Best Management Practices for Feeder Rodent Production and Distribution

Scott Hardin, Pet Advocacy Network Science Advisor

Introduction

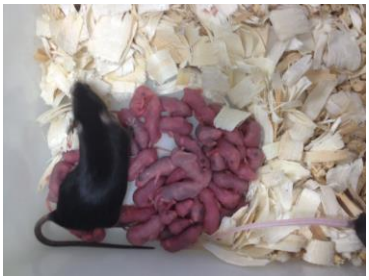


Photo by Vin Russo

The feeder rodent industry is the business of growing and selling rats and mice - live and frozen - as a food source for reptiles and birds of prey. Domestic strains of the house mouse (*Mus musculus*) and Norway rat (*Rattus norvegicus*) comprise the vast majority of feeder rodents. A brief description of the life history and reproduction of these species is in Appendix A.

The bulk of these rodents are used to feed reptiles at production facilities, retail stores and in the homes of reptile hobbyists. Without a steady supply of quality rats and mice, there would be a significant disruption in the production, distribution and health of captive reptiles in private possession as wells as in zoos and museum collections. In addition, rodents are a preferred food item for birds of prey at wildlife rehabilitation facilities.

Unlike other rodents, rats and mice are not governed by the Animal Welfare Act (USDA 2013) and thus are not subject to federal regulations on caging, transportation and handling. Nonetheless, successful producers generally adhere to professional standards of husbandry. As with any industry, there have been a few operations with unsanitary conditions and substandard care and housing, along with a few unusual incidents, which has cast a negative light on feeder rodent producers. Additionally, feeder rodents have been vectors in zoonotic outbreaks, e.g., salmonellosis, lymphocytic choriomeningitis virus (LCMV), rat bite fever (see Appendix B).

In the absence of an accepted set of professional standards for the production of feeder rodents, Best Management Practices (BMP) were developed in conjunction with Pet Advocacy Network's Herp Committee. We sought advice from and techniques used by the more accomplished rodent breeders, veterinarians and public health organizations to develop these guidelines. The BMP deal with general husbandry matters (caging, buildings, sanitation, nutrition, disease prevention), transportation, euthanasia, and the critical issue of timely response to a zoonotic outbreak.

Best Management Practices are flexible recommendations based on the experience of successful rodent producers. Following these BMP will lead to greater yields of quality rodents which, in turn, will result in healthy reptiles and a more profitable operation. However, we recognize that these BMP will be implemented differently among breeders and distributors due to the diversity of the feeder rodent industry. For example, small breeders or start-up operations may not have floor drains or state-of-the-art cages and will find other acceptable methods to prevent accumulation of waste material that could impact rodent or human health. As rodent breeders become larger and more successful, they will often strive to implement the best possible practices described in this document.

Feeder Rodent Culture

Culture of feeder rodents is similar to the production of laboratory animals (Edling 2011). There has been no standard to which rodent production facilities adhere, and the following description captures practices broadly used in the industry. Breeders are kept in plastic tubs or cages at ratios ranging from 1 male to 3-5 females. Larger operations may have 10 males and 50 females in a single breeding tub. Water is provided through elevated gravity-fed bottles, either filled manually or via self-watering systems. Rodents are fed commercial diets or laboratory formulated chow placed in the tubs or in feeding troughs above the tub or cage. Cage substrate is typically wood shavings or paper strips to absorb waste products and moisture from water bottles. In some operations, two different substrates are used, e.g., aspen for bedding and pine for an "in-cage latrine."

Rodent rack system with tubs and chow trays. Photo by TSK, Inc.

Rodent enclosures are cleaned regularly depending on the density of rodents, extent of waste product accumulation, and age of recent offspring. Solid waste and substrate are disposed of in an appropriate container, and the tubs are washed in detergent to remove remaining particulates. A common practice is to soak tubs in a 10% bleach solution followed by rinsing; optionally tubs are sprayed with additional disinfectant and allowed to dry before re-use.

Photos by TSK, Inc.

