

Guideline 21
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Guidelines for the Housing of Guinea Pigs in Scientific Institutions

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Key Recommendations

- 1.5.1 *To meet the requirements of the Code of Practice (i.e. to provide accommodation that meets the species specific needs of guinea pigs), housing should be provided which allows guinea pigs the opportunity to carry out normal behaviours including social interaction; chewing / gnawing; locomotion (including tunnelling, exploring and playing) and; rest / hiding.*
- 1.5.2 *The Code of Practice recognises that there may be circumstances where the requirements of experimental procedures will preclude meeting some species specific needs (Clause 4.4.19). Housing in these situations should still meet the physiological and behavioural needs of guinea pigs as closely as possible.*
- 2.1.1 *The living area for guinea pigs should incorporate open space interspersed with shelters to meet the physiological and behavioural needs of the animals including withdrawal from aggressive encounters and retreat from view.*
- 2.1.2 *The predilection of guinea pigs for retreating to shelter to rest and hide necessitates the provision of adequate cover and shelter when they are housed in research or teaching institutions. This can be achieved by placing permanent shelters such as sections of PVC pipe, timber, cardboard or plastic hiding boxes in the enclosure. Providing straw, hay or wood wool in which the animals can form temporary tunnels provides an additional opportunity for activity.*
- 2.1.3 *Floor pens allow the provision of a large floor area for housing groups of guinea pigs and facilitate the use of a deep litter bedding system. Pens should be run on an all-in, all-out basis to permit effective decontamination between groups of animals.*
- 2.1.4 *Where tiered cages or raised pens are used the arrangement must incorporate easy access for checking of animals and cleaning.*
- 2.2.1 *In breeding colonies, a breeding pair with a litter requires a useable floor area of 2500cm² with an additional 1000cm² for each additional breeding female.*
- 2.2.2 *Weaned guinea pigs kept in non-breeding groups require a minimum useable floor area of 1800cm² for animals weighing 200 - 450g allowing 200cm² for each additional animal weighing up to 200g; 350cm² for each additional animal weighing >200g - 300g and 500cm² for each additional animal weighing >300 - 450g. For guinea pigs weighing >450g, a minimum floor area of 2500cm² is required allowing*

700cm² for each additional animal weighing >450 - 700g and 900cm² for each additional animal weighing >700g.

- 2.3.1 The minimum wall height of pens should be 230mm and the minimum height of cages used to accommodate guinea pigs should be 250mm.*
- 2.3.2 Pen walls and cage sides should be constructed with a mesh panel that allows the animals to see people approaching the enclosure.*
- 2.4.1 Enclosure shape is not critical but the area should be arranged so as to enable the animals to make effective use of the available space, taking account of their behavioural and physiological needs. Square or rectangular enclosures generally make the most efficient use of floor space and meet the behavioural needs of thigmotaxic species such as guinea pigs.*
- 2.5.1 Materials used to construct, pens, cages and permanent shelters should be durable, non-toxic to guinea pigs, easily cleaned and not interfere with the science.*
- 2.5.2 For enclosure construction opaque materials should be used with mesh panels that permit personnel to easily see the animals and which provide some visibility for the animals but also allows them to hide. Transparent or translucent materials are not recommended.*
- 2.5.3 Wood is difficult to clean and disinfect and therefore not recommended for constructing pens and permanent shelters. Timbers that have been treated with pesticides or fungicides must not be used.*
- 2.5.4 If metal is used in enclosure construction stainless steel is recommended. Galvanised, plated or coated steels are prone to surface damage and corrosion and therefore not recommended.*
- 2.6.1 Guinea pig enclosures should have solid floors covered with suitable substrate.*
- 2.6.2 Wire mesh floors should not be used in guinea pig enclosures except with the specific approval of the institutional AEC on the basis of compelling scientific evidence of the need to use such flooring.*
- 2.6.3 If the use of mesh is approved by the AEC the enclosure must include an area of solid floor for resting that is capable of accommodating all of the animals in the enclosure. The use of perforated plastic or perforated stainless steel flooring should be considered as an alternative to mesh.*
- 2.7.1 Commercially sourced substrate in the form of steam-treated wood shavings, straw, shredded or pelleted paper is recommended.*

- 2.7.2 *Substrate derived from timber that emits strong odours from naturally occurring aromatic hydrocarbons and material processed from wood treated with pesticides or fungicides is potentially harmful to guinea pigs and must not be used.*
- 2.8.1 *Nesting material may be provided but is not necessary for guinea pigs so long as a comfortable substrate is available.*
- 2.8.2 *A secure shelter or retreat where pregnant females can give birth is required.*
- 2.9.1 *Shelters should be provided within guinea pig enclosures to provide privacy, to enable guinea pigs to retreat and to ensure that the space available in the enclosure can be effectively utilised by the animals.*
- 2.9.2 *Shelters may be permanent, made of durable, easily cleaned non-toxic materials or temporary such as clean recycled cardboard cartons that can be replaced when they become soiled, or biscuits of hay that the animals can tunnel under or through. Hay should be replaced regularly as the leaf is eaten and stalks are trodden down by the animals.*
- 3.1.1 *Guinea pigs are social animals and should be kept either in single sex groups or in stable breeding colonies.*
- 3.1.2 *Guinea pigs require considerable socialisation to acquire the skills necessary to establish stable social structures. Attention to this requirement when housing guinea pigs in groups and particularly when forming new groups is essential to avoid problems of social instability that may adversely affect the welfare of subordinate individuals and the quality of scientific data obtained from them.*
- 3.2.1 *Guinea pigs should not be housed individually unless with the express permission of the Animal Ethics Committee of the institution on the basis of compelling scientific evidence for the need to house guinea pigs in this way. In such cases, where feasible under the experimental protocol, guinea pigs should be in visual, auditory and olfactory contact with other guinea pigs.*
- 3.2.2 *In situations where a guinea pig must be removed from its social group for individual treatment, the housing of a suitable companion animal with the treated animal should be considered to reduce the effects of stress caused by the separation.*
- 3.2.3 *Males that have previously been raised in isolation must be very closely monitored if placed into a colony, as their welfare can be seriously compromised by the aggression of males already established in the social hierarchy.*

- 3.3.1 *Guinea pigs should not be housed in metabolism cages except with the specific approval of the AEC and then only for the minimum time necessary to complete the approved protocol.*
- 3.3.2 *If the use of metabolism cages with mesh floors is approved by the AEC, where feasible, the enclosures must include an area of solid floor for resting that is capable of accommodating all of the animals in the enclosure. The use of perforated plastic or perforated stainless steel flooring in the enclosures should be considered as an alternative to mesh. An appropriately designed refuge that does not interfere with urine or faecal collection should be provided.*
- 3.4.1 *Frequent gentle handling of guinea pigs is recommended to condition the animals to being captured and manipulated. Such handling should commence at an early age before experimental work begins and may include training animals with a reward.*
- 3.4.2 *Guinea pigs are highly sensitive to human activity and sounds in the animal room. It is very important to approach the animals and perform husbandry tasks with due empathy to avoid startling them.*
- 3.5.1 *As appropriate under the experimental protocol, guinea pigs should be given items to enrich their environment. Items that assist guinea pigs to perform each of the 4 following categories of behaviours should be provided:*
- *Social interaction;*
 - *Gnawing / chewing;*
 - *Locomotion (including tunnelling, exploration and play) and;*
 - *Hiding / resting.*
- 3.5.2 *When techniques are used in an effort to provide environmental enrichment for guinea pigs, it is important that each technique is evaluated to ensure that it has no detrimental effect on the animals or the science.*
- 3.5.3 *Proposed enrichment items should be assessed for likely risks that may affect the health of guinea pigs and interaction of the animals with new items should be monitored to identify any problems.*
- 3.6.1 *Where it is necessary to identify individual guinea pigs, the least invasive method that is compatible with the use of the animals should be used. Recording of individual coat colour and pattern may be sufficient.*
- 3.6.2 *Non-toxic dyes and permanent markers may be used on the fur. These methods of identification usually need to be replaced every two weeks.*
- 3.6.3 *Fur clipping may be used but needs to be carried out frequently.*

- 3.6.4 *Where permanent identification is necessary, passive integrated transponder tags (commonly known as RFID tags, PIT tags or microchips) implanted subcutaneously or tattoos applied to the pinna by trained, competent staff using local anaesthesia may also be used.*
- 3.6.5 *A permanent record of the individual tag numbers should be kept.*
- 3.6.6 *The use of ear tags is not recommended as they can tear the pinna causing pain, infection and keloid formation.*
- 3.6.7 *Toe amputation is a painful procedure and should not be used.*
- 3.7.1 *Guinea pigs require a balanced diet that accommodates their nutritional and behavioural needs, such as a balanced pelleted ration that is high in fibre, supplemented with good quality hay and fresh vegetables as a source of environmental enrichment and variety.*
- 3.7.2 *An adequate level of vitamin C is essential in the diet and may be provided through supplementation in the water supply or ration sufficient to meet the needs of the animals. Supplementation with fresh vegetables is a safeguard where appropriate levels of vitamin C cannot be maintained via addition to drinking water or in a fortified pelleted ration.*
- 3.7.3 *The diet provided to guinea pigs must maintain an adequate level of zinc and trace amounts of selenium. Food is one of the least controlled variables in the research environment. Periodic detailed analysis by a competent laboratory may avoid long-term deficiencies that can affect research results. Storage conditions must be taken into account.*
- 3.7.4 *Food hoppers should be positioned to minimise faecal soiling and should be separate from watering points to avoid dampening and caking of the feed.*
- 3.7.5 *An adequate supply of clean, fresh water must be maintained daily. Water dishes are prone to faecal soiling and contamination with spilled feed and are therefore not recommended. Water bottles with sipper tubes may also become contaminated with food residues if placed too close to food hoppers and should be positioned away from the food containers. Tubes should be positioned to allow access by all animals in the enclosure but far enough above the substrate to avoid wicking and loss of water into the bedding. Stainless steel sipper tubes are less prone to damage from chewing and are recommended.*
- 3.7.6 *Where automatic watering systems are used, a drip channel should be provided outside the enclosure to collect spilled water and carry it away from the substrate.*

