Module: Infection & Immunity
Semester: 5
Session: 4
Lecture Duration: 2h.

Lecture Title: Hospital Acquired Infection

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

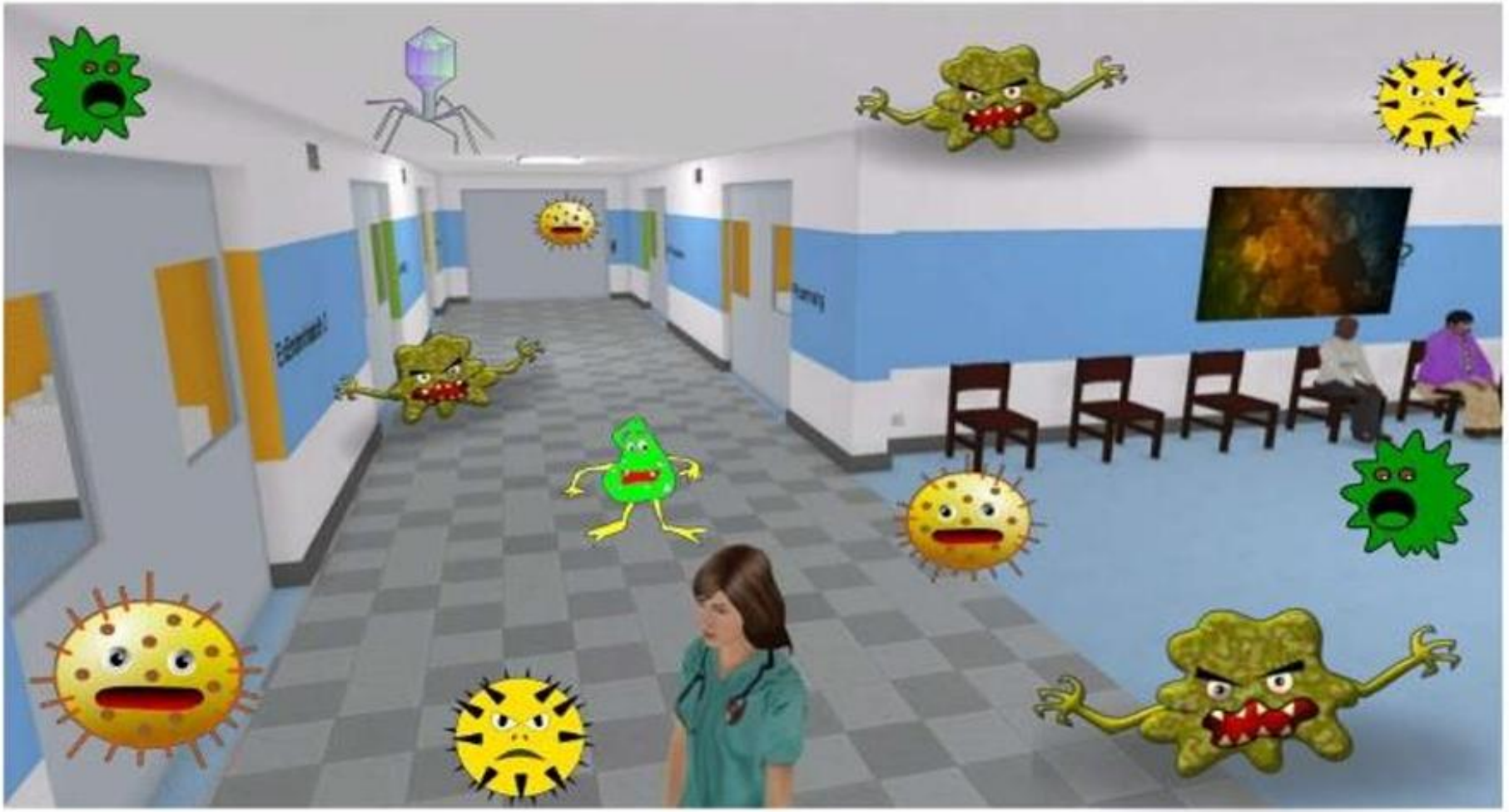
For more detailed instructions, any question, or you have a case you need help in, please post to the group of session

Learning Objectives (LO)

1. Apply an infection model to a patient presented with a hospital infection
2. To further expand the description of pathogen/person/practice/ Place as it applies to hospital acquired infection
3. Understand the hospital acquired infection
4. Describe the principle of antibiotic resistance
5. Describe principles relating to infection control in a hospital setting
6. Describe the use of personal protective equipment's with regard to infections in hospital setting
7. To appreciate and describe some of global concerns relating to hospital infection

Nosocomial Infections

LO-1



- Kalpesh Zunjarrao

History: Ignaz Semmelweis and childbed fever

LO-1

Childbed Fever at the Vienna General Hospital

	Division I (Teaching Unit)			Division II (Midwife Unit)		
Year	Births	Maternal Deaths	Percentage	Births	Maternal Deaths	Percentage
1846[a]	4010	459	11.4	3754	105	2.7
1848[b]	3556	45	1.3	3219	43	1.3

[a] No handwashing.

[b] First full year of chlorine handwashing.

Sources of nosocomial infections

LO-1

- Endogenous (self-infection), the infecting organism being derived from the patient's own skin, gastrointestinal or upper respiratory flora.
- Exogenous source may be another person in the hospital (cross-infection) or a contaminated item of equipment or building service (environmental infection).

