

# Safety Guidelines for Handling and Sampling Rodents

## Chapter 7



# Infectious Disease Surveillance

- In the spring of 1993, a cluster of human cases of adult respiratory in the southwestern United States came to the attention of public health officials. The rapid progression of the disease and the high case-fatality caused alarm. Numerous agencies working together soon identified the infectious agent and how it was spread. It was identified as a hantavirus that infected rodents. The virus is named Sin Nombre virus (SNV) and the disease that it cause is called hantavirus pulmonary syndrome (HPS). The main reservoir species in the Southwest is the deer mouse, *Peromyscus maniculatus*. Although the deer mouse is the primary reservoir of SNV, other species if rodents may serve as hosts for SNV or other hantaviruses.
- The main mode of infections to humans is thought to be inhalation of infectious airborne virus excreted in urine, feces, and saliva from infective rodents. Exposure is most likely to occur when contaminated soil, litter, or nesting materials when they are stirred up into the air within a poorly ventilated space.
- Disease surveillance cannot be achieved by simple observation of rodents, but capturing is needed. People who handle rodents as part of surveillance efforts place themselves at an increased risk of contact with infectious materials. Those who participate in these surveillance activities should educate themselves on proper safety precautions and adhere strictly to them to reduce the risk of infection.



# Safety Guideline Objectives



These guidelines are informational and are intended for people who handle rodents as part of ecological and epidemiological studies of rodent or small mammal populations where exposure to an infectious zoonotic agent (e.g. hantavirus, plague) could be possible. Check with your agency if an approved institutional animal care and use protocol is required.

Individuals must obtain a Scientific Collecting Permit from the California Department of Fish and Wildlife.

# Trapping and Processing Rodents

- In addition to knowledge of the risks posed from handling live and dead rodents, principles of humane treatment of mammals should be practiced by all persons conducting disease surveillance and research.
- Care and handling of rodents.
  - Mammals should always be collected and handled using humane procedures and professional judgment that maximize the scientific data obtained from a minimum of individuals or samples, while causing minimal pain or distress. Trapped animals should be collected and processed in a timely manner to minimize the stress of capture. After processing, animals should be released at their site of capture as soon as possible.

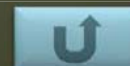


- Threatened habitats and species.

- Local, state, and federal regulations govern scientific collecting, transport, and possession of all specimens taken. Individuals collecting mammals for scientific study must comply with all relevant laws and regulations. Ignorance of the law or inadvertent violation of regulations is never a valid excuse and may result in prosecution. Persons who survey mammals in threatened habitats must proceed with sensitivity and careful judgment so that populations will not be adversely affected. The welfare of the threatened species should be the foremost concern.

- Collecting and transporting rodents.

- Live-capture traps, suitable for the rodent species to be captured, are preferred over kill-type traps for collecting specimens when blood samples are required. Traps in which rodents were captured should be disinfected as part of normal processing cleanup. No special clothing or equipment is required for setting and baiting clean traps, although a long-sleeved long pants, socks, and sturdy lace-up shoes are recommended for all field work. Workers checking or retrieving traps should wear rubber gloves in addition to normal field attire. When a closed trap is encountered, workers may carefully peer inside while holding the trap at arm's length. Traps containing rodents of the desired species should be placed in a plastic bag before transporting to the processing site, and kept out of direct sunlight to prevent overheating. Gloved hands should be washed or disinfected, and hands thoroughly cleaned after removing the gloves. Transport bagged rodents in the back of a pickup truck or other compartment isolated from passenger sections.





- Choosing a processing site.

It is essential to locate a processing area before trapping is begun. The field processing site should be in a secluded area, away from other humans or domestic animals. A table and other work surfaces should be of a nonporous material that can be easily disinfected and cleaned. Weather permitting, outdoor processing is preferred because of greater ventilation and penetration of natural ultraviolet light. All required equipment and supplies should be placed inside the processing area within easy access of protected workers. Only workers wearing proper safety attire should be permitted in the designated area once processing has begun. If processing must be conducted indoors, there should be adequate ventilation to the outside.



# Personal Protective Equipment



- Respirators.

- Because the primary mode of transmission of hantavirus to humans is through inhalation of infectious airborne virus, it is important that anyone working closely with potentially infected rodents wear a proper respirator. There are several different types of respirators that provide adequate protection against viral particles: maintenance-free (disposable) half mask respirators, reusable half mask respirators full-face respirators, and supplied-air respirators. Regardless of which type is used, the respirator should fit well, not be clogged or damaged, and provide adequate filtering of the smallest particles (N-100 or REPA filter designation). Some of the respirators require a respiratory fit test and a medical evaluation. The supplied-air respirators reduce the dangers of a poor fit, especially for users with facial hair, by supplying a continuous flow of filtered air from a battery-powered source through a head covering, across the face, and out the base of the head covering. These supplied air units (powered air purifying respirators, PAPRS) are more comfortable than the other half or full-mask negative pressure respirators, and also provide protection for the head, eyes, nose, and face. Respirators should receive regular maintenance and be checked for proper functioning before entering a hazardous area.



