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Environmental Enrichment Information Resources for Laboratory Animals: 1965 - 1995

Birds, Cats, Dogs, Farm Animals, Ferrets, Rabbits, and Rodents

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Contents

- **Introduction**...v
- **How to Use This Document**...vii

Articles and Bibliographies

- **Environmental Enrichment for Birds**
  by Christine Nicol, Bristol University...1
  - **Bird Bibliography**...5
- **Enriching the Environment of the Laboratory Cat**
  by Sandra McCune, University of Cambridge...27
  - **Cat Bibliography**...35
- **Dogs and Dog Housing** *by Robert Hubrecht, UFAW*...43
  - **Dog Bibliography**...49
- **Enrichment for Farm Animals**
  by Michael C. Appleby, University of Edinburgh...63
  - Farm Animal Bibliography
    - General...69
    - Cattle...73
    - Horses...79
    - Sheep and Goats...87
    - Swine...93
- **The Effects of Environmental Enrichment in Ferrets**
  by Dorothy Einon, University College, London...113
  - Ferret Bibliography...117
- **Rabbits**

by Debbie Gunn and David Morton, University of Birmingham...127
    - Rabbit Bibliography...133
- **Environmental Enrichment in Rodents**
  by Heleen A. van de Weerd and Vera Baumans, Utrecht University...145
    - **Rodent Bibliography**
        - Gerbils and Hamsters...151
        - Guinea Pigs...155
        - Mice...157
        - Rats...169
        - Wild Rodents...211
- **Journal Listing**...213
- **Subscription Information for Selected Publications**...223
- **Organizations**
    - North American Resources...227
    - European, Asian, and Australian Resources...232
- **Suppliers and Products**...237
- **Common Devices and Programs**...243
- **Subject Index**
    - Birds...247
    - Cats...251
    - Dogs...253
    - Farm Animals
        - Cattle...257
        - Horses...259
        - Sheep and Goats...261
        - Swine...263
    - Ferrets...267
    - Rabbits...269
    - Rodents
        - Hamsters and Gerbils...273
        - Guinea pigs...275
        - Mice...277
        - Rats...281
        - Wild Rodents...289
- **Document Delivery Information**...291-294

Introduction

Environmental Enrichment Information Resources for Laboratory Animals has been produced jointly by the Animal Welfare Information Center (AWIC) of the U.S. Department of Agriculture's National Agricultural Library (NAL) and the Universities Federation for Animal Welfare (UFAW) in an effort to encourage the implementation of environmental enrichment programs in laboratory animal husbandry. This publication covers birds, cats, dogs, farm animals, ferrets, rabbits, and rodents. The exclusion of non-human primates is deliberate as they are covered in a separate AWIC publication, *Environmental Enrichment Information Resources for Nonhuman Primates: 1987-1992.*

Various terms are used to describe the welfare requirements of animals in captivity--"psychological well-being," "ethological" or "behavioral needs," and "environmental enrichment." Whatever the term used, they are essential requirements, not luxuries. Legislation and guidelines in the European Union (EU) and the United States recognize this. The Council Directive of the EU concerning all laboratory animals stipulates that facilities "...should permit the satisfaction of certain ethological needs...." In the United States, the Animal Welfare Act requires facilities to provide exercise for dogs and programs to promote the psychological well-being of non-human primates, while the U.S. Public Health Service *Guide to the Care and Use of Laboratory Animals* encourages "enriching the environment as appropriate to the species...." The literature cited in this bibliography reflects the extent of research that has taken place

in the field of environmental enrichment or deprivation. While offering a useful resource, the bibliography also reveals areas that are lacking in basic information. Consequently, for species about which little information exists, we have provided literature sources on natural and captive behaviors as a foundation for the development of enrichment programs.

Each section of this bibliography is introduced by a paper which provides general background information on the biology of the animals and their currently accepted needs in captivity. It is advisable to refer to all of the contributions. This should act as a starting point for those about to embark on an enrichment project and the citations can then provide further relevant information.

The staffs of the Animal Welfare Information Center and the Universities Federation for Animal Welfare hope that you find this publication to be a useful addition to your laboratory animal resources and welcome any comments for future editions.

How To Use This Document

This publication is divided into 8 sections: articles and bibliographies, journal listing, subscription information for selected journals, organizations, suppliers and products, common devices and programs, subject index, and document delivery information for U.S. and foreign patrons.

Articles and Bibliographies

The primary section of this publication consists of seven subsections broken out by species or class of animal. Each subsection is introduced by an article written by a recognized authority in the field of environmental enrichment or behavior. The reference section for each article may or may not overlap with citations in the bibliographic portion of each subsection. Immediately following each article is a comprehensive bibliography containing citations that are arranged alphabetically according to the last name of the primary author. Each entry also contains descriptors and the NAL Call Number if the particular source is available at the National Agricultural Library (NAL).

Journal Listing

This section is a listing of journals that appear in the bibliography. It is further categorized by species or class of animal with all entries appearing in alphabetical order. Each entry lists the journal title, place of publication, language, International Standard Serial Number (ISSN) listing, brief description of contents, the NAL Call Number (if available at NAL), and the electronic databases that index the journal.

Subscription Information for Selected Publications

During the production of this publication, we found ourselves routinely going to several publications because of their excellent coverage of environmental enrichment research or applied programs. Consequently, we felt it important to include information on how to subscribe to these publications.

Organizations

There are many organizations that produce extremely useful materials for their members and other interested parties. In this section, organized by world regions, you will find information on how to contact these organizations via a variety of electronic means and that old standby, the postal service. You will also find World Wide Web addresses for those organizations that have posted homepages on the Web. However, readers are cautioned that because the WEB is a very dynamic media, these addres ses may change. You will also find information on the type of organization, the resources or services offered, requestor priority, and fees (if any).

Suppliers and Products

To make it even easier for you to develop enrichment programs, we have put together a lengthy, but by no means

exhaustive, listing of commercial vendors and the enrichment products they supply. This listing include items as diverse as plastic tubes or tunnels for rodents to electric netting for free range chickens. All contact information is current as of September 1, 1995. Please note that "800" telephone numbers for U.S. companies may not be reached by all countries.

Common Enrichment Devices and Programs

In an effort to show the wide variety of items or strategies commonly employed in enrichment programs, we searched through articles for toys, devices, feed items, socialization programs, etc. and listed them according to the species or class of animal for which they are used.

Subject Index

The index for the publication was generated primarily from the descriptors that accompany each entry. In some instances, index words may have been taken from the title. Because people are more likely to be interested in a particular animal, indexes were generated for each species or class covered. The number associated with each index term corresponds to the *page number* on which the index term can be found.

Document Delivery Information

The information contained here provides directions on how to obtain copies of articles mentioned in the bibliography. There are separate directions for U.S. patrons and those readers outside the United States. **All patrons are encouraged to use their local resources before contacting the National Agricultural Library.** While the National Agricultural Library provides a variety of services to patrons around the world, videocassettes are not available for loan outside the United States and Canada.

Go to:

[AWIC] [Top of Document] [Main Contents] [Main Introduction] [How to Use This Document]
[Birds] [Laboratory Cat] [Dogs and Dog Housing] [Farm Animals] [Ferrets] [Rabbits] [Rodents]
[Journal Listing] [Subscription Information for Selected Publications] [Organizations] [Suppliers and Products]
[Common Devices and Programs] [Main Subject Index] [Document Delivery Information]

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Environmental Enrichment for Birds

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- Introduction
- Recommendations
- References
- Bird Bibliography

"Environmental Enrichment for Birds" is a chapter from: Smith, C.P. and V. Taylor (September 1995). **Environmental Enrichment Information Resources for Laboratory Animals: 1965 - 1995: Birds, Cats, Dogs, Farm Animals, Ferrets, Rabbits, and Rodents**. *AWIC Resource Series* No. 2. U.S. Department of Agriculture, Beltsville, MD and Universities Federation for Animal Welfare (UFAW), Potters Bar, Herts, UK, pp. 1-25.

The following links access AWIC and other chapters in this publication:

[AWIC] [Main Contents] [Main Introduction] [How to Use This Document]
[Birds] [Laboratory Cat] [Dogs and Dog Housing] [Farm Animals] [Ferrets] [Rabbits] [Rodents]
[Journal Listing] [Subscription Information for Selected Publications] [Organizations] [Suppliers and Products]
[Common Devices and Programs] [Main Subject Index] [Document Delivery Information]

Introduction

Birds of many different species from a wide variety of original habitats are housed in research laboratories. Galliformes such as the quail (*Coturnix coturnix*) and the chicken (*Gallus gallus*) are used in biomedical research in studies of reproductive, digestive and "biological clock" physiology, and in genetic research. Pigeons (*Columba livia*) are stalwarts of the psychological laboratory, used primarily for learning and cognitive studies, whilst diverse species such as budgerigars (*Melopsittacus undulatus*), starlings (*Sturnis vulgaris*) and passerine species (e.g., the great tit, *Parus major*) may also be kept for behavioral research purposes. This diversity makes it difficult to generalize about the specific physical or behavioral needs of laboratory birds, and a preliminary first step should always be to consider the natural behavior of each species in the wild.

Wild quail and jungle fowl (the ancestor of the domestic fowl) live in small social groups, devote much of their day to scratching and foraging for food on the ground, and perform complex sequences of behavior such as dustbathing and pre-laying nesting. In the laboratory they may be housed in aviaries or floor pens, or in cages with varying opportunity to perform these behavioral patterns. The spatial restriction imposed by typical laboratory chicken (50 x 60 x 56cm high) or quail (27 x 36 x 20cm hi gh) cages may restrict even relatively simple movements such as wing-flapping. The pigeon is a more gregarious bird, often found in very large flocks, and capable of flying fast over distances of more than 1000km. In the laboratory pigeons are kept eith er in aviaries, pigeon lofts, or in cages (typically 44 x 44 x 54cm high).

In most laboratories veterinary supervision is good and careful attention is devoted to hygiene, and to the maintenance of strict temperature and lighting regimes. Despite this care, the welfare of many laboratory birds may be prejudiced in barren or restrictive environments. This may be a particular oversight when the birds are subjects of behavioral or psychological research, as there is some evidence that cognitive abilities may be detrimentally affected by barren housing. It is probably not possible to recreate a completely natural environment for all laboratory birds, but much can be achieved by relatively simple environmental enrichment, especially in conjunction with information about behavioral needs and priorities.

More is known about the welfare requirements of the domestic fowl than any other bird, largely because of research generated by the controversy over agricultural battery cages. Caution is required when generalizing across species, but a number of important points have emerged from this research, relating to both physical and mental well-being, that can be applied to the laboratory situation.

