# Lecture 10 – Introduction to Biological and Ergonomic Hazards Student Notes

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## Biological Hazards

Biological hazards, or biohazards, are risks to human health arising from exposure to harmful biological substances such as infectious microorganisms, allergens, and toxins. In the **European Union (EU)**, several systems are in place to identify and manage these hazards effectively. This guide provides a comprehensive overview of these systems, supplemented with real-world examples to enhance understanding.

Biological hazards, often referred to as biohazards, encompass harmful organisms or substances that pose a risk to human health. These hazards include a variety of biological agents such as microorganisms—like bacteria, viruses, and fungi—that can cause infectious diseases, allergic reactions, or other health conditions. In addition to naturally occurring pathogens, genetically modified organisms (GMOs), cell cultures (artificially grown cells in laboratory settings), and human or animal parasites are also categorised as biological hazards.

To effectively identify and manage biological hazards, various systems and frameworks are employed globally. These systems typically assess the nature and severity of the hazard, as well as its potential to cause harm. For instance, biological agents are classified into specific categories based on their risk to human health. This classification often considers factors such as infectivity, transmissibility, and the availability of treatments or vaccines.

Different countries adopt standardised systems for classifying biological hazards to ensure effective regulation and safety management. For example, many nations, following guidelines from the World Health Organization (WHO) or regional directives such as the European Union's Directive 2000/54/EC, group biological agents into risk levels. These categories range from low-risk agents, which pose minimal harm to humans, to high-risk agents, which can cause severe, untreatable diseases.

By systematically identifying and classifying biological hazards, workplaces and laboratories can implement appropriate control measures to protect workers and minimise exposure risks.

# Biological Hazard Exposure Routes

## 1. Inhalation

Inhalation is one of the most common routes through which biological hazards enter the body. Airborne biological agents such as bacteria, viruses, fungal spores, and aerosols can be inhaled into the respiratory system, leading to infections and other health complications.

- **Examples of Hazards**:
    - *Mycobacterium tuberculosis*: Causes tuberculosis, primarily transmitted through respiratory droplets.
    - *Legionella pneumophila*: Found in contaminated water systems like cooling towers or poorly maintained air conditioning, causing Legionnaire's disease.
    - *SARS-CoV-2*: The virus responsible for COVID-19, spread through airborne droplets and aerosols.
- **Health Effects**:
    - Respiratory infections (e.g., pneumonia, bronchitis).
    - Allergic reactions (e.g., hypersensitivity pneumonitis caused by mould spores).
    - Chronic respiratory conditions (e.g., occupational asthma from organic dust).
- **Control Measures**:
    - **Engineering Controls**: Ventilation systems with high-efficiency particulate air (HEPA) filters, and local exhaust ventilation in high-risk areas.
    - **Administrative Controls**: Regular maintenance of water and air systems, training on respiratory risks.
    - **Personal Protective Equipment (PPE)**: Use of masks or respirators (e.g., N95 or FFP2) in high-risk environments.

- **Hygiene Practices**: Ensuring cleanliness and minimising dust or droplets in the workplace.



**2. Ingestion**

Ingestion occurs when biological hazards enter the body through the gastrointestinal tract, typically due to hand-to-mouth contact, contaminated food or water, or accidental swallowing of infectious materials.

- **Examples of Hazards**:
  - *Salmonella spp.* and *Campylobacter*: Bacteria causing food poisoning, often found in undercooked poultry or contaminated food surfaces.
  - *Escherichia coli (E. coli)*: Found in contaminated water or food, leading to severe diarrhoea and gastrointestinal illness.
  - Hepatitis A virus: Transmitted through faecal-oral contamination, often due to poor hygiene practices.
- **Health Effects**:
  - Gastrointestinal infections (e.g., vomiting, diarrhoea, dehydration).
  - Long-term complications like kidney failure (e.g., severe *E. coli* infections).
  - Liver inflammation and dysfunction (e.g., hepatitis A).
- **Control Measures**:
  - **Food Safety**: Ensuring proper food hygiene practices such as adequate cooking and preventing cross-contamination.
  - **Hand Hygiene**: Regular handwashing with soap, particularly before eating or after handling contaminants.
  - **Water Safety**: Providing clean drinking water through filtration and proper treatment methods.
  - **Training**: Educating workers on hygiene and safe food-handling protocols.

### 3. Skin Contact

Biological hazards can enter the body through direct contact with contaminated materials, surfaces, or animals. The skin acts as a barrier, but damaged skin, such as cuts, abrasions, or dermatitis, increases the risk of exposure.

