BIO-RISK MANAGEMENT

ENGINEERING CONTROL AND LABORATORY EQUIPMENT

MCB 8204

Dr. IBRAHIM YUSUF

DEPARTMENT OF MICROBIOLOGY
iyusuf.bio@buk.edu.ng
www.ibrahimyusuf187.wixsite.com/driy

COURSE INFORMATION

Course Code	Duration	Time/venue	Grading system	Target students
MCB 8204	ONE SEMESTER	10am-1pm Tuesday MCB PG class	EXAM	M.Sc . MICROBIOLOGY students

AIMS:

(1). To give students advanced understanding of the principles, hierarchy, applications and types of hazard control.

(2). To expose students to the principle and application of engineering control to reduce biorisk.

(3). To update students' knowledge of commonly used laboratory equipments, their functions, operation as well as maintenance and care.

LEARNING OUTCOMES

On completion of this unit, students will understand:

- Hazards and their control
- The hierarchy of hazard control
- Engineering control and its various applications in the laboratory
- Some basic maintenance practice of laboratory equipments related to engineering control

COURSE CONTENTS:

- Definition of hazard control and types
- Stages or hierarchy of hazard control
- Engineering controls
- Types of engineering control
- Examples of laboratory equipments with engineering control features
- Maintenance, checks and care of some laboratory equipments

Note: This portion of MCB 8204 will be divided into two parts;

Part 1: Engineering control

Part 2: Laboratory equipments

TERMS DEFINITION

Biorisk……

Biorisk generally refers to the risk associated with biological materials and/or infectious agents.

OR

The probability or chance that a particular adverse event such as accidental infectious agent (possibly leading to harm) will occur.

Biorisk assessment

Identifying and exploring, preferably in quantified terms, the types, intensities and likelihood of the consequences related to a risk. Risk assessment comprises hazard identification and estimation, exposure and vulnerability assessment and risk estimation

TERMS……

Risk Prevention

Measures to stop a risk being realized; typically means stopping the activity giving rise to the risk

Biorisk management

The analysis of ways and development of strategies to minimize the likelihood of the occurrence of biorisks.

Goals biorisk management

to develop a comprehensive laboratory biosafety and biosecurity culture, allowing biosafety and biosecurity to become part of the daily routine of a laboratory, improving the overall level of working conditions, and pushing for expected good laboratory **management**.

HAZARD CONTROL

HAZARD CONTROL

- Hazard control can be defined as **set of programs or measures** meant to reduce or control the exposures of workers to occupational hazards.
- Hazard control methods are many, selection depend upon

1. The type of process involved

2. The nature of the contaminant source (its toxicity and release mechanism)

3. The route of exposure (inhalation, dermal, and ingestion).

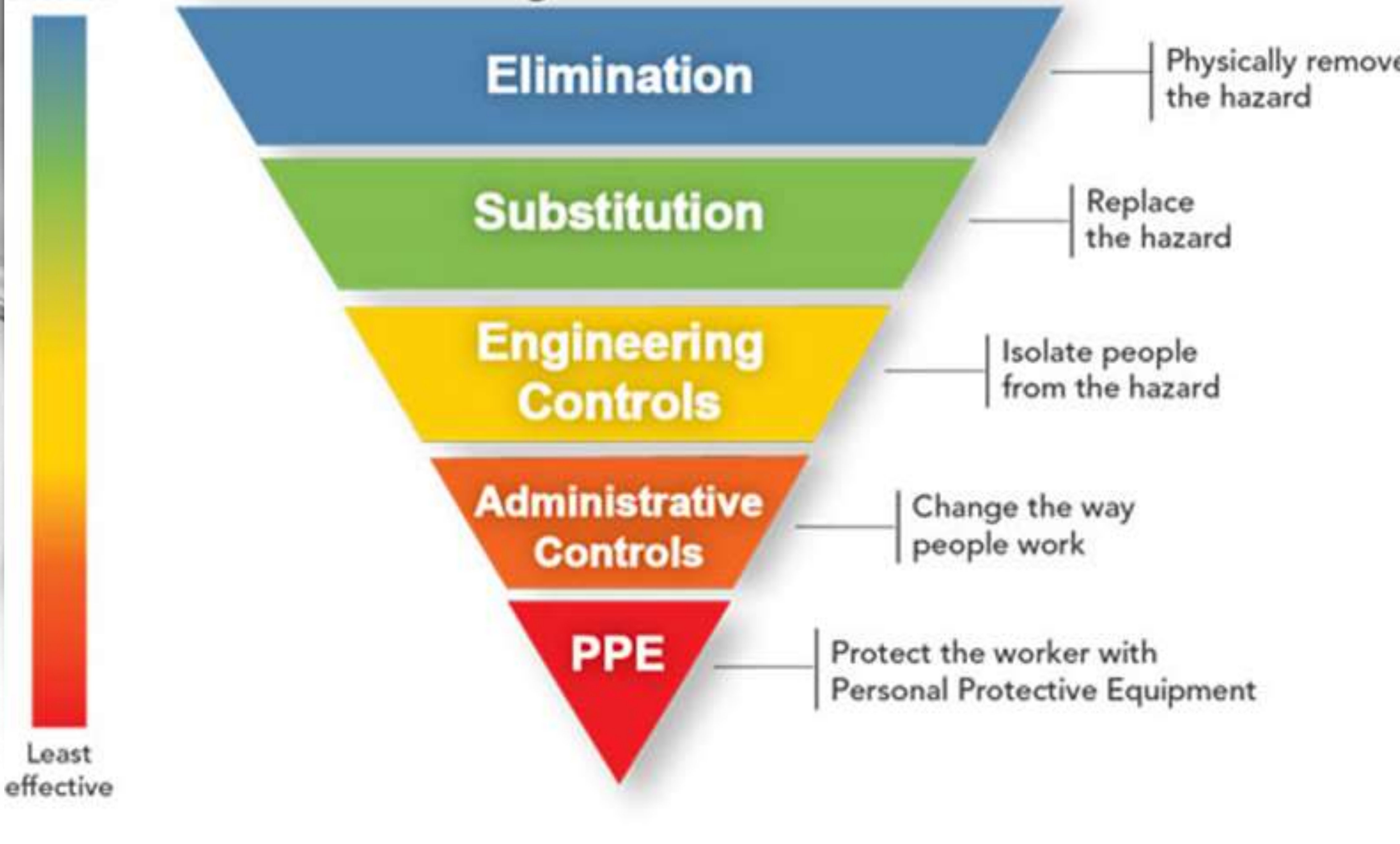
……..**no single control method in isolation will be successful; control is always a mixture of equipment and ways of working.**

