

INTRODUCTION TO BIORISK MANAGEMENT

ENGINEERING CONTROLS

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LICENSE



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INTRODUCTION

This lecture will introduce you to the basics of **engineering controls**. The design and layout of a containment facility will be discussed in detail. You will learn about the essential laboratory equipment which is the **Biological Safety Cabinet (BSC)**, the different types of BSCs and their safe operation within a containment facility.



LEARNING OBJECTIVES

The objectives of this lecture are to introduce you to:

1. The fundamental principles of **facility design**.
 2. The **biological safety cabinet**.
 3. The **interdependencies** between different controls within a facility.
-



LEARNING OUTCOMES

Upon completion of this module you should demonstrate the ability to:

1. Understand the **basic elements** of facility design.
 2. Design a **layout** of a containment facility.
 3. Understand the **operation** of a biological safety cabinet.
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CONTAINMENT FACILITY

INTRODUCTION TO DESIGN
ELEMENTS





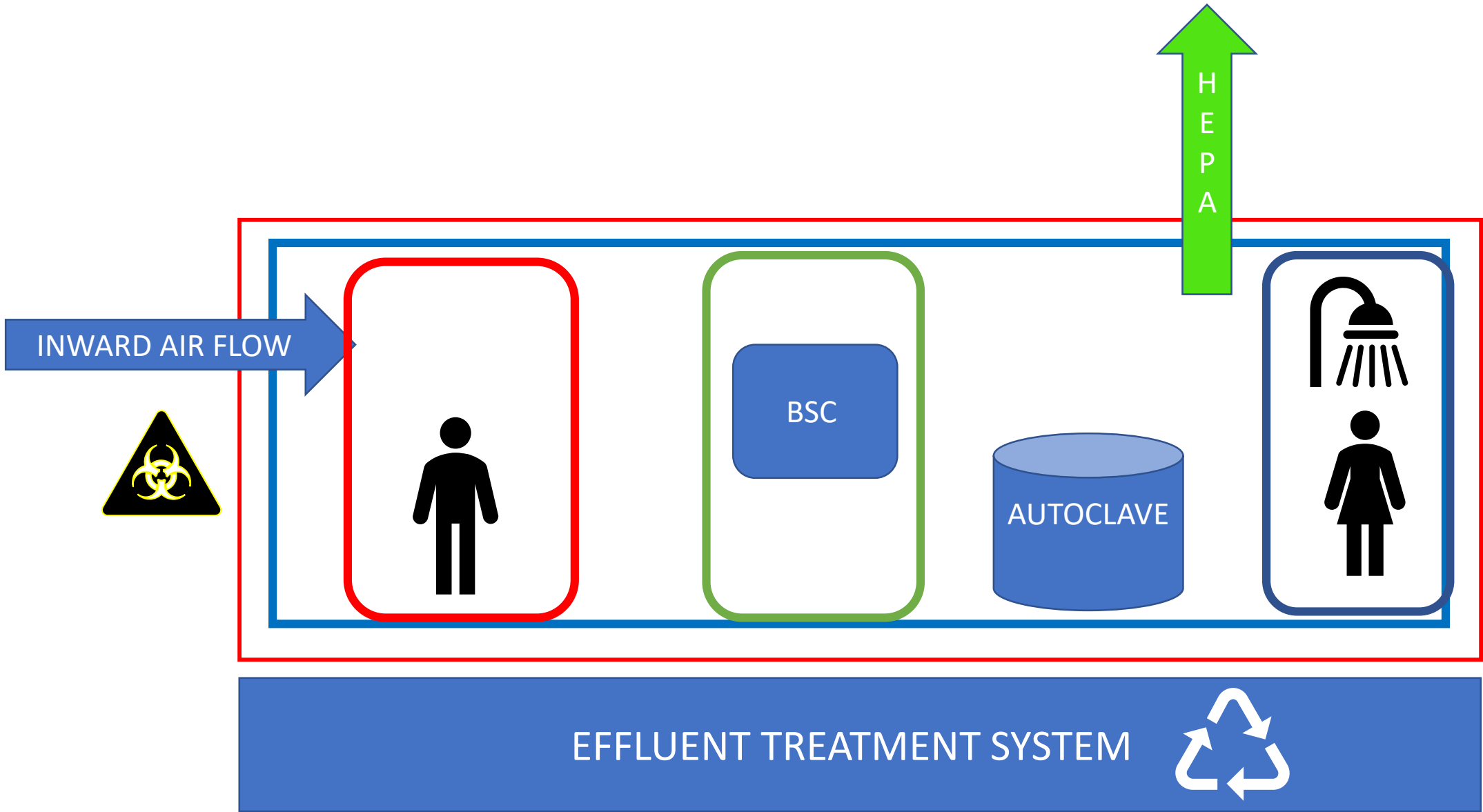
CONTAINMENT FACILITIES

Containment facilities are categorized in terms of Biosafety Levels. The Biosafety levels are designated as Biosafety Level (BSL) 1 to 4.

The specifications for each containment facility have been described in the WHO LBM.