Laying hens are alarmingly prone to bone breakage if they fly into solid structures such as cage walls, or poorly positioned perches. The risk of breakage is exacerbated if bones are weak due to insufficient exercise in spatially restricted housing. Most cages for laboratory birds appear to allow sufficient space for wing stretching, if not for flapping or actual flight, but many birds may avoid stretching their limbs too close to solid walls or partitions. The greatest risk of physical injury will occur if birds become frightened and attempt to escape from their cages, either during catching procedures or simply when disturbed by human presence. It is therefore important to allow sufficient space for running and wing flapping to maintain bone strength, and because these are important behaviors in their own right (Nicol 1987). This freedom must be coupled with the provision of a small, safe catching area. Birds can often be enticed into such areas if they are well lit whilst the rest of the roo m is temporarily darkened. Protection from injury can also be facilitated by suspending protective nets just below the cage or aviary roof or by lining the cage or catching area (e.g., with fiberglass) and ensuring there are no rough projections.

If fear levels in laboratory-housed birds are low then panic flights leading to physical injury are less likely, and general welfare is improved. New birds should be gradually exposed to the specific sounds or stimuli that they will encounter in the laboratory so that they can habituate. Research on many species, including chickens and quail, has also shown that baseline fear levels can be reduced by providing an enriched environment. Rearing young birds with access to a variety of stimuli such as colored objects and background music appears to have long-term beneficial effects. But, for adult birds, environmental enrichment must do more than simply provide a more complex general environment. It must also provide opportunities for birds to perform high priority behavior patterns. Increasing evidence suggests that functional behavior performance is crucial to good welfare. Even when birds are provided with *ad libitum* food and pre-formed nests, they still need to perform foraging and nest -building behavior. Laying hens are even willing to "pay a cost" to obtain their food by foraging in litter, rather than eat readily available food from a dish.

To: Top of Document | Introduction | Recommendations | References | Bird Bibliography

Recommendations

Some simple suggestions for the environmental enrichment of laboratory birds include:

1. Allow birds to forage for their food (which should be as varied as possible), either by scattering the food in wood-shavings on the aviary floor, by hiding it amongst shredded paper in a large trough, or by providing it in a form where birds have to work e.g., stuck together in a grain-block. Operant feeders, where a button must be pecked to release food, may occupy solitary birds, but cannot be recommended for group-housed birds as they may not allow birds to feed simultaneously and hence could result in increased competition and risk of feather pecking.
2. Allow egg-laying birds the opportunity to perform nesting behavior by the provision of suitable nest-boxes and building material. If hen or quail have to be kept in cages consider the possibility of modifying the cage to incorporate a roll-away nest box. This can work successfully for laying hens housed in cages (Sherwin 1994).
3. Allow sufficient space for running or flying activity, and consider ways of increasing the value of the space available. Perches or roosting shelves can be incorporated cheaply into all housing systems. In small cages perches can be inserted at night to allow roosting but removed during the day to allow unrestricted space.
4. House birds in suitable stable social groups. If birds must be housed individually arrange the cages so that they have visual contact with others. This may reduce the incidence of stereotypic behavior (Keiper 1970). Since birds seem able to perceive 2-dimensional images the use of mirrors may also reduce the negative effects of social isolation.

To: Top of Document | Introduction | Recommendations | References | Bird Bibliography

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To: Top of Document | Introduction | Recommendations | References | Bird Bibliography

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Descriptors: cage, hens, feeder, apparatus, motivation, production.

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Descriptors: operant conditioning, feeder size, demand elasticity, behavior, space, hen, cage.

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Descriptors: hen, pre-laying behavior, cage, nest, housing, welfare, egg-laying behavior.

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Descriptors: battery cage, litter-reared, nests, social interactions, cage, hens.

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Descriptors: housing density, feather-pecking, space, feeding, drinking, hens, behavior, cage.

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To: Top of Document | Introduction | Recommendations | References | Bird Bibliography

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[Main Contents] [Main Introduction] [How to Use This Document]
[Birds] [Laboratory Cat] [Dogs and Dog Housing] [Farm Animals] [Ferrets] [Rabbits] [Rodents]
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Enriching the Environment of the Laboratory Cat

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- Introduction
- Environmental Enrichment
- Social Enrichment
- References
- Cat Bibliography

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[Journal Listing] [Subscription Information for Selected Publications] [Organizations] [Suppliers and Products]
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Cats are intelligent, highly specialized carnivores. Like many predators, their senses are highly developed (reviewed by Bradshaw 1992). The cat's ability to hear, see and smell outside our own range give it a very different perception of its environment to ours. For example, it has a second olfactory system, the vomerosensory system which is associated with social behavior. The system is used when cats come into contact with other cats or their urine. In addition, the cat's visual images are supplemented with information from its highly developed sense of balance and sensory hairs on the head and legs which give the cat its position relative to other objects.

The domestic cat, *Felis silvestris catus,* used in laboratories is the same species that is commonly kept as a pet and exists in substantial numbers in feral colonies. Until recently, cats were thought to be essentially solitary but studies h ave shown they are also found in large socially structured groups (at densities of over 2000 per km^2 Izawa 1984; Izawa *et al.* 1982; Kerby and Macdonald 1988). The key to the success of the domestic cat is flexibility. Its ability to adapt enables it to survive in environments as diverse as the laboratory cage and isolated islands where individual territories can reach 6 km^2 (Liberg and Sandell 1988). The rest of this paper introduces the problems of confinement experiene d by domestic cats, the principles of enrichment relevant to this species and the role of enrichment in preventing and relieving problems.

Specific problems associated with confinement include boredom, aggression to people and to cats, fearfulness, poor reproductive success, anorexia, tail-chasing, stereotypies, fabric eating and self-mutilation (Mellen 1988; Holmes 1993). It seems that cats confined in relatively restricted environments are more likely to develop behavior problems as Mertens and Schär (1988) claim pet cats restricted to indoors are more likely to be presented for behavior problems than cats with access to outdoors. As single laboratory caging represents the most extreme and barren environment in which cats are confined, it is likely that this is where the worst problems will develop. However, any form of cat housing can be made more stimulating, complex, and less predictable through both environmental and social enrichment.

To: Top of Document | Introduction | Environmental Enrichment | Social Enrichment | References | Cat Bibliography

Environmental enrichment

Above a critical minimum, improving *quality* of space for cats rather than *quantity* may be a better investment (Mansard 1989). In several species, increasing housing space alone did not change levels of activity (Hite *et al.* 1977; Bebak and Beck 1993). Quality of space can be improved by providing a range of resting places, by extending vertical space, by increasing complexity and by frequently changing internal structure and contents.

Elevated resting places are particularly favored by cats for watching their surroundings. They also preferred resting places that were warm, dry, and protected on one, or even better, two sides (Smith 1990; Roy 1992) and situated in the corners or edges of an enclosure where they can watch without the possibility of being approached from behind (Roy 1992). A range of resting places should be provided so that cats can choose their degree of contact with other cats. This may be particularly important if they are timid or the focus of aggression. The provision of shelves, ropes and climbing poles (illustrated in Loveridge 1984; Horrocks 1994) enrich the enclosure's vertical complexity and extend the available space. The latest advances in enriched group-housing are illustrated in Loveridge's paper (1994). Shelving allows the available space to be separated into functional areas. For example, the areas can be allocated to food, litter, scratch posts, toys, bedding and viewing points. These areas can be changed to promote activity. If shelves are hinged so they can fold down, the internal space periodically can be changed by erecting different combinations of the shelves available. Surface materials commonly used are metal and plastic but cats pr efer materials which maintain a constant temperature such as straw, shredded paper, shavings, sacks, clothes or wood (Roy 1992).

Within the available space, furniture and objects can be provided to create a focus of interest, exploration and play. Toys which provide movement and which are frequently changed attract the most interest.

Food has been the focus of enrichment for several other *Felis* species (Mellen *et al.* 1981; Law *et al.* 1990). In laboratories, dry food is particularly suitable for hiding in the enclosure or for placing inside containers which the cat has to work at to extract individual pieces. A cheap version of a food puzzle can be made by gluing together two yoghurt containers containing dry food, with holes just large enough to extract one piece at a time. The puzzle can be made more challenging by hanging the tubs just above the cat's head height. Puzzle boxes for cats are now commercially available. Alternatives include hiding food inside cardboard boxes, in bedding, on shelves and inside rolling toys.

To: Top of Document | Introduction | Environmental Enrichment | Social Enrichment | References | Cat Bibliography

Social enrichment

The social environment can also improve the quality of time spent confined. Cats vary in their degree of sociability. In colonies where new cats frequently join the group, some cats remain essentially solitary (Roy 1992) whereas others form social attachments which undoubtedly enrich their lives by adding variety and complexity. By providing a variety of retreats and resting places, cats have the opportunity to interact closely with other cats or to remain alone if less sociable.

Social contact with cats

Singly caged cats lack the opportunity that communally confined cats have for rich, interactive relationships. Ideally, cats should remain in stable groups. If research requires single housing, cats can often be returned to social groups in between trials or for a period each day.

Social contact with people

People are also a rich source of stimulation. Many cats respond positively to human social contact. Cats kept in a

relatively restricted environment will seek additional stimulation from people (Turner and Stammbach-Geering 1990) indicating they may derive some benefit from the contact.

If direct contact is not possible, social enrichment can be indirect. Visual, vocal and olfactory communication are possible without direct contact by the use of glass partitions and grills between pens. Access to a communal room in which other cats have previously left chemical messages, rubbed from their glands, or sprayed in their urine, convey information to cats about each other (Natioli 1984). Providing scratch posts enables cats to keep their claws trimmed but also allows them to leave olfactory and visual messages (scratch marks) to other cats in the colony. The sound of voices on radio may habituate timid cats to people (Hurni and Rossbach 1987).

Many problems associated with confinement can be prevented by adequate early socialization and careful selection of cats for suitable temperament (McCune in press; Reisner 1994; McCune *et al.* 1995). One study showed that friendly, confident cats were less distressed by being caged, their normal behavior was less inhibited and they adapted sooner than timid cats (McCune 1992). For cats inadequately socialized as kittens and already stressed by caging, social contact can be an additional stressor. For these individuals, methods other than handling must be used to relieve stress and enrich the captive environment (McCune 1995). Individuals will vary in both their need for enrichment and the benefit it provides them. For example, cats with a timid temperament (McCune 1992), extremes of age (McCune 1994) and restricted experience (Konrad and Bagshaw 1970; Ledger 1993) are more likely to have problems adjusting to confinement and responding to novelty. Mellen (1988) claims that male cats are more likely than female cats to develop problems in restricted environments.

Few of these studies were primarily interested in environmental enrichment. Techniques of enrichment need to be scientifically validated to promote and communicate methods that work for cats and to avoid techniques which produce problems. Assessments should look for a decrease in abnormal behavior and a behavioral repertoire which more closely resembles that of free-ranging cats (UK Cat Behavior Working Group 1995). Research animals without behavior problems are likely to have better welfare and produce better quality data.

