A brief introduction to Biosafety

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Biological Safety - Biosafety

The aim of Biosafety is to reduce or eliminate accidental exposure to, or release of, infectious agents (includes Bacteria, Fungi, Viruses, Parasites and cell cultures)
What are the major biological hazards in laboratories?

Risk of Infection from:-
Deliberate culture of various agents
Virus vector work - e.g. AAV, Adenoviruses, Retroviruses
Clinical Samples, bloods, histology specimens, FACS etc
Zoonosis (agents that can infect animals and humans)
Cell culture - risk mainly from adventitious agents that may be present in primary cultures

(risks may be altered by Genetic Modification)

Biological experiments with Carcinogenic, Teratogenic or Toxic chemicals/agents
WHO Classification of infective microorganisms by risk group

Risk Group 1 (no or low individual and community risk)

Risk Group 2 (moderate individual risk, low community risk)

Risk Group 3 (high individual risk, low community risk)

Risk Group 4 (high individual and community risk)
Risk group allocation

Based on degree of hazard to the individual, community and environment.

Degree of Hazard determined by:-

Infectivity

<table>
<thead>
<tr>
<th>Disease or agent</th>
<th>Infectious Dose</th>
<th>Route of Infection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Measles</td>
<td>0.2</td>
<td>Inhalation</td>
</tr>
<tr>
<td><em>Shigella flexneri</em></td>
<td>180</td>
<td>Ingestion</td>
</tr>
<tr>
<td><em>Vibrio cholerae</em></td>
<td>$10^8$</td>
<td>Ingestion</td>
</tr>
</tbody>
</table>

Ease of Transmissibility

Result of infection

Host Range of agent

Availability of treatment/vaccine
Risk Group/ Hazard Group 1

*E. Coli* K12
*Saccharomyces cerevisiae*
Adeno-associated virus
*Bacillus subtilis*
Baculovirus

Secondary Schools, Undergraduate teaching etc, Basic research

Risk Group/ Hazard Group 2

8 human herpesviruses - HSV, VSV, EBV, CMV, HHV6,7 & KSHV
ETEC, UroTEC
Adenovirus (all 50+ human serotypes)
*Corynbacteria diphtheria*
*Neisseria meningitidis*
*Staphylococcus aureus* (including MRSA)
Ringworm

Most research laboratories, primary healthcare labs, teaching
**Risk Group 3**

Vibrio cholera (783 cases and 8 deaths Senegal 05/05)
Herpes B virus (upgraded to level 4 in some lists)
HCV, HBV, HIV (cf EU/UK and US)
*E coli* O 157 (cf EU/UK and US)
*Shigella flexnerii*
*Mycobacterium tuberculosis*
*SARS*

**Risk Group 4.**

Hemorrhagic fever viruses such as:-
Rift Valley Fever (264 cases and 109 deaths in Tanzania up to 05/07); Marburg (423 cases and 357 deaths in Angola 06/05); Ebola (12 cases and 1 death in Republic of Congo 05/05)
*Smallpox*

Some clinical path labs; a specialist laboratory facility

High spec, specially built, relatively few worldwide but numbers increasing
Controlling the risks

Biosafety Levels 1–4

- Provide increasing levels of personnel and environmental protection;
- Guidelines for working safely in laboratories using biological agents

and describe combinations of:–

Laboratory Practices and Techniques
Safety Equipment including PPE (Primary Barriers)
Laboratory Facilities (Secondary Barriers)

Work with a particular agent is assigned to one of these 4 categories
Biosafety Levels 1-4

Laboratory Practices and Techniques
Knowledgeable/Responsible supervisor

Personnel Aware of potential hazards and proficient in practices/techniques - training arrangements

Biosafety manual (local code of practice) specific to lab

1. Introduction
2. General procedures
3. Operation of unit
4. Local rules
5. Waste - cradle to grave
6. Staff health
7. Testing and maintenance
8. Emergency procedures
Biosafety Levels 1–4

Laboratory Practices and Techniques

Basic Protective Procedures

Include:-
1. tying long hair back, wearing PPE appropriately (eye protection, laboratory coats, gloves, closed shoes, glasses rather than contacts in some circumstances)
2. always using appropriate pipetting devices (no mouth pipetting)
3. never eating or drinking in the laboratory
4. never applying cosmetics, handling contact lenses or placing objects (fingers-nail biting, pencils etc) in the mouth or touching the face, avoid using mobile phones
Controlling the risks - Safety Equipment

Class II Biosafety Cabinets
Facility Design

- Easily cleaned and decontaminated, including benchtops
- Sink for handwashing
- Sturdy furniture
<table>
<thead>
<tr>
<th>Containment Measure</th>
<th>Containment levels</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2</td>
</tr>
<tr>
<td>Workplace separation</td>
<td>No</td>
</tr>
<tr>
<td>Air In and Out HEPA filtered</td>
<td>No</td>
</tr>
<tr>
<td>Access restricted</td>
<td>Yes</td>
</tr>
<tr>
<td>Sealable to permit disinfection</td>
<td>No</td>
</tr>
<tr>
<td>Special disinfection procedure</td>
<td>Yes</td>
</tr>
<tr>
<td>Air -ve to wrt outside</td>
<td>No</td>
</tr>
<tr>
<td>Efficient vector control</td>
<td>Yes (for animal work)</td>
</tr>
<tr>
<td>Surfaces impervious to water easy to clean</td>
<td>Yes for bench</td>
</tr>
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**UK COSHH biological agents measures 1-8 (of 14)**
SUMMARY

The risk group of an organism gives a good indication of which level of containment and what procedures are necessary

i.e. A risk group 2 agent requires BSL2/Physical containment level 2 - e.g. Adenoviruses, Lentiviruses etc

Other features of the activity may modify the requirements e.g. HIV, HBV or simple diagnostics

GM work can present novel hazards

For GM work and activities at class 2 or above a full RISK ASSESSMENT is often required
Integrated Laboratory Safety

Plans for next 12-18 months:-

To introduce a two tier review and audit system for lab safety as a whole:

Not to look at Biosafety on its own but all aspects of laboratory safety as a whole

Self Inspection Checklists - fairly detailed. Will be provided by the safety office, can be modified to suit needs.

Safety Office Audit - every 1-3 years - risk based dependant to some extent on new personnel.