THE HIERARCHY OF CONTROL

- Hierarchy of Control is a system used in laboratories, industries and factories to minimize or eliminate exposure to hazards.

- It is the order in which hazards should be controlled.
- It is a often presented graphically in triangle.
- The idea behind this hierarchy is that the control methods at the top of graphic are potentially more effective and protective than those at the bottom. Following this hierarchy normally leads to the implementation of inherently safer systems, where the risk of illness or injury will be substantially reduced.

Hierarchy of Controls



Bio-risk management (Prepared by Dr. Ibrahim Yusuf) 8

- Elimination
- Substitution
- Engineering control
- Administrative control
- PPE

COMPONENTS OF HIERARCHY OF CONTROL

1. ***Elimination***: Elimination is the process of removing hazards from the workplace. It is the most effective way to control a risk because the hazard is no longer present. It is the preferred way to control a hazard and should be used whenever possible.

2. ***Substitution***: Substitute (replace) hazardous materials or machines with less hazardous ones.

Using liquid chemicals instead of dusty powder

Using non flammable solvents in place of flammable ones

Instead Of:	Consider:
Carbon tetrachloride (causes liver damage, cancer)	1,1,1-trichloroethane, dichloromethane
Benzene (causes cancer)	toluene, cyclohexane, ketones
Pesticides (causes various effects on body)	"natural" pesticides such as pyrethrins
Organic solvents (causes various effects on body)	water-detergent solutions
Leaded glazes, paints, pigments (causes various effects on body)	versions that do not contain lead

3. ***Engineering control***: are strategies designed to protect workers by removing hazardous conditions or by placing a barrier between the worker and the hazard. They are control methods that are built into the design of a laboratory, equipment or process to minimize the hazard.

4. Work Practices (administrative control)

They include altering the way in which a procedure is done, monitored and/or restricted.

-Using proper labelling and signage to communicate the hazard to others

-Conducting monthly lab self-inspections to regularly eliminate any noticeable hazards

-Having an emergency plan: consider "What if...." Then, train lab users before an emergency happens,

-Restricting the length of time that a person is exposed to noise, a particular substance or a specific activity,


