

*Review Article*

# Advances in Rodent Housing and Management: Optimizing Conditions for Medical Research Excellence

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## Abstract

**Objective:** Housing and management of experimental animals are important aspects to consider alongside the welfare of experimental animals. Both are related to the behavior of animals and the results of the research to be conducted. Every laboratorian should pay attention to the management and housing of experimental animals, starting from the characteristics of cages according to the needs of the animals, sanitation that must be considered, and cage enrichment so that animals can express their natural behaviors. The focus on good management and housing aims to reduce stress on animals, create comfort and optimal care, and ensure more accurate research results.

**Methods:** This article is based on scientific information obtained from various literature such as articles and books published from various sources in the last 10 years from 2014-2024. Data collection was carried out by searching for scientific articles and journals using the Google Scholar search engine containing the concepts being studied. Article searches were carried out using the keywords "Characteristics of Animal Housing", "Management of experimental rodents", and "Rodentia" so that the articles that appeared matched the research topic.

**Results:** Providing suitable living conditions enables animals to develop, reach maturity, reproduce, and exhibit normal behavior in both laboratory and healthy environments.

**Conclusions:** It was concluded that guar gum and cornstarch can maintain the quality of the Yoghurt drink for 6 weeks of storage.

**Keywords:** Rodent Animals; Animal Management; Cages; Housing; Characteristics of Animal Homes

## INTRODUCTION

Rodentia species, including rats, mice, and guinea pigs, have physiological similarities starting from the development of the fetus which originates from eggs and sperm, and has similarities in several organs such as the heart, brain, lungs, kidneys, and digestive system (stomach, intestines, liver) which have similarities in the circulatory, reproductive, digestive, hormonal, and nervous systems so many researchers choose to use rodents for experimental studies. There are several reasons researchers use rodents that have similar biological characteristics, results that can be implemented, are not dangerous for researchers, fewer animals are needed, and ideal financial and housing conditions.<sup>[1]</sup>

Genetically, laboratory-used rodents, employed for over a century, exhibit similarities in anatomy and physiology. The excellent reproductive capabilities, particularly in mice, contribute to decreased variability. Nevertheless, in studies focusing on product safety, the emphasis shifts to characteristics that vary among species.<sup>[2]</sup>

Scientists must ensure that animals do not have natural infections before handling them in the laboratory. As a result, hygienic standards have been developed for over a hundred years. Monitoring for infectious agents that could harm animals, employees, or research is an important part of hygienic standards.<sup>[2]</sup>

The choice of animal cage enclosures for laboratory settings is impacted by various factors. The overall design of the facility and the configuration of the housing system play a crucial role in affecting the well-being and health of research rodents, consequently influencing the outcomes of the research. In general, the desired cage environment is a comfortable environment where they can carry out species-specific behavior and can be used for scientific research.<sup>[3]</sup>

Every year, at least 120 million rodents are used in research worldwide. These animals are usually confined to shoebox-sized cages, which limits their ability to carry out their natural activities, such as nest-building and burrowing. This can lead to decreased physical fitness, problems with temperature regulation, and well-being problems, including triggering repetitive behaviors.<sup>[4]</sup> Therefore, our aim in creating this literature is to share how to manage rodents for medical research by paying attention to various factors that can influence research results, one of which is the environment where the animals live.<sup>[4]</sup>

## MATERIAL AND METHODS

This article is based on scientific information obtained from various literature such as articles and books published from various sources in the last 10 years from 2014-2024 that match with our topic. Data collection was carried out by searching for scientific articles and journals using the Google Scholar search engine containing the concepts being studied. Article searches were carried out using the keywords "Characteristics of Animal Housing", "Management of experimental rodents", and "Rodentia" so that the articles that appeared matched the research topic.