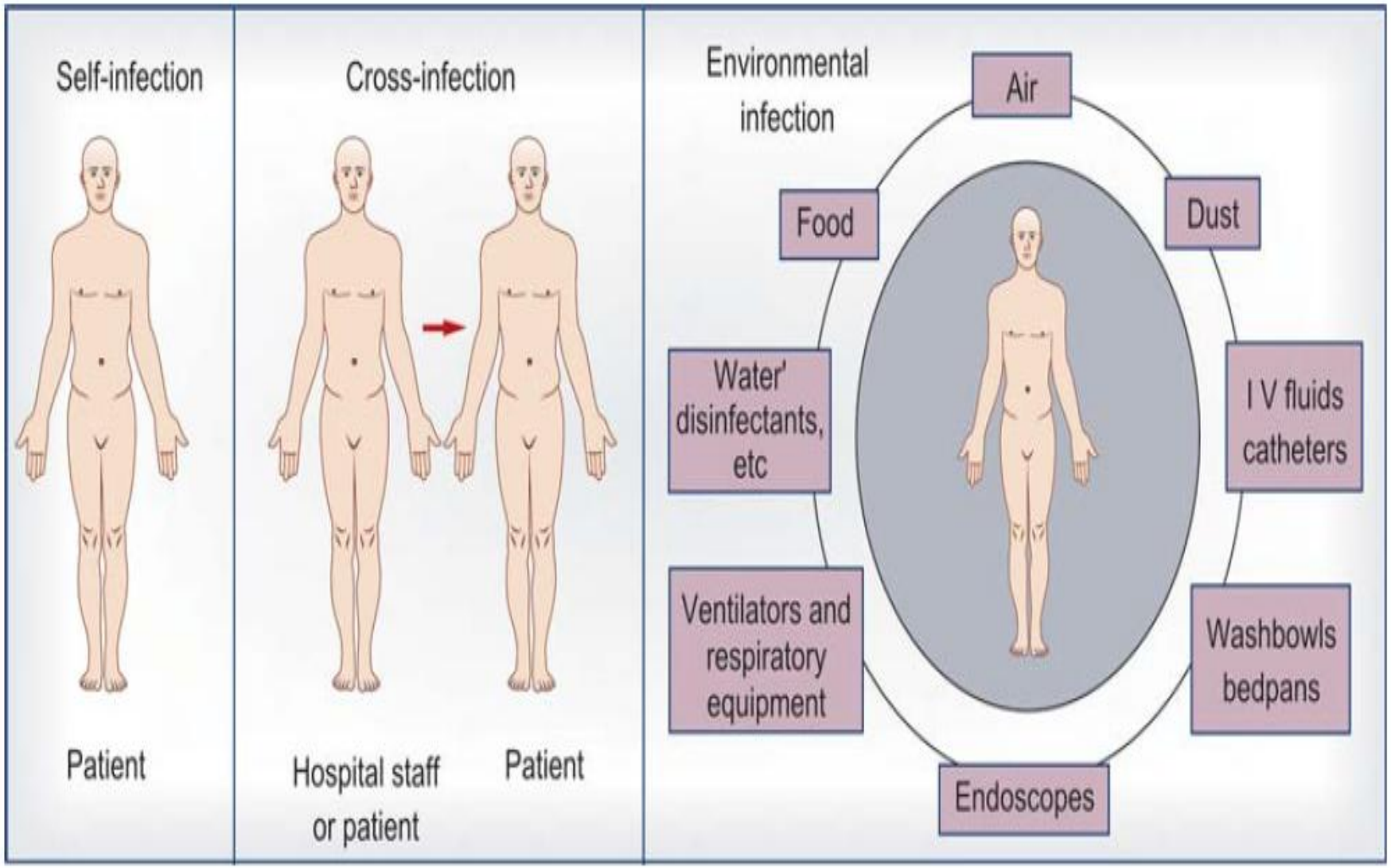
Route of transmission

LO-1

1. Airborne transmission
2. Contact spread (direct or indirect contact)
3. Food-borne spread
4. Blood-borne spread (HIV, hepatitis B and C)
5. Self-infection
6. Insect and rodent act as carriers of microbes

Acquisition of hospital infections

LO-1



Hospital infection: source and spread

LO-1

Route	Source	Examples of disease
1. Aerial (from persons)	Mouth	Measles, tuberculosis, pneumonia
Droplets	Nose	Staphylococcal sepsis
Skin scales	Skin exudate, infected lesion	Staphylococcal and streptococcal sepsis
2. Aerial (from inanimate sources)	Respiratory equipment	Gram-negative respiratory infection
Particles	Air-conditioning plant	Legionnaires' disease, fungal infections
3. Contact (from persons)		
Direct spread	Respiratory secretions	Staphylococcal and streptococcal sepsis
Indirect via equipment	Faeces, urine, skin and wound exudate	Enterobacterial and viral diarrhoea, Pseudomonas aeruginosa sepsis
4. Contact (environmental source)	Equipment, food, medicaments, fluids	Enterobacterial sepsis (Klebsiella/Serratia/ Enterobacter spp.) Ps. aeruginosa and other pseudomonads
5. Inoculation	Sharp injury, blood products	Hepatitis B, HIV, malaria

