

# INTRODUCTION TO BIORISK MANAGEMENT

## BIOLOGICAL AGENTS

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# INTRODUCTION

Biological agents include viruses, bacteria, fungi, yeasts, parasites, toxins and genetically modified organisms (GMOs) which have the potential to cause harm in healthy human or animal subjects. A thorough understanding of the biological agent forms the cornerstone of good biorisk management. Concepts such as routes of transmission and the portal of entry must be clearly understood in order to develop a strategy for the mitigation of risks posed by biological agents in your respective laboratory environments.

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# LEARNING OBJECTIVES

The objectives of this lecture are to:

1. Introduce you to the term "**biological agent**".
  2. Describe the **categories** of biological agents.
  3. Explain the **classification** of biological agents into "**risk groups**".
  4. Elaborate upon specific **epidemiological terms** used to describe biological agents.
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# LEARNING OUTCOMES

Upon completion of this module you should be able to:

1. **Describe** the various biological agents.
  2. **Classify** biological agents into risk groups.
  3. Apply specific **regional criteria** for the classification of biological agents.
  4. Describe specific **epidemiological terms** associated with biological agents and their transmission.
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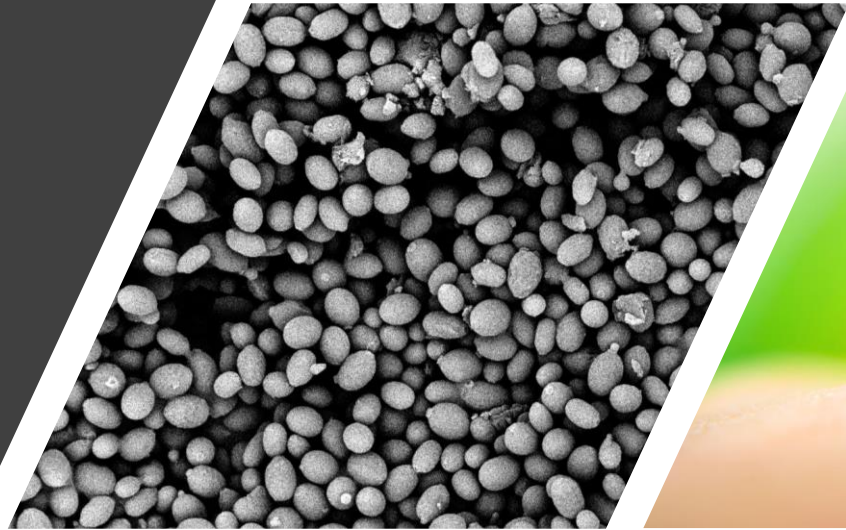
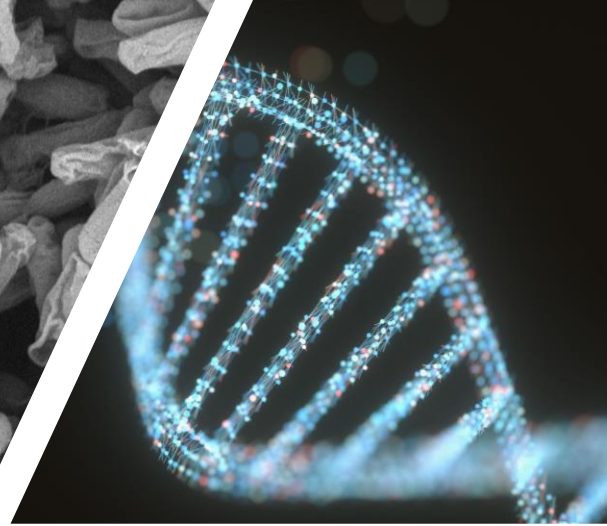
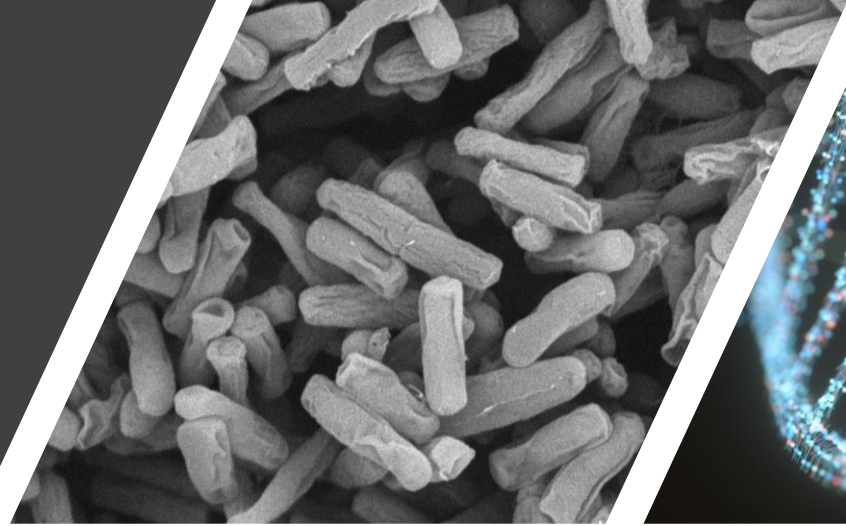
# BIOLOGICAL AGENTS

