Learning Outcomes:

At the end of the presentation, students should:

1. Understand **principles** of biosafety.
2. State **routes and sources** of laboratory infection.
3. Describe **general consideration** when working in the lab.
4. Define **procedure** for handling a patient specimen of known potential infection hazard.
5. Define **Biocontainment term**.
6. Define **barriers** used by laboratories to protect workers and others from infection.
7. Describe the **biological safety cabinets**.
8. Classify of infective microorganisms by **risk group**.
9. Describe the **Four biosafety levels**.
What is Biosafety?

- Principles and practices employed to protect laboratory personnel and the environment from exposure or infection while working with living organisms, biological materials, or agents.

- Included are any materials that may be potentially infectious.

- Includes recombinant DNA research.
Principles of biosafety

To protect:

- The patient
- Yourself
- The environment
Biological Safety in Laboratories

**Routes of Laboratory Infection**

- Aerosol inhalation
- Ingestion
- Injection by syringe
- Absorption through skin
- Absorption through cuts/ abrasions
Sources of Laboratory Infection

These can contain hazardous bacteria, viruses, fungi or parasites and all lab. Samples should be treated as potentially dangerous in routine clinical labs.

- Blood samples
- Urine samples
- Sputum samples
- Tissue samples
- Faeces samples

Research labs. Must be aware of their work hazards and risk to the staff
General considerations-

See additional file

1. Before working in the lab, each technologist must be immunized against potentially infective diseases that may be transmitted from patients and biological samples such as; hepatitis.

2. Consider ALL patients specimens are a serious source of infection.

3. Always wear personal protective materials.

4. NEVER EAT, DRINK, SMOKE, CHEW GUM IN THE LAB

5. Never wear the normal head gear (eqal & ghutra) during working in the lab.

6. Always wash your hands thoroughly with an antiseptic, bactericidal soap before and after wearing gloves.

7. Never wear the lab coat outside the lab except for work connected with the lab work.

8. Dispose off needles and sharp objects in the sharps disposal bin.

9. Ensure that the lab has eye-wash kit and solution.

10. The lab must have a suitable antiseptic, bactericidal, fungicidal and antiviral solution (Na hypochlorate; colorox, cidex or any suitable bleach) to remove and decontaminate spills from specimens.
Procedure for handling a patient specimen of known potential infection hazard.

See additional file

1. All materials for collection must be sterile and disposable.
2. Wear proper protection gear.
3. Wash your hands thoroughly with an antiseptic, bactericidal soap before and after wearing gloves.
4. Collected specimen must be placed in tightly sealed double bag.
5. Both the specimen container and the bag must be clearly labelled with proper warning sign e.g. BIOLOGICAL HAZARD HEPATITIS RISK OR HIV RISK.
6. The request form should be placed in another bag accompanying the specimen and it must bear the same warning sign as the specimen.
7. All needles, syringes, gloves, masks, aprons, gowns, hair cover and overshoes that were used during collection must be placed in a special biohazard bag which bears proper warning and sealed properly and taken for incineration.
8. When the specimen arrives in the lab, it must be placed in the safety cabinet until analysis.
9. The specimen may be analyzed by its own in separate run or may be placed to be the last in a normal routine run.

10. In the analyzer it must be followed by a hypochlorate (or any disinfectant) wash.

11. All pipettes, centrifuge, analyzers and any other device used for the specimen must be thoroughly disinfected and cleaned with hypochlorite or other strong disinfectant.

12. After finishing with the specimen, place it in a double plastic bag which must then be tightly sealed and labelled as BIOHAZARD and taken for incineration.

14. If storage of the specimen is required, then the tightly sealed double bag must be placed in a sealed rigid plastic box then place in a specified area in the fridge or freezer.
DEALING WITH ACCIDENTS AND INJURIES

(Please read from the additional file)

- NEEDLE STICK INJURY
- CHEMICAL SPLASH ON THE SKIN
- SPLASH ON THE EYES
- RESPIRATORY HAZARD
- INGESTION OF CHEMICALS
- GENERAL HEALTH PRECAUTIONS
- PREGNANT WOMEN
- FIRST AID BOX
Biocintainment

- Safe methods for managing infectious materials in the laboratory environment where they are being handled or maintained.