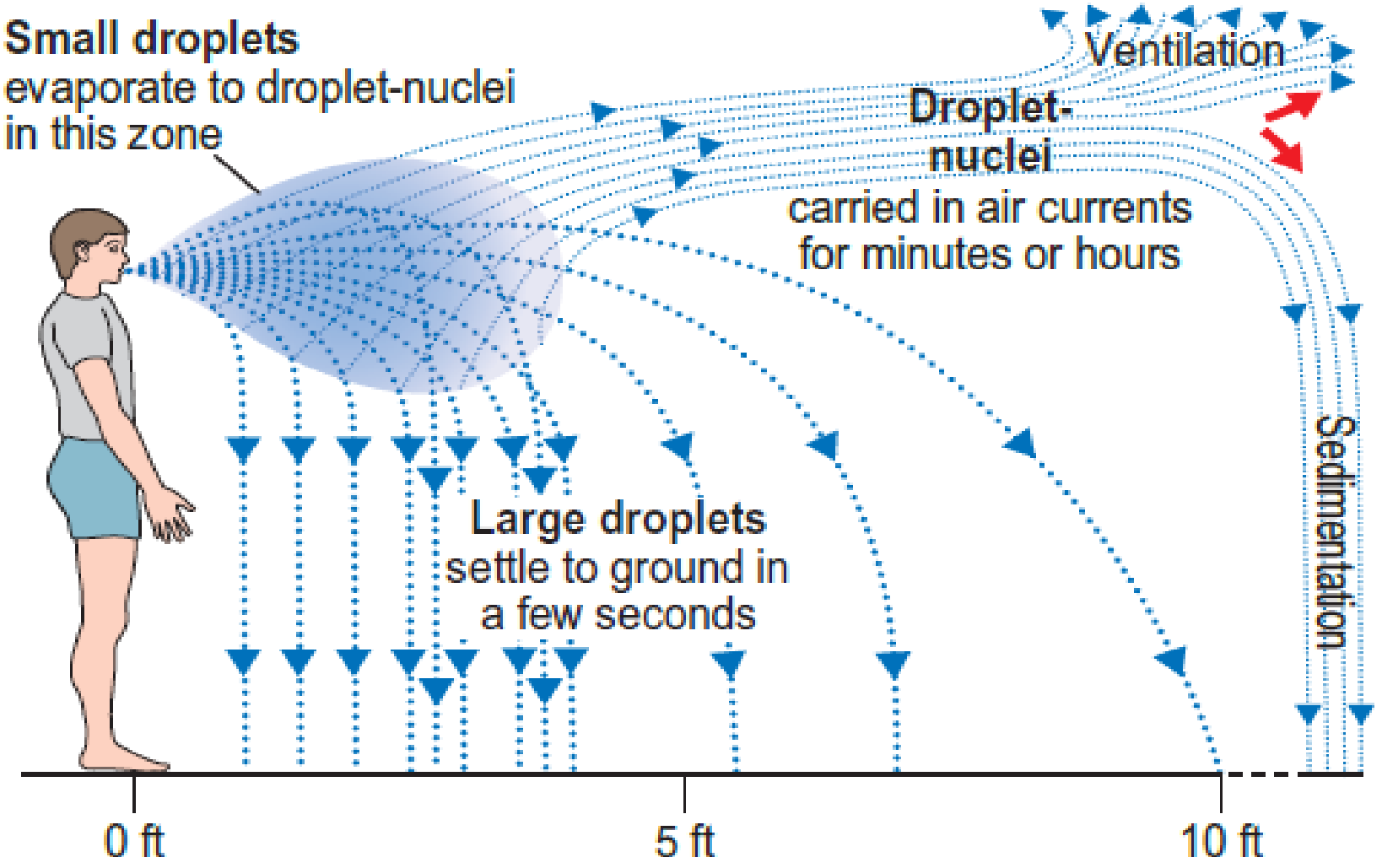
Airborne transmission

LO-2

- Infectious agents may be dispersed as small particles or droplets over long distances.
- Droplets travelling 1–2 metres
- Smaller droplet nuclei travelling a kilometre or more

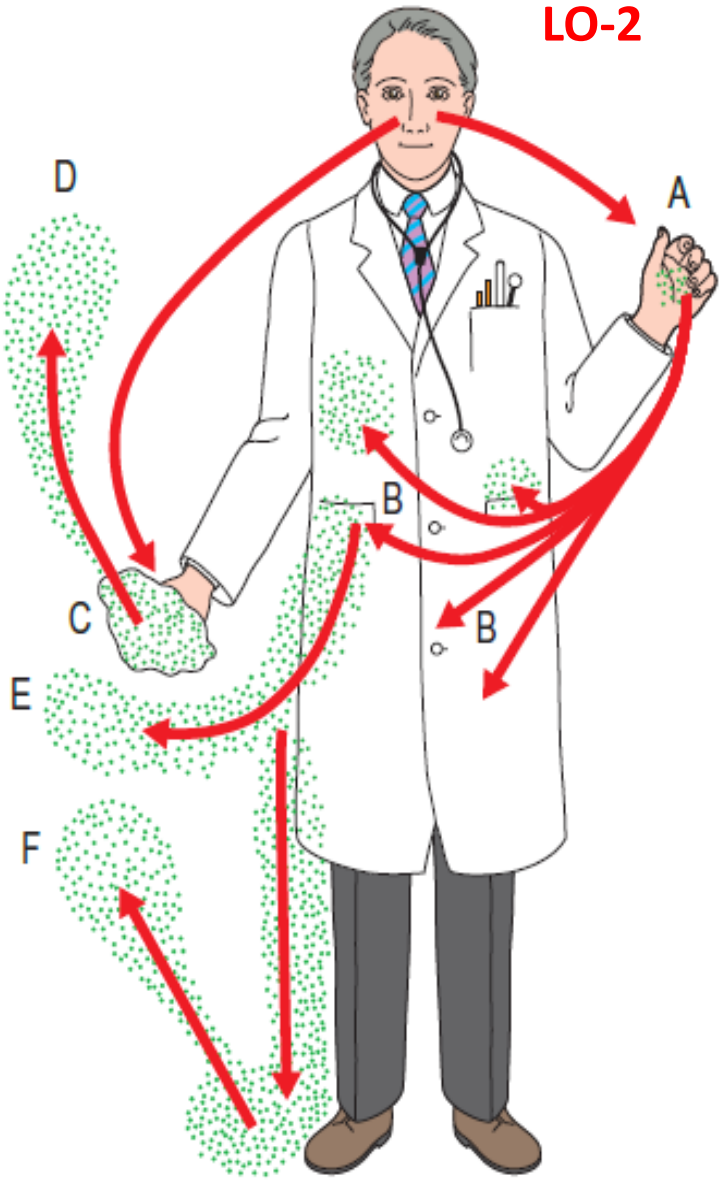
Airborne transmission

LO-2



Infection of the air with dust particles derived from nasal and oral secretions contaminating hands, handkerchief, clothing and surrounding surfaces

LO-2



(A)hand soiled with secretions from lips or nose-picking
(B)clothing contaminated by hand
(C)soiled handkerchief
(D)infected dust from handkerchief
(E)dust from clothing
(F)infected dust raised after settling on floor

High risk patients of the infection acquired in the hospital LO-3

High-risk patients have impaired host defences:

1. **age: the very young and the elderly**
2. **antibody defects: lack of vaccination or previous exposure (chickenpox, CMV, hepatitis B)**
3. **disease causing immune defects: e.g., HIV, diabetes, hepatic or renal impairment, cancer**
4. **drugs causing immune defects: e.g., cytotoxics, steroids or immunosuppressives (e.g., transplant patients)**
5. **defective organs: e.g., pre-existing urinary, lung or skin disease**
6. **defective skin or tissues: trauma, burn, surgery**