- 3.8.1 *Guinea pigs should be monitored by observation at least daily for any signs of abnormality, illness, pain or distress and to ensure adequacy of environmental conditions, food and water supplies.*
- 3.8.2 *In addition to daily observations, weekly health checks should include a review of health and husbandry records, routine husbandry, diagnoses, treatments and fertility, fecundity, morbidity and mortality in breeding colonies.*
- 3.8.3 *Animal carers should be aware of the normal behaviour of guinea pigs and of the individuals within a group and observe for deviations from normal. Guinea pigs that give cause for concern (either excessively aggressive or timid) may need to be removed from a group.*
- 3.8.4 *In particular, subordinate guinea pigs should be monitored for signs of bullying (which may, for example, result in fight wounds or denial of access to food or water).*
- 3.8.5 *Guinea pig behaviour can be difficult to interpret and subjective judgements cannot always be reliable. Objective indicators of health and welfare such as body mass should be regularly monitored. Sick guinea pigs should be examined and diagnosed by a veterinarian and any animals that die unexpectedly should routinely be submitted for post-mortem examination and diagnosis.*
- 4.2.1 *A daily cycle ranging from 12 to 16 hours light and 8 to 12 hours dark is recommended for guinea pigs housed under artificial light.*
- 4.3.1 *A room temperature range of 18°C to 24°C is recommended for housed guinea pigs.*
- 4.3.2 *Prolonged exposure of guinea pigs and particularly pregnant females, for more than a day to room temperatures above 25°C should be avoided.*
- 4.3.3 *Prolonged exposure of neonate and juvenile guinea pigs for more than a day to room temperatures below 17°C should be avoided.*
- 4.4.1 *A relative humidity of between 40 and 70% is recommended for housed guinea pigs.*
- 4.5.1 *An air change rate of between 8 and 20 changes per hour is recommended. The number of air changes per hour that are needed will be influenced by the air flow patterns at the level of the pen or cage.*
- 4.5.2 *Concentrations of ammonia should be monitored at the level of the pens or cages or and should not exceed 10ppm by the time cleaning is scheduled to occur.*

- 4.6.1 *Sources of noise including ultrasound should be considered when assessing sound levels to which guinea pigs are exposed.*
- 4.6.2 *Potential sources of ultrasonic noise in animal houses should be shielded or avoided.*
- 4.6.3 *The value of sources of background noise for mitigating the effects of sudden loud noises, including ultrasonic noise, is probably limited in animal houses. If a radio, piped music, white noise generator or other sources of background noise are used, the volume of sound from these should not be excessive.*
- 4.7.1 *Guinea pig rooms should have temperature and humidity read-outs in a position where staff can easily see them.*
- 4.7.2 *Sensors should be fitted to monitor and report malfunctions in ventilation, temperature and humidity control on a 24 hour basis, with automatic alarm activation and alerting of appropriate staff.*
- 4.7.3 *Regardless of centralised computer systems regulating the general environmental conditions, it is still essential to check these variables regularly in the room. Automatic monitoring and control systems should be regularly calibrated and validated at room level.*
- 4.8.1 *Depending upon the number of animals housed in cages, it is recommended that cleaning occur at least weekly and more frequently if necessary.*
- 4.8.2 *Floor pens should be cleaned when each batch of animals is moved out or at monthly intervals.*
- 5.1.1 *Pens and cages should have labels attached to them that provide the following information:*
- *Guinea pig identification*
 - *Name, location and contact numbers of the Principal Investigator / Teacher and (if applicable) other investigators / teachers using the guinea pigs*
 - *Name, location and contact numbers of staff associated with the housing and care of the guinea pigs*
 - *Name and approval number of protocol in which guinea pigs are being used*
 - *Age (date of birth) of guinea pigs*
 - *Date of entry of guinea pigs into the pen or cage.*
- 5.1.2 *Health records for each guinea pig should be kept detailing dates of inspection and any adverse events such as injuries, fighting etc.*

1. General

1.1 Introduction

- i) These guidelines are intended for use by people involved in the housing and care of guinea pigs in scientific institutions. The guidelines are not intended to be a complete manual on guinea pig care and management but rather to provide some key guiding principles on good contemporary practice in guinea pig housing. The guidelines will be revised from time to time to take account of advances in the understanding of guinea pig physiology and behaviour, technological advances, and changes in community attitudes and expectations about the welfare of animals.
- ii) The guidelines are based on principles regarding the care and management of guinea pigs taken from scientific literature. These principles are detailed throughout the document, as are recommendations for the care and management of guinea pigs which are derived from these principles. In some areas, the conclusions drawn from the available literature differ between authors and are equivocal. In such cases recommendations are extrapolated from the information available and based on practices found acceptable for guinea pig care and management current at the time of writing.
- iii) The principles outlined in the document address requirements of the Australian Code of Practice for the Care and Use of Animals for Scientific Purposes (as outlined below in Section 1.2). The requirements of the Code of Practice include that animals held for scientific purposes should have their species-specific behavioural and physical needs met, whilst at the same time ensuring that the animals can be monitored adequately and are protected from disease and taking into account the requirements of the research for which the animals are being used.
- iv) The guidelines focus on the welfare of guinea pigs and it is implicit that providing housing and husbandry conditions that meet the physiological and behavioural needs of guinea pigs will also contribute to the quality of scientific outcomes. Information on the behaviour and activities of guinea pigs in the wild is used to inform decisions on providing opportunities for the expression of normal behaviours in animals housed in scientific establishments. The guidelines contain examples of the effects on guinea pigs of variables in housing and the likely implications for these animals as research subjects.

1.2 Responsibilities of Institutions

Requirements

1.2.1 *Institutions using guinea pigs for scientific purposes are responsible for responding promptly and effectively to recommendations of the institution's Animal Ethics Committee to ensure that facilities for the housing and care of guinea pigs are appropriate to the maintenance of well-being and health of the guinea pigs.* (Section 2.1.1 (iv) of the Australian Code of Practice for the Care and Use of Animals for Scientific Purposes 2004⁸).

1.3 Responsibilities of Principal Investigators / Teachers

Requirements

1.3.1 *Investigators and teachers have personal responsibility for all matters related to the welfare of guinea pigs under their control, which includes their housing and care.* (Section 3.1.1 of the Australian Code of Practice for the Care and Use of Animals for Scientific Purposes 2004⁹).

1.3.2 *In order to ensure the wellbeing of animals used in their projects, the principal investigator/teacher must ensure that the level of supervision of personnel involved in the care and management of the guinea pigs in their projects takes into account the levels of competence of each person and the responsibilities they are given.* (Section 3.1.2 of the Australian Code of Practice for the Care and Use of Animals for Scientific Purposes 2004⁹).

1.4 Care of Animals in Holding and Production Facilities - Housing

Requirements

1.4.1 *The Australian Code of Practice for the Care and Use of Animals for Scientific Purposes 2004¹¹ sections 4.4.19 to 4.4.23 states:*

4.4.19 Animal Accommodation should be designed and managed to meet species-specific needs. Pens, cages and containers should ensure animal wellbeing and comfort. Variations to these requirements as part of a project must receive prior AEC approval. The following factors should be taken into account:

- (i) Species-specific behavioural requirements, including the availability and design of space to enable free movement and activity, sleeping, privacy, contact with others of the same species, and environmental enrichment;*
- (ii) provision of single housing for animals when appropriate for the species and if necessary for the purpose of the*

project (for example, during recovery from surgery or collection of samples);

- (iii) species-specific environmental requirements, such as lighting, temperature, air quality, appropriate day/night cycles and protection from excessive noise and vibrations;*
- (iv) the need to provide ready access to food and water;*
- (v) the need to clean the pen, cage or container;*
- (vi) protection from spread of pests and disease;*
- (vii) requirements of the project; and*
- (viii) the need to observe the animals readily.*

4.4.20 Pens, cages and containers must:

- (i) be constructed of safe, durable materials;*
- (ii) be kept clean;*
- (iii) be maintained in good repair;*
- (iv) be secure and escape-proof;*
- (v) protect animals from climatic extremes;*
- (vi) not cause injury to animals;*
- (vii) be large enough for the species and the number of animals held; and*
- (viii) be compatible with the behavioural needs of the species.*

4.4.21 The number of animals within cages, pens or containers and the placement of these should enable social and environmental conditions for the species to be maintained. Where it is necessary to individually house animals of a species that normally exists in social groups, the impact and time of social isolation should be kept to a minimum.

4.4.22 Bedding and litter must be provided if appropriate to the species and should be comfortable, absorbent, safe, non-toxic, able to be sterilised if needed, and suitable for the particular scientific or educational aims. Pregnant animals must be provided with nesting materials where appropriate.

4.4.23 The AEC, investigators and teachers should be consulted in advance of planned changes to these conditions, since these may affect both the welfare of animals and results of the scientific and teaching activities.

1.5 Aspects of guinea pig behaviour relevant to housing and husbandry

- i) The earliest domestication of the guinea pig occurred between 6000 and 3000 years ago by the Andean Indians of Peru who used the animals as a food source, in traditional medicines and as sacrificial offerings to Incan gods. Dutch explorers were probably the first to introduce the species to Europe in the 16th century⁴ and introductions also occurred with returning Spanish conquistadors. Probably the first recorded use of guinea pigs in research was in 1777 when the French chemists Anton Laurent Lavoisier and Jean Baptiste Michel Bucquet used them to measure oxygen consumption and heat production, laying the foundations for subsequent work on energy balance that began the explanation of animal respiration and metabolism.
- ii) The domesticated guinea pig (*Cavia aperea f. porcellus*) is currently considered a rodent belonging to the sub-order Hystricognathi, family Caviidae which includes 14 species of animals native to South America, commonly known as cavies, cuy or maras (Patagonian hares). The family is characterised by a forepaw bearing 4 digits and a hind foot with 3 digits²⁶. Guinea pigs are considered to be related taxonomically to the chinchilla and porcupine⁴. However, evidence based on the sequence of the mitochondrial genome of the guinea pig contradicts a rodent phylogeny and suggests that the species could represent a new order, distinct from the Rodentia²⁵.
- iii) The wild *C. aperea* from which the domestic species is probably derived⁵⁷ live in habitats ranging from rocky areas to savannah, forest edges and swamps; in locations from Columbia and Venezuela, south to Brazil and northern Argentina.
- iv) Guinea pigs are social animals. *C. aperea* typically inhabit burrows that have been abandoned by other animals, living in family groups of up to 10 individuals centred on an alpha male. Compared with more promiscuous species such as *Galea musteloides*, which have a high incidence of polyandry amongst litters and little involvement of the males in caring for offspring, the high certainty of paternity resulting from the stable social arrangement experienced by *C. aperea* is associated with parenting behaviour directed by males of this species towards their offspring¹. Rival sexually mature males will fight, particularly when females in oestrus are present²⁶.
- v) A study comparing wild *C. aperea* with domesticated *C. porcellus* concluded that the repertoire of behaviour patterns in the two groups was similar, however wild cavies were more aggressive and the domesticated animals exhibited more socially positive behaviours such as social grooming and nudging⁵⁷. The domesticated animals also had reduced alertness, were less nervous and less sensitive to changes in

their environs compared with their wild counterparts. It was also suggested that their stress responses, particularly when exposed to conditions commonly found in a captive habitat, were lower than those of the wild animals. These differences have consequences for the social organisation of the domesticated animals, allowing multi-male, multi-female groups to be established with minimal stress and aggression. Fighting does not usually occur between males (either sibling or unrelated) that have been raised together without females, or within groups of non-breeding females²⁶, but the introduction of unfamiliar guinea pigs (and in particular males) into breeding groups, must be done with careful observation to assess any adverse effects on individuals and the established social structure.

