

The Laboratory Guinea Pig

Rodent Users Wetlab

Administered by
Laboratory Animals Centre
National University of Singapore



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THE LABORATORY GUINEA PIG

Kingdom: Animal
 Phylum: Chordata
 Class: Mammalia
 Order: Rodentia
 Suborder: Hystricomorpha
 Family: Caviidae
 Genus: *Cavia*
 Species: *porcellus*

Introduction

The laboratory guinea pig was derived from domesticated stocks of wild guinea pigs (*Cavia cutleri*) which originated in Peru, South America. In South America the guinea pig was and still is raised as a source of meat. These animals were bred for show and fancy, and kept as pets for up to 300 years before their introduction into biomedical research. Many of the laboratory strains used today originated with the breeding work of Dunkin and Hartley in 1926. Sewell Wright used the guinea pig to study genetics and was responsible for developing a number of the inbred strains.

Guinea pigs are *hystricomorph* (hedgehog-like) rodents and are more closely related to porcupines and chinchillas than to mice and rats. The bodies of guinea pigs are stocky and compact, and their legs are short. Unlike most other rodents they have no tail. Four coat types are recognized in the guinea pig. The “English” guinea pig has short, smooth hair, and is the most commonly encountered type in the laboratory setting. The “Abyssinian” guinea pig has a coarse, short hair coat with the hair forming whorls or rosettes. The “Peruvian” guinea pig has a coarse, long coat, while the “Angora” or “silky” guinea pig has a fine, medium-length coat of hair. Guinea pigs may be monocolored, bicolored, or tricolored.

The *Dunkin-Hartley* and *Hartley* stocks remain the major outbred stocks of guinea pigs used in the United States today. These guinea pigs are of the short haired, English type. The *Pirbright-Hartley* is an outbred stock used in England, which is the same type of animal. Of the original 20 or so inbred strains of guinea pigs, only two remain today, *Strains 2 and 13*. The inbred strains are used when defined genotypes are required for a study or to propagate oncogenic leukemia viruses.

Female guinea pigs are referred to as sows, and the males are called boars. Guinea pigs can live up to 8 years, although 5 years is the average lifespan. The weight of mature females ranges from 700-850 g, and from 950-1200 g for adult males.

Behavior

If handled gently, guinea pigs make good pets and are easy to work with in the laboratory. They rarely bite or scratch, and respond to frequent and gentle handling. Guinea pigs are active during daylight hours. They are generally calm animals, but are also sensitive and are easily excited by loud sudden noises, fast movements, and changes in their environment. Guinea pigs tend to freeze when they hear unfamiliar sounds, and may remain immobile from several seconds to 20 minutes. They also exhibit a *Preyer or pinna reflex*, that is, they will cock their ears in response to sound. Conversely, they tend to run and scatter when they see sudden movements. This scattering behavior can involve “stampeding”, jumping, or rapid circling of the cage. Care should be taken to avoid inducing guinea pigs to stampede if very young animals are present within the group as they may be trampled and injured by the adults.

Guinea pigs are communal animals that generally live together peacefully. Animals that are group-housed establish male-dominated social hierarchies, and once this hierarchy is formed the group is generally stable. Introduction of a new male into a stable group can lead to fighting, and should be avoided whenever possible. Dominant animals will frequently “barber” or chew off the hair of subordinate animals. This results in a patch of hair loss with the underlying skin having a normal appearance. Barbering is also associated with boredom or the stress of overcrowding. Adult boars may sometimes chew on the ears of young within the group. In addition, fighting animals may have bite wounds on the ears or back.

Vocalization among group members is important in their social interactions, and at least 11 different vocalizations have been recorded. Guinea pigs whistle in anticipation of feeding, chut and purr during social interactions, and scream when injured or fearful.

