

4.0 CHAPTER 4 – INFECTIOUS AGENTS

4.1 Infectious Agents and the Lab Worker

A laboratory-acquired infection was defined by Sulkin and Pike (1951) as one that resulted from laboratory work, whether it occurred in a laboratory worker or in another person who happened to be exposed as a result of research or clinical work with infectious agents. **If you are immune compromised you are at a much higher risk of acquiring infections and you should meet with Occupational Health for a medical consultation to determine your risk of infection.**

4.2 Work with Infectious Agents at UCSB

Research or teaching activities involving infectious agents must be conducted with prior approval by the Institutional Biosafety Committee. Researchers and students must follow requirements as specified in the [CDC/NIH Biosafety in Microbiological and Biomedical Laboratories Manual](#) THE LINK SHOULD BE TO THE 4TH EDITION BMBL as the minimum containment required for this work. Containment requirements may be subject to modification by the IBC.

4.2.1 Storage of Infectious Materials

Infectious materials must be clearly identified and stored in such a manner as to preclude accidental exposure. This normally includes double containment and labeling the freezer/refrigerator.

A number of infectious agents have been documented as causes of laboratory-acquired infections. They include bacterial, viral, chlamydial and rickettsial, and parasitic organisms, as listed below:

4.2.2 Principal Bacterial Infections

- **Brucellosis** (This has the dubious distinction of being the most frequently acquired lab infection.)
- **Typhoid fever**
- **Tularaemia**
- **Tuberculosis** (Lab-acquired TB has defied definition because its mode of spread, its prevalence and incidence in the general population, the opportunities for exposure outside the lab and its long incubation period make it difficult to determine the source of infection.)
- **Leptospirosis** (Rodents and dogs, which are common lab animals, are the natural reservoir of leptospira.)
- **Shigellosis**
- **Salmonellosis** (Some of the reported cases have been unusual in some respect, such as those involving *Salm. abortus equi*, *Salm. Senegal*, and

that in which the infecting strain of *Salm. typhimurium* was thought to have become avirulent.)

- **Diphtheria**
- **Rat bite fever** (The causative agents of this disease, *Streptobacillus moniliformis* and *Spirillum minus*, are found in rodents.)
- **Glanders and melioidosis** (Glanders, a disease of horses transmissible to man, and melioidosis, acquired from rodents in the Far East used to be considered similar, but their causative agents are now considered to be unrelated. Causative organisms are *Loefflerella mallei* for glanders, and *Burkholderia pseudomallei* for melioidosis.)
- **Cholera**
- **Plague**
- **Syphilis, gonorrhea and chancre** (Lab-acquired infections are non-venereal, being cutaneous or ophthalmic.)

4.2.3 Other Bacterial Infections

Anthrax

Bordetella pertussis

Campylobacter

Clostridia

Erysipeloid

Escherichia coli

Hemophilus

Leprosy

Listeria

Meningitis (Neisserial)

Mycobacteriosis (After accidental inoculation with *M. marinum*. Chappler et al. 1977.)

Mycoplasma

Pasteurella (other than plague)

Relapsing fever

Serratia

Staphylococcus aureus

Streptococci

Vibrios (other than cholera)

4.2.4 Viral Infections

Hepatitis (This has been one of the most frequently reported infections. There are at least 5 official types of hepatitis viruses: Hepatitis A, B, C, D and E. Principal investigators are required to offer medically-supervised hepatitis B vaccinations to lab workers within 10 days of the latter starting work in the lab.)

Venezuelan equine encephalitis

Kyasanur Forest disease

Rift Valley fever

Vesicular Stomatitis
Chikunguya fever
Yellow fever
Coxsackie B
Marburg disease
Yaba and Tanavirus
Japanese encephalitis
Louping ill
Junin
Simian B virus
West Nile
Colorado tick fever
Pitchinde virus
Lymphocytic choriomeningitis
Influenza
Orungo disease
Poliovirus
Wesselbron virus
Piry fever
Mucambo fever
Adenoviruses
Russian spring summer encephalitis
Congo-Crimean fever
Dengue fever
Oropouche fever
Newcastle disease
Omsk hemorrhagic fever
Western equine encephalitis
Germiston fever
Kunjin fever
Bhanja fever
Catu fever
Hantaan (Hanta, Korean hemorrhagic) fever
Eastern equine encephalitis
Lassa fever
Pseudorabies (also known as Aujeszky's disease of cattle)
Rabies
Mumps

Other laboratory-acquired viral infections, reportedly occurring less commonly than those listed above include the following (numbers in parenthesis): Human Immunodeficiency Virus, Mayoro (5), Caraparu (5), Spondweni (4), St. Louis encephalitis (4), Bunyanwera (4), Zika (4), Semliki Forest (3), Powassa (2), Dugbe (2), Apeu (2), Marituba (2), Tacaube (2), Machupo (1), Ebola (1), Issk-kul (1), Kautango (1), Muructucu (1), O'nyong nyong (1), Modoc (1), Oriboca (1), Ossa (1), Keystone (1), Bebaru (1) and Bluetongue (1).