Rodent offspring are removed for sale at various stages of life to accommodate the variety of reptiles being fed. Terminology and descriptions differ somewhat among producers, but the table below describes the general classes of feeder mice and rats. Feeder rodents are sold live or frozen; the majority of animals are frozen which simplifies transportation and avoids degradation in quality of live animals from transport stress. Neonates typically are frozen directly per standards of the American Veterinary Medical Association, while larger rodents are euthanized before freezing (AVMA 2013). Frozen rodents are bagged and shipped in quantity according to the size of the order. Live mice and rats are shipped in well ventilated, leak-proof containers with absorbent bedding. Water and food are provided for animals in transit for more than six hours.

Frozen mice and rats, labeled and packaged for shipping. Photo by TSK, Inc.

Size classes of feeder mice (*Mus musculus*) and rats (*Rattus norvegicus*).

Mice

	Description	**Age**	**Size**
Pinks (reds)	Newborn, hairless, eyes closed	<48 hours	1 g
Fuzzies	Fine hair	8-10 days	< 5 g
Hoppers	Almost weaned; name refers to movement when startled	10-20 days	Up to 6 g
Weans	No longer nursing	>21 days	12-15 g
Adult	Sexually mature	5-7 weeks	> 25 g
Jumbo	Ex-breeder	>9 months	> 50 g

Rats

	Description	Age	Size
Pinks	Newborn, hairless, eyes closed	<48 hours	5 g
Fuzzies	Fine hair	8-12 days	
Pups	Fully developed but nursing	13-21 days	
Small/Weans		3-4 weeks	
Medium	Young adults	4-12 weeks	100-150 g
Large		3-9 months	200-275 g
Jumbo	Ex-breeders	>9 months	> 350 g

The Feeder Rodent Industry

The production of rodents specifically for reptile nutrition is a young industry. Before the 1990s, reptile owners purchased rats and mice from small local breeders (Dino Ferri, personal communication) or from facilities that bred rodents as laboratory research animals (Vincent Russo, personal communication). With the growth of the herp industry, demand for rodents increased concomitantly and led to large-scale production facilities throughout the United States and Europe. Chinese producers have entered the market in the past few years.

The structure of the feeder rodent industry is well described by Edling (2011). In short, rodents are produced through a loose and fluid relationship among breeders and distributors in all states, i.e., vendors buy and sell animals to each other based on price and availability with few contractual obligations. Large breeding operations produce thousands of animals weekly, but small operations persist that supply local pet stores or to feed their own reptile collections. Despite the variability in size and scope of operations, the industry is generally vertically integrated with commercial breeders supplying distributors, who in turn move rodents to the retail market, as illustrated in the pathway below.

Feeder Rodents v. Laboratory Research Animals and Pets

Much of the literature on husbandry, housing and veterinary care is focused on laboratory research animals (White 2000; National Research Council 1996, 2011; FELASA 2002), or on rodents as pets (e.g., Merck Veterinary Manual). There are substantial differences in the care of

feeder rodents compared to laboratory animals. For example, mice and rats used in research are maintained for the duration of an experiment or for the animal's life span. The presence of infectious agents in laboratory animals is a substantial concern because of the potential for pathogens to compromise research results. Because of this concern, laboratory rodents are classified based on pathogen status, e.g., Specific Pathogen Free (SPF) animals are demonstrated to be free of a specified list of pathogens. Routine testing for a suite of rodent pathogens is practiced for laboratory rodents (National Research Council 1996), including infectious agents that may not cause apparent symptoms.

The importance of disease prevention in lab rodents also leads to sophisticated facility design and construction. Animals may be located in separate rooms based on their microbiologic status (National Research Council 2011). Isolation facilities may be used for suspected diseases or to separate animals of known but different microbiological status. Barriers to movement of pathogens (e.g., laminar air flow, particle filtration) are justified by the cost and potential results of experiments. In addition, research objectives may dictate the elimination of other potential stressors such as fluctuations in temperature, humidity or excessive noise or vibration (National Research Council 2011).