- vi) Domesticated guinea pigs do not have a seasonal breeding cycle. Breeding females kept as livestock under traditional management conditions produce litters throughout the year and have an average reproductive rate of just over 9 pups per female per annum with a litter size usually ranging from 1 to 4 and averaging about 1.6. The mean interval between litters is 65.6 days with a slightly shorter period of 63.5 days between the first and second litters. Individual birth weights of pups are generally lower in young primiparous females compared with older multiparous females. Mortality rates of pups are higher with multiple births and about 60% of pre-weaning deaths of pups occur in-utero or at the time of birth due to unknown causes⁵⁹.
- vii) Guinea pigs are variously described as being nocturnal, crepuscular or polyphasic⁶⁵. In an environment free of abnormal and disturbing stimuli and at a constant comfortable temperature, guinea pigs are observed to be active most of the time, exhibiting some periods of continuous activity interspersed with periods of intermittent activity. The animals are active during both light and dark periods with only a small difference in the level of activity observed between light and dark conditions⁶².
- viii) Guinea pigs have highly developed senses of smell and hearing. They seek bodily contact with each other during periods of rest. Guinea pigs can readily distinguish the scents of known individuals from unknown ones and determine whether familiar scents are those of dominant or subordinate cohorts⁶⁰. Scent marking, with urine squirted on the coat of a partner and secretions from the perineal and supra-caudal glands rubbed on the substrate, indicate the animals' social status relative to others in the group⁶⁷.
- ix) In captivity, guinea pigs of lower social rank may exhibit hair loss from chewing by more dominant members of the group and juveniles may pull hair from their mothers⁴. Empirical observations have shown that the provision of hay *ad libitum* in the diet has been shown to substantially reduce hair loss associated with this behaviour³³. Generalised hair thinning in older female guinea pigs is not associated with hair chewing and not responsive to hay in the diet.

- x) Guinea pigs produce a range of vocalisations in relation to feeding, social encounters, mating and mothering²⁶. Vocalisation plays an important part in communication with up to 11 distinct calls recognized¹⁶ some of which include frequencies extending into the ultrasonic range⁶⁵, however no exclusively ultrasonic calls are identified¹⁶.
- xi) Normal behaviours of guinea pigs include walking, running, tunnelling through and under hay or straw, lying fully stretched out, retreating to shelter to rest, foraging and gnawing. Within the suborder Hystricomorpha, guinea pigs are specialised ground dwelling vegetarians that do not use their forepaws for manipulation of food or objects, owing to the absence of a thumb and the configuration of the claws⁸⁴. In common with other hystricomorph rodents, guinea pigs practice coprophagy. Soft, nitrogen rich faeces derived from the caecum are re-ingested almost immediately after being passed, usually at night²⁶. Guinea pigs do not routinely adopt a bipedal stance, however to facilitate orientation, rearing-up on their hind legs either free standing or with the support of the enclosure wall is a documented behaviour⁵¹. Juveniles will engage in leaping, running and chasing during play⁶⁷ but guinea pigs will not attempt to climb or jump over high vertical or near vertical surfaces. They will climb onto or jump over low obstacles in their enclosure.
- xii) When faced with a real or perceived threat the two principal responses of guinea pigs are, depending upon the nature of the threat and the circumstances, either to freeze or to stampede. Guinea pigs that are habituated to the presence of people will nevertheless freeze for periods of up to 30 minutes if startled by a sudden and unexpected noise^{62, 65}. The freezing response is typically preceded by the animal orienting itself to the direction of the stimulus and emitting a "Drrr" call before becoming motionless¹⁶. Alternatively, guinea pigs may stampede if startled by an unexpected noise or movement such as the sudden appearance of an unfamiliar person. This can cause injuries, particularly to young animals and pregnant females, if they are trampled⁶⁵.

Recommendations

- 1.5.1 *To meet the requirements of the Code of Practice (i.e. to provide accommodation that meets the species specific needs of guinea pigs), housing should be provided which allows guinea pigs the opportunity to carry out normal behaviours including social interaction; chewing / gnawing; locomotion (including tunnelling, exploring and playing) and; rest / hiding.*
- 1.5.2 *The Code of Practice recognises that there may be circumstances where the requirements of experimental procedures will preclude meeting some species specific needs (Clause 4.4.19). Housing in*

these situations should still meet the physiological and behavioural needs of guinea pigs as closely as possible.

2. Enclosure design

Several methods of housing guinea pigs are described, including various types of floor pens and metal or plastic cages mounted on shelves or in fixed or mobile racks⁶⁵. Access for checking of animals and cleaning may be difficult where guinea pigs are housed in tiered compartments⁶⁵.

The advantages of floor pens are that they facilitate the use of a deep litter type bedding system, are simple to construct and less expensive than cages and allow the provision of a large floor area. Disadvantages are that they do not utilise vertical space and must be run on an all-in, all-out basis to allow effective decontamination and minimise the risk of introducing diseases into the facility. Regular sanitation using water and aqueous cleaning agents and disinfectants is not feasible. Floor pens may not be practical for individual dosing and capture stress may occur unless adequate attention is given to operant conditioning of the animals. The animals may stampede in response to the entry of humans, which can result in crush injuries and broken legs.

2.1 Living area

Principles

- i) The type of enclosure and material from which it is constructed should incorporate sufficient floor space for the number of animals, should be able to be cleaned and serviced safely and efficiently, should accommodate the animals' behavioural needs including requirements for shelter and retreat from view, particularly in breeding colonies. The living area should have a solid floor with a suitable substrate. The use of floor pens to house guinea pigs is facilitated by the availability of good quality commercially prepared bedding material and recognises that group housing in an enriched environment is important to the well-being of the animals⁶⁵.
- ii) The living area for guinea pigs should incorporate a floor area which includes open space interspersed with shelter that allows the animals to retreat and hide, which may be in the form of temporary cover such as piles of lucerne hay, straw or wood wool and permanent shelters such as plastic or timber boxes and sections of PVC or similar pipe²⁶. Hay and other natural products may not be suitable where animals are specific pathogen free or their immune system is compromised.

Recommendations

- 2.1.1 *The living area for guinea pigs should incorporate open space interspersed with shelters to meet the physiological and behavioural*

needs of the animals including withdrawal from aggressive encounters and retreat from view.

- 2.1.2 *The predilection of guinea pigs for retreating to shelter to rest and hide necessitates the provision of adequate cover and shelter when they are housed in research or teaching institutions. This can be achieved by placing permanent shelters such as sections of PVC pipe, timber, cardboard or plastic hiding boxes in the enclosure. Providing straw, hay or wood wool in which the animals can form temporary tunnels provides an additional opportunity for activity.*
- 2.1.3 *Floor pens allow the provision of a large floor area for housing groups of guinea pigs and facilitate the use of a deep litter bedding system. Pens should be run on an all-in, all-out basis to permit effective decontamination between groups of animals.*
- 2.1.4 *Where tiered cages or raised pens are used the arrangement must incorporate easy access for checking of animals and cleaning.*

2.2 Enclosure floor area

Principles

- i) The suggested minimum floor area for housing guinea pigs varies between authors and differs according to whether or not the animal is part of a breeding group. However, with advancing knowledge of guinea pig behaviour and husbandry, the recommended areas per individual reported in recent literature tend to be greater than those published in earlier papers. It is generally accepted that the provision of sufficient floor space is essential to the well-being of the animals and the careful positioning of appropriate shelters within the enclosure optimises the floor space that is useable by the guinea pigs⁶⁷.
- ii) Suggested minimum floor areas^{24, 45, 46}.

Breeding pair with litter	2500 cm ²
Each additional breeding female	+ 1000 cm ²
Non-breeding guinea pig weighing 200g to 450g	1800 cm ²
Each additional animal weighing 200g	+ 200 cm ²
" >200g - 300g	+ 350 cm ²
" >300g - 450g	+ 500 cm ²
Non-breeding guinea pig weighing >450g	2500 cm ²
Each additional animal weighing >450g - 700g	+ 700 cm ²
" >700g	+ 900 cm ²

- iii) Empirical observations suggest that overcrowding of guinea pigs is associated with decreased reproduction and increased hair chewing⁴.

Recommendations

- 2.2.1 *In breeding colonies, a breeding pair with a litter requires a useable floor area of 2500cm² with an additional 1000cm² for each additional breeding female.*
- 2.2.2 *Weaned guinea pigs kept in non-breeding groups require a minimum useable floor area of 1800cm² for animals weighing 200 - 450g allowing 200cm² for each additional animal weighing up to 200g; 350cm² for each additional animal weighing >200g - 300g and 500cm² for each additional animal weighing >300 - 450g. For guinea pigs weighing >450g, a minimum floor area of 2500cm² is required allowing 700cm² for each additional animal weighing >450 - 700g and 900cm² for each additional animal weighing >700g.*

2.3 Enclosure height

Principles

- i) A 230mm high wall is sufficient to contain guinea pigs in pens²⁴.
- ii) When cages are used to accommodate guinea pigs, the cage sides should be 250 - 320 mm high⁶⁵. Preferably, cages and floor pens should not have completely solid sides. The use of a mesh panel at the front or walls that have a solid section at the bottom and mesh towards the top, allows the animals to see people approaching and reduces the likelihood of a startle response that can cause the animals to rush about the enclosure when disturbed by a sudden movement or noise^{75, 65}.

Recommendations

- 2.3.1 *The minimum wall height of pens should be 230mm and the minimum height of cages used to accommodate guinea pigs should be 250mm.*
- 2.3.2 *Pen walls and cage sides should be constructed with a mesh panel that allows the animals to see people approaching the enclosure.*

2.4 Enclosure shape

Principles

- i) The shape of the enclosure is probably not critical, provided it is furnished in such a way that the animals can effectively utilise the available space, taking account of their behavioural needs and the relationships that operate particularly in breeding groups where the male to female sex ratio normally ranges from a minimum of 1:4 to a maximum of 1:7. In such groups subunits may form typically consisting of one to four males and one to seven females centred on an alpha male⁶⁹ and areas may be established that do not normally overlap with those of other subunits⁷².

