MODULE 1: RISK MANAGEMENT, LABORATORY RISKS AND DISASTER AWARENESS

1. Scope of the Training Module

- Purpose and Objectives of the Training Module
- Learning Outcomes of the Training Module
- Methods and Techniques of the Training Module
- Hazard and Risk Concepts
- 5x5 Risk Assessment Method
- Laboratory Safety Hierarchy
- Disaster Concept and Classification
- Disaster Awareness and Risk Management
- Bioterrorism
- Biosafety and Biosecurity
- Special Risks of Laboratories in Disaster Situations

1a. Purpose of the Training Module

This training module aims to teach health professionals working in microbiology laboratories how to systematically assess laboratory risks before, during, and after disasters, to understand and apply the fundamental differences between biosafety and biosecurity concepts, and to be prepared for possible disaster scenarios. The module seeks to enable participants to effectively manage risks in the laboratory environment.

1b. Objective of the Training Module

To define risk management strategies and laboratory safety procedures, adapt them to disaster scenarios, and develop the competency to manage biosafety and biosecurity risks simultaneously.

2. Learning Outcomes of the Training Module

- Distinguish between hazard and risk concepts and correctly apply the 5x5 risk assessment matrix.
- Classify natural and human-induced disaster types and analyze their effects on laboratory processes.
- List and apply control measures in the laboratory safety hierarchy according to priority.
- Distinguish between biosafety and biosecurity concepts and manage them simultaneously in disaster situations.
- Recognize bioterrorism scenarios, explain CDC Category A agents and protection protocols.
- Create an institution-specific vulnerability map and prepare an improvement action plan.

3. Methods and Techniques of the Training Module

- Lecture
- Team-Based Learning
- Brainstorming
- Gamification

4. Hazard and Risk Concepts

In every profession, there are hazards that affect the health and life of the employee depending on the nature of the work performed. The laboratory environment is a high-risk work area that contains biological, chemical, physical, and ergonomic hazards together.

HAZARD: Any source or situation with the potential to cause injury, illness, damage, or harm.

RISK: The combination of the probability of a hazard occurring and the severity of the consequence if it does occur. **RISK = PROBABILITY × SEVERITY**

5. 5x5 Risk Assessment Method

Although there are many different methods for risk assessment, the 5x5 matrix is one of the most commonly used tools. The 5x5 matrix is a systematic tool that visualizes the risk score obtained by multiplying the probability of a hazard occurring (1-5) by the severity of the possible outcome (1-5).

Color Coding:

- Green (1-4) = Acceptable
- Yellow (5-9) = Low
- Orange (10-16) = Medium
- Red (17-25) = Unacceptable

Probability / Severity	**1**	**2**	**3**	**4**	**5**
1 - Once a year (Negligible)	1	2	3	4	5
2 - Once every 3 months	2	4	6	8	10
3 - Once a month	3	6	9	12	15
4 - Once a week	4	8	12	16	**20**
5- Every day	5	10	15	**20**	**25**

Application Example: The probability of a needlestick injury while drawing blood is "every day" (5 points), and the severity is "fatal" (5 points) due to the risk of HIV (0.3%) and HBV (~1%) transmission. Result: RISK = 5 × 5 = 25 → UNACCEPTABLE risk level. In this case, measures must be taken to either reduce the probability of the event or decrease the severity of the outcome.

6. Laboratory Safety Hierarchy

The laboratory safety hierarchy is a pyramid structure that ranks control measures according to their effectiveness, with the strongest measures at the top that eliminate the hazard at its source:

1. **Elimination** – Completely removing the hazard
2. **Substitution** – Replacing the hazard with a less risky alternative
3. **Engineering Controls** – Biological Safety Cabinet (BSC), sharps containers, automation
4. **Administrative Controls** – Training, procedures, rotation plans
5. **Personal Protective Equipment (PPE)** – Gloves, lab coat, goggles, mask

7. Disaster Concept and Classification

A disaster is a set of events that disrupt the normal functioning of a society or institution, threaten human health and the environment, and require rapid intervention.

Natural Disasters: Earthquake, volcanic eruption, landslide, avalanche, storm, typhoon, hurricane, tsunami, flood, drought, fire, insect infestation, epidemic, and pandemic.

