

Overview of Occupational Hazards in Biotechnology

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- Biological: viruses, bacteria, fungi, parasites, animals.
- Chemical
- Physical

Biological Hazards

- Viral Pathogens
 - Not all viruses used in labs are human pathogens
 - May be wild type, altered or attenuated in some way (such as vaccine strains)
 - May be rendered replication deficient (able to infect a cell, but unable to reproduce)
 - May have only part of the genome.
 - May be recombinant (contain a gene from another species).

Biological Hazards

- Viral Pathogens: Routes of Exposure
 - Aerosolization (respiratory exposure)
 - Skin contact
 - Mucous membrane exposure

Biological Hazards

- Viral Pathogens: pre- and post-exposure considerations.
 - Is there a licensed vaccine available to prevent infection from a lab virus?
 - Are there approved anti-viral medications which can be used as post-exposure prophylaxis (such as acyclovir, amantidine, oseltamivir, etc.)?

Biological Hazards

- Bacterial Pathogens
 - Again, not all bacteria are human pathogens
 - May be wild type or attenuated in some way
 - Routes of exposure are the same as for viruses (respiratory from aerosolization, skin contact, mucous membrane exposure).

Biological Hazards

- Bacterial Pathogens: pre- and post-exposure considerations.
 - Is there antibiotic susceptibility data available for the bacteria being used (in order to guide clinicians in post exposure prophylaxis)?
 - Is there a vaccine available?

Biological Hazards

- Lab Animals:
 - Are the species known to harbor zoonotic agents (such as sheep and Q fever, macaque monkeys and B virus)?
 - Are the species known to cause allergic sensitization (particularly rodents)?

Biological Hazards

- Lab Animals: pre- and post exposure considerations.
 - Allergy surveillance program
 - Up to date tetanus boosters
 - Appropriate access to medical facility for treatment of bites.

Biosafety Containment Levels

- Risk Groups are defined by NIH Guidelines.
- RG1: Agents that are not associated with disease in healthy adult humans (Bacillus subtilis, E. coli K-12). Used in BL1 labs (lowest level containment).

Biosafety Containment Levels

- RG2: Agents that are associated with human disease which is rarely serious and for which preventive or therapeutic interventions are often available (S. aureus, S. pneumoniae, adenoviruses, influenza, EBV). Requires BL2 containment.

Biosafety Containment Levels

- RG3: Agents that are associated with serious or lethal human disease for which preventive or therapeutic interventions *may be* available (high individual risk but low community risk). Examples include: Yersinia pestis, HIV, Japanese encephalitis, Creutzfeldt-Jacob, etc.

Biosafety Containment Levels

- RG4: Agents that are likely to cause serious or lethal human disease for which preventive or therapeutic interventions are *not usually* available (high individual risk and high community risk). Examples include Ebola, other hemorrhagic fever agents, Simian B virus, smallpox. Requires BL4 containment: In U.S., only at CDC, Fort Detrick, MD, and soon (?) Boston, MA.

Biosafety Containment Levels

- BL 2+: Used for agents that are technically RG2 but require more careful handling or have unknown long term effects: BL3 procedures performed in a lab with BL2 engineering, usually with limited access. Commonly used with lentiviruses and other human retroviruses.

Chemical Hazards

- OSHA regulated: most commonly methylene chloride
- Chemicals for which pre-ER treatment may be available: cyanide compounds, phenol
- Other commonly used chemicals (mostly organic solvents).
- “Potent” compounds: substances which can cause adverse health effects at low dosages (most commonly chemotherapeutic agents)

Commonly Used Organic Solvents

- Acetonitrile: used as a reagent in high pressure liquid chromatography (HPLC)- a process used to identify components of nucleic acids. Converted in vivo to cyanide.
- Methylene Chloride: Organic solvent used in HPLC processes. Converted in vivo to carbon monoxide.

Commonly Used Organic Solvents

- Hexane: In biotech, used in HPLC processes. Potent neurotoxin.
- Dimethyl Formamide: HPLC reagent. Hepatotoxin, facilitates absorption of other compounds across the skin.
- Dimethyl Sulfoxide: Used as a “universal solvent” because of the many compounds that can be dissolved into it. Facilitates absorption of other compounds across the skin.

Other Chemical Hazards

- Ethidium Bromide: used in gel electrophoresis for nucleic acid sequencing: mutagen.
- Ethanol spray for disinfecting benches and biological safety cabinets- may be an issue for pregnant lab workers.
- Other irritants: Beta-mercaptoethanol (used in gel buffers) and trifluoroacetic acid (HPLC reagent).

“Potent” Compounds

- Chemotherapeutic agents currently FDA approved which are used in research (paclitaxel, etc.).
- Toxins produced by biological agents (*Clostridium difficile*, botulinum, snake venom).
- Novel proteins produced by recombinant technology for which there is no safety information.
- Prostaglandins and other inflammatory mediators.
- Hormones and other endocrine disruptors.

Physical Hazards

- Radiation
 - Isotopes
 - machine produced radiation (e.g. x-ray and proton beams).
- Lasers
- Ergonomics (awkward postures while pipetting in a biological safety cabinet or repetitive hand/wrist motion in animal husbandry or surgery).
- Lifting (especially animal facilities with heavy cages and feed bags).

Challenges in Health Screening and Surveillance in Biotechnology

- Broad range of potential exposures
- Experiments and projects change frequently
- Employees’ job tasks change frequently
- High turnover of employees

Challenges in Health Screening and Surveillance in Biotechnology

- New/novel proteins/substances with little or no toxicity data
- Lack of specific markers of exposure
- Employee resistance
- Budget constraints

