occurs within 30 days after the operative procedure if no implant is left in place or within 1 year if implant is in place and the infection appears to be relatedto the operative procedure.

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Chapter 1: Introduction to microbiology and classification of micro-organisms

Objectives

Define key microbiology -related terms and concepts

Explain the structure of different microorganisms.

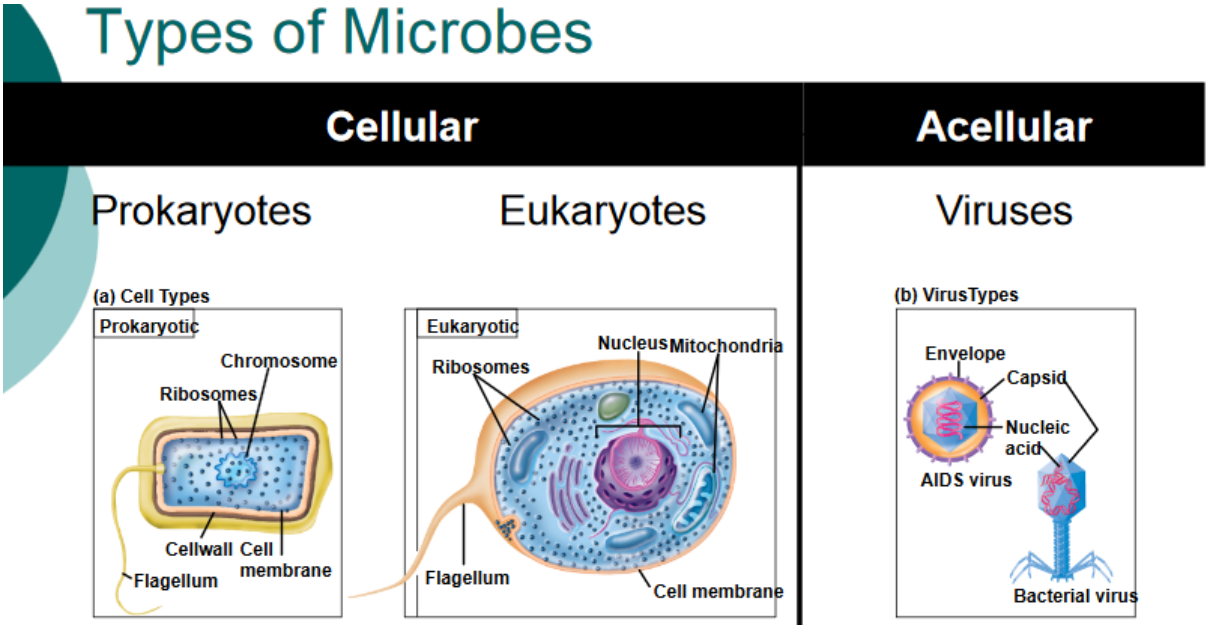
Overview of Microbiota and Related Concepts

I.Micro-organisms

- Living organism (such as bacteria, fungi, viruses) too small to be seen with naked eye but visible under a microscope.
- May be unicellular or multicellular.
- Can be useful or harmful

II. Classification of Microorganisms -

- The 5 major groups of microorganisms: bacteria, algae, fungi, protozoa, and viruses
- *Less than 1% of known microorganisms cause disease.



■ Types of microbes and their characteristics

►Bacteria:

- Bacteria are unicellular organisms. Because they have no nucleus, the cells are described as prokaryotic.
- The three major basic shapes of bacteria are bacillus, coccus and spiral.
- Reproduction: Bacteria grow in number not in size, they make copies of themselves by dividing into half. Most bacteria multiply by a process called binary fission. A single bacterial cell, the "parent," makes a copy of its DNA and grows large in size by doubling its cellular content. The doubled contents are pushed out to either end of the cell. Then a small fissure emerges at the center of the parent, eventually splitting it into two identical "daughter" cells.

Fig. : Bacterial division

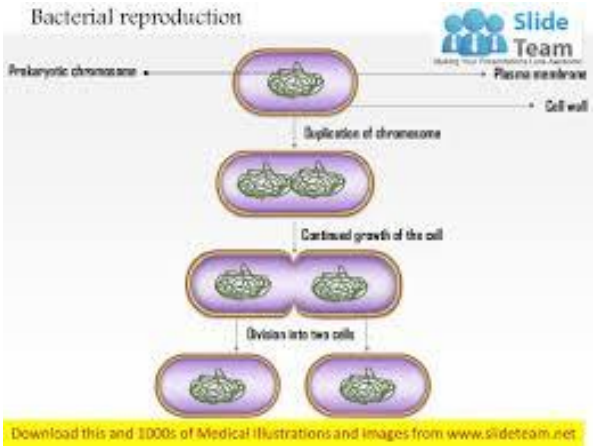
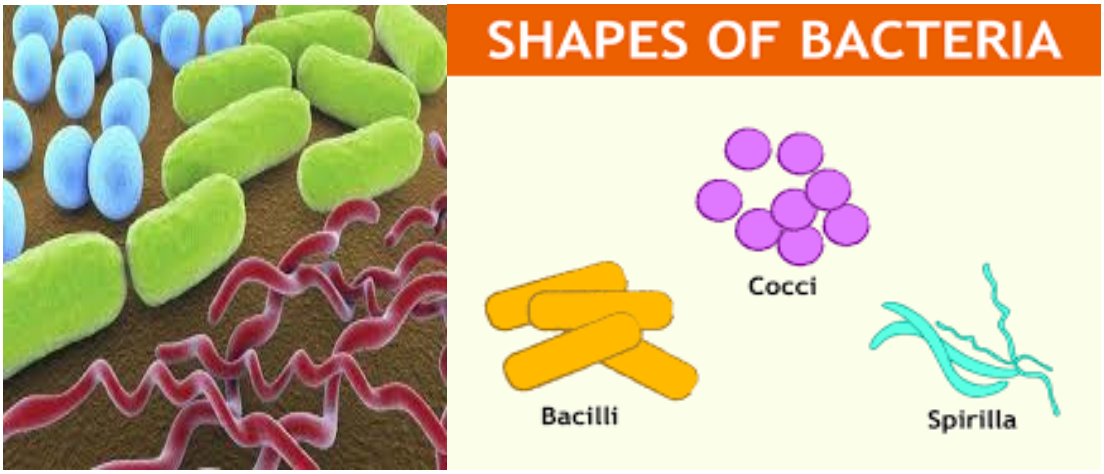


Fig. : Shapes of bacteria



Prokaryotic Cell structure

Cell envelope

- It is the external layers that enclose the cytoplasm. It consists mainly of three different layers: Capsule, Cell wall and Cytoplasmic membrane.
- **Also the bacterial cell may have hair like appendages of two kinds:** Flagella and Pili.

The cytoplasm and intracellular organelles:

Cytoplasm, Nucleoid and Ribosomes.

1-Cell wall: Thick rigid layer is responsible for:
Shape of bacterial cell (spherical, rod like, or spiral).

2-Cell membrane: It is a thin membrane that encloses the cytoplasm.
Functions of cell membrane:
i. To regulate transport – that is the passage of nutrients into cell and the discharge of wastes.
ii. Enzyme secretion – the enzymes of respiration are located at the membrane. Macromolecules (carbohydrate, protein and fat) cannot permeate through the cell membrane. The enzyme is needed to brake the macromolecules.
iii. Cell membrane provides a site for the functions such as energy reactions.

3-Flagella: long filaments that enable bacteria to move.

4-Pili: Thin hair-like appendages on the surface of many bacteria.
They function as adhesion organs to attach the bacterial cell to the surface of the host cell.

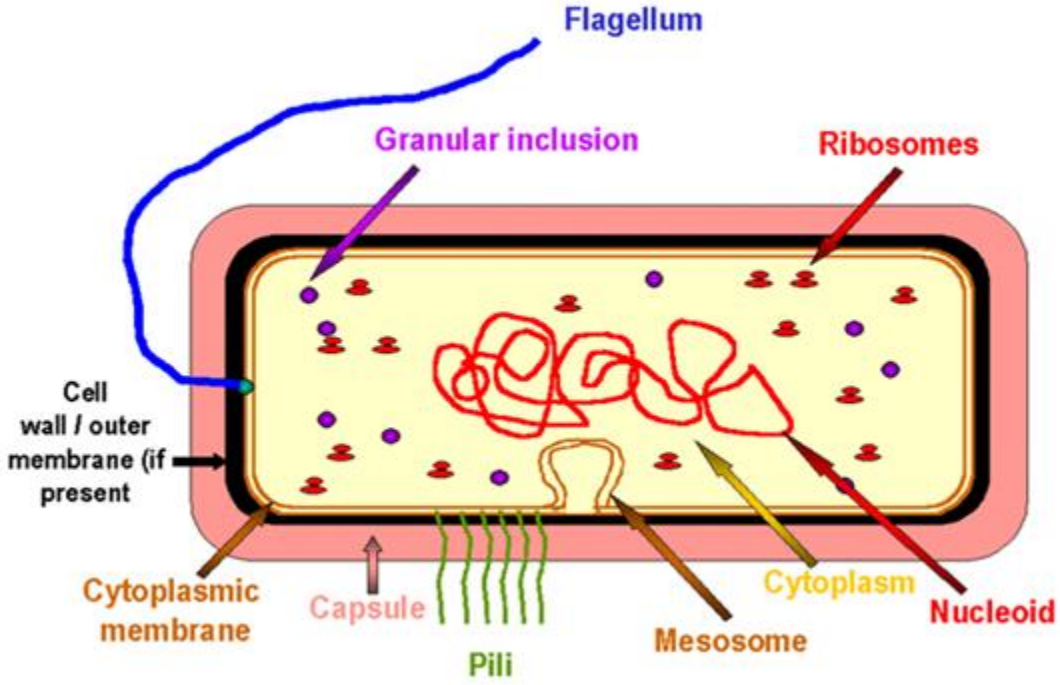
5-Cytoplasm: is a complex fluid mixture — 80% water — containing, lipids, carbohydrates, ions, and enzymes. Nucleoid, ribosomes, inclusion granules, and are suspended and embedded in this fluid.

6-Nucleoid (chromosome): Chromatin bodies – the heredity material of bacteria exists in the form of a single circular strand of DNA designated as the chromatin body or bacterial chromosome. By the definition, bacteria do not

have a nucleus that is their DNA is not enclosed by a nuclear membrane, but instead is aggregated in a dense area of the cell called the **nucleoid**.

7-Ribosomes: a bacterial cell contains thousands of tiny, discrete units called ribosomes. Ribosomes is where the protein synthesis is performed.

8-Endospore: Only certain bacteria have endospore. This type of bacteria is called an endospore because it is produced inside a cell. It is inactive form of the bacteria (dormant cell) which can survive and allow the organism to resist adverse environmental conditions which is not suitable for the bacteria to be reproductive, for example, drying, high temperatures, bactericidal agents, ultraviolet light and nutritional deprivation.



► Viruses:

Viruses are the smallest micro-organisms known to be infective agents. They vary in size between 10 and 300nm, being visible only under the electric microscope.

- *Viral properties*:

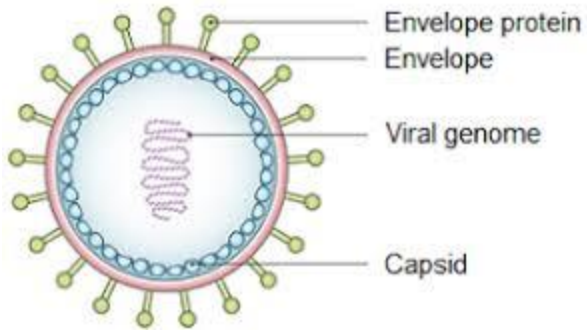
They are Ultramicroscopic, obligate intracellular parasites that:

- contain only one type of nucleic acid, either DNA or RNA,
- surrounded by a protein coat to protect it from adverse environmental conditions.

- possess no enzymatic energy-producing system and no protein-synthesizing apparatus, and
- force infected host cells to synthesize virus particles.

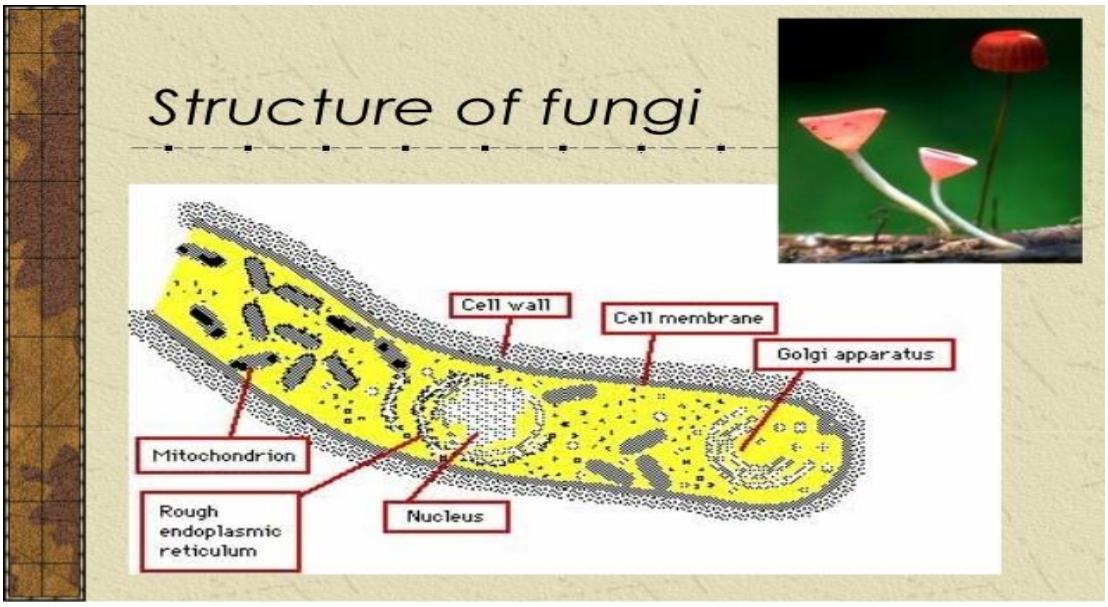
Thus, viruses can not replicate on their own and depends on the machinery of the host cell for replication.

Fig. : structure of viruses



Fungi

- Have eukaryotic cells (with true nucleus).
- Most fungi are multi cellular.
- Fungi obtain nutrients by absorbing organic material from their environment.



Chapter 2: Normal microbial flora

Objectives

Define microbial flora.
List the sites of microbial flora in human body.
Discuss advantages and disadvantages of microbial flora.
Understand the host parasite relationship.
Understand different types of infectious diseases.
Discuss different stages of infectious diseases.

Overview of normal microbial flora and Related Concepts

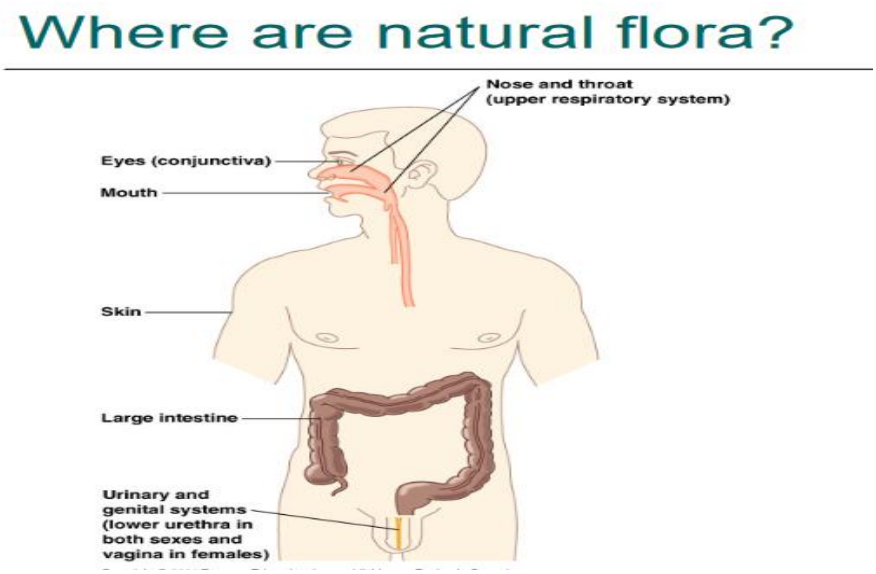
The term "normal microbial flora" denotes the population of microorganisms that inhabit the skin and mucous membranes of healthy normal persons.

It can be arranged into two groups:

1. **The resident flora** consists of relatively fixed types of microorganisms regularly found in a given area at a given age; if disturbed, it promptly reestablishes itself.
2. **The transient flora** consists of nonpathogenic or potentially pathogenic microorganisms that inhabit the skin or mucous membranes for hours, days, or weeks; it is derived from the environment, does not produce disease, and does not establish itself permanently on the surface. Members of the transient flora are generally of little significance so long as the normal resident flora remains intact. However, if the resident flora is disturbed, transient microorganisms may colonize, proliferate, and produce disease.

•A fetus is sterile when born (No Normal Flora), then newborn start having the normal flora from its mother, air, food and the environment.
•Our internal organs are sterile like the spleen, liver, pancreas, bladder, CSF, and blood unless during infection.

Where Can We find Normal Flora?
•Resident normal flora are found in sites exposed to the outside world (external environment) like the skin, all body openings, and mucous membranes that line the digestive ,respiratory and genitourinary tracts.



Advantages of normal flora:

(i) They synthesize the vitamins especially Vit.-K and B12 in intestine.

(ii) They prevent the entry of the pathogens by Their physical occupancy and Competition for essential nutrients.

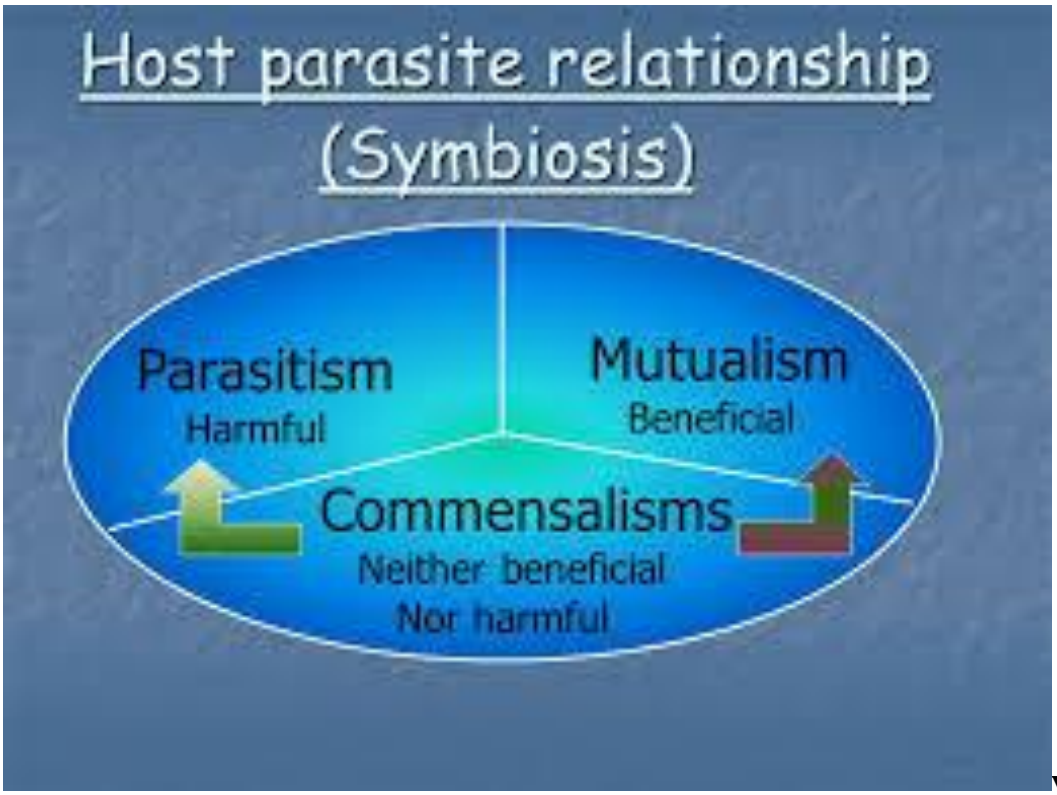
(iii) produce anti-bacterial chemicals as a side product of their metabolism, therefore, taking a local antibiotic effect which suppress pathogens.

Disadvantages

(i) They become pathogenic when the immunity is lowered.

(ii) They may act as pathogens in different tissues (other than their normal habitat) e.g. normal flora of intestine may cause urinary tract infection (UTI).

Host parasite relationship



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Pathogen – parasite capable of causing disease

Host – an organism that harbors another organism

Relationship between microbes and their inhabiting human body have several forms that may be:

1. **commensalism -** one organism benefits, the other is neither harmed or benefited.

2. **mutualism -** both partners benefit.

    Ex. Large numbers of *E. coli* live in the large intestine of humans. These bacteria release vitamin K, which we use to make certain blood-clotting factors.

Ex. Natural flora protects the host by competing with many pathogens. This phenomenon is called **microbial antagonism**.

1. **parasitism -** host is harmed, the parasite benefits; microbial parasites = pathogens.

Colonization:

It is the process of multiplication of an organism on a body surface of the host, with no tissue invasion and not causing a disease.

Infection:

The entry and multiplication of infectious agents in the tissues of the host with tissue invasion or damage

TYPES OF INFECTIOUS DISEASE

Acute disease : develops rapidly and runs its course quickly

Chronic disease : develops more slowly, is usually less severe, and persists for a long period.