By contrast, most feeder rodents typically are sold before or shortly after weaning, and the presence of infectious agents at subclinical levels is not a concern. Commercial breeder animals are maintained for their effective reproductive lives and typically are resistant to common pathogens. Most disease management approaches employed at research facilities are inappropriate for commercial feeder operations. Put simply, a well-managed rodent production facility will be clean but not sterile. Therefore the best management practices for feeder rodent facilities recommended in this document focus on observing gross symptoms of infectious agents rather than detecting the presence of potential pathogens in the absence of clinical signs of disease. As with research rodents, the longer life span of pet rodents suggests standards for caging and veterinary care that are unnecessary for feeder rodents.

A well-managed feeder rodent facility will be clean, but not sterile. Photo by TSK, Inc.

Production and distribution pathway for the feeder rodent industry. The size of the arrows indicates the relative volume of rodents moving through the pathway. Most rodents move from large-scale production facilities through distributors to the retail market.

BEST MANAGEMENT PRACTICES FOR FEEDER RODENT PRODUCTION AND DISTRIBUTION

HUSBANDRY

- Rodent Enclosures (cages, tubs, etc.)
  - should be designed to prevent escape by feeder rodents, e.g., closed rack systems
  - should allow for normal postural and behavioral movements
  - should allow access to food and water and allow easy refilling and cleaning of the devices that contain food and water
  - should be ventilated, maintained at appropriate temperature (typically 68^{o}F- 80^{o}F, 20^{o}C - 26^{o}C), and should avoid humidity extremes (preferred 30-70% relative humidity)
  - should be free of sharp edges that could cause injury
  - should have corrosion-resistant surfaces that can be sanitized with hot water, detergents, and disinfectants
  - should have appropriate bedding for nesting and to absorb urine and feces

- Bedding
  - should have adequate absorbent capacity
  - wood chips (pine, aspen) recommended
  - scented or aromatic bedding (cedar) should be avoided because aromatic compounds may cause respiratory problems or liver abnormalities
  - must be disposed of properly.
    - Avoid placing bedding in areas where nutrients can leach into wetlands.
    - Consider composting to avoid landfill costs (several laboratory rodent producers compost their bedding).

- Buildings
  - should provide barriers to entry by wild rodents and other animals (insects, birds, reptiles)
  - should have adequate ventilation or air movement
  - should maintain light-dark balance within practical limits (preferably 12 hrs light/12 hrs dark)
  - should have isolation/quarantine areas for rodents acquired from outside sources

Photo by TSK, Inc.

- should have non-porous floors with drains for ease of cleaning (or similar arrangement for cage/tub rack systems)
- should have secure feed storage

■ Nutrition/Diet

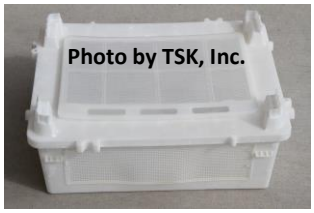
- should meet rodent nutritional requirements rather than generic animal chow
- could be commercial diet formulated for laboratory animals or a custom formulation for the producer
- labeling of significant diet constituents (protein, fat, carbohydrates, minerals, etc.) is recommended
- avoid consistent use of prophylactic antibiotics (may lead to resistant pathogen strains)

■ Rodent Disease Prevention and Management

- Consult with veterinarian familiar with rodent health, diseases, and nutritional requirements.
- Maintain an ongoing pest control program to prevent or minimize wild rodents, e.g., rodent traps at the perimeter of the facility, in rodent rooms, and in areas where feed is stored.
- Promptly remove and euthanize any wild rodents or colony rodents that escape from captivity.
- Train staff to recognize signs and symptoms of disease (e.g., abnormal or labored breathing, weight loss, ruffled coat, dry skin, abnormal posture, lethargic behavior, diarrhea, discharge, eye redness, abnormal gait, loss of balance, unusual head movement, tumors).
- Keep records (e.g., location, date, # animals affected) for animals exhibiting signs or symptoms of disease or death.
- Isolate or quarantine animals with symptoms of disease.
- New breeders should come from a source with adequate biosecurity to prevent rodent pathogens; alternatively, new breeders should be isolated until disease-free status is confirmed.
- Distributors should avoid combining animals from different shipments to prevent disease transmission.
- Feed, water containers, equipment for handling cages, and bedding should not be moved among facility units (depends on the configuration of the facility; e.g., racks, rooms, buildings) to prevent cross-contamination.
- Equipment should be disinfected regularly.