SAFETY FIRST
Keep this area clean


WASH HANDS BEFORE LEAVING LABORATORY


MAKEUP


NO SMOKING, EATING, OR DRINKING


NO
LOOSE CLOTHING
LOOSE SCARVES
LONG HAIR EXPOSED


NOTICE
CLEAN UP SPILLS IMMEDIATELY

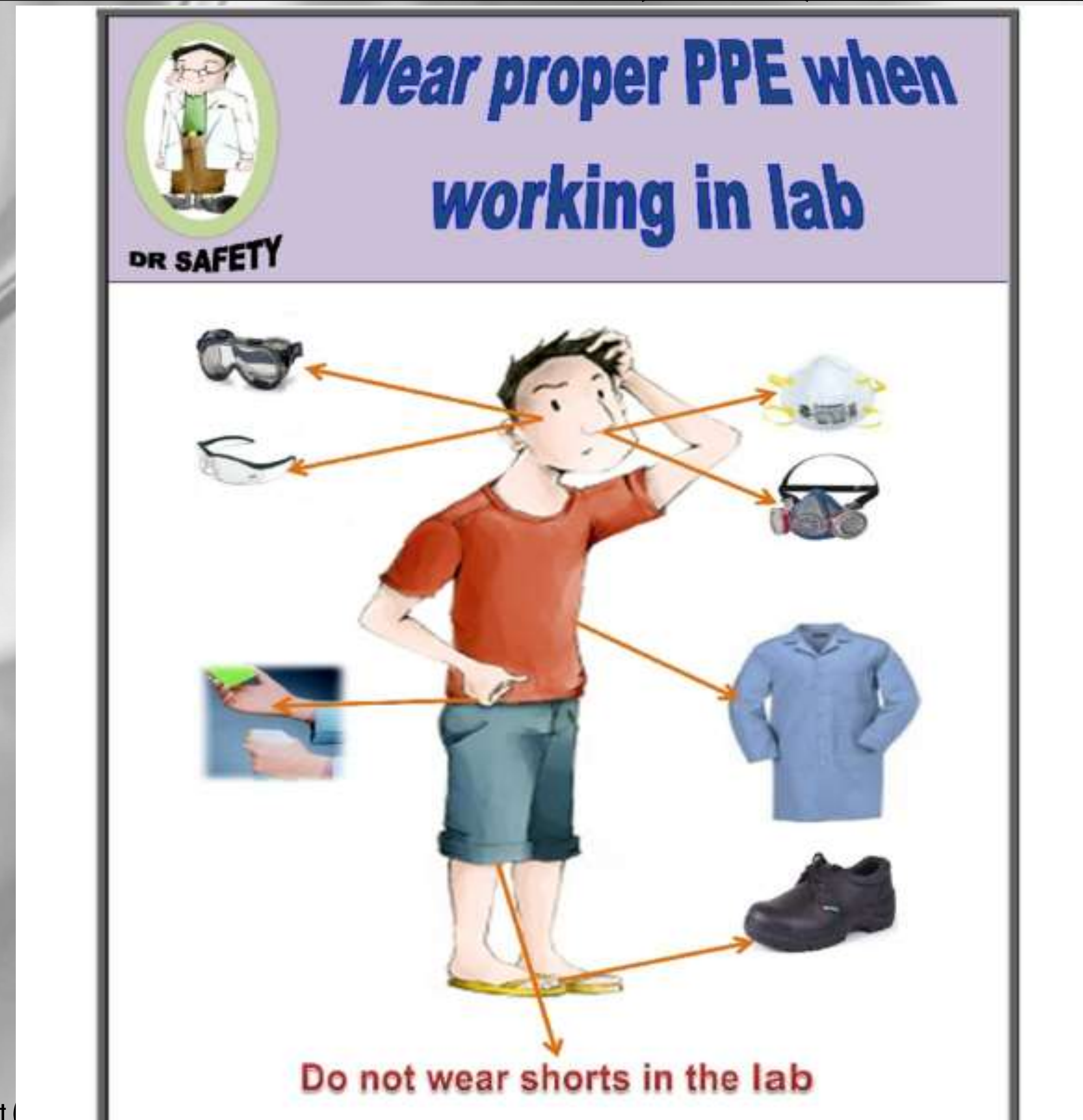

DO NOT BLOCK


NOTICE
NO OPEN TOE SHOES


Do not work alone

5. PERSONAL PROTECTIVE EQUIPMENT (PPE)

Where exposure cannot be prevented by other means, the application of individual protection measures including PPE.



ENGINEERING CONTROLS

Engineering controls are physical changes to work stations, equipment, materials, production facilities, or any other relevant aspect of the work environment that reduce or prevent exposure to hazards.

Or

possible interventions that are intended to reduce worker exposure, to chemical, physical and biological agents through the use or substitution of engineered machinery or equipment.

In the laboratory examples could include:

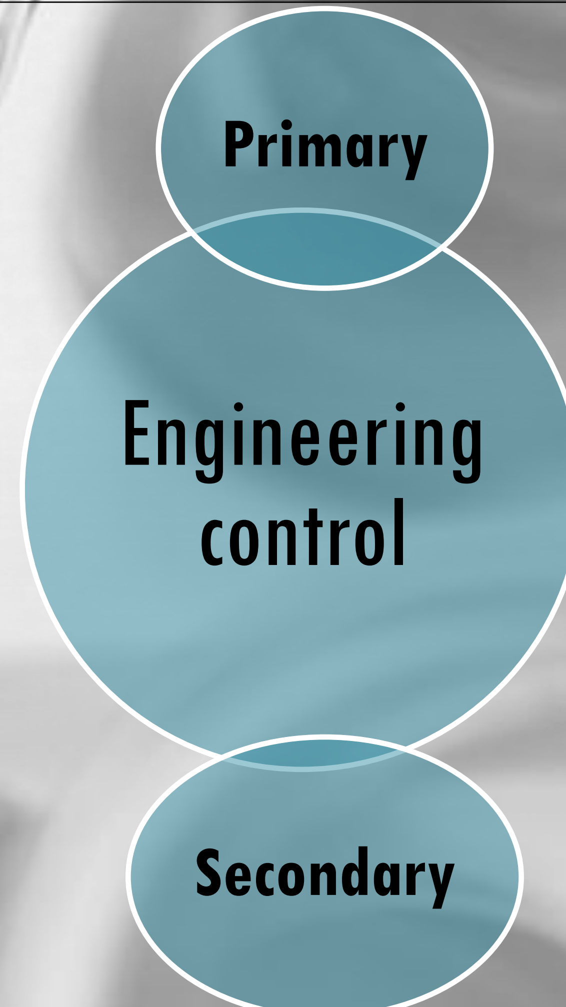
Biosafety Cabinets, **Airflow Systems**, **Workspace Layout**