To: Top of Document | Introduction | Environmental Enrichment | Social Enrichment | References | Cat Bibliography

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To: Top of Document | Introduction | Environmental Enrichment | Social Enrichment | References | Cat Bibliography

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To: Top of Document | Introduction | Environmental Enrichment | Social Enrichment | References | Cat Bibliography

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[Main Contents] [Main Introduction] [How to Use This Document]
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Dogs and Dog Housing

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- Brief Background
- Physical Needs
- Social Needs
- Environmental Enrichment
- References
- Dog Bibliography

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Brief background

The dog is descended from the wolf, possibly the Southern wolf *(Canis lupus pallipes)*. Wolves are social carnivores that can combine into packs, and this trait is still shown by some feral dogs (Feddersen-Petersen 1994). Thousands of years of domestication and artificial selection have produced breeds, with modified social repertoires (Bradshaw and Brown 1990), that are capable of transferring conspecific social behavior to humans. Like most larger mammals, dogs spend a considerable portion of their time inactive (Hubrecht *et al.* 1992, Adams and Johnson 1993). However, as a diet opportunist, the dog is adapted to seeking a wide variety of foods in unpredictable locations, it is therefore much more likely to be tolerant of novel items and circumstances than a more specialized feeder. Conversely, during its active periods it may be more easily bored by a predictable and limiting environment.

To: Top of Document | Brief Background | Physical Needs | Social Needs | Environmental Enrichment | References | Dog Bibliography

Physical needs

There are many publications that provide recommendations for the dog's general husbandry (e.g., MacArthur 1987, HMSO 1989, 1995). These are based on experience and provide valuable information but there has been very little research into specific physical requirements apart from diet. In most scientific work a tightly controlled environment is required to reduce unwanted variation, however, the dog is a very adaptable animal and a healthy adult can cope with a range of conditions, particularly if it has access to areas with different micro-climates.

Temperature, humidity, ventilation and lighting

An indoor temperature range of 15-24°C, and humidity of 55 percent ± 10 percent, with 8-12 air changes per hour is suitable. New-born puppies require an ambient temperature of 26-28°C for at least the first 10 days of life. Lighting should be adequate for staff to work, and there may be a case for a low level of nocturnal illumination in totally enclosed facilities.

Diet

Dogs appear to prefer meat to cereal diets (Houpt and Smith 1981). Some breeds have a propensity for obesity (Anderson 1973), however, they will usually adapt well to the many proprietary diets available. Advice, if needed, should be sought from the suppliers.

Noise

Dog housing is often very noisy because of barking, and sound pressures of well over 100 decibels have been recorded (Senn and Lewin 1975). Ottewill (1968) provided recommendations to reduce noise, mainly with the aim of improving conditions for the humans. The dog has a hearing frequency range of up to 55 kHz (Gamble 1982) with the most sensitive frequencies at 500Hz -16kHz. At these frequencies their hearing can be up to four times as acute as that of humans. Prolonged exposure to sound pressures of over 90 decibels is known to damage human hearing, and many sites advise or require hearing protection for the staff. It is not unreasonable to assume that such levels might also damage dog hearing, although there is very little evidence on this subject.

To: Top of Document | Brief Background | Physical Needs | Social Needs | Environmental Enrichment | References | Dog Bibliography

Social needs

It has been known for a long time that inadequate housing can lead to behavioral problems in dogs (Fuller 1967, Solarz 1970). Normal husbandry for the dog should allow plenty of opportunities for social interactions with humans (Wolfle 1992) and conspecifics (Fox 1986). Group housing of compatible dogs in pairs or larger groups is the preferred housing method, (HMSO 1989, Hubrecht *et al.* 1992, Hubrecht 1993b) but care is needed to control any fighting. Regular human contact during the puppie s' socialization period (3-14 weeks) is particularly important to produce dogs that are relaxed with humans (Scott and Fuller 1965).

To: Top of Document | Brief Background | Physical Needs | Social Needs | Environmental Enrichment | References | Dog Bibliography

Environmental enrichment

Many laboratory enclosures are simple structures, with little or no complexity provided by cage furniture or subdivisions, and in some countries it is still legal and common practice to house dogs in what would seem to be very small cages. It is unlikely that such small enclosures can provide for the dogs' psychological needs (Hetts 1991). A good housing system should allow the dog to exercise an element of choice, to manipulate or chew safe objects, and provide opportunities for human and canine socialization (Hubrecht 1993a). Dogs sometimes have to be housed singly for experimental or quarantine reasons, in which case greater thought should be given to providing extra human contact time and an interesting environment.

Dog pens should be subdivided into separate sleeping and exercise areas which provide complexity, choice and allows the dog to defecate/urinate away from its sleeping area (Fox 1986). Solid partitions between pens provide privacy and help to prevent injuries, but can isolate the dog from its surroundings. A good pen design should allow the occupants to satisfy their natural curiosity about what is happening outside the enclosure. One solution is to provide platforms at a

height that allows the dog to see over the partitions whilst lying down (Hubrecht 1993a). Such devices have the additional advantage of increasing the useable space available to dogs.

There have been a number of studies on the effects of exercise, and pen size (e.g., Campbell *et al.* 1988, Hughes *et al.* 1989, Bebak and Beck 1993, Hetts *et al.* 1992). There is no evidence that providing extra exercise *per se* improves welfare (Clark *et al.* 1991), although walks outside the enclosure are undoubtedly enjoyed.

Olfaction is an important canid sense. We know little about how to enrich an environment through odors but Hubrecht *et al.* (1992) found that dogs housed in groups spend more of their time sniffing and investigating the floor of their enclosure. Dogs will also make extensive use of chews, particularly if they taste of food and are presented properly (DeLuca and Kranda 1992, Hubrecht 1993a).

Breed differences and husbandry requirements should be kept in mind when considering enrichment options. It is also important to remember that dogs vary in temperament (Cattell and Korth 1973) and perhaps also in their housing requirements and ability to cope with a particular kennelling system.

To: Top of Document | Brief Background | Physical Needs | Social Needs | Environmental Enrichment | References | Dog Bibliography

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To: Top of Document | Brief Background | Physical Needs | Social Needs | Environmental Enrichment | References | Dog Bibliography

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Descriptors: dogs, pens, cages, animal housing, animal behavior, social interaction, isolation, space requirements, animal welfare.

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Descriptors: welfare, behavior, socialization, stereotypies, enrichment, toys.

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Descriptors: dogs, kennels, cage size, animal behavior, shelters, laboratories, social behavior, animal housing, animal welfare.

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Descriptors: dogs, animal housing, cage size, cage density, exercise, animal welfare, regulations.

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Descriptors: dogs, competitive behavior, physiology, feeding.

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Descriptors: circadian activity, behavioral patterns, rhythms, eating, elimination, aggression, environmental conditions.

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Descriptors: pets, housing, design and construction, pet supplies, building, amateurs' manuals, handicraft.

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Descriptors: human sex differences, animal sex, familiarity.

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Descriptors: excessive grooming, stone chewing, wool sucking, polydipsia, barking, tail or foot biting, aggression, environmental enrichment.

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Descriptors: genetics, behavior, breed differences, exercise.

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Descriptors: animal welfare, laboratory animals, physiology, dogs, housing, standards, quality control.

To: Top of Document | Brief Background | Physical Needs | Social Needs | Environmental Enrichment | References | Dog Bibliography

The following links access other chapters in *Environmental Enrichment Information Resources for Laboratory Animals*:

[Main Contents] [Main Introduction] [How to Use This Document]
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Enrichment for Farm Animals

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- Introduction
- Human Contact
- Social Conditions
- Physical Conditions
- References
- Farm Animal Bibliography
  - General
  - Cattle
  - Horses
  - Sheep and Goats
  - Swine

"Enrichment for Farm Animals" is a chapter from: Smith, C.P. and V. Taylor (September 1995). **Environmental Enrichment Information Resources for Laboratory Animals: 1965 - 1995: Birds, Cats, Dogs, Farm Animals, Ferrets, Rabbits, and Rodents**. *AWIC Resource Series* No. 2. U.S. Department of Agriculture, Beltsville, MD and Universities Federation for Animal Welfare (UFAW), Potters Bar, Herts, UK, pp. 69-112.

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[AWIC] [Main Contents] [Main Introduction] [How to Use This Document]
[Birds] [Laboratory Cat] [Dogs and Dog Housing] [Farm Animals] [Ferrets] [Rabbits] [Rodents]
[Journal Listing] [Subscription Information for Selected Publications] [Organizations] [Suppliers and Products]
[Common Devices and Programs] [Main Subject Index] [Document Delivery Information]

There has been relatively little published on environmental enrichment for the mammalian farm animals used in "laboratory" studies. This may be partly because most such studies are carried out either in normal farm conditions, or in conditions regarded as similar to these (for example, growing pigs housed singly, similar to normal housing for sows) or on animals removed only temporarily from such conditions. There may, however, be welfare problems in normal farm conditions and the considerable work which has now been done on improvement of these is relevant here. In addition, the special treatment necessary for experimental work may cause further problems and also cast doubt on the results of the research, not least when imposed temporarily. In this brief commentary, three aspects of such treatment will be considered which act separately and in combination: human contact, social conditions and physical conditions.

To: Top of Document | Introduction | Human Contact | Social Conditions | Physical Conditions | References | Farm Animal Bibliography: General, Cattle, Horses, Sheep and Goats, Swine

Human contact

Animals react to human contact behaviorally and physiologically in ways which may interfere with the topic under study. This is particularly likely if restraint is involved; for example, to obtain blood samples. A common approach to minimize such effects is to use remote sampling methods such as filming behavior, strapping on or implanting heart rate meters (Porges 1985), and automatically withdrawing blood samples from a catheter (Mayes *et al.* 1988). Other non-invasive techniques are also being developed, such as measurement of hormones in saliva, urine and faeces. Less

attention has been given to the possibility of accustoming animals to human contact including handling, which may considerably reduce such effects (Pearce *et al.* 1989), despite the fact that more is known about this for farm animals than for other species (Gonyou 1991). A particularly promising finding is that pigs and sheep can be trained to enter a restraining device for procedures including blood withdrawal voluntarily and repeatedly (Grandin 1986, 1989). Another important aspect of human contact is predictability (Carlstead 1986). Thus if feeding times are to be manipulated experimentally, animals can be trained in advance not to expect food at the same time each day (Reid and Mills 1962). As a general rule it is better to accustom animals to disturbance than to attempt to avoid disturbing them; if there is little disturbance for long periods then any disruption which does occur may be very stressful. This is probably the main basis of the idea which is sometimes expressed that animals should be subjected to "adequate levels of stress".

To: Top of Document | Introduction | Human Contact | Social Conditions | Physical Conditions | References | Farm Animal Bibliography: General, Cattle, Horses, Sheep and Goats, Swine

Social conditions

Many experiments involve isolation of animals. This can have very strong effects: heart rate of sheep when first isolated is greatly elevated (Baldock and Sibly 1986) and sheep on restricted diets behave more abnormally in isolation than in groups (Done-Currie *et al.* 1984). There is some indication that the chance of conception by dairy cows is lower if they have been kept in isolation prior to artificial insemination (cf. Moberg 1991). Effects are usually reduced if animals can see each other and it should be possible to arrange this even in restrictive housing such as metabolism crates. More consideration should also be given to methods for housing animals in groups while making individual measurements; for example, using film (Pajor *et al.* 1991) or electronic devices (Lambert *et al.* 1983) for recording individual food intake. When animals are housed in groups, though, care must be taken to minimize harmful social behavior such as aggression, as in any husbandry system. Precautions should include careful consideration of physical conditions.