	BIOSAFETY LEVEL			
	1	2	3	4
Isolation ^a of laboratory	No	No	Yes	Yes
Room sealable for decontamination	No	No	Yes	Yes
Ventilation:				
— inward airflow	No	Desirable	Yes	Yes
— controlled ventilating system	No	Desirable	Yes	Yes
— HEPA-filtered air exhaust	No	No	Yes/No ^b	Yes
Double-door entry	No	No	Yes	Yes
Airlock	No	No	No	Yes
Airlock with shower	No	No	No	Yes
Anteroom	No	No	Yes	—
Anteroom with shower	No	No	Yes/No ^c	No
Effluent treatment	No	No	Yes/No ^c	Yes
Autoclave:				
— on site	No	Desirable	Yes	Yes
— in laboratory room	No	No	Desirable	Yes
— double-ended	No	No	Desirable	Yes
Biological safety cabinets	No	Desirable	Yes	Yes
Personnel safety monitoring capability ^d	No	No	Desirable	Yes

Reference: World Health Organization, Laboratory Biosafety Manual. Third Edition.





BSL1 (BASIC)

- Basic teaching and research.
 - Good microbiological techniques (GMT).
 - Open bench work.
-

BSL2 (BASIC)



- Primary health services, diagnostic service, research.
 - GMT plus Personal Protective Equipment (PPEs).
 - Biohazard signage.
 - Open bench work plus **Biological Safety Cabinet (BSC)**.
-



BSL3 (CONTAINMENT)

- Special diagnostic service, research.
 - PPEs.
 - Directional airflow.
 - Access control.
 - All laboratory procedures involving biological agents to be carried out within a BSC.
-



BSL4 (MAXIMUM CONTAINMENT)

- Dangerous pathogens unit.
 - Airlock entry.
 - Shower on exit.
 - Special disposal for hazardous waste.
 - Class III Biological Safety Cabinet.
 - PPEs: Pressurized suits.
 - Double door autoclave.
-

OTHER DESIGNATIONS

- **Animal containment** facilities are designated with the prefix (A), thus ABSL1, ABSL2, ABSL3 and ABSL4.
 - **Plant containment** facilities are designated as BSL-1P, BSL-2P, BSL-3P, BSL-4P.
 - The designation **(+)** at the end of BSL, e.g. BSL3+ indicates that the BSL3 containment facility has incorporated some design elements from BSL4.
-

The background of the image shows several rolled-up architectural blueprints resting on a light-colored wooden surface. The blueprints are partially unrolled, revealing technical drawings with various lines, dimensions, and grid markers. Some visible numbers include 1250, 2560, 250, 1780, 880, 360, 1010, 270, 425, 155, 1125, 250, 1185, 2500, 3175, 3100, 5, 6, 3, 200, 39x, 800, and 130.15. The blueprints are arranged in a way that creates a sense of depth and focus on the design process.

FACILITY DESIGN

THE IMPORTANCE OF AIRFLOW AND AIR PRESSURE

SELECTING A SITE

1. Natural disasters: low risk.
2. Population: low density.
3. Utilities: electricity and water
4. Contingencies: ready access to HAZMAT teams.
5. Conflict zones: avoid.