## RESULTS

Providing suitable living conditions enables animals to develop, reach maturity, reproduce, and exhibit normal behavior in both laboratory and healthy environments. Social animals such as rodents thrive when they have companionship. Mice and rats are active during the night, while guinea pigs are active in daylight. Cage size is adjusted to the needs of each animal so that they can engage in their natural activities. Room temperature is also considered to avoid problems for the animals. Environmental enrichment for rodent animals needs to be considered to minimize stress.

## DISCUSSION

### GENERAL DESCRIPTION OF RODENTS

Rodents typically exhibit a small size, with some as light as 10 grams, and a round shape accompanied by short legs. However, the largest

rodents, like the capybara, can reach a substantial weight of almost 70kg.<sup>[5]</sup> Rodents are generally nocturnal, although certain species hibernate, while others do not. The rodent family encompasses a broad spectrum of specializations, such as cheek pouches for food transport, varied limb and claw development for activities like digging, jumping, climbing, or flying, diverse sensory organs like vibrissae, large ears, or eyes, unique integuments and specialized features like porcupine spines and chinchilla feathers, and tail adaptations like prehensile tails for grip or fat storage. Rodents have a keen sense of smell and a well-developed vomeronasal organ crucial for reproductive and social behavior by detecting pheromones. Notably, due to the absence of sweat glands, rodents are prone to overheating.<sup>[5]</sup>

Ensuring comfortable housing for animals is a crucial aspect of proper animal care. The concept of comfort is influenced by a range of both subjective and objective factors, and these factors interact in diverse ways across various institutions. As a result, it is impractical to formulate a universal definition of comfortable housing applicable to all establishments. Nonetheless, comfortable housing is generally characterized as any system of management, care, and accommodation that enables animals to undergo growth, maturation, reproduction, and normal behavior within laboratory settings while sustaining good health.<sup>[6, 7]</sup>

### MICE

Mice are communal creatures that require companionship and are best kept in groups. However, they are also very productive breeders, so males and females should be kept in separate cages.<sup>[8, 9]</sup>

### CHARACTERISTICS OF MICE CAGES

A cage should have good ventilation, be easy to clean, and be escape-proof.<sup>[44]</sup> Researchers frequently utilize two primary categories of cages: traditional open cages and individually ventilated cages (IVC). The size of a cage influences both the number of mice it can accommodate and their ability to engage in locomotor and exploratory behaviors. Minimum cage size for 1-3 adult mice (25-45 gram) are 330 cm<sup>2</sup>.<sup>[45]</sup> The approved minimum size for cages housing adult mice is 18,17 cm, with the floor area per mouse in group housing conditions varying from 8 to 10 cm, contingent on the body weight of the mouse. Furthermore, the minimum permissible cage height is 12 cm. Conventional cages and individually ventilated cages are made of the same plastic material. The difference between them is the air filter: air entering and exiting the IVCs is filtered with a HEPA filter, whereas conventional cages are not. IVCs are better than conventional cages because each IVC is independent, thus allowing individual isolation from one cage to another. This is useful for

avoiding the spread of disease between animals and providing better control over environmental conditions that can affect research results.<sup>[10, 11]</sup> IVCs are also equipped with HEPA air filters or similar filters, which help control the number of microbes and allergens in the environment. IVCs are better than conventional cages because each IVC is independent, allowing individual isolation of one cage from another. This is useful for avoiding the spread of disease between animals and provides better control over environmental conditions that can affect research results. IVCs are also equipped with HEPA or similar air filters, which help control the number of microbes and allergens in the environment. However, even though IVCs offer better safety, researchers often use conventional cages because individually ventilated cages are more expensive.<sup>[10]</sup>

In conventional cages, it is recommended to place water and food at one end or top of the cage, while the other end is left empty to be used as a place to urinate and defecate.<sup>[12]</sup> To enhance cage complexity and accommodate natural behaviors, researchers can introduce conical tubes, boxes, and climbing structures. To ensure optimal comfort, mice typically favor denser floors equipped with suitable bedding, such as wood shavings.<sup>[13]</sup> It is recommended to refrain from employing grid or wire mesh flooring to prevent potential injuries. If the use of grid or wire mesh is unavoidable, a solid or padded area should be provided for the animals to rest, unless specific experimental conditions dictate otherwise, and approval from research ethics has been secured.<sup>[14]</sup>



