

Rodent Husbandry and Care

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The order Rodentia contains 2020 living species placed in 28 families (approximately half of all mammalian species) and is the largest order of mammals (1). Rodents are found worldwide except in Antarctica and on some small islands. Some spend their entire lives above the ground in the canopy of rainforests; others rarely emerge from beneath the ground. Some rodents are highly aquatic, while others are equally specialized for life in deserts. Many rodents are omnivorous; others are highly specialized, eating, for example, only a few species of invertebrates or fungi.

Despite the large number of rodents, few are owned as pets. The common pet rodents are rats, mice, hamsters, gerbils, guinea pigs and chinchillas. Rats, mice, hamsters, and gerbils belong to the Family Muridae in the rodent suborder Sciurognathi, one of the two major suborders of rodents. Guinea-pigs and chinchillas are placed in the other rodent suborder Hystricognathi. Less common pet rodents are prairie dogs, degus, African giant pouched rats, spiny mice and voles.

A Husbandry

A1 Housing

The immediate physical environment of the cage or enclosure surrounding a rodent can be quite different from the environment in the surrounding room. Temperature, humidity, and concentrations of gases and particulate matter are often higher in an animal's cage (2). These microenvironmental conditions can alter metabolic and physiologic processes that predispose the rodent to diseases.

The microenvironment is considered the cage itself, feeders and water bottles, equipment for environmental enrichment, and cage complexities such as platforms, and multiple levels. Ventilation of the cage and of the room it is in affects the microenvironment, in addition to daily husbandry practices. Besides providing an environment that meets the animal's physical needs, we should also provide a structural environment that takes into account the animal's behavior. Observing preferences expressed by animals given free choice allows us to detect discomfort induced by husbandry conditions. With rats and mice, we can state with confidence that their housing should include nesting materials and boxes, tunnels and running-wheels. Animal behaviorists are unsure about other objects that may increase opportunities to enhance the animals' well-being.

We have based our housing recommendations primarily on the applied scientific study of animal behavior used in laboratory animal welfare. Our recommendations also take into account environments that ensure good health and a normal physiological and physical state.

a substrate or bedding

The purpose of bedding is to keep animals dry and clean. Pet-owners generally choose bedding based on cost and availability; laboratory veterinarians choose bedding based on cost and water-holding capacity (3). Bedding can be described based on its use e.g. contact, non-

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contact and enrichment bedding; or the material from which it is made e.g. wood-based (chips, shavings, peelings, wood-wool and sawdust); paper-based (cotton and pulp fiber, recycled paper), corn (husks and cobs); cellulose and vermiculite. Some pet bedding contains lemon and chlorophyll to give them a pleasant scent. In our experience, this type of bedding irritates pet rodents, and the coloring agents can stain white rats or mice, so we do not recommend this bedding.

Owners should combine frequent bedding changes with good husbandry such as regular cage cleaning, low animal density and low environmental temperature and humidity. This will reduce the toxic or odor-causing gases such as ammonia from building up because of urease-positive bacteria in the feces breaking down urea from the urine.

Traditionally animal caregivers have preferred paper and softwood chips such as pine or aspen, to straw because it requires fewer bedding changes. Cedar and other wood chip shavings reduce ectoparasite problems and have a pleasant scent. However, we do not recommend their use because they emit toxic aromatic hydrocarbons that increase the incidence of cancer in animals and cause mouse and rat pup mortality (4).

Increasing awareness of animals' behavioral needs have led ethologists to look at bedding preferences. They found size and manipulability of bedding material are the main determinants of mice and rats' choices. Mice and rats avoid bedding consisting of small particles (less than 0.002×0.0025 sq in [1.2×1.6 sq mm]), whereas they prefer bedding consisting of large fibrous particles (5). When exposed to different types of nesting materials such as paper strips, corn husks, sawdust, wood shavings, peelings and chips, rats choose long strips of soft paper (6). Rats also select opaque or semi-opaque nest-boxes to transparent nest-boxes (7).

Mice show no preference between paper and wood-derived materials, but show clear preference for materials that they can manipulate such as paper tissues, string, and wood shavings, peelings and chips (8). Many mice will combine two preferred nesting materials to make complex nests. Mice typically dislike wire-bottomed cages; however, both male and female mice will spend more time in a wire-bottomed cage with nesting material, despite the grid floor that they usually avoid (9).

b cage set up

For many rodents, the opportunity to retreat from light into a burrow is especially important. Mice will perform tasks that involve running through tunnels, pushing levers and tolerating pain to obtain resources such as toys, shelter, bedding, running wheels, and increased space (10). Studies have been done to measure the frequency (or persistence-of-use) with which rodents use three activity resources (locomotion-loop of plastic tunnels, complex tunnel environment, and running-wheel) to learn their importance to the rodents. Researchers found the duration of visits remained constant for the running-wheel but decreased for the loop and tunnel system (11). Wheel-running is highly motivated mouse behavior, and running wheels are appropriate environmental enrichment for mice. We recommend an axil free wheel if more than one mouse is in a cage. The wheel axil can result in serious injury such as digit or limb fracture and back fracture. Transonic (Portland, OR) offers Woden WheelsJ, which feature a unique design with a safe solid running surface and a support stand without dangerous pinch areas. The wheels are available in three sizes: 8, 11, and 12-inch diameter. For more information, access their web site at <http://www.transoniq.com/>.

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In environmentally enriched cages with hollow tubes, mice have no overwhelming group-preference for shape, opacity, or openness of tubes and prefer to sleep in sawdust when it is available (12). Mice will sleep in hollow tubes only after the sawdust is removed. Then they use short, wide tubes more frequently than long or short narrow tubes.

Environmental temperature and relative humidity can depend on husbandry and housing design and can differ considerably between the cage and room. Factors that contribute to variation in temperature and humidity include cage material and construction, number of animals per cage, frequency of bedding changes, and bedding type.

Aquariums are not suitable cages for rats and mice because of inadequate air circulation. The best cages are made of a material that will be easy to clean and deodorize and is indestructible to rodent chewing or digging in the corners. The cage floor can be solid, but should be waterproof and easy to clean. We do not recommend wire mesh floors because rats and mice can trap their feet and especially hind limbs in the openings, resulting in fractures and injuries. A web-site with images of different rodent cages, travel cages, and cage accessories is Martins Cages at <http://www.martinscages.com/default.htm>.