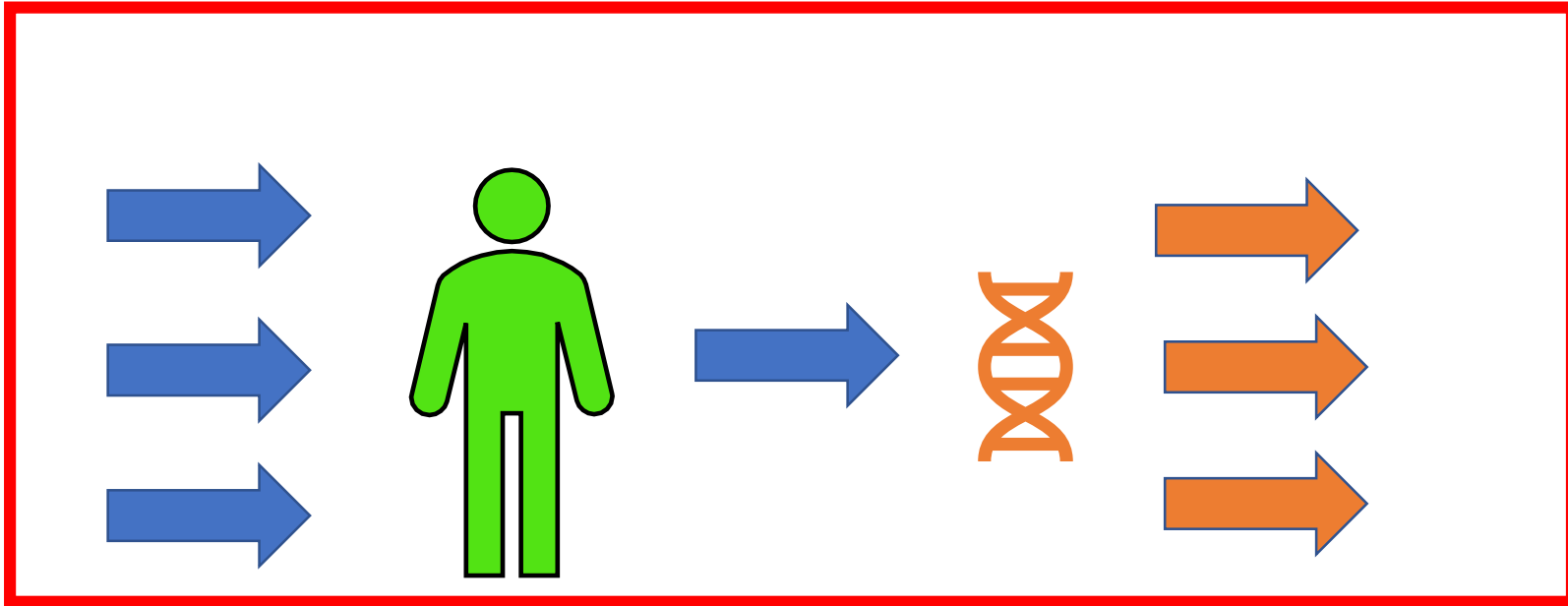




DIRECTIONAL AIRFLOW

The characteristic of air which is its fluidity and ability to be pressurized makes it an indispensable agent for the containment of biological agents.

The design of a containment facility ensures that the air flows from the "clean" to the "dirty" zones within a facility prior to release into the environment via the HEPA filters.

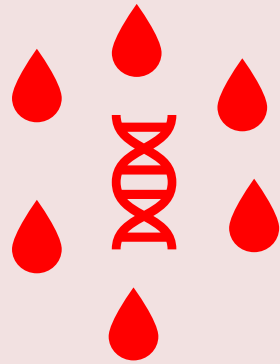


The laboratory worker is protected from the biological agent by directional flow of air.



NEGATIVE PRESSURE

A containment facility is maintained at a negative pressure with reference to the external environment. This ensures that aerosols containing biological agents are contained within the negative pressure zone.