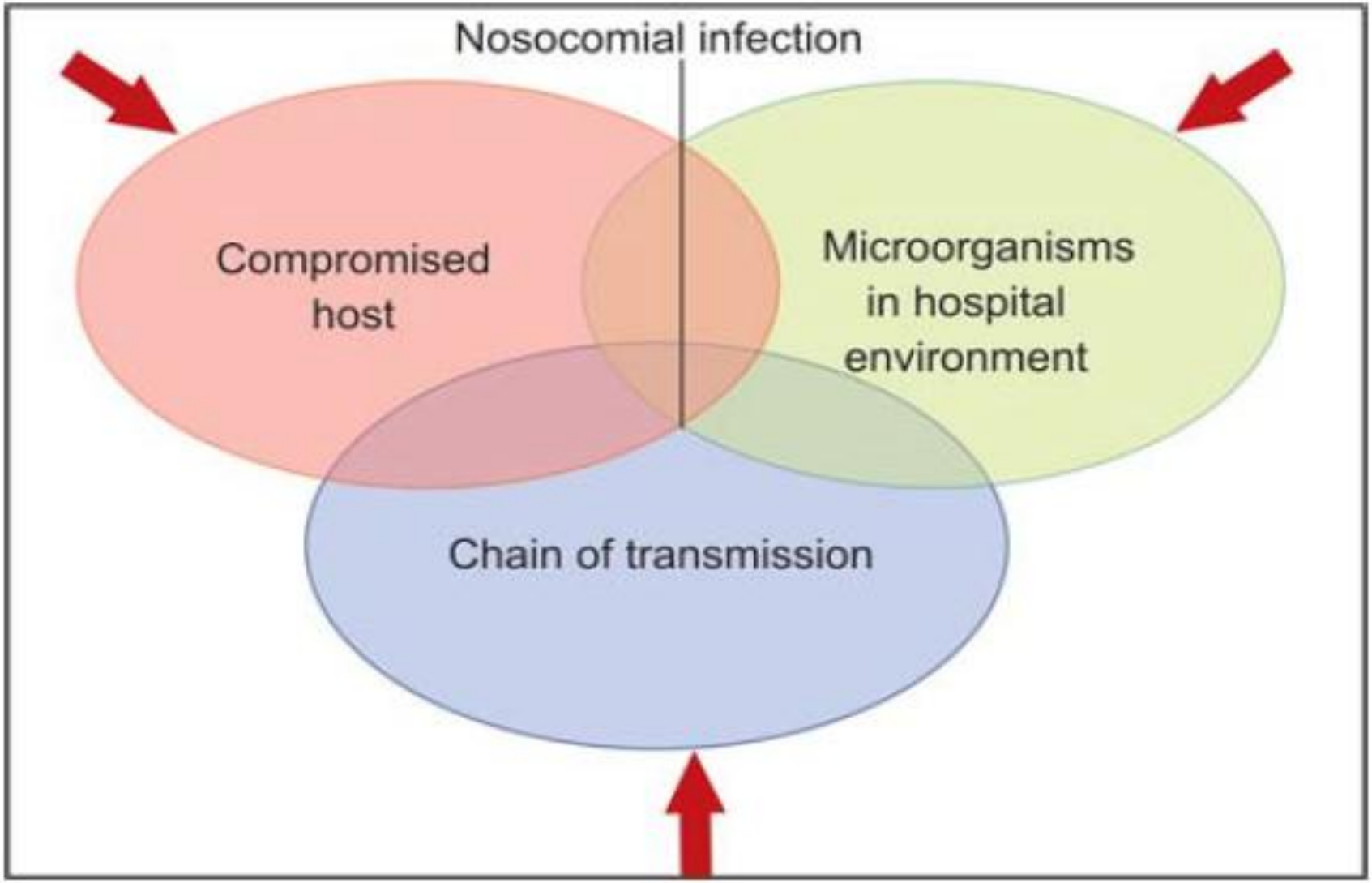
Predisposing factors for nosocomial infections

LO-3

- Hospital environment heavily laden with a variety of pathogens. Organisms present in air, dust, antiseptic lotion, water and food or may spread from sheddings from the patients.
- Hospital microbial flora is usually multi-drug resistant. Patients have impaired defence mechanism due to: Disease therapy and investigations in the hospital.
- Instrumentation in hospitals may introduce infection.
- Blood, blood products and intravenous fluids may transmit many infections.
- Accidental inoculation of infectious material

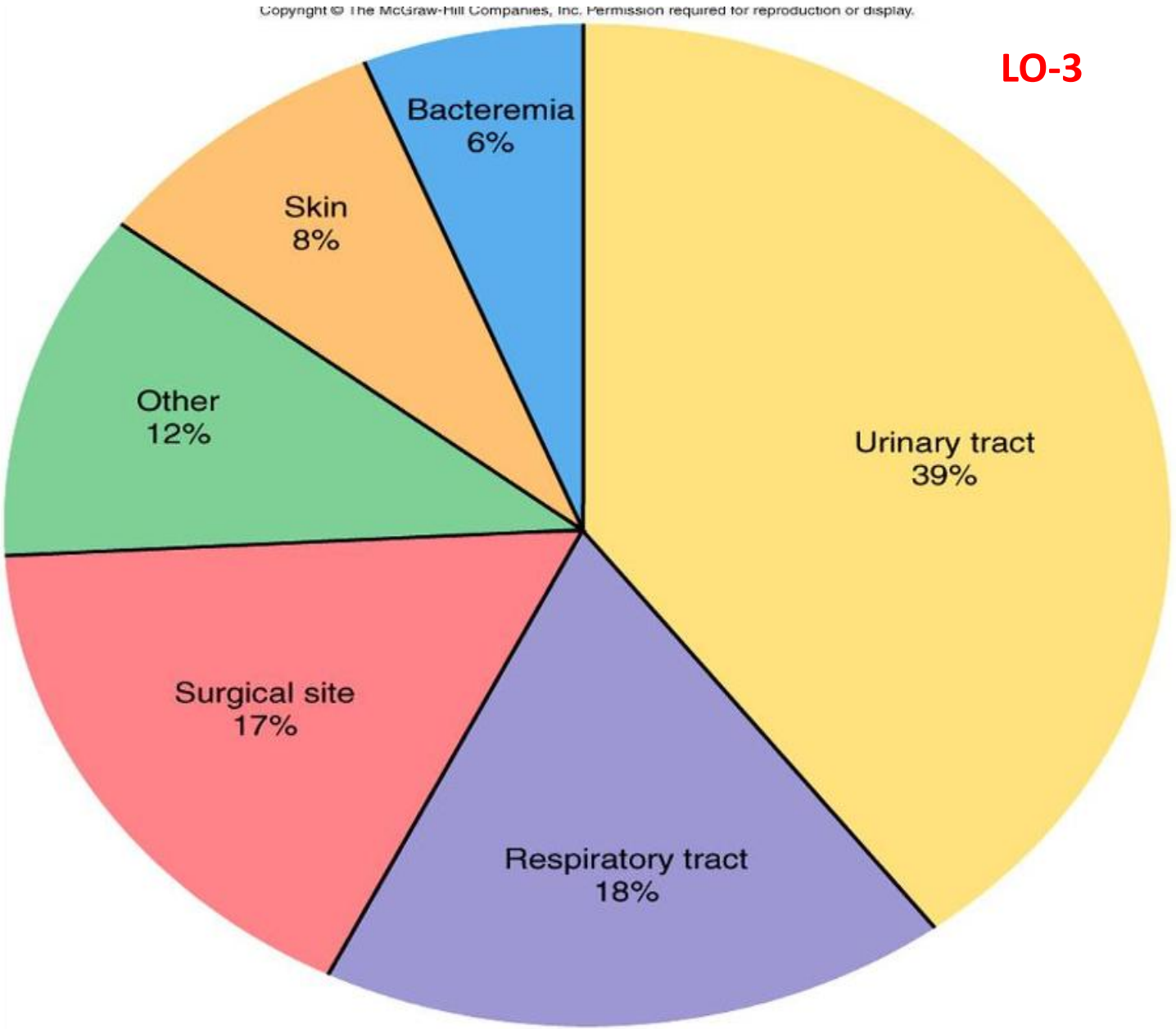
Interplay of factor for nosocomial infections