Housing

Guinea pigs may be housed in solid-bottom cages such as shoebox cages or tubs, or on wire mesh cages. The use of wire mesh should be avoided unless the animals were raised on this type of flooring; guinea pigs unaccustomed to wire mesh may lacerate or break limbs walking or running on the mesh when their feet get entangled. Solid-bottom cages with adequate bedding are the preferred method of housing these animals. Tops are not required for the cages as guinea pigs seldom jump or climb, but the cages should be at least 25 cm high. Rectangular cages are preferred to round to decrease the incidence of stampeding. Bedding materials should be as dust-free as possible, and wood shavings, corn cobs or shredded paper are acceptable. Cedar shavings should not be used as the dust may cause respiratory problems.

Cage space requirements for guinea pigs are listed in “*Guidelines on the Care and Use of Laboratory Animals for Scientific Purposes*” (NACLAR, 2004). Animals weighing up to 350 grams require 387 square cm of floor space per animal, and animals weighing more than 350 grams must have at least 651 square cm of space each. Nursing females with their litters also require a minimum of 651 square cm. The minimum height for cages for all sizes of guinea pigs is 17 cm. Unweaned guinea pigs should not be housed with adult animals other than their own parents unless harem breeding is being practiced.

The temperature range listed for guinea pigs in the NACLAR Guidelines is (18-26°C). The optimum temperature for guinea pigs is about 21°C. Lower temperatures may decrease the survival rate of newborns, and the combination of low temperatures and wet bedding often results in respiratory disease. High ambient temperatures without adequate airflow predispose the animals to sterility and heat stress; the compact, stocky body of the guinea pig does not dissipate heat very well. Guinea pigs housed singly in wire bottom cages will require a slightly higher room temperature than those housed in solid bottom cages or with other individuals. The relative humidity of animal housing areas should be between 30% and 70%. Air changes should be in the range of 10-15 per hour to reduce odors and ammonia levels. A 12:12 light:dark cycle is commonly used in the guinea pig housing areas.

Guinea pigs should never be housed with animal species such as rabbits, dogs, and cats because they carry the bacterium *Bordetella bronchiseptica* as a subclinical infection. This infection results in pneumonia and is lethal in guinea pigs. Areas housing guinea pigs should be visited or cared for prior to handling rabbits, cats, and dogs.

Primary enclosures (i.e. the cage) must be sanitized at least once every 2 weeks. Animals in cages becoming overly dirty before this time period must be transferred to clean cages. A de-scaling treatment may be required to remove adherent urinary salts from cages before they are washed.

Diet and Nutrition

Like humans and nonhuman primates the guinea pig is unable to synthesize its own vitamin C, thus, it must be supplied in the diet. It is extremely important to store food properly and use it within 90 days of the milling date. If the amount of vitamin C in the diet is questionable, ascorbic acid may be added to the drinking water. Fresh fruits and vegetables are rich in vitamin C, such as kale, parsley, beet greens, kiwi fruit, broccoli, oranges, or cabbage, may also be offered as treats (not to exceed 10-15% of the diet's weight). Fresh foods must be washed well before feeding as they may be contaminated with pathogenic organisms such as *Salmonella*. Any uneaten fresh foods should be promptly removed from the cage.

Guinea pigs are strict herbivores, and a pelleted, alfalfa-based diet is generally fed in the laboratory setting. Self-feeders such as those of the J-style are preferred to avoid contamination with bedding and feces. Bowls of food placed on the floor of the cage are quickly contaminated as the guinea pigs tend to sit in them and defecate while they are there. Guinea pigs consume an average of 6 g of food/100 g body weight daily. Rations for guinea pigs usually contain 20% protein due to the high requirement they have for certain amino acids.

Guinea pigs are strongly *coprophagic*, eating feces directly from the anus or the cage floor. The feces contain essential vitamins produced by the fermentation of feed by microorganisms within the cecum.

Fresh water should always be available and may be offered by bottles with sipper tubes or automatic waterers. Bowls of water placed on the cage floor quickly become contaminated with feces and bedding. Adult guinea pigs drink an average of 10 ml/100 g body weight per day. Guinea pigs are untidy drinkers, and tend to chew on and play with sipper tubes and valves, resulting in a significant amount of water waste and wet cage bedding. These habits may also result in dehydration if the guinea pigs drain their entire bottle of water. They may also blow food into the sipper tube and foul the entire bottle of water. If automatic waterers are used they must be checked frequently to ensure that they are not blocked with food debris. Animals accustomed to drinking from bowls may become dehydrated if switched suddenly to sipper tubes or automatic waterers. It is best to include both sources of water within a cage when a change is being made so that the animals learn to drink from the tubes or automatic waterers.