Latent disease : the organism is never eliminated. No apparent illness. characterized by period of inactivity (ex. Herpes)

Local infection : confined to a specific area

Systemic infection : generalized infection; affects most of the body.

Super infection : secondary infection that results from the destruction of normal microflora and often follows the use of broad-spectrum antibiotics.

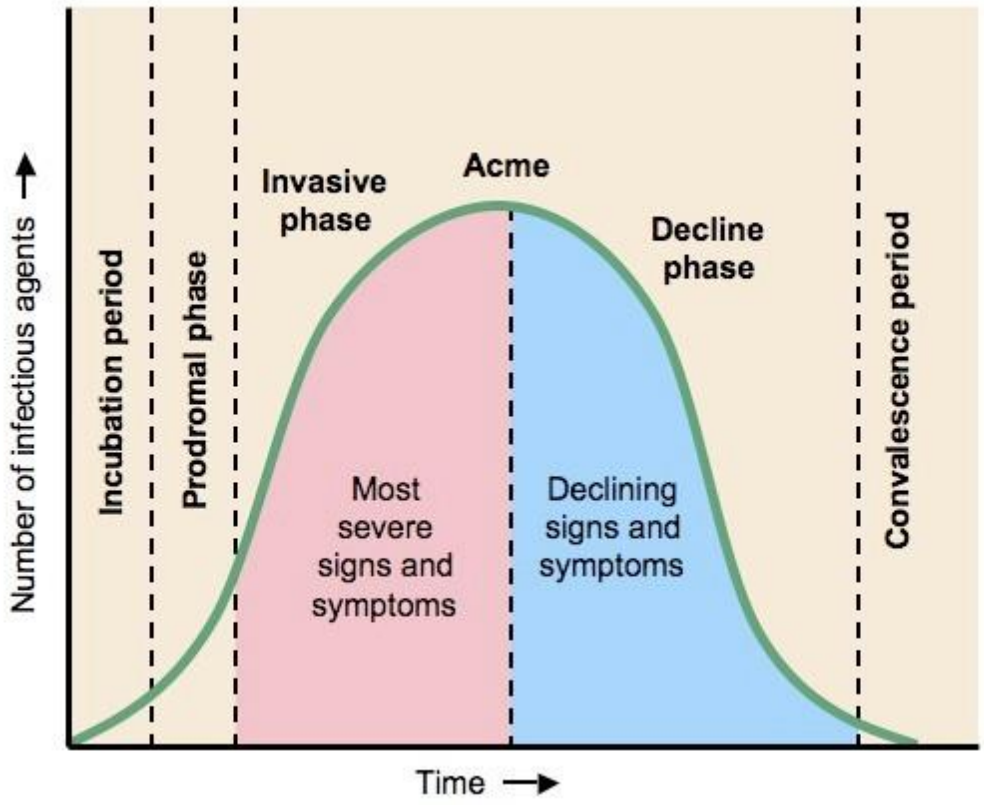
Mixed infection : caused by several organisms at the same time.

STAGES OF INFECTIOUS DISEASE

A. Incubation period: Time between infection and the appearance of signs and symptoms. Although the infected person is not aware of the presence of an infectious agent, he can spread the disease to others. Each infectious disease has a typical incubation period.

B. Phase of illness: The period during which the individual experiences the typical signs and symptoms of the disease.

C. Convalescence phase: Tissues are repaired, healing takes place, and the body regains strength and recovers. Individuals no longer have disease symptoms, but they may still be able to transmit pathogens to others.



Chapter 3: Chain of infection

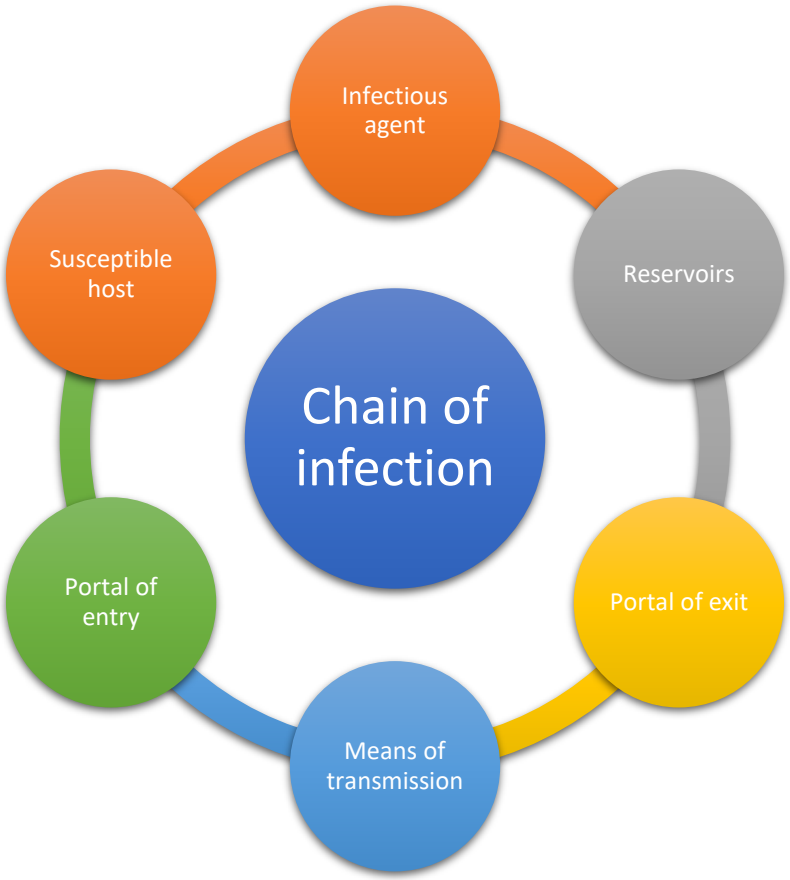
Objectives

Define the chain of infection.
Discuss different components of chain of infection.
Understand the different methods of transmission of infectious diseases.

Overview of chain of infection and Related Concepts

Chain of infection

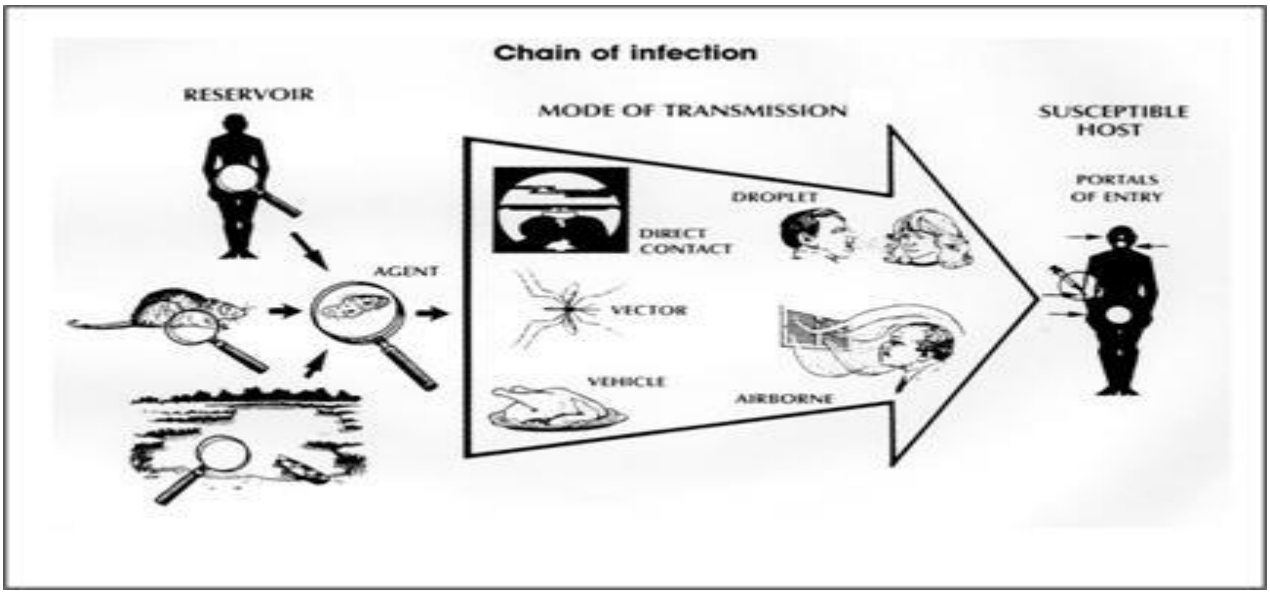
Infectious diseases result from the interaction of agent, host, and environment.



1-Infectious agent:

Including bacteria, fungi and viruses

2-Reservoir



is the place in which the agent can survive but may or may not multiply.

There are three common reservoirs;

a. Human reservoirs: either

- Acute clinical case
- Asymptomatic cases or carriers.

A carrier: is a person who shows no recognizable signs or symptoms of a disease but is capable of spreading disease to others, such as:

Persons in the **prodromal period** of infectious disease or health care worker with MRSA nasal **colonization**.

Convalescent carriers are those who recovered from the disease but still can transmit infection to others (e.g.cholera)

Chronic carriers may continue to have organisms present for very long periods of time (e.g.typhoid)

Intermittent carriers who periodically shed organisms.

*Carriers present a particular risk of transmission to susceptible hosts in the healthcare setting because they are less likely to be recognized.

b. Animal reservoirs:

Zoonotic diseases: can be transmitted to human but primarily exist in animals e.g. plague.

c. Environmental reservoirs:

Example: *Clostridium tetani* are widely spread in soil.

3- Portal of exit

Portal of exit is the path by which a pathogen leaves its host.

- Organisms of intestinal tract → stools.
- Respiratory organisms → droplet or saliva.
- Genital pathogens → semen or cervical secretions.

4-Modes of transmission

Is the movement of pathogens from the reservoir to the host.

- **Vertical transmission:**
  From mother to her baby during pregnancy or labour.
- **Horizontal transmission:**
  From one person to another.

Methods of transmission:

A. Contact transmission:

- Direct contact: person to person with actual physical contact e.g. patient care activities as bathing or turning of patients.
- Indirect contact: contact with a contaminated intermediate object e.g. contaminated gloves of health care workers that are not changed between patients.

B. Inhalation:

Droplet transmission:

Large droplets (5µm) containing microorganisms are generated from infected persons e.g. during sneezing, performing certain procedures as suction of respiratory secretions.

They are too heavy to remain floating in air & are transferred >5 meters from source.

- Direct droplet transmission: droplets reach mucous membrane or are inhaled (close contact > 1 meter).

- Droplet to contact transmission: droplets contaminate surfaces & can be transmitted via hands or contaminated objects.

Airborne transmission:

It occurs by dissemination of:

- Airborne droplet nuclei (small-particle residues of Evaporated droplets ≤ 5 um containing microorganisms).
- Skin scales.
- Dust particles containing microorganisms.)

These can be widely dispersed by air currents.

1- Direct airborne transmission:

The particles spread by air & can:

- Be inhaled to reach alveoli of susceptible hosts.
- Contaminate wounds.

2- Airborne to contact transmission:

Particles contaminate surfaces & are transported on hands or objects.

C. Food and water transmission:

Pathogens that infect gastrointestinal tract can be transmitted by contaminating food or water.

Food can be contaminated:

1. During preparation.
2. Infected animal products e.g. eggs or meat.

D. Arthropod borne transmission:

Example: mosquitoes act as vectors in transmission of malaria.

E. Blood borne transmission:

- By blood transfusion: HIV or HCV.
- By wounds or needle injuries: HBV.

F. Sexual transmission:

Example: Syphilis and HIV.

5-Portal of entry

Is the path by which a pathogen enters a susceptible host.Through non intact skin, respiratory tract or mouth.

6-Susceptible host:

A person lacking effective resistance to a Particular pathogenic agent

Chapter 4: Nosocomial infection (Health care Associated Infections; HAI)

Objectives

Define the Health care Associated Infections.
Discuss Predisposing Factors of Health care Associated Infections.
Understand the Sources of nosocomial infection.

Overview of Nosocomial infection and Related Concepts

Health care Associated Infection:

Is an infection meeting the following criteria:

a. Not present or incubating at time of admission, usually becomes evident 48 hours or more after admission.
b. Infection associated with admission to or a procedure done at a healthcare facility.
c. An infection present or incubating at the time of admission that is related to previous hospitalization at the same facility.

There are two special situations in which infections are not believed as nosocomial are:
(1) The infections associated with complications or extensions of infections already present on admission unless a change in pathogens or symptoms strongly suggests the acquisition of a new infection.
(2) The infections that are acquired trans-placentally due to some diseases like toxoplasmosis, rubella, syphilis or cytomegalovirus and appear 48 h after birth.

Sources of nosocomial infection

- **Endogenous infections** are caused by opportunistic pathogens that come from a patient's own normal flora.
  Endogenous infections may be acquired due to:
  -patients being immunologically depressed.
  -in the course of invasive procedure.
  -due to injury.
- Exogenous infections
  -come from sources outside of the patient's own body.

-such pathogens can come from Other patients, Healthcare personnel and Contaminated medical devices .many of these pathogens have antibiotic resistance.

Microorganisms causing Nosocomial Infections:

- Are usually of low pathogenicity but can cause serious infections in immunocompromised.
- Exhibit a high degree of drug resistance due to widespread & frequent use of antimicrobial agents in hospitals.

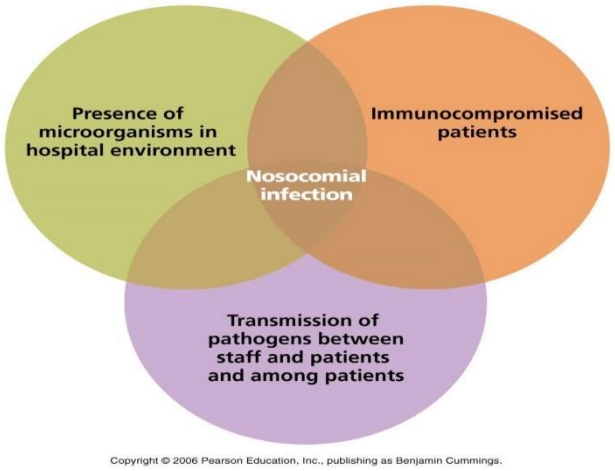
The occurrence of infection requires that all of the following conditions be present:

- A source…….
- A portal of exit…..
- A mode of transmission……..
- A portal of entry…….
- A susceptible host.

Predisposing Factors:

1. Impairment of general host defense including:
   - e.g. diabetes, malignancy, and recipients of renal transplant.
2. Impairment of local host defense including:
   - Burn, ulcers, surgical, traumatic wounds.
   - Insertion of device e.g. cannula and urinary catheters.

Fig. : Factors contributing to occurrence of nosocomial infections:



Prevention of HAI

Effective infection prevention and control strategies prevent disease transmission by interrupting one or more links in the chain of infection particularly the **mode of transmission**. This is accomplished by two main categories of precautions as follows:

1. **Standard precautions:**

They are used with all patients, as they are the primary strategy of preventing transmission of microorganisms in health care facilities.

2. **Transmission based isolation precautions:**

They are recommended to contain highly transmissible microorganisms and are based on the mode of transmission of the specific pathogens. They include contact, droplet and airborne isolation precautions.

Chapter 5: Standard Precautions

Objectives

Define the Standard Precautions.

Discuss different components of Standard Precautions.

Overview of Standard Precautions and Related Concepts

Standard Precautions

- They are a standard of care designed to reduce the risk of transmission of microorganisms from both recognized and unrecognized sources of infection in health care facilities.
- They are applied to all patients.
- They are designed to protect **health care personnel, patients and environment** from pathogens that can be spread by:
  - Blood.
  - All body fluids, secretions, and excretions regardless of whether they contain blood (potentially infectious material).
  - Mucous membranes.
  - Non-intact skin.

Standard precautions include:

1. Hand Hygiene.
2. Personal Protective Equipment (PPE).
3. Proper handling of patient care equipment.
4. Environmental surfaces control.
5. Safe disposal of waste including sharps.
6. Respiratory hygiene and cough etiquette.
7. Safe injection and aseptic techniques.
8. Personnel safety and health.

[1] Hand Hygiene

Hand transmission is one of the most important methods of spread of infectious agent in health care facilities.

Hand hygiene is a core element of patient safety for the prevention of health care associated infections.

Bacterial flora on hands:

Resident microbial flora:	**Transient microbial flora:**
Attached to deeper layers of the skin.	Colonize the superficial layers of the skin.
More difficult to remove.	**Removed be routine hand washing.**
Less likely to be associated with HAIs.	**Most frequently associated with HAIs.**
Hands of healthcare workers (HCWs) may become persistently colonized with pathogenic organisms.	Acquired by HCWs during direct contact with patients or contact with contaminated surfaces.

Hand washing (remove soil & transient flora):

✓ Washing hands with plain soap and water.

Indications:

- Before handling food & before eating.
- Before feeding the patient.
- After visiting the toilet.

Hand antisepsis (remove transient & reduce resident flora):

✓ Rubbing hands with an alcoholic hand preparation (solutions or gels) or washing hands with water and antiseptic soap e.g. iodophore (betadine) or chlorhexidine.

Indications:

- Before & after nursing the patient.
- Before performing invasive procedure e.g. IV cannula.
- Before caring for susceptible patients e.g. immunocompromised.

- Before & after touching wounds, urethral catheter & other indwelling devices.
- Before & after wearing gloves.
- After contact with blood, secretions.
- After contact with a patient known to be colonized with significant nosocomial pathogen as MRSA.

Surgical hand antisepsis (remove transient & reduce resident flora with persistent effect):

- ✓ Washing hands and forearms with antimicrobial soap for 2-6 minutes (surgical scrub).
- ✓ Rubbing hands and forearms with alcoholic preparation after washing with plain soap (surgical rub).

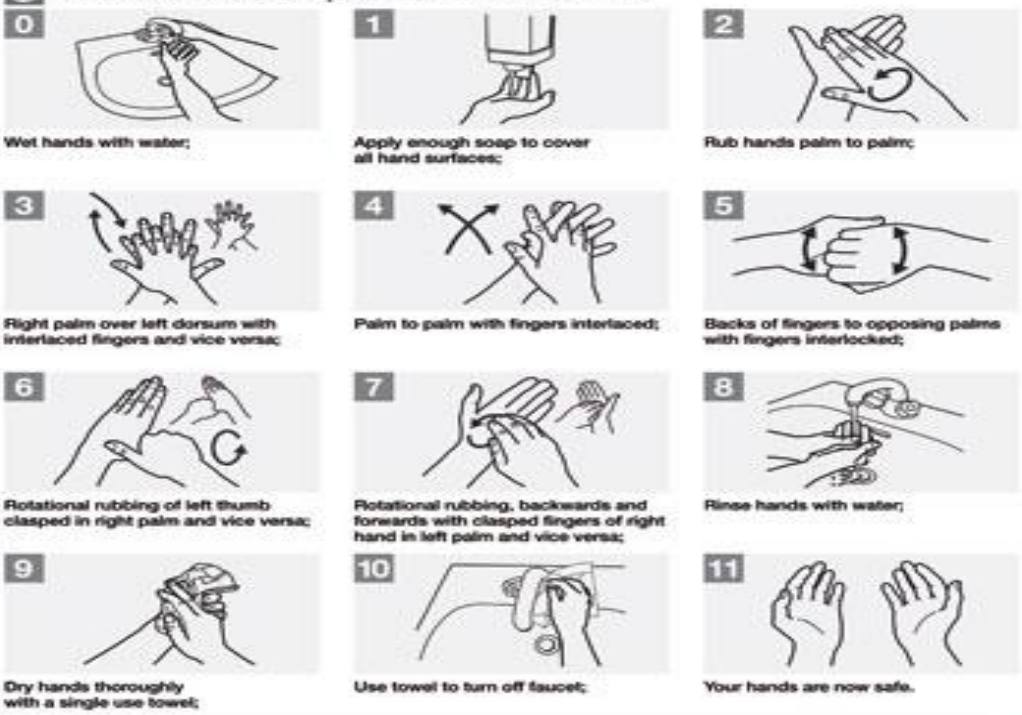
Indications:

Before all surgical procedures.

How to Handwash?

WASH HANDS WHEN VISIBLY SOILED! OTHERWISE, USE HANDRUB

Duration of the handwash (steps 2-7): 15-20 seconds
Duration of the entire procedure: 40-60 seconds



World Health Organization | Patient Safety | SAVE LIVES Clean Your Hands

Moment 1	Before touching a patient	**WHEN?** Clean your hands before touching a patient when approaching him/her **EXAMPLES:** shaking hands, helping a patient to move around, clinical examination
Moment 2	Before clean/aseptic procedure	**WHEN?** Clean your hands immediately before any aseptic task **EXAMPLES:** oral/dental care, secretion aspiration, wound dressing, catheter insertion, preparation of food, medications
Moment 3	After body fluid exposure risk	**WHEN?** Clean your hands immediately after an exposure risk to body fluids (and after glove removal) **EXAMPLES:** oral/dental care, secretion aspiration, drawing and manipulating

		blood, clearing up urine, faeces, handling waste.
Moment 4	After touching a patient	**WHEN?** Clean your hands after touching a patient and her/his immediate surroundings, when leaving the patient's side **EXAMPLES:** shaking hands, helping a patient to move around, and clinical examination.
Moment 5	After touching patient surroundings	**WHEN?** Clean your hands after touching any object or furniture in the patient's immediate surroundings, when leaving - even if the patient has not been touched **EXAMPLES:** changing bed linen, perfusion speed adjustment

[2] Personal Protective Equipment (PPE)

Personal protective equipment (PPE) involves use of protective barriers such as gloves, gowns, aprons, masks, or protective eyewear to reduce the risk of exposure of HCWs to potentially infectious materials.

a. Gloves

Sterile gloves:

Indications:

- Before surgery
- Before any invasive procedure that require antiseptic techniques as insertion of urinary catheter or central venous catheter.
- Before wound dressing.
- Mixing intravenous fluids and using multidose vials.