- **Examples of Hazards**:
    - *Brucella spp.*: A bacterial infection affecting farmers and veterinarians handling infected livestock.
    - *Dermatophytes* (fungal infections): Cause conditions like athlete's foot from prolonged skin contact in moist environments.
    - *Staphylococcus aureus*: Found in contaminated equipment, leading to skin infections.
- **Health Effects**:
    - Localised infections (e.g., boils, rashes).
    - Allergic reactions (e.g., contact dermatitis).
    - Systemic infections if pathogens enter the bloodstream.
- **Control Measures**:
    - **Protective Clothing**: Gloves, gowns, and coveralls when handling biological materials or contaminated surfaces.
    - **Personal Hygiene**: Regular handwashing and skin cleaning after exposure.
    - **Work Practices**: Reducing direct skin contact with hazardous materials and ensuring proper disposal of contaminated items.
    - **Barrier Creams**: Use of skin protectants for workers exposed to irritants.

**4. Injection/Penetration**

Injection or penetration occurs when biological agents enter the body through breaks in the skin caused by sharp objects, bites, or accidental punctures. This route is particularly common in healthcare, laboratories, and animal handling environments.

- **Examples of Hazards**:
    - **Needlestick Injuries**: Exposure to bloodborne viruses like HIV, Hepatitis B, and Hepatitis C due to accidental puncture wounds.
    - **Animal Bites or Scratches**: Transmission of rabies, tetanus, or other zoonotic infections.
    - **Sharp Instruments**: Broken glass, contaminated needles, or tools causing skin penetration.
- **Health Effects**:
    - Bloodborne infections leading to long-term illness or fatal outcomes.
    - Systemic infections if untreated (e.g., sepsis).
    - Allergic reactions or complications at the injury site.
- **Control Measures**:
    - **Safe Disposal Systems**: Use of puncture-proof sharps containers to discard needles and sharp objects safely.
    - **PPE**: Puncture-resistant gloves and proper body protection in high-risk tasks.
    - **Workplace Training**: Educating workers on safe handling of sharps and immediate response to injuries.

- **Vaccination**: Providing vaccines (e.g., for Hepatitis B or rabies) to workers at risk.
- **Incident Reporting**: Implementing protocols for documenting and responding to needlestick or penetration injuries.



## ILO - ILC.112/Report IV

### 1. Classification Systems

The EU classifies biological agents into four risk groups based on their potential to cause disease, as outlined in **Directive 2000/54/EC**

EU-OSHA

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- **Risk Group 1**: Agents unlikely to cause human disease.
  - *Example*: **Lactobacillus species**, commonly used in the production of yogurt and other fermented foods, are generally considered safe and beneficial.
- **Risk Group 2**: Agents that can cause human disease but are unlikely to spread to the community; effective prophylaxis or treatment is usually available.
  - *Example*: Certain strains of **Escherichia coli (E. coli)**, which can cause foodborne illnesses, are classified in this group.
- **Risk Group 3**: Agents that can cause severe human disease and present a serious hazard; they may spread to the community, but effective prophylaxis or treatment is available.
  - *Example*: **Mycobacterium tuberculosis**, the bacterium responsible for tuberculosis, poses significant health risks but can be treated with appropriate antibiotics.
- **Risk Group 4**: Agents that cause severe human disease and are a

serious hazard; they are likely to spread to the community, and there is usually no effective prophylaxis or treatment.

- *Example*: **Ebola virus** is highly contagious and often fatal, with limited treatment options.

These classifications guide the implementation of safety measures in laboratories and workplaces to protect workers and the public.

**2. Laboratory Biosafety Levels (BSL)**

Laboratories are designated biosafety levels (BSL 1 to 4) corresponding to the risk groups of the biological agents they handle, with each level specifying containment and safety protocols.



- **BSL-1**: For work with low-risk agents not known to cause disease in healthy adults.
  - *Example*: Handling **Bacillus subtilis**, a non-pathogenic bacterium found in soil, requires standard microbiological practices without special containment.
- **BSL-2**: For work with agents associated with human diseases that pose moderate hazards.
  - *Example*: Laboratories working with **Staphylococcus aureus**, which can cause skin infections, implement access restrictions and use biological safety cabinets.
- **BSL-3**: For work with agents that can cause serious or potentially lethal diseases through inhalation.
  - *Example*: Research involving **Mycobacterium tuberculosis** is conducted in facilities with controlled access and specialised ventilation systems.
- **BSL-4**: For work with high-risk agents that pose a life-threatening risk and for which no treatment is available.
  - *Example*: Handling **Ebola virus** requires maximum containment facilities, including full-body suits and decontamination procedures.

These biosafety levels ensure that appropriate safety measures are in place to prevent exposure to hazardous agents.