ENGINEERING CONTROLS

- Engineering controls are a very reliable way to control worker exposures as long as the controls are designed, used and maintained properly.
- They are preferred over administrative and personal protective equipment (PPE) for controlling existing worker exposures in the workplace because they are designed to remove the hazard at the source, before it comes in contact with the worker.

CLASSIFICATION….?

Primary contain the agent at the source



Secondary protect the personnel or the environment in case of release from primary containment

EXERCISE……

Biosafety cabinets

Puncture proof sharps container

Engineered self-locking syringe

Plastic test tubes

Sealed, unbreakable, leak-proof containers.

Building ventilation system

Laboratory separated from areas that are open to unrestricted access

Directional airflow

Doors

Locks

Effluent decontamination systems

Engineered traffic flow patterns

Sealed windows with safety glass

Controlled access systems (locks, alarms, card readers, etc.),

Backflow prevention

Autoclave

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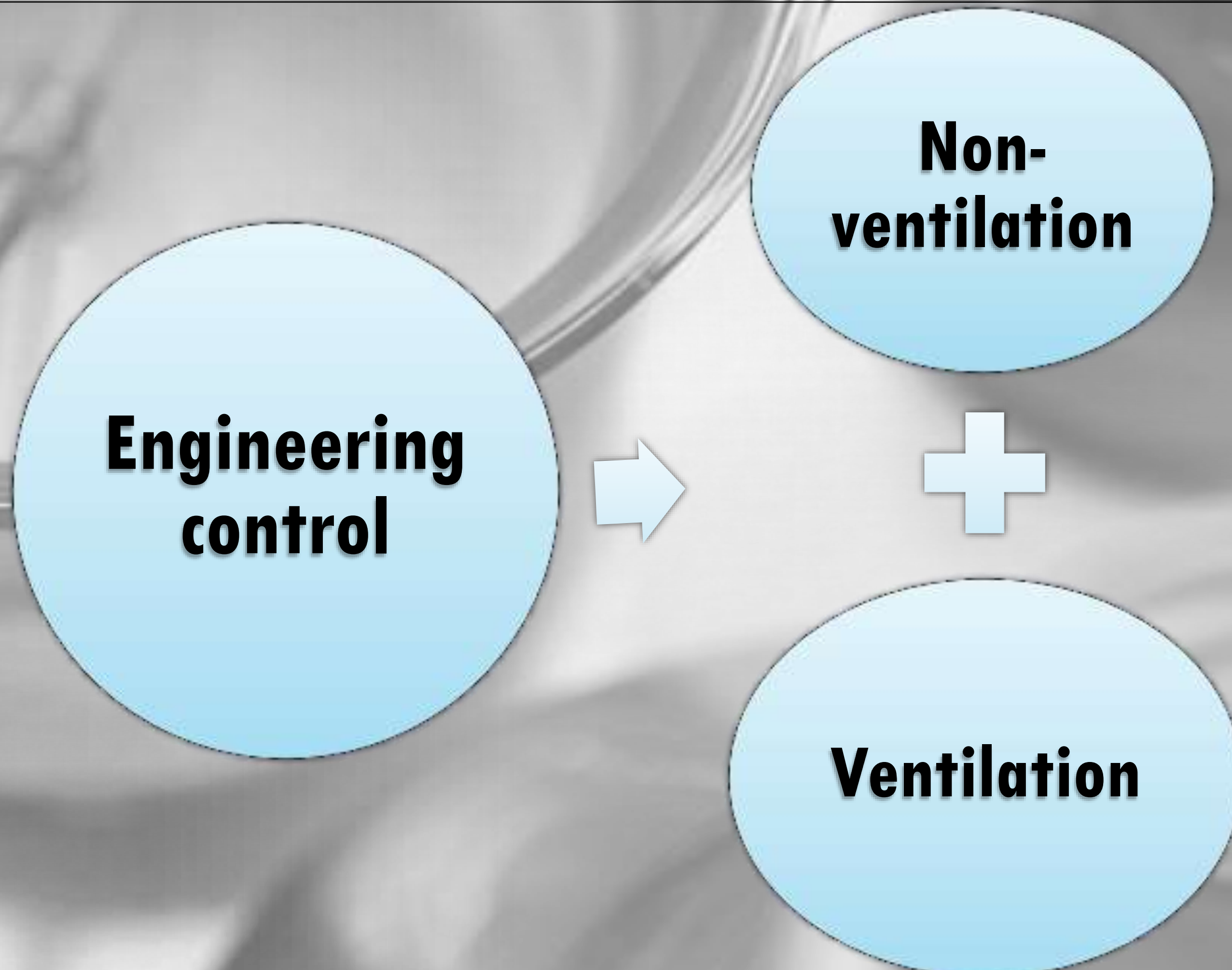
TYPES AND DESIGN OF ENGINEERING CONTROL