Kucic, M. 2023 The best mice cages for an ethical living environment.<sup>[46]</sup>

Since these arrangements often cannot be realized in the laboratory, a conspecific grouping of mice is often adopted to fulfill their social interaction requirements. Group housing serves to promote their social life and their natural behavior like marking through their scents or digging.<sup>[9]</sup>

Social compatibility is not guaranteed among all group members, and placing socially incompatible rats in a group setting can lead to issues such as aggression, chronic stress, injuries, and in extreme cases, death.<sup>[8, 15]</sup> Instances of aggression are more prevalent in male mice

housed in groups as opposed to female mice, given the territorial nature of male mice.<sup>[8, 9]</sup>

Due to mice having a nocturnal life cycle, the standard practice in mouse rooms is to uphold a 12-hour lighting cycle. It is recommended to maintain low light levels in their environment, especially for albino animals, as they are more susceptible to retinal damage due to bright lights.<sup>[16]</sup>

These animals were highly sensitive to ultrasonic waves, which is a way for them to communicate. Various types of ultrasonic waves in the laboratory, such as water dripping, moving trolleys, and operating computers, could impact the behavior of mice.<sup>[17]</sup> As certain ultrasound sources, like laboratory equipment, may be challenging to eliminate, playing background music is suggested as a means to mask stress-inducing sounds.<sup>[18]</sup> It is recommended to minimize sudden sounds as they tend to increase disturbance. Additionally, such disturbance may increase the risk of erroneous behavior in caring for offspring or lead to cannibalism.<sup>[14]</sup>

Mice should be housed in rooms that are between 20 and 24°C, according to UK Home Office Standards, and measures should be taken to keep the temperature stable at this range.<sup>[14]</sup> On the other hand, mice's thermoneutral range is 26°C-34°C, because of this, laboratory mice may suffer from cold stress if they aren't given nesting materials to help them control their body temperature and establish a comfortable environment in their cage.<sup>[19]</sup> It is essential to provide enough nesting material so that mice can build functional nests, which can get as hot as thirty-two degrees Celsius. Since newborn rat pups are unable to control their body temperature on their own, this becomes very important.<sup>[20]</sup>

Maintaining air quality in the mice room requires frequent air renewal, typically at a rate of 5-20x/hour. It is recommended to maintain relative humidity within 45-65%.<sup>[14]</sup> In the case of Individually Ventilated Cages (IVCs), the typical range for the number of air changes per hour is generally 25-120 times. It is important to note that in IVCs, the high-velocity air blown into the enclosure can potentially cause chronic stress and heat loss due to drafts.<sup>[11]</sup> Monitoring mice in an IVC for signs of discomfort is crucial. Indications that they react to high airflow involve alterations in nest location or the creation of barriers against strong winds with their bedding materials. If such behavior changes appear, we need to move the mice to a comfortable environment for them.<sup>[12]</sup> Poor environmental quality, can increase the risk of bacterial or viral infections in mice.<sup>[44]</sup>

### **SANITIZATION OF MICE CAGES**

All facilities, including culture rooms and hallways, must be cleaned regularly and disinfected appropriately at least once a week, except that bedding must be changed approximately twice a week. The cage to be replaced will be taken to the "Cage Changing Station" to be replaced and washed with special detergent and/or hot water.<sup>[12, 21]</sup>

### **ENRICHMENT OF MICE CAGES**

Environmental enrichment is typically comprised of 3 primary components which are physical activity, cognitive stimulation, and social interaction. Enhanced physical activity is often facilitated by giving a running wheel to an enriched cage.<sup>[21, 22]</sup> Cognitive stimulation is achieved through the provision of a cage containing toys and tubes interspersed with obstacles. Social interactions increased as they were placed in groups.<sup>[22]</sup>