Recommendations

2.4.1 *Enclosure shape is not critical but the area should be arranged so as to enable the animals to make effective use of the available space, taking account of their behavioural and physiological needs. Square or rectangular enclosures generally make the most efficient use of floor space and meet the behavioural needs of thigmotaxic species such as guinea pigs.*

2.5 Enclosure materials

Principles

- i) A variety of materials may be used for the construction of guinea pig enclosures, including combinations of opaque plastic or metal panels with mesh that permit personnel to easily see the animals and which allow guinea pigs to see outside the enclosure, but also allow them to hide. Transparent or translucent plastic cages and wire mesh cages are not recommended for guinea pigs⁷⁵.
- ii) Wood is best avoided as a structural material in enclosures because it is difficult to clean and disinfect. Stainless steel is preferable to galvanised steel because of the greater tendency of the latter to corrode⁴. Wood treated with preservatives such as fungicides or insecticides poses a risk of poisoning to guinea pigs and must be avoided.

Recommendations

- 2.5.1 *Materials used to construct, pens, cages and permanent shelters should be durable, non-toxic to guinea pigs, easily cleaned and not interfere with the science.*
- 2.5.2 *For enclosure construction opaque materials should be used with mesh panels that permit personnel to easily see the animals and which provide some visibility for the animals but also allows them to hide. Transparent or translucent materials are not recommended.*
- 2.5.3 *Wood is difficult to clean and disinfect and therefore not recommended for constructing pens and permanent shelters. Timbers that have been treated with pesticides or fungicides must not be used.*
- 2.5.4 *If metal is used in enclosure construction stainless steel is recommended. Galvanised, plated or coated steels are prone to surface damage and corrosion and therefore not recommended.*

2.6 Enclosure flooring

Principles

- i) Floors in guinea pig enclosures should preferably be solid⁷⁵ to assist normal toenail wear and obviate the need to trim toenails. There is evidence indicating that guinea pigs prefer a dark coloured floor with a textured surface over a light coloured one with a smooth surface¹⁸. The potential of wire mesh flooring to cause injuries such as pressure neuropathy in guinea pigs kept on wire for periods of 8 to 12 months has been reported³². Wire mesh flooring has also been associated with an increased risk of hair loss, foot pad ulcers and dermatitis, decreased breeding activity and slower weight gain^{4, 26}. Consequently, enclosures with wire mesh floors are not recommended for long-term housing of guinea pigs. Young animals reared on solid floors may not adapt well to mesh and may have an increased risk of broken limbs and foot injuries⁴.
- ii) Where the use of mesh flooring is approved by an AEC, for example, to permit collection of faeces and urine, the mesh used must provide an adequate footing for the animals and should have a solid area for resting that is capable of accommodating all of the animals in the enclosure. Perforated plastic or perforated stainless steel floors are preferable to mesh floors²⁴.
- iii) Guinea pigs used in experiments involving the disruption of innervation to the distal limb are reported to develop pressure necrosis of the plantar surface of the foot⁷⁶. The changes occurred to the same degree in animals kept on a solid floor covered with sawdust as on a mesh floor. These findings indicate the need for special attention to monitoring the condition of the feet in animals used for this type of study, regardless of the type of surface on which they are kept.

Recommendations

2.6.1 *Guinea pig enclosures should have solid floors covered with suitable substrate.*

2.6.2 *Wire mesh floors should not be used in guinea pig enclosures except with the specific approval of the institutional AEC on the basis of compelling scientific evidence of the need to use such flooring.*

2.6.3 *If the use of mesh is approved by the AEC the enclosure must include an area of solid floor for resting that is capable of accommodating all of the animals in the enclosure. The use of perforated plastic or perforated stainless steel flooring should be considered as an alternative to mesh.*

2.7 Substrate

Principles

- i) Various types of substrate have been used in guinea pig enclosures, including straw, shredded paper, pelleted paper, wood shavings and sawdust.
- ii) Wood shavings or shredded paper are preferable to sawdust, which may form an impaction around the penis in males and inhibit copulation⁴. Grass awns and hard straws in the substrate can cause injuries to the foot pads²⁶.
- iii) If wood shavings are to be used, a commercially prepared steam or heat-treated type should be selected which will have had some organic compounds removed. Wood shavings from species that may contain aromatic hydrocarbons are not recommended as they can cause respiratory problems²⁶ and those that may have come from poisonous species or which originate from timbers treated with insecticides or fungicides must not be used.
- iv) An apparent difference in the preferences of 2 to 5 month old guinea pigs for wood shavings or paper substrate, according to the light levels and time of day has been reported⁵³. While resting during the light phase of the daily cycle, the animals preferred the wood shavings substrate to the paper, with a reversal of this preference coinciding with higher levels of activity and less resting during the dark phase. It was suggested that the elasticity of the wood shavings may have offered more cover, greater warmth and more protection from light than the paper substrate, which may have accounted for the preference shown by the animals⁵³.

Recommendations

2.7.1 Commercially sourced substrate in the form of steam-treated wood shavings, straw, shredded or pelleted paper is recommended.

2.7.2 Substrate derived from timber that emits strong odours from naturally occurring aromatic hydrocarbons and material processed from wood treated with pesticides or fungicides is potentially harmful to guinea pigs and must not be used.

2.8 Nesting material

Principles

- i) As a result of a long (59 to 72 days) gestation period for the size of animal, guinea pigs produce precocial young that are fully furred, have their eyes open and are capable of coordinated locomotion almost immediately after birth. Consequently, female guinea pigs do not construct a nest but do require comfortable substrate and a secure shelter or retreat where they can give birth⁶⁷.

Recommendations

2.8.1 *Nesting material may be provided but is not necessary for guinea pigs so long as a comfortable substrate is available.*

2.8.2 *A secure shelter or retreat where pregnant females can give birth is required.*

2.9 In- enclosure shelters

Principles

- i) The degree to which guinea pigs will utilise the space provided to them depends upon the provision of shelters and retreats to which they can retire when a threat is perceived or to rest. Extensive open space in an enclosure will generally be avoided by the animals if there is no shelter close-by. In the absence of shelter, the animals tend to utilize the space on the periphery of the enclosure, resting and sleeping close together next to the walls⁸⁵. When adequate shelter is provided, use of the space develops over time until it is fully utilised^{54, 75}.
- ii) Permanent shelters can be made from a variety of materials such as:
- Pieces of straight, angled, Y section or T section 100 to 150mm diameter PVC or similar water pipe. Holes drilled along the top to promote air circulation avoid the risk of smothering the animals at the centre if a large number of guinea pigs crowd into the pipe at one time. Plastic pipe has the advantage that it can be readily cleaned and disinfected²⁶.
 - Pieces of larger diameter pipe cut lengthways yield two semicircular sections that can be inverted to create tunnel shelters.
 - Clean, recycled plastic drums cut down if necessary and with a suitable hole cut in the side.
 - Clean, recycled cardboard cartons cut down if necessary and with a suitable hole cut in the side. These must be replaced as they become soiled or damaged and when enclosures are cleaned and disinfected between groups of guinea pigs.
 - Purpose built boxes with suitable holes cut in the side. These may be made of plastic, stainless steel, exterior grade plywood or timber provided the wood is not treated with an insecticide or fungicide and has an impervious, non-toxic finish that can be cleaned effectively.

- Some establishments use boxes fitted with a floor, a top opening lid and a sliding door across the access hole in the side, which allows the staff to capture animals quickly and easily when necessary and facilitates the handling of individuals for examination or treatment⁶⁷.
- iii) Temporary shelter can be provided with biscuits of lucerne hay heaped in the enclosure. The guinea pigs tunnel through and under the hay gradually eating the leafy material and progressively trampling the stalks. The hay must be regularly replenished to maintain its value as a feed supplement and shelter. The provision of hay may also help prevent behaviour problems such as hair damage due to barbering and assist in maintaining normal tooth wear. Mouldy or dirty hay must not be used⁴.

Recommendations

- 2.9.1 *Shelters should be provided within guinea pig enclosures to provide privacy, to enable guinea pigs to retreat and to ensure that the space available in the enclosure can be effectively utilised by the animals.*
- 2.9.2 *Shelters may be permanent, made of durable, easily cleaned non-toxic materials or temporary such as clean recycled cardboard cartons that can be replaced when they become soiled, or biscuits of hay that the animals can tunnel under or through. Hay should be replaced regularly as the leaf is eaten and stalks are trodden down by the animals.*

3. Guinea pig care and management

3.1 The social environment

Guinea pigs are social animals preferring to form small groups with strong dominance hierarchies between males and weaker hierarchies between females. In large mixed-sex colonies, smaller groupings are formed based on a dominant male with a retinue of chosen females and may include subordinate males and other females. If there is sufficient space for large colonies where breeding groups have more than one male, dominant males may establish individual territories within the area occupied by the colony. Some research establishments may prefer to maintain smaller colonies consisting of a single male with a group of allocated females. Young guinea pigs raised in a colony learn the skills necessary to interact within social groupings and minimise conflict. The incidence of fighting may increase when established social structures are changed and new groups are formed. This is an important consideration, particularly for the management of breeding colonies. Vocalisation is an important feature of the social interactions between guinea pigs and is also directed towards their human carers.

Principles

- i) The social organisation amongst guinea pigs is complex and adaptable to environmental variation. The social interactions and group dynamics that occur between animals under different circumstances are accompanied by hypothalamic, pituitary, and adrenal glandular activity and sympathetic nervous system responses³⁶. In guinea pigs social bonding between adult animals is the predominant characteristic of social organisation, with emphasis upon bonding between individual partners and evidence to indicate that social support between partners significantly reduces endocrine responses to stressful situations⁵¹.
- ii) Guinea pigs require considerable socialisation to acquire the skills necessary to establish stable social structures⁷². Inadequate attention to this requirement when housing guinea pigs can create conditions of social instability which result in significant stress in affected animals, indicated by increased outputs of hormones from the adrenal glands^{70, 71}.
- iii) When housed together with females, male guinea pigs form a fairly stable linear dominance hierarchy¹⁷. The linear rank order of males appears to be the most obvious feature of social structure when the group size is small (around 8 animals). As the number of animals increases (to around 24) the more dominant feature becomes the long lasting male-female preference relationships⁶⁹. In colonies where there are a number of males and females in an area large enough for males to avoid each other, an incomplete dominance hierarchy is established. In such circumstances colony sub-units are established consisting of dominant males, with a small retinue of males and females in territories that tend not to overlap within the enclosure, although territorial defence by males is incomplete and lower ranking males particularly, may enter each others' territories⁷².