The Guide for the Care and Use of Laboratory Animals (Guide) (2) recommends air-temperatures of 64-79F (18-26C) for mice, rats, hamsters, gerbils and guinea-pigs. Relative humidity should also be controlled, but not nearly as narrowly as temperature. The Guide's acceptable range of relative humidity is 30 to 70%. Both temperature and humidity regulation are important to prevent ring-tail, nasal dermatitis and exacerbation of respiratory disease. Avascular necrosis of the tail, or ringtail, occurs primarily in young rats in low-humidity environments; gerbils develop nasal dermatitis when exposed to a relative humidity greater than 50%; and excess heat and humidity cause heat stroke and indirectly cause decompensation of chronic respiratory disease, resulting in death.

We encourage rodent owners, and especially mouse owners to check water bottles daily. If mice are deprived of water for only a short time, and experience dramatic fluctuations in the surrounding temperature, especially over 99F (37C), they die. In contrast, healthy rats tolerate water deprivation and temperature fluctuations better. They can live a whole week without water, in temperatures between 64-79F, although they may lose up to 65% of their body weight.

Any cage should provide a secure environment that does not allow escape. It should be free of sharp edges or projections that could cause injury and not allow accidental entrapment of animals or their limbs in structural or floor openings.

c space allocations

The Guide (2) recommends minimal space allocations of 23 sq in (58 sq cm) for individual rats weighing 200 gm or less, and 60 sq in (152 sq cm) for rats weighing 500 gm or more. For mice, the Guide recommends 15 sq in (38 sq cm) for individual mice weighing more than 25 gm. These are small surface areas and we advocate that owners provide larger space for their pets.

Most rodent enrichment studies focus on modifying the area inside the enclosure rather than the size of an enclosure. However, one study showed rats prefer larger cages (84 sq in vs. 251 sq in [540 sq cm vs. 1620 sq cm]) whether it is the only rat in the cage or shares the cage with other rats (13). The results suggest that we should give rats a larger space allowance and allow sharing of the space with up to four other rats.

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The minimum recommended height of cages for rodents is different between the US and other countries. For example in the US, the minimum height of enclosures for rats is 7 in (18 cm) and for mice is 5 in (13 cm). Research standards for the UK and Australia recommend that cage height should take into account typical postures of a rat or mouse. This includes the animal standing fully erect on its hind legs, and vertical movements such as stretching upwards and possibly climbing. Consequently, these countries have minimal cage heights 12-15 in (30-38 cm) for rats and 7-8 (18-20 cm) for mice.

Technicians can educate owners on the normal behavior and postural adjustments of rats and mice and recommend owners to allow for these measurements when evaluating cage height. Some owners purchase multilevel cages with gradual sloping ramps and place rat hammocks on the top level of these multilevel cages. Ramps should ideally be composed of solid material with traction and not of wire, to prevent injuries.

d enrichment items

Environmental enrichment objects for rodents are now commercially available. Manufacturers developed these toys for laboratory rodents that are often housed in behaviorally impoverished environments. Two companies Bio-Serv (Frenchtown, NJ) and Otto Environmental (Milwaukee, WI) have enrichment items such as tinted polycarbonate tunnels that allow owners to see where the pet is, yet not compromise the pet's sense of security and seclusion. The tunnels can be placed on the cage floor or suspended with stainless steel wire hangers. Other enrichment items include transparent tinted polycarbonate mouse igloos and activity wheels; non-toxic Gumabones made of indigestible polyurethane and Nylabones made of indigestible nylon, that rats and mice love to gnaw; sturdy hollow plastic balls with holes around the outside and a stainless steel rattle on the inside. Their web sites are <http://www.bio-serv.com> and <http://www.ottoenvironmental.com>.

Owners and technicians can also create enrichment toys. For example, suspended cloth hammocks are popular with rats and suspended (plastic or stainless steel) shower-hooks fitted into one another make a swinging chain. Rats will use more enrichment devices than mice. However, we find they stop using the devices after 3-4 days. Rotation of enrichment toys and introduction of novel devices excite their curiosity.

Do not underestimate the value of food treats. These can range from simple inexpensive treats such as a daily piece of a breakfast cereal such as Cheerios (General Mills, Minneapolis, MN) to formulated nutritious or calorie-free treats. The designer treats are wafer or gumball-shaped and come in flavors such as pina-colada, marshmallow and bacon (refer to Bio-Serv web site). Rats also love chocolate and it is not toxic when fed in small amounts as it is in dogs (14). We find that rats and to some extent mice will look forward to their daily treat. If the owner shakes the bag or container holding the treats, the noise will stimulate the pet rodent to stand up in its cage or look for the treat. We caution owners not to offer treats by placing them between the wire openings of the cage. Rats conditioned to accept treats this way, can mistakenly bite fingers that are innocently placed between the wire openings when strangers or guests visit, or when the cage is held or moved. Pet rodents accustomed to handling will eat the treat out of the owner's hand. This daily routine can detect subtle changes in the pet's behavior. Sick rodents are very good at hiding signs of disease. Sick rats do not show the same interest in their daily treat, and this can alert the owner early to disease when it is still treatable and reversible.

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e compatibility of housing like rodents together

Owners should house different species of rodents separately to prevent interspecies disease transmission. For example, rats carry *Streptobacillus moniliformis*, a cause of fatal septicemia in mice, as part of the normal nasopharyngeal bacterial flora. Rodents of the same species should be housed in such a way to protect vulnerable animals from more aggressive members of their group. This includes young animals from older animals, and male hamsters from female hamsters. Female rodents are generally compatible when housed in the same cage, unless one female has lived much of her life in alone. Male rats are generally compatible, especially if raised together. However, owners should never house strange male rats in the same cage together because they will fight. Male mice generally fight if housed together, unless they are litter mates raised together without females present. Male mice are best housed singly or with female mice.

Housing male and female rodents together will result in mating and subsequent litters. Mice and rats experience post-parturient estrus and fertilization can take place. However, implantation of the resulting blastocysts is delayed during lactation and occurs at weaning, ensuring that the next litter is not born until they have weaned the earlier one. Female mice become sexually mature at 6 to 8 weeks of age and female rats are sexually mature by 10 weeks of age. Unless opposite sex rodents housed together are separated or neutered, having a new litter every 3-5 weeks is possible.

A2 Nutrition

a problems arising from improper diet and husbandry

Rats and mice are not strict herbivores like rabbits, guinea pigs, or chinchillas. They are omnivores and will eat food of both plant and animal origin. In the wild rats and mice will eat a wide variety of seeds, grains and other plant material as well as invertebrates, small vertebrates and carrion. Their ability to scavenge partly accounts for their successful colonization of diverse geographic regions.