### **RATS**

Laboratory rats are one of the types of rodents most widely used in research. Although generally docile, laboratory rats exhibit many of the behaviors observed in their wild counterparts. In their natural habitat, rats are social animals that live in large groups. Similarly, Norway rats are known for digging and inhabiting large tunnels. In laboratory settings, researchers observe analogous burrowing behavior in rats when suitable substrates are provided. To accommodate the instinct of rats to build tunnels or nests, researchers commonly furnish materials such as sawdust or other burrowable substances.<sup>[23]</sup>

In their natural habitat, the tunnels are typically inhabited by males, females, and their young ones. While laboratory settings placed mice based on their genders. Male rats can be placed together, but it must be ascertained whether those placed in the same cage are aggressive towards each other or not, the most harmonious groups of males generally consist of siblings. If an injured rat is found in the cage, it must be ascertained what caused the injury. If fighting is suspected, the rat suspected of attacking must be isolated or moved to a separate cage.<sup>[23]</sup>

Before giving birth, female rats often separate themselves from other groups and construct a nest. During the nursing period, female rats may exhibit aggression towards both other animals and their caregivers, necessitating isolation in a nursing cage before the birth process.<sup>[18]</sup>

Rats are nocturnal animals, displaying heightened activity levels, particularly in the early evening and predawn hours.<sup>[16, 24]</sup> From an

early age, rats display active behaviors such as fighting and chasing, which play a crucial role in forming social bonds. These bonds are further reinforced in adulthood through grooming, a significant aspect of attention, care, and social support within rat groups. Through grooming, adult rats attend to each other's fur, fostering a cohesive and harmonious social atmosphere among them. These behaviors are crucial for maintaining group harmony and should not be misinterpreted as aggression. Rats regularly engage in auto-grooming as part of their routine, typically after waking up or eating. Additionally, mice may resort to self-grooming as a coping mechanism when feeling anxious or threatened. Prolonged or irregular episodes of auto-grooming could indicate underlying stress or illness in the animal and therefore merit further investigation.<sup>[25]</sup>

The primary means of interaction for mice is through the place where they live, predominantly through smell and touch. They utilize pheromones that appear in their urine and feces to communicate information and indications of anxiety or discomfort.<sup>[26]</sup> When cleaning a rat's cage, it's essential to avoid spreading unfamiliar odors or odors from conspecifics (rats of the same sex), as they can potentially trigger anxiety or aggression in the rats.<sup>[27]</sup>

Rats are omnivorous creatures. Rats can thrive when provided with appropriate care and housing. In laboratory settings, rats experiencing stress or anxiety tend to exhibit cautious behavior when encountering unfamiliar foods. They may approach the new item cautiously, taking small samples until they feel confident that it is safe to consume.<sup>[28]</sup>

Due to their high intelligence, rats can be taught to collaborate during handling and various procedures. This training not only benefits the animal but also positively impacts its handler.<sup>[29]</sup>

### **CHARACTERISTICS OF RAT CAGES**

The location of rats enclosure is just as important as the type of cage and its accessories. A good choice is on a room that's not too loud or crowded but is still frequently used, and also avoid placing the enclosure in high-traffic areas, like hallways, to allow them some quiet time. They need around 8 to 12 hours of dark, quiet time each day. The minimum permitted cage size for adults under 600 grams is 28,28 cm for floor area, which increases to 38,73 cm for rats weighing over 600 grams. The height of the cage is 18 cm minimum. However, Traditional cages can cause uncomfortable positions for rats, as these cages do not provide enough space for natural behaviors like stretching and standing upright. Rats usually adopt lateral stretching

behavior to alleviate the negative impacts of conventional housing on their posture. Therefore, it is highly recommended to use taller cages (26-30cm) to allow rats a full range of natural movement.<sup>[30]</sup>