To: Top of Document | Introduction | Human Contact | Social Conditions | Physical Conditions | References | Farm Animal Bibliography: General, Cattle, Horses, Sheep and Goats, Swine

Physical conditions

The space provided in experimental conditions is usually less constrained than that in commercial conditions with one major exception: the metabolism crate. This is commonly used to keep the animal in a fixed position for collection of urine and faeces, but more use could be made of bags fixed to the animal for this purpose; in pigs, it should also be possible to make use of their habitual urination and defecation sites as has been done for cats (Carlstead *et al.* 1993). Reactions of animals to close confinement may be extreme especially if it is combined with food restriction (Appleby *et al.* 1987). In experiments which do not use such crates, problems such as harmful social behavior and frustration of various behavior patterns are more likely to be associated with barrenness of the environment than with lack of space. Common causes for barrenness are cleanliness and avoidance of unwanted edible material (such as straw). Yet cleanliness is not always strictly necessary, and an acceptable degree of cleanliness may be achieved even with substrates such as woodchips (Chamove *et al.* 1982). The environment can be made more complex quite easily, for example by fitting barriers (Waran and Broom 1993) and providing manipulable objects. Many techniques which have been developed for other species such as primates could also be used for farm animals; these include, for example, increasing the animals' control over their physical environment (Baldwin 1979). Among other advantages, provision of "toys" makes handling of pigs easier (Grandin *et al.* 1987). It should be pointed out, however, that the effects of environmental enrichment need to be assessed rather than just assumed; there may be deleterious effects such as increased aggression (McGregor and Ayling 1990). Food can also be provided in ways which are more stimulating than a trough, such as operant devices. As with several of the other factors already mentioned, this will be particularly valuable if food is restricted. Without such measures, food restriction can have severe effects on behavior (Willard *et al.* 1977, Appleby and Lawrence 1987) with implications for physiological effects on the measurements being made (Marsden and Wood-Gush 1986). Such effects include extreme variability: one nutritional study of sheep which kept them without food for a period to obtain baseline measurements found that some reacted violently, with high metabolic

rate, while others were somnolent with low metabolism (Blaxter and Wainman 1961).

Environmental enrichment for farm animals in experiments is important both for the validity of the experiments and for the animals themselves.

To: Top of Document | Introduction | Human Contact | Social Conditions | Physical Conditions | References | Farm Animal Bibliography: General, Cattle, Horses, Sheep and Goats, Swine

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To: Top of Document | Introduction | Human Contact | Social Conditions | Physical Conditions | References | Farm Animal Bibliography: General, Cattle, Horses, Sheep and Goats, Swine

Farm Animal Bibliography

General

Berry, D.J. (1994). ***Transport and Handling of Livestock and Poultry: January 1984 - January 1994.*** *Quick Bibliography Series* U.S. Department of Agriculture, National Agricultural Library: Beltsville, MD, 62p.
NAL call number: aZ5071.N3 no. 94-32
Descriptors: bibliography, livestock, poultry, handling, husbandry, transport, care.

Cregier, S.E. (1989). ***Farm Animal Ethology: A Source Book.*** Captus Press: Ontario, Canada, 213p.
NAL call number: SF81 C73
Descriptors: directory, information, journals, funding sources, academia, audio-visuals, conferences, books, reviews.

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NAL call number: QL55 A1L33
Descriptors: canine, swine, feline, welfare, exercise, toys, play, balls, runs, comparisons.

Ewbank, R. (1985). **The behavioural needs of farm and laboratory animals**. In: *Animal Experimentation: Improvements and Alternatives* N. Marsh and S. Heywood, eds., FRAME: Nottingham, UK, pp. 31-35.
NAL call number: QL55 A5
Descriptors: behavioral needs, comfort, shelter, flooring, legislation.

Fox, M.W. (1965). **Environmental factors influencing stereotyped and allelomimatic behavior in animals.** *Laboratory Animal Care* 15(5):363-370.
NAL call number: 410.9 P94

Descriptors: boredom, crowding, space, noise, photoperiod.

Grandin, T. (April 1993). **The effect of previous experiences on livestock behavior during handling**. *Agri-Practice* 14(4):15-20.
NAL call number: SF601.B6
Descriptors: cattle, sheep, handling, restraint, behavior.

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NAL call number: QL750.A6
Descriptors: cattle, pigs, sheep, floor, lighting, chutes, pens, transport.

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NAL call number: SF601.V535
Descriptors: livestock, handling, stress, movement, behavior, facilities.

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NAL call number: 41.8 M69
Descriptors: cattle, physiology, stress, behavior.

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NAL call number: QL55 A1L33
Descriptors: zoo, farm, laboratory, outdoor housing, noise.

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Descriptors: stock people, human-animal bond, fear, handling.

Hemsworth, P.H. and J.L. Barnett (1987). **Human-animal interactions**. In: *Farm Animal Behaviour. The Veterinary Clinics of North America - Food Animal Practice* 3(2):339-356.
NAL call number: SF601 V535
Descriptors: fear, handling, noise, husbandry, housing.

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NAL call number: 410 B77
Descriptors: behavioral elasticity, motivation, appetitive and consummatory behavior.

Kilgour, R., T.M. Foster, W. Temple, L.R. Matthews, and K.J. Bremner (April 1991). **Operant technology applied to solving farm animal problems. An assessment**. *Applied Animal Behaviour Science* 30(1/2):141-166.
NAL call number: QL750.A6
Descriptors: cattle, goats, horses, sheep, pigs, feed preferences, conditioning.

Mench, J.A. (February 1994). **Environmental enrichment and exploration**. *Lab Animal* 23(2):38-41.
NAL call number: QL55 A1L33
Descriptors: exploratory behavior, appetitive behavior, genetics, experience.

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NAL call number: videocassette no. 1542
Descriptors: farm animals, pointless behavior, physiology, genetics, parasites, nutritional deficiencies.

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NAL call number: videocassette no. 1327
Descriptors: zoo animals, housing, guidelines, captivity

Wood-Gush, D.G.M. and K. Vestergaard (1991). **The seeking of novelty and its relation to play**. *Animal Behaviour* 42:599-606.
NAL call number: 410 B77
Descriptors: novel objects, exploration, learning.

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NAL call number: BJ52.5 J68
Descriptors: pigs, exploration, learning, social behavior, housing.

To: Top of Document | Introduction | Human Contact | Social Conditions | Physical Conditions | References | Farm Animal Bibliography: General, Cattle, Horses, Sheep and Goats, Swine

Cattle

Albright, J.L., T.H. Blosser, and S.E. Curtis (1987). **Dairy animal welfare: Current and needed research.** *Journal of Dairy Science* 70(12):2711-2731.
NAL call number: 44.8 J822
Descriptors: cows, welfare, review, housing, environment, behavior, environmental factors.

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NAL call number: aZ5071.N3 no. 95-16
Descriptors: bibliography, handling, husbandry, facilities, care, welfare, well-being, behavior, stress, humane.

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NAL call number: aZ5071.N3 no. 95-15
Descriptors: bibliography, handling, husbandry, facilities, care, welfare.

Berry, D.J. (1992). ***Veal Calves: January 1979 - August 1992.*** *Quick Bibliography Series* U.S. Department of Agriculture, National Agricultural Library: Beltsville, MD, 49p.
NAL call number: aZ5071.N3 no. 92-67
Descriptors: bibliography, handling, husbandry, facilities, care, welfare, behavior, stress, humane.

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To: Top of Document | Introduction | Human Contact | Social Conditions | Physical Conditions | References | Farm Animal Bibliography: General, Cattle, Horses, Sheep and Goats, Swine

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Descriptors: animal behavior, group dynamics, social behavior, exercise, field size, pastured, grazing.

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Descriptors: isolation, stalls, cortisol, stress, disease, adrenal glands, haemoglobin, thyroid hormones, mitogens, lymphocyte transformation, environment, housing, haematology, immune response, age differences.

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Descriptors: stables, animal health, metabolic changes, humidity, environment, temperature, ammonia concentrations.

To: Top of Document | Introduction | Human Contact | Social Conditions | Physical Conditions | References | Farm Animal Bibliography: General, Cattle, Horses, Sheep and Goats, Swine

Sheep and Goats

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Descriptors: housing, environmental temperature, feed intake, production.

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To: Top of Document | Introduction | Human Contact | Social Conditions | Physical Conditions | References | Farm Animal Bibliography: General, Cattle, Horses, Sheep and Goats, Swine

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To: Top of Document | Introduction | Human Contact | Social Conditions | Physical Conditions | References | Farm Animal Bibliography: General, Cattle, Horses, Sheep and Goats, Swine

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[Main Contents] [Main Introduction] [How to Use This Document]
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The Effects of Environmental Enrichment in Ferrets

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- Introduction
- References
- Ferret Bibliography

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Environmental enrichment and impoverishment are relative terms. We can measure them with reference to the normal keeping environment of laboratory animals or to the environment of their wild counterparts; in doing so we might form quite different conclusions. The environment of the average laboratory animal is clearly less complex than that of its wild counterpart, yet for many burrow-living species the average amount of visual and auditory stimulation may be higher in the laboratory (Milligan *et al.* 1993), and this is especially true during rearing. On the other hand the ready provision of food in all seasons, and the protection from both conspecific aggression and predation may make a good laboratory environment less stressful than a natural one if assessed on a life-time basis.

The ferret is a close relative of the polecat (*Mustela putorius*) and has been domesticated for 2000 years. It is widely kept as a working animal for use in trapping rabbits and is an increasingly popular laboratory animal: small enough to keep easily in the laboratory and relatively easy to breed and handle.

Social environment and impoverishment must always be measured with reference to the development stage of an animal and the environment in which this usually occurs. Feral ferrets are essentially solitary and nocturnal, but in captivity show much diurnal activity and individuals may be kept together, although males are often intolerant when in breeding condition. Keeping breeding males apart may reduce stress, but depriving ferret kits of conspecifics during the first month of life when much time is spent in play clearly impoverishes. By analogy with the rat (Potegal and Einon 1989, Morgan 1976, Einon and Sahakian 1983, Einon 1980) such impoverishment could alter later social interaction, sexual behavior, learning, drug tolerance, activity and body size. However as yet there has been little investigation of any of these questions in ferrets.