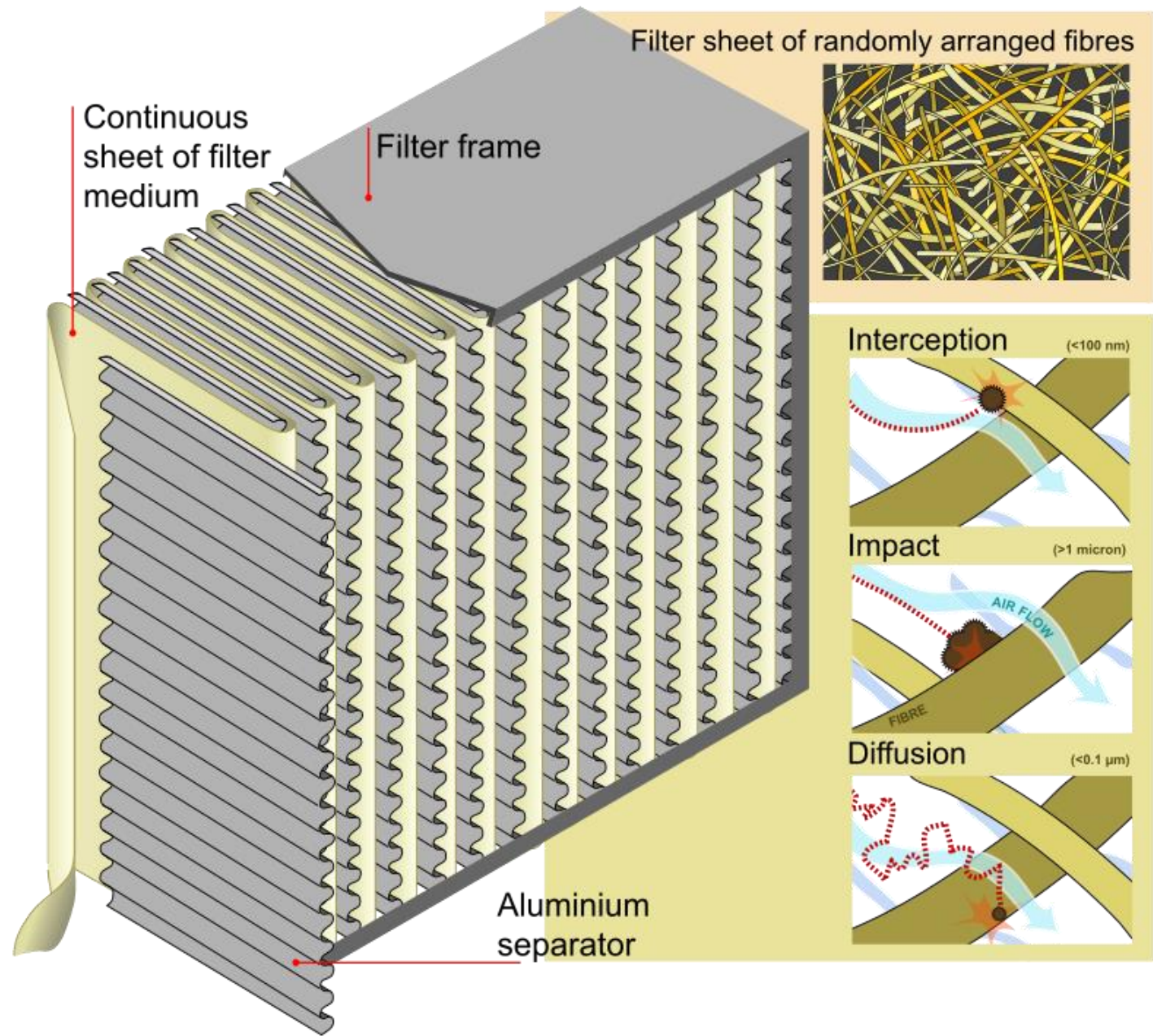


Aerosols generated by operations involving biological agents are retained within the containment facility by virtue of the negative pressure maintained within the facility.



HEPA FILTERS

Filters meeting the HEPA standard must satisfy certain levels of efficiency. Common standards require that a HEPA air filter must remove at least **99.95%** (European Standard) of particles whose diameter is equal to **0.3 μm** ; with the filtration efficiency increasing for particle diameters both less than and greater than 0.3 μm .