### 3. Occupational Exposure Limits (OELs)

OELs define the maximum acceptable concentrations of hazardous substances in workplace air to protect workers' health. While specific OELs for biological agents are less common than for chemicals, certain industries monitor and control exposure to bioaerosols:

- **Waste Management**: Workers in composting facilities may be exposed to airborne **Aspergillus spores**, which can cause respiratory issues. Monitoring air quality and implementing ventilation controls help minimise exposure.
- **Healthcare**: Healthcare workers are at risk of exposure to **tuberculosis**. Implementing isolation rooms with negative pressure and using personal protective equipment (PPE) are standard practices to reduce this risk.



These measures are crucial in maintaining safe working environments across various sectors.

### 4. Hazard Identification Systems

Systematic identification of biological hazards is essential in workplaces to implement effective control measures:

- **Healthcare Settings**: Hospitals utilise infection control programmes to monitor and manage exposure to pathogens like **Methicillin-Resistant Staphylococcus aureus (MRSA)**. Regular screening of patients and staff, along with strict hygiene protocols, help prevent the spread of infections.
- **Food Industry**: Food processing plants conduct hazard analyses to detect potential contamination by organisms such as **Listeria monocytogenes**, which can thrive in refrigerated environments. Implementing Hazard Analysis and Critical Control Points (HACCP) systems ensures food safety.

Proactive hazard identification is key to preventing occupational illnesses and ensuring product safety.

### 5. Pathogen Lists and Databases

Maintaining comprehensive lists of biological agents aids in risk assessment and regulatory compliance:

- **EU Classification**: Annex III of **Directive 2000/54/EC** provides a community classification of biological agents known to infect humans, serving as a reference for employers to assess workplace risks

EUR-Lex.

- **National Databases**: Countries like Germany have developed extensive classifications of biological agents, which are regularly updated to reflect new scientific knowledge

BAuA

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These resources support informed decision-making in occupational health and safety.



**6. Risk Assessment Frameworks**

Conducting thorough risk assessments is fundamental to managing biological hazards:

- **Healthcare**: Assessing the risk of exposure to bloodborne pathogens such as **HIV** during surgical procedures involves evaluating factors like the prevalence of infection and the effectiveness of existing controls. Implementing standard precautions, including the use of gloves and safe needle practices, mitigates these risks.

- **Agriculture**: Farmers assess the risk of **Hantavirus** exposure from rodent droppings

# Ergonomics

### 1. Introduction to Ergonomics

Ergonomics, or human factors, is the science of optimising the interaction between workers and their work systems, with a dual focus on **physical** and **cognitive** factors. Its objective is to reduce workplace risks, improve safety, and enhance efficiency by aligning work tasks, tools, and environments with the capabilities and limitations of the human body and mind.

The importance of ergonomics has been addressed comprehensively through **EU Directives**, national Maltese legislation (**Cap 424** and **Cap 646**), and the use of internationally recognised **ergonomic assessment tools**.

## 2. Key EU Directives and Maltese Legal Framework

### 2.1. Manual Handling Directive (90/269/EEC)

Focuses on preventing injuries caused by **manual handling** tasks involving heavy lifting, pushing, pulling, or awkward postures.

- Employers are required to:
    - Assess and mitigate risks associated with manual handling.
    - Provide lifting aids and safe handling training.
    - Ensure tasks are adapted to workers' physical capacities.

### 2.2. Display Screen Equipment (DSE) Directive (90/270/EEC)

Covers **ergonomic design** of screen-based workstations to reduce risks of repetitive strain injuries (RSIs), musculoskeletal disorders (MSDs), and eye strain.

- Employers must:
    - Design adjustable and supportive workstations (e.g., chairs, monitors, keyboards).
    - Schedule regular breaks for workers performing repetitive tasks. ○ Conduct DSE risk assessments and provide ergonomic training.



### 2.3. Machinery Directive (2006/42/EC) and 2010 Guidelines on Ergonomics

Mandates that machinery manufacturers incorporate **ergonomic principles** into design and production. This ensures that equipment is adaptable to human needs, reducing physical strain and improving usability.

- **Key Requirements**:

- Machinery controls and interfaces must be intuitive to reduce cognitive overload.
- Design must prevent awkward postures, repetitive strain, or excessive physical effort.

### 2.4. Maltese Legislation

- **Cap 424 (Older legislative framework repealed by Cap 646)–**: Integrates EU directives, requiring risk assessments for manual handling and DSE tasks.
- **Cap 646 – OHSA Act**: In addition to the above, extends ergonomic focus to include **psychological risks**, such as mental workload, stress, and cognitive ergonomics.

