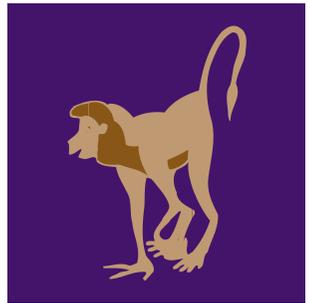
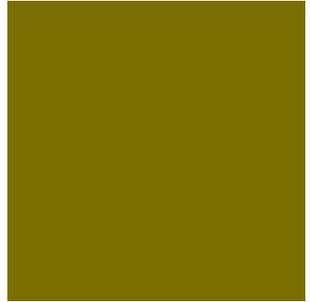


Macaques

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AAALAC International



enrichment
for nonhuman primates



Introduction

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Nonhuman primates maintained in captivity have a valuable role in education and research. They are also occasionally used in entertainment. The scope of these activities can range from large, accredited zoos to small “roadside” exhibits; from national primate research centers to small academic institutions with only a few monkeys; and from movie sets to street performers. Attached to these uses of primates comes an ethical responsibility to provide the animals with an environment that promotes their physical and behavioral health and well-being. Thus, an obligation is entailed that those individuals/institutions caring for captive primates should make every effort to ensure adequate veterinary care and husbandry are provided, that the animals are housed in appropriate facilities, and that as broad a range of species-typical behaviors are able to be expressed by the animals as is possible for the captive environment.

This book serves as an introduction to the basic behavior and environmental enrichment of several species of nonhuman primates that are more commonly used in education, research and entertainment. In many ways, this book is meant to be a “how to” manual; it is not intended to be a broad scientific review of the primate behavior and enrichment literature. The fundamental premise taken throughout each chapter is that for an enrichment program to be effective, there must be a basic understanding of the biology and behavior of the primate species. The species addressed in this series are: baboons, capuchins, chimpanzees, macaques, marmosets and tamarins, and squirrel monkeys. Each species-section can be read as a stand-alone document without need to reference the other sections. This then allows the user to distribute the different sections to personnel caring for the specific animals.

Each section is divided into five parts: 1) Background, comprised of the habitat of the primate, the physical features of the primate, its psychological and/or so



social behavior, and its mating and reproductive behavior; 2) Social World; 3) Physical World; 4) Special Cases, describing any age-related considerations and concerns associated with individual housing; and 5) Problem Behaviors. The content of this series has been provided by members of the Association of Primate Veterinarians (APV) and the American Society of Primatologists (ASP) who have special expertise in the species addressed. This book is intended to be a primer because it is, indeed, an introduction to the subject of environmental enrichment for primates housed in a diversity of conditions. A list of references and/or other resources (principally on-line) is provided at the end of each chapter that provide additional guidance. The use of scientific references has been limited, but should the reader desire more information about a specific subject, the links at the end of the sections will provide direction to obtaining additional detailed information. Readers are also directed to the National Research Council publication, the Guide for the Care and Use of Laboratory Animals (1996) and the U.S. Department of Agriculture's (USDA) Animal Welfare Regulations to review the regulatory requirements of the Public Health Service and the USDA for the provision of environmental enrichment.

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ii

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Editor, Working Group

This project is dedicated to the memory of Dr. Sylvia Taylor, Veterinary Medical Officer, Animal Care, U.S. Department of Agriculture, who was a proponent of providing enrichment to nonhuman primates and was generous in sharing her knowledge and expertise in this regard.

Macaques

Background

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Habitat

The macaques represent a collection of approximately 20 species of monkeys, most of which are found in Asia. They occupy a wide geographic range that is considered second only to man in its extent. In this range, the habitat occupied by macaques varies from near desert to rainforest, and from sea level to snowy mountain tops. Some macaques spend the majority of their time in trees, while others are predominantly ground-dwellers. Many live in close proximity to human beings; the rhesus monkey is sacred to Hindus and is often found near temples in India and Nepal.