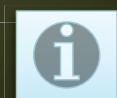
- Clothing. While conducting any field work, wear a long-sleeved shirt, long pants, socks, and shoes or boots. Disposable or non-disposable coveralls provide an additional level of safety while handling rodents. If the coveralls are non-disposable, they should be removed soon after completing rodent handling activities, placed in a plastic bag, and thoroughly laundered with hot soapy water before reuse.





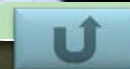


- Gloves. When handling traps that contain captured rodents or are potentially contaminated by rodents, a pair of thick rubber gloves should be worn. When handling rodents, disposable latex gloves (or another thin type of material that will not compromise dexterity) should be worn. If a tear occurs, a quick spray of disinfectant should be applied and a new glove placed over the tear. Gloves should be sprayed with a disinfectant before removal and hands washed after their removal.
- Eye protection. Individuals wearing a half mask respirator should also wear additional eye protection (e.g., safety glasses or goggles).
- Other. Rubber boots, disposable shoe covers, and other protective wear can be considered for use; all materials should be either disposable or readily disinfected.



# Anesthesia

- Invasive and non-invasive techniques can be used to sample tissues from live mammals. Humane considerations, professional judgment, and the scientific data desired will help determine which technique is appropriate. Any procedure that causes pain or significant distress mandates the use of an appropriate anesthetic.
- Animals should not be handled outside of traps unless they have been anesthetized. Inhalant anesthetics are recommended over injectables because they reduce or obviate the use of needles and legal logistics potentially required for using injectable drugs that are considered controlled substances.
- Animals in live-capture traps may be anesthetized by placing the entire trap into a plastic bag containing gauze or cotton soaked with an inhalant anesthetic.
- Anesthetics used in rodent surveillance are potentially hazardous to workers. Therefore, personnel should take care to minimize inhaling anesthetic during these procedures. Use inhalant anesthetics in well-ventilated areas and keep containers tightly closed.
- Currently Isoflurane is the more common inhalant anesthetic used because the animal is quickly anesthetized and also recovers quickly. Rodents should be carefully visually monitored for slowed respiration and lack of response to physical stimulation before removal from the jar.



# Blood Collection

- Aseptic techniques are challenging in the field, but cleanliness in all surgical and invasive techniques is essential to minimize the potential for infection and to provide reliable biological samples.
- Obtaining blood samples. Small blood samples (<1 ml) can be obtained from the retrobulbar sinus of anesthetized rodents. This technique requires practice and dexterity. Sampling from the retrobulbar sinus has the advantage of reducing the risk of needle-stick injury to the worker and being least injurious to the rodent. Cardiac puncture can also yield moderate amounts of blood from anesthetized rodents that will be euthanized (non-release studies).



# Syringes and Syringe Safety

- All syringes and needles should be kept in sterile condition and never be reused. Match the syringe and needle size to the approximate size of the rodent. For small rodents (e.g., deer mice) it is best to use a 1cc syringe with a 5/8-inch 25 gauge needle or approximate equivalent. For larger rodents (e.g., woodrats and squirrels) it is best to use a 3cc syringe with a 1-inch 23 gauge needle or approximate equivalent.
- Extreme caution should be used to avoid needle-stick injury. Use a clean needle and syringe for each animal, never replace the plastic cap on the needle, never remove the needle from the syringe after use, and never place your hand or finger in the path of the needle. Dispose of the needle and syringe in a leak-proof, puncture-resistant sharps container immediately after use. Use extreme care when expelling the blood sample into a blood tube/vial or onto a filter paper strip to avoid the splashing or aerosolization of blood.
- If a needle stick, bite, or other injury occurs which breaks the skin, stop work and cleanse the injury site with disinfectant. Leave the processing area, remove the glove or other skin covering, wash hands with soap and water while trying to express blood or fluid from the wound, and clean the site of injury thoroughly with disinfectant. Report the injury immediately to your supervisor. If swelling, pain, or discharge from the injury site occurs within 7-10 days, or fever, muscle aches, or other influenza-like symptoms appear within 45 days, seek medical attention and alert the attending physician to the possibility of infection.





# Clean-up and Disinfection

- Site clean-up

- After the processing of rodents has been completed, the processing area and all work surfaces, equipment, and remaining supplies should be sprayed and wiped down with disinfectant. All equipment should be allowed to air dry before handling and storage. All soiled paper towels, trap bedding, disposable gloves and clothing, and any remaining bait or feces should be placed in a plastic bag, sealed, and disposed of in accordance with state and local requirements. If processing was done indoors, the floor should be sprayed with disinfectant and the area well-ventilated before permitting access to persons without respirators.



- Trap clean-up

- Traps previously occupied by rodents should be disinfected and cleaned before reuse. With Sherman traps, this process is best done with 5-gallon buckets, one with disinfectant and another with rinse-water. A brush will aid in removing fecal material. After traps have been cleaned, disinfected, and rinsed, they should be allowed to air dry, preferably in the sun, before reuse or packing them away. When cleaning traps, wear heavy rubber gloves over disposable gloves to avoid sharp edges and any potential tears or punctures. Safety glasses or goggles should be worn to prevent splash-back of disinfectant into the eyes. Larger Tomahawk-type traps can be sprayed with disinfectant, cleaned, rinsed, and air-dried.