- iv) Control over access to other resources, such as water, does not necessarily reflect the same dominance hierarchy as that associated with mating and different males may exercise dominance over others in this situation. Dominance of males is not strongly correlated to their body weight¹⁷.
- v) The commonest guinea pig call that occurs during social interactions is the "chut", which is emitted during initial exploration of the other animal. When the type of encounter, for example sexual, aggressive or nursing is determined, a call more specific to those circumstances is used. Guinea pigs in mildly aversive social encounters vocalise with a series of short calls "chutters" which may become a whining call when the animal is alarmed. Animals suffering a minor accidental injury from cohorts may squeal and those defeated in serious aggressive encounters may lie in a defensive posture and emit a series of tremulous screams¹⁶.
- vi) The position of a male in the hierarchy will determine the degree of courtship behaviour exhibited and his success in mating. Typical vocalisation during courtship is a purring call accompanied by circling and swaying movements sometimes referred to as "the rumba". These movements, accompanied by purring may also be seen preceding aggressive encounters between unfamiliar males¹⁶. Dominance problems are uncommon among males raised together without the presence of females and in groups of non-breeding females²⁶.
- vii) There is a tendency for males to associate with particular females and it is suggested that the dominance of males within the colony increases transiently when their females come into oestrus. However there is generally an alpha male that dominates the hierarchy in the colony¹⁷.
- viii) Female guinea pigs in a breeding colony do not normally show aggression towards other animals in the group, however a social hierarchy of females is established⁷².
- ix) Female guinea pigs are more adaptable than males in moving from an established social grouping to a new one. Females reared in a colony situation experience no stress in moving to a new colony. Approaches from males are inhibited for a time to females that have been scent marked by males from their previous colony. Females raised in a pair with just one male are generally not similarly marked and therefore experience immediate attention from males when placed in a new colony. This attention triggers avoidance and defensive aggressive behaviour by the females, however there is also social orientation behaviour. These behaviours do not lead to a high degree of social stress and are not accompanied by a rise in plasma cortisol⁵¹.
- x) Pregnant females that are subject to an unstable social environment in the form of frequent introduction of new females to the group and

removal of familiar animals (creating constant social instability in the colony), produce female offspring with higher levels of testosterone, more masculine behaviour and higher adrenal gland weights than the female offspring of dams from a more stable social environment^{73, 52}. Such permanent physiological changes in the animals may affect the outcomes of some types of experimental work. Consequently, the availability of reliable information on the housing environment and husbandry of the animals may be an important consideration for investigators when sourcing guinea pigs for particular research projects.

- xi) Males that are reared with one female do not learn how to deal with agonistic behaviour in a colony situation and if exposed to other males in the presence of females, high levels of aggressive behaviour are often displayed⁷².
- xii) Where guinea pigs are housed in family groups, there is evidence to suggest that mating between pubescent males and their female siblings and dams is suppressed thus apparently avoiding in-breeding. Normal sexual behaviour is directed towards unrelated females⁴⁰.
- xiii) Lactating females will readily nurse the pups of other females as well as their own, suggesting that the mother infant bond is loose rather than rigidly exclusive³¹ and young guinea pigs will follow juvenile cohorts or adults other than their mother within a few days after birth⁵⁴. Once suckling is initiated lactating females may drive away any other females or stray pups that attempt to approach them, including their own⁶⁷.
- xiv) The majority of nursing bouts are initiated by the pups lifting the abdomen of the lactating female to facilitate attachment to a nipple. This approach may stimulate the adoption of a crouching stance by the lactating animal that facilitates nursing. The adoption of this posture may be necessary for the successful delivery of milk to the pups³⁸. During these encounters the female noses the anogenital region of the pup stimulating the pup to exhibit lordosis and pudendal dilation with eversion of the anogenital region accompanied by a low amplitude tweet emitted by the pup. Licking continues until the pup urinates and defecates¹⁶. The length of time between bouts of suckling is influenced by the length of time spent by lactating females in foraging and feeding and varies between individual mothers³.

Recommendations

3.1.1 *Guinea pigs are social animals and should be kept either in single sex groups or in stable breeding colonies.*

3.1.2 *Guinea pigs require considerable socialisation to acquire the skills necessary to establish stable social structures. Attention to this*

requirement when housing guinea pigs in groups and particularly when forming new groups is essential to avoid problems of social instability that may adversely affect the welfare of subordinate individuals and the quality of scientific data obtained from them.

3.2 Isolation / Individual housing

Bonds existing between guinea pigs as parent-infant, filial and intersexual relationships provide security and health-promoting effects that significantly influence the individual's ability to cope with stress and to survive. The severing of these bonds by the isolation of individuals has measurable physiological effects, with potentially deleterious outcomes for the welfare of the guinea pigs. The maintenance of a familiar environment and provision of visual, olfactory and auditory contact with familiar cohorts reduces the stress associated with individual housing, although some physiological effects persist that may be detrimental to the wellbeing of the animals. These effects may also confound experimental outcomes if not taken into account during the planning of the work and interpretation of the results.

Principles

- i) Transient separation of dams from their pups while foraging in the home enclosure results in an increased resting plasma cortisol level in the pups⁴² but does not cause a stress response on the part of the pups to the same degree as isolation⁸³. In situations that are mildly fear producing, guinea pigs that are separated from each other emit low whistles which may become louder if the separation continues¹⁶.
- ii) There is a two stage behavioural response of young guinea pigs subjected to maternal separation and isolation in a new enclosure³⁷. The initial response is an active one characterised by increased vocalisation and movement combined with an increase in plasma cortisol levels⁴¹ plasma ACTH, epinephrine and norepinephrine⁴³. Suppression of vocalisation and locomotion occurs in the isolated animals at about 30 to 60 minutes after separation and is associated with the release of corticotrophin releasing factor from the hypothalamus and other sites³⁹. This is followed after about an hour by a passive response characterised by crouching, eye closing and piloerection that follows a transient rise in rectal temperature. The latter is a physiological response that bears some similarities to changes that may accompany the onset of illness³⁷.
- iii) The level of vocalisation and plasma cortisol responses are reduced and the passive responses do not occur when the young animals are exposed to the novel environment in the company of their dam^{41, 37}. The presence of an unfamiliar adult female guinea pig has a similar effect on the behaviour and plasma cortisol level in the pups, but to a lesser degree than if their mother is present³⁴. The availability of

physical contact with the mother or another adult female is the factor that apparently influences the expression of these responses in the pups³⁵.

- iv) Young guinea pigs call in the absence of adults when alone in unfamiliar surroundings or when hungry⁵⁴ and the type of vocalisation that may accompany separation of young animals from their mother or siblings ranges from low whistles to whistles and screams¹⁶.
- v) Maternal separation and isolation of female pups until adulthood apparently does not affect the maternal behaviour of the isolated guinea pigs. There were no differences found in nursing time, nursing posture, pup oriented responses or weight gain of offspring between socially isolated and naturally reared mothers⁷⁷. Similarly, there was no long-term effect of early isolation in guinea pigs attributable to deprivation of the opportunity to engage in social play²⁸. Also, unlike the juveniles of some other species, isolated guinea pig pups apparently do not form attachments to inanimate objects in their environment⁴⁹.
- vi) Male guinea pigs separated from their colony at 30 days of age (i.e. after weaning but before sexual maturity) did not exhibit signs of stress when housed in individual enclosures in a room that permitted olfactory and auditory contact with familiar cohorts⁷⁰. Their adrenocortical, adrenomedullary and gonadal activities are lower than comparable males maintained in a colony.
- vii) Males raised in isolation and subsequently exposed to males raised in a colony are unlikely to initiate agonistic encounters with colony-raised males and when such encounters are initiated by the colony-raised animals the males raised in isolation are generally unsuccessful at defending themselves. Previously isolated males placed into a colony suffer significant losses in body weight and either die or if they survive, are near the bottom of the social ranking⁷⁰.
- viii) Sociability in guinea pigs does not respond consistently when housing conditions are manipulated although age at the time of isolation is apparently an important factor in determining aggressiveness. It is suggested that there may be a period of time, perhaps shortly after weaning, when learning of aggression-reducing communication normally occurs and this may be prevented by isolation during that time⁴⁸. Similarly, the capability of isolated males to subsequently display normal sexual behaviour and achieve successful mating when introduced to females, appears dependent upon the age at which isolation occurs⁸¹.
- ix) Prolonged isolation does not prevent the display of normal mating behaviour, provided males have an opportunity to acquire the pattern after weaning and before being isolated. Males that did not acquire the behaviour before isolation were initially unable to mate but did

eventually develop normal behaviour at a mature age after being housed for a time with sexually active males and females. The rate at which the mating pattern was acquired and learned varied between strains of guinea pigs indicating that males of some strains may require longer to learn and to organise the behaviour⁸¹.

- x) Guinea pigs moved from group housing into single enclosures in an unfamiliar room sustain a loss in body weight and have reduced water intake. These changes are not observed in guinea pigs separated into single accommodation in their familiar room, where visual, olfactory and auditory contacts with cohorts are maintained³⁰.
- xi) Presence of a preferred partner can ameliorate the effects of sudden exposure to a stressor such as noise. A reduction in stress induced immobility has been reported following exposure to noise in male guinea pigs selected for cohabitation by females and, to a lesser extent, in their female partners. The paired animals also had higher levels of peripheral oxytocin when compared with isolated guinea pigs⁵⁸.
- xii) If a protocol that is approved by the AEC requires individual housing, provision must be made for visual, auditory and olfactory contact with other guinea pigs^{30, 67}. If for example, a single animal will remain for a period of time after cohorts have been removed from a treatment group, then wherever possible an untreated companion should be provided, which could be a neutered adult male or female guinea pig.
- xiii) In situations where a guinea pig must be removed from its social group for individual treatment, the housing of a familiar companion animal with the treated animal will help reduce the effects of stress caused by the separation²⁶.

Recommendations

3.2.1 *Guinea pigs should not be housed individually unless with the express permission of the Animal Ethics Committee of the institution on the basis of compelling scientific evidence for the need to house guinea pigs in this way. In such cases, where feasible under the experimental protocol, guinea pigs should be in visual, auditory and olfactory contact with other guinea pigs.*

3.2.2 *In situations where a guinea pig must be removed from its social group for individual treatment, the housing of a suitable companion animal with the treated animal should be considered to reduce the effects of stress caused by the separation.*

3.2.3 *Males that have previously been raised in isolation must be very closely monitored if placed into a colony, as their welfare can be seriously compromised by the aggression of males already established in the social hierarchy.*

3.3 Metabolism cages

Principles

- i) Where the use of metabolism cages is approved by an AEC, the stress associated with separating guinea pigs from their social group into individual cages should be minimised where feasible under the experimental protocol by housing them in a room that permits visual, olfactory and auditory contact with familiar cohorts³⁰.
- ii) Punched metal or plastic flooring is preferable to a mesh floor. Where metal flooring of any type is used, stainless steel is preferable to galvanised steel. Guinea pigs maintained on a wire mesh floor should, where feasible, be provided with an area of solid floor large enough for all animals in the enclosure to rest at the same time²⁴. An appropriately designed refuge that does not interfere with urine or faecal collection should be provided.