NON-VENTILATION ENGINEERING CONTROLS

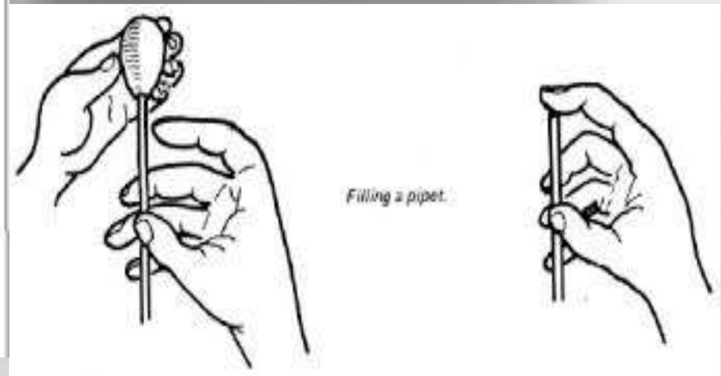
- Non-ventilation controls have the capability to reduce or eliminate process emission rate, for example the use of well fitting lids to liquid containers. They can range from enclosures, seals, and handling aids.

Types of Non-ventilation engineering controls

- (a) ***Process control/substitution***
- (b) ***Enclosure and/or isolation of emission source.***

PROCESS CONTROL

Process control involves changing the way a job activity or process is done to reduce the risk.



Examples of process changes include to:

- Use pipette instead of mouth
- Use wet methods rather than dry when drilling or grinding.
- Use an appropriate vacuum or "wet method" instead of dry sweeping
- Use electric motors rather than diesel ones to eliminate diesel exhaust emissions.

ENCLOSURE AND ISOLATION

These methods aim to keep the contaminant "in" and the worker "out" (or vice versa).

- Enclosed equipments
- Abrasive blasting cabinets, or remote control devices

The enclosure itself must be well maintained to prevent leaks.

VENTILATION CONTROL

it is designed to control the contaminant once it has been released.

It is probably the most widely used method to control airborne contaminants in the workplace

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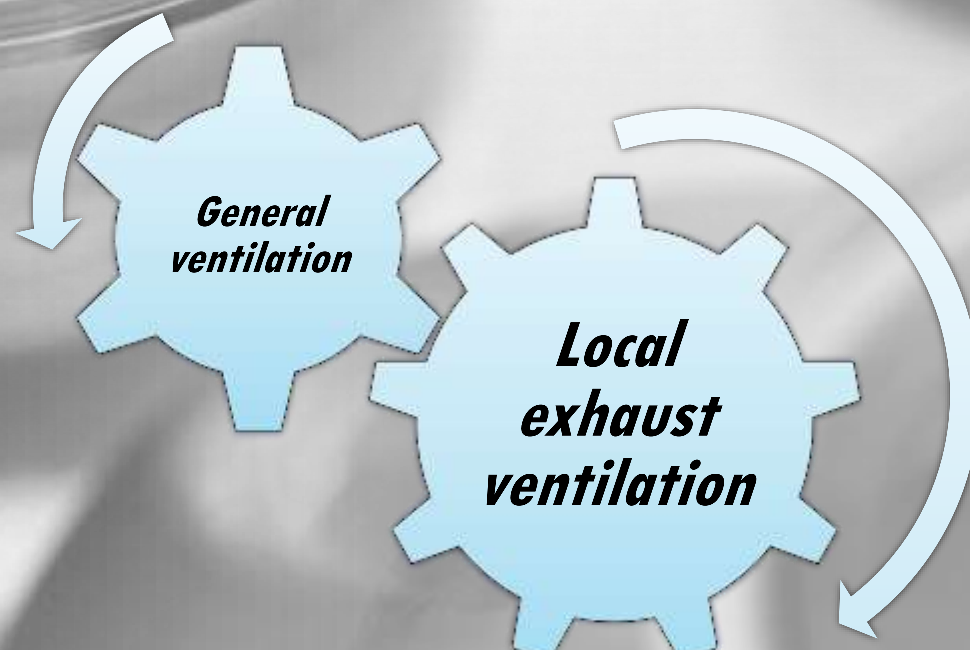


- **General Ventilation:** is the introduction of clean air into the workplace that eventually replaces the contaminated air.

General ventilation can be subdivided into two further types:

(a) dilution ventilation and (b) displacement ventilation

- ***Dilution ventilation***: this involves mixing the clean air that is continually introduced in to the workplace uniformly with the contaminated air in order to dilute the contaminant concentration to an acceptable level.
- Its application is limited to low toxicity sources that are usually diffused throughout the workplace and where the workers are a sufficient distance from the source(s).
- ***Displacement ventilation:*** is where air is introduced with the aim of replacing the contaminated air by clean air with little or no mixing. In practice this is difficult to achieve, particularly over large areas and therefore needs specialist assistance.