Guinea pigs are fastidious eaters, and their eating habits, likes and dislikes are established within the first few days of life. They may refuse to eat or drink if either the feed or the feeders are changed. This may be dangerous, especially for pregnant sows.

Special Anatomical and Physiological Characteristics

Guinea pig teeth are “*open-rooted*” (*hypsodontic*) and erupt continuously, therefore, the teeth must be well-opposed in order to keep them worn to a normal level. Animals whose teeth overgrow are said to have “malocclusion”, and these animals may starve to death because they are unable to chew food. This condition is often inherited, and these guinea pigs should not be used as breeding stock. In addition, malocclusion may be the result of a vitamin C deficiency during early life. The premolars (cheek teeth) are most predisposed to this problem in the guinea pig. The dental formula is I(1/1) C(0/0) P(1/1) M(3/3). Guinea pigs are unique among rodents in that they have premolar teeth.

Guinea pigs have sebaceous glands located circumannally and on their rump. These glands are used for scent marking, and the guinea pigs may often be seen to walk or sit with these glands pressed against a surface.

Both male and female guinea pigs have a pair of inguinal nipples; the sow's nipples are longer and more prominent. Despite having only two mammary glands, guinea pigs can raise litters of four and more young.

Unlike mice and rats, guinea pigs have little difference in the anogenital distance. The penis can be palpated under the skin of the inguinal area and can be protruded by manual pressure. The boar has no break in the ridge between the urethral-penile opening and the anus. The sow has a Y-shaped genital-anal opening. The vulvar opening is represented by the branches of the Y, and is sealed with a *vaginal closure membrane* except during estrus and parturition.

The urine is normally yellow and somewhat cloudy. It has an alkaline pH of 8-9 and contains crystals.

Guinea pigs have 4 digits on the forelimbs and 3 digits on their hind limbs.

Breeding and Reproduction

Sows are usually bred at 2-3 months of age, which generally corresponds to a weight of 350-450 grams. It is important that sows be bred prior to 7 months of age to prevent permanent fusion of the pelvic symphysis, which often results in dystocia. Boars are usually bred at 3-4 months of age, or 600-700 grams body weight. The breeding life of the sow is from 18 months to 4 years of age. Outbred stocks of guinea pigs have better reproductive performance than do the inbred strains. Inbred strains in general have decreased vigor, reproductive potential, and fertility.

The sow is a non-seasonal, polyestrous breeder with an estrous cycle of 15-17 days. Detection of estrus is not necessary unless timed breedings are required. A post-partum estrus occurs 2-15 hours following parturition, and 60-80% of sows housed with males will become pregnant at that time if bred. Ovulation is spontaneous, and occurs approximately 10 hours after the beginning of estrus. The total length of estrus is about 50 hours, with the female being receptive for about 15 hours, usually between the hours of 5 PM and 5 AM. Females in estrus exhibit the *copulatory reflex*, which is arching and straightening of the back with elevation of the perineal area.

Guinea pigs may be pair-housed or placed in harems (one male and up to 10 females) for breeding. Harem breeding arrangements should not contain more than one male to avoid fighting. Sows in advanced pregnancy may be removed from harem systems and returned after the young are weaned. The young are raised communally in harem systems.

Mating may be detected by either the presence of sperm in the vaginal tract or by the presence of a vaginal plug. The plug is formed in part by the secretions from the coagulating glands of the male. After a few hours the plug falls out and may be observed as a waxy mass on the cage floor. The presence of plugs is an efficient method of predicting pregnancy.