Disposable Non-sterile gloves:

Indications:

- When starting intravenous (I.V.) lines or performing phlebotomy.
- When suctioning the respiratory tract of a patient or performing oral care.

Heavy-duty household gloves:

Indications:

- Handling contaminated items and waste.
- Performing environmental cleaning.

They can be reused after decontamination, but they should be discarded when punctured or torn.

- **Changing gloves:**

1- between patients.

2- between procedures on the same patient after contact with contaminated material.

3- If they become torn or perforated while caring for a single patient.

b. Masks, Eye Protection, Face Shields

Impermeable face masks and goggles or full-face shields (that protects the eyes, nose and mouth) should be worn when there is risk of splashes or sprays of blood or body fluids into the face and eyes of HCWs.

For Respiratory Protection:

Standard (surgical) masks: are used for:

- Protection from microorganisms that are transmitted by droplets e.g. *Neisseria meningitides*.
- Trapping droplets from the wearer's exhaled breath: to provide patient protection in the Operating Room (O.R).

High efficiency masks:

(e.g. N95 mask) are designed to capture high percentages (>95%) of particles that are less than 5 um in size for protection of HCWs from airborne infectious agents such as *Mycobacterium tuberculosis.*

c. ***Gowns and Aprons***

- Single use plastic aprons or impermeable clean gowns are used during procedures that are likely to generate splashes of blood or body fluids.
- Sterile gowns are worn to:
  - Maintain sterile field during surgery and other invasive procedures.
  - Care for immuno-compromised patients.

d. ***Head Caps***

Disposable caps should be worn to contain hair during certain procedures such as surgical procedures performed in the Operating Theater (OT). They should be well-fitting and sealed.

e. ***Footwear***

- Overshoes worn over the ordinary shoes are not recommended as it is an ideal way of transferring microorganisms from floor and shoes to hand.

- Closed footwear replacing the ordinary shoes is needed for some special areas such as the OT to protect the personnel's skin from exposure to blood.

- **Putting on PPE (when all PPE items are needed)**

1. Identify hazards and manage risk. Gather the necessary PPE.
2. Put on a gown.
3. Put on mask.
4. Put on eye protection e.g. face shield/goggles
5. Caps are optional: if worn, put on after eye protection.
6. Wash hands.
7. Put on gloves (over cuffs)

- **Taking off PPE**

• Avoid contamination of self, others and the environment

• Remove the most heavily contaminated item first:

1. Remove gloves FIRST
2. Peel off gloves and roll inside, out
3. Dispose gloves safely
4. Remove cap (if worn)
5. Remove goggles from behind
6. Put goggles in a separate container for reprocessing
7. Remove mask from behind (untie lower then upper strip)
8. Perform hand hygiene

All PPE must be removed when leaving the treatment area

[3] Proper Handling of Soiled Patient Care Equipment

Used patient-care equipment soiled with blood, body fluids, secretions, and excretions should be handled in a manner that prevents skin and mucous membrane exposures, contamination of clothing, and transfer of microorganisms to other patients and environments.

Single-use items: should be discarded properly.

Reusable equipment: should not be used for the care of another patient until it has been cleaned and reprocessed appropriately.

Reprocessing of reusable equipment:

Patient-care items are categorized as critical, semi critical or non critical, depending on the potential risk for infection associated with their intended use.

a. **Critical Items (Items of high risk)**: Items that penetrate sterile tissues, including body cavities and the vascular system, [e.g. surgical instruments, intra-uterine devices, vascular catheters]. Cleaning followed by **sterilization** is required.
b. **Semi critical Items (Items of intermediate risk)**: Items that does not penetrate the skin or enter sterile areas of the body but is in contact with intact mucous membranes or non-intact skin [e.g. respiratory equipment, gastrointestinal endoscopes, vaginal instruments and thermometers]. Cleaning followed by **disinfection** is usually adequate.

c. **Non critical Items (Items of low risk)**: Items in contact with normal and intact skin, or the inanimate environment not in contact with the patient [e.g. walls, floors, ceilings, furniture, sinks and drains]. **Cleaning and drying** is usually adequate.

- **CLEANING:**

It is a process that removes foreign material (e.g. soil, organic material, micro-organisms) from an object.

- **DISINFECTION:**

It is a process that reduces the number of pathogenic microorganisms, but not necessarily bacterial spores to a level which is not harmful to health.

- **STERILIZATION:**

It is a controlled process that destroys all microorganisms including bacterial spores.

[4] Environmental Surfaces Control

Environmental surfaces can be divided into:

- Clinical contact surfaces.
- Housekeeping surfaces.

Clinical Contact Surfaces e.g. procedure surfaces, equipment surfaces ……..

These surfaces should be **cleaned and disinfected**. Impermeable barriers can prevent contamination of clinical contact surfaces that are difficult to clean.

Housekeeping Surfaces

- Floors should be cleaned regularly using hospital disinfectant/detergent.
- Spills should be cleaned immediately.
- Walls must be kept clean, disinfected if contaminated.

[5] Safe Waste Disposal

Types of Waste:

Wastes of health care facilities can be divided into two categories:

1. General waste (or non-hazardous waste): e.g. paper, boxes, hand towels, and similar materials that are not contaminated with blood or body fluids.

2. Infectious waste (hazardous waste) including:

- Any liquid or semi-liquid blood or other potentially infectious materials
- Contaminated items that would release blood or other potentially infectious materials in a liquid or semi-liquid state if compressed e.g. contaminated dressings.
- Pathological and anatomical waste.
- Sharps e.g. used syringes, needles, disposable scalpels and blades.

Guidelines for Proper Waste disposal

- Infectious waste should **not be mixed** with general waste**.**
- **Black bags** for general waste.
  Leak -proof red bags labeled with the biohazard symbol for infectious waste.
- Bags must not be overfilled. When bags are maximally **3/4** full, they must be closed securely.

- Personnel must wear heavy duty gloves while handling waste bags.

Needles and sharp disposal:

- All needles, other sharp items must be disposed of immediately in appropriate puncture-resistant containers with a lid, located as close as practical to the area in which the items were used.

- Containers must be removed when they are maximally 3/4 full, closed securely and disposed by incineration.

■ Stages of medical waste disposal:

Stage 1: Collection and Segregation

The best practice for medical waste collection is at the point of generation. This approach reduces the risk of the waste spilling on its way from the generation site to the collection container. For example, carrying a bloody gauze from the patient's bed to a waste container at the end of the room may lead to drips along the way, and is therefore impractical.

For segregation purposes, bio-medical waste is traditionally classified into these 8 categories:

- General waste: paperwork, food waste, packaging materials, etc.
- Radioactive waste: contaminated glassware and other waste from radiotherapy or lab research
- Pharmaceutical waste: unused, expired or contaminated medications
- Sharps: scalpels, needles, scissors, etc.
- Pathological waste: organs, tissues and body parts
- Infectious waste: items capable of transmitting an infection
- Chemical waste: cleaning agents, lab reagents and similar chemicals
- Pressurized containers: cylinders containing pressurized gas

Using the Right Containers

Use of the right collection containers based on the type of waste is crucial. Placing the wrong item in the wrong container may not only hinder safe disposal, but also pose risk of contaminating the environment or infecting your staff or patients. Here are the common medical waste containers and what they are used for:

- **Sharps containers** are typically red, shatter-proof and close securely to prevent sharps from falling out or puncturing through.
- **Biohazard containers** are red with a biohazard symbol in the front and are used for infectious and potentially infectious waste such as blood and bodily fluids.
- **Trace chemotherapy containers** are yellow and are used for a variety of chemical and other types of waste that came in contact with chemo medications.
- **RCRA hazardous containers** are black and are used for wastes that are classified as hazardous under RCRA, which includes a variety of chemical, pathological, infectious and other wastes.
- **Pharmaceutical containers** are blue and are used for pharmaceutical waste.

- **Radioactive waste containers** are yellow and have a radioactive symbol.

Stage 2: Storage and Transportation

Upon segregation, it is determined which waste is being picked up and disposed of through a medical waste removal vendor and which waste is reusable or can be disposed of on site. Whether you are working with a vendor or have an on-site autoclave or incinerator, you will probably need to store your medical waste somewhere until it can be processed in bulk.

Storage areas should be chosen carefully and should be inaccessible to the general public. The way containers are transported to and from the storage site is also important, because you don't want to damage them in the process and cause a spill. If you are working with a medical waste removal company, be sure to choose a good one. **You are responsible for your medical waste until it's been safely processed**, and some unprofessional companies have been caught dumping such waste in places where it doesn't belong.

Stage 3: Treatment and Disposal

There are different ways medical waste can be treated and decontaminated. Incineration is a common approach that can be used on site or off site to both treat and dispose of waste at the same time. However, you can also decontaminate waste with thermal processing (autoclaving), irradiative, chemical or biological (enzyme) treatments. Chemical treatment is often used to decontaminate liquid waste, so that it can be disposed of locally. The rest of the methods can be used to decontaminate waste before it can be land-filled. decontaminate waste with thermal processing (autoclaving), irradiative, chemical or biological (enzyme) treatments. Chemical treatment is often used to decontaminate liquid waste, so that it can be disposed of locally. The rest of the methods can be used to decontaminate waste before it can be land-filled.

[6] Respiratory Hygiene and cough etiquette

It applies to any person with signs of illness including cough, congestion, rhinorrhea, or increased production of respiratory secretions when entering a healthcare facility. It should begin at initial point of encounter e.g., reception areas. It includes:

- Education of healthcare facility staff, patients, and visitors.
- Posted signs, in language(s) appropriate to the population served, with instructions to patients and accompanying family members or friends.
- Source control measures:
  - Instruct symptomatic persons to cover mouth/nose when sneezing/coughing.
  - Use tissues and dispose in no-touch receptacle.
  - Perform hand hygiene after soiling of hands with respiratory secretions.
  - Wear surgical mask if tolerated or maintain spatial separation, >3 feet if possible.

[7] Aseptic techniques and Safe injection

Aseptic Technique is a general term involving practices that minimize the transmission of micro-organisms during patient care.

Procedures with the highest risk for causing infections include:

- Surgical procedures.
- The placement of device into sterile body spaces such as intravenous lines and Urinary catheters.
- Wound care.
- Intravenous or intramuscular injection.

Aseptic techniques include:

1. Hand antisepsis.
2. Patient skin antiseptics before injection, catheter insertion, or surgical operations.
3. Using no-touch-technique during insertion of invasive devices.
4. Using and maintaining safe injection for multidose medication vials, intravenous fluids, and devices.
5. Wearing a face mask for the individual placing a catheter or injecting material into the spinal or epidural space (e.g., lumbar puncture, spinal and epidural anesthesia, intrathecal chemotherapy).
6. Maintaining sterile field during surgical procedures e.g. **No touch technique:**

- Do not contaminate sterile/disinfected items while Opening, transferring or applying them.

Basic principles of aseptic technique for the preparation and administration of parenteral medications are as follows:

- Use aseptic technique to avoid contamination of sterile injection equipment.
- **Do not** administer medications from a syringe to multiple patients, even if the needle is changed.
- Needles, and syringes are sterile, single-use items; they should not be reused for another patient.
- Consider a syringe or needle contaminated once it has been used.
- **Do not** administer medications from single-dose vials or ampoules to multiple patients or combine leftover contents for later use.

- **Do not** keep multidose vials in the immediate patient treatment area.

Multi Dose Vials:

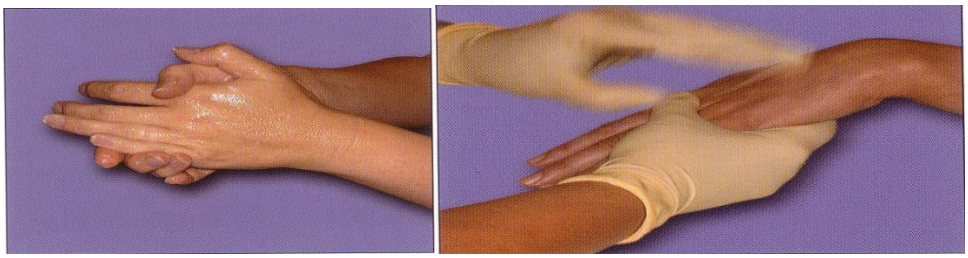
- Check the vial for leaks or cracks.
- Check the solution.
- Wipe the top of the vial with a fresh cotton swab soaked with 70% alcohol, and allow it to dry.
- Always use a new needle and syringe every time fluid is withdrawn from a multidose vial.
- **Never** leave one needle inserted in the vial cap for multiple uses.

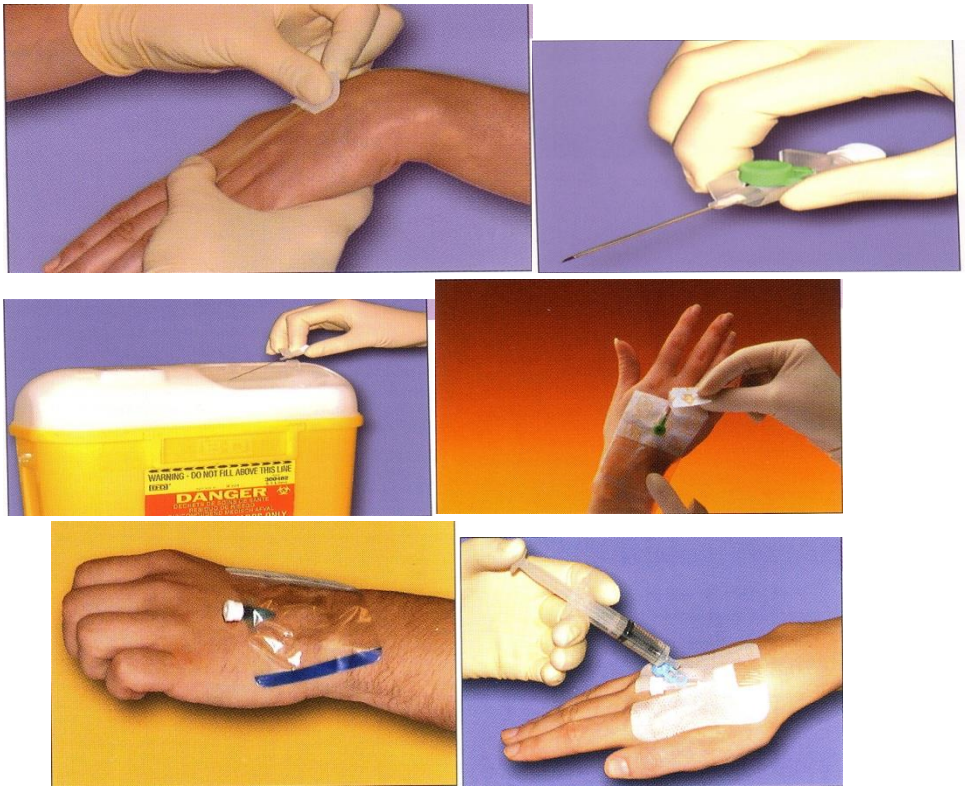
Maintaining a sterile field:

- A ***sterile field*** is an area created by placing sterile towels or surgical drapes around the procedure site and on the stand that will hold sterile instruments and other items needed during the procedure.

Application of peripheral IV catheter:

- Do proper hand Hygiene.
- Wear Gloves.
- Select insertion site with the lowest risk.
- Palpate the vein.
- Disinfect **clean skin** with an appropriate antiseptic.
- Allow the antiseptic to remain on the insertion site and to air dry before catheter insertion.
- Apply Sterile equipment.
- Dispose off sharp safely.
- Sterile gauze or sterile transparent ,semi permeable dressing to cover the catheter site.
- Flushing.





Removal of IV catheter:

- Wash and dry your hands or use an alcohol hand rub.
- Apply a clean pair of gloves.
- Remove dressings.
- Do not use scissors, as this may result in cutting the catheter and embolising catheter fragments.
- Apply a piece of dry sterile cotton gauze over the insertion site.
- Remove the cannula.

Application of urinary catheter:

- Wash hands.
- Don clean gloves.
- Have patient move legs apart and bend knees to visualize perineal area
- Cleanse perineum with washcloth if needed.
- Remove gloves and wash hands after perineal cleansing.
- Don sterile gloves.
- Drape the patient.
- Use sterile lubricant.

Health care Personnel Safety and health elements

Infection prevention and control program should include the following elements to protect and monitor staff health:

1. Education and training.
2. Immunization.
3. Exposure prevention.
4. Exposure Management.

Blood Borne Viruses:

Blood borne viruses such as hepatitis B virus (HBV), hepatitis C virus (HCV), and human immunodeficiency virus (HIV) are of concern in health care. These viruses can be transmitted to patients and health care personnel (HCP). They can produce chronic infection and dangerous complications. They are often carried by persons unaware of their infection.

An exposure that might place HCP at risk for HBV, HCV, or HIV infection via:

- Percutaneous injury (e.g., a needle stick or cut with a sharp object).
- Contact of mucous membrane or non intact skin with blood, or other potentially infectious material (e.g. bloody saliva).

Immunization of healthcare Personnel:

Important vaccines for HCP include:

- Hepatitis B vaccine.
- Influenza vaccine.
- Varicella (Chicken Pox).
- Measles, Mumps and Rubella vaccines (MMR).
- Tetanus, Diphtheria vaccines (TD).

Exposure Prevention:

1. **How to prevent needle sticks and other sharps-related injuries?**
   - Take care to prevent injuries:
   - ❖ When using needles, scalpels, and other sharp instruments or devices.
   - ❖ When handling sharp instruments after procedures.
   - ❖ When cleaning reused instruments.
   - ❖ When disposing of used single use items.
   - Never recap used needles by two hands, use either a one-handed "scoop" technique or a mechanical device designed for holding the needle sheath.

- Do not remove used needles from disposable syringes by hand, do not bend, or break.
- Dispose off needles and other sharps in puncture resistant sharp waste disposal boxes.

2. How to prevent mucous membrane contact:

- Use appropriate personal protective equipment.

Management of Exposure to blood borne viruses:

1. IMMEDIATE cleaning of the exposure site should be the first priority.

2. Reporting of the exposure incident

3. Testing of source patient (if applicable).

4. Management of exposures to specific viruses:

- HBV → initiation of the hepatitis B vaccine series.
- HCV → early identification of infection by base line and follow up testing.
- HIV → administration of antiretroviral medications as soon as possible after exposure.

Transmission Based Isolation Precautions

Transmission based precautions: are recommended to contain highly transmissible and/or epidemiologically important agents and is based on the mode of transmission of the specific pathogen e .g . contact, droplet, airborne precautions.

A. Contact Isolation Precautions

Contact, or touch, is the most common and most significant mode of transmission of infectious agents.

Contact transmission can occur by directly touching the patient,
through contact with the patient's environment, or by using contaminated gloves or equipment. Patients in Contact Isolation Precautions
include those with confirmed or suspected Clostridium difficileinfection (CDI)
rotavirus, or other organisms deemed significant by Infection Control.
Contact Isolation Precautions
requires:

1.**Private Room**

2.Dedicated, disposable equipment (e.g., stethoscope, blood pressure cuff, thermometer, etc.). If shared equipment is used, it must be cleaned with hospital disinfectant(e.g. disposable detergent disinfectant-impregnated wipes) after each use.
3.Children under 2 years who are in Droplet Precautions are also placed in Contact Precautions.
4.Appropriate door signage(green)
5.Education for the patient/representative: " Contact Isolation Precautions Patient Information Sheet"

Healthcare workers caring for patients in Contact Isolation Precautions must:
1.Clean hands before putting on gloves.
2. Put on **gloves and gown** prior to entering the patient's room.
3. Remove and discard gloves and gown and clean hands before leaving the patient's room or, in semi-private room or multi-bed bay situation, before leaving the patient's immediate vicinity.
5. Patients on Contact Isolation Precautions are not allowed in communal spaces , but may ambulate in hallways wearing a clean hospital gown and after washing hands with soap and water.
6. Place a clean patient gown on the patient prior to transporting patient off unit for test/procedure.
7. Notify receiving department of patient isolation status.

b-Droplet Isolation Precautions

1.**private room**, except when directed otherwise by Infection Control.
2.Patients to remain in their room except for essential purposes
(surgery, tests, treatments, therapy services). The patient may ambulate in the hallway, however not allowed in communal spaces (playroom, school rooms, solarium, cafeteria, etc.).
3.When patients on droplet precautions are out of their room they must wear a **standard surgical mask.**
4.Children under the age of 2years who require Droplet Precautions also require Contact Precautions.
5.Appropriate door signage (yellow).
6.Education for the patient/ representative:" Droplet Isolation Precautions Patient Information Sheet".