- The purpose of containment is to reduce or eliminate exposure to potentially hazardous agents.

- Exposure could involve not only laboratory workers but other individuals working close by and the outside environment.
The three elements of containment include:

- laboratory practice and technique (Primary barrier).
- safety equipment (Primary barrier).
- facility design (secondary barrier).
Primary containment is the protection of personnel and the immediate laboratory environment from exposure to infectious agents. Primary containment is provided by both good laboratory technique and the use of appropriate safety equipment.

- For example, Personal protective equipment (PPE) such as gowns, face shields, masks, and gloves and biological safety cabinets, and fumehood offer protection when used properly in conjunction with good laboratory techniques.
Primary Barriers - Equipment

- **Personnel Protection**
  - Any aerosol generated within the cabinet is contained and kept away from the researcher

- **Product Protection**
  - Air within the work space of the cabinet has been filtered so that it is virtually free of airborne particles and organisms; thus protecting the work from outside contamination

- **Environmental Protection**
  - Aerosols generated within the unit are removed from the air before the air is discharged
Ventilation Equipment-Classes and Types

- Chemical Fume Hoods
- Biological Safety Cabinets
- Isolators
- Clean Benches

- Class I BSCs
- Class II BSCs
- Class III BSCs
- Class II Type A1 BSCs
- Class II Type A2 BSCs
- Class II Type B1 BSCs
- Class II Type B2 BSCs
A- Chemical Fume Hood

- Offer only personnel protection
- Always exhaust air to the outside
- **Do not offer protection to the product** or the environment, as there is no filtration of intake and exhaust air (Sometimes air cleaning treatment is added to the exhaust.)
- Do draw contaminants in the laboratory air directly over the product being worked on
- **Used for work with chemical hazards**
Clean Bench / Laminar Flow Hoods

- Provide product protection only
- Product protection is provided by creating a unidirectional airflow generated through a HEPA filter
- Discharge air goes directly into workroom
- Applications
  - Any application where the product is not hazardous but must be kept contaminant free
  - Preparation of non-hazardous intravenous mixtures and media
  - Particulate free assembly of sterile equipment and electronic devices
Clean Bench / Laminar Flow Hoods

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Biological Safety in Laboratories

Class I

- Provide operator and environmental protection but gives no product protection.

- Class I cabinets are open-fronted safety cabinets.

- The air is drawn from the room into the work opening and it passes the operator and the product before it leaves the cabinet via a HEPA filter. Normally ducted to atmosphere.
Class II

- Give both Operator and Work protection with Laminar downflow for work and inward airflow for operator.

- Must not be confused with simple Laminar flow cabinets.

- Single exhaust filter, or Direct duct connection to extract system.
Class II

- Give both Operator and Work protection with Laminar downflow for work and inward airflow for operator.
- Must not be confused with simple Laminar flow cabinets.
- Single exhaust filter, or Direct duct connection to extract system.
Class III

Class III Cabinets

Inlet

HEPA Fan

Anti blow-back valve + alarm

Exhaust

HEPA

Pre-filter

Fan

Inlet HEPA

Pre-filter
# Primary Barriers

<table>
<thead>
<tr>
<th></th>
<th>Personnel</th>
<th>Product</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Chemical Fumehood</strong></td>
<td>x</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Laminar Flowhood</strong></td>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td><strong>Class I Biosafety Cabinet</strong></td>
<td>x</td>
<td></td>
<td>x</td>
</tr>
<tr>
<td><strong>Class II Biosafety Cabinet</strong></td>
<td>x</td>
<td>x</td>
<td>x</td>
</tr>
<tr>
<td><strong>Class III Biosafety Cabinet</strong></td>
<td>x</td>
<td>x</td>
<td>x</td>
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</tbody>
</table>
Secondary Containment

- **Secondary containment**: structural aspects of the laboratory that make working environment safer against infection - Outside and inside the laboratory.

- Secondary containment is provided by a combination of facility design and construction.