LO-3



Types of nosocomial infection

LO-3



LO-3

Type of infection and the causative agent of nosocomial infection

Type of infection	Micro-organisms responsible
Urinary tract infections	*Escherichia coli* *Klebsiella, Serratia, Proteus* spp. *Pseudomonas aeruginosa* *Enterococcus* spp. *Candida albicans*
Respiratory infections	*Haemophilus influenzae* *Streptococcus pneumoniae* *Staphylococcus aureus* Enterobacteriaceae Respiratory viruses (influenza, respiratory synctial) Fungi (*Candida* spp., *Aspergilli*)
Wounds and skin sepsis	*Staph. aureus* *Str. pyogenes* *Esch. coli* Proteus spp. Anaerobes Enterococcus spp. Coagulase-negative staphylococci
Gastro-intestinal infections	*Salmonella* serotypes *Clostridium difficile* Viruses (norovirus, rotavirus)

Urinary tract infections

LO-3

- Predisposing factors are catheters, surgery or obstruction
- Route of infection is usually ascending, with the usual uropathogens.
- Symptoms and signs are often only cloudy offensive urine: fever is often absent or minimal, and dysuria.

Lower respiratory infections

LO-3

- Predisposing factors are pulmonary disease or trauma, and mechanical ventilation.
- The route of infection is by inhalation.
- Symptoms and signs vary. Fever and dyspnoea are common, increasing difficulty in oxygenation.

Bacteraemias

LO-3

- Predisposing factors are intravascular devices and infection elsewhere, causing bacteraemia or fungaemia.
- Route of infection is direct contact from imperfect aseptic technique, or blood-borne from infection elsewhere.
- Symptoms and signs are fever, then septicaemia.

Surgical site infections

LO-3

- Redness, swelling, local pain and heat occur around the wound, progressing to purulent discharge (superficial infections) or deep abscesses

LO-3

Skin disease:

necrotising fasciitis after hip surgery

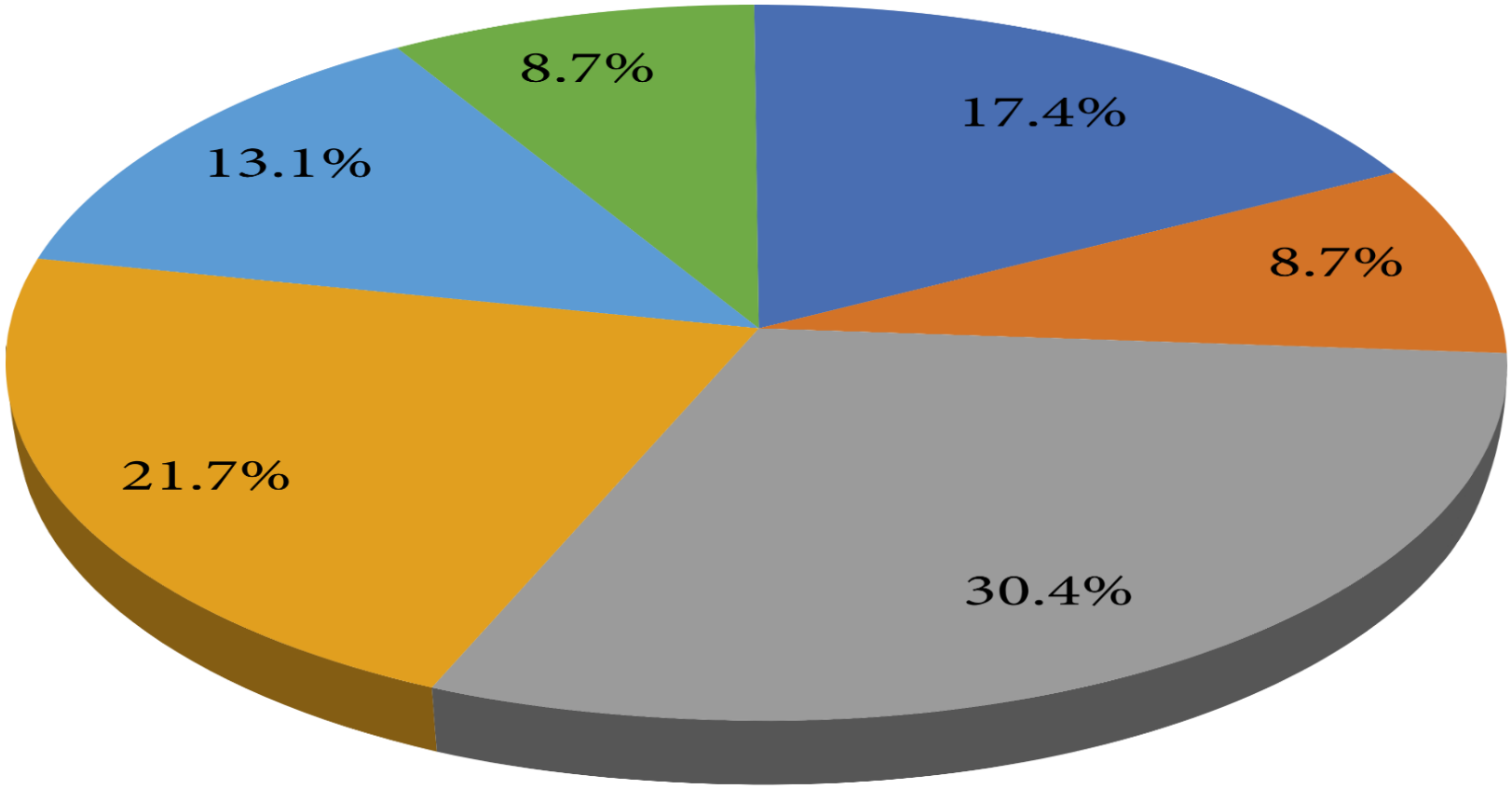
Antibiotic resistance

LO-4

- Antibiotic resistance quickly spreads worldwide and causes a critical threat to public health
- The predominant bacteria include Methicillin-resistant *Staphylococcus aureus* (MRSA*), Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, *Escherichia coli*, and *Streptococcus pneumoniae*.
- In these bacteria, resistance emerged from antibiotic resistant genes and many of those can be exchanged between bacteria.