Physical Features

In general, the macaques have a medium-sized body, with a stocky build. Animals belonging to the smallest species weigh approximately 13 pounds, while representatives of the largest species weigh an average of 40 pounds. Tail length varies among the different species. All macaques have long, sharp canine teeth and finger nails that can pose a risk to human handlers through either bite or scratch wounds. They also have cheek pouches and a fully opposable thumb. The opposable thumb gives these animals the ability to manipulate objects (e.g., cage latches) with great precision. They feed on both animal and vegetable resources and have a highly varied diet. Macaques are primarily active during the daylight hours, and most species sleep in trees at night.



Rhesus (Macaca mulatta) monkey with cheek pouches full of food (photo courtesy of K. Bayne).

Behavior

As a rule, the macaques are social animals, living in groups of multiple males and females; the sex ratio typically reflects more females than males in a group. Even for the same species, group size tends to be smaller when the home range size is also smaller (e.g., when constrained by human activities). Within these groups, individuals are ranked according to dominance (hierarchies), with the higher ranking animals doing more of the successful breeding and having first access to food and other desirable resources. Often it is the rank of the mother, rather than the father, that determines the rank of offspring. Young males may be evicted from their birth group as they approach puberty, forming temporary “bachelor” groups until they join a new group. Wounding of animals can occur when challenges for dominance occur.

Because these animals rely in large part on visual communication, they use a number of facial signals, often accompanied by vocalizations, to threaten or to make friendly overtures.

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Threat displays include opening the mouth in the shape of an “O”, a direct stare, raising the eyebrows quickly and repeatedly, flapping the ears, a jerky head-bob, shaking an object in their environment such as a tree branch or cage door, slapping the ground, or charging with intent to fight. Occasionally, a lack of compatibility between animals can be detected simply by the increased physical distance maintained between them. Behavioral indicators of compatibility between animals include social grooming, lip-smacking, and sitting in close proximity. Food sharing has also been used to assess compatibility between pairs of animals.



*Social grooming is an integral part of forming affiliations
(photo courtesy of K. Rasmussen).*

Mating and Reproduction

The reproductive cycle of macaques is characterized by a seasonal estrus period, with menstrual cycles occurring throughout the year. Females have been reported to begin cycling as early as approximately 1.5 years, although a more typical age is 2.5 years. Most species of macaques exhibit swelling and reddening of the skin of the rump, perineum, and occasionally arms, legs and face (referred to as “sex skin”). The swelling and reddening becomes more pronounced from beginning to end of the menstrual cycle. Exceptions to this are bonnet macaques and toque monkeys, who do not have marked sex skin. Menopause occurs in the macaques, with the number of menstrual cycles decreasing each year when the animal reaches her third decade of life.



Social defense of territory (photo courtesy of K.Rasmussen).

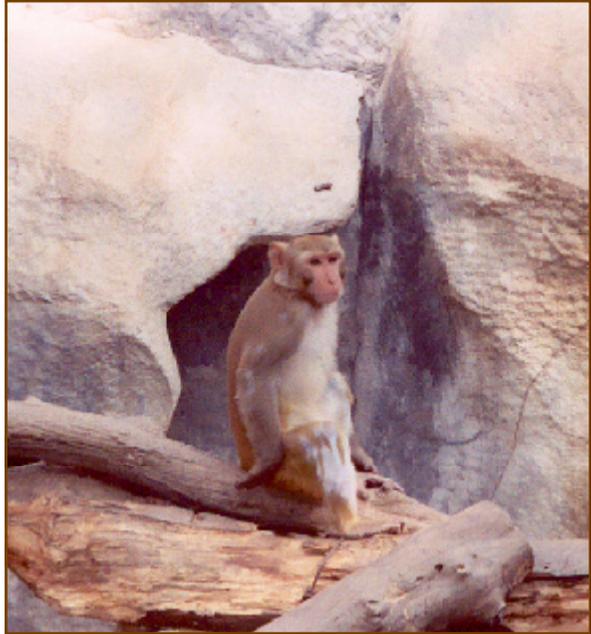
In general, the female actively solicits mating by the male (again, the bonnet macaque is an exception to this). Usually, the dominant males in the group breed the females more often, although less dominant males in a group have been reported to breed and reproduce successfully. The rhesus monkey’s gestation period is between five and six months. The infant is quite dependent upon the mother, and the current preference is to leave the infant with its mother until approximately one year of age to help ensure adequate development of social, particularly maternal, skills by the developing infant.