Healthcare workers caring for patients in Droplet Isolation Precautions will:

1.Hand hygiene with alcohol based hand rub or soap and water should be performed prior to entering room. Put on **a standard surgical mask** that covers the mouth and nose and eye protection (safety goggles, fluid shield) upon entering the room of a patient in precautions.

c-Airborne Isolation Precautions

1.**Private Airborne Infection Isolation Room (Negative Pressure Isolation Room**)

2.Healthcare workers entering the room of a patient with suspected or confirmed diseases requiring Airborne isolation precautions to wear **a fit -tested N-95 respirator.**

4.When a patient is suspected or confirmed to have an infection with chickenpox, disseminated varicella or measles, susceptible healthcare workers or visitors should not enter the room

5.Patients to be confined to their room except for essential purposes, in which case, **a standard surgical mask** is worn by the patient at all times when outside the negative pressure environment.

Chapter 6: Disinfection and sterilization

Objectives

Define Disinfection and sterilization
Discuss different methods of sterilization.
Understand the monitoring of sterilization process.
Discuss types of disinfectant.

Overview of sterilization and Related Concepts

The term decontamination refers to the combination of processes by which pathogenic microorganisms are removed from an item, making it safe to handle, use or discard. Decontamination is achieved at three levels:

- Cleaning
- Disinfection
- Sterilization

► Cleaning: It is a process that uses detergent and water to remove visible contamination. It does not necessarily destroy microbes. Effective cleaning is essential before disinfection or sterilization.

► Disinfection: It is a process that uses chemical agents or heat to eliminate many or all pathogenic microorganisms on inanimate objects, with the exception of bacterial spores.

► Sterilization: This is the complete elimination or destruction of all forms of microbial life, including bacterial spores.

Sterilization

All critical and semi-critical instruments that are heat stable should be sterilized routinely between uses by steam under pressure (autoclaving), by dry heat, or by chemical sterilization, following the instructions of the manufacturers of the instruments and of the sterilizers. Critical and semi-critical instruments that will not be used immediately should be wrapped before sterilization.[1]

Methods of sterilization

- **Steam autoclave:** Suitable for sterilization of most reusable items and instruments

- **Dry heat:** Dry heat ovens are used in certain clinical settings to sterilize instruments, which can become dull and/or corroded when exposed to steam under pressure. The majority of reusable instruments are heat stable and can withstand repeated exposures to heat sterilization cycles.
- **Chemical sterilization:** There is limited use of chemical sterilization For heat-sensitive instruments, this procedure may require up to 10 hours of exposure to a liquid chemical agent (e.g., glutaraldehyde). This sterilization process should be followed by aseptic rinsing with sterile water, drying, and, if the instrument is not used immediately, placement in a sterile container.

Characteristics of autoclave sterilization	**Characteristics of dry heat sterilization**
Temperature: • 121°C for unwrapped instruments (20min) • 121 °C for wrapped instruments (30min) • 134°C for unwrapped instruments (3 min) • 134°C for wrapped instruments (15 min) ***Pressure****:* 15 psi ***Package material requirements:*** • Must allow steam to penetrate • Acceptable materials: Paper, plastic, or cloth • Unacceptable materials: Closed metal and glass containers	***Temperature:*** • 180° C for 30 min • 170 °C for 1 hour • 160 °C for 2 hrs • 149 °C for 2.5 hrs • 141 °C for 3 hrs ***Package material requirements:*** • Must not insulate items from heat • Must not be destroyed by temperature used • Acceptable materials: Plastic and paper bags, aluminum foil, polyfilm plastic tubing • Unacceptable materials: Plastic and paper bags that are unable to withstand dry-heat temperatures
Advantages: • Short, efficient cycle time • Good penetration	***Advantages:*** • Effective and safe for sterilization of metal instruments and mirrors • Does not dull cutting edges

• Wide range of materials can be processed without destruction ***Disadvantages:*** • Corrosion of unprotected carbon steel instruments • Dulling of unprotected cutting edges • Packages may remain wet at end of cycle • Use of hard water may leave deposits • May destroy heat-sensitive materials	• Does not rust or corrode ***Disadvantages:*** • Long cycle required for sterilization except for forced air • Poor penetration • May discolor and char fabric • Destroys heat-labile items • Cannot sterilize liquids • Generally not suitable for handpieces

Table: Advantages and Disadvantages of Various Sterilization Methods

Method	**Advantages**	**Disadvantages**
Steam Sterilization	• Most common sterilization process in healthcare facilities • Safe for environment and healthcare workers • Nontoxic • Inexpensive • Short sterilization time	• Success of sterilization can be impaired by trapped air, grossly wet materials, and decreased steam quality • Heat and moisture sensitive components can be damaged
Dry Heat Sterilization	• Low corrosiveness • Deep penetration in the material • Safe for the environment • No aeration necessary	• Requires long sterilization time • Requirements of different countries regarding temperature and cycle time are conflicting • Heat-labile components can be damaged
100% Ethylene Oxide (ETO)	• Penetrates packaging materials and many plastics • Compatible with most medical materials • Simple to operate and monitor	• Requires aeration time • Small sterilization chamber • ETO is toxic, probable carcinogen, and flammable • ETO cartridges need storage in flammable liquid storage cabinet
Peroxide Gas Plasma Sterilization	• Low process temperature • No aeration necessary • No toxic residuals • Safe for environment and healthcare worker	• Cellulose, linens, and liquids cannot be processed • Small sterilization chamber

	• Simple to operate, install, and monitor	• Medical devices with long or narrow lumen cannot be processed • Requires synthetic packaging
Formaldehyde	• Formaldehyde is not flammable and explosive • Compatible with most medical materials	• Potential for residual formaldehyde on the surface • Formaldehyde is toxic and allergenic • Requires long sterilization time Formaldehyde • Long processing time due to removal of formaldehyde after sterilization

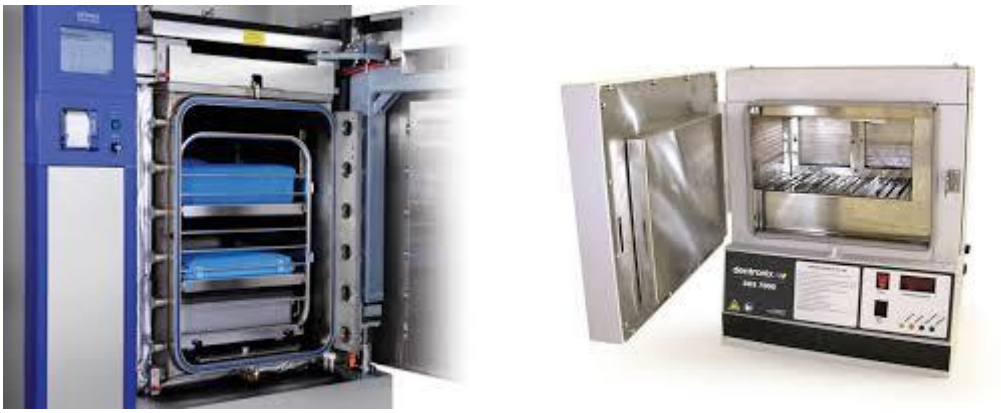
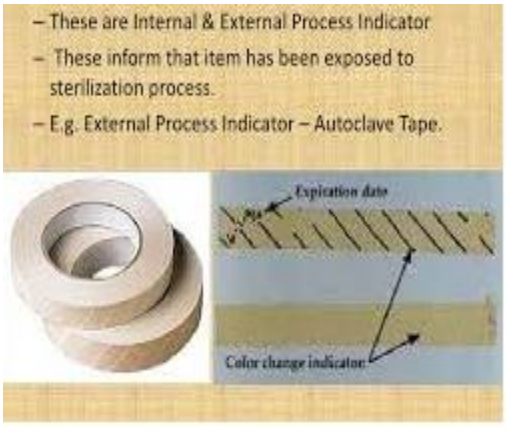


Fig : Steam and dry heat sterilization

Monitoring sterilization

Proper functioning of sterilization cycles should be verified by the periodic use (at least weekly) of biologic indicators (i.e., spore tests). Heat-sensitive chemical indicators (e.g., those that change color after exposure to heat) alone do not ensure adequacy of a sterilization cycle but may be used on the outside of each pack to identify packs that have been processed through the heating cycle. A simple and inexpensive method to confirm heat penetration to all instruments during each cycle is the use of a chemical indicator inside and in the center of either a load of unwrapped instruments or in each multiple instrument pack.



- *<u>Disinfection:</u>*

The aim of disinfection is to reduce the number of micro-organisms to a level below the infective dose. Disinfection is usually achieved by chemical methods 9using disinfectants).

A disinfectant is a material that kills pathogens. They are potent antimicrobials but relatively strong substances and toxic to living tissues. They rapidly kill the vegetative forms of all pathogenic organisms. They are suitable for application to inanimate objects. Disinfection is carried out where absolute sterility is not essential or not practicable.

Types of disinfectants:

To be acceptable in the hospital environment, they must also be:

- easy to use
- non-volatile

- not harmful to equipment, staff or patients
- free from unpleasant smells
- effective within a relatively short time.

They include:

Alcohol Disinfectants

Alcohols, usually ethanol or isopropanol, are sometimes used as a disinfectant, but more often as an antiseptic, the distinction being that alcohol tends to be used on living tissue rather than nonliving surfaces. These alcohols are non-corrosive but can be a fire hazard. They also have limited residual activity due to evaporation, which results in brief contact times unless the surface is submerged. They also have a limited activity in the presence of organic material.

Alcohols are most effective when combined with purified water to facilitate diffusion through the cell membrane; 100% alcohol typically denatures only external membrane proteins. A mixture of 70% ethanol or isopropanol diluted in water is effective against a wide spectrum of bacteria, though higher concentrations are often

needed to disinfect wet surfaces. Additionally, high-concentration mixtures (such as 80% ethanol + 5% isopropanol) are required to effectively inactivate lipid-enveloped viruses (such as HIV, hepatitis B, and hepatitis C). Alcohol is only partly effective against most non-enveloped viruses (such as hepatitis A), and is not at all effective against fungal and bacterial spores.

The efficacy of alcohol is enhanced when in solution with the wetting agent dodecanoic acid (coconut soap). The synergistic effect of 29.4% ethanol with dodecanoic acid is effective against a broad spectrum of bacteria, fungi, and viruses. Further testing is being performed against *Clostridium difficile* (*C. Diff*) spores using higher concentrations of ethanol and dodecanoic acid, which has been indicated to be effective with a contact time of ten minutes.

Alchol is convenient because it can be incorporated into sprays, impregnated into swabs or combined with emollients into handrubs.

Clear soluble phenolics: e.g. Clearasol, Stericol). They are suitable as environmental disinfectants as concentrations of 1-2%. They are toxic and corrosive but stable in solution, are not easily neutralized, are cheap and destroy a wide range of micro-organisms, although not spores or viruses.

Hypochlorites: (e.g. bleach, presept) are marketed at different solutions, expressed as parts per million (ppm) of available chlorine. Hypochlorites destroy a wide range of micro-organisms and are effective against the hepatitis B and Human immunodeficiency (HIV) viruses. Their activity is reduced in the presence of organic matter. They are corrosive at concentrations necessary for environmental disinfection.

Glutaraldehyde: (cidex) is used as 2% solution to decontaminate expensive, precision items, principally fiberoptic equipment that would be damaged by heat or more corrosive chemicals.Disinfection is achieved after a contact time of 20 minutes. Prolonged contact of 3 hours or more will destroy spores, acid fast bacilli and viruses, achieving sterilization.

Chlorhexidine: (e.g. Hibitane) is formulated to disinfect human tissue. It is a non-toxic non-corrosive but relatively expensive fluid. Its expense and narrow range of bactericidal activity make it unsuitable for environmental use, It is incorporated in alcoholic handrub and is sometimes used preoperatively as a skin antiseptic.

Idophors: Idophors (povidone iodine) is marketed as Betadine. They have a broder spectrum than chlorhexidine and destroy spores.

Quaternary ammonium compounds (quats) destroy most gram positive and negative bacteria, but not acid fast bacilli or spores. These compounds are rapidly inactivated by organic matter and many other chemicals. The most widely used member of the group is cetrimide, which has natural detergent properties. It is sometimes used as a wound disinfectant. Cetrimide and chlorhexidine are marketed in combination as savlon, a wound and skin disinfectant.

Chapter 7: Innate and acquired immunity

Objectives

Distinguish between different components of immune system.
Discuss Role and mechanism of innate immunity.
Discuss Role and mechanism of acquired immunity

Overview of immune system and Related Concepts

Immunity is body's ability to resist or eliminate potentially harmful foreign materials or abnormal cells. It is a **functional system** not an organ system.

Fig. : Foreign material and abnormal cells attacking the body

COMPONENETS OF IMMUNE SYSTEM

The immune system is divided into two main components: **the innate** (natural, non-specific) immune system and **the adaptive** (acquired or specific) immune system.

Components of the immune system	
Innate immune system	**Adaptive immune system**
Response is non-specific	Pathogen and antigen specific response
Exposure leads to immediate maximal response	Lag time between exposure and maximal response

No immunological memory	Exposure leads to immunological memory

■ Definition of innate immunity:

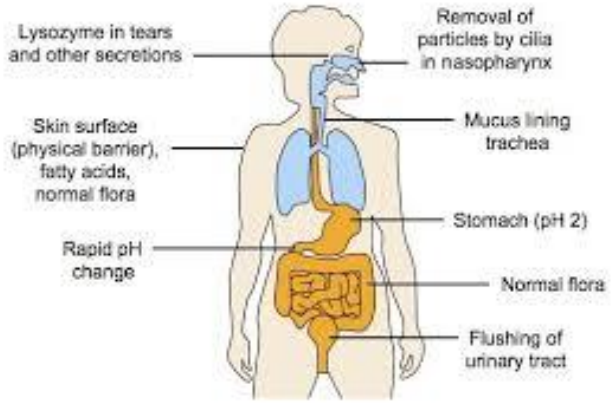
- Immunity that is naturally present and is not due to prior sensitization to an antigen from, for example, an infection or vaccination.
- It is the first line of defense (present in all individuals, at all times).
- Immediate (0-4 hours)
- Since it is not stimulated by specific antigens, innate immunity is generally nonspecific.
- Does not generate lasting protective immunity.

■ Role and mechanism of innate immunity: *External and internal*

- ***External innate immunity (first line defense):***
  - Physical (mechanical) barriers: All external and internal surfaces of the human body are a key element of the innate immune system. The closed surface of the skin and of all mucous membranes already forms a mechanical barrier for pathogens, which prevents them from entering. Movements created, for example, by hair-like structures in the bronchi (cilia) or by bowel muscles stop germs from settling in the body.

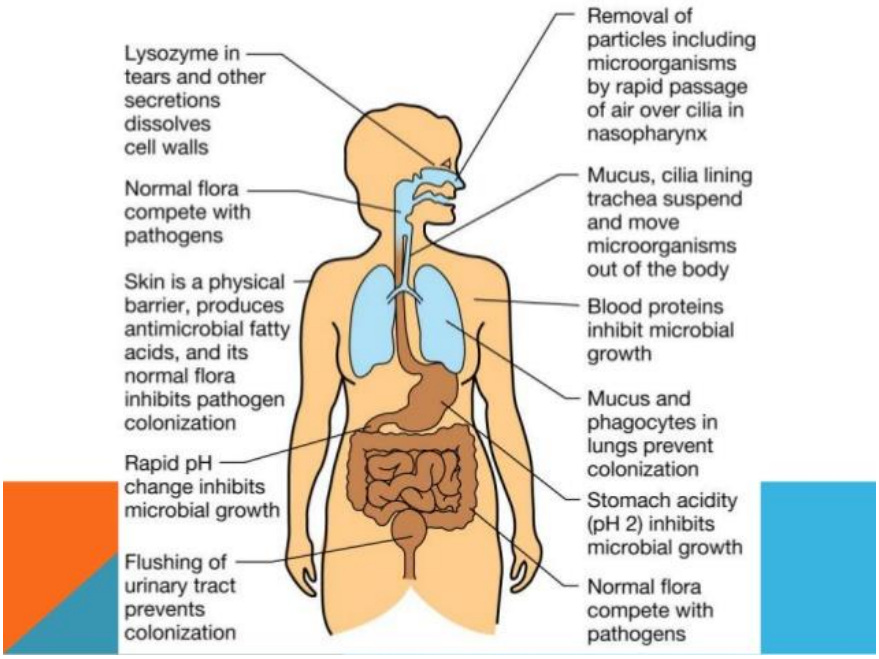
  - Chemical barriers: Chemical substances like acid, enzymes or mucus prevent the bacteria or viruses from gaining a foothold. Tear fluid, sweat, or urine rinsing the urinary organs all have a similar effect.

Fig. : External innate immunity



- Normal flora: present in many parts of the body. Competes with pathogens for nutrients and space.

Fig. : External innate immunity



- ***Internal innate immunity (Second line defense):***

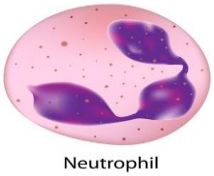
Fig. : Components of internal innate immunity:

- **Phagocytosis**
- **Anti-microbial proteins**
- **Inflammatory response**
- **Natural killer cells**
- **Complement system**

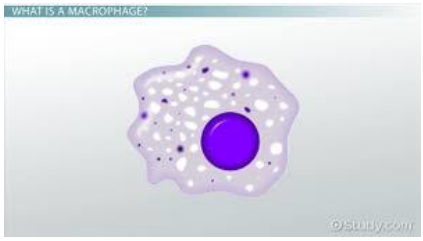
- Phagocytic cells: *Phago: to eat, cyte: cell*

Neutrophils are the most abundant white blood cells, they are efficient phagocytes, most important cells of the innate immune system

Fig. : Shape of the neutrophil



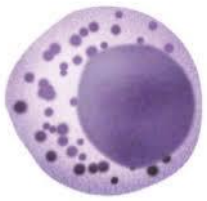
Macrophages: eats microbes in tissues (neutrophils present only in blood)



- Antimicrobial proteins (cytokines): Small proteins – secreted by cells of the immune system, affect the behaviour of other cells, signalling molecules, key players in innate and acquired immunity e.g. interferons, interleukins, tumour necrosis factor

- Inflammatory response: is one of the first responses of the immune system to infection or irritation. Inflammation is stimulated by chemical factors released by injured cells and serves to establish a physical barrier against the spread of infection, and to promote healing of any damaged tissue following the clearance of pathogens

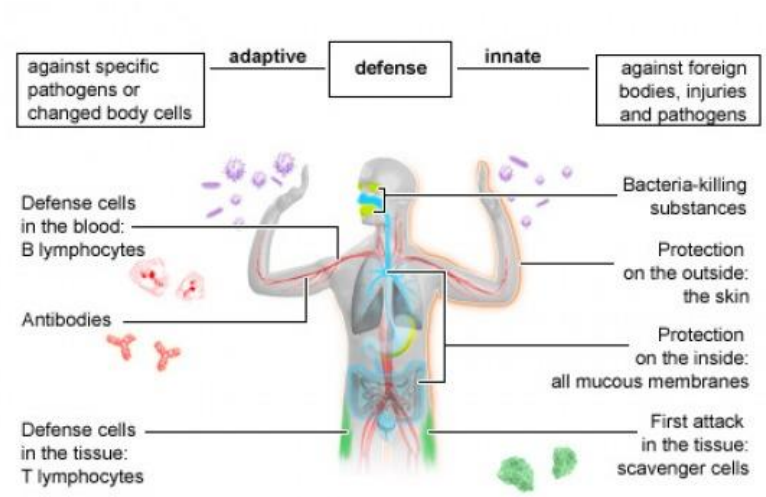
- Natural killer cells: Kill virus /bacteria infected cells (Intracellular pathogens), kill cancer cells



Natural killer cell

- Complement: a large number of distinct plasma proteins that react with one another (C1 to C9), complement can bind to microbes and coat the microbes, essential part of innate immune response. It facilitates phagocytosis and cause direct lysis of pathogens.