The gestation period lasts 59-72 days, with an average of 68 days. The weight of the uterus increases from 2 g to 300 g, and the weight of the sow is often doubled in advanced pregnancy. Fetal masses are palpable at about 15 days. Approximately 2 weeks before parturition the pelvic symphysis degenerates and begins to separate; the width of the separation can be used to estimate the time of birth. Delivery of the young occurs in about 30 minutes. The sow eats the placenta and cleans the young, but rarely cannibalizes dead or live neonates. Litter size ranges from 2-5. Guinea pigs do not build nests. Separation of the symphysis returns to normal 24 hours after delivery.

The offspring of guinea pigs are said to be *precocious*, that is, their eyes and ears are fully open, they are covered with hair, and they are capable of keeping up with the adults. The birth weight is approximately

70-100 g, and young that are 60 g or less are not likely to survive. Although the young nurse the sow, they are capable of eating solid foods almost immediately. Young guinea pigs that do not receive the sow's milk during the first 3-4 days of life may not survive. Young will nurse mothers other than their own, which may present a problem when guinea pigs of various ages are present. Milk supply does not increase with demand, and older guinea pigs may strip the sow of milk. The young are weaned at 14-28 days and are approximately 150-200 g at that time. During the first week of life, guinea pigs are incapable of voluntary micturition (urination) and defecation on their own and depend on licking of the perineal area by the mother to stimulate such reflexes. If the young must be hand-reared, the caretaker must massage the perineal area of the pups several times daily to stimulate these functions.

Common causes of death within a breeding colony are uterine hemorrhage, pregnancy toxemia, dystocia, and exhaustion from prolonged labor.

Handling, Restraint, and Identification

Guinea pigs should be handled gently but firmly. They should be lifted by grasping under the trunk with one hand while supporting the rear quarters with the other hand (Figure 3). It is particularly important to support adults and pregnant animals. Do not hold a guinea pig too firmly around the thorax or abdomen or breathing can be impaired or the lungs or liver may be damaged.

Cage cards may be used to identify singly-housed animals. Coat color patterns can be used to identify individuals. Permanent identification of an individual can be accomplished by the use of ear notching, ear tagging, tattooing, or microchips. Dyes and markers can be used for temporary identification.

Blood Collection

The amount of blood needed and other factors will govern the method and sites of collection. The area of collection should be preferably be cleaned with alcohol or other appropriate disinfectants. Some blood sampling procedures will require sedation or anesthesia while others may be carried out without anesthesia provided that suitable restraint is used. Always apply pressure to the site after blood collection to enhance hemostasis.

- Lateral Saphenous Vein: A small amount of blood can be obtained via the lateral saphenous vein (using a 22-23 gauge needle) while applying pressure in the thigh region to create venous stasis.
- Cranial Vena Cava: This is an acceptable site if you need to collect more than a one milliliter of blood repetitively. Animals must be anesthetized and restrained in dorsal recumbency. The manubrium of the sternum is palpated and needle is inserted lateral to the manubrium under the first right rib at a 30 to 35 degree angle to the horizontal axis of the animal. Insert a 22-23 gauge needle at the site, apply slight negative pressure and slowly withdraw until blood flows. If not blood is obtained, withdraw the needle and start over. **Do not try to reposition the needle while inserted to avoid laceration of vessels and other vital structures.** Blood should be withdrawn slowly, and the amount must be limited (up to 7 ml/kg in an adult guinea pig) unless euthanasia is indicated.
- Cardiac Puncture: This is another accepted method of blood collection from guinea pigs when more than a few drops are required. However, this method also carries considerable risk to the animal and occasionally deaths occur. **It is not recommended as a repetitive blood sampling procedure.** Animals must be anesthetized and restrained in dorsal recumbency. Use a 20-22 gauge needle and insert it under the xyphoid cartilage slightly to the left of midline. The needle is advanced at a 20 to 30 degree angle from the horizontal axis to the sternum to enter the heart.

Aspirate lightly while advancing the needle. Blood should be withdrawn slowly, and the amount must be limited (up to 7 ml/kg in an adult guinea pig) unless euthanasia is indicated.