Du, D. 2021. How big should a rat cage be? A rat cage size guide.<sup>[47]</sup>

Over time, laboratories have increasingly embraced a cage referred to as “Double Decker” This cage is 38 cm tall and provides rats with additional space to engage in their behaviors. The effectiveness of this cage has already been evaluated in multiple studies conducted on animals previously housed in conventional cages, demonstrating its potential to enhance animal welfare in research settings. The traditional cage and the double-decker cage are made of the same material, plastic with a metal cover. The only difference between the two cages is their height. As the name suggests, the double-decker cage is taller than the traditional one, making it more comfortable for the rats.<sup>[31, 32]</sup>

Rats room upholds a 12-hour lighting cycle and makes sure that the room does not exceed 50 lux. It is recommended to maintain low light levels in their environment, especially for albino animals, as they are more susceptible to retinal damage due to bright lights.<sup>[33]</sup>

Rat's room temperature should be in the range of 20-24°C. They should also have appropriate nesting materials for them to regulate their body temperature effectively and engage in their natural nesting behavior. Just like any pet, rats kept in poor conditions are likely to develop health issues quickly. A dirty cage along with low-quality bedding can heighten the risk of bacterial and viral infections in rats.<sup>[14]</sup>

### SANITIZING RAT CAGES

Similar to other rodents, it's essential to regularly clean cages or bedding that becomes wet or soiled, typically requiring replacement approximately twice a week. The used bedding and cages should then be taken to the cage changing station for proper disposal, and fresh bedding and cages should be provided.<sup>[21]</sup>

Cleaning their cages could make them feel uncomfortable, not only because they usually clean the cages during the day when the rats are normally asleep, but because putting these rats

in a new place can make changes in their pheromone communication.<sup>[26]</sup>

### RAT CAGE ENRICHMENT

Rat's housing should be carefully designed to suit their natural behaviors, including their interactions, climbing, biting, and digging. Providing substrate for bedding and insulation is crucial, with an appropriate depth that enables rats to engage in burrowing and foraging behaviors. Typically, rats prefer wood shreds for bedding in large particle sizes.<sup>[34]</sup>

Depending on the availability and suitability of resources, each pen should ideally include a hut or holding box. Rats tend to prefer huts with a single entrance over tunnels that are open at both ends.<sup>[35]</sup>

Similar to other rodents, rats have continuously growing front teeth throughout their lives, necessitating the provision of hard objects to chew on to prevent overgrowth. Usually, we provide them with hard pallets, wooden blocks, or sticks to chew to prevent the teeth from overgrowing.<sup>[35-37]</sup>

Rats love to socialize, so it is best to provide them with a cage that lets them socialize more. Separating one rat from their cage can induce stress for the other cage mates. If isolation is necessary, efforts should be made to minimize the duration of the separation. Rats mother that nursing their kid usually choose to be kept away from their pups.<sup>[38]</sup>

Creating play and exercise areas is an effective way to enhance the well-being of rats, benefiting both their physiological and psychological health.<sup>[39]</sup> Rats Playgrounds can be easily fashioned using materials available in animal facilities, enriched with items like ladders, tunnels, ropes, and many more. Given their generally explorative nature, rats readily accept and engage with new elements in their environment.<sup>[37, 39]</sup>

### GUINEA PIG

Just like mice and rats, guinea pig is also a social animal. They were usually very calm and typically exhibited peak activity during the daytime.<sup>[40]</sup> These animals produce a variety of sounds which serve as indicators of their mood.<sup>[40, 41]</sup> Guinea pigs are also neophobic, meaning they have a fear of new things, and they can become stressed when encountering unfamiliar people or objects.<sup>[41]</sup>

Guinea pigs generally exhibit less aggression compared to other rodents. But males, also known as boars, can become highly aggressive toward each other if they have visual or olfactory contact with female pigs. Therefore, it is advisable to separate guinea pigs by gender at around three weeks after birth.<sup>[14, 40, 41]</sup>