Most work on lifetime environmental enrichment and impoverishment has been carried out with rats and mice, work on ferrets has largely concerned the provision of objects and conspecifics for play during development. Exceptions include work by Korhonen and colleagues (Korhonen and Harri 1990, Korhonen *et al.* 1992) who examined the effects of differing housing regimes on body weight and pelt quality, concluding that males housed singly had poorer pelt quality than males raised in groups, but t hat large, all male groups weighed less. Floor space used in housing also influenced pelt quality. They suggest that cages containing one male and one female produces the best pelt size and quality. If body weight and pelt quality reflect the health of animals then this is the optimal housing outside the breeding season. They found that social status correlated with weight; but whether this is causal is unclear. The authors also found that

balls and bite cups reduced skin biting. The addition of "toys" to ferret cages is certainly desirable. Other work suggests that changing these toys on a day-to-day basis has advantages.

Where ferrets are kept in cages which restrict movements there are skeletal changes especially of the hind limbs (Slesarenko 1986), and in a related species social impoverishment has been found to induce more stereotyped behavior (Bildsøe *et al.* 1990). In hot climates there are reports that restriction, crowding and captivity may itself be stressful (Gazizov 1987). Heat stress, and such severe restriction of movement reflect poor husbandry, but while such work is of less relevance in countries with controls upon animal housing, giving ferrets and other mustelids access to space for exercise is clearly important. We should bear in mind that while the whole surface of a cage can provide a "gym" for young mice and rats, ferrets do not swing and climb in the same way.

Chivers and Einon (1982) found that some of the isolation induced effects on behavior which had been shown in rats also occurred in ferrets. Specifically, deprivation of rough and tumble social play caused hyperactivity which persisted into adulthood. Rats deprived in this way also showed poor reversal of previously learned tasks (Morgan 1976), increased susceptibility to amphetamine (Einon and Sahakian 1983) and poor spatial memory (Einon 1980). The fact that a group of socially reared ferrets whose environment was enriched with a series of changing tube systems (Weiss-Buerger 1981) were superior in maze learning and reversal, suggests that they may respond in a similar fashion. Chivers and Einon also showed that the isolation induced deficits in object exploration found in rats were absent in ferrets raised in isolation. The way in which ferrets manipulate objects is influenced by rearing environment. Russell (1990) found that isolated ferrets raised in enriched conditions (with a daily change of play objects) would choose the arm of a maze leading to the more prey-like of two play objects; were superior in capturing both crickets and moving prey-models, and that more elaborate prey-catching responses were elicited from enriched than impoverished animals when placed with dummy objects and remote controlled fur-covered toy cars. Captive as compared to laboratory rearing (Miller *et al.* 1990) also affects predatory skills, particularly the location of prey.

In conclusion although little work has been carried out on impoverishment and enrichment in ferrets, investigations so far suggest impoverishment, whether physical restriction, social or in manipulation of objects has wide ranging effects; especially when imposed during rearing.

To: Top of Document | Introduction | References | Ferret Bibliography

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To: Top of Document | Introduction | References | Ferret Bibliography

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To: Top of Document | Introduction | References | Ferret Bibliography

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[Main Contents] [Main Introduction] [How to Use This Document]
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Rabbits

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- Introduction
- The Natural Environment
- The Laboratory Environment
- Conventional Housing for Rabbits
- Welfare and Behavioral Needs
- Improvements in Rabbit Housing
- References
- Rabbit Bibliography

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[AWIC] [Main Contents] [Main Introduction] [How to Use This Document]
[Birds] [Laboratory Cat] [Dogs and Dog Housing] [Farm Animals] [Ferrets] [Rabbits] [Rodents]
[Journal Listing] [Subscription Information for Selected Publications] [Organizations] [Suppliers and Products]
[Common Devices and Programs] [Main Subject Index] [Document Delivery Information]

This short paper introduces the general housing and husbandry of laboratory rabbits. The behavior of wild rabbits is compared with that of their laboratory counterparts, and consideration is given to their behavioral needs from the welfare point of view as well as to the effects of husbandry on scientific research.

The natural environment

The wild rabbit is gregarious, living in family groups in natural colonies or warrens (Cowan 1987). Rabbits spend most of their time underground in burrows during the diurnal period and venture above ground at night when they are generally more active, feeding mainly at dawn and dusk (Mykytowycz 1958). Females dig burrows to prepare nests for the protection of their young which are born helpless and blind; they also serve as a haven in an emergency (Cowan and Bell 1986). In terms of their social activities, stable breeding groups are formed with linear hierarchies of both males and females (Mykytowycz 1958, Cowan 1987). Once stabilized, the order of dominance is generally sustained and fighting is rare (Mykytowycz and Rowley 1958, Lockley 1961); the social organization being controlled by scent marking and territorial patrols which involve chin-marking from cutaneous glands, urination, defecation, and behavioral displays. Male rabbits naturally distance themselves to avoid conflict (Mykytowycz 1958) while females will only fight to compete for burrows if they are in limited supply (Kunkele 1992). Social behaviors include allogrooming and group foraging activities. Rabbits adopt "look-out" positions for potential predators and foot-thumping serves as an alarm signal to alert the colony (McFarland 1987), from which the rabbits run at high speeds for cover, often leaping and jumping obstacles in the process.

Observations on domestic rabbits have shown that there are few differences in their behavior compared with their wild counterparts (Mykytowycz and Hesterman 1975, Bell 1984) so it remains likely that the potential for the full range of behavior of wild rabbits is still present genetically, despite some selection for physical, physiological and behavioral

traits.

To: Top of Document | Introduction | The Natural Environment | The Laboratory Environment | Conventional Housing for Rabbits | Welfare and Behavioral Needs | Improvements in Rabbit Housing | References | Rabbit Bibliography

The laboratory environment

Whilst the quality and quantity of laboratory bred rabbits have improved over the past 40 years or so, their psychological well-being has largely been neglected. Advances have included genetic selection for clearly defined pure-bred strains, such as New Zealand Whites, Dutch and Lops, with traits for docility, reproductive performance and growth as well as a vastly improved health status. Other improvements include a standardized complete diet, and a protected and standardized environment of caging, ventilation, lighting, temperature and humidity (Clough 1982). However, such standardized cage designs have evolved mainly for the ease of husbandry and economic considerations, and it is apparent that some of these designs have had undesirable effects on the animals, particularly a reduction in space (Gunn and Morton 1994). Physical and social isolation offers no mental stimulation (Huls *et al.* 1991). Furthermore, the constant feeding of a highly refined pelleted diet is likely to be monotono us (BVAAWF/FRAME/RSPCA/UFAW 1993). There is evidence that all of these have lead to both physiological (Lehmann 1984, Wieser 1984) and psychological problems. Caged rabbits also show behavioral abnormalities including stereotypies (Stauffacher 1992, BVA AWF/FRAME/RSPCA/UFAW 1993) which may be signs of discomfort, mental suffering and distress (Lawrence and Rushen 1993, Gunn 1994) even though the animals are able to grow and reproduce. There is an ethical mandate to improve the animal's well-being (Broo m 1988, Wemelsfelder 1984). It is important to minimize suffering not only for welfare reasons, but also because such "suffering" may result in a range of physiological or psychological changes which could add unintentional variables to the experimental design and affect the accuracy and reliability of the scientific results (BVAAWF/FRAME/RSPCA/UFAW 1993, Gunn 1994). This in turn may lead to more animals being used in research than is necessary.

To: Top of Document | Introduction | The Natural Environment | The Laboratory Environment | Conventional Housing for Rabbits | Welfare and Behavioral Needs | Improvements in Rabbit Housing | References | Rabbit Bibliography

Conventional housing for rabbits

For many years rabbits have been housed in purpose-built metal cages. Single caging isolates rabbits from physical and visual contact and prevents any social interaction, particularly in solid-walled cages (Gunn 1994, Huls *et al.* 1991). They also restrict movement (with minimal floor area (Gunn and Morton 1994, BVAAWF/FRAME/RSPCA/UFAW 1993) and height) so that rabbits are unable to perform normal ambulation or rearing activities (Gunn and Morton 1994, BVAAWF/FRAME/RSPCA/UFAW 1993). The barren environment provides no stimulation which leads to abnormal behavior patterns such as bar-biting and clawing of the cage (Stauffacher 1992, Gunn and Morton 1994). These stereotypic activities substitute for natural behaviors which are denied by standard laboratory conditions (Stauffacher 1992) and may indicate frustration, anxiety or boredom, and develop in stages involving a progressive narrowing of the behavioral repertoire (Gunn 1994). A lack of exteroceptive stimulation, restricted movement and social inhibition are reported to be initial causal factors (Dantzer 1986). Other indicators of boredom have been observed such as hunched posture (Gunn and Morton 1994), inertia (Metz 1984), and a staring coat and dull eyes which may also indicate poor health (Wallace *et al.* 1990). As the caged environment is not sufficient to permit an adequate level of physical activity, caged rabbits can develop osteoporosis (Lehmann 1984) and back-bone distortions (Wieser 1984), and a high percentage of intestinal disorders (Jackson 1991) may be a result of "caging stress".

To: Top of Document | Introduction | The Natural Environment | The Laboratory Environment | Conventional Housing for Rabbits | Welfare and Behavioral Needs | Improvements in Rabbit Housing | References | Rabbit Bibliography

Welfare and behavioral needs

It is no longer considered acceptable to only provide for animals' physiological needs or to provide conditions which maximize productivity (Dawkins 1980). The care of captive animals should also include consideration of their behavioral needs. Some behaviors which are essential to the animal's well-being are not provided for in the laboratory, such as allogrooming, digging for the purpose of nest-building (Podberscek *et al.* 1991), and foraging (Stauffacher 1992). The inability to perform certain behaviors is thought to lead to intention movements, or inappropriate or abnormal behaviors (Dantzer 1986, Lawrence and Rushen 1993). Subjective states, such as boredom and frustration, can be evaluated through the use of careful experimental design. Other abnormal activities include under- or over-grooming and eating, leading to a staring coat, hair-balls (intestinal stasis - Jackson 1991), weight loss and obesity, respectively. These conditions are commonly observed in singly caged rabbits (BVAAWF/FRAME/RSPCA/UFAW 1993, Gunn 1994). Such behaviors are maladaptive and provide clear evidence of a need for some environmental improvement. These activities are often associated with apathy and a refusal to respond which are indicative of psycholo gical disorders and show a lack of adaptation rather than a coping strategy (Lawrence and Rushen 1993).