Multidrug resistant bacteria isolated from nosocomial infection-suspected patients

LO-4



Bacteria can develop resistance to antibiotics through several mechanisms: LO-4

1- Genetic Mutation: Random mutations in bacterial DNA can lead to changes that make the bacteria less susceptible to the effects of antibiotics. For example, a mutation might alter the target site of the antibiotic, reducing its binding ability.

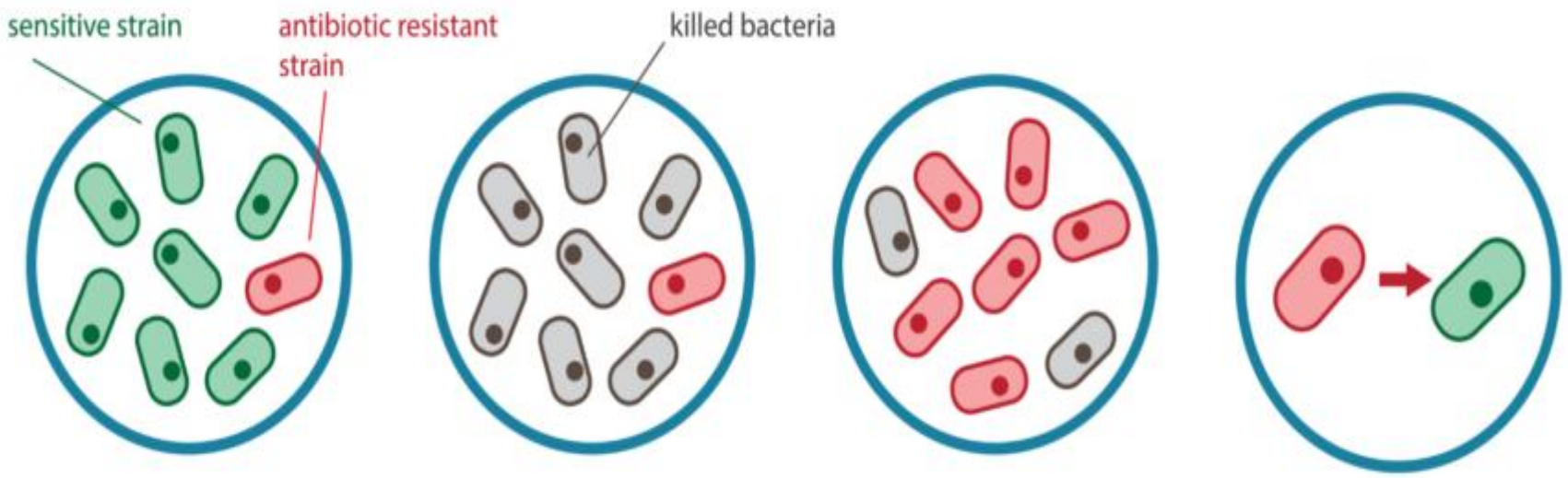
2- Horizontal Gene Transfer: Bacteria can acquire resistance genes from other bacteria through processes such as:

- **Transformation:** Uptake of free DNA from the environment.
- **Transduction:** Transfer of DNA between bacteria via bacteriophages (viruses that infect bacteria).
- **Conjugation:** Transfer of genetic material through direct contact, often involving plasmids that carry resistance genes.

LO-4

Drug resistant bacteria

How does it happen?



When there are high number of bacteria, some of them have mutated and become antibiotic resistant strain

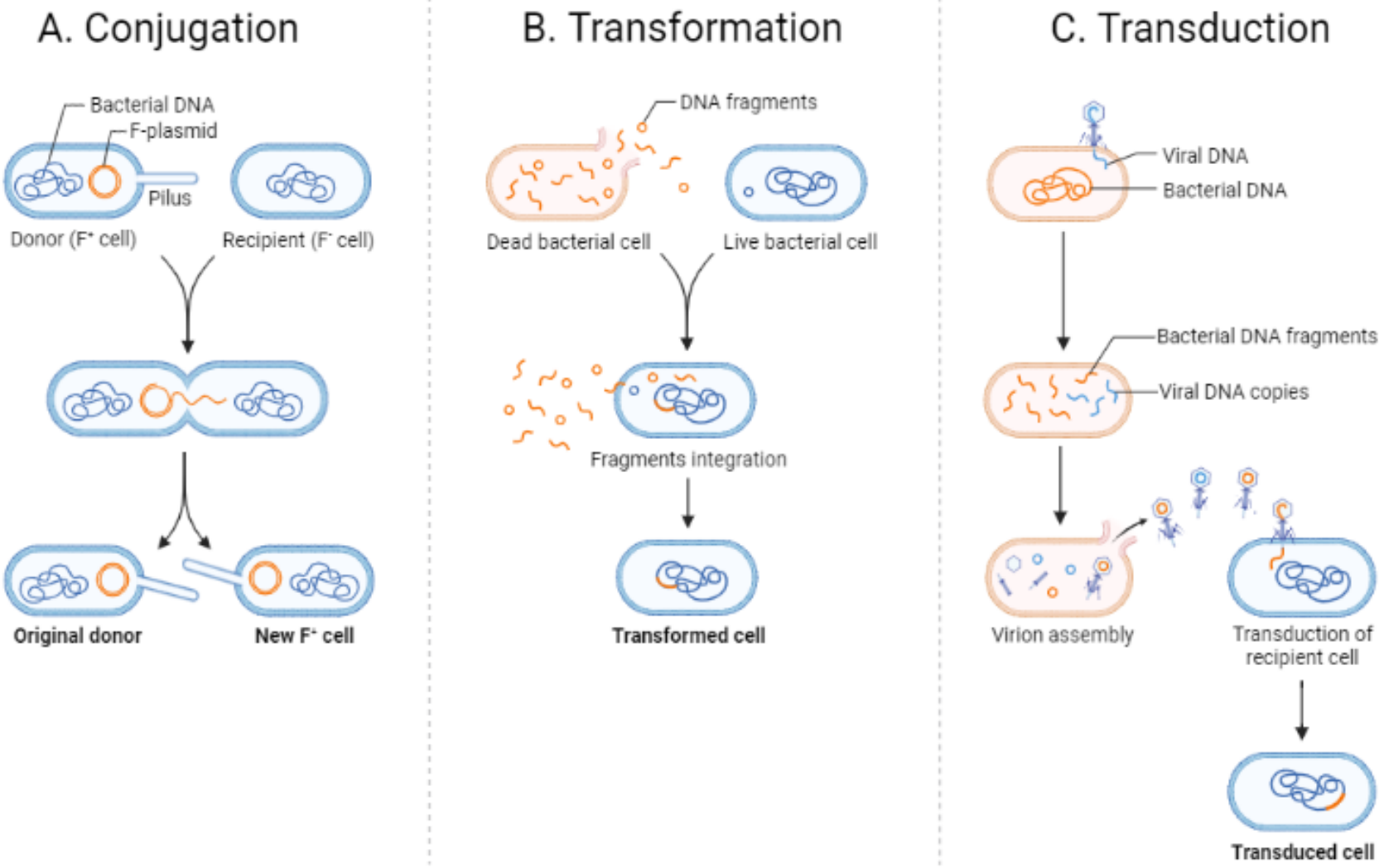
When antibiotic is added, the sensitive strains are killed. However, no effect against antibiotic resistant strain