TRANSPORTATION OF LIVE RODENTS

- Animals should be examined for ectoparasites prior to transport.
  - consider use of parasite control dust in the substrate/bedding
- Animals must be transported in appropriate containers.
  - containers must be non-porous or leak-proof with clean, absorbent bedding
  - containers must have adequate ventilation
  - container surfaces should not have sharp edges of objects that might cause injury
  - containers must allow reasonable postural movements
  - containers should be clearly marked to indicate LIVE ANIMALS
  - containers should allow observation of animals during ground transport



- Extreme temperatures should be avoided; preferred temperature is 65-85^{O}F.
  - ground transport vehicles should have adequate climate control for the size of the vehicle and density of animals per container, e.g., multiple air vents, fans to increase circulation
- Transportation of rodents by airline must follow IATA Live Animals Regulations.
- Animals should have access to food and water for longer trips (more than 6 hours).

EUTHANASIA

- Guidelines of the American Veterinary Medical Association (AVMA) should be followed; refer to https://www.avma.org/KB/Policies/Documents/euthanasia.pdf pages 48-50).
  - Neonates less than 7 days old may be euthanized by freezing provided that the rodents do not come into direct contact with "ice or pre-cooled surfaces."
  - Carbon dioxide is an acceptable method for rodents > 7 days, preferably compressed CO_2 in a cylinder fitted with a regulator.

SANITATION/DISPOSAL

- Multi-step sanitation of rodent enclosures should be used.
  - solid material should be removed into appropriate container
  - surfactants and/or power spray should be used to remove remaining particulate material
  - tubs or cages should be washed in a detergent solution
  - after washing, tubs should be soaked in a sanitizing agent (e.g., diluted chlorine solution)
  - tubs and cages should be allowed to dry thoroughly before re-use
- Waste (including bedding and animal waste) should be disposed of properly.
  - avoid contamination of water supplies and wetlands
  - consider disposal in a dry bed or septic system

ZOONOTICS

- Prevention
  - Barriers to infectious agents should be in place (prevent entry or active removal of wild rodents, insects, birds and reptiles.
  - General hygiene practices should be established to minimize bacterial or viral growth.
    - Steps should be taken to prevent *Salmonella* contamination of live and frozen rodents.
    - regular cleaning of cages, floors, feed storage areas
    - use of disinfectants or sanitizers, surfactants and hot water
    - Employees should not work in different areas of the facility; if employees service multiple areas, footbaths at entrances are recommended (footbath solutions must be changed regularly).
    - available hand washing stations for staff
  - Staff should be informed regarding zoonotic diseases and methods of transmission.
  - Drinking, eating, or smoking should not take place in rodent rooms.
  - Staff should wear gloves when handling live or frozen rodents, used bedding, or dirty cages; hand washing should occur promptly when gloves are removed.
  - In facilities that also culture reptiles, care should be taken to avoid transmitting *Salmonella* to rodents.
    - Rodent and reptile areas should be physically separate.
    - Where practical, employees should not work in both facilities.
  - Pregnant women or persons with compromised immune systems should not directly handle rodents or their enclosures.
  - Newly acquired breeder animals should be isolated or tested for *Salmonella* and LCMV.
  - Rodent shipments should have a permanently affixed or indelible lot identification label to include
    - package date
    - shipment date
    - category code (e.g., pinkie, fuzzy)
    - supplier code (if rodents are acquired from multiple sources)
  - Records of animals leaving the facility should maintained for at least 12 months (in the event of undetected zoonotic carriers).
    - date of shipment
    - species, type/age and number of animals shipped
    - specific location within facility where shipped animals were housed (if applicable)
    - destination of animals
    - carrier