Specially formulated diets for laboratory rodents that come as pellets are convenient and nutritionally balanced sources of nourishment. Unfortunately, most of these diets are only available in 50 lb. bags from wholesale feed distributors. Some private rat breeders/owners purchase the 50 lb bags and break them down into smaller sizes that they then sell online. Most feed manufacturers produce a basic diet designed to meet the nutritional needs of all stages of life (reproduction, growth, and maintenance). In contrast, laboratory rabbit and guinea pig diets are generally available either as high energy (for reproduction and growth) or as high fiber (for maintenance). Laboratory rodent diets are relatively high in fat and low in fiber. We are concerned that when provided ad libitum, they cause pathological obesity. Restricting the number of calories, without compromising the overall nutrition, in food offered to several invertebrates and vertebrates including spiders, fish, rats and mice, results in increased lifespan of animals (15). Obesity in pet rats and mice is common, and it is our observation that calorie restricted pets live longer. Consequently, we believe the amount of pelleted diet owners provide daily should be limited. Owners should supplement their pet=s diet with feeds high in fiber such as vegetables, limited amounts of fruit, and occasional treats.

Three commercial feed manufacturers, Kaytee (Chilton, WI), Mazuri (St. Louis, MO) and Oxbow Hay Products (Murdock, NE) have developed pellet diets for pet rodents and rabbits. Kaytee products are readily found in many pet stores, while Oxbow Hay and Mazuri products are available by direct order or from selected veterinary clinics. The diets are available in 1 or

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2, 5, 10 and 50 lb bags. We find useful feeding information is available from the manufacturers' web-sites: www.oxbowhay.com, www.mazuri.com, and www.kaytee.com. Other manufacturers of pet rodent feed that owners often see in pet stores and supermarkets are Vitakraft Pet Products (Bound Brook, NJ) and Hartz Mountain Corporation (Secaucus, NJ). More information is available from their web sites: www.vitakraft.de/en/indexen.htm and www.hartz.com. These manufacturers have developed assortments of seeds, grains, nuts, fruits, vegetables, and vitamin-minerals for pet rodents and rabbits that come in 1, 2, 4 and 5 lb boxes, jars, and bags. We find these products are suitable as treats but not as the primary diet because pet rodents often selectively eat only one ingredient (e.g., sunflower seeds), when offered mixed-seed and grain diets.

b coprophagy

Coprophagy, or eating of feces, is well-known in rabbits, but rodents also do it. It is an inherent behavior as it occurs in gnotobiotic (or germ-free) rodents purposely bred for research (16). Coprophagy supplies many essential nutrients such as vitamin B12 and folic acid, because bacterial synthesis of these nutrients occurs in rodents' lower gastrointestinal tract where little absorption takes place.

Unlike rabbits, which eat cecal feces from their anus, rodents eat fecal pellets on the floor of their caging. The amount of feces eaten varies between rodents, their age and physiological status (e.g., in pregnancy coprophagy increases) and the diet fed. On a nutritionally complete diet, rats will eat about 10% of their feces. When rats are housed together, they ingest each other's feces. The unique odor of a colony is due in part to ingestion of feces and the group scent enables distinction between members and non-members (17). Mice perform coprophagy about six times per day. Growing mice show vigorous coprophagous activity eating 13 pellets per day. However, it gradually decreases to 2 pellets at 1.5 years and 1.5 pellets at two years of age (18).

A3 Table listing average life spans of different pet rodents

Mice	Rats	Hamsters	Gerbils	Degus
1.5 years	2 years	1.5 years	3 years	7 years

A4 Reproductive characteristics of pet rodents

	Rat	Mouse	Guinea pig
Sexual maturity in weeks (male)	6-10	6-8	10-12
Sexual maturity in weeks (female)	8-12	6-8	10-12
Breeding life in months (male)	9-12	9	24

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Breeding life in months (female)	9-12	9	24
Estrous cycle length (days)	4-5	4-5	16
Estrus duration (hr)	10-20	10-20	6-11
Ovulation rate (egg number)	10-20	6-10	3-4
Gestation (days)	21-23	19-21	63-69
Pseudopregnancy (days)	12	12	none
Litter size	8-18	5-12	1-6

Male rodents are sexually mature at a similar age to females, but produce a small amount of sperm daily at puberty (e.g., 40 to 50 days in a rat). It is not until 75 to 100 days (10-14 weeks) in a rat that optimum sperm production and reserve occur. While male rodents show a constant libido after sexual maturity, in contrast to females that are receptive to copulation only during estrus, they cannot fertilize females until 6-8 weeks after reaching puberty.

Rodents confine initiation of copulation to basic patterns such as sniffing, licking, nuzzling, reciprocal grooming, and following the female. Male rats and mice will mount females 10 to 20 times and display multiple vaginal intromissions before ejaculation. A male rat will mount and ejaculate 7 to 10 times, with increasing lengths of post-ejaculatory refractory periods. Lasting from 5 to 8 minutes, the male shows little interest in the female before initiating mounting again. The time before a male rat reaches sexual satiation may take up to 3 hours. Male mice also show a similar copulatory pattern but usually cease after 2 or 3 ejaculations. This behavior is essential for the stimulus of coitus to cause prolactin release from the anterior pituitary of the female. Only under these conditions, does the corpus luteum become functional and secrete progesterone for the maintenance of pregnancy.

B Instructions When Making an Appointment

Rats are essentially nocturnal animals and are only occasionally active during the day. In contrast, mice are active during both the night and day. Healthy rodents are generally active during the awake part of their normal circadian cycle. It is possible to overlook subtle signs of diseases when seeing a rat during its diurnal sleep period. Try to schedule appointments for rats for early evening hours; appointment times are not as critical for mice.

B1 Transportation to the hospital

Scientists have shown that transportation stresses rats and mice. Transportation affects mice more than rats. The classic study by Landi showed that transport in a vehicle markedly increases corticosterone values in the mice for a 48-hour period (19). Even moving mice from one room to another, or cage to a transit box, results in weight loss, elevated corticosterone values and changes in rearing, climbing, grooming, feeding and sexual behavior for 24 hours (20). Under the best conditions, laboratory mice lose 5% of their initial weight when moved. Transporting mice without food will result in greater weight loss and death occurs when 20% of initial weight is lost (21). Rats are hardier animals. Transport of rats by truck results in an increased water intake and a decrease in corticosterone values for three days (22).