FACILITY DESIGN: BUILDING

SERVICE FLOORS: AIR HANDLING

ADMINISTRATIVE
OFFICES

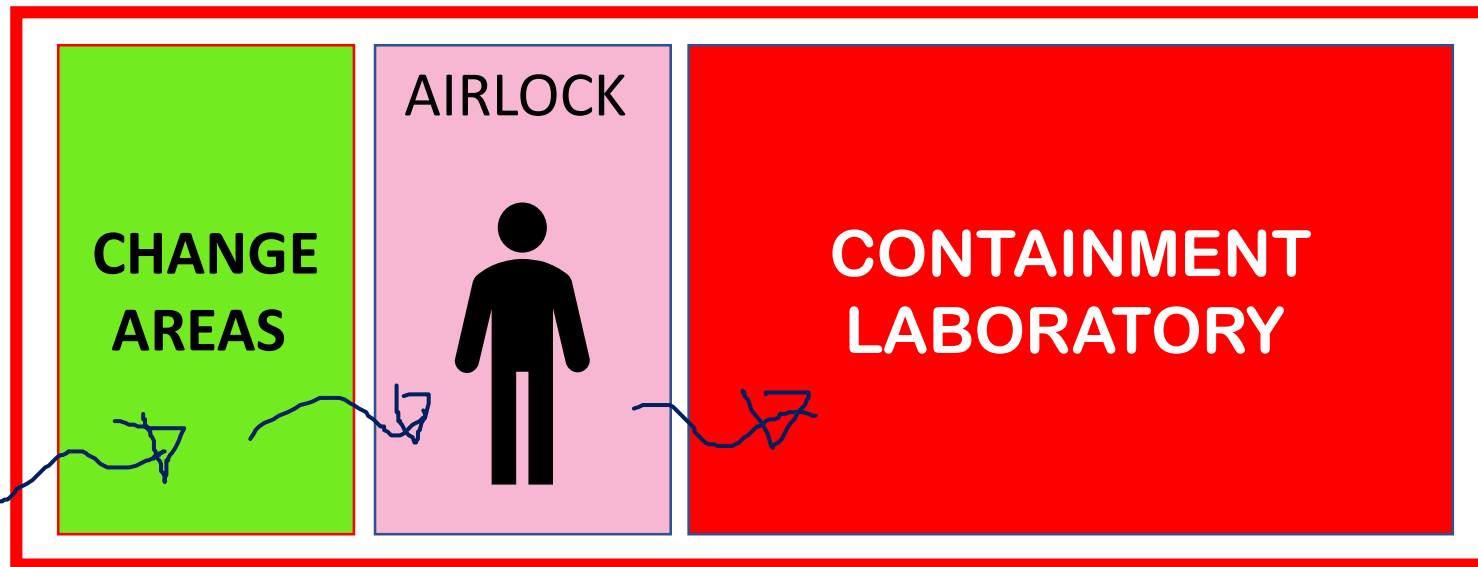


LABORATORIES

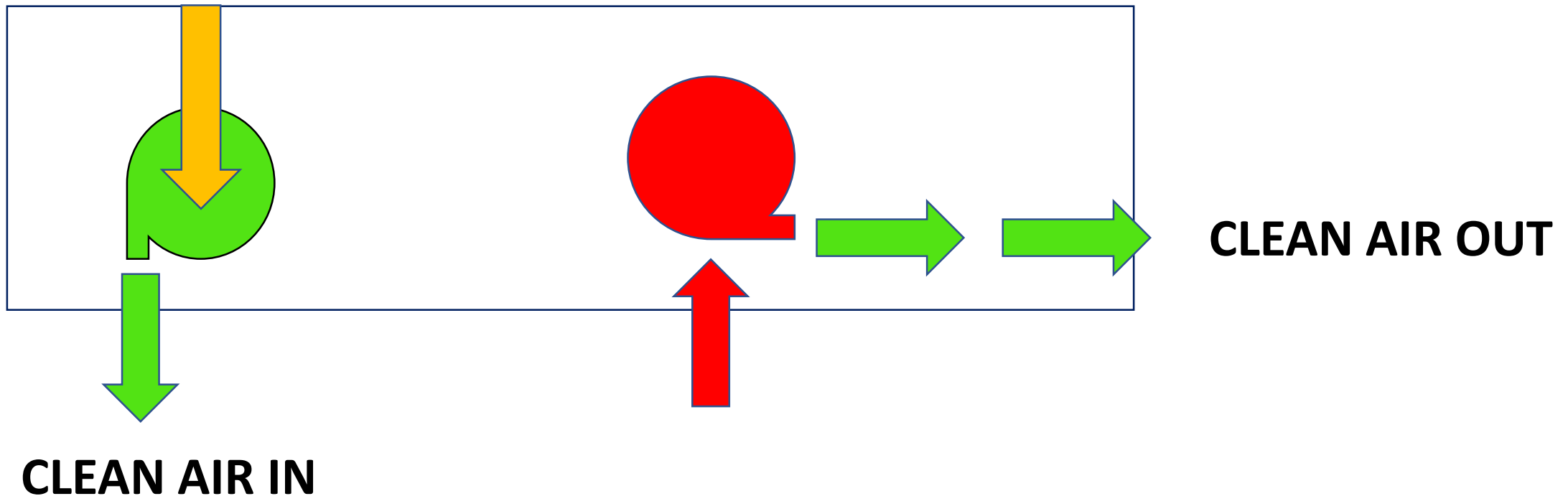


EFFLUENT DISPOSAL SYSTEM

FACILITY DESIGN: LABORATORIES



SERVICE FLOORS: AIR HANDLING

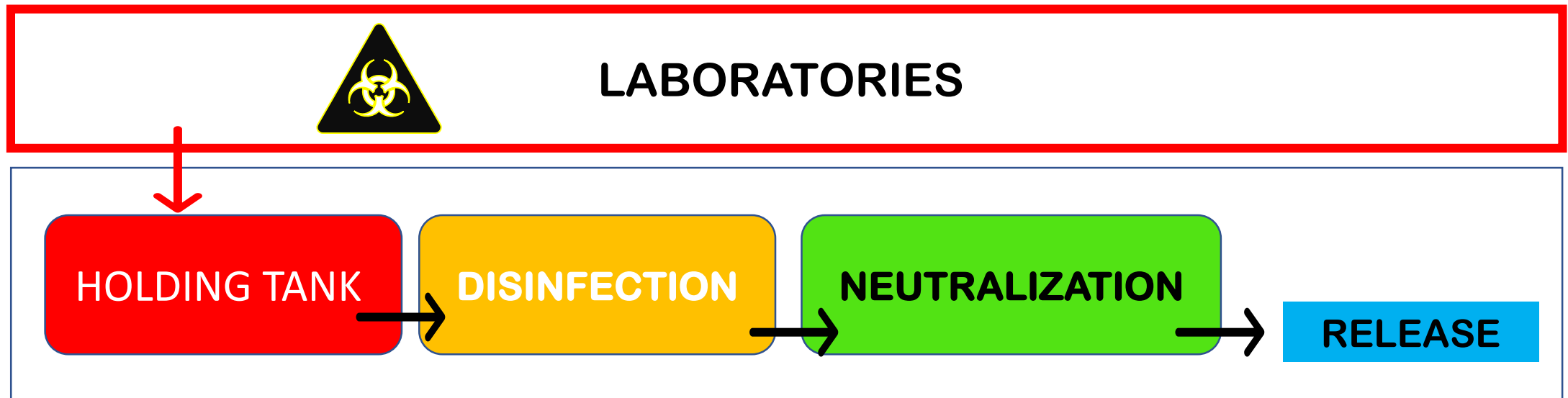


Please view the video on service floors which can be accessed at the following link:

https://youtu.be/xN5_OCBHajU



FACILITY DESIGN: EFFLUENT DISPOSAL





FACILITY DESIGN: BIOSECURITY

Biosecurity features must be incorporated into the building design, these include physical security in the form of access control as well as information security.



BIOLOGICAL SAFETY CABINETS

THE BSC



BIOLOGICAL SAFETY CABINETS

Biological safety cabinets (BSCs) are designed to protect the operator, the laboratory environment and work materials from exposure to infectious **aerosols** and splashes that may be generated when manipulating materials containing infectious agents, such as primary cultures, stocks and diagnostic specimens.