  Example: Ventilation systems, controlled access, airlocks, Lockable doors, Sink, Bench tops impervious and easily cleaned, Eyewash.
<table>
<thead>
<tr>
<th>Risk Group</th>
<th>Individual risk</th>
<th>Community risk</th>
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</thead>
<tbody>
<tr>
<td>1</td>
<td>no, low</td>
<td>no, low</td>
</tr>
<tr>
<td>2</td>
<td>moderate</td>
<td>low</td>
</tr>
<tr>
<td>3</td>
<td>high</td>
<td>low</td>
</tr>
<tr>
<td>4</td>
<td>high</td>
<td>high</td>
</tr>
</tbody>
</table>
Risk Group 1

- Unlikely to cause animal or human disease
- Non pathogenic agent
Risk Group 2

- Pathogenic for humans
- Unlikely a serious hazard
- Treatment and preventive measures available
- Limited risk of spread of infection
Risk Group 3

- Pathogenic, cause serious disease.
- Little person-to-person spread.
- Effective treatment and preventive measures usually available.
Risk Group 4

- Lethal, pathogenic agent
- Readily transmittable
  - direct, indirect
- Effective treatment and preventive measures not usually available
Biosafety containment levels

- Biosafety levels
  - Level 1 & 2: basic laboratories
  - Level 3: containment laboratories
  - Level 4: high containment laboratories

- Each level associated with appropriate
  - Equipment, practices, work procedures

- Diagnostic and health-care laboratories must be biosafety level 2 or above
Example of biosafety sign posted outside lab working with infectious agents

- Lab’s biosafety level
- Infectious agents under study
- Contact information for responsible person and 2 emergency contacts
Containment level 1

- BSL-1 laboratories are used to study agents not known to consistently cause disease in healthy adults.
  - E.Coli
- They follow basic safety procedures and require no special equipment or design features.
  - Instruction in lab. Procedures
  - Easy to clean
  - Lab. door closed during work
  - Lab. Coats to be worn
  - No eating, drinking, smoking
  - No mouth pipetting
  - Minimise aerosols
  - Wash hands before leaving lab.
  - Safe storage of waste material
  - Report all accidents
Containment level 2

- **BL2** - microorganisms of moderate potential hazard, transmitted by contact, ingestion, puncture
  - *Salmonella*, herpesvirus

- Training in handling pathogens
- Work supervision
- Autoclave in same building
- Special lab. Coats
- Biohazard cabinets should be used
- Disinfecting after use.
Containment level 3

BL3 - microorganisms that cause serious disease, transmitted by inhalation.

- *M. tuberculosis*, yellow fever virus, hantavirus, *Y. pestis* (plague)

- Full training
- High work supervision
- Restricted access to lab.
- “Biohazard” labels
- Negative pressure room
- Laboratory autoclave
- Gloves must be worn
- Biohazard cabinets must be used
- Double door entry.
Containment level 4

- **BL4** - microorganisms that cause lethal disease, with no known treatment or vaccine
  - Ebola virus, Marburg virus

- Code of practice/ safety officer
- Specific training/ full supervision
- Lab. must be sealable
- Separate building
- Negative pressure vi- Entry via airlock
- Use Class III safety cabinet
- Install airlock and shower.
- Interlocked air inlet/ exhaust
- Complete clothing change
- Double ended autoclave
- All waste to be made save
<table>
<thead>
<tr>
<th>BSL</th>
<th>Laboratory type</th>
<th>Laboratory practices</th>
<th>Safety equipment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Basic teaching, research</td>
<td>Good microbiological techniques</td>
<td>None</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Open bench work</td>
</tr>
<tr>
<td>2</td>
<td>Primary health services; diagnostic services, research</td>
<td>Good microbiological techniques, protective clothing, biohazard sign</td>
<td>Open bench PLUS biological safety cabinet for potential aerosols</td>
</tr>
<tr>
<td>3</td>
<td>Special diagnostic services, research</td>
<td>As BSL 2 PLUS special clothing, controlled access, directional airflow</td>
<td>Biological safety cabinet and/or other primary devices for all activities</td>
</tr>
<tr>
<td>4</td>
<td>Dangerous pathogen units</td>
<td>As BSL 3 PLUS airlock entry, shower exit, special waste</td>
<td>Class III biological safety cabinet, positive pressure suits, double ended autoclave (through the wall), filtered air</td>
</tr>
</tbody>
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