To: Top of Document | Introduction | The Natural Environment | The Laboratory Environment | Conventional Housing for Rabbits | Welfare and Behavioral Needs | Improvements in Rabbit Housing | References | Rabbit Bibliography

Improvements in rabbit housing

The natural social organization of this species should influence how we house rabbits in laboratories. Since wild rabbits live in groups containing at least one other rabbit of the same sex (Cowan 1987), it seems sensible to suggest that they should at least be housed in pairs, with the exception of mature males (unless they have been castrated - Gunn 1994). Whether grouping rabbits in pairs in cages, in floor pens, or in breeding groups, they should have opportunities for "exercise" and social interaction (BVAAWF/FRAME/RSPCA/UFAW 1993, Batchelor 1991), allowing them more control over their immediate environment. As they are social animals they mix well at an early age, although there may be problems with removal or replacement of adults in an est ablished group (Hammond and Love 1989, Love and Hammond 1991). Males can also be group-housed until they reach sexual maturity, but may then have to be castrated to be housed successfully in stable groups for lengthy periods. If rabbits must be caged in dividually for experimental reasons, enriching the cage environment has been shown to be beneficial. The cages should be, as a minimum, large enough to enable the rabbits to sit upright and lie out at full stretch (Gunn 1994), have visual contact with ot her rabbits, an area to withdraw to, a shelf for resting on (Stauffacher 1992) as well as an improved visual field. The provision of roughage such as hay (Gunn 1994), and straw, a varied diet and objects to gnaw on (Stauffacher 1992) or manipulate (e.g., wooden shapes - Huls *et al.* 1991) have been suggested to alleviate boredom and stereotypic activities (Brooks *et al.* 1993, Gunn 1994) and thus substantially improve welfare. Some of these enrichments apply equally to rabbits grouped in pens. It is recommended from an animal welfare point of view that whenever possible rabbits should be group-housed (Home Office 1989, Batchelor 1991) unless the experimental design prohibits it.

To: Top of Document | Introduction | The Natural Environment | The Laboratory Environment | Conventional Housing for Rabbits | Welfare and Behavioral Needs | Improvements in Rabbit Housing | References | Rabbit Bibliography

References

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To: Top of Document | Introduction | The Natural Environment | The Laboratory Environment | Conventional Housing for Rabbits | Welfare and Behavioral Needs | Improvements in Rabbit Housing | References | Rabbit Bibliography

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Descriptors: movement, vertebrae, hypoplasia, cages, housing, cancellous bone.

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Descriptors: exercise, social contact, group housing, single housing, environmental enrichment, behavior.

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NAL call number: QP351 D4
Descriptors: psychology, social activity, exploratory activity, open-field test, handling, infancy.

To: Top of Document | Introduction | The Natural Environment | The Laboratory Environment | Conventional Housing for Rabbits | Welfare and Behavioral Needs | Improvements in Rabbit Housing | References | Rabbit Bibliography

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[Main Contents] [Main Introduction] [How to Use This Document]
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Environmental Enrichment in Rodents

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- Introduction
- Social Environment
- Nutritional Environment
- Sensory Environment
- Psychological Environment
- Physical Environment
- Evaluation of an Enrichment Program
- References
- Rodent Bibliography
  - Gerbils and Hamsters
  - Guinea Pigs
  - Mice
  - Rats
  - Wild Rodents

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[Journal Listing] [Subscription Information for Selected Publications] [Organizations] [Suppliers and Products]
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Environments of laboratory animals have often been designed on the basis of economic and ergonomic aspects, with little or no consideration for animal welfare. Laboratory housing conditions can deprive animals the possibility of performing a full repertoire of normal behavior. As a response to this lack of stimulation animals may show abnormal behaviors, such as stereotypies or passiveness (Wemelsfelder 1990).

The living conditions and therefore the well-being of captive animals can be improved through environmental enrichment. Environmental enrichment can be defined as altering the living environment of captive animals in order to provide opportunities to express more of their natural behavioral repertoire. It is widely acknowledged that allowing animals to perform the widest possible range of behaviors is likely to be beneficial and, furthermore, providing environmental enrichment has been shown to reduce stereotypic behavior in captivity (e.g., bank voles: Ödberg 1987).

The environment of an animal consists of a wide range of stimuli, including the social environment of conspecifics, contraspecifics and humans, and the physical environment such as the cage and its contents (See Figure 1). Currently used caging for rodents restricts various behaviors (O' Donoghue 1993) and it is recommended that the cage environment should be improved to cater for physiological and ethological "needs" including resting, grooming, exploring, hiding, searching for food, and gnawing.

[Note: Figure 1 is not available in electronic format. Caption: "Stimuli in the environment of laboratory animals

(Baumans 1994)." Stimuli listed are: 1) Cage Size Structure Accessories, 2) Conspecifics, 3) Contraspecifics, 4) Humans, 5) Auditory Visual Olfactory Tactile, and 6) Nutrition.]

To: Top of Document | Introduction | Social Environment | Nutritional Environment | Sensory Environment | Psychological Environment | Physical Environment | Evaluation of an Enrichment Program | References | Rodent Bibliography: Gerbils and Hamsters, Guinea Pigs, Mice, Rats, Wild Rodents

Social environment

Conspecifics, contraspecifics, and humans

The social environment of animals can be enriched by housing them together with conspecifics in pairs or in groups. This will only be successful if the groups or pairs formed are harmonious and stable. Mice and rats are social animals and often housed in groups, although this is not a natural situation for the males. In some strains, especially in mice, aggression may be a problem and the males need to be separated. In contrast, hamsters are not social, which eventually can lead to problems when housing such animals together.

Housing together several animal species in the same room is often common practice. It is not known whether contraspecifics housed in one animal room are affected by the olfactory and auditory cues from each other. Humans are part of the social environment of laboratory animals and handling the animals is a very important aspect of this daily care routine. It is also beneficial to train animals to become used to routine handling and procedures (Biological Council 1992).

To: Top of Document | Introduction | Social Environment | Nutritional Environment | Sensory Environment | Psychological Environment | Physical Environment | Evaluation of an Enrichment Program | References | Rodent Bibliography: Gerbils and Hamsters, Guinea Pigs, Mice, Rats, Wild Rodents

Nutritional environment

Supply and type

In the wild, rodents spend a major proportion of their time searching for and consuming food. In the laboratory food is mostly provided *ad libitum* and easily obtained by the animals. For enrichment purposes food items can be scattered in the substrate or bedding so that the animals spend time searching for it. Carder and Berkowitz (1970) found that rats preferred earned food although free food was available, when the work demands were not too high . For hamsters who naturally hoard their food, scattering food pellets into the cage is an easy source of stimulation.

The type of food given to laboratory animals is usually standardized in the form of pellets but additional food such as hay or straw can be supplied to satisfy the need for roughage.

To: Top of Document | Introduction | Social Environment | Nutritional Environment | Sensory Environment | Psychological Environment | Physical Environment | Evaluation of an Enrichment Program | References | Rodent Bibliography: Gerbils and Hamsters, Guinea Pigs, Mice, Rats, Wild Rodents

Sensory environment

Auditory, visual, olfactory and tactile

Sensory enrichment can be provided in many forms. Animals such as guinea pigs, which are easily frightened, react to noises in their environment; a radio which plays softly during the day can mask sudden background noises.

In many animal facilities, light intensity is usually too high. This may have deleterious effects on eyes such as retinal degeneration (Williams *et al.* 1985), especially in albinos. Rodents, who are essentially nocturnal animals, should be given the opportunity to hide from light.

To: Top of Document | Introduction | Social Environment | Nutritional Environment | Sensory Environment | Psychological Environment | Physical Environment | Evaluation of an Enrichment Program | References | Rodent Bibliography: Gerbils and Hamsters, Guinea Pigs, Mice, Rats, Wild Rodents

Psychological environment

Control of the environment

It is important that animals have a certain degree of control over their environment, as a lack of control may cause stress. Rats reared in an environment in which they could control lighting, food and water supply were less emotional compared to controls (Joffe *et al.* 1973). In the laboratory cage the possibilities for animals to control their environment are restricted. However providing a shelter or refuge gives them the opportunity to withdraw from frightening stimuli outside or inside their cage as well as hide from too much light. Plastic tubes (Peters and Festing 1990) or old drinking bottles (Ward and DeMille 1991) are simple solutions for shelters.

To: Top of Document | Introduction | Social Environment | Nutritional Environment | Sensory Environment | Psychological Environment | Physical Environment | Evaluation of an Enrichment Program | References | Rodent Bibliography: Gerbils and Hamsters, Guinea Pigs, Mice, Rats, Wild Rodents

Physical environment

Cage size, structure and accessories

Sometimes enlarging the available space for an animal can enhance well-being. Small cages may increase the incidence of stereotyped movements and other non-locomotor abnormal behaviors (Ödberg 1987). Enlarging the available space can be achieved by providing climbing accessories, shelters/refuges and exercise devices. When mice were given a divided cage with a bedding section and a wire mesh section, they deposited almost all excreta on the wire mesh floor, thus keeping their sleeping area clean (Blom 1993).

Nesting material such as tissues, hay or wood-wool enables rodents to perform nest-building behavior. Softwood sticks can be provided to guinea pigs for manipulation and gnawing (Sharmann 1991).

To: Top of Document | Introduction | Social Environment | Nutritional Environment | Sensory Environment | Psychological Environment | Physical Environment | Evaluation of an Enrichment Program | References | Rodent Bibliography: Gerbils and Hamsters, Guinea Pigs, Mice, Rats, Wild Rodents

Evaluation of an enrichment program

When introducing enrichment to an animal's environment, it is very important to evaluate the enrichment program used, by assessing whether or not the animals respond to the enrichment and maintain interest.

Assess baseline behavior; introduce enrichment; monitor behavior; analyze responses; long term effects

Reactions of the animals to the enrichment should be monitored and compared with baseline behavior, which was

assessed before introduction of enrichment. An increase in species-typical behavior or a decrease in abnormal behavior may be seen. Different strains of animals can respond differently to enrichment as has been observed in mice (van de Weerd *et al.* 1994). It is also important to assess whether the changes in behavior are short or long term effects, as the animals may be interested in the enrichment for a short period only. Physiological variables can also be monitored to assess responses to changes in laboratory environments, e.g., body-weight, heart rate, hormonal levels, immune status and reproductive function (Markowitz and Line 1990).

When introducing enrichment in the laboratory, costs and the practical use of enrichment items are also important. Objects introduced into the cage should be stimulating for the animals, but they should also be easy to remove, clean, and replace, so that personnel are willing to work with them. If it is clear to those responsible for animals that environmental enrichment is beneficial to the animals, their motivation to work with and to improve the enrichment program should increase.

To: Top of Document | Introduction | Social Environment | Nutritional Environment | Sensory Environment | Psychological Environment | Physical Environment | Evaluation of an Enrichment Program | References | Rodent Bibliography: Gerbils and Hamsters, Guinea Pigs, Mice, Rats , Wild Rodents

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To: Top of Document | Introduction | Social Environment | Nutritional Environment | Sensory Environment | Psychological Environment | Physical Environment | Evaluation of an Enrichment Program | References | Rodent Bibliography: Gerbils and Hamsters, Guinea Pigs, Mice, Rats, Wild Rodents

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NAL call number: QL55 A1L33
Descriptors: hamster, Golden, male, socialization, solitary nature, caging, Habitrail tunnels, bedding, handling, group housing.

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Descriptors: hamster, Golden, female, adult, isolation, socially reared, bedding, body weight, body fat.

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Descriptors: gerbil, adult, old, locomotor activity, outdoor experience vs. laboratory rearing, novel objects, odors, food.

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Descriptors: gerbil, male, female, cage density, body weight, vaginal opening, age.

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Descriptors: hamster, Golden, female, male, olfaction, pheromones, litter size, pregnancy rate.