Social World

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Because of the intrinsic social nature of macaques, pair or group housing of compatible animals is extremely important. It is well-known that raising a macaque alone, without the company of other macaques of the same species, will result in that animal expressing a pattern of abnormal behaviors that can become self-destructive. Even the behavior profiles of adult animals housed alone can degenerate into inciting these abnormal behaviors, which may include repeated pacing, circling, or somersaulting; hyper-aggression; depression; and self-injurious behavior, including hair plucking or self-biting. (See section on “Problem Behaviors”).

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Evidence of hair-plucking behavior, a type of self-injurious behavior (SIB) on the leg of this macaque (photo courtesy of K. Bayne).

While group or pair housing is strongly recommended for macaques, care should be taken in doing so. Since these primates establish dominance hierarchies and space is limited in captivity, the macaque wishing to flee the dominant animal has no place to fully escape. This can result in unresolved, increased aggression between the animals as well as wounding (and possibly killing) of one or more animals.

Larger groups of animals that previously have been living in smaller stable cohorts should not be formed, because this will increase fighting between the smaller, pre-established groups. A better approach is to place unfamiliar animals together in a new enclosure at the same time. In this way, coalitions have not already been formed, and each macaque must establish its own place in the hierarchy without support from other animals.

One approach to forming pairs of macaques is provided at the end of this chapter. The key steps include the following:

- Introducing the animals into an area that they do not consider as their territory
- Assessing facial expressions, postures and physical distance between the animals
- Proceeding slowly in forming pairs
- Planning ahead to have a way of separating animals should the fighting become intense (e.g., a panel to slide between cages, use of water, etc.)
- Ensuring the safety of people performing the animal introductions
- Providing ongoing monitoring of animal interactions, because animal relationships can change over time



Offering vulnerable areas of the body to be groomed by another animal indicates a degree of trust and affiliation between the animals (photo courtesy of K. Bayne).

Using the natural social structure of the macaques will assist in forming compatible



pairs or groups of monkeys. For example, because macaques will form bachelor troops, often males can be pair-housed successfully. Successful pairings of a young macaque with an older animal (so that the dominance hierarchy is clear and fighting is minimized) also have been reported.

Providing three-dimensional space in the primary enclosure, using Primahedrons® (photo courtesy of K. Bayne).

Physical World

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Housing

Macaques have been housed successfully in a variety of types of housing, including island environments, corrals, corn cribs, indoor-outdoor runs, pens and cages. Regardless of the enclosure design or size, it must be sturdy enough to withstand being shaken and chewed on by its inhabitants. Because of the animals' tendency to flee upward when escaping a perceived threat, they benefit from perches, shelves or other structures that increase the three-dimensional space of the enclosure. Generally, older macaques prefer a non-moving shelf or perch, while the younger ones will readily use swings. Because macaques can strangle on lengths of chain, swings should be short in length and/or constructed of materials that cannot loop around the neck, such as flexible polyvinyl chloride (PVC) tubing. Similarly, ropes can be picked apart or chewed on, and this may result in a gastric obstruction. Thus, in most cases, ropes of cotton, sisal or jute should be avoided.

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6 In general, macaques should not be exposed to cold or wet weather without a method for them to conserve body heat. Japanese macaques living in the snowy mountains of Japan manage to stay warm by soaking in natural hot springs. A number of captive macaques, however, have lost parts of their tails or one or more digits to frostbite. This problem can be reduced or prevented by providing them with supplemental heating or a shelter.



A horse water trough, shown here, serves as a swimming pool for young macaques (photo courtesy of K. Bayne).

During conditions of high heat and humidity, macaques may overheat if they undergo a physical stress, such as being chased around an enclosure. Providing macaques with a shallow and indestructible pool in which to swim and cool off can be an asset to macaques housed outdoors in warmer climates. The swimming pool should be shallow, to prevent animals from drowning, and resistant to deterioration from chewing. The pool should be cleaned routinely to provide animals with good quality water for swimming.