Human-Induced Disasters: Nuclear, biological, physical, and chemical warfare, explosion, bioterrorism and biological release, chemical exposure and poisoning.

Human-Induced Artificial Laboratory Incidents: Laboratory accidents and equipment failures, improper waste management, human errors, infrastructure failures, biosecurity breaches.

8. Disaster Awareness and Risk Management

Disaster awareness involves recognizing potential risks before an event occurs, predicting their effects, and making proactive preparations.

8a. Hazard Identification

First, a situation assessment should be conducted to identify hazards in the laboratory.

Hazard Category	Laboratory-Specific Examples
Physical	Fire, flood, earthquake, power outage, -80°C freezer failure
Biological	Culture leakage, spill, aerosolization, pathogen spread
Chemical	Disinfectant/solvent spill, flammable material fire
Human Resources	Staff shortage, transportation barriers, unsustainable shifts
Supply-Logistics	Culture media, antibiotic disks, consumables supply disruption

8b. 8b. Risk Assessment Matrix (Probability × Impact)

Once the hazards have been identified, their probability and impact should be assessed, and a risk score calculated. The level of brightness should then be determined based on this score.

Risk Factor	Probability	Impact	Risk Score	Priority
Earthquake	High	Very High	5×5=25	Critical
Power outage	Very High	High	5×4=20	Critical
-80°C freezer failure	Medium	Very High	3×5=15	High Priority
Staff unable to reach	Medium	High	3×4=12	High Priority
Culture spill	Low/Medium	Medium/High	2×3=6	Under Control

9. Bioterrorism

When disasters are mentioned, natural disasters usually come to mind first, and threats such as bioterrorism are often overlooked. Microbiology laboratories must also be prepared for such attempts.

Bioterrorism is the deliberate release of biological agents to cause disease, death, fear, or disruption of social order. Civilian populations, food and water sources, agriculture and livestock, and health systems can be targeted. The microbiological agents most likely to be used fall under **CDC Category A**.

CDC Category A High-Risk Agents:

- *Bacillus anthracis* – Anthrax
- *Yersinia pestis* – Plague
- *Variola virus* – Smallpox
- *Francisella tularensis* – Tularemia
- Botulinum toxin – Botulism

10. Biosafety and Biosecurity

Biosecurity refers to all institutional and personal measures taken to prevent unauthorized acquisition, use, or misuse of high-risk biological materials such as pathogens, toxins, vaccines, pharmaceutical products, and microorganism stocks.

Biosafety focuses on the safe handling of pathogens within the laboratory, control of aerosol formation, exposure to infectious agents, contaminated surfaces, secondary transmission, PPE, biological safety cabinets, disinfection, and sterilization.

Biosecurity prioritizes preventing unauthorized access, theft of pathogens, data security breaches, and malicious use (e.g., locked storage areas and access card systems).

BIOSAFETY (Biosafety)	BIOSECURITY (Biosecurity)
Prevents accidental exposure	Prevents intentional misuse
Protects laboratory workers	Protects biological materials
Focuses on safe handling of pathogens	Focuses on access control and monitoring
Example: PPE use, BSC working rules	Example: Sample locking and access logging

11. Special Risks of Laboratories in Disaster Situations

In disasters, risks increase exponentially; systems collapse, human error rises, and security vulnerabilities emerge. Therefore, rapid risk assessment, prioritization, and dual risk management (biosafety + biosecurity) are essential.

Critical Principles in Biorisk Management:

- Risk always exists and must be managed
- The human factor is the greatest risk
- Training is the strongest control
- Biosafety and biosecurity are inseparable

Common mistakes when preparedness and risk assessment have not been done before a disaster:

- Starting work without risk assessment
- PPE violations
- Neglecting sample tracking
- Failure to report incidents
- Ignoring biosecurity

12. Conclusion

First, hazards in laboratories must be identified; progress should be made with the principle of "recognize the risk, control it, manage it." During disasters, biosafety and biosecurity risks emerge simultaneously. The biggest mistake in a disaster situation is "focusing only on infection and forgetting safety." The correct approach is to protect people, control the agent, and manage the system — managing both biosafety and biosecurity together.

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