## 3. Ergonomic Risk Assessment Tools

To comply with the above legislation, employers must perform **ergonomic risk assessments**. Several tools have been developed to systematically identify and evaluate ergonomic risks in various workplace settings.

### 3.1. KIM (Key Indicator Method)

- **Origin**: Developed by the German Federal Institute for Occupational Safety and Health (*BAuA*).
- **Purpose**: Assesses manual handling tasks such as lifting, carrying, pushing, and pulling.
- **Application**:
  - Provides a quantitative assessment of physical workloads.
  - Identifies deficits in task design and suggests control measures. **Example**:

Evaluating workers manually transporting heavy boxes on construction sites.



### 3.2. REBA (Rapid Entire Body Assessment)

- **Origin**: Developed to assess postural risks in tasks involving static and dynamic movements.

- **Purpose**: Evaluates whole-body postural strain and assigns risk scores indicating intervention urgency.
- **Application**:
    - Suitable for dynamic and physical work environments.
    - Assesses bending, twisting, force exertion, and posture.

**Example**: Nurses repositioning patients in hospitals can be evaluated to reduce bending and twisting risks.

### 3.3. RULA (Rapid Upper Limb Assessment)

- **Origin**: Designed to assess biomechanical and postural stress on the **neck, trunk, and upper limbs**.
- **Purpose**: Identifies risks of MSDs in tasks requiring upper limb movement.
- **Application**:
    - Particularly useful for sedentary tasks and those requiring fine motor skills.
    - Assigns a risk score, prompting ergonomic interventions.

**Example**: Office workers using poorly designed workstations (e.g., low desks, fixed chairs).

### 3.4. MAC (Manual Handling Assessment Charts)

- **Origin**: Developed by the UK's Health and Safety Executive (*HSE*).
- **Purpose**: Identifies risks in **lifting, carrying, and team manual handling operations**.
- **Application**:
    - Uses a colour-coded and numerical risk system to assess tasks.
    - Provides guidance for safe manual handling practices.



**Example**: Assessing workers manually lifting heavy construction materials over extended periods.

### 3.5. QEC (Quick Exposure Check)

- **Origin**: Developed in collaboration with ergonomists at the *Robens Centre for Health Ergonomics*.
- **Purpose**: Evaluates **worker exposure** to ergonomic risks based on posture, movement, and manual handling.
- **Application**:
    - Combines worker and assessor input for a holistic evaluation.
    - Identifies key intervention areas for task redesign.

**Example**: Assembly-line workers performing repetitive hand movements under poor lighting.

## 4. Integrating Tools into a Comprehensive Risk Management Framework

To address ergonomic hazards systematically, organisations can integrate these tools into a structured **risk management process**:

1. **Identify Ergonomic Risks**
    - Use tools like **KIM**, **REBA**, and **RULA** to identify physical risks in work tasks and postures.
    - Use **QEC** to evaluate worker-reported exposures.
2. **Assess the Severity and Impact**
    - Tools like **MAC** and **RULA** provide quantitative risk scores, prioritising high-risk areas.
3. **Implement Control Measures**
    - **Engineering Controls**: Adjust workstation heights, provide lifting aids, and reduce repetitive movements through automation.
    - **Administrative Controls**: Introduce task rotation, scheduled breaks, and ergonomic training.
    - **Personal Protective Equipment (PPE)**: Use vibration-reducing gloves and anti-fatigue mats.



4. **Monitor and Reassess**

- Conduct regular ergonomic assessments to ensure interventions remain effective.

### 5. Addressing Psychological and Cognitive Ergonomic Risks

In compliance with Maltese legislation (**Cap 646**) and EU guidelines, employers must address cognitive ergonomics alongside physical factors:

- **Workload Management**: Prevent cognitive overload through balanced task assignments.
- **Work Design**: Ensure systems and interfaces are intuitive, reducing mental stress.
- **Environment**: Minimise distractions (e.g., noise), provide adequate lighting, and offer calm workspaces.
- **Stress Management**: Implement mental health support programs, task variety, and regular breaks.

**Example**: Healthcare settings require not only proper lifting aids but also stress reduction programs to manage mental strain caused by patient care responsibilities.

### 6. Conclusion

Ergonomics is integral to occupational health and safety frameworks under EU Directives (Manual Handling, DSE, Machinery) and Maltese legislation (Cap 646). Employers must address physical and cognitive ergonomic risks using tools like **KIM**, **REBA**, **RULA**, **MAC**, and **QEC**. A comprehensive approach ensures worker safety, compliance with legal requirements, and improved productivity.

By systematically identifying, assessing, and mitigating ergonomic hazards, workplaces can prevent **musculoskeletal disorders**, **mental fatigue**, and related injuries, fostering a safer and healthier workforce.