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NAL call number: 447.8 Am3
Descriptors: hamster, Siberian, male, ambient temperature, body temperature, gonadectomized, running wheel, body mass.

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To: Top of Document | Introduction | Social Environment | Nutritional Environment | Sensory Environment |

Guinea Pigs

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Descriptors: guinea pig, female, pregnant, nonpregnant, transport simulator, ACTH, zinc.

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Descriptors: guinea pig, female, neonate, lactating, virgin, behavior, silence, nonvocal sounds, communication, maternal behavior.

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NAL call number: 410 Z35
Descriptors: guinea pig, male, female, behavior, activity, social group, dominance, aggression, vocal communication.

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Descriptors: guinea pig, male, female, isolation, maternal care, exploratory behavior, activity, play, open-field behavior.

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NAL call number: QP1 P4
Descriptors: guinea pig, male, female, isolation, group-housed, body weight, tyrosine hydroxylase, activity, aggression.

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To: Top of Document | Introduction | Social Environment | Nutritional Environment | Sensory Environment | Psychological Environment | Physical Environment | Evaluation of an Enrichment Program | References | Rodent Bibliography: Gerbils and Hamsters, Guinea Pigs, Mice, Rats, Wild Rodents

Mice

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Descriptors: mouse, environmental enrichment, impoverishment, open field, activity.

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Descriptors: mouse, Swiss, aversive stimuli, environmental enrichment, darkness, handling, open field, defecation, activity.

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Descriptors: mouse, female, caging, preference testing, shelter.

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NAL call number: QP351 S6
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Descriptors: mouse, dwarf, locomotor activity, learning.

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NAL call number: QH301 C63
Descriptors: mouse, weanling, dwarf, open-field, habituation, behavior.

Bouchon, R. and B. Will (1983). **Effects of post-weaning environment and apparatus dimension on spontaneous alternation as a function of phenotype in "dwarf" mice.** *Physiology and Behavior* 30(2):213-219.
NAL call number: QP1 P4
Descriptors: mouse, DW/Orl-dw, inbred strain, male, maze, spatial information, behavior.

Brain, P.F. (1992). **Understanding the behaviours of feral species may facilitate design of optimal living conditions for common laboratory rodents.** *Animal Technology*: *Journal of the Institute of Animal Technology* 43(2):99-105.
NAL call number: QL55 I5
Descriptors: welfare, housing, husbandry, rabbit, mouse, rat, gerbil, hamster, optimal living conditions.

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NAL call number: 442.8 L62
Descriptors: mouse, isolation, caging, socially reared, adrenal medullary function, adenocortical function, reproduction, neurochemistry, defeat experiments, review.

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NAL call number: 470 Sci25
Descriptors: mouse, running wheel, burrow, reproduction, foraging, temperature, social cues, behavior, review.

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NAL call number: QL55 A1L3
Descriptors: mouse, caging, partitions, activity, stress, adrenal glands, behavior, complexity.

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NAL call number: BF671 J6
Descriptors: mouse, Swiss CD-1, isolation, olfaction, agonistic behavior, dominance.

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Descriptors: mouse, Quackenbush albino, male, strychnine, chlorpromazine, activity, socialization.

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Descriptors: mouse, neonate, weanling, aging, occipital cortex, neuronal development, metabolic activity.

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Descriptors: mouse, BALB/c, young, maze, open field, exploration, aversive response, swimming, induced grooming, whole brain, cerebellum, brain stem, diencephalon, telencephalon, prosencephalon.

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Descriptors: mouse, cortex, discrimination tasks.

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restriction effects on reactivity, exploration and maze learning in mice with septal lesions. *Physiology and Behavior* 29(5):885-893.
NAL call number: QP1 P4
Descriptors: mouse, Binghamton, heterogenous, male, handling-reactivity test, open-field, water-maze, learning, behavior.

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NAL call number: S543.V5V5
Descriptors: mouse, ICR-albino, female, prebreeding, postbreeding, embryo survival, density, corticosteroids.

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NAL call number: QL55 A1L3
Descriptors: mouse, BALB/c, TO, CD-1, Laboratory Animal Breeders Association Guidelines, housing, male, female, breeding, litter size.

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NAL call number: 12 N3892
Descriptors: mouse, male, female, weanling, liver weight, P-450 enzymes, polychlorophenols, bedding.

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Descriptors: mouse, visual cortex, maze, neuronal plasticity.

Goodlet, C.R., W.J. Engellenner, R.G. Burright, and P.J. Donovick (1982). **Influence of environmental rearing history and postsurgical environmental change on the septal rage syndrome in mice.** *Physiology and Behavior* 28(6):1077-1081.
NAL call number: QP1 P4
Descriptors: mouse, Binghamton, heterogenous, septal lesions, handling reactions.

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Descriptors: mouse, behaviorally deficient mutant, environmental enrichment, vestibular, muscular, and visual stimulation.

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NAL call number: 447.8 Am3
Descriptors: mouse, noise, stress, temperature, gastrointestinal transit.

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NAL call number: QL737 R638M68
Descriptors: mouse, high fat content, plastic vs. aluminum caging.

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NAL call number: QH301 B45
Descriptors: mouse, genetic variance, genotype, housing, environmental enrichment.

Hoffman, G.L., J.R. Simpson, and Y. Arumugam (1991). **Impact of changes in housing condition on mouse natural**

killer cell activity. *Physiology and Behavior* 49(3):657-660.
NAL call number: QP1 P4
Descriptors: mouse, male, caging, tumors, in vitro, cytolytic activity.

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NAL call number: 410 B77
Descriptors: mouse, male, bedding, olfaction, isolation, interaction.

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NAL call number: SF406 I52
Descriptors: mouse, age, noise, test interval, seizure-prone, drugs, non-auditory stimuli.

Iturrian, W.B. and G.B. Fink (1968). **Comparison of bedding material: Habitat preference of pregnant mice and reproductive performance.** *Laboratory Animal Care* 18(2):160-164.
NAL call number: 410.9 P94
Descriptors: mouse, female, behavior, cellulose, nesting.

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NAL call number: 176.622 J82
Descriptors: mouse, SWJ/Jac, male, female, hepatoma, cedar shavings, bedding.

Jones, R.B. (1992). **Reply to McGregor, Barnard, and Hurst** (see App.Anim.Behav.Sci. 33:297-299). *Applied Animal Behaviour Science* 33:300-301.
Descriptors: mouse, environmental enrichment, impoverished, aggression, caging, animal welfare.

Jones, R.B. (1992). **Varied cages and aggression.** *Applied Animal Behaviour Science* 33(2-3):295-296.
Descriptors: mouse, male, environmental enrichment, standard caging, impoverished, dominance, submission, fighting, olfaction, benefits.

Karp, J.D., J.A. Moynihan, and R. Ader (1993). **Effects of differential housing on the primary and secondary antibody responses of male C57BL/6 and BALB/c mice.** *Brain, Behavior, and Immunity* 7(4):326-333.
Descriptors: mouse, inbred, male, keyhole limpet hemocyanin, isolation, group-reared, IgM, IgG.

Klipple, J.A. (1978). **Behavioral persistence following switchovers between environmental enrichment and impoverishment in mice.** *Developmental Psychobiology* 11(6):541-557.
NAL call number: QP351 D4
Descriptors: mouse, weanling, environmental enrichment, impoverishment, behavior.

Koyama, S. (1993). **Isolation effect in mice (*Mus musculus*):(i) Does it really induce aggression?** *Journal of Ethology* 11(2):117-130.
NAL call number: QL750 J68
Descriptors: mouse, isolation, group-reared, dominance, territorial dominance, behavior.

Koyama, S. (1993). **Isolation effect in mice (*Mus musculus*):(ii) Variance in aggression.** *Journal of Ethology* 11(2):131-140.
NAL call number: QL750 J68
Descriptors: mouse, isolation, dominance, behavior.

Kropveld, D. and R.A. Chamuleau (1993). **Doppler radar device as a useful tool to quantify the liveliness of the experimental animal.** *Medical and Biological Engineering and Computing* 31(4):340-342.
Descriptors: mouse, BALB/c, rat, Wistar, activity, circadian rhythm.

Kubanis, P., S.F. Zornetzer, and G. Freund (1982). **Memory and postsynaptic cholinergic receptors in aging mice.** *Pharmacology, Biochemistry, and Behavior* 17(2):313-322.
NAL call number: QP901 P4
Descriptors: mouse, C57BL/6, male, female, young, old, passive avoidance tasks, ^{3}H-QNB, muscarinic receptor binding, benzodiazepine binding, cortex, striatum, hippocampus, cerebellum, brain stem.

Levine, L., J. Grossfield, and R.F. Rockwell (1979). **Functional relationships between genotypes and environments in behavior: Effects of different kinds of early social experience on interstrain fighting in male mice.** *Journal of Heredity* 70(5):317-320.
NAL call number: 442.8 Am3
Descriptors: mouse, ST/bJ, CBA/J, male, socially reared, isolation, behavior.

Manosevitz, M. and J.B. Pryor (1975). **Cage size as a factor in environmental enrichment.** *Journal of Comparative and Physiological Psychology* 89(6):648-654.
NAL call number: 410 J822
Descriptors: mouse, C57BL/6J, cage size, surface texture, wire, Plexiglas, body weight, open-field, defecation, running-wheel, exploration, water consumption.

Manosevitz, M., R.B. Campenot, and C.F. Swencionis (1968). **Effects of enriched environment upon hoarding.** *Journal of Comparative and Physiological Psychology* 66(2):319-324.
NAL call number: 410 J822
Descriptors: mouse, inbred, genotype, genotype/environment interactions.

Manosevitz, M. and U. Joel (1973). **Behavioral effects of environmental enrichment in randomly bred mice.** *Journal of Comparative and Physiological Psychology* 85(2):373-382.
NAL call number: 410 J822
Descriptors: mouse, open field, defecation, running wheel, exploration, hoarding, activity, adrenal gland, body weight, behavior.

Manosevitz, M. (1970). **Early environmental enrichment and mouse behavior.** *Journal of Comparative and Physiological Psychology* 71(3):459-466.
NAL call number: 410 J822
Descriptors: mouse, open field, running wheel, food competition, defecation.

Manosevitz, M. and R.J. Montemayor (1972). **Interaction of environmental enrichment and genotype.** *Journal of Comparative and Physiological Psychology* 79(1):67-76.
NAL call number: 410 J822
Descriptors: mouse, A/J, C3H/HeJ, C57BL/10J, neonate, weanling, open field, exploration, running wheel, activity.

Martinez, S., M. Ramirez, A. Salvador, and V.M. Simon (1993). **Olfaction of defeated mice may play an important role in subsequent agonistic behavior of the winners.** *Aggressive Behavior* 19(1):60-61.
NAL call number: BF575 A3A57
Descriptors: mouse, male, isolation, socially housed, behavior, exploration, activity, abstract.