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Transportation also incidentally decreases blood glucose, free fatty acids and urea concentrations, and increases cholesterol levels in rats. Body weight, growth, and clinical observation appear unaffected in the rat.

Rodents are sensitive to heat. In the wild, their main method of modulating body temperature involves escape from the heat by burrowing or seeking cool places. Mice in particular are very sensitive to the effects of heat. The Guide (2) recommends a temperature range of 64.4-78.8F for housing and transporting rodents.

Owners should be encouraged to reduce the stress of transportation. This can involve transportation in a quiet, air-conditioned car instead of public transport. A pet rodent accustomed to handling should be allowed to snuggle next to the familiar smell of its owner, or remain in the familiar environment of its cage. If the transport cage is not used to house the pet, encourage the owner to place used bedding and/or familiar objects marked with the scent of the animal or owner in the cage. This could be a worn T-shirt or article of clothing. If the rodent is not housed singly, we encourage the owner to bring the cagemate along in the same cage. On occasion fights can occur upon reintroduction of the pet brought to the hospital due to the unfamiliar hospital and handling scents on it. The company of cagemates reduces this risk.

The transport container should have food and water. As water bottles leak during transportation, we recommend placing pieces of chopped fruit like apples, pears, or grapes to provide food and moisture. Finally, the transport cage should be placed in a bag or a cover that keeps it relatively dark inside. Some opening or holes in the bag are necessary for ventilation.

B2 What to ask the client to bring

Knowledge of the rodent's husbandry and sanitation are essential to taking a good clinical history. We ask the client to bring the rodent to the hospital in its own cage. Sometimes the rodent cage is too big or too difficult to bring to the appointment. We instruct these clients to bring a sample of dirty bedding, clean bedding, feed, and fresh feces. If the owner has access to a digital camera, they can take photographs of the cage and accessories for evaluation. Only by seeing the cage, water supply, feed containers, bedding, feces, and food can we understand the environment in which the rodent lives. Instruct clients not to clean the rodent's housing in preparation for the appointment because doing so they may inadvertently destroy information important for diagnosis and treatment.

C Recognizing Illness

Recognizing disease in prey species such as rodents is more difficult than recognizing disease in predators like dogs, cats, or ferrets. Prey species are very good at hiding signs of disease and pain as a survival mechanism. Any obvious indication of weakness makes that animal an easier target for a predator. Self-induced analgesia is part of a rodent's defensive behavior system. Stress odors and handling stimuli are danger signals in rats that activate endogenous analgesia. Brief exposure to a predator elicits a benzodiazepine-mediated analgesia lasting 15-30 minutes, while a more prolonged exposure to a predator induces opioid-mediated analgesia lasting 45 minutes (23). Handling a rat not used to being held or picked up will also trigger an endogenous opioid analgesic response (24).

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C1 Anorexia

Anorexia, or decreased appetite, is a general indicator of an underlying problem. Recognizing anorexia in rodents can be difficult if owners house them in groups and make large volumes of food available free choice. This makes it difficult to know if each animal is consuming normal amounts of food. Therefore, we recommend using treats on a daily basis to assess the animal's interest in food. While it may not always be an accurate representation as the pet can accept the favorite treat and reject the staple diet, we find refusing the daily treat warrants closer monitoring. If anorexia is suspected, we place the pet in a separate smaller enclosure so we can evaluate it more carefully.

C2 Lethargy/weakness

Lethargy or weakness is unusual in rodents. Many things such as dehydration, anorexia, heat prostration, infection, and neoplasia can result in lethargy/weakness. A veterinarian should promptly evaluate any rodent that is lethargic or weak. Rodents become hypoglycemic if food is absent or withheld for long periods. If an owner is reporting a lethargic or weak rodent, recommend that they try to feed the animal, and bring it in for evaluation right away. Ask the owners about the temperature in the pet's cage and surroundings, and if it exceeds 79F (26C) recommend cooling the pet by misting it with cool water and/or allowing it to walk through a shallow pan of cool water.

C3 Changes in droppings

Normal rodent droppings can vary in color from black to tan, and in consistency from hard pellets to firm paste. Changes in the droppings can indicate an underlying problem. If the droppings are dry, it might be due to dehydration. Smaller than usual droppings generally means the pet has decreased its food intake. When diarrhea is present, a stool sample should be evaluated for abnormal gut flora, microbial or parasitic infection. In neonatal and adult mice, diarrhea is usually of viral origin. Enteritis is more severe in neonates and sucklings than in adults. Besides diarrhea, retarded growth, and dehydration, the absence of milk in the gastrointestinal tract is an important sign of digestive disease in young mice. If droppings are absent altogether, we recommend evaluating the animal as soon as possible.

C4 Changes in normal behavior

The owner is the best person to perceive a change in their pet's normal behavior. Abnormal behavior may consist of any or all of the following: lethargy, weakness, personality change, pruritus, dietary habit change, sneezing, head tilt, ocular discharge, nasal discharge, or chattering. Recommend that the veterinarian examine the pet.

C5 Nasal or ocular discharge

The Harderian glands of rats are found behind the eyes and secrete various porphyrins that give the tears a reddish color. Rats increase Harderian gland secretion in response to stress and disease, and the tears dry around the eyes and external nares (the nasolacrimal duct drains into the nasal cavity), resembling crusts of blood. Owners commonly report bleeding from the eyes and nose of their pet rats. The porphyrins fluoresce under ultraviolet light and can be readily differentiated from blood with a Wood's lamp. The condition is known as chromodacryorrhea or red tears, and although not pathologic, it is a consequence of acute-

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onset stress caused by pain, illness, or restraint. Red tears are often an indication of a chronic underlying disease, and their discovery warrants a thorough evaluation of the affected pet rat.

C6 Recognizing signs associated with pain or distress

Assessing pain in animals, is similar to assessing pain in human babies, and relies on the observations of technicians, owners, and veterinarians. A notable drawback is observer variability and the interpretation as to whether an animal is in pain or distress. Knowledge of clinical signs associated with pain potentially provides an objective, rather than a subjective judgment. However, for such signs to be effective observers must have good powers of observation and knowledge of what is normal for the individual animal species.