Recommendations

- 3.3.1 *Guinea pigs should not be housed in metabolism cages except with the specific approval of the AEC and then only for the minimum time necessary to complete the approved protocol.*
- 3.3.2 *If the use of metabolism cages with mesh floors is approved by the AEC, where feasible, the enclosures must include an area of solid floor for resting that is capable of accommodating all of the animals in the enclosure. The use of perforated plastic or perforated stainless steel flooring in the enclosures should be considered as an alternative to mesh. An appropriately designed refuge that does not interfere with urine or faecal collection should be provided.*

3.4 Effects of handling and human activity

Principles

- i) Guinea pigs maintain a docile temperament when handled frequently and gently⁴.
- ii) Guinea pigs seek the attention of their human carers⁵⁴ and very quickly learn the sounds associated with caretaking of the colony, such as

refilling of water bottles, opening of food containers, rustling of hay and other associated sounds¹⁶. Activities such as these or the entry of a person into the room housing the animals will normally be accompanied by a number of low whistles followed by a louder whistle¹⁶.

- iii) Using telemetry, increases in heart rate above the resting rate can be observed in the environment. The mean resting heart rate of guinea pigs, measured by telemetry, is 275.5 beats per minute with a wide normal range between 229 and 319 beats per minute²⁹. Increases in heart rate above the resting rate are observed with changes in the cage environment such as opening the door or introducing something new such as a water bottle, the researcher's hand or another guinea pig. Overt behaviour such as movement or vocalisation generally does not accompany the increased heart rate, which nonetheless indicates that the animals are constantly sensitive and responsive to changes in their environment. The introduction of a stronger stimulus may cause a transient decrease in heart rate followed by a sharp increase as the guinea pig initiates an overt aggressive or defensive response²⁹.
- iv) Frightened animals may emit a low whistling call, particularly when separated from their cohorts. Distress in young animals following excessive disturbance of their environment or separation may cause them to scream¹⁶.
- v) It has been reported that immobilizing guinea pigs by holding them in the hand for 15 minutes caused an increase in respiration rate, plasma zinc and ACTH levels similar to that found when the animals were exposed to noise and vibration¹⁴. It has also been noted that handling guinea pigs may affect modulation of their immune system and influence subsequent responses of the animals to behavioural conditioning⁶⁶.

Recommendations

3.4.1 Frequent gentle handling of guinea pigs is recommended to condition the animals to being captured and manipulated. Such handling should commence at an early age before experimental work begins and may include training animals with a reward.

3.4.2 Guinea pigs are highly sensitive to human activity and sounds in the animal room. It is very important to approach the animals and perform husbandry tasks with due empathy to avoid startling them.

3.5 Environmental enrichment

Environmental enrichment has been defined as a concept which describes how the environments of captive animals can be changed for the benefit of

the inhabitants⁸⁶. It is designed to meet species specific behavioural requirements and to enable guinea pigs to express their natural behaviours and avoid developing abnormal ones. The aims of environmental enrichment are not simply to prevent suffering, but to have a positive effect on the physical and psychological well-being of the guinea pig⁶¹ and to achieve optimum outcomes of experimental work through the application of accepted best practice in animal husbandry and care⁸².

Principles

- i) Guinea pigs have four important groups of natural behaviours that should be allowed expression:
 - social interaction;
 - chewing/gnawing;
 - locomotion (including tunnelling, exploring and playing); and
 - rest/hiding.

- ii) Examples of enrichment:

Social interaction: Housing guinea pigs in social groups See 3.1 The Social Environment.

Chewing / gnawing: Small blocks of softwood, wooden tongue depressors or pop sticks, hay and straw²⁶. Guinea pigs that are routinely provided with softwood sticks usually do not attempt to gnaw fittings such as food hoppers in their enclosure⁷⁵.

Locomotion (including tunnelling, exploring and playing): Lucerne hay biscuits or a hay rack positioned just above the floor which permits tunnelling; open space interspersed with shelters that encourage the guinea pigs to use the available floor space.

Resting / hiding: Shelters in the form of PVC or similar pipes, timber, plastic or metal boxes, clean plastic drums or cardboard boxes with holes cut in the sides¹⁵; bedding material⁵³.

- iii) The suitability of items for enrichment should be critically assessed to ensure that the strategies improve, and are not detrimental to guinea pigs' welfare. Assessment may include, for example, whether enrichment strategies assist with the expression of any of the above behaviours⁸².

- iv) Enrichment items need to be assessed for their health risks. Some materials, such as some plastics, treated wood, galvanised or painted materials, may be dangerous because of their toxicity when chewed.

Recommendations

3.5.1 As appropriate under the experimental protocol, guinea pigs should be given items to enrich their environment. Items that assist guinea pigs to perform each of the 4 following categories of behaviours should be provided:

- *Social interaction;*
- *Gnawing / chewing;*
- *Locomotion (including tunnelling, exploration and play) and;*
- *Hiding / resting.*

3.5.2 *When techniques are used in an effort to provide environmental enrichment for guinea pigs, it is important that each technique is evaluated to ensure that it has no detrimental effect on the animals or the science.*

3.5.3 *Proposed enrichment items should be assessed for likely risks that may affect the health of guinea pigs and interaction of the animals with new items should be monitored to identify any problems.*

3.6 Identification

Principles

- i) Guinea pigs must be identifiable whether individually or in groups. It is essential that the more invasive identification procedures be performed, or closely supervised, by an experienced practitioner. The method chosen should be the most appropriate for the species and result in the least pain and distress to the guinea pig¹³.
- ii) Recording individual coat colour and patterns may be all that is required to distinguish one individual from another. Electronic tags (commonly known as RFID tags, PIT tags or micro-chips) implanted subcutaneously may be used for the permanent identification of individuals¹³. The latter system requires the use of a compatible scanner in order to detect and read the tag numbers. Tattooing of the pinna by trained, competent staff using local anaesthesia may also be used. Numbered ear tags should be avoided as they can tear the pinna, causing pain, infection and keloid formation. Temporary identification (of individuals allocated to a treatment group, for example) can be achieved by hair clipping and dye marking.

Recommendations

3.6.1 *Where it is necessary to identify individual guinea pigs, the least invasive method that is compatible with the use of the animals should be used. Recording of individual coat colour and pattern may be sufficient.*

3.6.2 *Non-toxic dyes and permanent markers may be used on the fur. These methods of identification usually need to be replaced every two weeks.*

3.6.3 *Fur clipping may be used but needs to be carried out frequently.*

- 3.6.4 *Where permanent identification is necessary, passive integrated transponder tags (commonly known as RFID tags, PIT tags or microchips) implanted subcutaneously or tattoos applied to the pinna by trained, competent staff using local anaesthesia may also be used.*
- 3.6.5 *A permanent record of the individual tag numbers should be kept.*
- 3.6.6 *The use of ear tags is not recommended as they can tear the pinna causing pain, infection and keloid formation.*
- 3.6.7 *Toe amputation is a painful procedure and should not be used.*

3.7 Food and water

Principles

- i) Guinea pigs have evolved to utilise a diet low in caloric value and high in fibre. Free feeding behaviour is characterised by a large number of small meals with brief periods of feeding interspersed with non-feeding periods of typically less than 90 minutes. Food intake is influenced by the availability of food and the availability of water, with drinking typically occurring within 20 minutes after feeding⁴⁴.
- ii) There is no reported difference in feeding pattern between periods of light and dark⁴⁴, although it has been noted that guinea pigs eat considerable quantities of food during the day with the highest intake occurring in the late afternoon and evening²⁶.
- iii) Adult guinea pigs normally consume 3.5g of dry-matter per 100g of body weight per day²⁶, however, a greater intake than this is reported in growing juveniles⁵⁶.
- iv) Although energy intake in the mother guinea pig increases during both pregnancy and lactation, litter size significantly affects her energy intake during pregnancy but not during lactation. Consequently, offspring from large litters consume more solid food earlier than individuals from smaller litters and their growth rate is slower compared with those from smaller litters⁵⁶.
- v) Guinea pigs are monogastric herbivores with a simple stomach and a voluminous caecum from which short-chain fatty acids are absorbed. Ingesta moves through the stomach and intestines over a period of about 2 hours but remains in the caecum up to 48 hours⁴⁴. The guinea pig gut has been found to be more efficient in the digestion of fibre than that of the rabbit and rat⁷⁴ and on a similar diet, has shown equivalent efficiency to the gut of the horse in digesting organic matter and crude fibre.

- vi) A pelleted diet is normally consumed in greater amounts than hay if both are offered *ad libitum*. A diet based completely on hay is considered inadequate and supplementation with pellets and some succulent feeds such as carrots or apples is essential, but excessive feeding of succulents should be avoided, as diarrhoea and other gastrointestinal upsets can occur. Sudden changes to the diet can affect normal gut flora and must be avoided²⁶.
- vii) Guinea pigs raised on a pelleted diet experienced maximum weight gains when the pellets contain 50% fibre, with the animals exhibiting a preference for rations containing fibre sourced from forages such as lucerne hay and oaten hay. Other fibre sources may also be utilised⁷⁴.
- viii) Animals of lower rank may exhibit hair loss from fur chewing by more dominant members in the group and young animals may pull hair from their mothers⁴. Providing hay may satisfy the animals' need for crude fibre better than pelleted rations alone and less hair loss reportedly occurs from animals in enclosures where hay is routinely provided *ad libitum*³³.
- ix) Guinea pigs have a daily maintenance requirement of 10mg of vitamin C/kg⁻¹ of body weight which increases to 30mg/kg⁻¹ for pregnant females²⁶. The ration should normally contain 500mg of vitamin C/kg⁻¹ of diet⁵⁵. Dampness, heat and light can all reduce the vitamin C content of stored foods. Storage of feed at a temperature above 22°C for 90 days may oxidize half of the vitamin C present in the ration²⁶. Autoclaving the ration destroys vitamin C but can be corrected by fortification, which adds to the cost of the diet. Fresh vegetables such as sweet peppers, spinach, tomatoes, kale and asparagus are good sources of vitamin C. Vitamin C may also be added as a supplement in the water supply. Open water containers may lose up to half of the vitamin C over a period of 24 hours and losses may also occur in hard water, metal containers or if the water is heated. The vitamin is more stable in neutral to alkaline conditions²⁶. An alternative is to spray the vitamin onto the food just prior to use, although this may be a less precise method of supplementation than the use of a fortified ration. The vitamin solution should be made fresh for each application.
- x) Vitamin C concentrations in the adrenal glands and spleens of individually housed guinea pigs may be significantly higher than those of group housed cohorts⁴⁷, an observation that may need to be considered in the interpretation of some experimental outcomes where the animals have been housed singly.
- xi) Vitamin C deficiency causes the condition known as scurvy which is characterised in guinea pigs by clinical signs including weight loss, unkempt coat with alopecia, diarrhoea, joint swelling and pain and occasionally pinpoint haemorrhages (petechiae) in the mucous membranes and blood in the urine (haematuria). Clinical signs may

begin to appear in guinea pigs after 2 weeks on diets that lack the vitamin²⁶. Other pathological changes include subnormal bone formation, reduced bone density with lowered mineral content associated with reduced deposition of calcium, increased bone resorption and thinning of the growth plates in juvenile animals⁵⁵. Marginal levels of vitamin C may manifest as deficiency after 6-8 weeks, initially as reproductive problems and then as other changes often in pregnant females and young animals.