Ventilation equipments

Fume Hoods

When to use?

- When working with extremely volatile chemicals
- High probability of chemical vapors

Designed for use with large amounts of chemicals

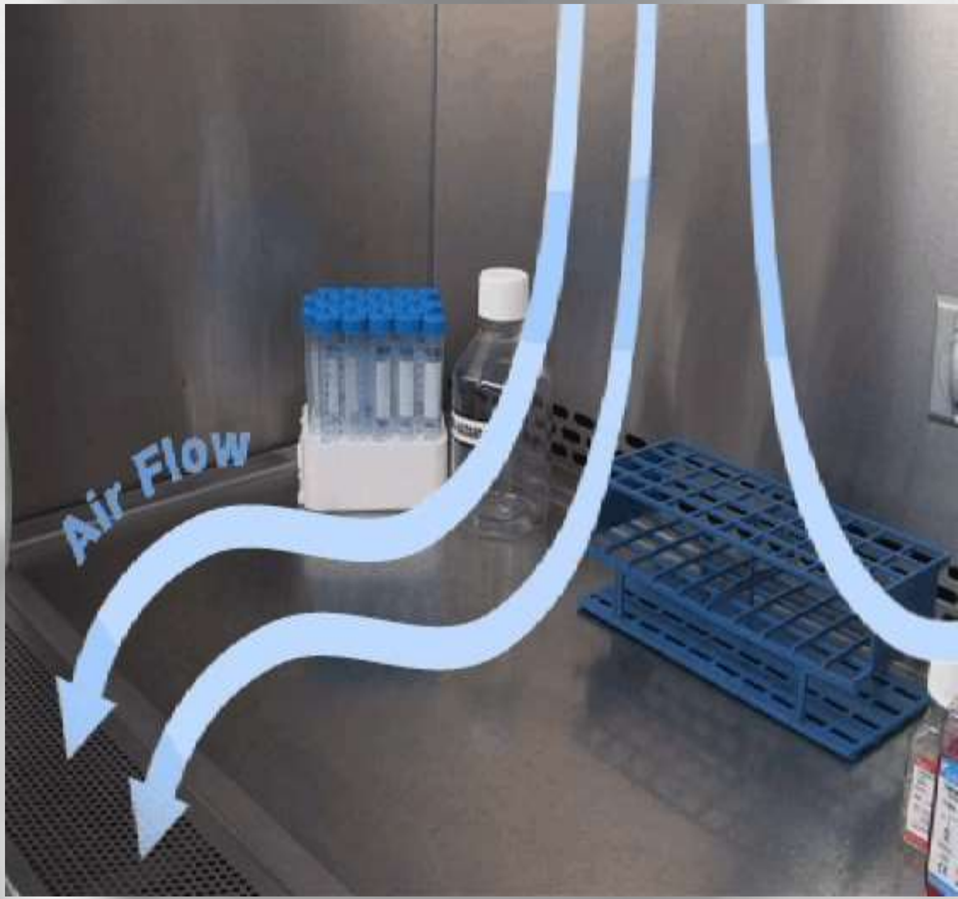
- Provides personnel protection through inward airflow through the sash opening
- Does **not** provide any product protection since contaminated air

from the laboratory is drawn directly over the work surface

- Does **not** provide any environment protection (typically no HEPA

LAMINAR FLOW HOOD

- The laminar flow hood provides an aseptic work area while allowing the containment of infectious splashes or aerosols generated by many microbiological procedures