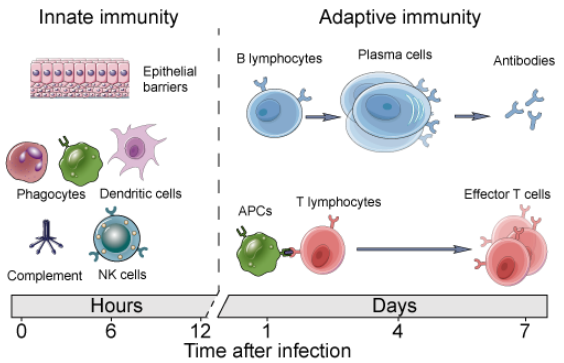
Fig. : Components of the immune system



■ Definition of acquired immunity:

- It is where the immune system 'adapts' itself to a pathogen and finds the best way possible to eliminate an invader quickly and efficiently, based on the pathogen's own characteristics.
- It is a specific type of immunity and has memory.
- It is the second level of defense in the immune system.
- Response is delayed (days)

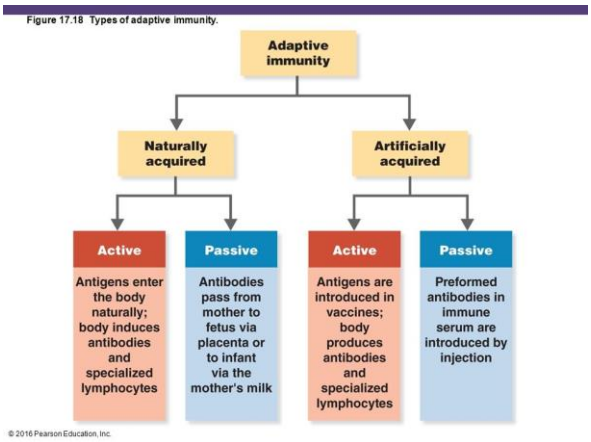
Fig. : Difference between innate and adaptive immunity



So, adaptive immunity creates immunological memory after an initial response to a specific pathogen, and leads to an enhanced response to subsequent encounters with that pathogen. This process of acquired immunity is the basis of vaccination**.**

■ Types and componenets of adaptive immunity:

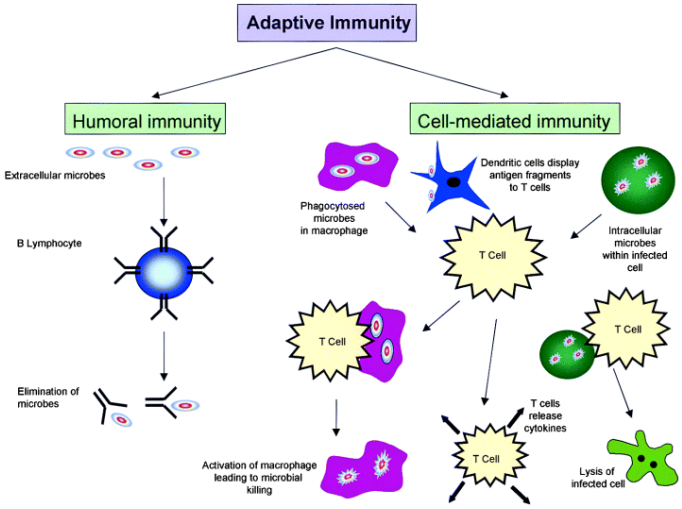
Fig. : Types of adaptive immunity:



Components and mechanisms of adaptive immunity:

Adaptive immunity has 2 arms: Humoral immunity by B lymphocytes and cell mediated immunity by T lymphocytes

Fig. : Components of adaptive immunity:



In antibody responses, B cells are activated to secrete antibodies, which are proteins also known as immunoglobulins. Antibodies travel through the bloodstream and bind to the foreign antigen causing it to inactivate, which does not allow the antigen to bind to the host.

In cell mediated immunity, no antibodies are involved, but rather there is activation of phagocytes, antigen-specific cytotoxic T-lymphocytes, and the release of various cytokines in response to an antigen.

Chapter 8: Collection and transport of specimens for microbiological examination

Objectives

Discuss Hazards of improper collection and transport of specimens.
Understand Proper collection time of different specimens.

Overview of Collection and transport of specimens and Related Concepts

Collection and transport of specimens for microbiological examination

■ Hazards of improper collection and transport of specimens obtained from patients:

"If a physician is dependent upon microbiology laboratory data for helping to save his patients the one who collects the specimen may determine the course of the patient recovery"

Improper collection and delay in transportation may result in overgrowth of normal microbiota prevailing at the site of collection, outgrowing of opportunistic flora and death of labile, fastidious but more virulent organisms which are in fact might be the cause of the infection.

■ The main steps that should be put into consideration during transport of the specimens:

1. Collect before antibiotic therapy whenever possible
2. Collect the specimen where the suspected organism is likely to be found
3. Absolute aseptic precautions should be observed while collecting the sample.
4. Consider the stage of the disease.
5. Instruct the patient clearly.
6. Use proper containers and/or suitable transport media.
7. Specimen should be delivered to the laboratory as soon as possible.
8. Suffecient and relevant information should be provided to the laboratory.

The requisition form should include:

- patients name, age, sex
- patient location (ward, room number or address)
- name of the treating physician
- nature of the specimen
- specific anatomic culture site
- clinical diagnosis
- procedure used in obtaining the specimen
- name of the individual transcribing the orders

- antimicrobial therapy if any patient is receiving

■ Proper collection time of different specimens:

Specimen	Storage	Container	To lab
Wound Swab	Refrigerate overnight if not reaching lab same day	Bacterial swab containing transport medium (usually black or blue top)	ASAP/within 24 hours
Viral swab	Refrigerate overnight if not reaching lab same day	Viral swab or viral transport medium	ASAP/within 24 hours
Chlamydia (1) First catch urine	Refrigerate overnight if not reaching lab same day.	Plain universal container or Chlamydia transport tube	ASAP/within 24 hours
Chlamydia (2) Female endocervical swab/ female self-taken low vaginal swab	Refrigerate overnight if not reaching lab same day	Chlamydia swab or Chlamydia transport tube	ASAP/within 24 hours
Tissue/pus	Refrigerate if not possible to send directly to lab	Plain universal container	Immediately
Urine	Refrigerate overnight only *If antibiotics are to be commenced immediately, obtain a specimen now and*	Plain universal container	ASAP/within 24 hours

	refrigerate until collection, even if at a weekend/public holiday		
Sputum	Refrigerate overnight if not reaching lab same day	Plain universal container	ASAP/within 24 hours
Feces	Refrigerate overnight if not reaching lab same day	Stool specimen container	ASAP/within 24 hours
Blood cultures	**Send directly to lab for incubation**	Blood culture bottles	Immediately
Serology/Virology blood tests	Refrigerate overnight if not reaching lab same day	Serum or EDTA blood tube (check with laboratory, depends on the test required)	ASAP/within 24 hours
CSF	Send directly to lab	Plain universal container	Immediately

Chapter 9: Antimicrobial agents

Objectives

Discuss Mechanisms of action of antimicrobial drugs.

Understand Properties of ideal antimicrobial agent.

Discuss complications of antimicrobial therapy

Overview of Antimicrobial agents and Related Concepts

■ Definition of antimicrobials:

An **ANTIMICROBIAL** is any substance of natural, semisynthetic or synthetic origin that kills or inhibits the growth of microorganisms but causes little or no damage to the host. It includes all agents that act against all types of microorganisms – bacteria (antibacterial), viruses (antiviral) and fungi (antifungal).

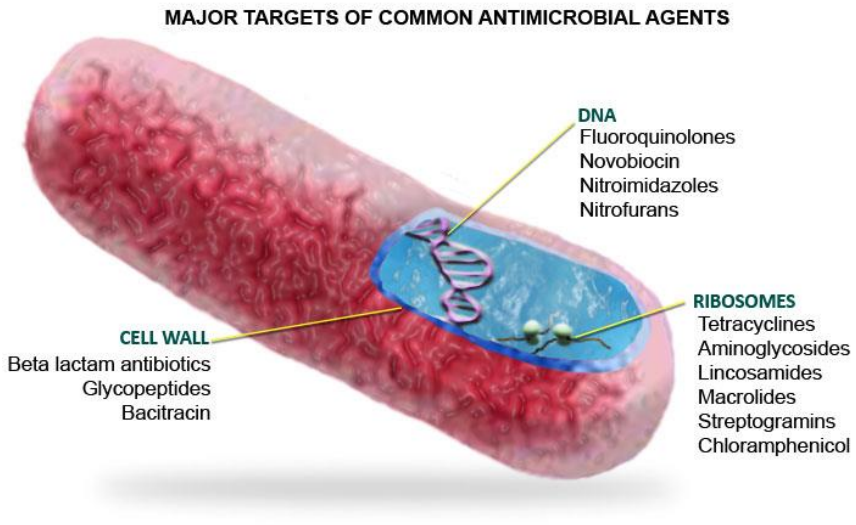
Narrow spectrum antimicrobials:

These drugs are effective only against narrow range of bacteria e.g. gram negative or gram positive bacteria.

Broad spectrum antibacterial agents:

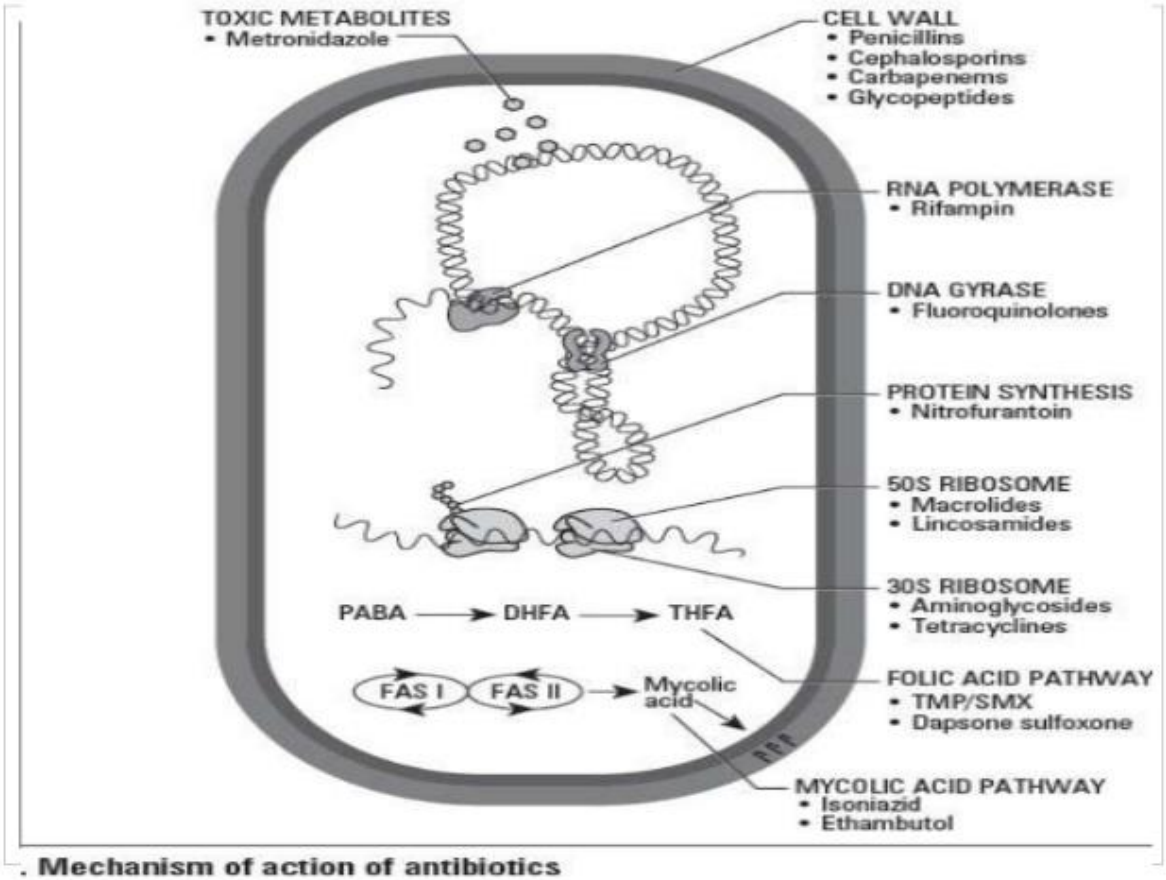
Drugs that affect a wide range of gram positive and gram negative bacteria.

Mechanisms of action of antimicrobial drugs:

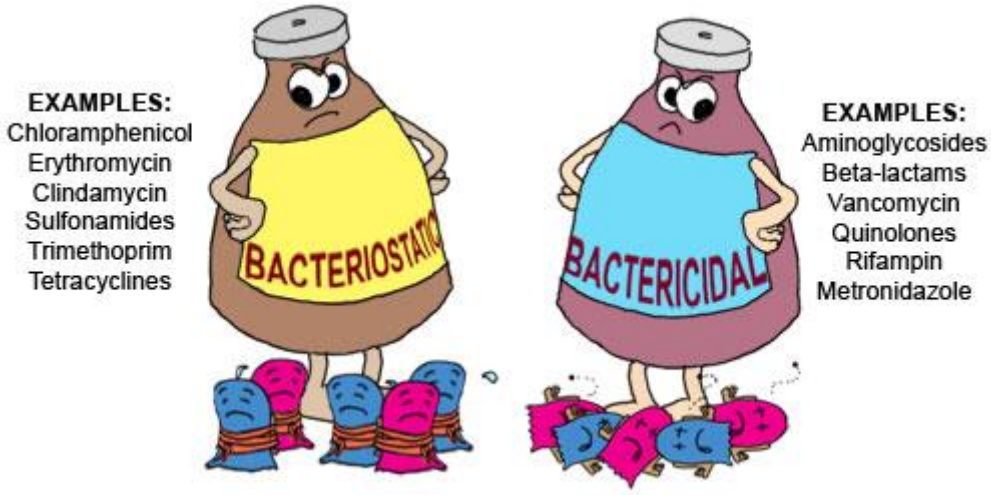


Different antibiotics have different modes of action, owing to the nature of their structure and degree of affinity to certain target sites within bacterial cells.

1. **Inhibitors of cell wall synthesis**. While the cells of humans and animals do not have cell walls, this structure is critical for the life and survival of bacterial species. A drug that targets cell walls can therefore selectively kill or inhibit bacterial organisms. Examples: penicllins, cephalosporins, bacitracin and vancomycin.
2. **Inhibitors of cell membrane function**. Cell membranes are important barriers that segregate and regulate the intra- and extracellular flow of substances. A disruption or damage to this structure could result in leakage of important solutes essential for the cell's survival. Because this structure is found in both eukaryotic and prokaryotic cells, the action of this class of antibiotic are often poorly selective and can often be toxic for systemic use in the mammalian host. Most clinical usage is therefore limited to topical applications. Examples: polymixin B and colistin.
3. **Inhibitors of protein synthesis**. Enzymes and cellular structures are primarily made of proteins. Protein synthesis is an essential process necessary for the multiplication and survival of all bacterial cells. Several types of antibacterial agents target bacterial protein synthesis by binding to either the 30S or 50S subunits of the intracellular ribosomes. This activity then results in the disruption of the normal cellular metabolism of the bacteria, and consequently leads to the death of the organism or the inhibition of its growth and multiplication. Examples: Aminoglycosides, macrolides, lincosamides, streptogramins, chloramphenicol, tetracyclines.
4. **Inhibitors of nucleic acid synthesis**. DNA and RNA are keys to the replication of all living forms, including bacteria. Some antibiotics work by binding to components involved in the process of DNA or RNA synthesis, which causes interference of the normal cellular processes which will ultimately compromise bacterial multiplication and survival. Examples: quinolones, metronidazole, and rifampin.
5. **Inhibitors of other metabolic processes**. Other antibiotics act on selected cellular processes essential for the survival of the bacterial pathogens. For example, both sulfonamides and trimethoprim disrupt the folic acid pathway, which is a necessary step for bacteria to produce precursors important for DNA synthesis. Sulfonamides target and bind to dihydropteroate synthase, trimethophrim inhibit dihydrofolate reductase; both of these enzymes are essential for the production of folic acid, a vitamin synthesized by bacteria, but not humans.



. Mechanism of action of antibiotics



Classes of antibiotics:

1. Penicillins
2. Tetracyclines
3. Cephalosporins
4. Quinolones
5. Lincomycins
6. Macrolides
7. Sulfonamides
8. Glycopeptides
9. Aminoglycosides
10. Carbapenems

- *Antiviral:*

Antiviral drugs are a class of medication used specifically for treating viral infections. Unlike most antibiotics, antiviral drugs do not destroy their target pathogen; instead they inhibit their development.

Treating viral infections is difficult because:

- Viruses are obligate intracellular parasites that use the host cell's biosynthetic machinery and enzymes for replication, hence it is more difficult to inhibit viral replication without it also being toxic to the host.
- Infection is usually well established before the patient develop symptoms
- Many of the agents currently used have severe toxic side-effects.

Viruses treatable with antiviral drugs:

- *Herpes simplex virus*
- *Varicella-Zoster virus*
- *Cytomegalovirus*
- *Human immunodefeciency virus*
- *Influenza A virus*
- *Respiratory syncitial virus*
- *Hepatitis A, B, and C viruses (some still experimental)*
- *Papillomavirus*

- *Antifungal:*

Antifungals are used to kill or prevent further growth of fungi.
Most serious fungal infections warranting treatment occur in patients who are immunocompromised, especially if they have received powerful broad spectrum antibiotics resulting in superinfection.

Properties of ideal antimicrobial agent:

1. Selective toxicity: non toxic to the host.
2. Not affected by body fluids.
3. Bactericidal (killing) activity not bacteriostatic (inhibitory) activity.
4. Broad spectrum activity.
5. Easily administered (orally).
6. Reach effective level in all body fluids.
7. No allergy or hypersensitivity.
8. No resistance against the drug.

Complications of antimicrobial therapy:

1. **Superinfection:** overgrowth of resistant bacteria flora e.g. Candida leading to oral thrush or Clostridium difficile leading to antibiotic associated diarrhea.

2. **Drug toxicity:** e.g. aminoglycosides are nephrotoxic.

3. **Allergy (hypersensitivity):** e.g. penicillin or sulfonamides.

4. **Drug resistance:** emergence of resistant strains of a microorganism is due to the misuse of antibiotics e.g.:
    - Low dosage.
    - Interrupted course.
    - Antibiotic not actually indicated.
    - Wrong choice of antibiotic.

Chapter 10:Important diseases caused by bacteria

Objectives

Discuss Bacterial diseases transmitted by inhalation.

Discuss Bacterial diseases transmitted by ingestion of food or drink Discuss Sexually Transmitted Diseases.

Understand Bacterial diseases transmitted by Insects.

Discuss Bacterial Diseases transmitted via skin and mucus membranes.

Overview of different bacterial diseases and Related Concepts

I. Bacterial diseases transmitted by inhalation

1. Acute follicular tonsillitis:

Cause: Gram +ve cocci called ***Streptoc occus pyogenes***

Source of infection: Case

Method of transmission: Inhalation

Symptoms & Signs:

- Fever
- Whitish pyogenic spots on the tonsillar surface
- Tonsils are enlarged and red
- Enlarged lymph nodes

Some types of ***Strept. pyogenes*** produce a toxin that causes skin rash, and the disease is called **Scarlet fever**

Lab diagnosis

- Specimen: Throat swab
- Gram stain film examined under the microscope → Gram +ve cocci arranged in chains
- Culture on suitable media

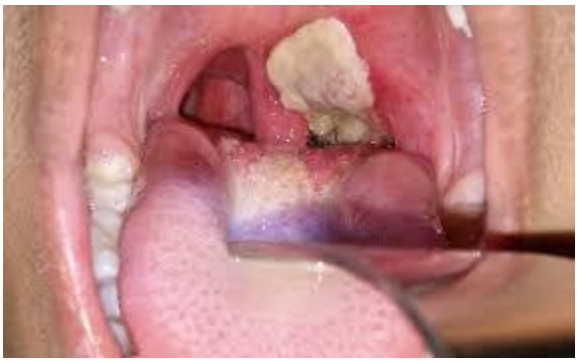
Complications:

Rheumatic fever

Acute glomerulonephritis

Prevention: Adequate treatment, Long acting penicillin

2. **Diphtheria:**



Acute infectious disease, associated with toxemia.

Cause: Gram +ve ***Corynebacterium diphtheriae*** bacilli

Source: Case or carrier

Mode: Inhalation

Symptoms & Signs:

- Fever
- Very bad general condition
- Grayish white membrane. on tonsils that may extend to larynx→ suffocation
- Toxin may affect heart, kidneys & nerves

Diagnosis:

Throat swab

Gram stained film examined → Gram +ve bacilli

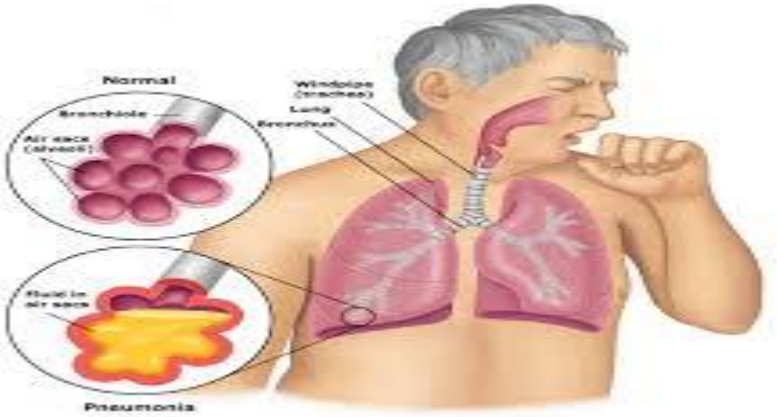
Culture on suitable media

Treatment: Diphtheria antitoxin

Prophylaxis:

Active	Passive
DPT vaccine	***Diph. Ig***

3. **Pneumonia**



Cause: Many organisms. Commonest is Pneumococci (Gram +ve)
Source: Case or carrier
Symptoms: High fever
Cough
Expectoration
Diagnosis: Sputum specimen
Gram stained film → Gram +ve cocci
Culture on suitable media, Blood culture if indicated

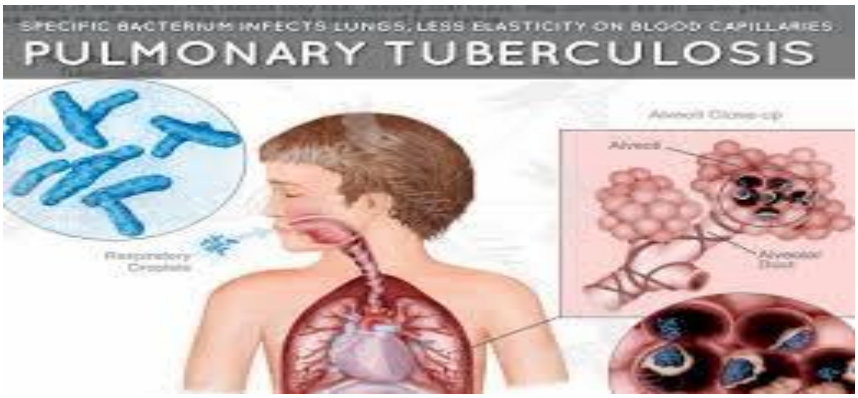
4. **Whooping cough**

Cause: Bordetella pertussis **Source**: Case

Symptoms & Signs: Fever
running nose
Cough ending in whoop

Prophylaxis: DPT vaccine

5. **Pulmonary Tuberculosis**



Cause: Tubercle bacilli.