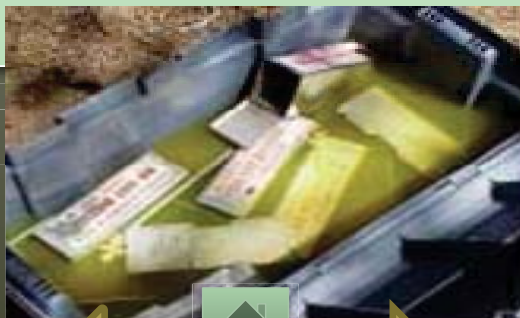






# Disinfectants

- The use of appropriate disinfectants is one of the easiest and most effective ways of reducing the risk of the spread of hantaviruses. Hantaviruses are sensitive to household bleach (dilute hypochlorite solutions), ammonium solutions, phenolics, detergents, and most all-purpose household disinfectants.
- An appropriate disinfectant should be used for:
  - Decontaminating traps that contained or were soiled by rodents.
  - Clean gloved hands before removal and disposal of gloves.
  - Disinfect any instruments used while processing rodents.
  - Disinfect or wipe down any work surfaces or other items which may have been contaminated.



# Transport and Disposal of Hazardous Waste

- All bagged waste material should be disposed of in accordance with state and local requirements.
- Full sharps containers should be turned over to a local hospital or laboratory for disposal in accordance with regulations for infectious materials.



# Packing and Shipping Specimens

- Packing and shipping of biologic specimens are strictly regulated and should be done in accordance with the latest regulations.
- All persons who transport infectious or potentially infectious materials must carry a current hauling permit from the California Department of Public Health, Medical Waste Management Program.



# Other Infectious Disease Concerns

- People conducting field work, collecting and handling of small mammals are at increased risk for many zoonotic infections. Precautions to prevent infection with hantavirus should also be effective in preventing other infections spread by aerosol or direct contact.
- Efforts to prevent flea and tick bites are very important. Ectoparasites can vector several infections from animals to humans including plague, Colorado tick fever, Lyme disease, babesiosis, anaplasmosis, Rocky Mountain spotted fever, and tularemia. When processing animals disposable gloves should be pulled over the cuffs of clothing and taped to deny fleas access to arms.



# Zoonotic Diseases Associated With California Vertebrates

Chapter 8





# Viral Diseases

- **Rabies**

- Agent: Rabies virus (*Lyssavirus*)
- Reservoir: Principally bats and skunks in California, though any mammal can become infected and transmit the virus.
- Transmission: Contamination of bite or scratch with virus-laden saliva of an infected animal.
- Symptoms/signs: Incubation 3-6 weeks, but can be several months. Symptoms are initially headache, fever, malaise. Continuing to weakness, paralysis, convulsions, delirium, Regularly fatal 2-7 days after onset.
- Diagnosis: Characteristic staining of brain tissue.
- Treatment: There is no treatment once symptoms arise. Prophylaxis is, vaccination prior or immediately following exposure to an infected animal.
- Significance: 1975-2014: 16 human rabies deaths, one survivor. In between 300-500 cases of rabies in terrestrial mammals are reported each year in California. Skunk and bat strains are endemic in California with these mammals representing 80% and 14% of positive animals.

- **Hantavirus pulmonary syndrome (HPS)**

- Agent: Sin Nombre virus (SNV) in western United States.
- Reservoir: Deer mice ( *Peromyscus maniculatus*). Maybe to a lesser amount other *Peromyscus* spp.
- Transmission: Inhalation of aerosolized virus-laden urine or feces of deer mice.
- Symptoms/signs: Incubation 1-2 weeks, rarely up to 6 weeks. Symptoms are initially flu-like: It progresses to a rapid onset of severe respiratory distress. Case-fatality is around 40%.
- Diagnosis: Serology or identification of SNV in lung tissue of fatal cases.
- Treatment: None specific. Support of cardiopulmonary function.
- Significance: There had been 69 cases of HPS in California residents (2014); approximately half with exposure likely in eastern Sierra Nevada. Deer mice prevalent throughout the state have an infection rate of about 11%.



- **Lymphocytic choriomeningitis (LCM)**

- Agent LCM arenavirus.
- Reservoir: House mouse (*Mus musculus*).
- Transmission: Virus is shed in rodent's urine and feces. Humans infected by consumption or inhalation of virus-contaminated excreta or contact with infected rodents.
- Symptoms/signs: Diverse symptoms include fever, headache, and muscle pain. Rash, neurologic symptoms, and arthritis may occur in some patients. Death rarely occurs.
- Diagnosis: Isolation of virus from blood or spinal fluid; serology.
- Treatment: None.
- Significance: No cases of LCM have been reported in California since it was made a reportable disease in 1996.