Now, the antibiotic resistant strain can grow and multiply

Moreover, they can transfer drug-resistance to other bacteria and forming a group of antibiotic resistant bacteria

Gene transfer

LO-4



LO-4

Global burden of antibiotic resistance

- Prolonged illnesses and higher mortality rates
- Creates the possibility of returning to a preantibiotic era
- Increased health care costs
- Reduces the successes of organ transplantation, cancer treatments, surgery etc.

Precautions for Prevention of Nosocomial Infections

LO-6

	Elements					
Precaution	Room	Handwashing[a]	Gloves	Gowns	Mask[b]	Typical Diseases
Standard		After removing gloves, between patients	Blood, fluid contact	Blood, fluid contact		All
Transmission-based						
Airborne	Private, negative pressure[c]	After removing gloves, between patients	Room entry	Room entry	Room entry or respirator[d]	Measles, chickenpox, tuberculosis[d]
Droplet	Private[e]	After removing gloves, between patients	Blood, fluid contact	Blood, fluid contact	Within 3 feet of patient	Meningococcal meningitis, pertussis, plague, group A streptococcus, adenovirus, influenza, rubella
Contact	Private[e]	After removing gloves, between patients	Room entry	Patient contact		Infectious diarrhea,[f] impetigo, *S. aureus* wounds, herpes, respiratory syncytial virus, parainfluenza virus, scabies

[a] Using a disinfectant soap.

[b] Standard surgical mask.

[c] Room pressure must be negative in relation to surrounding area and the circulation exhausted outside the building.

[d] For patients with diagnosed or suspect tuberculosis, a specially filtered respirator/mask must be worn.

[e] Door may be left open and patients with the same organism may share a room.

[f] Particularly *Clostridium difficile*, *Escherichia coli* O:157, *Shigella* and incontinent patient shedding rotavirus or hepatitis A.

Asepsis of operating room

LO-5

- The procedure begins with the use of an antiseptic scrub of the skin over the operative site and the hands and forearms of all who will have contact with the patient.
- The use of sterile drapes, gowns, and instruments serves to prevent spread through direct contact, and caps and face masks reduce airborne spread from personnel to the wound.