    - Trip logs are recommended for the carrier, e.g., vehicle identification, time of departure and arrival, other stops made, other cargo.
  - Frozen rodent packages for retailers should be prominently labeled to advise the retail customer about the potential for disease transmission and how to avoid contracting *Salmonella* and other zoonoses.
    - Use of the generic “Safe Handling Instructions” label (Appendix C) is encouraged.
- Remediation in the event of a zoonotic outbreak
  - Movement of animals, cages and equipment within the areas of facility without prior sanitation and disinfection should be avoided.
  - Staff working with infected (or potentially infected) animals should have access to appropriate personal protective equipment (respirator, gloves, washable coveralls and footwear).
  - Producers should cooperate fully with the Centers for Disease Control, local or state health departments, and departments of agriculture or animal health.
  - All recent records of shipments should be made available to inspectors.
  - Customers that have received animals should be notified immediately.
    - customers of all animals shipped after the zoonotic was discovered
    - includes animals potentially exposed to the disease carriers prior to discovery
  - Transporters of animals in transit should be notified immediately.
  - Animals in the facility (or part of the facility) should be isolated until the extent of the zoonotic has been determined.
  - In the case of suspected LCMV
    - Representative animals within potentially infected units within the facility should be tested via PCR and serology to determine the extent of infection.
    - Animals should not be moved between facility units.
    - Employees should wear waterproof washable (or disposable) footwear that should be cleaned between rooms, and disposable gloves; overwear should remain within its designated room.
  - In the case of confirmed LCMV
    - All animals within potentially affected units should be euthanized.
    - People handling rodents, bedding, caging and exposed equipment should wear a respirator/filter with >N95 rating, fitted per OSHA regulations.
    - Gloves, waterproof washable footwear and coveralls should be worn.
    - Protective gear should be disinfected before re-use and employees should wash their hands after removing gear.

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APPENDIX A - Life History and Reproduction of the Principal Feeder Rodents

House Mouse (*Mus musculus*)

The house mouse is a small rodent with an adult length of 125 - 200 mm (5-8 inches) including tail, and weighs from 12 - 30 g. The tail is about as long as the body. Its ears are relatively large and naked. Natural body color is light brown to black with a light belly, although albinos are common in the pet trade and as laboratory animals.

Taxonomy and Distribution

House mice may have originated in Asia but are distributed worldwide, largely as result of movement with and by humans. Several subspecies are recognized by different taxonomists, and the captive variety in America is probably the Western European subspecies (*M. musculus domesticus*). House mice are typically found in close association with humans or human sources of food.

Reproduction

House mice are reproductively mature at 35-60 days, with females maturing at around 5 weeks. Breeding takes place throughout the year. Estrus cycle is 4-6 days, with estrus lasting less than one day. Gestation period is 19-21 days, although this may be extended by several days if the female is lactating. House mice will bear 5-10 litters per year, with litter size ranging from 3-12 (usually 5-6) altricial young (require parental care to survive).

Life History

Newborn mice weigh around 1 g, are naked except for short vibrissae, and their eyes and ears are closed. They are fully furred after 10 days, open their eyes at 14 days, and are weaned at 3 weeks at a weight of around 6 g. In the wild, mice rarely live longer than 18 months. Captive mice live 2 years on average. House mice are primarily nocturnal, but will often be active during daylight. Diet is primarily plants, including grains, seeds, and stems; occasionally insects are eaten.


Photo by Vin Russo

Diseases and Parasites

The Merck Veterinary Manual (online) lists several infectious agents of concern in laboratory and research settings because of their potential to compromise experimental results. In feeder rodent operations, these diseases seldom lead to disruptions in culture. The most common problem is mite infestation, manifesting itself as thinning hair or a coat with a greasy appearance. Infestations respond to ivermectin treatment at 0.2 mg/kg orally or by subcutaneous injection; an alternative delivery is a few drops of diluted ivermectin on the head (Merck Veterinary Manual). Occasionally wood or moss mites, which are attracted to wood substrate, may infest enclosures and irritate mice. Sevin (carbaryl) dust is an effective treatment at label rates.