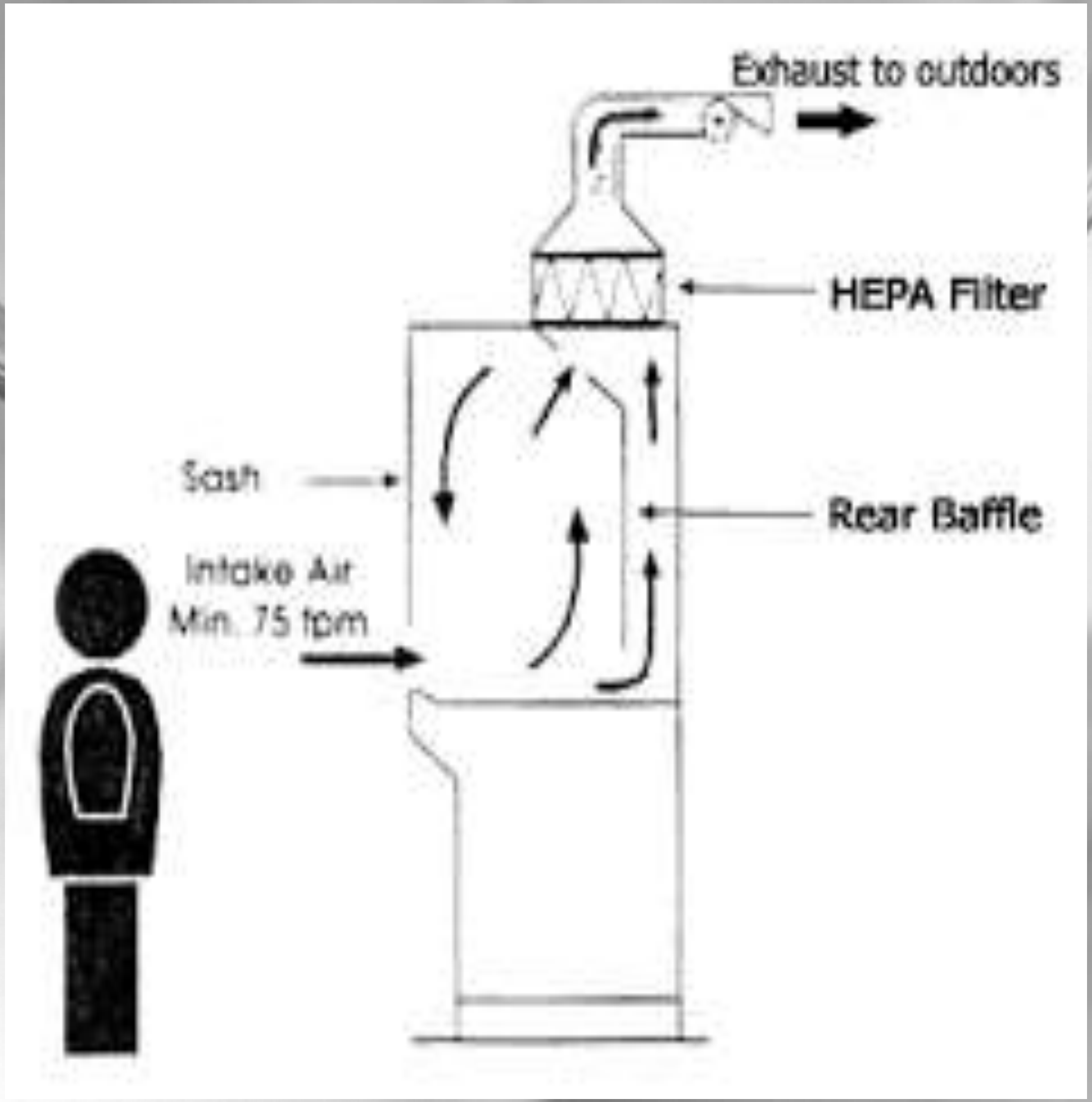


- Laminar flow hoods protect the working environment from dust and other airborne contaminants by maintaining a constant, unidirectional flow of **HEPA-filtered air** over the work area.

BIOSAFETY CABINETS (BSC)

Synonyms -- **biological safety cabinet**, **microbiological safety cabinet**

is an enclosed, ventilated laboratory workspace for safely working with materials contaminated with (or potentially contaminated with) pathogens requiring a defined **biosafety** level.


Exhaust to outdoors
HEPA Filter
Sash
Rear Baffle
Intake Air
Min. 75 fpm

Demonstrating airflow differences between class II Biological Safety Cabinets and Laminar Flow Hoods.

Multimedia Protocols in Bioscience

Viral and Human Genomics Laboratory

CA García Sepúlveda MD PhD

Facultad de Medicina
Universidad Autónoma de San Luis Potosí
Mexico

HEPA (HIGH EFFICIENCY PARTICULATE AIR)

- All engineering control employing ventilation uses HEPA filters
- The key feature that provides protection is the use of HEPA filters
- In BSC., HEPA filters are one of the most important engineering controls in a biocontainment.
- Airflow into the workspace of the BSC is HEPA filtered as is exhaust air from the BSC.
- HEPA filters capture and remove particles from the air

HEPA FILTERS

- Filters 0.3 microns particles at minimum efficiency of 99.97%
- Filter all other particles bigger or smaller at an efficiency greater than 99.77%

viruses are smaller than 0.3 microns and therefore readily captured.

Bacteria are larger than 0.3 microns andtherefore also readily captured by a HEPA filter.

- HEPA filter do not filter out gases, chemicals and vapours

HOW HEPA WORKS?