## GUINEA PIG CAGE CHARACTERISTICS

Guinea pigs need appropriate room to roam, with separate spaces for a nest, bathroom area and food and water. In providing cages for guinea pigs we must pay attention to their needs in the macro and micro environment. Things in the macro environment that must be considered in developing optimal housing for guinea pigs are the location of animal rooms in the facility which ought to be distant from ranges of intemperate clamor and vibration since they have been demonstrated to cause physiological stress responses.<sup>[40]</sup>

The design of the room ought to give sufficient space to encourage the development of staff carrying out animal care every day and the movement of personnel carrying out daily animal care errands, such as cleaning and changing cages. Ideally, the floor should slope gently toward a drain, although it should not be overly steep. While not essential, having a drain in the room can simplify cleaning procedures. Additionally, the presence of a sink with hot and cold water in the animal room greatly facilitates various activities.<sup>[42]</sup>

All floor and wall surfaces, as well as sealed wall-floor joints and doors, must be constructed from materials capable of withstanding repeated disinfection procedures. The floor should facilitate the movement of equipment while also providing stable footing for animal care personnel. It should also ensure the safety of both personnel and the animals housed within the facility.<sup>[40]</sup>



C&C Guinea Pig Cages. 2024. Mesh and Grid Cages for Pets.<sup>[48]</sup>

The cage must be spacious enough to accommodate the natural movements, body shape, and size of the breeding pair, as well as the mother and her offspring simultaneously. The material used for the cage should offer a smooth, non-porous surface, be easy to clean, withstand repeated disinfection procedures, resist corrosion, and be strong enough to hold guinea pig weight. Stainless steel and durable plastic are the most commonly used materials for cage construction. Their cage is usually constructed from stainless steel with a plastic molded bottom and bedding.<sup>[40, 42]</sup>

The minimum cage size for guinea pigs weighing  $\leq 350$  g is 20 cm with a height of 17,78 cm. For guinea pigs weighing  $> 350$  g, the minimum cage size is a floor area of  $\geq 25,5$  cm with

the same cage height of 17,78 cm. Guinea pigs with nursing mothers should also have the same size of  $\geq 25,5$  cm.<sup>[40]</sup>

One of the cage systems commonly used for guinea pigs is the plastic “shoebox” cage. This type of cage is designed to facilitate easy provision of food and water and is straightforward to clean.<sup>[43]</sup>

The housing design should adequately meet the guinea pig’s normal behavioral and physiological needs. The cage should enable the animal to stay clean and dry, ensure easy access to food and water, be free from sharp edges and potential hazards, and offer a safe environment.<sup>[43]</sup>

Cage floors can be constructed from solid material, perforated material, or mesh wire. When using wire mesh floors, it’s important to ensure that the openings are large enough to allow urine and feces to pass through, yet small enough to prevent the guinea pig’s feet from getting trapped. Guinea pigs can reach an adult weight of up to 1 kg and have relatively small feet. Inappropriate wire mesh sizes can lead to pressure sores on the plantar surface of the foot (pododermatitis) in adults or bone fractures in young individuals. The recommended wire opening size is 75 mm x 12 mm.<sup>[40, 41, 43]</sup>

Guinea pigs typically do not engage in jumping or climbing activities. For water supply, suitable options include bottles installed on the exterior of the cage or an automatic watering system. It’s important to position the watering device above the level of the bedding and have the valve located outside the pen, as guinea pigs may play with their water devices and inadvertently flood their pen by placing bedding inside. When selecting a watering device, it’s crucial to consider that guinea pigs do not readily adapt to new items in their environment.