Flexible PVC tubing can be installed in the primary enclosure to simulate branches for swinging (photo courtesy of K. Bayne).

Enrichment

The macaques are curious and intelligent animals. Providing them with opportunities to investigate and explore their environment is enriching for them. This can be accomplished by maintaining toys in the animals' enclosures. Since macaques have color vision, the toys (also known as manipulanda) should be of different colors; they can also be of different shapes and texture. Because the monkeys will chew on these toys, they should be relatively durable, such as heavy-duty dog toys. Toys should be removed from the enclosure when they become sufficiently damaged that the primate might swallow or choke on a piece. Rotating different toys in the enclosure and removing them periodically will help to keep the toys novel and increase the animals' interest in them.



A variety of toys used with macaques (photo courtesy of K. Bayne and S. Dexter).



The damage inflicted on toys after usage by macaques. Small remnants can pose a choke hazard to the animals (photo courtesy of K. Bayne and S. Dexter).



Food treats may be dispensed from puzzle balls (photo courtesy of K. Bayne and S. Dexter).

A very successful way to fulfill these animals' inclination to explore and investigate is to give them the opportunity to forage (or search) for food. Since many primates will spend up to 70% of their waking hours in foraging-related activities, offering captive primates the opportunity to engage in this behavior can be important in preventing the development of abnormal behaviors. Numerous in-house and commercially produced devices are avail-

able, including toys that simply hold the food item and require the monkey to fish for or push it out. Also available are containers with finger holes or slots through which the monkey removes the food item, as well as puzzle boards in which the monkeys must manipulate the food item though a maze before it reaches a hole large enough from which the food can be retrieved. Food may be hidden throughout the enclosure to encourage searching behaviors. Food items may also be ground up into small pieces or pre-purchased as "crumbles" and then placed on an Astroturf® or artificial fleece foraging board. The small size of the food particle encourages manual dexterity and extends the amount of time the animal spends searching for and eating the food. Food treats, as enrichment, should not be offered in such quantity that the animal ignores its more nutritional daily diet or gains excessive weight. Many commercially available food treats come in a variety of flavors and are nutritious.



Wedging food treats inside a Kong® toy is another way to extend the animal's time spent in "foraging" (photo courtesy of W. Brandon).



This animal forages for food “crumbles” in an artificial shearling foraging/grooming board (photo courtesy of K. Bayne).

Special Cases

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Age-related Considerations

The macaques are long-lived animals, with reports of some animals living in captivity over 30 years. This lifespan entails a commitment of considerable duration, with substantial, changing needs of the animal over the course of its life. As with other species of primates, the design of the environment should take into account the age of the macaque. For example, older monkeys will develop arthritis, limiting their ability to jump onto perches, swing, or otherwise navigate their enclosure. Older primates can also have reduced vision capabilities, thus further limiting their ability to move around the enclosure and interact with other animals or people.

Conversely, young animals are very active and curious. The enclosure design should allow them to express these characteristics without compromising their physical safety. Young animals also are particularly sensitive to the effects of social deprivation and should be housed with other primates of the same species whenever possible.

Individual Housing

The circumstance in which only one macaque is housed on the premises should be avoided. If several macaques are housed individually in cages, they should

be able to see, hear and smell each other. If possible, individually caged animals also should have access to visual barriers in order to avoid being seen by other animals, should they so choose. It is recommended that if an animal cannot be socially housed, other forms of enrichment (e.g., toys, foraging opportunities) should be provided to compensate for the lack of social stimulation.

Susceptibility to Disease

Because of their close genetic relationship to humans, nonhuman primates can be susceptible to human diseases. Of particular concern is the exposure of macaques to tuberculosis from a human. Tuberculosis is a highly contagious, fatal disease in Old World Monkeys. Routine testing of the animals is highly recommended. Macaques are also susceptible to measles virus, and will show a rash similar to that of people having the disease. Most colonies of macaques are vaccinated for measles virus. Because numerous individuals may be assisting with the enrichment program (including volunteers), close attention should be paid to the possible transmission of diseases from humans to macaques.