Respiratory infections in mice are of viral or bacterial origin. Sendai virus may lead to an acute infection and mortality in neonates and weanlings. *Mycoplasma pulmonis* may cause chronic pneumonia; antibiotics alleviate clinical signs but will not clear the infection.

Mouse hepatitis virus (MHV) is common in wild and laboratory mice, and occasionally becomes problematic in feeder colonies. Typically MHV is asymptomatic in healthy mice, but cross-

contamination of neonates may cause mortality. Treatment involves identification and removal of infected mice. Testing or isolation of acquired breeding stock is recommended to prevent introduction of MHV or different strains of the virus (White 2009).

Norway rat (*Rattus norvegicus*)

The Norway rat is a larger species within the mouse family, reaching an adult length of 400 mm (16 inches) including tail, and weighing up to 500 g. The tail is shorter than the body. The ears and tail are naked. Natural body color is brownish with a lighter underside; captive rats are white, brown, black or splotched. Albino Norway rats are valuable as laboratory animals.

Taxonomy and Distribution

Despite their name, Norway rats are native to China. Like the house mouse, this species has been introduced throughout the world, and found its way to the New World as stow-aways in the late 1700s. Norway rats are typically found in close association with humans or human sources of food.

Reproduction

Male Norway rats reach sexual maturity at 6-10 weeks and females mature at 8-12 weeks (Merck Veterinary Website). Breeding occurs in large groups with females mating several males during a 6-hour estrus. Gestation period is 21-23 days, and females will bear litters of 8-18 pups (average=8) as many as 7 times a year. The young are cared for communally. The breeding life of Norway rats is 9-12 months.

Life History

Newborn rats weigh around 5 g and are altricial (require parental care to survive). Eyes open at about 2 weeks and fur begins to develop in the second week. Norway rats are weaned at 3-4 weeks. Data on longevity is inconclusive but most Norway rats probably live no more than 2 years (the Merck Veterinary Manual lists typical lifespan as 18-36 months). This is an opportunistic omnivorous species feeding on grain, garbage, green vegetation and small animals.

Photo by Vin Russo

Diseases

Respiratory infections from bacteria (principally *Mycoplasma pulmonis*, *Streptococcus pneumoniae*, *Corynebacterium kutscheri*) may act with minor infectious agents to cause chronic respiratory disease (CRD). CRD symptoms are variable, and antibiotic therapy will alleviate symptoms but will not affect respiratory viruses present. *S. pneumoniae* is the principal agent in bacterial pneumonia in rats and treatment with penicillin derivatives is recommended. The Merck Veterinary Manual (online) lists several infectious agents of concern in laboratory and research settings; in feeder rodent operations, these diseases seldom lead to disruptions in culture.

APPENDIX B - Feeder Rodent Zoonotic Diseases

Salmonellosis

Salmonellosis is caused by the bacterium *Salmonella*. The Centers for Disease Control and Prevention estimates 1.2 million cases annually with 23,128 hospitalizations, and 452 deaths each year in the United States (Scallan et al. 2011). While most *Salmonella* infections result from contaminated foods, an estimated 11% of all *Salmonella* infections are attributed to animal exposure (including reptiles), resulting from directly handling animals, as well as indirect contact through cleaning cages or bedding, handling food or food bowls, or touching other things where the animals live (Hale 2012). Most persons infected with *Salmonella* develop diarrhea, fever, and abdominal cramps 12 to 72 hours after infection. The elderly, infants, and those with impaired immune systems are more likely to have a severe illness.

In general, salmonellosis is preventable by thoroughly washing hands with soap and water after contact with a potentially contaminated surface. Children are more prone to *Salmonella* infection than adults, presumably because they are less likely to wash their hands after contact with contaminated items. Older people and those with compromised immune systems are also more vulnerable.