Therefore, newly acquired guinea pigs should be trained to use the watering system by gently guiding them to the device and touching their mouths to the water source several times daily for 2-3 days. There have been instances of guinea pigs dying from dehydration because they were not accustomed to using watering devices. It’s advisable to rearrange familiar objects in the cage rather than introduce new ones.<sup>[40]</sup>

Common bedding materials used for housing guinea pigs include paper products, corn products, and hardwood products, as they can be crushed, chopped, ground, or pelleted. Softwood products are avoided due to their content of aromatic hydrocarbons, which can stimulate liver enzymes, increase the risk of cancer, and potentially impact research outcomes.<sup>[41, 43]</sup>

Regardless of the material used, it should be virtually dust-free, as guinea pigs tend to dig with their noses in the bedding, and fine particles can be inhaled into their lungs. Mats that are too small can be easily ingested or

become lodged in the guinea pig's genital opening, leading to infertility. Additionally, the bedding material should be absorbent to help reduce humidity and odors in the cage.<sup>[40]</sup>

This animal is sensitive to hot temperatures. Guinea pigs have difficulty dissipating heat efficiently, which renders them susceptible to heat stroke. Indeed, environmental temperatures exceeding 24°C can induce heat stress or stroke in guinea pigs. Therefore, it's recommended to house them in a room of 15-21°C, ideally within an open-floor enclosure to ensure adequate ventilation. Guinea pigs don't do well under humid conditions. Dampness promotes the growth of mold in their hay and bedding and can make guinea pigs more prone to sickness.<sup>[40]</sup>

### SANITIZATION OF GUINEA PIG CAGES

Weekly sanitation procedures should involve relocating animals to clean, disinfected pens equipped with fresh water and feed. This process can be conducted once every two weeks under appropriate conditions. Additionally, weekly cleaning and disinfection of room equipment, such as sinks and countertops, should be performed. Solid-bottom cages should have their bedding fully replaced, while dirty trays under hanging cages if used, should be disinfected weekly. Any cage found to be wet or heavily soiled should be replaced promptly. Furthermore, the cage rack should be swapped with a clean, disinfected one every month. Complete sanitation of the room should be carried out at least every six months.<sup>[41]</sup>

Sanitation methods may differ among institutions, but it's generally recommended to remove visible organic materials like hair, food, bedding, waste, and urine. This can be achieved by brushing the surface and rinsing it with water, although detergent use can aid in this process. Stubborn urine stains may necessitate washing or soaking the cage or tray in diluted organic acid, commonly phosphoric acid or citric acid. Individuals undertaking these tasks should wear suitable protective clothing to prevent potential chemical or thermal injuries, including protection for the skin, eyes, and nasal passages.<sup>[40]</sup>

Cage washing machines are commonly employed for cleaning and disinfecting cages and equipment. These machines utilize detergent, disinfectant, and hot water. Whenever chemicals are utilized as part of a sanitation regimen, it's important to thoroughly rinse this equipment with water as a final step to prevent exposure to the product. Rinse water temperatures of 82°C for 15 minutes are effective for disinfecting cages and equipment, as are lower temperatures over longer periods.<sup>[40, 43]</sup>

### GUINEA PIG CAGE ENRICHMENT

Animals should be housed in pairs, and single cages for guinea pigs are not allowed without special

reasons. It is advisable to enhance the diet by incorporating fresh fruits and vegetables, like lettuce or carrots, to provide enrichment for the animals. Hand-feeding these treats can also help foster a positive relationship between the handler and the animal. It's important to note that guinea pigs cannot synthesize sufficient amounts of vitamin C to meet their nutritional needs, so providing vitamin C-rich foods or supplements is essential for their health. It is highly recommended to maintain consistent food choices from a young age for guinea pigs, as they typically refuse to eat unfamiliar foods. Guinea pigs exhibit specific behaviors in response to their favorite food or handler, like emitting 'tweaking' vocalizations or performing a rapid jumping movement known as 'popcorning'. These behaviors were related to their mood which can be an indicator of good husbandry.<sup>[14, 40, 41]</sup>