Source: Case, or endogenous by reactivation

All people in Egypt are exposed to tubercle bacilli → dormant focus when immunity is good

If immunity decreases → active disease

Symptoms & Signs: Cough
Expectoration
Low grade fever
Decreased body weight

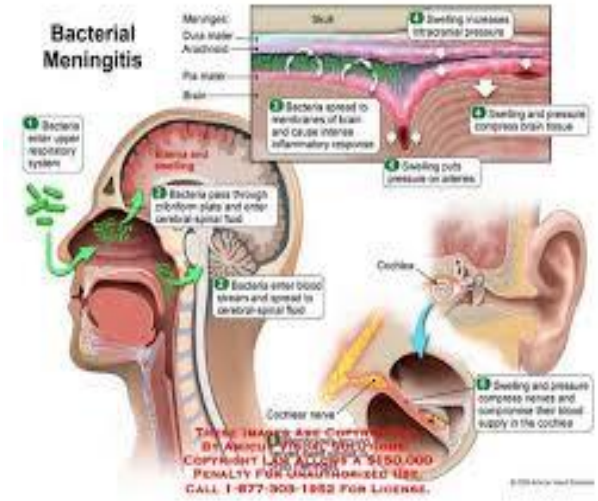
Diagnosis: Sputum examined after staining with Ziehl-Neilsen

3 successive morning specimens

Culture on suitable culture media, culture takes 4-6 weeks

Prophylaxis: BCG vaccine

6-Cerebrospinal meningitis



Cause: Many bacteria can cause it but Nisseria meningitides →*Epidemic cerebrospinal meningitis*
Source: Case &Carrier (organism. present in nasopharynx)
Mode of transmission: Respiratory droplets
Symptoms and signs : Fever, severe headache, neck stiffness, photophobia
Prevention

- ✓ Antibiotic to contacts of cases: ***Rifampicin*** is preferred because it is efficiently secreted into saliva (also eradicates carriers); or ***Ciprofloxacin***: widely used as a prophylactic drug for adolescents as a single oral dose.
- ✓ Vaccine

Laboratory diagnosis

- **samples**: cerebrospinal fluid-turbid and under tension

It is obtained by : a sterile lumbar puncture needle under complete aseptic conditions.

- Microscopic examination of gram stained film
- Culture on suitable media

The specimen should be transferred quickly to the laboratory. If delay is unavoidable, the specimen should be kept at 37 °c.

II. Bacterial diseases transmitted by ingestion of food or water

The source is from case or carrier

The bacteria may reach the food directly or by insects

1. Enteric Fever:

Typhoid fever

Paratyphoid fever

Mode of transmission :

Ingestion of contaminated food or water by the excreta of a case or a carrier.

Symptoms & Signs:

Fever

Headache

Abdominal pain

Constipation rather than diarrhea .

Lab. Diagnosis

Direct

Blood culture .

Stool culture

Indirect

Widal test for antibody production

Prevention:

Follow general preventive measures

1- Proper sewage disposal
2- Disinfection of drinking water
3- Proper food preparation and Storage
4- food handlers should have three negative consecutive stool samples at weekly intervals before being allowed to resume work.
5- Vaccination: Vaccine containing killed bacteria, but protection is short.

2. Cholera:

Cause: Vibrio cholera

Symptoms & Signs:

Rice water diarrhea

Dehydration

Lab. Diagnosis: Stool culture

Prevention:

1- Follow general preventive measures
2- Vaccine containing killed bacteria gives only a short protection

4. **<u>Bacterial food poisoning:</u>**

Bacterial food poisoning occurs **when a group of people sharing the same meal** have common symptoms, usually vomiting & diarrhea. Usually this meal contains large numbers of **bacteria and bacterial toxins**. Several types of bacteria can cause food poisoning.

III. Sexually Transmitted Diseases (STDs)

1-Syphilis:

Cause: Spirochaetes,

Source: Case

Stages: The patient passes through 3 stages:

- Primary stage:
  - Ulcer on external genitalia
  - Lymph node enlargement
- Secondary stage:
  - Rash all over the body
- Tertiary stage:
  - Important organs are affected as heart and central nervous system

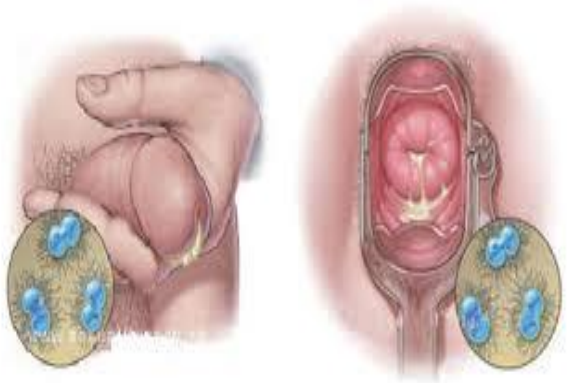
Lab. Diagnosis:

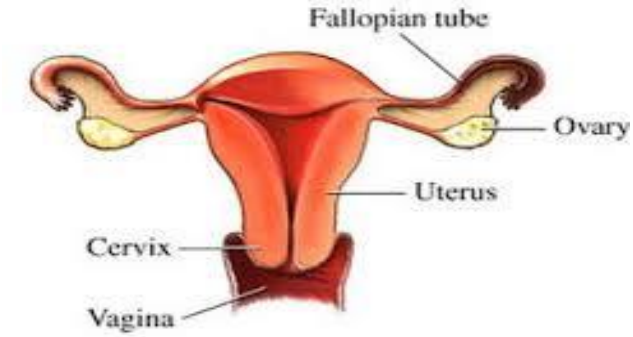
- Direct:

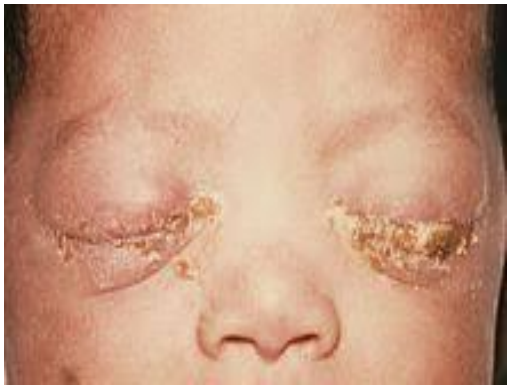
Specimens: From ulcer, rash or lymph nodes

  - Special stain and view under microscope
- Indirect: For antibody detection

3. Gonorrhea:







Cause: ***Neisseria gonorrhea*** – Gram –ve cocci

Source: Case

Symptoms & Signs:

- In males-
  - Purulent discharge from the external urethral meatus
  - Acute urethritis

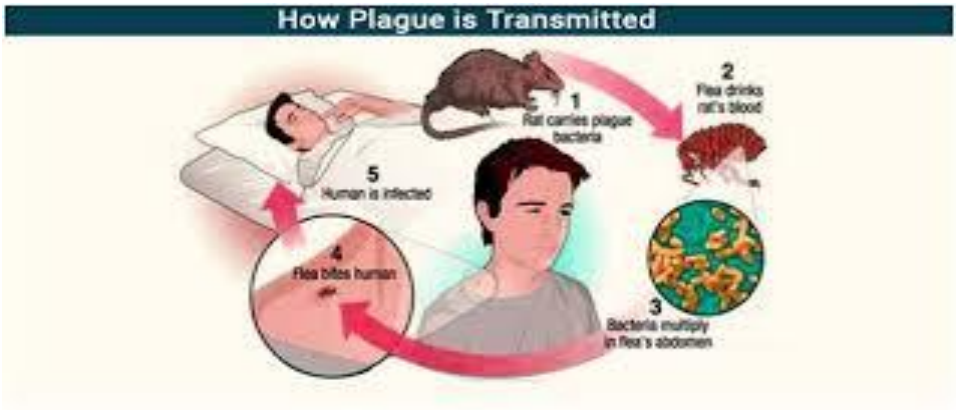
- In females-
  - Cervicitis with purulent discharge
  - Urethritis
  - If baby passes through infected birth canal → ophthalmia neonatorum

Lab. Diagnosis:

- Microscopic examination of Gram stained film → Gram –ve cocci inside & outside pus cells
- Culture on suitable media

IV. Bacterial diseases transmitted by Insects

Plague:



Cause: ***Yersinia pestis***

Transmitted by: Rat flea

Symptoms & Signs:

Fever

Lymph node enlargement

Pneumonia

Septicemia

Lab. Diagnosis: According to site of infection- Blood culture

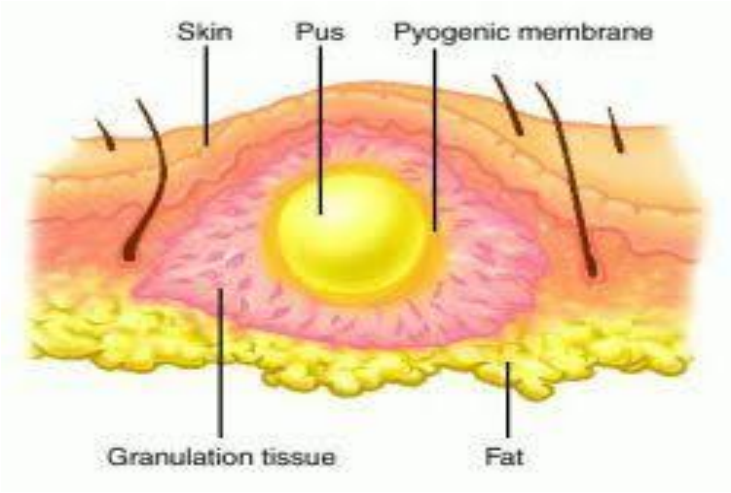
Sputum

Lymph node aspirate

- Culture on suitable media

V. Bacterial Diseases transmitted via skin and mucus membranes

1) Abscesses:



Cause: Most common- *Staphylococcus aureus* – Gram +ve cocci
Source: - Patient himself as bacteria is present on skin and in the nose
May cause infection through minor skin abrasions

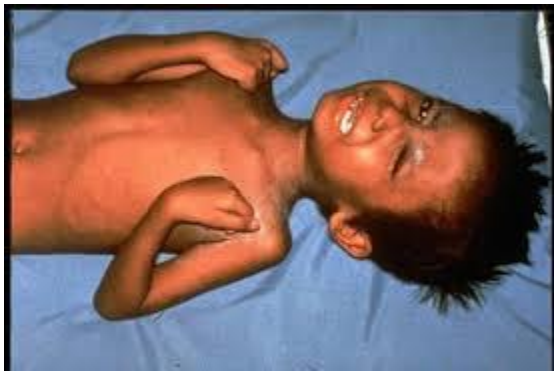
Lab. Diagnosis:

- Specimen is pus. Swab if small volume, syringe aspirate if large amount.
- Gram stained film: Shows bacteria and pus cells
- Culture on suitable media

2) Trachoma:

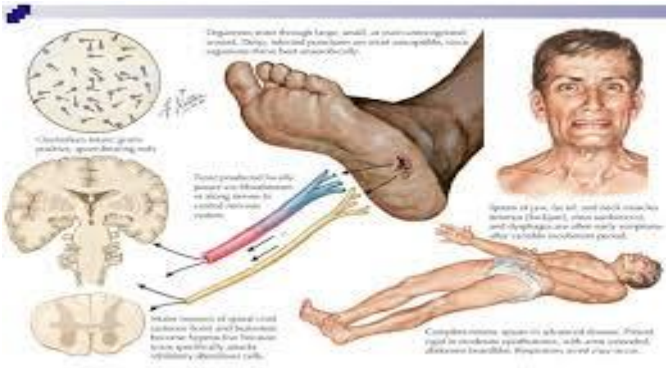
Cause: *Chlamydia trachomatis*
Source: Patient, through conjunctival discharge
Transmission: Direct, or mechanical by flies

3) Tetanus:



Cause: Clostridium tetani- Gram +ve anaerobic spore-forming bacilli

Source:



- Deep wound contamination by soil
- Contaminated surgical instruments → uterine infection after birth or abortion, or neonatal infection of umbilical cord stump
- Contaminated surgical sutures → Surgical wound infection

Symptoms & Signs: Muscle spasms and convulsions.

Lab. Diagnosis: Wound swab from deep areas. Stain by Gram and culture on suitable media

Prevention & Treatment: Proper sterilization, proper wound care

DPT- active immunization

Antitetanic serum for treatment 

4) Wound sepsis:

Cause: Accidental wounds, surgical wounds

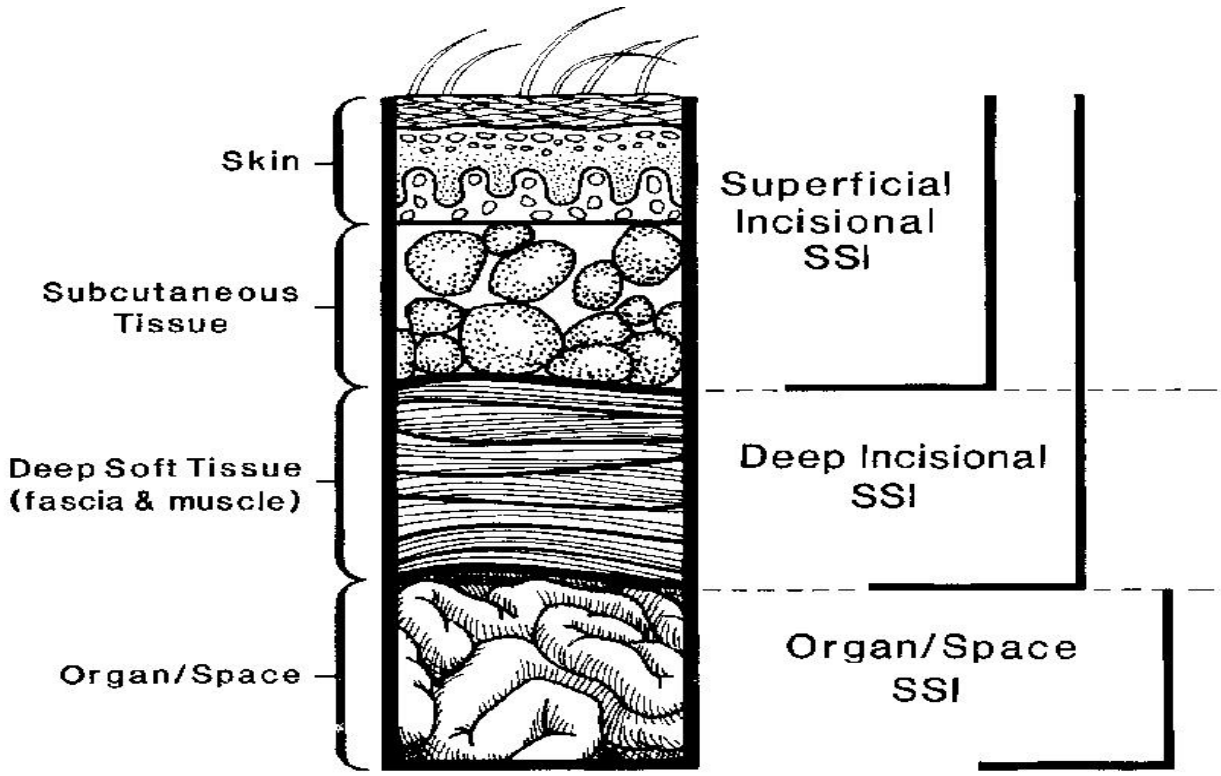
Source: Patient himself
Surgical instruments
Doctors & nurses- through inappropriate application of Standard Precautions

Symptoms and signs
Fever, wound exudate, cellulitis

Lab. Diagnosis:
Swab or pus, examined after Gram staining, and culture on suitable media

Surgical site infections (SSI)

Infection occurs within 30 days after the operative procedure if no implant is left in place or within 1 year if implant is in place and the infection appears to be related to the operative procedure.

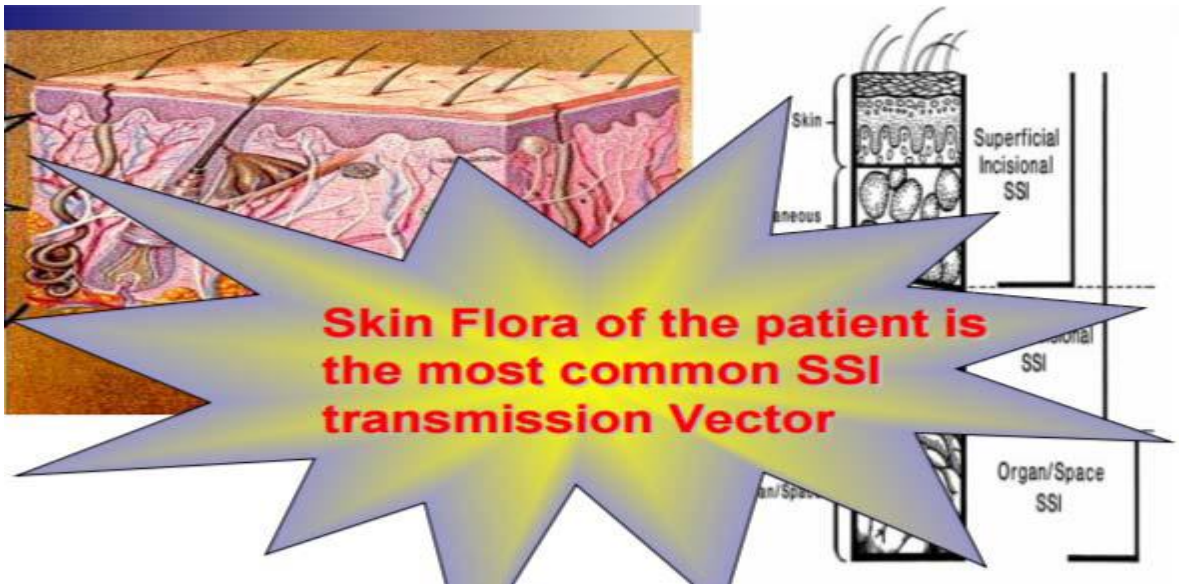


SSI risk factors:

- Age
- Obesity
- Diabetes
- Malnutrition
- Prolonged preoperative stay
- Infection at remote site
- Systemic steroid use
- Nicotine use
- Duration of surgery
- Hair removal/Shaving

Source of SSI Pathogens

- Endogenous flora of the patient
- Operating theater environment
- Hospital personnel (MDs/RNs/staff)
- Seeding of the operative site from distant focus of infection (prosthetic device, implants)



Prevention

SSI Preventive Strategies

Preoperative measures	Intra-operative measures	Postoperative measures
▪Preoperative antiseptic showering ▪Preoperative assessment for infection ▪Preoperative hair removal ▪Patient skin preparation in the operating room ▪Preoperative hand/forearm antisepsis ▪Antimicrobial prophylaxis	▪Operating room environment ▪Surgical attire and drapes ▪Establishing and Maintaining a Sterile Field ▪Asepsis and surgical technique	▪Incision care ▪ Discharge planning

1. Preoperative

a. preoperative antiseptic skin preparation:

- **Preoperative antiseptic showering:** Preoperative showers/baths with an antiseptic agent at least the night before the operation.

Why: Decreases skin microbial colony counts

How: Thoroughly wash and clean at and around the incision site to remove gross contamination before Performing antiseptic skin preparation.

- **Preoperative hair removal**

Clipping immediately before operation associated with lower SSI risk than shaving or clipping the night before operation . Only the incision area is cleared of hair. This is done in the anesthetic room.

b. preoperative surgical scrub

c. antimicrobial prophylaxis for operations where there is a significant risk of wound infection.

d.Patient skin preparation in the operating room

Most common used: Alcohol solutions (Skin)
Chlorhexidine gluconate (Skin & mm)
Iodophors (Skin & mm)

How: Apply preoperative antiseptic skin preparation in concentric circles moving out toward the periphery.

2. Intraoperative

a. Positive pressure ventilation with filtered air

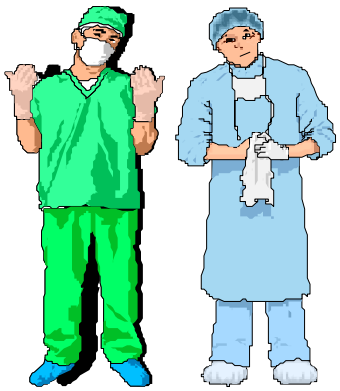
b. Sterilization of surgical instruments

C. Surgical attire and drapes

The use of barriers:

- → patient: minimize exposure to the skin, mucous membranes, or hair of surgical team members
- → surgical team members: protect from exposure to blood and blood borne pathogens.
- → Surgical attire can include such as items as sterile gloves, caps, masks, gowns or waterproof aprons, and protective eyewear.
- → Sterile drapes are used to create a barrier between the surgical field and the potential sources of bacteria. These are placed over the patient.