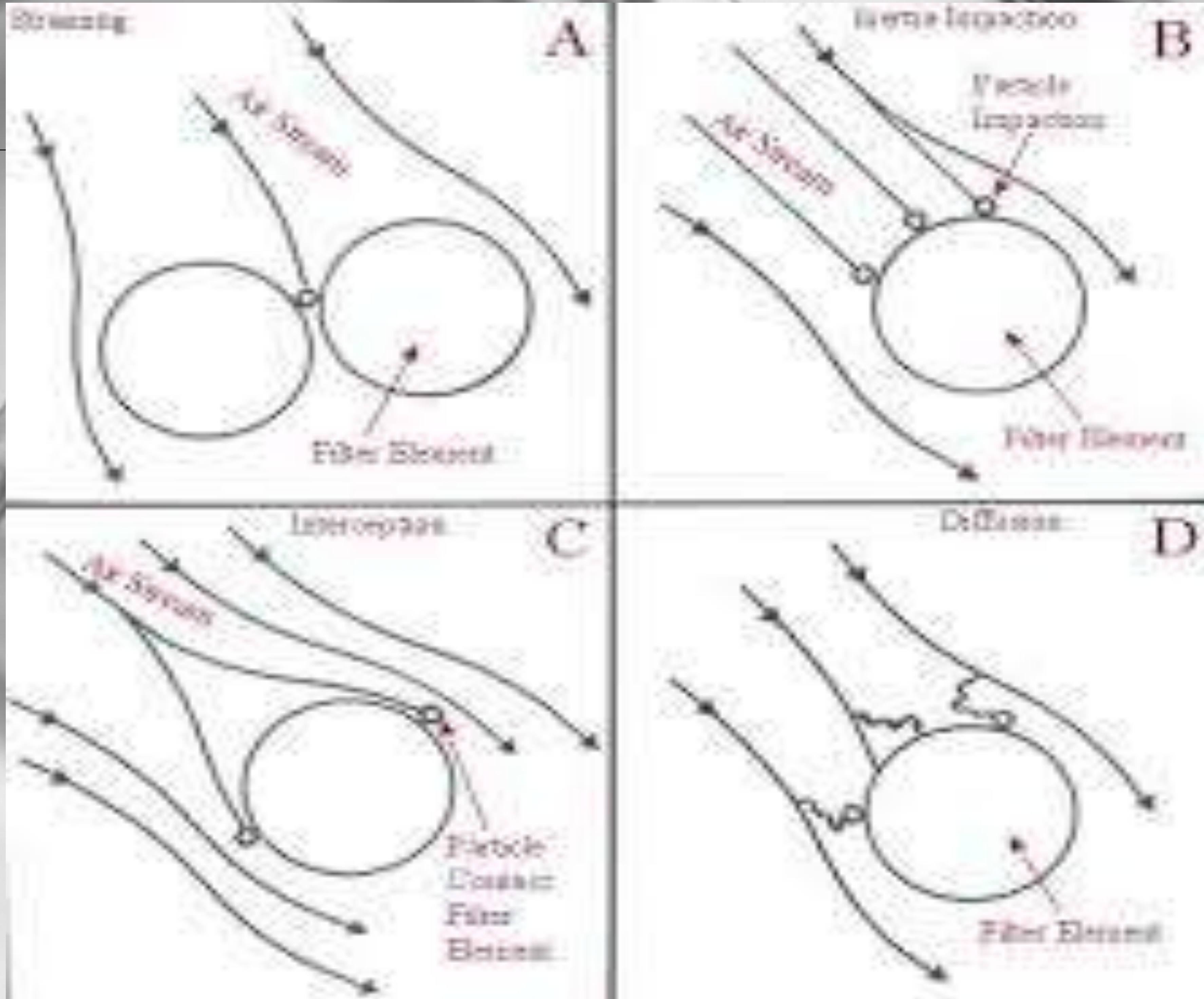
1. Straining/sieving: (most common) extremely large particle will become trapped between two filters.

2. Impaction: large, heavy particles (> 0.4 μm) follows the air flowstream in a straight line and collides into the fiber becomes embedded/trapped.

3. Interception: mid-sized particle follows a follows the curve of the air flow stream and bends through the fiber spaces. The particles are generally intercepted or captured when they touch the fiber.

4. Diffusion: the smallest particles (< 0.1 μm diameter) collides with the gas molecules inside the filter thus slowing it down and will be stopped by either interception or impaction.

5. Electrostatic: the air purification method uses static electricity to move and attract particles and causes the stuck particles to fall


A
Air Stream
Filter Element
B
Air Stream
Filter Element
C
Air Stream
D
Filter Element

LABORATORY EQUIPMENT

CENTRIFUGE

- When changing out rotors, make sure they are secured/locked (i.e. some models click-lock into place and other's must use a key to lock it in to the centrifuge).
- Also, prior to running the centrifuge, observe the manufacturers maximum speed capacity (i.e. the maximum rotational speed/force that the rotor can take) and inspect the rotor for cracks and pitting (if any are found, do not use it).

CENTRIFUGE SAFETY

- Follow recommended maintenance schedules
- Balance motor carefully
- Wash rotor with mild detergent
- Routinely decontaminate rotors and centrifuge interior with appropriately disinfectants
- Use secondary cups when spinning infectious agents
- Load and unload rotors/safety cups containing infectious materials inside a BSC
- Wipe off the outside of each secondary container with a suitable disinfectants

TRANSPORT CONTAINER

- Robust, leakproof, unbreakabkle, autoclavable
- Used to transport infectious agents with lab facilities
- Load and unload in a BSC
- With exterior with appropriate disinfectants
- Autoclave in between use

AUTOCLAVES

POOR ENGINEERING CONTROLS

[redacted]

SAMPLE QUESTIONS

- Give an account of hazard control system and its hierarchy
- Discuss the perfect way to reduce biological hazards when elimination and/or substitution of hazard fails
- Discuss with examples different types of engineering control system

END OF LECTURE……

Thanks for listening

Wish you best of luck in your programs