Rats and mice in pain may show decreased food and water consumption, weight loss, self-imposed isolation, self-mutilation and gnawing at limbs; rapid breathing, open-mouth breathing and abdominal breathing; increased or decreased movement; unkempt appearance such as a dirty, greasy or dull hair coat; abnormal posture such as a hunched back; dehydration, skin tenting and sunken eyes; twitching and trembling; and familiar signs such as redness or swelling around a wound or lesion.

Recognizing distress is more difficult. The presence of disease, self mutilation, abnormal behavior, or failure to grow are obvious indicators of distress. However, we do not have simple, definitive measures of distress, and we believe the best approach is to use one's intuition and sensitivity. Ideally, we should have an empathetic attitude and base our evaluation on critical anthropomorphism (25).

A good strategy for assessment of pain and distress is to involve everyone involved with the pet rodent, as each person will bring a different focus to bear: owners "know" their animals and veterinarians possess clinical skills. Technicians are crucial in this identification because they know the biology of the species, including its relevant behavioral and physiologic responses. Furthermore, technicians are most likely to know when a hospitalized animal is "not right" and are likely to pick up changes in behavior, posture, appearance, or even the feel of the animal.

D Capture and Restraint

Whenever possible, allow the pet to be present while interviewing the owner. We suggest interacting with the pet in a non-threatening way during this time. Letting the pet rodent crawl on your hands without restraining it is a good introduction. The pet is more likely to allow a physical examination without chemical restraint with this approach.

Pet rodents that have been frequently and gently handled usually only require mild restraint. Less cooperative patients may need firm restraint using a towel or even heavy leather gloves. Although pet rodents do not often bite, their nips can be painful and elicit an unfortunate reflex response that results in pitching the pet onto the floor or at a wall. Besides the potential for traumatic injury, the rodent may escape and become harmed.

We find that even the calmest pet rodent can be a challenge to handle and restrain in the office. For the rodent, the stress of a new location and strangers handling it, as well as any underlying disease, can escalate the clinical examination to a state of panic. Animals that do not tolerate physical restraint will need chemical restraint to obtain a complete physical examination. In our experience even seriously ill rodents tolerate brief periods (<15 minutes)

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of Isoflurane sedation well. Too commonly, the stress from physical restraint far outweighs the risk of a brief period of anesthesia.

E Sample Collection

Individuals who work with mice and other species such as rats or guinea pigs should receive basic instructions that include specific techniques for picking up and restraining the animals. We cannot adequately describe these techniques in text. Instead, we recommend that individuals who will handle pet rodents view one of the CDs listed under ARcommended Reference Material@ at the end of this chapter.

E1 Blood collection

Obtaining blood from a pet rodent in a clinical setting is very different to obtaining blood from a research rodent in a laboratory. First, taking blood from a small pet rodent is virtually impossible (gerbil, mouse, rat, hamster) without sedation. Second, we do not use the same venipuncture techniques on pet rodents that we might use on laboratory rodents.

An insulin syringe with a 27-gauge needle can be used successfully to obtain small amounts of blood for blood smears and microhematocrits. Larger syringes and needles will result in collapse of the vein and unsuccessful venipuncture. Sometimes, we induce vasodilation using acepromazine (0.5-1.0 mg/kg SC or IM) to permit better visualization of the lateral saphenous and cephalic veins for small samples (we do not recommend acepromazine in cardiovascular compromised pets). If we require larger blood samples, the jugular vein or vena cava can be used. Only attempt to take blood from these sites with the patient anesthetized or sedated.

Although instructional laboratory animal videos show techniques such as tail snipping, retro-orbital, lingual, penile, and cardiac punctures, we do not recommend these techniques for pet rodents due to the potential side effects.

With very small amounts of blood we use one lithium heparinized (green top) microtainer tube (Becton Dickinson, Franklin Lakes, NJ) for the sample, instead of an EDTA (purple top) tube and plain (red top) tube. Always let the clinical laboratory know the blood collection technique, as different anticoagulants cause different blood artefacts, and can invalidate certain biochemical parameters. Rats will often suffer from chronic renal disease and in addition to a urine dipstick analysis for proteinuria; a simple (but crude) BUN level can be estimated on a blood dipstick.

E2 Fecal Collection

Rodents defecate frequently and therefore getting a fecal sample during an examination is usually easy. Rats usually urinate when first picked up, so with forethought obtaining a urinalysis by holding a urine dipstick under the pet ready to catch the few drops of urine is possible. Owners can also be asked in advance to bring a sample of the rodent's feces with them to the appointment. Submission requirements and diagnostic tests such as fecal smears and flotations are no different from that for other species fecal samples.

F Medication Administration

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There is a tendency to overdose mice and small rats due to an overestimation of their weight. Small gram scales (such as postage or medical scales) are necessary to obtain accurate weights of rats and mice. Dilution of medications and the use of a tuberculin or insulin syringe will permit increased accuracy of the dosage. Intravenous injections are difficult and therefore rarely performed. Intramuscular or subcutaneous injections are the most common routes for administration of medication.

F1 Oral medications

Medication is often administered by mixing it into the feed. We do not recommend adding medication to water as rats will not drink if they find the taste of their water objectionable. Oral medications for rodents should be liquid pediatric formulations or those made into liquid oral suspensions by a compounding pharmacy. Food items that can be used to administer medication are yogurt, cottage cheese, whipped cream, ice cream, or muffin crumbs. A recent study demonstrated that mixing a medication with chocolate is an effective method of administering drugs to rats for long periods (14). We find any food that will mix with or absorb a liquid medication and is palatable to the pet will work as an oral drug delivery carrier. Sometimes, rodents will not consistently accept medication in the same food and in these cases, we recommend rotating carrier-foods to keep the pet interested.

Providing a small portion of food with the medication is important so that the pet ingests the entire drug dosage. If owners still have trouble getting their pet to accept medication, we suggest withholding food for a few hours so that the pet develops an appetite by the time the owner offers it the >spiked= food item. We do not like owners using oral dosing needles to administer drugs to their pets. They are effective for trained technicians and some have flexible catheters to provide a less stressful gavage technique (26). However, in unqualified hands oral dosing needles cause stress and have potential for traumatic injury of the oropharynx, rupture of the esophagus and stomach, and intratracheal drug administration.

F2 Injections

Subcutaneous injection is the most common technique for drug administration in rodents. The best tolerated sites to inject are internuchal, interscapular, and the flanks. A new, small gauge needle (< 25 g) reduces patient discomfort for non-viscous solutions; we may use a 23 or 21 g needle for suspensions or viscous solutions. Intravenous injections are rarely used in pet rodent species. If the animal is suitably large for placement of an intravenous catheter, then intravenous injections can be done, using the same veins in a large rodent as in a cat or dog.