- **Arboviral encephalitides**

- Agent : West Nile virus (WNV), Western equine encephalomyelitis virus (WEE), St. Louis encephalitis virus (SLE).
- Reservoir: Wild birds.
- Transmission: Bite of infected mosquito, mainly (*Culex tarsalis*).
- Symptoms/signs: Most infected persons are without symptoms or with mild, flu-like illness. Some people, especially children and the elderly, develop fever, headache, neck pain and stiffness that may lead to severe neurological symptoms and possibly coma and death.
- Diagnosis: Serology.
- Treatment: None.
- Significance: WEE, WNV, SLE are enzootic in birds in California. Surveillance of mosquitoes and sentinel chicken flocks between late spring and autumn detect transmission of these viruses. Clinical cases of WEE/SLE are currently rare, but there are between 300-400 cases if WNV yearly in California.



# Rickettsial Disease

- **Anaplasmosis**

- Agent: *Anaplasma phagocytophilum*.
- Reservoir: wild rodents.
- Transmission: Bite of infected *Ixodes pacificus*.
- Symptoms/signs: Ranges from no symptoms to fatal fever, headache, muscle ache, and chills are common. Severe complications include neurologic symptoms and organ failure. Case fatality is 2% to 10%.
- Diagnosis: Observation of inclusion bodies on blood smear; serology.
- Treatment: Antibiotics (tetracyclines).
- Significance: Approximately 1-2 cases of anaplasmosis occur each year in California. Most cases have occurred in northern coastal counties. Illness in horses due to infection with *A. phagocytophilum* (formerly *Ehrlichia equi*) has been recognized in California since the 1960's.

- **Murine typhus (flea-borne typhus, endemic typhus)**

- Agent: *Rickettsia typhi*.
- Reservoir: Commensal rodents (*Rattus* spp.); in southern California, the opossum (*Didelphis virginianus*).
- Transmission: Contamination of bite from infected flea (*Ctenocephalides felis*) with flea feces.
- Symptoms/signs: Fever headache, chills, muscle ache, macular rash on trunk that spreads to most of the body. Case-fatality < 1%.
- Diagnosis: Serology.
- Treatment: Antibiotics (tetracycline).
- Significance: Typhus is enzootic in the opossum population of some regions of greater Los Angeles Basin.



- **Rickettsialpox**

- Agent: *Rickettsia akari*.
- Reservoir: House mouse (*Mus musculus*).
- Transmission: Bite of infected mite, *Liponyssoides sanguineus*.
- Symptoms/signs: Rash begins at mite bite site and spreads over the body, except palms and soles. Lymph nodes are often swollen.
- Diagnosis: Serology or immunostaining of skin lesions.
- Treatment: Antibiotics(tetracyclines).
- Significance: Incidence in California is unknown but is believed to be low. Risk would be greatest in areas where plentiful food stores or poor sanitary conditions support extensive *M. musculus* populations.

- **Rocky Mountain Spotted Fever**

- Agent: *Rickettsia rickettsii*.
- Reservoir: Wild rodents, occasionally domestic dogs, and ticks (*Dermacentor* and *Rhipicephalus sanguineus*).
- Transmission: Bite of infected *Dermacentor* spp. or *Rhipicephalus sanguineus*.
- Symptoms/signs: Serious disease can be fatal; fever headache, muscle ache, and chills are common. Rash on extremities spreading to the trunk 2-5 days after fever. Case fatality 20-80%.
- Diagnosis: Serology, PCR, immunohistochemistry of tissues.
- Treatment: Antibiotics ( tetracyclines).
- Significance: 1-3 confirmed cases each year are reported in CA.



# Bacterial Diseases

- **Salmonellosis**

- Agent: Numerous serovars of *Salmonella enterica*.
- Reservoir: Various wild and domestic animals. Pet reptiles are a frequent source of infection.
- Transmission: Consumption of fecal-contaminated water or food. Hand to mouth contact with infected animals.
- Symptoms/signs: Sudden onset of diarrhea, abdominal pain, nausea, headache, and fever. Symptoms usually subside in a few days. Rarely, may infect other organ systems.
- Diagnosis: Isolation of *Salmonella* organisms from feces.
- Treatment: None, usually from uncomplicated cases.
- Significance: 4000-6000 cases of salmonellosis are reported in California per year. This represents an underestimate of true incidence. The animal source of the infection is rarely definitively identified.

- **Plague**

- Agent: *Yersinia pestis*
- Reservoir: Wild rodents, primarily chipmunks, ground squirrels, and mice.
- Transmission: Saliva from bite of infected flea; contact with tissues, secretions, or respiratory particles from infected animals, especially domestic cats.
- Symptoms/signs: Most commonly fever, malaise, swollen painful lymph nodes. If untreated may progress to infection of blood and lungs. Case-fatality of plague pneumonia is >90%.
- Diagnosis: Serology, identification/culture of organism from lymph tissue, blood, sputum.
- Treatment: Antibiotics (Streptomycin, tetracyclines)
- Significance: Plague is enzootic in wild rodent populations in much of California. When epizootics occur, the risk for human infection increases. On average there are 1-2 cases of plague per year in California. Plague acquired through contact with an infected cat is more likely to be pneumonic and more likely to be fatal. It is also listed by the CDC as a Category A (top priority) bioterrorism threat agent.