Hay plays a crucial role as a food enrichment for this animal, complementing the guinea pig's regular eating cycle. A deficiency in dietary components can result in repetitive behaviors like trichophagia (compulsive hair-eating). The quality of the hay needs to be good and not sharp.<sup>[40]</sup>

Similar to other rodents, guinea pigs have continuously growing front teeth throughout their lives, necessitating the provision of hard objects to chew on to prevent overgrowth. Usually, we provide them with hard pallets, wooden blocks, or sticks to chew to prevent the teeth from overgrowing.<sup>[40]</sup>

### CONCLUSION

Providing a comfortable home for experimental animals is a crucial aspect of animal care. Comfortable housing enables animals to develop, mature, reproduce, and exhibit normal behaviors in the laboratory while maintaining good health. Rodents, being social animals, benefit from companionship. Mice and rats, which are nocturnal, typically experience a 12-hour light-dark cycle in their rooms. While more active in the morning and evening, Guinea pigs also adhere to a 12-hour light-dark indoor cycle. Cage sizes are tailored to each animal's specific needs to prevent stress and facilitate natural behaviors. The recommended room temperature for mice and rats ranges from 20°C to 24°C, while for guinea pigs, it should be between 15°C and 21°C. Environmental enrichment measures for rodents are essential to minimize stress and support their growth and reproductive success. Cages should be cleaned regularly, and disinfectants used in the facility typically include Quaternary ammonium compounds, Chlorine compounds, peroxygen compounds, and hot water (180°C). Alcohol can also be used, however, it has some disadvantages, such as not being effective against non-enveloped viruses or bacterial spores.

**Table 1.** Characteristics of the animal model for medical research

	Mice	Rats	Guinea Pig
Social behavior	Social animal. However, it must be supervised because it has the potential to fight and cause injury.	Social animal. They behave actively to build social bonds. Grooming others is a sign of socialization.	Social animals are generally docile and non-aggressive compared to other rodents. They may respond to unfamiliar humans with fear.
Social enrichment	Increased physical activity is achieved with a running wheel. Cognitive stimulation with toys/obstacle tubes. Increased social interactions result from the number of mice living together in enriched cages.	Rats are given substrate for bedding and insulation for digging and foraging. Hard objects are important to prevent overgrowth. Hard pellet diet to maintain long teeth. Play and sports areas are used for both physiological and psychological well-being.	Hay is important for supplementing the diet, as well as encouraging natural foraging and grazing behavior. Hard material preparations are important to prevent overgrowth. A hard pellet diet is important for maintaining tooth length.
Temperature	Room temperature for mice is between 20–24°C. The thermoneutral zone of mice is between 26°C and 34°C.	Room temperature for rats is between 20°C-24°C.	Guinea pigs are sensitive to extreme temperatures. Their room temperature is in the range of 15-21°C, and the cage floor is open to provide good ventilation.
Lighting	Mice are nocturnal animals. The mouse room has a 12-hour light-dark cycle. Light levels in the cage should be low to prevent retinal damage.	Rats are nocturnal animals. The mouse room has a 12-hour light-dark cycle. Prolonged exposure to bright light can damage the mouse's retina.	Guinea pigs are usually most active in the morning and evening. Lighting in the guinea pig cage should be soft and follow a 12-hour day-night cycle.
Cage structure	Cage size min. : 330 cm <sup>2</sup> , floor area min. : 60-100 cm <sup>2</sup> , min-height: 12 cm.	Min floor area for weight <600g: 800 cm <sup>2</sup> , weight >600g: 1,500 cm <sup>2</sup> . Min height. : 18 cm but 26-30 cm is recommended.	Cage size min. for weight ≤ 350 g: 387 cm <sup>2</sup> , weight > 350 g: ≥ 651,5 cm <sup>2</sup> . A mother who is breastfeeding: ≥ 651,5 cm <sup>2</sup> . Cage height: 17,78 cm <sup>2</sup> .

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