4.2.5 Chlamydial and Rickettsial Infections

Q fever

Psittacosis

Trachoma

Typhus (epidemic and murine)

Scrub typhus

Rocky Mountain spotted fever

4.2.6 Fungal Infections

Coccidioidomycosis

Cryptococcosis

Dermatomycoses

Histoplasmosis

Sporotrichosis

Blastomycosis

4.2.7 Parasitic Infections

Toxoplasmosis

Malaria

Trypanosomiasis

Babesiosis

Giardiasis

Isosporiosis

Fascioliasis

Cryptosporidiosis

Prions

Prions are proteinaceous infectious particles that lack nucleic acids. Prions are composed largely, if not entirely, of an abnormal isoform of a normal cellular protein.

The Prion Diseases

Disease	Natural Host	Prion
Scrapie	sheep and goats	scrapie prion
Transmissible mink encephalopathy (TME)	mink	TME prion
Chronic wasting disease (CWD)	mule deer and elk	CWD prion
Bovine spongiform encephalopathy (BSE)	cattle	BSE prion
Feline spongiform encephalopathy (FSE)	cats	FSE prion
Exotic ungulate encephalopathy (EUE)	nyala and greater kudu	EUE prion
Kuru	humans	kuru prion
Creutzfeldt-Jakob disease (CJD)	humans	CJD prion
Gerstmann-Sträussler-Scheinker syndrome	humans	GSS prion

(GSS)		
Gatal familial insomnia (FFI)	humans	FFI prion

Microorganisms can enter the body through the mouth, the respiratory tract broken or intact skin and the conjunctivae. It should be noted that in laboratory-acquired infections, the route may not be the same as when the disease is acquired naturally.

Infectious materials and cultures of microorganisms accumulate in large amounts in clinical and microbiological laboratories and, as it is necessary to transfer them from one container to another and to manipulate them in various ways, the potential hazards are much greater than in most other occupations. Nevertheless, according to UCSB EH&S and IBC requirements, documented, deliberate effort must be exerted by Principal Investigators and lab workers to make certain that nobody is exposed to biohazards.

4.3 Modes of Infection

Modes of infection can be classified into two categories:

4.3.1. Infections preceded by overt personal accidents, which include:

- A. Inoculation (resulting from pricking, jabbing or cutting the skin with contaminated instruments such as hypodermic needles, scalpels and glassware; and from animal bites or scratches).
- B. Ingestion (resulting from mouth-pipetting, eating, drinking and smoking, which is why these practices are not permitted in the lab).
- C. Splashing into the face and eyes.
- D. Spillage and direct contact.

4.3.2. Infections not preceded by personal accidents:

- A. Aerosols, droplets and fomites. These are speculated (from Pike's 1976 data) to be responsible for up to 82 percent of all laboratory-acquired infections. Aerosols are defined as a cloud of very small liquid droplets produced whenever energy is applied to a liquid, and such liquid is allowed to escape into the environment. It has been shown (Wells, 1934) that if the liquid contains infectious agents, these would be distributed in the aerosol and would remain viable for some time. The larger droplets (greater than 0.1 mm in diameter) will settle quickly and contaminate the surfaces upon which they come to rest. The smaller droplets do not settle but evaporate very rapidly. It was found that those with diameter of 0.1 mm would evaporate in 1.7 seconds, and those with a diameter of 0.05 mm would evaporate in 0.4 seconds.

The infectious agents in the droplets remain in a dried state as "droplet nuclei" or fomites. The smaller the number of organisms

and amount of dried material, the longer they will remain airborne, and they are moved around buildings by air currents generated by ventilation and people traffic.

It has been shown that many laboratory techniques using both simple and complex mechanical equipment, as well as laboratory accidents, produce aerosols. These include: use of microbiology loops, pipettes, syringes and needles, opening tubes and bottles, use of centrifuges and blenders, harvesting of eggs and other virological procedures, lyophilization, and breakage of cultures.

There are many regulations in place to forestall the problem of laboratory-acquired infections. However, the responsibility for compliance with the regulations still lies primarily with the Principal Investigator and, secondarily, with the laboratory staff.

In addition, it is crucial for the PI and laboratory groups to always bear in mind that a large number of organisms that would ordinarily be innocuous can be infective in immunocompromised persons. Therefore, additional and more stringent measures must be established by the PI in an effort to prevent the occurrence of lab-acquired infections in such individuals.