- **Tularemia**

- Agent: *Francisella tularensis*.
- Reservoir: Rabbits and some rodents.
- Transmission: Handling of tissues of infected animals (esp. rabbits, beaver); ingestion of undercooked tissues of infected animals; consumption of contaminated water; arthropod bite (ticks, deerflies); rarely, inhalation of dust from contaminated soil or dried vegetable matter.
- Symptoms/signs: Variable by route of infection and biovar of organism. Most commonly, ulceration of skin and swollen lymph nodes. Pneumonia, pharyngitis, and gastrointestinal manifestations also possible. Can often resemble plague.
- Diagnosis: Serology, identification/culture of organism from ulcer/lymph node.
- Treatment: Antibiotics (streptomycin, also tetracyclines, gentamicin).
- Significance: Zero to 10 cases of tularemia are reported in California each year. Listed by CDC as Category A (top priority) bioterrorism threat agent.

- **Leptospirosis**

- Agent: Over 200 serovars of *Leptospira interrogans* (esp. *canicola*, *pomona*, *icterohemorrhagiae*).
- Reservoir: Numerous wild and domestic mammals.
- Transmission: Contact of abraded skin or mucus membranes with animal urine or consumption of water contaminated with animal urine (esp. rats, cattle, swine, dogs).
- Symptoms/signs: Varies with infecting serovar. Fever, headache, chills, muscle pain common initially. Later may resemble encephalitis/meningitis.
- Diagnosis: Serology.
- Treatment: Any of several antibiotics can be effective.
- Significance: One to 15 cases of leptospirosis are reported in California each year. Clusters of cases among persons with common exposure to a contaminated water source occasionally occur.



- **Lyme disease**

- Agent: *Borrelia burgdorferi*.
- Reservoir: Wild rodents, principally woodrats, gray squirrels in California.
- Transmission: Bite of infected Ixodid (hard) tick; in California, the western black-legged tick (*Ixodes pacificus*).
- Symptoms/signs: Red, expanding rash and flu-like symptoms early; if untreated can progress to arthritis and neurologic symptoms.
- Diagnosis: Based on clinical symptoms, especially characteristic rash; supported by serology.
- Treatment: Oral antibiotics (e.g., tetracyclines) for early symptoms; intravenous antibiotics (e.g., ceftriaxone) for later neurologic disease.
- Significance: About 100 cases are reported in California each year. Highest incidence is in coastal counties north of the Bay Area - Sonoma, Mendocino, Humboldt, Trinity. Lower percentage of ticks infected in California compared to East Coast due to *I. pacificus* feeding on lizards which eliminate the spirochetes.

- **Tick-borne relapsing fever**

- Agent: *Borrelia hermsii*
- Reservoir: Wild rodents, particularly chipmunks.
- Transmission: Bite of infected argasid (soft) tick, usually *Ornithodoros hermsi*. Ticks will feed on humans when their preferred rodent hosts are not available.
- Symptoms/signs: Cyclical fever (up to 106°) that lasts for a few days, disappears for a few days then will reappear. If not treated several (up to 20) relapses can occur.
- Diagnosis: Observation of *Borrelia* spirochetes on blood smear, serology.
- Treatment: Antibiotics (tetracyclines) usually will relieve the fever within 24 hours.
- Significance: Five to 20 cases per year in California. Most cases are acquired while occupying and sleeping in buildings located in underdeveloped areas between 1200-2700m., elevation. Clusters of cases among people sharing sleeping quarters are not uncommon.



- **Psittacosis (ornithosis, parrot fever)**

- Agent: *Chlamydophila psittaci*.
- Reservoir: Psittacine birds (e.g., parrots, parakeets), occasionally other wild and domestic fowl and wild mammals.
- Transmission: Inhalation of organism from feces or other secretions of infected birds, generally within an enclosed space. Also, handling of contaminated birds or tissues.
- Symptoms/signs: Fever, headache, chills, cough, chest pain. Can be severe, rarely fatal.
- Diagnosis: Serology, recovery of the organism from sputum.
- Treatment: Tetracycline for 10-14 days.
- Significance: Fewer than 10 cases are reported annually in California, but this is likely under-diagnosed. Pet store staff and exotic bird fanciers are at particular risk of exposure.

- **Rat bite fever**

- Agent: *Streptobacillus, Spirillum minus*.
- Reservoir: Any rodent, but most commonly associated with *Rattus* spp.
- Transmission: Bacteria shed in saliva and urine. Transmission usually through rodent bite. Rarely, infection occurs through contact of broken skin with contaminated surfaces (e.g. rodent cage) or consumption of contaminated water.
- Symptoms/signs: Abrupt onset of fever, chills, headache, muscle pain 3-10 days after exposure. A rash on the arms and joint swelling may follow in 1-3 days. Infection of heart tissue and brain may occur in severe, untreated cases. Case-fatality is about 10%.
- Diagnosis: Isolation of the organism from blood or other infected tissues.
- Treatment: Antibiotics (e.g., penicillin) for 7-10 days.
- Significance: Cases are rarely reported, so the true incidence is unknown. There is an ever present risk to anyone who handles rodents since the infectious agent can be found in the saliva of up to 100% of laboratory rats and up to 100% of wild rodents.