- xii) Zinc (Zn) plays a key role in central and peripheral nervous system function in guinea pigs. Zinc deficiency may cause abnormal posture and locomotion, tactile hypersensitivity or hyperalgesia and reduced motor conduction in the sciatic nerve. An adequate zinc level is 100mgkg^{-1} of diet if fed *ad libitum*¹⁹.
- xiii) Guinea pigs differ from other species of rodents in their metabolism of dietary selenium (Se). The activity of the selenium dependant antioxidant enzyme glutathione peroxidase is normally lower in guinea pigs than in other species. Selenium deficiency in guinea pigs significantly reduces the activity of this enzyme, reduces the steady state level of thyroxine and significantly reduces the growth rate compared with animals receiving a normal concentration of dietary selenium. The selenium concentration should be 0.5mgkg^{-1} of diet (equivalent to 1.2mg of sodium selenate kg^{-1} of diet)²¹.
- xiv) In common with other hystricomorph rodents, guinea pigs practice coprophagy. They produce two types of faeces. One form is nitrogen rich, soft, derived from the caecum and is re-ingested shortly after being passed. About 40% of the faeces produced are consumed, usually at night. The other type of scat is passed as firm faecal pellets²⁶.
- xv) On a pelleted ration, water consumption will normally be 6mlg^{-1} of diet. For rations containing hay and fresh grass or other succulent foods, water consumption will normally be $2\text{-}3\text{mlg}^{-1}$ of diet²⁶. Separation of water supplies from food hoppers is recommended as there is tendency for guinea pigs to dribble water into the food which causes caking and wastage of pelleted rations⁶⁵.
- xvi) Water supplies need to be replenished daily. Water dishes tend to become soiled with food and faeces and through guinea pigs resting in them. Where water bottles are used the sipper tubes can become clogged with masticated food if they are placed too close to food bowls. Sipper tubes should be situated sufficiently far above the level of the substrate to ensure that wicking and loss of water into the substrate does not occur⁴. Stainless steel tubes are less prone to damage by chewing than brass tubes⁶⁵. If an automatic watering system is used the animals should access the drinker by sticking their muzzle out of the enclosure. The incorporation of a drip channel to convey spilled

water away from the enclosure is essential to avoid problems of wet substrate caused when valves leak or guinea pigs play with them⁶⁵.

Recommendations

- 3.7.1 *Guinea pigs require a balanced diet that accommodates their nutritional and behavioural needs, such as a balanced pelleted ration that is high in fibre, supplemented with good quality hay and fresh vegetables as a source of environmental enrichment and variety.*
- 3.7.2 *An adequate level of vitamin C is essential in the diet and may be provided through supplementation in the water supply or ration sufficient to meet the needs of the animals. Supplementation with fresh vegetables is a safeguard where appropriate levels of vitamin C cannot be maintained via addition to drinking water or in a fortified pelleted ration.*
- 3.7.3 *The diet provided to guinea pigs must maintain an adequate level of zinc and trace amounts of selenium. Food is one of the least controlled variables in the research environment. Periodic detailed analysis by a competent laboratory may avoid long-term deficiencies that can affect research results. Storage conditions must be taken into account.*
- 3.7.4 *Food hoppers should be positioned to minimise faecal soiling and should be separate from watering points to avoid dampening and caking of the feed.*
- 3.7.5 *An adequate supply of clean, fresh water must be maintained daily. Water dishes are prone to faecal soiling and contamination with spilled feed and are therefore not recommended. Water bottles with sipper tubes may also become contaminated with food residues if placed too close to food hoppers and should be positioned away from the food containers. Tubes should be positioned to allow access by all animals in the enclosure but far enough above the substrate to avoid wicking and loss of water into the bedding. Stainless steel sipper tubes are less prone to damage from chewing and are recommended.*
- 3.7.6 *Where automatic watering systems are used, a drip channel should be provided outside the enclosure to collect spilled water and carry it away from the substrate.*

3.8 Monitoring of Guinea Pigs

Principles

- i) A high standard of animal care is crucial for the success of housing guinea pigs in groups. Guinea pigs must be monitored both for health and for social interactions within the group⁶⁴.

- ii) The day to day observations of the animal care staff are the first and most important part of a health monitoring program. Familiarity of the animal carer with the normal appearance and behaviour of healthy guinea pigs is essential and any deviation should be investigated promptly, since it may be the earliest sign that a problem exists⁶⁴.
- iii) Sick guinea pigs should be examined and diagnosed by a veterinarian. Any animals that die unexpectedly should be routinely submitted for post-mortem examination and diagnosis⁶³.
- iv) Guinea pig behaviour can be difficult to interpret and subjective judgements cannot always be reliable. Objective indicators of health and welfare such as body mass should be regularly monitored. Health monitoring data and results of surveillance testing for specific diseases should routinely be made available to the researchers responsible for the guinea pigs and to the AEC⁶³.

Recommendations

- 3.8.1 *Guinea pigs should be monitored by observation at least daily for any signs of abnormality, illness, pain or distress and to ensure adequacy of environmental conditions, food and water supplies.*
- 3.8.2 *In addition to daily observations, weekly health checks should include a review of health and husbandry records, routine husbandry, diagnoses, treatments and fertility, fecundity, morbidity and mortality in breeding colonies.*
- 3.8.3 *Animal carers should be aware of the normal behaviour of guinea pigs and of the individuals within a group and observe for deviations from normal. Guinea pigs that give cause for concern (either excessively aggressive or timid) may need to be removed from a group.*
- 3.8.4 *In particular, subordinate guinea pigs should be monitored for signs of bullying (which may, for example, result in fight wounds or denial of access to food or water).*
- 3.8.5 *Guinea pig behaviour can be difficult to interpret and subjective judgements cannot always be reliable. Objective indicators of health and welfare such as body mass should be regularly monitored. Sick guinea pigs should be examined and diagnosed by a veterinarian and any animals that die unexpectedly should routinely be submitted for post-mortem examination and diagnosis.*

4. Environmental variables

4.1 General

Principles

- i) A variety of environmental factors, including light, temperature, humidity, air quality and sound may impact on the behavioural responses and health of guinea pigs. The design, construction and management of guinea pig pens and cages will largely determine how these factors will impact on the animals⁶⁸.

4.2 Light

Principles

- i) Observations on the sleep pattern⁷⁹ and the daily pattern of heart rate, body temperature and locomotor activity in guinea pigs² showed that, while circadian rhythms were apparently well developed in some animals, they were less evident or absent in others. The pattern of sleep and waking in guinea pigs was found to be polyphasic and fragmented and accompanied by periods of increased activity after lights were turned on and again after they were switched off⁷⁹. This confirmed earlier observations showing that under conditions of optimal temperature, guinea pigs were active most of the time, with comparatively little difference in overall activity levels between periods of light or darkness⁶².
- ii) Behavioural phases of activity have been observed lasting about 70 minutes alternating with similar periods of rest⁷⁸. The rhythm occurred independently of the light-dark cycle and was described as ultradian rather than circadian in character. The total period spent resting was longest in guinea pigs maintained under a light-dark cycle and peaks in activity were reported after lights were turned off and again 8 hours later²⁰. Guinea pigs spend the least amount of time sleeping, compared to other species of rodents in which activity and sleep patterns have been studied⁶² and peaks in activity are apparently associated with light-dark transitions²⁰. In guinea pigs kept under natural lighting conditions, increases in activity are documented during the immediate periods after dawn and after dusk⁵⁴. Similar increases occur in animals in an enclosed facility under artificial lighting with a light/dark cycle, commencing shortly after lights switch on and shortly before they switch off⁷⁹.
- iii) Although individual animals may respond differently, the provision of a light-dark cycle is suggested for housed guinea pigs, regardless of whether or not they exhibit a pronounced circadian rhythm. A cycle of 12 hours light and 12 hours dark is most commonly used for guinea pigs maintained in animal houses under artificial lighting, although a

cycle of 16 hours light and 8 hours dark is also considered satisfactory⁶⁵.

- iv) The occurrence of vaginal oestrus in laboratory guinea pigs raised inside under artificial lighting was found to be correlated with the light-dark sequence of illumination. The influx of leucocytes coincident with ovulation occurred during or soon after the period of darkness. However there was considerable variation between individuals indicating that the timing of ovulation and oestrus may be less influenced by light in guinea pigs than in some other species²⁷. There is no indication that photoperiod influences the reproductive activity of wild guinea pigs (*Cavia aperea*) raised under natural conditions outdoors at a high latitude, or under artificial conditions of simulated long or short day length. In common with some other species indigenous to tropical areas, the wild guinea pig is considered more responsive to changing seasonal conditions affecting the availability of food, than to changing day length⁸⁰.

Recommendation

4.2.1 *A daily cycle ranging from 12 to 16 hours light and 8 to 12 hours dark is recommended for guinea pigs housed under artificial light.*

4.3 Temperature

Principles

- i) Guinea pigs are better adapted to deal with cold than heat. The recommended temperature range for housing guinea pigs is 18°C to 24°C⁴.
- ii) At a room temperature of 17°C to 20°C guinea pigs are active most of the time. They become inactive for long periods of time once the ambient temperature rises to between 25°C and 30°C. At high temperatures, activity occurs in short bursts interspersed with long periods of quiescence, and is reduced by 50% compared with activity at lower temperatures. These observations were made at elevated temperatures over a period of 4 days⁶². Productivity in breeding colonies falls if temperatures regularly rise above 25°C and pregnant females particularly can suffer heat prostration once the temperature reaches 30°C⁶⁵.
- iii) It is reported that prolonged exposure to low temperature (5°C) does not inhibit reproduction in wild guinea pigs (*Cavia aperea*) raised under natural conditions or controlled conditions in the laboratory, but mortality of neonates is greater under conditions of constant low temperature. Although the wild guinea pig is indigenous to tropical and sub-tropical areas, the mean monthly temperature in parts of the animal's natural habitat in Argentina ranges from 5°C to 20°C during

the year⁸⁰. In the laboratory situation, survival of neonates and juvenile guinea pigs declines at temperatures below 17°C⁶⁵.