In 2010, CDC investigated an outbreak of salmonellosis involving 34 people from 17 states with illnesses reported between December 4, 2009 and June 9, 2010 (for more information on this outbreak, visit the CDC website http://www.cdc.gov/salmonella/frozenrodents/index.html). This was part of a larger international investigation into over 500 human cases that spanned the U.S., the United Kingdom, and Canada (Harker 2011, CDC unpublished data). The cause was attributed to frozen rodents from a single U.S. rodent producer. On July 26, 2010, the producer announced a recall of its frozen reptile feed. CDC advised discarding recalled products in stores and homes in closed plastic bags and sealed trash cans.

Between August 29, 2011 and February 2, 2012, 46 additional cases of salmonellosis were reported from 22 states (CDC 2012). Twenty-seven of the 46 cases were interviewed; 20 of these reported reptile or amphibian exposure and 15 reported rodent exposure. From January through May 2014, CDC reported 41 cases of salmonellosis in 21 states that were linked to exposure to frozen rodents; 16% of the cases were hospitalized and no deaths were reported. No further outbreaks associated with frozen rodents have been reported as of June 2015.

For more information, visit Pet Advocacy Network's Zoonotic Disease Prevention Series for Retailers - Salmonellosis

Lymphocytic Choriomeningitis

Lymphocytic choriomeningitis is a disease that develops after infection with the LCM virus. The principal transmission route to humans is via contact with urine, feces, saliva or blood from the

house mouse (*M*. *musculus*), wild or cultured, which is the natural reservoir for this virus (Edling 2011). High densities of infected mice, which may be present during an outbreak in a breeding colony, may lead to aerosol transmission of the virus to humans. Syrian hamsters (*Mesocricetus auratus*) also carry LCMV, and in rare instances, rats, guinea pigs, or other rodents may become infected from contact with infected mice or hamsters. It is estimated that 5% of wild house mice in the U.S. carry LCMV (CDC 2013), although this can vary by location; locally, 9% of house mice in Baltimore, MD were found to have antibodies to the virus (Edling 2011). Among house mice and hamsters, LCMV is transmitted horizontally as well as vertically from infected dams to offspring, perpetuating the prevalence of the virus in wild and captive populations. Infected mice and hamsters can shed the virus for several months or throughout their lives, and there is no vaccine or treatment.

Typically, human exposure to the virus results in an asymptomatic or mild illness (aseptic meningitis) without need for treatment. Patients may experience a variety of symptoms including fever, headache, muscle aches, loss of appetite, and nausea. After a few days of apparent recovery, meningitis symptoms appear (return of fever, headache, stiff neck) along with symptoms of encephalitis (drowsiness, confusion, sensory disturbances, difficulty in moving).

Infection during pregnancy has been associated with severe symptoms in the fetus, including hydrocephalus, chorioretinitis and mental retardation (CDC 2013). Although the disease in healthy adults is rarely fatal, three organ transplant recipients died after receiving infected tissues from an organ donor who had been exposed to an infected pet hamster (Amman 2007).

Prevention in rodent breeding colonies centers on avoiding contact with wild mice using barriers to entrance along with an active pest control program. In the case of breeding and distribution facilities for feeder mice, secure confinement of stock is recommended to decrease the opportunity for contact with wild mice. For staff at culture/distribution facilities and pet owners, hands should be thoroughly washed with soap and water after exposure to pet rodents or cultured feeder mice.

Currently, blood tests are commercially available that can detect the virus or antibodies to LCMV. Post-mortem sampling of tissues (kidney, liver, and spleen) is most effective for virus testing, while serum or whole blood is used to detect antibodies. Edling (2011) has investigated the feasibility of testing breeding stock in commercial facilities using environmental swabs for genetic analysis.

In 2012, CDC investigated a rodent breeding facility where a staff member developed aseptic meningitis that was caused by LCMV infection. Subsequent testing revealed that 13 of 52 employees had current or past infection. Five employees sought medical treatment and four of these were diagnosed with aseptic meningitis. Testing discovered LCMV antibodies in 21% of frozen mice from the facility, leading to a quarantine on further shipments, a depopulation of all live mice and disposal of frozen mice. Live mice had been shipped to points in 21 states, but to date no further LCMV infections have been reported.