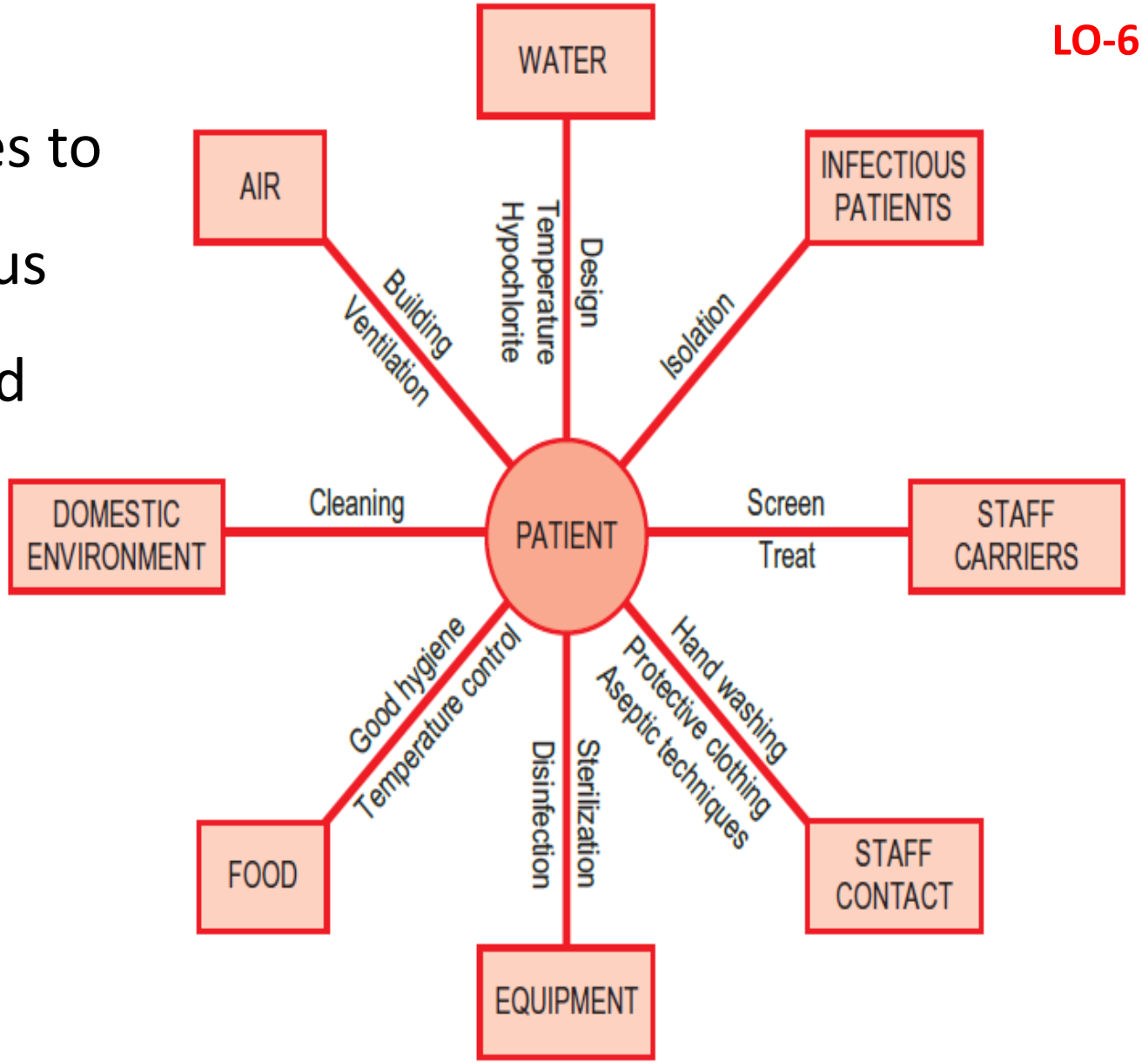
Asepsis of hospital ward

LO-5

- Asepsis is practiced by the use of sterile needles, medications, dressings, and other items that could serve as transmission vehicles if contaminated.
- Invasive procedures such as catheter insertion and lumbar punctures are performed under aseptic precautions similar to those used in the operating room.

LO-6

Control measures to reduce exogenous hospital-acquired infection.



LO-6

Physical barriers:

Masks, gloves and aprons

LO-6

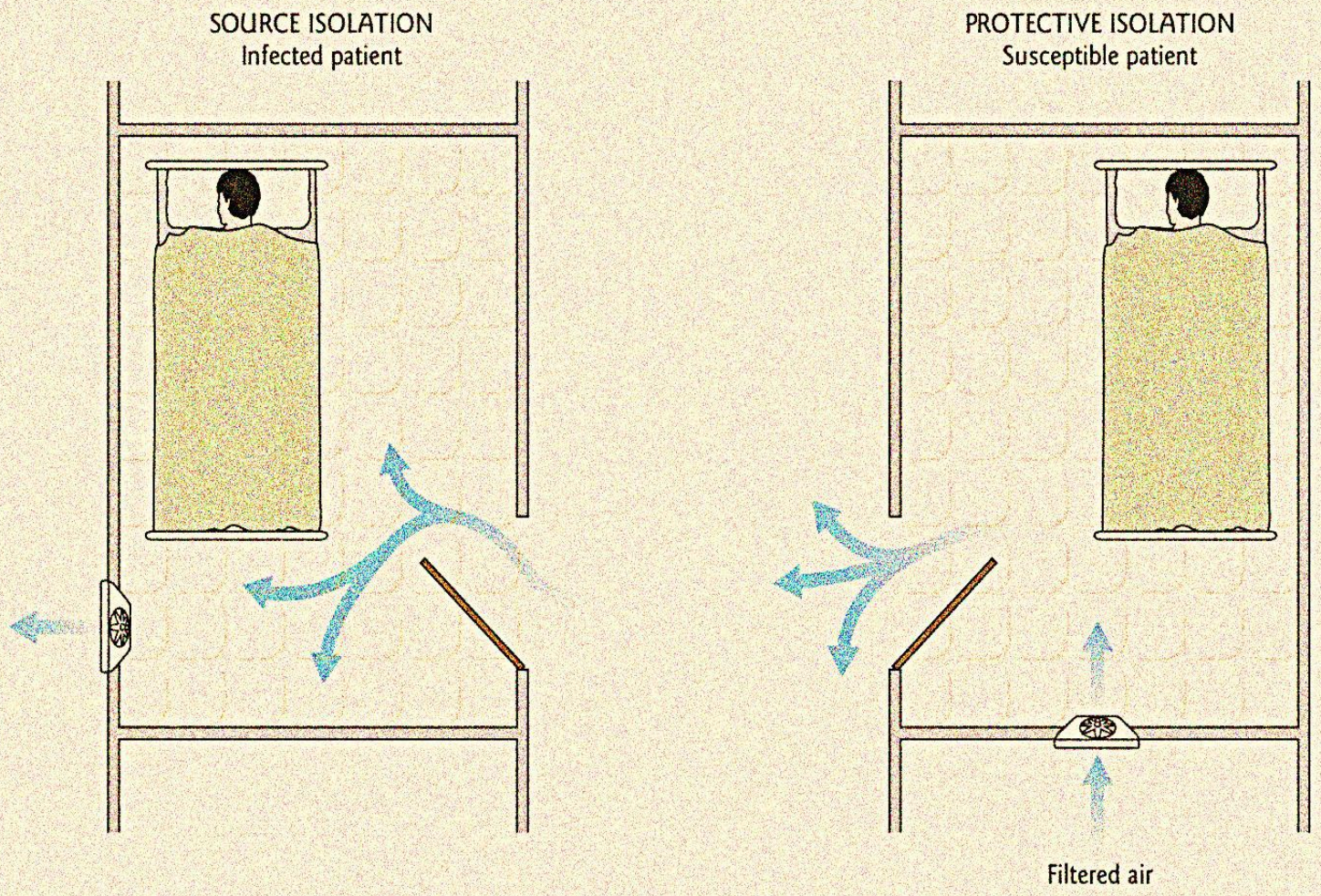


Figure 14.15 Isolation of patients. The Department of Microbiology, UCLH, London is gratefully acknowledged for use of this image

Six stage handwashing technique

LO-6

1. Palm to palm

2. Backs of hands

3. Interdigital spaces

4. Fingertips

5. Thumbs and wrists

6. Nails

LO-6

Disinfection	Sterilization
Minimize the number of microorganisms but not eliminate them completely.	Eliminates all microorganisms
Does not eliminate bacteria spores	Eliminate bacterial spores
Used for decontamination of air and surfaces	Used for decontamination for food, surgical instruments and medicines
Commonly used in daily life	In certain situation when sterilization is requested like in surgical theaters & laboratories
It does not need a strict guide line to be followed	Need a strict protocol to be followed to completely kill microorganisms
Example: alcohol, phenolic disinfectants & hydrogen peroxide	Examples: Heat, chemicals(povidone iodine), radiation & filtration

LO-7

Global concerns of Nosocomial Infections

- Nosocomial infections occur worldwide and affect both developed and developing countries.
- The prevalence of nosocomial infections of around 5-10%
- Nosocomial infections are among the major causes of death among hospitalized patients.
- Nosocomial infections are a significant burden both for the patient and for public health.

“ We always work together as a team ”