Recommendations

4.3.1 *A room temperature range of 18°C to 24°C is recommended for housed guinea pigs.*

4.3.2 *Prolonged exposure of guinea pigs and particularly pregnant females, for more than a day to room temperatures above 25°C should be avoided.*

4.3.3 *Prolonged exposure of neonate and juvenile guinea pigs for more than a day to room temperatures below 17°C should be avoided.*

4.4 Humidity

Principles

- i) Guinea pigs are reported to tolerate a relative humidity ranging between 40% and 70%⁴.

Recommendations

4.4.1 *A relative humidity of between 40 and 70% is recommended for housed guinea pigs.*

4.5 Air quality and ventilation

Principles

- i) An air change rate of 8 to 20 changes per hour has been suggested, dependent upon the stocking density and ambient temperature⁶⁵.
- ii) Odours in the environment may influence the behaviour of guinea pigs, affecting their approach to food and, in the case of males, to oestrus females. Compared with females, the behaviour of male guinea pigs appears to be more affected by the presence of unfamiliar odours²².
- iii) The effective ventilation of guinea pig enclosures is a critical consideration in the management of environmental factors. The adequacy of air exchange in the animals' immediate environment of the pen or cage will affect temperature, humidity and air quality. Air exchange rates should be based on the results of appropriate cooling load calculations. The placement of air inlets and outlets in a room and the rate of air exchange will affect the pattern and efficiency of air distribution²³.
- iv) The number of air changes per hour that are needed will in part be determined by the cleaning routine and stocking density of guinea pigs.

Air changes are less important than creating an efficient air flow to keep ammonia levels within the animals' immediate environment of the pen or cage at an acceptable level. Ammonia concentration is dependent upon factors including sanitation, temperature and relative humidity. The concentration of ammonia should not exceed 10 ppm at the time the enclosure is cleaned^{5, 24}.

Recommendations

- 4.5.1 *An air change rate of between 8 and 20 changes per hour is recommended. The number of air changes per hour that are needed will be influenced by the air flow patterns at the level of the pen or cage.*
- 4.5.2 *Concentrations of ammonia should be monitored at the level of the pens or cages or and should not exceed 10ppm by the time cleaning is scheduled to occur.*

4.6 Sound and Vibrations

Principles

- i) Guinea pigs communicate using sound frequencies extending into the ultrasonic range¹⁶ and are therefore probably sensitive to high sound frequencies which cannot be detected by humans (ultrasound). Ultrasound can be produced by common laboratory equipment such as temperature regulating devices, electronic equipment such as computer monitors, video recording equipment and telephones, cage cleaning equipment and vacuum hoses as well as by running water and squeaky door hinges, chairs or trolley wheels. Such sources should be eliminated by routine maintenance wherever possible and offending electrical equipment should be shielded or its use should be avoided in the animal house²³.
- ii) It has been reported that guinea pigs will jump when exposed to sudden very loud noise (139 -143db), exhibit a marked reduction in activity and remain huddled together for up to 30 minutes afterwards⁶.
- iii) Tooth grinding was also observed in male guinea pigs subjected to frequent loud noise over a period of 6 weeks. Compared with unexposed males they had signs of adrenal cortical activity combined with significant reductions in the sizes of the adrenal glands and thymus, indicative of stress. Some of the affected animals also showed signs of constriction indicative of healed ulceration in their stomachs⁷.
- iv) Artificial background noise such as a radio, piped music, a white noise generator, or white noise arising coincidentally from the operation of an air conditioning system, may be of some use in masking sudden noises that occur in an animal house. Although they are not known to be harmful, radio broadcasts, piped music and white noise sources may

be of limited benefit because they do not normally include the very high frequencies that are within the auditory range of laboratory animal species. There is also a risk that increasing the level of background sound to a level that effectively masks other noises may itself have an adverse effect on animals and people working in the facility. A background sound level of 50db(A) has been suggested to avoid disturbance to animals or personnel²³. Human conversation is normally around 65db.

- v) Observations on female guinea pigs exposed to vibration and noise, such as may occur during transport, showed increased respiration rates combined with a marked increase in plasma ACTH and zinc levels, indicative of a response to stress. Peak levels of zinc and ACTH occurred 1 minute and 4 minutes, respectively, after exposure and then decreased gradually over a period of 2 hours. Guinea pigs exposed to noise alone exhibited similar effects, but peak levels of zinc and ACTH were not as high¹⁴.

Recommendations

- 4.6.1 *Sources of noise including ultrasound should be considered when assessing sound levels to which guinea pigs are exposed.*
- 4.6.2 *Potential sources of ultrasonic noise in animal houses should be shielded or avoided.*
- 4.6.3 *The value of sources of background noise for mitigating the effects of sudden loud noises, including ultrasonic noise, is probably limited in animal houses. If a radio, piped music, white noise generator or other sources of background noise are used, the volume of sound from these should not be excessive.*

4.7 Monitoring of environmental variables

Principles

- (i) Air exchange, temperature, humidity, light and noise should be maintained within limits compatible with guinea pig wellbeing and good health¹⁰.
- (ii) Environmental variables of the guinea pigs' living area require regular monitoring. Temperature and humidity should be checked daily. Diurnal variation also should be checked where appropriate.
- (iii) At the pen or cage level, temperature, humidity and air quality are affected by the system controlling the air supply to each room.

Recommendations

4.7.1 *Guinea pig rooms should have temperature and humidity read-outs in a position where staff can easily see them.*

4.7.2 *Sensors should be fitted to monitor and report malfunctions in ventilation, temperature and humidity control on a 24 hour basis, with automatic alarm activation and alerting of appropriate staff.*

4.7.3 *Regardless of centralised computer systems regulating the general environmental conditions, it is still essential to check these variables regularly in the room. Automatic monitoring and control systems should be regularly calibrated and validated at room level.*

4.8 Cleaning

Principles

- (i) A balance needs to be struck between the human perception for the need for cleanliness and the level of disturbance to guinea pigs. The interval between cleaning will depend upon the type of cage or pen used⁶⁵. Cleaning of cages should be done at least weekly or more frequently if necessary⁴.
- (ii) To avoid the need to remove the guinea pigs from their pen and thus reduce the disturbance to the animals, floor pens may be temporarily divided at cleaning time, with the animals herded into one side, behind a removable partition, while the other side is cleaned. Cleaning should be undertaken at monthly intervals and when batches of animals are moved out⁶⁵.

Recommendations

4.8.1 *Depending upon the number of animals housed in cages, it is recommended that cleaning occur at least weekly and more frequently if necessary.*

4.8.2 *Floor pens should be cleaned when each batch of animals is moved out or at monthly intervals.*

5. Records

5.1 Pen / Cage Labels

Principle

i) Animals must be identifiable either individually or in groups¹³.

Recommendation

5.1.1 *Pens and cages should have labels attached to them that provide the following information:*

- *Guinea pig identification*
- *Name, location and contact numbers of the Principal Investigator / Teacher and (if applicable) other investigators / teachers using the guinea pigs*
- *Name, location and contact numbers of staff associated with the housing and care of the guinea pigs*
- *Name and approval number of protocol in which guinea pigs are being used*
- *Age (date of birth) of guinea pigs*
- *Date of entry of guinea pigs into the pen or cage.*

5.1.2 *Health records for each guinea pig should be kept detailing dates of inspection and any adverse events such as injuries, fighting etc.*

5.2 Breeding and Health Records

Principles

- i) Good record keeping is an essential adjunct to good observation. Accurately recorded production data can indicate early changes in the health status of a guinea pig colony that might otherwise pass undetected⁶⁴.
- ii) ARRP Guideline 16: *Supervision of Animal Supply by Animal Ethics Committees* details the types of records that should be kept, and information that should be provided to the Animal Ethics Committee, on animal breeding activities.
- iii) There are a number of breeds of domestic guinea pigs recognised, with the most commonly encountered being the American or English cavy⁴. Commonly used strains developed for use in research, such as the

Dunkin-Hartley and NIH strains are derived from this breed⁶⁵. Animals with short hair and a solid coat colour are known as selfs, while the non-selfs include the breeds with variant coat types and colours. Coat variants include Abyssinians, which have a wire haired coat arranged in whorls and rosettes, Rex, in which the short guard hairs do not appear above the undercoat, Long-haired varieties (including Peruvians, Silkies, Shelties, Coronets and Texels), Crested, Teddy, in which the hair shaft is kinked producing a coat that stands erect all over the animal's body and Satins in which the hair fibres have an unusual structure that produces a pearly sheen. The marked varieties include Dalmatians, tortoiseshells and Himalayans, which are regarded as colour variants rather than distinct breeds²⁶. The need for additional handling to maintain the coat condition, health and hygiene of long haired varieties must be considered in the choice of animals for use in research.

- iv) There is anecdotal evidence of a deleterious genetic combination of satin coat type and beige colour associated with failure to thrive and premature death. This may be due to an immunological defect akin to that documented in mice possessing a similar phenotype. The possibility of deleterious matings needs to be considered in the management of guinea pig breeding programs²⁶.

Requirements

5.2.1 *To assist in monitoring the management of guinea pig breeding colonies, regular reports must be provided to the Animal Ethics Committee, for review, on the fertility, fecundity, morbidity and mortality of all guinea pig breeding colonies. The frequency of such reports should be at least 6 monthly and more often if deemed necessary by the Animal Ethics Committee. (See ARRPP Guideline 16: Supervision of Animal Supply by Animal Ethics Committees)*

www.animaethics.org.au/reader/animal-supply/arrp-supervision-animal-supply.pdf

5.2.2 *The person-in-charge must maintain adequate records to allow effective management of the breeding stock including the detection of the origin and spread of disease. Records should include:*

- (i) *the source, care, allocation, movement between locations, use and fate of all animals;*
- (ii) *details of any diseases;*
- (iii) *the fertility, fecundity, morbidity and mortality in breeding colonies; and*
- (iv) *the health status, genetic constitution and physical environment of the animals (Section 4.5.8 Australian Code of Practice for the Care and Use of Animals for Scientific Purposes¹²).*

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10. *Ibid* Section 4.4.15 , pp 35.
11. *Ibid* Sections 4.4.19 to 4.4.23, pp 35-36.
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