Any microorganism including those which may have been genetically modified, cell cultures and endoparasites, which may be able to provoke any infection, allergy or toxicity in humans, animals or plants.

**(adapted from EU Directive 2000/54/EC)**

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# BIOLOGICAL AGENTS





# VIRUSES

- Viruses are **infectious agents** with a core that is composed of nucleic acids (RNA /DNA) that is encapsulated in a protein coat.
  - The **Baltimore** scheme classifies viruses based on their nucleic acid and their mode of replication.
  - The ability of viruses to **mutate** within the host is a cause for concern.
  - **Zoonotic** viruses can be transmitted from animals to human hosts.
  - Viruses can be transmitted via multiple routes including **aerosols**.
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# VIRUSES OF CONCERN

- Avian influenza A H5 viruses.
  - Ebola virus.
  - Corona viruses.
  - Human Immunodeficiency Virus.
  - Dengue Virus
  - West Nile Virus
  - Rabies Virus
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# BACTERIA

1. Bacteria: commensal and symbiotic bacteria.
  2. Pathogenic bacteria harbour specific genes encoding toxins which can be harmful to human subjects.
  3. Multi drug resistant bacteria have emerged as a result of the extensive use of antibiotic and other anti-microbial drugs
  4. Nosocomial infections (Hospital Acquired Infections).
  5. Spore forming bacteria.
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# BACTERIAL PATHOGENS

- *Mycobacterium tuberculosis*
  - *Escherichia coli* (O157:H7)
  - *Vibrio cholerae*
  - *Helicobacter pylori*
  - *Pseudomonas aeruginosa*
  - *Salmonella typhi*
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# FUNGI

1. **Aspergillosis:** the fungus *Aspergillus* and can cause infection in immunocompromised individuals.
  2. **Histoplasmosis** is an infection caused by a fungus *Histoplasma* which is present in bird and bat droppings.
  3. ***Cryptococcus neoformans*** is a fungus that infects patients with weakened immune systems cause by HIV/AIDS.
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# FUNGI & YEAST

1. Candidiasis is a fungal infection caused by a yeast called *Candida*.
  2. ***Candida auris*** is an emerging fungus that presents a serious global health threat as it is **multi-drug resistant**, difficult to identify using standard microbiological assays and has caused outbreaks in healthcare settings.
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# OTHER BIOLOGICAL AGENTS

1. **Parasites** are of special concern in biosafety facilities conducting research involving live animals.
  2. **Biotoxins** are poisons that are of plants or animal origin. These include ricin, saxitoxin, colchicine and abrin.
  3. **Prion diseases** or transmissible spongiform encephalopathies (TSEs) are a family of rare progressive neurodegenerative disorders that affect both humans and animals
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# GENETICALLY MODIFIED ORGANISMS

- Living organisms which have been **genetically modified** by the introduction of novel genes.
  - Lack of precedent: risk assessment is complicated as the organism may harbour genes and express specific biochemical pathways which may not have reported earlier.
  - **Gain of Function (GoF)** experiments are of special concern.
  - **Dual Use Research of Concern (DURC)**.
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A close-up photograph of a glass pipette dispensing a yellow liquid into a white multi-well plate. The pipette is positioned at the top right, and the liquid is being dropped into one of the wells. The plate has several wells, some of which are numbered '2' and '5'. The background is blurred, showing more of the plate and the pipette's handle.