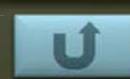
# Fungal Diseases

## • Cryptococcosis

- Agent: *Cryptococcus neoformans*
- Reservoir: Ever-present environmental saprophyte that grows in bird feces, especially pigeon droppings.
- Transmission: Inhalation of contaminated soil or pigeon droppings.
- Symptoms/signs: Organism localized in the lungs, then spreads to other parts of the body. Symptoms are commonly pneumonia and meningitis. The skin, bones and kidneys can be infected as well. If untreated cryptococcal meningoencephalitis is 100% fatal.
- Diagnosis: Observation of fungal bodies in the spinal fluid; serology; culture of fungi from skin lesions.
- Treatment: Antifungal drugs (Amphotericin B, 5-fluorocytosine).
- Significance: The most common fungal disease in immunocompromised individuals (e.g., AIDS, cancer patients), in whom cryptococcosis is more severe and 10-25% fatal.

## • Histoplasmosis

- Agent: *Histoplasma capsulatum*.
- Reservoir: Fungus frequently found in soil with high organic content. Grows in buildups of bat guano easily.
- Transmission: Inhalation of airborne fungus.
- Symptoms/signs: Several clinical forms recognized: asymptomatic, acute respiratory disease (fever, headache, cough), diseases involving other organ systems like the liver, kidney and spleen. Chronic disease like chronic respiratory disease similar to tuberculosis.
- Diagnosis: Culture or fungus seen in the sputum, blood or other tissues, serology.
- Treatment: Antifungal drugs (e.g., ketoconazole, itraconazole).
- Significance: One to 15 cases reported in California each year. Less common cause of fungal respiratory disease in California than *Coccidioides immitis*, “Valley fever”, with 700-1000 cases annually.



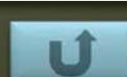
# Protozoal Disease

- **Babesiosis**

- Agent: *Babesia ducani*.
- Reservoir: Unknown.
- Transmission: Bite of infected tick and also through transfusion of blood products from an infected person.
- Symptoms/signs: Infection can be asymptomatic to mild having fever, chills and muscle ache. Some cases progress to anemia, blood clotting problems and respiratory difficulty. Rarely, babesiosis is fatal.
- Diagnosis: Observation of organisms on blood smear; serology.
- Treatment: Atovaquone and Azithromycin; Clindamycin.
- Significance: Babesiosis due to *B. ducani* is rarely reported (< 1 case per year). Babesiosis caused by *B. microti* reported in Californians (~1 per year), with exposure in eastern or upper midwestern U.S.

- **Chagas' disease**

- Agent: *Trypanosoma cruzi*.
- Reservoir: Opossum (*D. virginianus*) and woodrats (*Neotoma fuscipes*).
- Transmission: Reduviid bugs (e.g., *Triatoma* spp.) shed organism in feces while feeding. Contaminated feces are rubbed into the bite wound, mucus membranes or eyes.
- Symptoms/signs: The disease can be asymptomatic to acute illness with fever, malaise, enlarged lymph nodes, edema of the eyelids. Rarely chronic infection may result in cardiac and gastrointestinal dysfunction.
- Diagnosis: Observation of organism in blood.
- Treatment: Nifurtimox, benznidazole.
- Significance: Occurs primarily in Mexico and Central and South America. Cases have been rarely reported in California. *T. cruzi* has been isolated from two species of Reduviidae native to California, *Triatoma protracta* and *T. rubida*.





- **Giardiasis**

- Agent: *Giardia lamblia*, *G. intestinalis*, *G. duodenalis*
- Reservoir: Humans, many species of domestic and wild mammals. Beavers are often cited as the source of infection.
- Transmission: Ingestion of cysts present in water contaminated with feces from an infected human or animal.
- Symptoms/signs: Chronic diarrhea, abdominal cramps, weight loss. People can be asymptomatic as well.
- Diagnosis: Observation of cysts in feces.
- Treatment: Metronidazole.
- Significance: About 2000 cases of giardiasis are reported each year in California. Hikers, campers, and others who consume unfiltered water from natural sources in mountainous areas are most at risk.



# Parasitic Diseases

## • Visceral/ocular larval migrans

- Agent: Roundworm larvae of *Toxocara canis*. *Baylisascaris procyonis*.
- Reservoir: Wild and domestic dogs for *Toxocara*; raccoons for *Baylisascaris*.
- Transmission: Consumption of embryonated eggs shed in feces of canids and raccoons.
- Symptoms/signs: Usually asymptomatic in adults. In children, symptoms referable to tissues and organs to and through which the roundworm larvae migrate: commonly the eye and central nervous system. Occasionally fatal; long-term sequelae possible in children with heavy infection.
- Diagnosis: Serology, identification of larvae on tissue biopsy.
- Treatment: Anthelmintics (e.g., thiabendazole) are variably effective.
- Significance: Clinical cases of larval migrans are rarely diagnosed in California, though exposure to the infection ova is likely high.