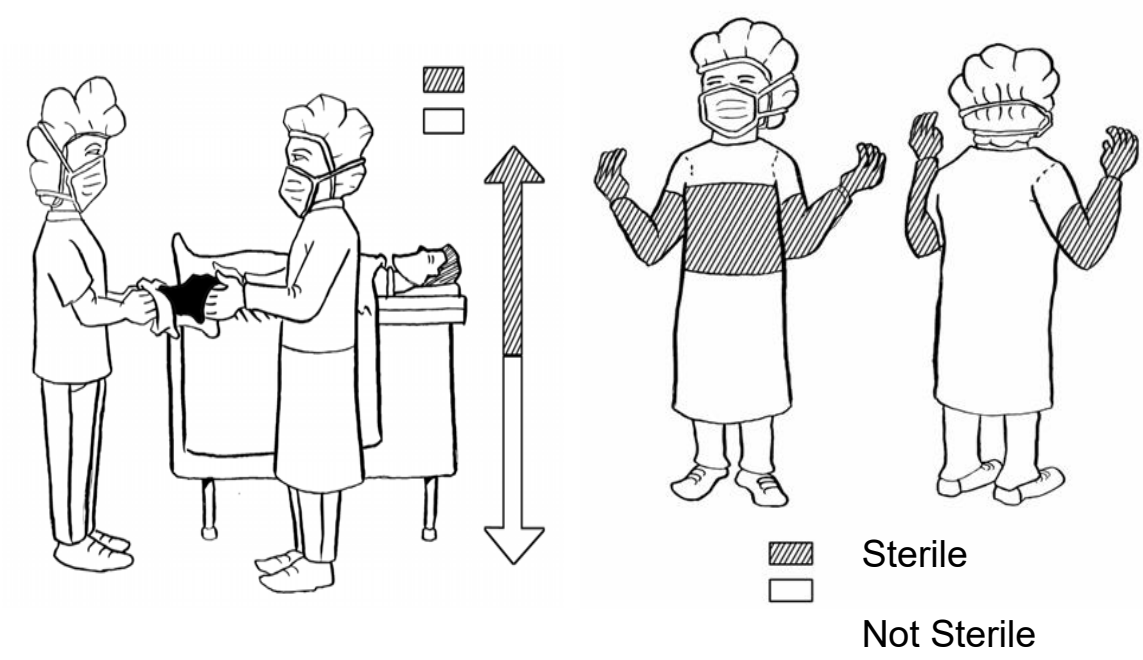
- Scrub suits
- Cap/hoods
- Shoe covers
- Masks
- Gloves
- Gowns



d. Establishing and Maintaining a Sterile Field

-The sterile field is created by placing sterile towels and/or surgical drapes around the surgical/procedure site.

- Additional sterile fields may also be established, such as on the stand that will hold instruments and other items that are needed during the procedure.



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d. Asepsis and surgical technique

- adherence to the principles of asepsis by all scrubbed personnel

→ Excellent surgical technique: reduce the risk of SSI.

→ Drains: increase incisional SSI risk.

3. Postoperative surgical site care

- **Incision care**

→ The type of postoperative incision care

- **closed primarily:** the incision is usually covered with a sterile dressing for 24 to 48 hours.
- **left open to be closed later:** the incision is packed with a sterile dressing.
- **left open to heal by second intention:** packed with sterile moist gauze and covered with a sterile dressing.

■ **Discharge planning**

→ **The intent of discharge planning:**

- Maintain integrity of the healing incision,
- Educate the patient about the signs and symptoms of infection,
- Advise the patient about whom to contact to report any problems.

Bundle:

- **Grouping of best practices.**
- **A group of processes needed by patients undergoing certain risky treatments.**
- **So to join scientifically grounded elements that reduce the risk of serious complications.**

Bundle approach to prevent SSI:

1-Monitor appropriate use of antibiotics.

2-Stop use of razors to remove a patient's hair.

3-keep the patient worm during surgery.

4-monitor the patient's blood sugar.

Chapter 11: Urinary Tract Infections (UTIs)

Objectives

List different Bacteria causing UTIs.

Understand Types of catheters.

Discuss definition and Guidelines for Preventing CAUTI.

Overview of Urinary Tract Infections and Related Concepts

Bacteria causing UTIs are commensals of the perineum or lower intestine:

- *E. Coli* –the most common
- Other coliforms e.g. *Klebsiella*
- *Proteus mirabilis*-associated with urinary tract stones
- *Pseudomonas aeruginosa*-ass. With catheterization
- *Staphylococcus saprophyticus*-young women
- *Enterococcus faecalis*
- *Candida albicans.*

Symptoms

Frequency of micturition

Dysuria(pain on passing urine)

Fever

Loin pain or tenderness

- ✓ Health care ass. UTI is the most common type of infections
- ✓ It is often a complication of catheterization or urinary tract operative procedures
- ✓ Source of infection:

Endogenous

Exogenous

Catheter associated urinary tract infection (CAUTI) Definition

A catheter-associated urinary tract infection is a UTI that occurs in a patient who had an indwelling urethral urinary catheter in place within the **48hour** period before the onset of the UTI.

Types of catheters

- A **condom catheter**, consists of a soft plastic or rubber sheath, tubing, and a collection bag for the urine. The sheath is placed over the penis and the collection bag is attached to the leg. Collects urine when there is no need for catheter insertion.
- A **straight catheter**, is used when the catheter is to be inserted and removed immediately.
- An **indwelling catheter**, also known as **Foley's catheter**, is left inside the bladder to provide continuous urine drainage.
- A **suprapubic catheter** is a type of indwelling catheter. The suprapubic catheter is inserted into the bladder through a surgical incision made in the abdominal wall, right above the pubic bone.
- A **3-way catheter for continuous bladder irrigation (CBI)** is a type of indwelling catheter. It is inserted to irrigate the bladder to prevent obstruction (i.e bleeding)

Organisms gain access in one of two ways:

- ☐ **Extraluminal contamination** may occur early, by direct inoculation when the catheter is inserted, or later, by organisms ascending from the perineum by capillary action in the thin mucous film contiguous to the external catheter surface.
- ☐ **Intraluminal contamination** occurs by reflux of microorganisms gaining access to the catheter lumen from failure of closed drainage or contamination of urine in the collection bag

- **Endogenous intestinal flora**, including *Escherichia coli*, *Enterobacter*, *Klebsiella*, Enterococci, and *Proteus*, are common pathogens of the urinary tract and potential colonizers of urinary catheters.
- Inadequately decontaminated equipment and hands of healthcare workers may introduce **environmental and common skin bacteria during insertion or maintenance of the urinary catheter.** Therefore, *Pseudomonas*, *Serratia*, coagulase-negative *Staphylococci*, *Acinetobacter*, and other non-intestinal or environmental microbes can result in healthcare-associated CAUTI.

Candida species are a common organism isolated from urine in (ICU) setting.

The use of antifungal drugs and of broad-spectrum antibiotics for empiric therapy increase prevalence of drug-resistant fungi and bacteria in ICU and long-term care settings.

Most infected urinary catheters are covered by a thick biofilm intraluminally, extraluminally, or both ways.

Complications of Indwelling Urinary Catheters

- **Infections related to indwelling urinary catheters include:**

Urinary tract infection (bladder)

Acute pyelonephritis

Urethral strictures, prostatitis and orchitis

Secondary bacteremia/sepsis

Late onset sequellae, e.g. metastatic osteomyelitis and meningitis

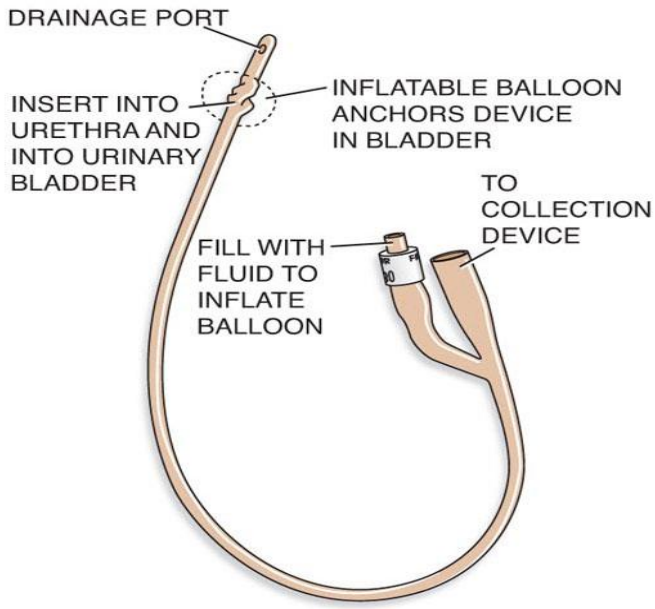
- **Prolonged hospital stay**
- **Increased mortality**
- **Selection for multidrug-resistant organisms (MDROs)**

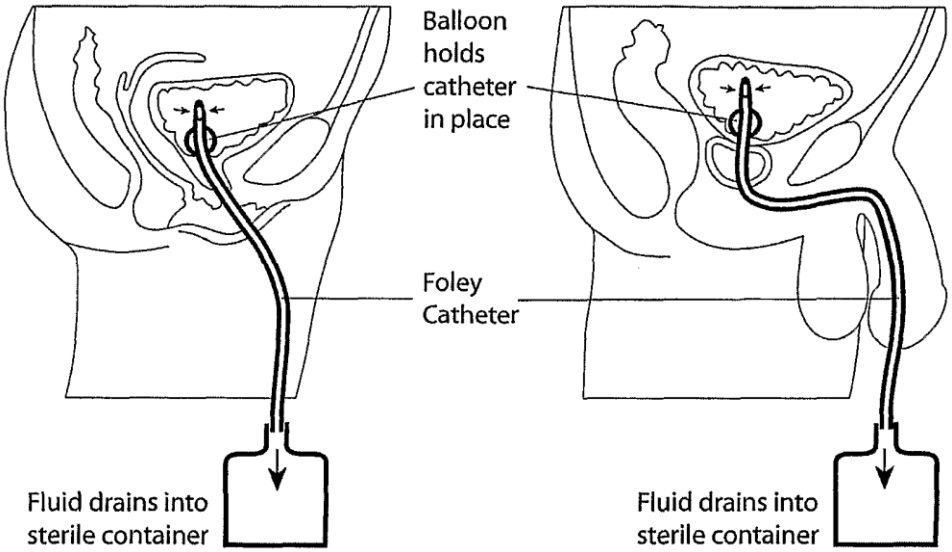
Evidence-based Risk Factors for CAUTI

Symptomatic UTI	Bacteriuria
Prolonged catheterization*	Disconnection of drainage system*
Female sex†	Lower professional training of inserter*
Older age†	Placement of catheter outside of OR†
Impaired immunity†	Incontinence†
	Diabetes
	Meatal colonization
	Renal dysfunction
	Orthopaedic/neurology services

* Main modifiable risk factors † Also inform recommendations

Urinary catheter





Guidelines for Preventing CAUTI

1. Avoid Unnecessary Catheterizations. Limit use of indwelling urethral catheters to:

- relief of anatomic or physiologic outlet obstruction;
- patients undergoing surgical repair of the genitourinary tract (to facilitate healing);
- critically ill or postoperative patients who need their urinary output accurately measured;
- paralyzed, or comatose patients (to prevent skin breakdown and infected pressure ulcers).
- When no longer needed, the catheter should be removed.

2. Consider Alternatives to Urethral Catheterization

- Suprapubic catheterization frequently used in patients on urologic or gynecologic services
- condom catheter drainage: for incontinent males without outlet obstruction
- condom drainage, associated with a lower risk than indwelling urethral catheters

3. Inserted under aseptic technique

FOLEY CATHETER INSERTION

- Explain procedure to patient.
- Obtain Foley catheter kit:
- Sterile drapes, sterile gauze, sterile gloves). Check supplies: drape, flashlight, sterile applicators gel, clean gloves, warm moistened wash cloth.

NB:

Use smallest suitable bore catheter

- Wash hands
- Don clean gloves.
- visualize perineal area.
- Cleanse perineum with wash cloth if needed. Wash hands after perineal cleansing.
- Place catheter kit between patient knees. Open sterile wrapper
- Place a drape under patient hips.
- Don sterile gloves.
- Place second fenestrated drape from kit box. Open and place to create sterile field at perineal area.

Prepare equipment (do in any order):

- Attach provided syringe of sterile water to foley port. Ensure balloon intact by inflating with 7-9cc water. Deflate. leave syringe attached to foley port.
- Open lubricant.
- Warn patient you are going to begin.

Foley catheter insertion in male

- Retract and hold foreskin to visualize meatus. Exerts a slight upward traction on penis, holding it nearly perpendicular to the body.
- Disinfect with povidon iodine in circular motion away from meatus.
- Inserts lubricated catheter into meatus until urine appears in tubing
- Inflates Foley balloon. Instill 7-9cc sterile water.
- Checks catheter to be sure it is secure in bladder (if Foley) by giving a little tug on the catheter. Push catheter back to avoid tension on neck of the bladder.
- Replaces foreskin if present

Foley catheter insertion in female

- Separate and holds labia apart,cleanse, swab pubic area to anus.

4. Closed Sterile Drainage:

- a. A sterile, continuously closed drainage system should be maintained.
- b. The catheter and drainage tube should not be disconnected unless the catheter must be irrigated .
- c. If breaks in aseptic technique, disconnection, or leakage occur, the collecting sys- tem should be replaced using aseptic technique after disinfecting the catheter-tub- ing junction. .

5. Irrigation:

- Irrigation should be avoided unless obstruction is anticipated.
- The catheter-tubing junction should be disinfected before disconnection.
- A large-volume sterile syringe and sterile irrigate should be used and then discarded.

The person performing irrigation should use aseptic technique.

- If the catheter becomes obstructed and can be kept open only by frequent irrigation, the catheter should be changed.

6. Specimen Collection:

A. If small volumes of fresh urine are needed for examination, -culture-, the distal end of thecatheter, or preferably the sampling port if present, should be cleansed with a disinfectant, and urine then aspirated with a sterile needle and syringe.

B. Larger volumes of urine for special analyses(24 h urine) should be obtained aseptically from the drainage bag.

7. Urinary Flow:

- To achieve free flow of urine:

1. the catheter and collecting tube should be kept from kinking;
2. the collecting bag should be emptied regularly using a separate collecting container for each patient.

3. poorly functioning or obstructed catheters should be irrigated or if necessary, replaced;
4. collecting bags should always be kept below the level of the bladder.

8. Meatal Care:
- At this time, daily meatal care with special regimen canot be endorsed.,

9. Catheter Change Interval:
- Indwelling catheters should not be changed at fixed intervals .

10. Spatial Separation of Catheterized Patients:
infected and uninfected patients with indwelling catheters should not share the same roomor adjacent beds.

11. Bacteriologic Monitoring:
- is not recommended

12. Remove the catheter when no longer needed

Application of Urinary Catheter
- Wash hands.
- Don clean gloves.
- Cleanse perineum with washcloth if needed.
- Remove gloves and perform antiseptic hand washing after perineal cleansing.
- Don sterile gloves.
- Drape the patient

In male
Retract and hold foreskin to visualize meatus.
Exert a slight upward traction on penis, holding it nearly perpendicular to the body.
Apply antiseptic in circular motion away from meatus.
In female
Separate and holds labia apart.
Visualize meatus.
Apply antisepsis from meatus backwards to anus in one direction.

Bladder bundle:

1- **Do not use the indwelling catheter unless you must.**
2- **Bladder ultrasound may avoid indwelling catheterization.**
3- **Condom or intermittent catheterization in appropriate patients.**
4- **Aseptic insertion and proper maintenance is paramount.**
5- **Early removal of the catheter using reminders.**

Chapter 12: Bloodstream Infections

Objectives

List different Clinical Manifestations of Bloodstream Infections.

Discuss sources of Intravenous Catheter Related Infection.

Understand different Strategies for Prevention of Catheter-Related Infections.

Overview of Bloodstream Infections and Related Concepts

Bloodstream Infections

Clinical Manifestations

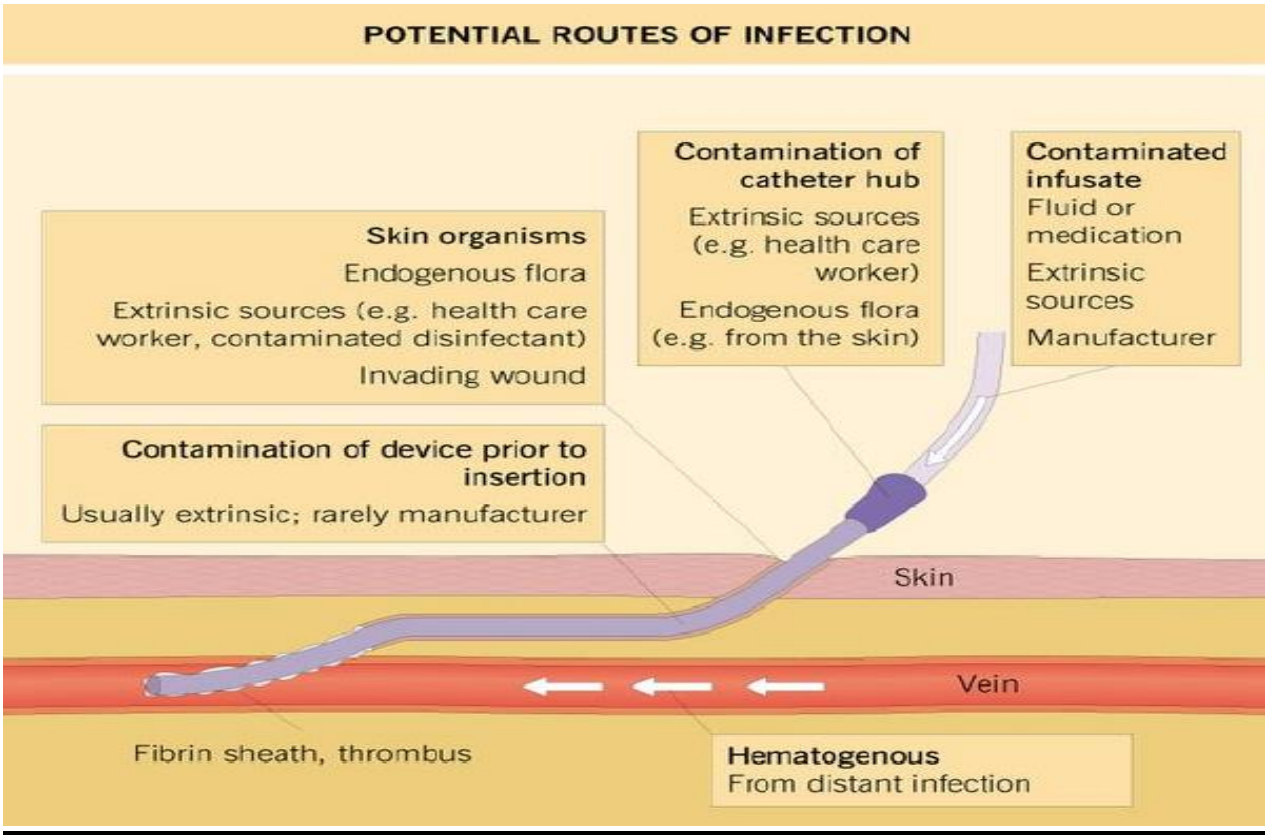
Bacteremia: Transient presence of bacteria in the bloodstream, there may be symptoms and signs of local infection.

Septicemia or sepsis: Presence of bacteria in the bloodstream associated with signs of shock, including tachycardia and reduced blood pressure

Laboratory diagnosis: Blood sample is obtained by complete aseptic technique for blood culture.

Intravenous Catheter Related Infection

Sources:



1- Skin organisms enter the catheter insertion site along the outside of the catheter.

2-Organisms from the hands of staff or the patient's skin enter through the hub when the catheter is disconnected, or from the injection ports.

3-Metastatic colonization of the catheter tip may occur, seeded from a distant site of infection (e.g. wound, lung, or kidney).

4-Rarely, infection will arise from organisms growing in commercially prepared infusate due to faulty sterilization or from contaminated added medications.

Strategies for Prevention of Catheter-Related Infections

- **Adherence to Hand hygiene and use of personal protective equipments (PPE):**

- **Apply antiseptic in a spiral manner from inside out. Use 0.5% chlorhexidine in 70% alcohol for skin antisepsis at the time of catheter insertion .**

Catheter-site dressing

Use either sterile gauze or transparent, semipermeable dressing.

Fix catheter in place .

- **Daily care and follow up:**

Evaluate the need

Evaluate the insertion site daily for infection (inspection & palpation). Remove if infection occurs.

- **Shift to oral medication when possible**
- **For single shoot use single puncture steel needle**

Replace dressing :

1- PVC

A: Gauze dressing

✓ Replace the catheter-site dressing when it becomes damp, loosened, or soiled or when inspection of the site is necessary.

B: Transparent dressing :

✓ can be left for the duration of catheter insertion.

2-Central Venous Catheters (in Adult and Pediatric Patients):

✓ Every 2 days for gauze dressings.
✓ Every 7 days for transparent dressings, except in those pediatric patients in which the risk for dis-lodging the catheter outweighs the benefit of changing the dressing.

Infusion fluid and IV medication

- Ensure fluid is pyrogen free.
- Avoid damage to container
- Maintain the closed system
- Inspect container for cracks, leaks, cloudiness and particulate matter.
- Aseptic precautions (wash hands, no touch technique)
- Add sterile medicament. Preferably carried out in pharmacy.

If multidose vials are used :

- ✓ Refrigerate multidose vials after they are opened if recommended by the manufacturer.
- ✓ Cleanse the access diaphragm of multidose vials with 70% alcohol before inserting a device into the vial.