# RISK GROUPS

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World Health Organization  
Classification



# RISK GROUP 1



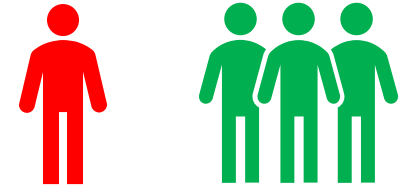
- **Low** individual risk.
  - **Low** community risk.
  - A microorganism that is **unlikely** to cause human or animal disease.
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# RISK GROUP 2



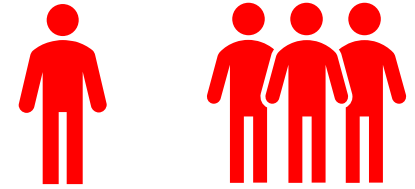
- **Moderate** individual risk.
  - **Low** community risk.
  - Pathogen that can cause human or animal disease but is **unlikely to be a serious** hazard to laboratory workers, the community, livestock or the environment.
  - Laboratory exposures may cause severe infection.
  - **Effective treatment** and preventive measures are available.
  - **Risk** of spread of infection is **limited**.
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# RISK GROUP 3



- **High** individual risk.
  - **Low** community risk.
  - A pathogen that usually causes serious human or animal disease but **does not ordinarily spread** from one infected individual to another.
  - **Effective treatment** and preventive measures are available.
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# RISK GROUP 4



- **High** individual risk.
  - **High** community risk.
  - A pathogen that usually causes **serious** human or animal disease and that can be **readily transmitted** from one individual to another, directly or indirectly.
  - **Effective treatment** and preventive measures are not usually available.
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# REGIONAL FACTORS



1. **Pathogenicity** of the organism: variants.
  2. **Mode of transmission** and host range of the organism: local immunity, density, mobility, **vectors**, environmental factors.
  3. Local availability of effective **preventive** measures.
  4. Local availability of effective **treatment**.
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An aerial, high-angle photograph of a large, dense crowd of people walking on a cobblestone street. The crowd is diverse in age and appearance, and many individuals are looking down at their mobile devices. The lighting is bright, suggesting daytime. The overall scene conveys a sense of a busy public space or a large gathering.


# ROUTES OF TRANSMISSION

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# ROUTES OF TRANSMISSION

1. **Direct contact:** tissue or fluids from infected individuals.
  2. **Fomites:** inanimate objects contaminated by an infected individual.
  3. **Aerosols:** transfer of pathogens via very small particles or droplet nuclei.
  4. **Oral:** ingestion of pathogenic organisms.
  5. **Vector-borne:** living organisms that can transfer pathogens.
  6. **Zoonotic:** pathogens which are transmitted from animals to human hosts.
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# PORTAL OF ENTRY

1. The portal of entry refers to the **manner in which a pathogen enters** a susceptible host.
  2. **Respiratory:** influenza virus.
  3. **Faecal-oral route:** *Escherichia coli*.
  4. **Ocular conjunctival route:** SARS.
  5. Cutaneous: skin.
  6. Percutaneous: below the skin.
  7. Mucous membranes.
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# SUMMARY

A thick yellow horizontal bar spans the width of the slide, with a vertical yellow bar extending downwards from its right end.

This module has introduced you to the following concepts and terminology which will be pertinent to your role in a biosafety laboratory.

- Biological agents.
- Risk Groups.
- Route of transmission.
- Portal of entry



THANK YOU

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