Biological Hazards:

Exposure to biological hazards in the workplace results in a significant amount of occupationally associated disease. Work related illnesses due to biological agents such as infectious microorganisms, biological allergens, and toxins have been widely reported. However, in many workplaces their presence and resultant illnesses are not recognized. It has been estimated that the population at risk from occupational biohazards may be several hundred million workers worldwide. The principles of hazard identification, assessment, classification, and control and the diverse environments associated with biological exposures are examined. Material on current topics in biological safety including bloodborne pathogens, tuberculosis, bioterrorism, legionellosis, building-related bioaerosol problems, organic dust toxic syndrome, mycotoxins, endotoxins. In a review of occupational biohazards, noted that some 193 biological agents are known to produce infectious, allergenic, toxic, and carcinogenic reactions in workers.

Most of the identified biohazardous agents belong to the following groups:

➢ Microorganisms and their toxins (viruses, bacteria, fungi, and their products): infection, inflammatory disease, or allergic reaction

➢ Arthropods (crustaceans, arachnids, and insects): bites or stings resulting in skin inflammation, systemic intoxication, transmission of infectious agents, or allergic reaction

➢ Allergens and toxins from higher plants: dermatitis from skin contact or allergic rhinitis or asthma as a result of inhalation

➢ Protein allergens from vertebrate animals (urine, feces, hair, saliva, and dander): hypersensitivity and inflammatory disease

➢ Other groups that pose a potential biohazard include lower plants other than fungi (lichens, liverworts, and ferns) and invertebrate animals other than arthropods (parasites such as protozoa, flatworms such as Schistosoma, and roundworms such as Ascaris)

Factors Affecting Infection and Exposure:

The following factors can affect the type of infection and exposure that workers encounter.

- **MODES OF TRANSMISSION**

The principal modes of transmission for infectious microorganisms and other biological materials include contact transmission (direct or indirect), vector-borne transmission, and airborne transmission. Direct contact of an infected person with another person is rare in the laboratory environment, but such transmission occurs commonly in the community and in medical settings where patients are treated. Animal to-human (zoonotic) transmission through bites and scratches can occur when animals are associated with work activities. Spills or splashes of infectious materials (gross contamination) onto a receptive site such as an open wound, cut, eczematous skin, or mucous membranes are an effective means of transmitting microorganisms. Indirect transmission occurs when common environmental surfaces (such as equipment, work benches, or laboratory accessories) become contaminated, and the infectious material is transferred to a host.

Vector-borne infection results when a causative agent is transmitted to a host mechanically or biologically by a living vector (such as a mosquito or tick) through a bite, directly through the skin in rare cases, or by mechanical means. Biological transmission involves propagation, multiplication, cyclic development, or a combination of these in the host before the arthropod can transmit the infective form of the agent. Infected ticks and mosquitoes have transmitted Rocky Mountain spotted fever, malaria, and yellow fever to investigators in the laboratory and in the field and are a potential hazard for other outdoor workers. The inhalation of airborne infectious particles into the respiratory system constitutes airborne transmission. This mode is important in the transmission of certain pathogens such as M. tuberculosis.

- **ROUTES OF ENTRY**

The routes of entry for microorganisms associated with occupationally-acquired infection include inhalation, ingestion, penetration through skin (intact or non-intact), and contact with the mucous membranes of the eyes, nose, and mouth. Many technical procedures (such as pressurizing liquids, sonicating, and grinding or sawing

infectious materials), equipment, and spills in the workplace release microbes into the air, where workers can inhale them.
Ingestion of infectious materials can occur when workers mouth-pipet or suction infectious materials or by hand-to mouth contamination as the result of eating, drinking, smoking, or applying cosmetics in contaminated work areas. Hand-washing minimizes the opportunity for oral and ocular exposure.

- **INFECTIOUS DOSE**

The infectious, or infective, dose is the number of microorganisms required to initiate an infection. Although there are data available from animal studies on ID50 (the number of organisms needed to infect 50 percent of a test population), only a modest amount of information exists for humans.

- **AGENT VIABILITY AND VIRULENCE**

The viability and virulence of an agent are also important in determining whether a person becomes infected. If a microorganism is not viable and able to replicate, the opportunity for infection does not exist. The external environment is critical in the replication of microorganisms. Factors such as temperature, humidity, and the presence or absence of growth factors or other chemicals all play an important role in viability. For example, some bacterial agents, such as Bacillus anthracis, are capable of producing spores that survive under adverse conditions, and agents such as M. tuberculosis or S. aureus are unaffected by drying and remain viable on environmental surfaces, whereas other agents such as the herpes viruses are very susceptible to drying.
The virulence, or relative pathogenicity, of microorganisms varies greatly among types and strains. Some microbes are highly pathogenic, even in healthy adults, whereas others are opportunistic pathogens, able to infect only hosts with lowered immunity or sites other than their normal habitat.

- **HOST SUSCEPTIBILITY**

Host susceptibility is often underestimated because the majority of persons working with potentially infectious material are healthy.

HAZARD CONTROL:

The process of developing controls to prevent or minimize occupational exposure to infectious agents or other biological agents becomes straightforward once the actual risk of work with the organism or agent is known and the risk category established. Prevention of exposure to potentially infectious agents can be achieved by source control, minimization of accidental release, and protection of the worker. Containment or barriers, used along with the other components of a comprehensive biosafety program, provide the means to work with biological agents without adverse effect.

DECONTAMINATION

The protection of personnel and the environment from exposure to infectious agents and the prevention of contamination of experimental materials by a variable, persistent, and unwanted background of microorganisms is an integral part of good microbiological procedure. Decontamination, the use of physical or chemical means to render materials safe for further handling by reducing the number of organisms present, must be differentiated from disinfection, a process that kills infectious agents outside the body. Neither of these terms should be confused with sterilization, which implies complete elimination or destruction of all forms of microbial life.

Chemical disinfectants inactivate microorganisms by one or more of a number of chemical reactions, primarily coagulation and denaturation of protein, lysis, or inactivation of an essential enzyme by either oxidation, binding, or destruction of the enzyme substrate. The level of effectiveness of chemical disinfectants is altered by changes in the concentration of active ingredients, contact duration, temperature, humidity, the concentration of organic matter, and the pH of the material being disinfected. Chemical disinfectants, classified by their active ingredients, include halogens, acids and alkalis, alcohols, heavy-metal salts, quaternary ammonium compounds, phenolics, aldehydes, ketones, and amines. The most frequently used disinfectants in the workplace include sodium hypochlorite (household bleach), isopropyl or ethyl alcohol, iodophors (Wescodyne), and phenolics (Lysol and amphyl).