PROCEDURES WHICH GENERATE AEROSOLS



BIOLOGICAL SAFETY CABINET: CLASS I

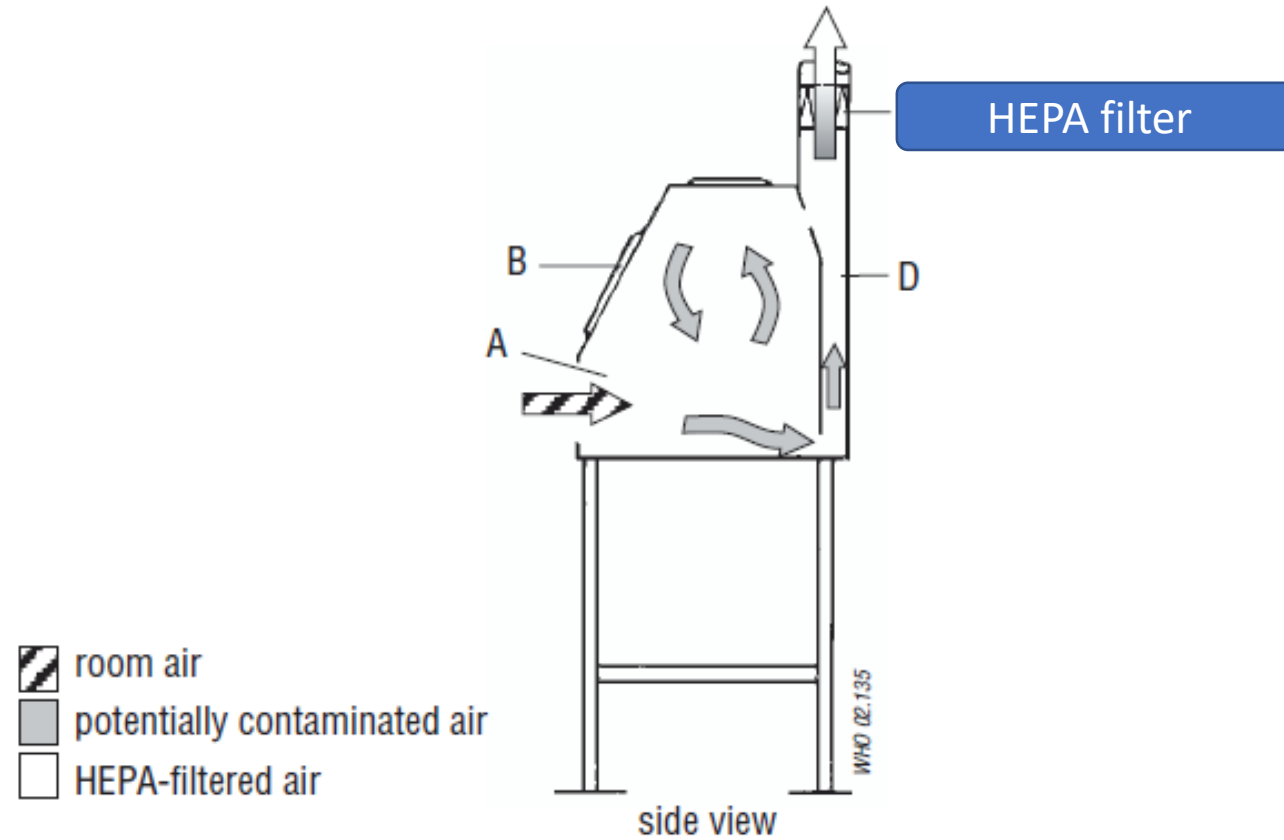


Image credits: World Health Organization, Laboratory Biosafety Manual (Third Edition)



CLASS II B1

EXHAUSTED: 70%

RECIRCULATED: 30%

HEPA filter traps 99.97%
of particles of 0.3 μm in
diameter.