We give intramuscular injections in the epaxial muscles. We do not use the hind limb (biceps femoris, semitendinosus and gluteus muscles) for intramuscular injection. The needle may lie in a fascial plane and not intramuscular. In addition, local irritation of ischiatic and femoral nerves, and injected muscle, can result in patient lameness, paralysis, and/or discomfort. Only administer intramuscular injections of large volumes with the pet sedated. Small volumes (< 0.5cc) can be administered without too much distress in the awake patient.

G Preventive Care

Prevention of disease in rodents is far more successful than treatment. Disease prevention is based primarily on common-sense husbandry practices, such as purchasing healthy animals; supplying balanced fresh food; providing clean, fresh water; furnishing adequate shelter

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including shade from direct sunlight; avoiding drafts and excessive temperature or humidity changes; keeping cages clean by preventing the accumulation of excess feces and urine; isolating a sick rodent from its cage-mates for treatment; and protecting the pet rodent from natural predators living in the same household. To prevent or reduce obesity, owners should also limit the pet's food intake and provide cage accessories that allow play and exploration (e.g., exercise wheels, tunnels, and ramps).

Most rats and mice obtained from a pet store were bred as reptile food. The trade in rodents as reptile food is enormous in the US. In research, approximately 500,000 rodents are transported interstate to various research laboratories every year. However, the number of rodents transported as reptile food is nearly two million every year. In our experience, the pet store and reptile owners are unaware of chronic infectious diseases in the rats or mice. Seeing sickly and scared rats and mice huddled in one corner of a cage in a pet-store is common. Owners should be strongly advised that pet rodents acquired from a private breeder or laboratory are less likely to suffer from infectious disease. A recent survey showed 7 out of 9 pet stores were selling infected rats, mice, and hamsters infected with *Hymenolepis nana*, a zoonotic tapeworm (27). Unlike other companion animals, pet rodents are not vaccinated. Because chronic infectious respiratory disease is prevalent in pet rodents, we should also warn owners not to mix their pet with other rodents at rodent-owner-gatherings or pet shows because of the risk of infectious disease.

Rats and mice are not as sensitive to antibiotic associated dysbacteriosis or antibiotic toxicity like guinea pigs or rabbits. Topical antibiotics have also caused fatal enterotoxemia in guinea pigs and rabbits. Fortunately, the known sensitivities of rats and mice are few. Streptomycin and procaine are toxic in mice and nitrofurantoin causes neuropathology in rats. Large doses of aminoglycosides (e.g., gentamicin) will cause renal disease and ototoxicity in rats and mice as it does in dogs and cats. The introduction of ivermectin, although not approved for use in any rodent species, has allowed routine systemic treatment of pet rodents with pinworms and mites.

G1 First visit

Ideally, the waiting area for rodents and owners should be quiet. When possible, avoid planning appointments for natural predators, such as cats or dogs, when scheduling a pet rodent for an examination. Studies have shown that predatory odors cause anxiety for rodents and will activate endogenous analgesia (24). Show special attention to young pet rodents on their first visit. The impression that a young animal develops of the veterinary office will influence how future interactions proceed. Kind words and gentle handling are key to decreasing stress and improving rapport. Anecdotally, children seem more vulnerable to stress than adults do. A study in mice showed that young mice show greater behavioral disturbances after stress than adult mice (28).

Seeing the condition of the rodent's living quarters provides information that is helpful in reaching a diagnosis or a reasonable prognosis. Information obtained from a physical examination is limited because of a rodent's size. However, it is only after thorough examination of the animal that we can evaluate the significance of the rodent's history and husbandry. With appropriate handling and a few specialized but simple pieces of equipment, it is possible to conduct a thorough review of the major organ systems. However, some habituation of the rodent to handling is necessary to avoid misinterpretation of their responses. Owners usually handle rats, but we find they do not handle mice as often. Consequently, the lack of handling and small size of mice makes their examination more challenging.

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a Complete physical exam

At the beginning of an assessment, we try to view the rat or mouse and note its appearance. When approaching the animal or preparing to pick it up, it will inevitably begin to interact with that person. This is the time to decide whether the interaction is normal or abnormal. Look for changes in behavior such as aggressiveness, fear, or even vocalization based on the owner's description.

Observe the pet rodent in its cage for activity, condition of grooming, and the presence of a head tilt or discharges. If dyspnea or depression are noted, be extremely careful when handling the animal, as it is probably very sick and could die of the stress of a physical examination.

Usually, the first component of the physical examination is accurate measurement of the patient's bodyweight. Accurate weight measurement is necessary to calculate appropriate dosages of medications. Weighing the pet also provides an opportunity for gauging the rodent's temperament before the actual physical examination begins. Rodents are easily weighed in metal or plastic containers placed on a small digital scale or a triple-beam balance. If the container has a lid, take care not to pinch any toes or the tail while securing the lid.

Many small rodents will require chemical restraint for a complete physical examination. We like to start at the head, examining first the ears, eyes, and nose for discharge and the oral cavity for dentition. A binocular loupe and an otoscope are helpful. The otoscope allows careful examination of the mouth and ears in most rodents except rats and mice. Lymph nodes and glands of the head can be observed for size and palpated for consistency. Assessment of the head is probably the most time-consuming part of the examination.

Palpate the abdomen for consistency and the presence of unusual masses. However, do not squeeze the patient too hard because overzealous palpation can result in visceral rupture. Examine the anogenital region for discharges and staining of the fur or skin. By this point in the examination, the condition of the fur should be noted and the body assessed overall. Palpate the limbs for tenderness or fractures and pay special attention to the paws, noting the length of the nails and the state of the footpads.

Respiration and heart rate are difficult to measure in rodents because they are rapid. Instead, look for signs of dyspnea. A sensitive pediatric stethoscope is useful for auscultation in large rodents. Some respiratory infections, such as mycoplasmosis, are clinically silent. We can better hear these diseases than see them - abnormal sounds called 'snuffling' in rats and 'chattering' in mice are noticeable without a stethoscope.

b Dental exam and recommendations

All rodents share one characteristic: a highly specialized dentition for gnawing (the term rodent is derived from the Latin rodens meaning gnawing). Rodents have a single pair of upper and a single pair of lower incisors. Between each incisor and the first cheek tooth is a toothless interval called the diastema. The incisors are rootless and grow continuously. Rodents deposit enamel on the anterior and lateral incisor surfaces; the posterior incisor surface is dentin. During gnawing, as the incisors chisel against each other, they wear away the softer dentin, leaving a sharp enamel edge. This "self-sharpening" system is very effective and is one of the keys to the enormous ecological success of rodents.