Problem Behaviors

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The most appropriate behavioral management program houses macaques in a sufficiently enriched and safe environment to prevent the development of abnormal behaviors. Nevertheless, personnel caring for macaques should be adequately trained and able to recognize the occurrence of abnormal behavior in macaques. It is important to note that not all macaque species exhibit the same types of abnormal behavior or to the same degree. Some abnormal behaviors are initially quite subtle in their expression, but over time can become more obvious and harder to stop. Abnormal behaviors include repetitive movements, such as pacing, circling, rocking, spinning, somersaulting and bouncing. Cage-licking, self-clasping, self-sucking, masturbation, “saluting,” and eating feces are some other aberrant, repetitive behaviors. Abnormal behaviors in macaques also can hurt or injure the animals, as in the case of hair plucking, self-biting and head banging.

Abnormal behaviors are an undesirable consequence of captive housing, reflecting an inadequate environment for maintaining the animal. Preventing the development of abnormal behaviors is critical, because they are difficult to stop once they start. In some cases, socially housing an animal that previously was singly housed can decrease the expression of abnormal behaviors, presuming that the animals are compatible. Progress has been made in reducing the occurrence of hair-plucking behavior by providing the animal with a fleece covered Plexiglas® board or coconut, thereby giving the monkey something else to pluck. However, redirection of an abnormal behavior is not a “cure” and should only be regarded as a temporary correction. Although occasionally self-biting behavior can be redirected to a toy, recent evidence has shown that some drugs will reduce the occurrence of this behavior more reliably. In this case, the veterinarian should be consulted.

Safety Issues

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In general, the least amount of restraint necessary to accomplish the task should be used when working with macaques. However, because macaques can seriously threaten people’s safety, the method of restraint should also ensure the safety of both the personnel and the animal. Restraint can be achieved by hand (e.g., with younger animals), by the use of various drugs such as ketamine hydrochloride, or by the use of equipment such as transport cages, the pole and collar system, or tunnels to move animals from one location to another. Macaques can be trained to cooperate in a variety of procedures, thus reducing the amount of restraint necessary. Examples include training the animals to move into a transport box to be removed temporarily from their home cage or training an animal to extend its arm or leg for a blood sample to be withdrawn. Such training is an important part of the enrichment program as it gives the animal some control over the situation and reduces the stress the animal might otherwise experience during basic husbandry and medical procedures in which it was not actively cooperating. Appropriate protective equipment, including gloves, mask, eye protection, etc., should be worn when working closely with macaques.

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In addition, the provision of many types of enrichment devices involve either attaching the device to the cage, reaching into a cage to place the enrichment, or entering the primates' enclosure. These can place the individual at risk of being grabbed, bitten, or scratched. Macaques are a frequent carrier of Herpes B-virus, which is asymptomatic in the animals but can be fatal to humans. This viral infection can be transmitted from animal bites, scratches, splashes, needle stick injuries, and other contact with mucous membranes or broken skin with infected body fluids (e.g., saliva, urine) from the monkey. Personnel should wear appropriate protective equipment, concomitant with the potential for exposure.



A transfer cage is placed against the door of the home cage, which is then opened, to move an animal without hand restraint or the use of drugs (photo courtesy of S.Dexter).

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12

Resources

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National Research Council. 1998. *The Psychological Well-Being of Nonhuman Primates*. Washington, DC: National Academy Press.

National Research Council. 2003. *Occupational Health and Safety in the Care and Use of Nonhuman Primates*. Washington, DC: National Academy Press.

Nowak R. 1999. *Walker's Primates of the World*. Baltimore, MD: The Johns Hopkins University Press.

National Research Council. 1996. *Guide for the Care and Use of Laboratory Animals*. Washington, DC: National Academy Press.

U.S. Department of Agriculture. 1991. *Animal Welfare Regulations*. Title 9, CFR Part 3, Federal Register, Volume 56, No. 32.