BIOLOGICAL SAFETY CABINET: CLASS II B1

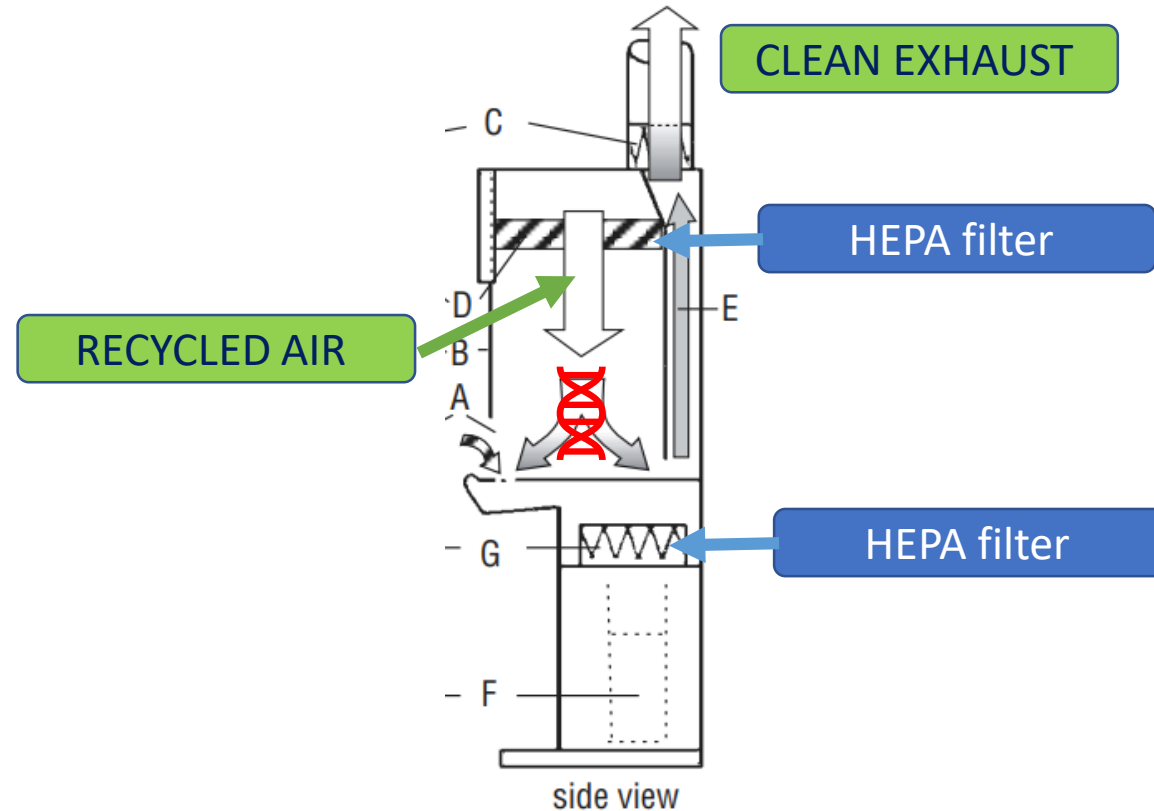
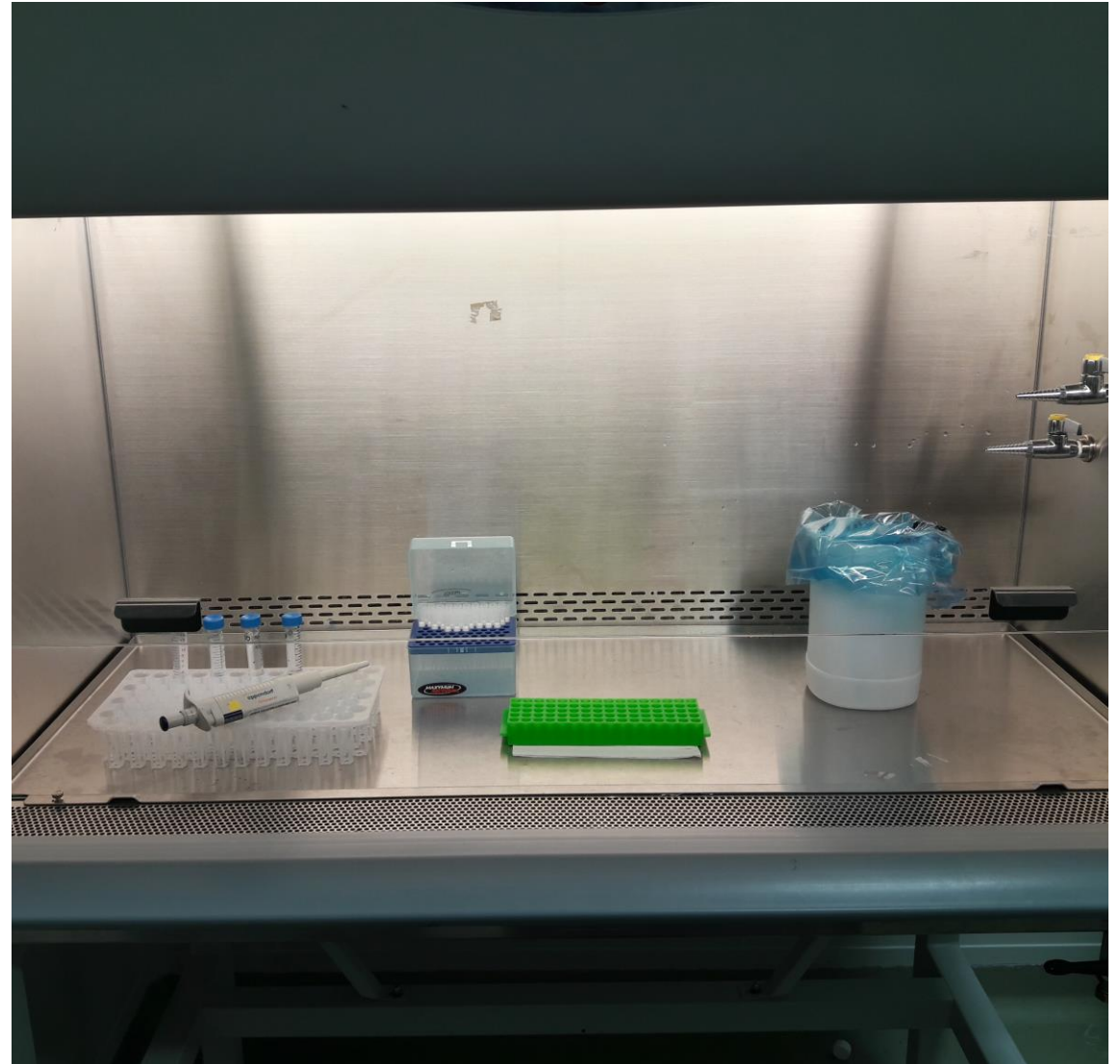