If you are planning to perform any surgery on your guinea pigs, you are required to attend the “Aseptic Surgery” component of the RCULA course which covers fundamentals of surgery including aseptic techniques, anaesthesia regimes, suturing, post-operative care and analgesia etc. For more information on course schedule, please contact Miss Tjou Yanqiu (ahuty@nus.edu.sg) and tel: 6516-6991.

Common Health Problems

Scurvy is the result of inadequate vitamin C in the diet. Signs of scurvy usually appear 2 weeks after guinea pigs have been deprived of vitamin C. Clinical signs include reluctance to move, unkempt appearance, swelling around the joints, pain upon movement, and sometimes hemorrhage. Affected guinea pigs should receive 50 mg/kg ascorbic acid daily until recovery is evident. Deficiencies in young animals may result in permanent skeletal defects.

Water deprivation with resulting dehydration and death may occur if animals are switched to unfamiliar watering systems. It may also be the result of a plugged water source, or territorialism by dominant individuals who prevent subordinates from drinking.

Dystocia (difficulty giving birth) may be the result of failure of the pubic symphysis to separate, excessively large or malformed fetuses, a large litter, obesity, pregnancy toxemia, or uterine inertia. Normal parturition occurs quickly, with a few minutes between the delivery of each pup. Guinea pigs should deliver their young in about 30 minutes, and may require a Cesarean section if they do not. Sows experiencing dystocia are depressed and may have a bloody or discolored vaginal discharge.

Pregnancy toxemia may occur in late pregnancy. It may be precipitated in obese sows during late pregnancy when the sows stop eating, due to changes in the feeding routine or other stressors. Affected animals become depressed, comatose, and die within 5-6 days; treatment is not usually successful. Prevention includes controlling food intake to prevent obesity and keeping other factors in the environment constant.

Heat stress is easily induced in guinea pigs because their body shape prevents dissemination of heat. Clinical signs include excessive salivation, rapid shallow breathing, hyperemia (redness) of the extremities, and elevated body temperature. Treatment consists of cooling the animal, and giving supportive nursing care.

Ulcerative pododermatitis, or “*bumblefoot*” occurs when lacerations on the feet become infected with bacteria. Predisposing factors include obesity, housing on wire flooring, and poor sanitation. Swollen, painful lesions develop on the bottom surface of the forefeet. Treatment consists of cleaning and bandaging the feet, and housing affected animals in solid bottom cages with soft, deep bedding.

Cervical lymphadenitis, or “*lumps*” is caused by bacterial infection of the lymph nodes in the neck. The lymph nodes will be swollen, but otherwise the affected animals do not appear to be ill. Treatment consists of drainage of the lymph nodes and administration of antibiotics.

Alopecia is common in guinea pigs, and may be the result of hair pulling or barbering by cagemates. Sows in advanced pregnancy and those nursing litters often have a loss of hair over the back and rump. Weanling animals also have a thinning of the hair during the transition time from “baby fur” to a more mature hair coat.

Euthanasia

Suitable methods for euthanasia include an overdose of carbon dioxide, pentobarbital (150-200 mg/kg) or other injectable euthanasia agents given by the intravenous or intraperitoneal routes. It is the responsibility of the investigator to ensure that the animal is dead before disposing of the carcass. Cessation of the heartbeat is used to determine that the animal is no longer alive if the thoracic cavity has not been opened.

Occupational Health Concerns

Diseases of public health significance in guinea pigs are rare. The most commonly encountered problem is the development of allergies to guinea pig dander and proteins. This problem can be minimized by wearing protective clothing (lab coat, gloves, and mask) when handling animals or cleaning cages. Wash well with soap after handling animals to remove proteins from the skin. Development of allergies should be reported to your supervisor.

Although guinea pigs rarely bite, tetanus immunizations should be current as a bite could result in a deep puncture wound. Anyone being bitten by a guinea pig should immediately report the injury to any of our laboratory officers in the respective facility. You must also report the injury immediately to the University Health and Wellness Centre, which is located at the Yusof Ishak Hall, Level 4. The phone numbers are 6776-1631 (Nurses Station) and 6516-2880/6516-2390 (Admin Office). For on-campus emergencies and after office hours, please proceed to NUH Accident and Emergency Unit.

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