<http://www.bioserv.com> (a company supplying food treats and other enrichments)

<http://www.ottoenvironmental.com/Default.asp> (a company supplying enrichment items)

<http://www.enrichment.org> (Web site for "The Shape of Enrichment")

http://www.awionline.org/Lab_animals/biblio/enrich.htm (a bibliography of enrichment articles)

<http://www.brown.edu/Research/Primate/> (Web site for *Lab Primate Newsletter*, a publication with behavior and enrichment articles)

http://www.aazk.org/committees/enrichment/comm_enrichment_title.php (Web site for the enrichment committee of the American Association of Zoo Keepers)

<http://www.aphis.usda.gov/ac/eejuly15.html> (Web site for the U.S. Department of Agriculture's "Final Report on Environment Enhancement to Promote the Psychological Well-Being of Nonhuman Primates")

Common Names of the Macaques

Macaca arctoides: Stump-tailed macaque; Bear macaque, Brown stump-tailed macaque

M. assamensis: Assamese macaque, Assam monkey, Mountain monkey, Himalayan Macaque, Montane Rhesus

M. brunnescens: Muna-Butung monkey

M. cyclopis: Taiwan macaque, Taiwanese macaque, Formosan macaque, Formosan rock macaque

M. fascicularis: Crab-eating macaque, Cyno, Cynomolgus, Iru monkey, Java monkey, Kra (or Kera), Long-tail macaque, Philippine monkey

M. fuscata: Japanese macaque, Snow monkey

M. hecki: Heck's macaque

M. maura: Moor macaque

M. mulatta: Rhesus monkey

M. nemestrina: Pig-tail macaque, Pigtail macaque, Pig-tailed macaque, Giant rhesus

M. nigra: Sulawesi crested macaque, Sulawesi black ape, Celebes black ape, Celebes ape, Celebes crested macaque, Black ape

M. nigrescens: Gorontalo macaque

M. ochreata: Sulawesi booted macaque, Booted monkey, Booted macaque

M. pagensis: Mentawai macaque

M. radiata: Bonnet macaque, Bonnet monkey

M. silenus: Lion-tail macaque, Liontail macaque, Lion-tailed macaque, Lion-maned macaque, Wanderoo, Wanderu, Ouanderu

M. sinica: Toque macaque, Toque monkey

M. sylvanus: Barbary ape, Barbary macaque, Gibraltar ape, Gibraltar macaque

M. thibetana: Père David's stump-tailed macaque, Tibetan stump-tailed macaque, Tibet monkey

M. tonkeana: Tonkean macaque

Sample Pair Housing SOP – Macaques

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Pair Housing: Following are descriptions of the five different pair housing combinations and the procedure for pairing each combination. It should be noted that on-going, vigilant monitoring is necessary to the successful social housing program. As animals mature, their relationship may change, necessitating separation of the animals and identification of new partners.

Juveniles: Two juveniles (three years of age or younger) of the same sex are paired together.

Place the animals in an appropriate size cage. Check the animals every hour for the first four hours and at least three times per day for the first week.

Adult with Infant or Juvenile: An adult (four years of age or older) of either sex is paired with a weaned infant or juvenile (eight months to three years) of either sex.

Adult Females: Two adult females (generally cynomolgus monkeys, four years of age or older) are paired together, with their unweaned infants (less than one year of age), if applicable.

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14

Adult Male and Female: An adult male (five years of age or older) is paired with an adult female (four years of age or older), for either breeding purposes or enrichment purposes.

Place the animals in a double cage with a clear Plexiglas® panel between them. If there are no signs of aggression after one hour, open the panel. Alternatively, if a Grooming-Contact (G-C) bar divider is available, use this first. Check the animals at least every hour for the first four hours and at least three times per day for the first week. Initially, the animals may be separated at night, until a compatible relationship is established.

Adults Males: Two adult males (four years of age or older) are paired together.

Place the males in a double cage with a clear Plexiglas® panel between them. Alternatively, if a G-C bar divider is available, use this first. If there are no signs of aggression after twenty-four hours, move the animals to a new double cage (to avoid territorial aggression) without a panel. Ensure that the males do not have visual contact with any breeding pairs. Check the animals at least every hour for the first four hours and at least four times per day for the first week. Initially, the animals may be separated at night, until a compatible relationship is established.

enrichment for nonhuman primates

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