We commonly see dental problems in pet rodents because of their continually erupting teeth. Always evaluate the rodents for underlying disease such as inner or middle ear infection, and

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pituitary or ear canal sebaceous gland tumors (Zymbal gland tumors) that can result in abnormal mastication and consequently malocclusion and incisor overgrowth. Overgrown incisors are seen most frequently in rats. Cutting the teeth with rongeurs easily treats incisor overgrowth and can be done in a conscious patient. However, it may not produce good long-term results, and problems may arise, e.g., the incisor may fracture longitudinally; the fracture may reach the apex and cause the rat discomfort. Bacteria can enter the fractured tooth, track down to the apex, and cause an apical abscess. In addition, clipped teeth have jagged edges that may lacerate the tongue and other soft tissues. An alternative technique involves the use of a high-speed drill; the drill cuts through the overgrown incisors without splitting or splintering them, leaving a clean, smooth surface. The rodent must be sedated or anesthetized for this procedure. Some owners may prefer not to return their pets regularly for tooth trimming for financial reasons. Extraction of the incisors is an alternative to trimming; however, this procedure is difficult because of the incisors' long roots. Old rats may show yellowing of the cranial aspect of their incisors due to iron deposition within the enamel. It is normal.

c Fecal direct smear and fecal flotation

Fecal direct smear is of little utility in most rodents. Occasionally chinchillas can be infected with giardiasis, which may be documented on a direct fecal mount. When a rodent is picked up, it generally urinates and defecates making collection of fecal samples easy. Pinworms are the most common gastrointestinal parasite found in rodents. Tapeworms such as *Hymenolepis nana* and *Hymenolepis diminuta*, both, which are zoonotic, may be seen especially from pets obtained at pet stores (27).

d Sexing

The age at which rodents attain sexual maturity varies considerably according to either the strain or breed. However if we plot the biological pattern of growth graphically then puberty occurs just after maximal rate of growth. Sexual maturation occurs at the point on the growth velocity curve where growth is still taking place but the rate is decelerating rapidly. This means that body weight is more important than age in determining sexual maturity.

Between birth and weaning, examination of external genitalia does not allow sex determination. At this early age, the testicles have yet to descend and the genital papilla does permit differentiation of external genital organs. The only reliable method to decide the sex of rats, mice, hamsters and gerbils is by measuring the distance between the anus and the genital papilla. This distance is always greater in males than in females.

e Any other tests as deemed necessary by veterinarian

The clinician can obtain a small amount of blood from a hind-limb skin stab, nail-clip, or nick of the tip of the tail. This can be used for a blood smear. Obtaining a larger amount of blood for a complete blood count (CBC) and biochemical analyses, can be difficult unless it is a larger rodent sedated for venipuncture. If the saphenous or dorsal metatarsal vein is easily visible, the rodent is often large enough to permit collection of a small amount of blood with a small-gauge needle and syringe.

Serology is well-developed for diagnostic testing of laboratory rodents and rabbits. We frequently use selected assays to test for exposure to viral and mycoplasmal agents. Although most laboratories performing serologic assays only test groups of research animals, two groups we use will test individual pet rodents. These are RADIL at the University of Missouri (Columbia, MO, <http://www.radil.missouri.edu>) and Taconic-Anmed (Rockville, MD, <http://www.taconic.com>)

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The value of determining rectal temperature is questionable. The examination stresses a rodent, and increases its body temperature. Furthermore, causing rectal damage and prolapse in the patient is easy because of its small size. In the conscious patient, unless it is recumbent, we do not recommend attempting to obtain rectal temperatures. We can monitor rectal temperatures safely in anesthetized patients with the use of small, semiflexible temperature probes connected to a digital clinical thermometer. They are ideal for monitoring body temperature when performing surgery on pet rodents.

Electrocardiography and detailed recordings of heart rate, respiratory rate, and blood pressure in research rodents are possible due to technologic advances. However, the cost of the equipment for doing these measurements has not made their use routine in small exotic animal practices. In the clinical setting, unless the patient is sedated electrocardiographic monitoring is impossible. Similar advances in high-resolution film screen combinations that require low radiographic exposures and developments in ultrasound have allowed diagnostic imaging to become a useful, ancillary examination. For routine thoracic radiographs in clinical practice, fine screen and mammography film provide the best detail. Dental film can also be used for radiographs of limbs and digits (29).

f Annual examinations or wellness examinations

We recommend annual examinations, but in healthy or clinically normal rodents call them wellness examinations. These are check-ups to evaluate the health of the pet and should include a complete physical examination, oral examination and a review of current diet and husbandry practices.

G2 Importance of Spay/Neuter

Ovariectomy can prevent the development of spontaneous or induced mammary tumors in rats. Mammary tumor forming ability is correlated positively to circulating estrogen levels. For example, pregnant females have low estrogen levels during gestation, and their pregnancy prevents the development of spontaneous and induced mammary tumors. Because owners usually prevent their pet rats from breeding, these animals develop mammary gland tumors. The prevalence of mammary tumors, and pituitary tumors, is much lower in ovariectomized rats compared with sexually intact rats (30). Survival to two years of age is also higher in ovariectomized than in sexually intact rats although mammary tumors do not contribute significantly to mortality.

The most common subcutaneous tumor in the rat is fibroadenoma of the mammary glands. Adenocarcinomas represent fewer than 10% of mammary tumors in rats. Distribution of the mammary tissue is extensive, and the tumors can reach 8-10 cm in diameter and occur anywhere from the neck to inguinal region. The surgical technique for tumor removal is straightforward, and survival following mastectomy is good if the tumor is benign. However, the recurrence of fibroadenomas is common in uninvolved mammary tissue, and often a rat needs several surgeries.

Mammary tumors in rats typically grow by expansion until they reach a size that the overlying skin becomes traumatized and infected. Large mammary tumors also contain infarcts and extensive areas of necrosis associated with cutaneous ulceration. Consequently, rats bearing large mammary tumors often become anemic and cachectic due to impaired mobility and the systemic effects of the tumor inflammation and necrosis. For these reasons, surgical excision of the tumor before it causes severe incapacitation and not chemotherapy is always the

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treatment of choice. If we see a female rat with a mammary tumor, we recommend both removal of the tumor and ovariectomy.