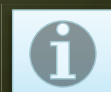
## • Trichinosis (Trichinellosis)

- Agent: *Trichinella spiralis*.
- Reservoir: Bear, wild and domestic swine.
- Transmission: Consumption of raw or undercooked meat that contains the encysted larvae.
- Symptoms/signs: Initially muscle pain, edema of the eyelids, ocular pain, photophobia. Progressing to fever, chills, prostration, profuse sweating, weakness. Late symptoms the larvae migrate and encyst, often causing myocardial failure.
- Diagnosis: Biopsy of affected tissue.
- Treatment: Anthelmintics ( mebendazole, thiabendazole).
- Significance: 1-3 cases in California are reported yearly.



- **Mite dermatitis**

- Agent: *Ornithonyssus bacoti*, *O. bursa*, *O. sylvarium*.
- Reservoir: *Rattus* spp. for *O. bacoti*, birds for *O. bursa* and *O. sylvarium*
- Transmission: Humans become accidental hosts for these mites following contact with infested animals or when the mites' preferred hosts are unavailable (e.g., following rodenticide population control).
- Symptoms/signs: Mite bites produce a painful, itchy rash. Some persons may experience an allergic reaction to mite bites.
- Diagnosis: Human infestations typically involve only a few mites, so detection is difficult. Diagnosis usually based on rash and history of contact with rodents or birds.
- Treatment: Treatment is symptomatic to relieve pain and itching. Control measures in the environment should be taken to prevent re-infestation.
- Significance: A few cases of rat mite dermatitis are informally reported to public health officials each year. The true incidence and risk of infestation with these mites in California is unknown.



# GLOSSARY

## Chapter 9



**Acute**: Referring to a health effect that is brief; sometimes also used to indicate severe. (cf. Chronic)

**Anthelmintic**: An agent or substance that destroys or expels parasitic worms, esp. intestinal worms.

**Arboreal**: Inhabiting or frequenting trees.

**Arbovirus**: ("Arbo" = "arthropod-borne"). General term for viruses which are transmitted from individual to individual by way of biting arthropods (e.g., mosquitoes).

**Arthropod**: Member of the Phylum Arthropoda, characterized by possession of a chitin exoskeleton and jointed appendages. (e.g., insects, crustaceans, arachnids)

**Asymptomatic**: Without, or producing no, symptoms.

**Bacillus**: Strictly, a bacterium that is a member of the genus Bacillus, any rod-shaped bacterium.

**Bacteria**: A single-celled organism that possesses a cell wall, lacks a nucleus, and typically reproduces by cell division.

**Biopsy**: Process of removing a tissue sample from a living patient for diagnostic purposes.

**Biovar**: A group of bacterial strains distinguishable from other groups within the same species based on physiological characteristics.

**Black Death**: Common name given to the pandemic of plague that occurred throughout Europe in the 14th Century.

**Cardiac**: Relating to the heart.

**Cardiopulmonary**: Relating to the heart and lungs.

**Case-fatality**: The proportion of patients with a particular illness who die.

**Chronic**: Referring to a health effect that is long-lasting.





**Commensal**: Living with or deriving benefit from another species. Specifically where one species benefits and the other species is neither benefitted nor harmed.

**Conjunctiva**: The mucous membrane surrounding the anterior surface of the eyeball and posterior surface of the eyelids.

**CSF**: Cerebrospinal fluid.

**Dermatitis**: Inflammation of the skin.

**Diurnal**: Active or occurring during the day.

**Dysfunction**: Impaired or abnormal function.

**Edema**: Swelling of a tissue or organ due to retention or infiltration of excessive fluid.

**Encephalitis**: Inflammation of the brain.

**Encephalopathy**: Any disorder of the brain.

**Encyst**: Formation of a membranous wall around an organism or other foreign substance within living tissue.

**Endemic**: A condition, typically a disease, that persists within a population of humans at a constant level (cf. Enzootic, Epidemic).

**Endophthalmitis**: Inflammation of the tissues within the eyeball.

**Enteric**: Relating to the intestine.

**Enzootic**: A condition, typically a disease, that persists within a population of animals at a constant level.

**Epidemic**: The occurrence of a disease within a population of humans at a level in excess of normal (cf. Endemic, Epizootic).



**Epizootic**: The occurrence of a disease within a population of animals at a level in excess of normal (cf. Epidemic, Enzootic).

**Estivation**: To pass the summer months in a state of torpor-a condition of physical inactivity.

**Etiologic**: Relating to the cause of a disease.

**Excreta**: The product of a tissue or organ that is expelled from the body. Commonly used to refer specifically to urine and feces.

**Fecundity**: The production of live offspring. Fertility. The ability to conceive offspring. Gastrointestinal. Relating to the stomach and intestines.