✓ Use a sterile device to access a multidose vial and avoid touch contamination of the device before penetrating the access diaphragm.

✓ Discard multidose vial if sterility is compromised.

- **Injection port:**

  - Clean with 70% alcohol and allow to dry before use.
  - Close ports that are not needed with sterile stopcocks

Hang time for parentral fluids:

- No recommendation for the hang time of intravenous fluids, including nonlipid-containing parenteral nutrition fluids.
- Complete infusion of **lipid-containing parenteral** nutrition fluids within **24** hours of hanging the fluid.
- When **lipid emulsions** are given alone, complete the infusion within **12** hours of hanging the emulsion

- Complete infusions of **blood or other blood products** within **4** hours of hanging the blood.

Changing of infusion set:

- Replace administration sets no more frequently than at 72-hour intervals after initiation of use, unless catheter-related infection is suspected or documented.
- Replace tubing used to administer **blood**, blood products, or **lipid** emulsions within 24 hours of initiating the infusion.
- Avoid excessive manipulation.
- Disinfect catheter hubs and sampling ports before accessing.

Catheter replacement

Peripheral venous catheter (PVC)

- In adult replace catheter every 72- hs.
- In pediatric patients& patient with difficult access leave catheters in place until IV therapy is completed, unless a complication occurs.
- Replace if signs of infection or purulence is observed at the insertion site .

Catheters inserted during a medical emergency should be replaced as soon as possible (< 24 hours).

Central venous catheter (CVC)

Replace the catheter if:

- patient is hemodynamically unstable& CRBSI suspected
- purulence is observed at the insertion site

N.B Do not administer systemic antimicrobial prophylaxis routinely before insertion or during use of an intravascular catheter to prevent catheter colonization or BSI.

Central Line Bundle:

1.Hand Hygiene
2. Maximal barrier precautions (as surgical technique)
3. Chlorhexidine skin antisepsis
4. Optimal catheter site selection (subclavian vein is the preferred site for non-tunneled catheters)
5. Daily review of line necessity, with immediate removal of unnecessary lines

Chapter 13: Important viral diseases

Objectives

List Routes of Transmission of different viruses causing hepatitis.

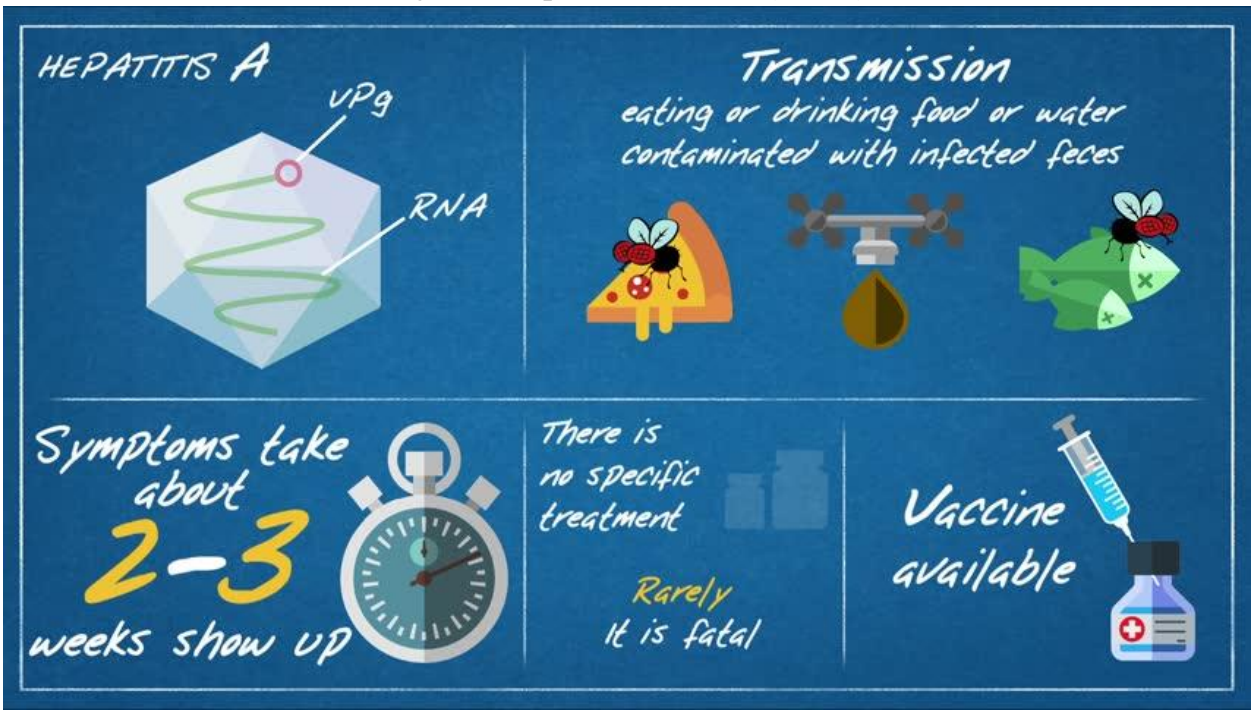
Understand methods of Prophylaxis against different viruses causing hepatitis.

Discuss Routes of Transmission of HIV.

Mention the value of MMR vaccine.

Overview of Important viral diseases and Related Concepts

HEPATITIS A:is caused by the Hepatitis A virus (HAV)



Routes of Transmission:

Ingestion of contaminated food or drinks

Symptoms of Acute Infection:

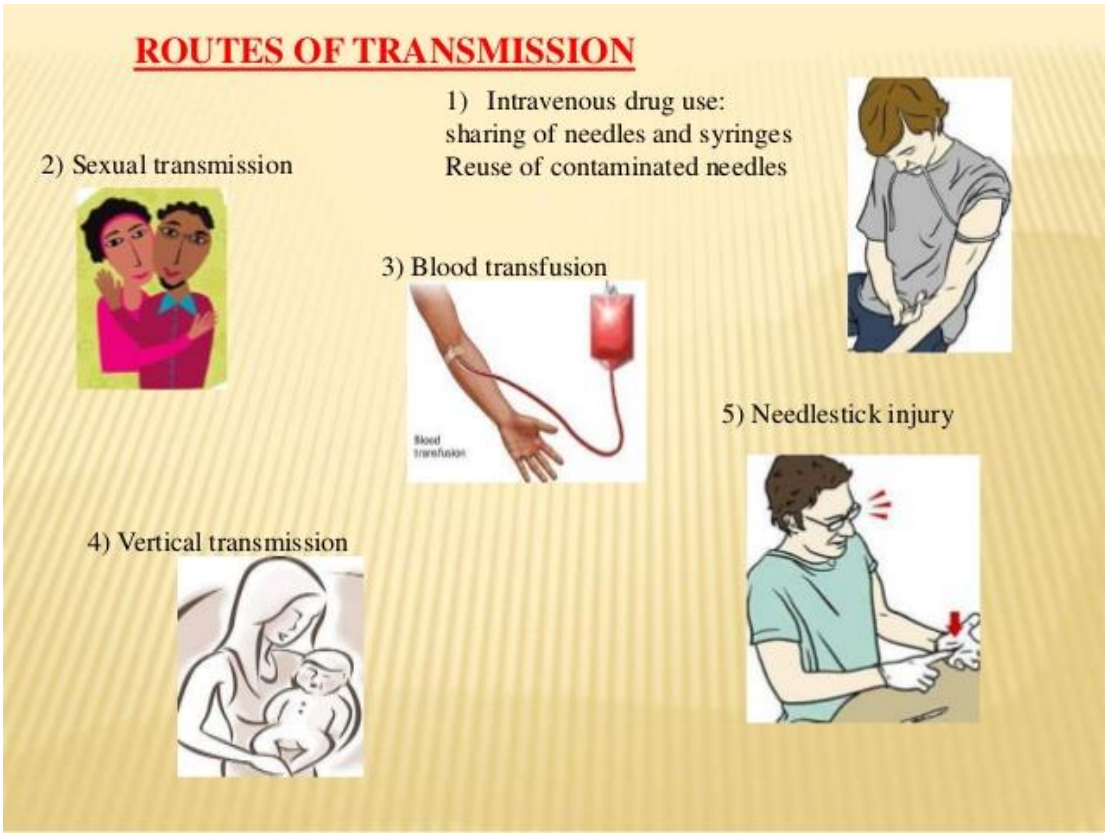
Symptoms of all types of viral hepatitis are similar and can include one or more of the following:

- Fever
- Fatigue
- Loss of appetite
- Nausea • Vomiting • Abdominal pain

• Gray-colored bowel movements
• Joint pain • Jaundice
Incubation Period: 15 to 50 days (average: 28 days)
Severity:
Most persons with acute disease recover with no lasting liver damage; rarely fatal

Prophylaxis: Vaccine – Ig

HEPATITIS B : is caused by the Hepatitis B virus (HBV)
Routes of Transmission:



Contact with infectious blood, semen, and other body fluids primarily through:
• Birth to an infected mother
• Sexual contact with an infected person
• Sharing of contaminated needles, syringes, or other
injection drug equipment
• Needle sticks or other sharp instrument injuries

Persons at Risk:

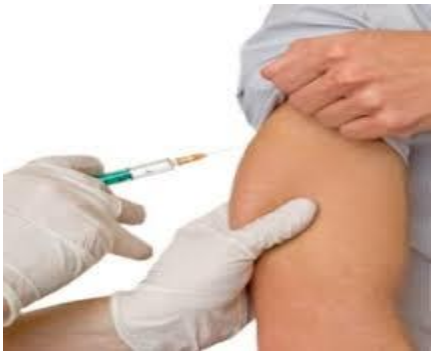
•Infants born to infected mothers
• Sex partners of infected persons
• Injection drug users
• Household contacts of infected persons
• Healthcare and public safety workers exposed to blood on the job
• Hemodialysis patients

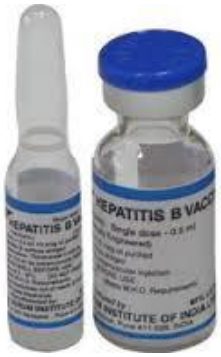
Incubation Period:45 to 160 days (average: 120 days)

Severity:

Most persons with acute disease recover with no lasting liver damage; acute illness is rarely fatal

• 15%–25% of chronically infected persons develop chronic liver disease, including cirrhosis, liver failure, or liver cancer





Prophylaxis: Vaccine – Ig

Hepatitis B vaccine

Hepatitis B vaccine is made from parts of the hepatitis B virus. It cannot cause hepatitis B infection. The vaccine is usually given as 3 or 4 shots over a 6-month period.

Infants should get their first dose of hepatitis B vaccine at birth and will usually complete the series at 6 months of age.

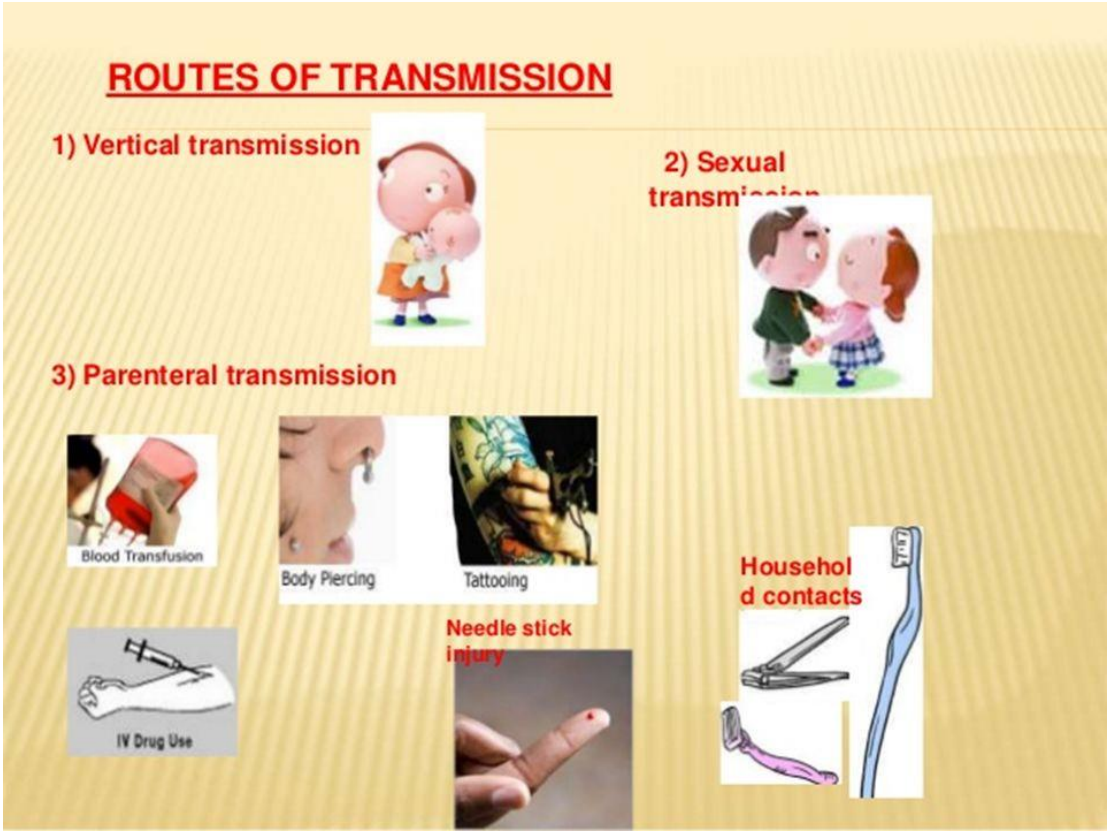
All **children and adolescents** younger than 19 years of age who have not yet gotten the vaccine should also be vaccinated.

Hepatitis B vaccine is recommended for unvaccinated **adults** who are at risk for hepatitis B virus infection, including:

- People whose sex partners have hepatitis B
- Persons seeking evaluation or treatment for a sexually transmitted disease
- People who have household contact with someone infected with the hepatitis B virus
- Health care and public safety workers at risk for exposure to blood or body fluids
- Travelers to regions with increased rates of hepatitis B
- People with chronic liver disease, kidney disease, HIV infection, or diabetes
- Anyone who wants to be protected from hepatitis B.

HEPATITIS C: is caused by the Hepatitis C virus (HCV)

Routes of Transmission:



Contact with blood of an infected person primarily through:

• Sharing of contaminated needles, syringes, or other injection drug equipment

Less commonly through:

• Sexual contact with an infected person

• Birth to an infected mother

• Needle stick or other sharp instrument injuries

Persons at Risk:
Current or former injection drug users
• Long-term hemodialysis patients
• Persons with known exposures to HCV (e.g., healthcare workers after needlesticks, recipients of blood or organs from a donor who later tested positive for HCV)
• Infants born to infected mothers
Incubation Period: 14 to 180 days (average: 45 days)
Severity:
Acute illness is uncommon.
Those who do develop acute illness recover with no lasting liver damage.
• 60%–70% of chronically infected persons develop chronic liver disease
• 5%–20% develop cirrhosis over a period of 20–30 years
• 1%–5% will die from cirrhosis or liver cancer
Prophylaxis: no available vaccine

Human Immunodeficiency Virus (HIV)

Transmission:

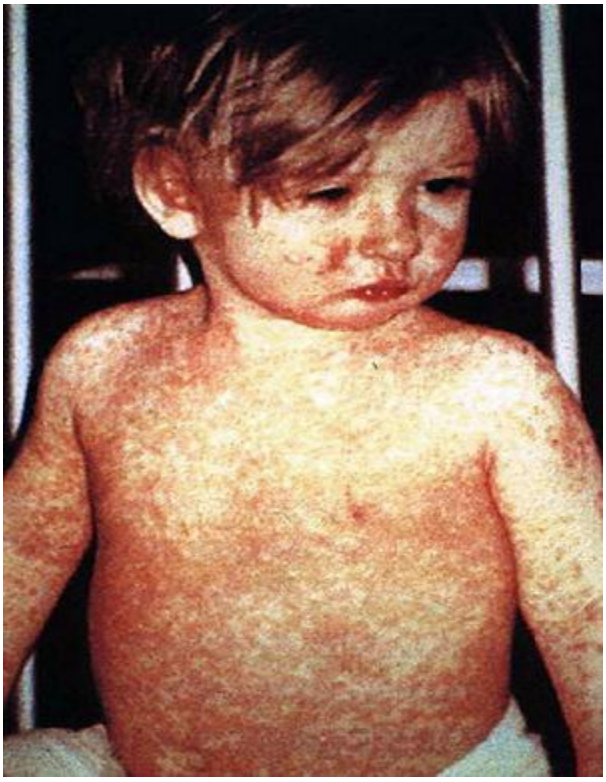
HIV is spread primarily by unprotected sex (including anal and oral sex), contaminated blood transfusions, needles, and from mother to child during pregnancy, delivery, or breastfeeding. Some bodily fluids, such as saliva and tears, do not transmit

Symptoms: Fever ,flue like symptoms

Complication: Wide variety of apportunistic infections

Prophylaxis: no available vaccine

The measles

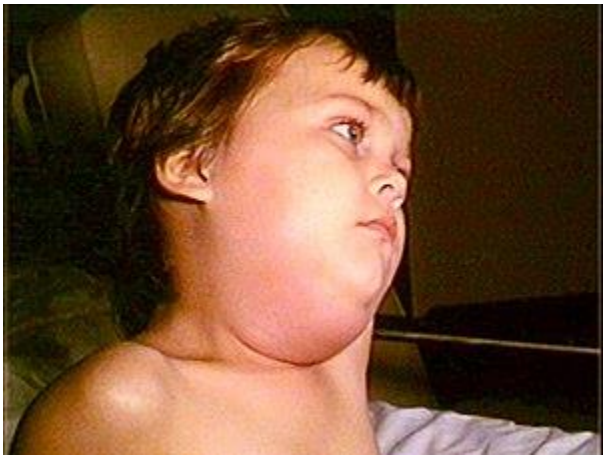


is caused by measles virus, an infection of the respiratory system. Symptoms include fever, cough, runny nose, red eyes and a generalized, maculopapular, erythematous rash. The virus is highly contagious and is spread by coughing and sneezing via close personal contact or direct contact with secretions.

Complication: Encephalitis- Pneumonia

Prevention: MMR vaccine

Mumps



Mumps is a viral disease caused by the mumps virus.

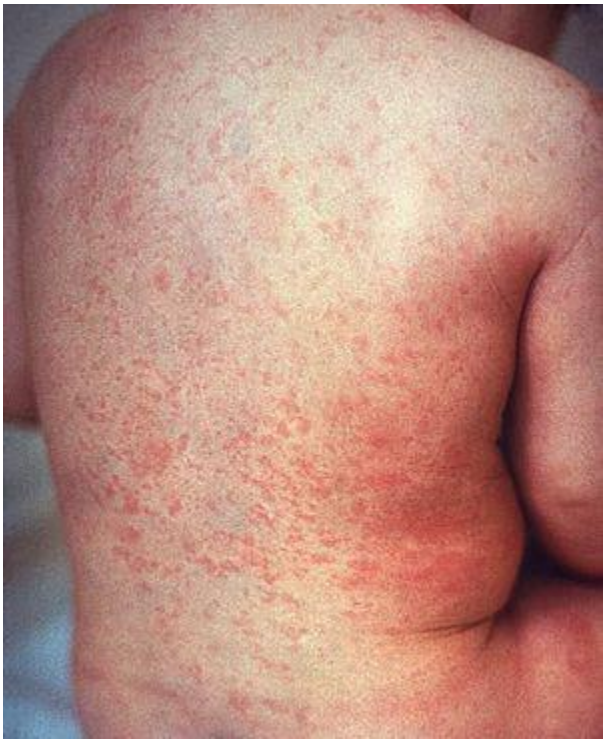
Signs and symptoms include fever, muscle pain, headache, and feeling tired. This is then usually followed by painful swelling of one or both parotid salivary glands. Symptoms typically occur 16 to 18 days after exposure and resolve after seven to ten days. Symptoms in adults are often more severe than in children.About a third of people have mild or no symptoms.

Complications include meningitis, pancreatitis , permanent deafness, and testicular inflammation which uncommonly results in infertility. Women may develop ovarian swelling but this does not increase the risk of infertility.

Mumps is highly contagious and spreads rapidly among people living in close quarters. The virus is transmitted by respiratory droplets or direct contact with an infected person. Only humans get and spread the disease. People are infectious to each other from about seven days before the start of symptoms to about eight days after. Once an infection has run its course, a person is typically immune for life Reinfection is possible but the ensuing infection tends to be mild.

Prevention: MMR vaccine

German measles



Rubella, also known as **German measles** or **three-day measles**, is an infection caused by the rubella virus. This disease is often mild with half of people not realizing that they are sick A rash may start around two weeks after exposure and last for three days. It usually starts on the face and spreads to the rest of the body. The rash is not as bright as that of measles and is sometimes itchy. Swollen lymph nodes are common and may last a few weeks. A fever, sore throat, and fatigue may also occur.[1][2] In adults joint pain is common. Complications may include bleeding problems, testicular swelling, and inflammation of nerves. Infection during early pregnancy may result in a child born with congenital rubella syndrome (CRS) or miscarriage. Symptoms of CRS include problems with the eyes such as cataracts, ears such as deafness, heart, and brain. Problems are rare after the 20th week of pregnancy.

Rubella is usually spread through the air via coughs of people who are infected. People are infectious during the week before and after the appearance of the rash. Babies with CRS may spread the virus for more than a year.

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