Image credits: World Health Organization, Laboratory Biosafety Manual (Third Edition)

WORKING WITH BSCs

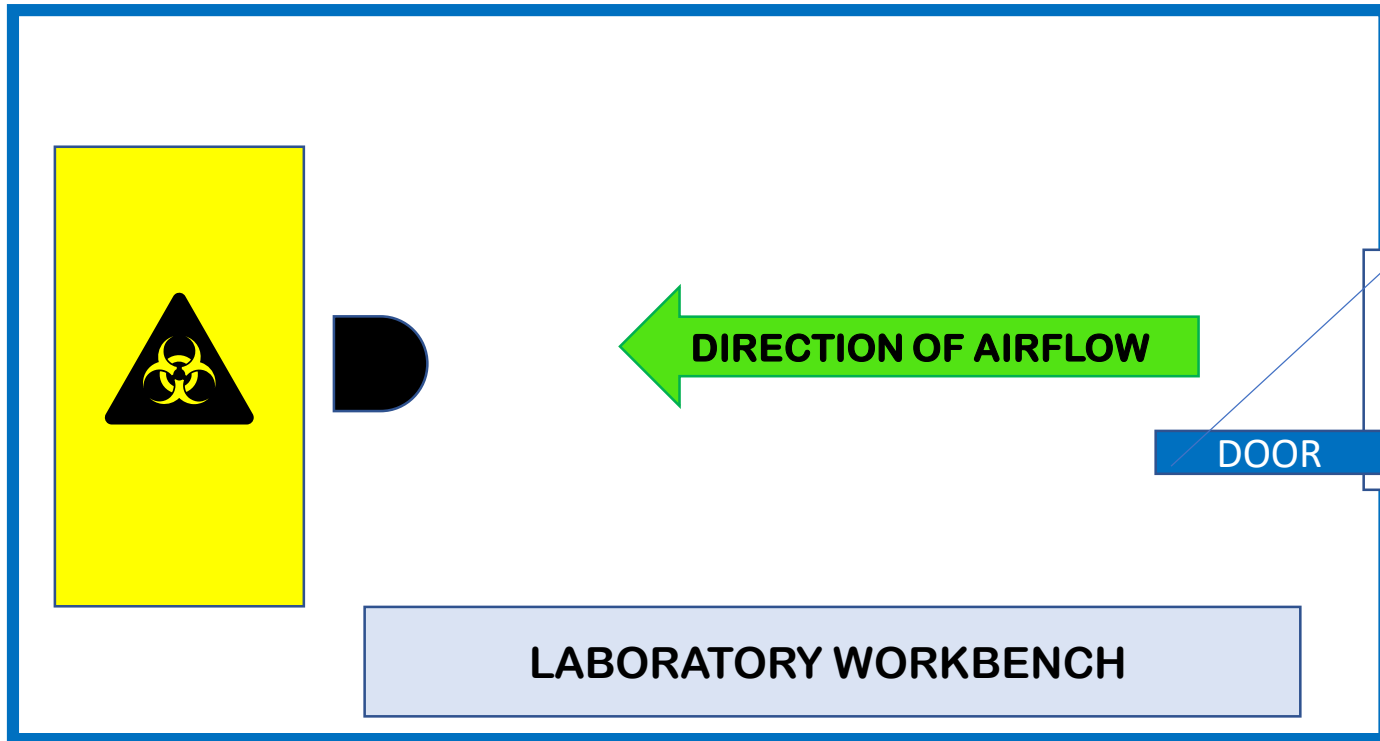
- Certification
- Location.
- Material placement.
- Operation.
- Cleaning and sterilization.
- Disinfection.
- Maintenance.





BSC: PLACEMENT

- Air currents.
 - Other BSCs.
 - Ergonomics.
 - Ducting.
-



FLOOR PLAN FOR BSC PLACEMENT



BSC: CERTIFICATION

- BSCs must be certified periodically in accordance with your National Standards,
 - If national standards do not exist in your specific jurisdiction, please refer to a reference standard from another jurisdiction.
-



BSC: STANDARD OPERATING PROCEDURES

- Certification.
 - Decontaminate prior to use.
 - Surface wipe.
 - Placement of instruments.
 - Spill cleanup.
 - Waste disposal.
 - Post usage decontamination.
-



Please view my video tutorial on working in a BSC at the following link.

<https://youtu.be/M5NyHryqHBc>



Please view my video tutorial on double bagging here.

https://youtu.be/8fjSagJ_4Dc



SUMMARY

- Facility Design.
- Directional Airflow.
- Biological Safety Cabinets.



THANK YOU