For more information visit Pet Advocacy Network's Zoonotic Disease Prevention Series for Retailers – Lymphocytic Choriomenigitis

Rat Bite Fever

Rat bite fever (RBF) is a rare disease in North America, where the infectious agent is the bacterium *Streptobacillus moniliformis*. As the name implies, rats are a reservoir for these bacteria, although rats are largely immune to the disease and do not exhibit symptoms of illness. RBF has been reported in mice, gerbils and guinea pigs (CDC 2013, Center for Food Security & Public Health 2006), but rats are the primary reservoir.

Bacteria are transmitted to humans through a bite or scratch, from contact with rat secretions, or consuming contaminated food or drink. Symptoms in people appear within three weeks of exposure (typically 3-10 days) and include swelling around the wound, fever, enlarged lymph nodes and a rash on the extremities, typically on the hands and feet.

Antibiotic therapy (penicillin, tetracycline) has been effective in treating the infection. However, untreated infections can lead to severe complications and even death. Following a rodent bite, antibiotics should not be given prophylactically because the disease is rare. If a fever or any of the above symptoms develop within 21 days, the person should be evaluated by a health-care provider for rat bite fever, and treated if appropriate.

For more information visit Pet Advocacy Network's Zoonotic Disease Prevention Series for Retailers – Rat Bite Fever.

Hemorrhagic Fever with Renal Syndrome (HFRS)

HFRS is caused by one of several hantaviruses, including Seoul virus that is found worldwide in Norway rats; other viruses that cause this disease (Hantaan, Dobrava, Saaremaa, Puumala) are found in Asia and Europe. Wild and pet Norway rats can carry Seoul virus and this virus can be transmitted to other rats and humans through exposure to aerosolized urine, feces or saliva of infected animals, as well as via dust from rat nests or bedding. Other infection routes are through a bite from an infected animal, or direct contact of urine, feces, or saliva into an open wound or human mucous membranes (eyes, nose, mouth). Gloves are appropriate if there is a possibility of contact with rat saliva, urine and feces (including when handling bedding or nesting material), particularly if a person has skin wounds or abrasions.

Infected animals do not become sick, and can shed virus in their urine, feces, and saliva throughout their lives. Seoul virus is transmitted between rats through direct contact (e.g., during mating or fighting), or through exposure to soiled bedding and other contaminated materials. Because infected animals can shed virus intermittently and there is no treatment available to eliminate infection, euthanasia is recommended to eliminate the risk of transmission to humans and other rats.

Symptoms of HFRS in humans usually develop within 1 to 2 weeks after exposure (in rare cases, up to 8 weeks). Initial symptoms begin suddenly and include intense headaches, back and abdominal pain, fever, chills, nausea, and blurred vision. Facial flushing, inflammation or redness of the eyes, or a rash may occur. Severe cases may lead to acute kidney failure or bleeding disorders. Symptoms of Seoul virus infection are usually more moderate than for

Hantaan and Dobrava viruses, but recovery can take weeks or months. Treatment in humans involves management of fluid and electrolyte levels. Antiviral drugs may be effective in the early stages of the illness. No figures on deaths from Seoul virus are available, but the fatality rate for another virus with moderate symptoms (Puumala) is less than 1%. Persons with exposure to rats and symptoms of HFRS should seek health care; local or state health departments may provide testing.

Testing for Seoul virus infection in rats can be done through commercially available blood antibody tests. The Centers for Disease Control and Prevention has confirmed the accuracy of antibody test results from private laboratories (Idexx, Charles River Laboratories); samples must be submitted through a veterinarian. Although RT-PCR testing is available to detect virus RNA, infected animals may not always have virus present in their blood, feces, or urine, resulting in a negative test result in an animal that is still infected. Therefore, PCR testing is not recommended to determine an animal's infection status.

The only known outbreak involving Seoul virus in pet rats in the U.S. began in December 2016. As of April 2017, 17 people in 7 states were confirmed to have a Seoul virus infection; one patient was hospitalized and all persons have recovered. The outbreak was linked to home breeders of pet rats.

APPENDIX C – Generic Packaging Label

Safe Handling Instructions for Frozen Rodents