**Gestation**: The process or period of conception and development of offspring.

**Gregarious**: Tending to reside or function in a group.

**Guano**: Excrement, usually of birds or bats, which accumulates in the environment.

**Hard tick**: Ticks belonging to the Family Ixodidae and possessing a dorsal scutum (e.g., *Ixodes pacificus*, the Western black-legged tick, vector of Lyme disease in California).

**Hemorrhage**: An escape of blood from a ruptured vessel.

**Hibernation**: To pass the winter months in a state of torpor-a condition of physical inactivity.

**Homeothermic**: Capable of maintaining a constant body temperature - "warm-blooded".

**Incidence**: The number of new cases of a disease that occur in a defined population over a specified period of time.

**Inclusion bodies**: Visual evidence of a foreign substance or organism within a cell or tissue, usually as observed under microscopy.

**Incubation**: The period of time between exposure to a disease agent and onset of symptoms.

**Larval migrans**: Migration of a larval worm, typically a nematode, through tissues of an abnormal host without maturation to an adult worm.

**Lymph**: A clear, faintly yellow fluid that is collected from the tissues of the body and transports proteins and other wastes by vessels through nodes and eventually into the blood.

**Lymph node**: One of numerous round or bean-shaped bodies located throughout the body and connected to the lymphatic vessels which process wastes collected from cells.

**Macular**: Different in color than surrounding tissue; often used in reference to discoloration of skin rashes.

**Meningitis**: Inflammation of the membranous covering of the brain and spinal cord.

**Meningoencephalitis**: Inflammation of the brain and its membranous covering.

**Mite**: Small, eight-legged, parasitic arthropods that bite or burrow into the skin of humans and other animals; occasionally serve as vectors of disease.

**Mucous membrane**: Cells lining various passages and cavities of the body which communicate with the exterior.

**Myocardial**: Relating to the muscles of the heart.

**Neophobic**: Fearful of the new or unfamiliar.

**Niche**: The ecologic role and position of a species in a community.

**Nocturnal**: Active or occurring at night.

**Ocular**: Relating to the eye.

**Omnivorous**: Tending to include both animal and vegetable matter as part of its normal diet.

**Oviparous**: Young develop in eggs outside the maternal body - "egg-laying".



**Ovoviviparous**: Young develop in eggs retained within the maternal body.

**Pandemic**: Denoting an outbreak of a disease that occurs over an extensive region, country, or continent (cf. Epidemic).

**Parasite**: An organism that lives in or on another and derives its sustenance therefrom.

**Pathogen**: A substance or organism capable of causing disease.

**Pathogenic**: Capable of causing disease.

**Peridomestic**: In and around site of human habitation.

**Pharyngitis**: Inflammation of the pharynx, the junction between the mouth and nasal passages.

**Photophobia**: Sensitivity to or avoidance of light.

**Phylogeny**: The evolutionary development of a species.

**Placental mammals**: Group of mammals that support the metabolic needs of the developing offspring in the uterus through a direct connection between the maternal and fetal blood circulation.

**Pneumonia**: Inflammation of the lung tissue and filling of the air spaces with fluid.

**Poikilothermic**: Varying in body temperature according to the temperature of the surrounding environment - Cold-blooded.

**Prophylaxis**: Prevention of a disease, before or after exposure to the agent.

**Prostration**: Marked loss of strength, exhaustion.

**Raptor**: Bird of prey.

**Reservoir**: Living or nonliving source capable of supporting growth and multiplication of a disease agent and serving as a source of transmission, directly or indirectly, to susceptible animal

**Rickettsia**: Genus of small bacteria that are obligate intracellular organisms and are often transmitted by biting arthropods.

**Roundworm**: A member of the Phylum Nematoda, characterized by elongated shape, complete digestive tract, and an outer cuticle.

**Saprophyte**: An organism that grows on dead organic matter.

**Sequelae**: Conditions which follow as a consequence of disease.

**Serology**: General class of laboratory tests in which serum is used to measure the presence of antibodies to disease agents.

**Serovar**: A group of bacterial strains distinguishable from other groups within the same species based on antigenic characteristics.

**Soft tick**: Ticks belonging to the Family Argasidae and lacking a dorsal scutum (e.g., *Ornithodoros hermsi*, vector of relapsing fever in California).

**sp**: Abbreviation referring to any single species within a genus.

**spp**: Abbreviation referring to multiple species within a genus.

**Spirochete**: Spiral-shaped bacteria; specifically members of the genus Spirochaeta.

**Sputum**: Thick fluid produced in the respiratory passages during disease.

**Symptomatic**: Relating to dysfunctions or departures from normal health associated with disease.

**Systemic infection**: Presence and distribution of a disease agent throughout an organ system or the whole body.

**Thigmotaxis**: Movement oriented by contact with surfaces or objects.

**Vector**: An animal (esp. arthropod) that is capable of transmitting an infectious disease agent, generally from a reservoir species to a susceptible species.

**Vertebrate**: Group of animals within the Phylum Chordata that have a hollow nerve cord enclosed within a bony or cartilaginous spinal column.

**Viremia**: Presence of viruses in the blood.

**Viviparous**: Relating to organisms that bear live young.