In situations of multiple pet housing, it is desirable to neuter male rats to improve cohabitation quality and for population control. Neutering male rats is a relatively simple procedure (31). The rats tolerate surgery well with few post operative complications. Elizabethan-collars (e-collars) designed to prevent animals from grooming and protect surgical sites are manufactured for rats and mice and should be used as needed. Braintree Scientific (Braintree, MA, <http://www.braintreesci.com/Collars.htm>).

G3 Grooming

Rats are social animals and grooming is a socially affiliative behavior. Singly housed rats may develop Isolated-rat-stress-syndrome@ (32) if left alone without human contact, and environmental enrichment. Isolation-reared rats will experience fighting, physical injuries, and weight loss when placed into a colony of socially experienced rats (33). Therefore, we recommend housing young rats together to develop social affiliation; we warn owners not to put singly housed rats together; and we encourage enrichment and human contact with pet rats because it increases production of growth factors and structural reorganization in areas of the brain involved in cognitive function (34).

Occasionally technicians need to bathe rodents with ectoparasite infestations. This can be done by lightly sedating the animal with an injectable drug such as medetomidine (Dormitor, Pfizer; 0.3-1.0 mg/kg IM) that can be reversed with atipamezole (Antisedan, Pfizer; 0.3-1.0 mg/kg SC) when the bath is complete. We recommend blow drying the pets while they are still sedated to reduce hypothermia. Allow the pet to wake up in a dry, warm place like an incubator. Be sure to lubricate their eyes well to prevent corneal ulceration. Owners may ask to have their rodents nails clipped. Rarely can a nail trim be safely done in the awake rodent. We like to remind owners that the sharp nails are necessary for traction and therefore safety of the pet. Always caution owners after a nail trim that their pet could fall and injure itself if they do not take extra care.

H Important Questions for Owners

Discover what owners know about rodents. Ask if they had rodents as pets before. Where do they obtain their information on caring for their pet? Is it from a book, a web-site, newsletter (electronic or paper), a pet store, or first-hand experience? Books and web-sites about rodents for owners are presented in the Recommended Reference Material at the end of this chapter. It is our experience that most animal technicians and veterinarians have not seen these books or web-sites and we encourage familiarity with them. Many books and web-sites are informative on husbandry requirements but unfortunately give misleading descriptions of diseases. We find it essential to evaluate pet rodent owners' sources of information to understand their ability to care for their pet, provide an accurate medical history, and follow up on prescribed medication at home.

Good questions to ask include:

- Where did the pet come from - a breeder, pet store or a laboratory?
- Are there other pets in the household?

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- If there are other pets, are they rats or mice or other animals?
- How often does the owner feed and clean the pet?
- What food does the owner give to the pet?
- What food does the pet like?
- Where does the owner buy the food?
- Where is the food stored and for how long?
- Who is responsible for feeding and cleaning?
- Who usually does these tasks and how often?

I Do rats and mice make good pets?

Two negative responses of rats and mice that detract from their popularity are freezing and biting, behaviors affected by handling. If owners handle rats and mice gently, they become tame and rarely bite unless roughly handled, startled, or hurt (35). Technicians are in an ideal situation to provide rat and mouse owners with basic instructions that include specific techniques for picking up and restraining their pets. Owners find these positive interactions with their pets highly rewarding. Positive dealings with their pets on a daily basis allow owners to empathize with their animals and acquire a sense of their preferences and desires.

A growing body of evidence suggests that animals of various species can discriminate among the humans with whom they have regular contact (36). Rats will show a preference for a particular familiar person and will retain this preference after the person had been absent five months (37). Additional evidence that rats value their relationships with humans is the fact that a rat will work to be petted by a care-giving person (38). Studies in this area clearly document that rats not only distinguish and prefer familiar humans rather than unfamiliar ones, but that they also seek out interactions with people.

In scientific research, rats are the small animal most favored by technicians. However, results of a survey of technicians and veterinarians at the University of California campuses revealed that half these individuals reported feeling less attracted to mice than any other species (39). Our experience treating pet rats and mice agree with the results of these surveys, as we find that pet rats outnumber pet mice by 10 to 1.

Rats also carry the human pathogen *Streptobacillus moniliformis*, the cause of rat-bite fever in their oral cavity. For this reason, they do not make good pets in contrast to rabbits and guinea pigs for young children or the immune suppressed individual. In addition human allergies to proteins in rat and mouse saliva (and thus their hair from grooming) and urine are common and the resulting acute hypersensitivity can diminish pleasure from playing with these animals.

I Recommended Reference Material

Books

Two good multi-authored books on exotic pets, one from the US and the other from the UK, are:

a Hillyer EV, Quesenberry KE, editors. *Ferrets, Rabbits and Rodents: Clinical Medicine and Surgery*. Philadelphia: WB Saunders; 1997 (ISBN 0-7216-4023-0). A 2nd edition is scheduled for 2004.

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b Meredith A, Redrobe S, editors. BSAVA Manual of Exotic Pets, 4th edition (BSAVA Manuals). Quedgeley, Gloucester: British Small Animal Veterinary Association; 2002 (ISBN 0-9052-1447-1).

Books of interest to pet owners of which we should be aware include:

c Barron's Complete Pet Owners Manuals, Hauppauge, NY. The Manuals include chinchillas, degus, dwarf hamsters, gerbils, guinea pigs, hamsters, mice, rats, rabbits and dwarf rabbits.

d TFH Publications, Neptune, NJ, has 84 titles on Small animals in its catalogue. They range from 32-page Your First series books to 256-page Proper Care Series.

Digital and Video CDS

a Digires (Digital Resources for Veterinary Trainers) is a non-profit organization based at the University of Newcastle in England. It has CDs on animal handling, procedures, anesthesia, and surgery in small mammals. Its web-site is <http://www.digires.co.uk/index.html>

b The University of Melbourne, Australia produced a multimedia CD entitled [Careful How You Hold Me](#) that covers husbandry, clinical techniques, and anesthesia in rabbits, guinea-pigs, rats, and mice.

Web-sites

There are many web sites on small exotic pets ranging from pet owners personal pages, breeders, societies and veterinary specialist groups. We find the best web-sites are:

[American Fancy Rat and Mouse Association](#)
[The National Fancy Rat Society of the UK](#)
[Association of Exotic Mammal Veterinarians](#)

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