

# Exercises

Master's degree in environmental science and engineering

## Occupational and environmental health

### Biological agents

**1)** A hotel has reported multiple cases of Legionnaires' disease among its guests. The suspected source is the hotel's hot tubs and spa pool. As an environmental engineer, you have been asked to investigate and propose measures to mitigate the situation and prevent recurrence.

Questions:

- Outline a step-by-step approach to confirm whether the hot tubs and spa pool are the source of the outbreak. What locations and components of the water system would you sample? Specify the sampling techniques and parameters to measure.

First, conduct a detailed site inspection of the hotel's hot tubs and spa pool, focusing on water system components that might foster Legionella growth, such as temperature zones between 20–50°C, stagnant water areas, and biofilm presence. Next, collect water samples from the hot tubs and spa pool, measure water temperature at the sampling sites, and send the samples to the lab for the detection and enumeration of cultivable Legionella.

- Propose a set of immediate control measures to minimize exposure while awaiting detailed testing results.

Restrict access to the hot tubs and spa pool until their safety is verified. Ensure clear communication with guests and staff about the reason for the restriction and the actions being taken to resolve the issue.

- Suggest a routine maintenance and monitoring plan for the hotel to prevent future outbreaks.

Implement adequate disinfection and circulation methods

Conduct regular Legionella testing, at least quarterly, with increased frequency in high-risk periods (June to September)

Maintain logs of maintenance, water quality tests, and Legionella results

**2)** Twelve employees, making up thirty in total, at a small-scale cheese factory have reported experiencing symptoms such as skin irritation, sneezing, and coughing. The safety officer seeks advice from an occupational hygienist to determine if the exposure standards are being met.

Question :

- What actions will the occupational hygienist take?

Identify the pollutants that may be present in this type of occupational activity (biological or chemical)  
 Categorize high-risk activities into homogeneous exposure groups (activities with similar exposure situations)  
 Sample pollutants in each homogeneous group

**3)** The hygienist conducted a study to assess the exposure to airborne microorganisms in several work areas.

The results of air sampling by agar impaction in each location (with 4 replicates per location) are as follows:

| Location                    | Volume air sampled (L) | CFUs on TSA<br>(total cultivable bacteria) | CFUs on DG18<br>(cultivable moulds) |
|-----------------------------|------------------------|--------------------------------------------|-------------------------------------|
| Milk cooking                | 100                    | 26, 44, 40, 30                             | 19, 18, 16, 12                      |
| Maturation of fromage frais | 100                    | 40, 44, 36, 40                             | 11, 24, 18, 16                      |
| Rind cheese washing         | 50                     | 400, 430, 450, 440                         | 250, 320, 250, 340                  |
| Shipping                    | 100                    | 22, 20, 18, 26                             | 12, 10, 8, 24                       |
| Office                      | 100                    | 10, 14, 20, 24                             | 20, 24, 38, 40                      |

Among the total bacteria found in the office, we detected the presence of one strain of *Staphylococcus aureus* (risk group 2) and one strain of *Escherichia coli* (risk group 2).

Questions :

- How do you interpret the results and what advice do you give the workers?

After calculating the mean concentration for each type of bioaerosol in different locations and determine the CFU/m<sup>3</sup> of bioaerosols using the formula:

$$\frac{\text{CFUs detected}}{\text{volume of Air}} * 1000$$

You obtained the following results:

| Location                    | CFUs on TSA / m <sup>3</sup><br>(total cultivable bacteria) | CFUs on DG18 / m <sup>3</sup><br>(cultivable moulds) |
|-----------------------------|-------------------------------------------------------------|------------------------------------------------------|
| Milk cooking                | 350                                                         | 350                                                  |
| Maturation of fromage frais | 400                                                         | 173                                                  |
| Rind cheese washing         | 8600                                                        | 5800                                                 |
| Shipping                    | 215                                                         | 135                                                  |
| Office                      | 170                                                         | 305                                                  |

The results are interpreted by comparing them to SUVA's recommended exposure limits to determine if they are within safe levels. You conclude that the CFU/m<sup>3</sup> results exceed the recommended limits in the rind cheese washing area.

To mitigate this, corrective measures such as task containment, hooding, and source extraction should be discussed with the employer to assess how they can be implemented in the cheese processing area. In the meantime, exposure can be reduced by assigning workers multiple tasks to spread out their exposure. The specific prevention needs of this area should be discussed with the workers involved in the cheese rind washing process, and respiratory protection (P2 masks) should be offered to them.

- Should any measures be taken in view of the discovery of the two potentially pathogenic bacterial strains?

*Staphylococcus aureus* is commonly carried by 30-40% of the population on their skin and in their nose, so no specific action is needed for its elimination. However, the presence of *E. coli* indicates fecal contamination. Investigating potential cross-contamination or hygiene lapses in the workplace is necessary.

4) a) As part of your job, you are tasked with evaluating health risks at a wastewater treatment plant (WWTP) receiving effluents from a cytostatic production site. Your activities include assisting in the removal of dried sludge (evacuation of pressed sludge).

That evening, you experience fever, body aches, and general malaise.

Question:

- What potential pathology could explain your symptoms?

Sludge from wastewater treatment plants can harbor high concentrations of gram-negative bacteria, which can cause illnesses like fever and body aches.

- Consider the hazards associated with wastewater from pharmaceutical or cytostatic production.

Wastewater or sludge from a cytostatic production site may contain residual cytotoxic compounds (e.g., methotrexate, cyclophosphamide). These substances can be harmful even at low concentrations and are designed to target and destroy rapidly dividing cells, but can also cause damage to healthy cells in the body.

- What further information would you gather to confirm your hypothesis (e.g., environmental conditions, specific toxins)?

Request an exposure assessment, including the collection of aerosols and the measurement of bioaerosol and cytostatic concentrations in the workplace.

b) The next day, you visit the cytostatic production site. You observe strict hygiene protocols, with operators consistently wearing personal protective equipment (PPE), particularly gloves. However, operators report frequent dermatitis and other skin problems.

- What could explain the reported skin issues despite stringent hygiene measures?  
Discuss the possible association between occupational exposure and the symptoms.

The skin issues could be caused by gloves trapping moisture, leading to skin maceration and making the skin more prone to irritation. Non-breathable gloves or tight-fitting gloves can cause excessive sweating, which worsens skin problems. Additionally, latex or other materials in gloves could contribute to allergic reactions and dermatitis.

- Suggest modifications to skin reactions in operators. Consider modifications in PPE, and potential changes in workflow or protocols.

#### PPE Modifications:

Consider using gloves made from hypoallergenic materials

Introduce regular glove changes to avoid prolonged contact with sweat

Consider offering cotton liners to be worn under gloves to absorb moisture and reduce friction

#### Protocol Changes:

Allow breaks for operators to let their skin breathe.

Train workers on proper hand hygiene and glove management to reduce skin irritation risks.