McGregor, P.K., C. Barnard, and J.L. Hurst (1992). **Reply [to R.B. Jones on Varied cages and aggression].** *Applied Animal Behaviour Science* 33: 297-299.
NAL call number: QL750 A6
Descriptors: mouse, male, aggression, caging, objects, dominance, submission, fighting, animal welfare, environmental enrichment, anthropocentric view, olfaction.

McGregor, P.K. and S.J. Ayling (1990). **Varied cages result in more aggression in male CFLP mice.** *Applied Animal Behaviour Science* 26(3):277-281.
NAL call number: QL750 A6
Descriptors: mouse, CFLP, male, behavior, caging.

Misslin, R. and P. Ropartz (1981). **Responses of mice to a novel object.** *Behaviour* 78(3-4):169-177.
NAL call number: 410 B393
Descriptors: mouse, Swiss albino, male, novel environment, familiar environment, contacts, behavior.

Mondragon, R., L. Mayagoitia, A. Lopez-Lujan, and J.-L. Diaz (1987). **Social structure features in three inbred strains of mice, C57BL/6J, Balb/cj, and NIH: A comparative study.** *Behavioral and Neural Biology* 47(3):384-391.
NAL call number: QH301 C63
Descriptors: mouse, male, adult, inbred, behavior, aggression, exercise wheel.

Mulder, J.B. (1975). **Bedding preferences of pregnant laboratory reared mice.** *Behavior Research Methods and Instrumentation* 7(1):21-22.
Descriptors: mouse, female, bedding.

Nielsen, J., O. Andersen, and P. Svendsen (1985). **Induction of liver-enzymes in mice by alpha-pinene from softwood bedding.** *Zeitschrift für Versuchstierkunde* 27((2):105.
NAL call number: 410 Z36
Descriptors: mouse, bedding, spruce/pine shavings, pinene, P-450 enzymes, anesthesia.

Nielsen, J.B., Andersen, O., and P. Svendsen (1986). **Hepatic O-deethylase activity in mice on different types of bedding.** *Zeitschrift für Versuchstierkunde* 28(1-2):69-75.
NAL call number: 410 Z36
Descriptors: mouse, male, female, wood shavings.

Petitto, J.M., D.T. Lysle, J.L. Gariepy, and M.H. Lewis (1994). **Association of genetic differences in social behavior and cellular immune responsiveness: Effects of social experience.** *Brain, Behavior, and Immunity* 8(2):111-122.
Descriptors: mouse, ICR, social behavior, isolation-induced aggressiveness, group housing, tumor development, natural killer cells, T cells, B cells.

Port, C.D. and J.P. Kalenbach (1969). **The effect of corncob bedding on reproductivity and leucine incorporation in mice.** *Laboratory Animal Care* 19(1):46-49.
NAL call number: 410.9 P94
Descriptors: mouse, mycotoxins, dietary proteins, liver metabolism.

Schrott, L.M., V.H. Denenberg, G.F. Sherman, N.S. Waters, G.D. Rosen, and A.M. Galaburda (1992). **Environmental enrichment, neocortical ectopias, and behavior in the autoimmune NZB mouse.** *Developmental Brain Research* (Netherlands) 67(1):85-93.
Descriptors: mouse, New Zealand Black, male, discrimination learning, spatial maze, shuttlebox, autoimmune disease.

Smith, W. and S. Ross (1953). **The hoarding behavior of the mouse.** *The Journal of Genetic Psychology* 82: 279-316.
Descriptors: mouse, behavior, feed.

Tennekes, H.A., A.S. Wright, K.M. Dix, and J.H. Koeman (1981). **Effects of dieldrin, diet, and bedding on enzyme function and tumor incidence in livers of male CF-1 mice.** *Cancer Research* 41(9):3615-3620.
NAL call number: 448.8 C16
Descriptors: mouse, CF-1, male, bedding, Douglas fir sawdust, body weight, organ weight, hepatomas, hepatocellular enzymes.

Terranova, M.L., G. Laviola, and E. Alleva (1993). **Ontogeny of amicable social behavior in the mouse: gender differences and ongoing isolation outcomes.** *Developmental Psychobiology* 26(8):467-481.
NAL call number: QP351 D4
Descriptors: mouse, outbred CD-1, male, female, weanling, isolation, pair housing, play behavior, social interactions, exploration, activity, affiliative behavior.

Torronen, R., K. Pelkonen, and S. Karenlampi (1989). **Enzyme-inducing and cytotoxic effects of wood-based**

materials used as bedding for laboratory animals. Comparison by a cell culture study. [published erratum appears in Life Science 1989: 45(24):2381] *Life Science* 45(6):559-565.
NAL call number: 442.8 L62
Descriptors: mouse hepatoma cell line, Hepa-1, hardwoods (aspen and alder), softwoods (pine and pine-spruce), cellulose materials, cytochrome P450I1A, aldehyde dehydrogenase.

van de Weerd, H. A., V. Baumans, J.M. Koolhaas, and L.F.M. van Zutphen (August 1994). **Strain specific behavioural response to environmental enrichment in the mouse.** *Journal of Experimental Animal Science*. 36(4-5):117-127.
Descriptors: behavior, environment design, housing, Inbred BALB C, Inbred C57BL, species specificity.

Vlahakis, G. (1977). **Possible carcinogenic effects of cedar shavings in bedding of C3H-AVY FB mice.** *Journal of the National Cancer Institute* 58(1):149-150.
NAL call number: 176.622 J82
Descriptors: mouse, C3H-AVY, female, bedding, pine shavings, cedar shavings, mammary gland tumors.

Wainwright, P.E., Y.S. Huang, B. Bulman-Fleming, S. Levesque, and D. McCutcheon (1994). **The effects of dietary fatty acid composition combined with environmental enrichment on brain and behavior in mice.** *Behavioural Brain Research* 60(2):125-136.
Descriptors: mouse, male, female, pregnancy, weaning, nutrition, brain composition, Morris water maze, learning.

Wainwright, P.E., S. Levesque, L. Krempulec, B. Bulman-Fleming, and D. McCutcheon (1993). **Effects of environmental enrichment on cortical depth and Morris-maze performance in B6D2F2 mice exposed prenatally to ethanol.** *Neurotoxicology and Teratology* 15(1):11-20.
Descriptors: mouse, cortex, body weight, water maze, learning.

Ward, G.E. and D. DeMille (1991). **Environmental enrichment for laboratory mice (*Mus musculus*).** *Animal Technology: Journal of the Institute of Animal Technology* 42(3):149-156.
NAL call number: QL55 I5
Descriptors: mouse, environmental enrichment, cages, bottles, toys.

Warren, J.M., C. Zerweck, and A. Anthony (1982). **Effects of environmental enrichment on old mice.** *Developmental Psychobiology* 15(1):13-18.
NAL call number: QP351 D4
Descriptors: mouse, C57BL/6J, male, old, behavior, brain chemistry, toys, housing, females, cerebral cortex, maze, tasks.

Wilson, R.A. and P.S. Coulson (1984). **The effect of soft-wood bedding on the maturation of an infection of *Schistosoma mansoni* in mice exposed to cercariae via the tail or abdominal skin.** *Transactions of the Royal Society of Tropical Medicine and Hygiene* 78(3):411-412.
NAL call number: 448.9 R813
Descriptors: mouse, bedding, softwood sawdust, *Schistosoma mansoni*.

Yates, G., J. Panksepp, S. Ikemoto, E. Nelson, and R. Conner (1991). **Social isolation effects on the "behavioral despair" forced swimming test: Effect of age and duration of testing.** *Physiology and Behavior* 49(2):347-353.
NAL call number: QP1 P4
Descriptors: mouse, Swiss Webster, male, female, weanling, young depression, immobility, body weight, reserpine.

Yoshimura, H. and N. Kimura (1993). **Ethopharmacology of behavioral disorders induced by prolonged individual housing in male mice.** *Japanese Journal of Pharmacology* 61(Supplement 1):94.
Descriptors: mouse, male, isolation, copulation, imipramine, chlordiazepoxide, anti-psychotic drugs.

Zahem, H.B. and C.W. Alliston (1974). **The effects of noise level and elevated ambient temperature upon selected reproductive traits in female Swiss Webster mice.** *Laboratory Animal Science* 24(3):469-475.
NAL call number: 410.9 P94
Descriptors: mouse, Swiss Webster, female, temperature, noise, reproduction, embryos, gestation.

Rats

Ando, S., Y. Ohashi, and S. Kobayashi (1993). **Enhancement of learning ability by enriched environment.** *Neuroscience Research Supplement* 0(18):S150.
Descriptors: rat, environmental enrichment, learning, abstract.

Anzaldo, A.J., P.C. Harrison, G.L. Riskowski, L.A. Sebek, R-G. Maghirang, W.R. Stricklin, and H.W. Gonyou (1994). **Increasing welfare of laboratory rats with the help of spatially enhanced cages.** *Animal Welfare Information Center Newsletter* 5(3):1-2, 5.
NAL call number: aHV4701 A952
Descriptors: rat, Sprague-Dawley, male, caging, platforms, decks, cage dividers, spatially enhanced.

Armario, A., J.M. Castellanos, and J. Balaseh (1985). **Chronic noise stress and insulin secretion in male rats.** *Physiology and Behavior* 34:359-361.
NAL call number: QP1 P4
Descriptors: rat, male, stress, insulin, noise, behavior.

Batchelor, G.R. (1994). **The rest/activity rhythm of the laboratory rat housed under different systems**. *Animal Technology: Journal of the Institute of Animal Technicians* 45(3):181-187.
NAL call number: QL55 I5
Descriptors: rat, Wistar, male, sleep, activity, caging, isolation, socially reared, ladders, climbing frame, funnel, tubes, boxes, nesting container, film canisters, foraging devices.

Batchelor, G.R. (1993). **An enriched commune housing system for laboratory rats: A preliminary view.** *Animal Technology: Journal of the Institute of Animal Technicians* 44(3):201-213.
NAL call number: QL55 I5
Descriptors: rat, rabbit, housing, social groups, behavior, ladders, shelves, tubes, funnels, climbing frame, boxes.

Bean, G. and T. Lee (1991). **Social isolation and cohabitation with haloperidol-treated partners: Effect on density of striatal dopamine D2 receptors in the developing rat brain.** *Psychiatry Research* 36(3):307-317.
Descriptors: rat, male, female, weanling, young, isolation, striatum, handling.

Bennett, E.L., et al. (1974). **Effects of successive environments on brain measures.** *Physiology and Behavior* 12(4):621-631.
NAL call number: QP1 P4
Descriptors: rat, Berkeley S_1, environmental enrichment, impoverished, cerebrum, brain weight, acetylcholinesterase, cholinesterase, interlaboratory comparison.

Bennett, E.L., M.R. Rosenzweig, and M.C. Diamond (1969). **Rat brain: Effects of environmental enrichment on wet and dry weights.** *Science* 163(3869):825-826.
NAL call number: 470 Sci2
Descriptors: rat, Berkeley S_1, male, cortex, brain weight, impoverished.

Bernstein, L. (1972). **The reversibility of learning deficits in early environmentally restricted rats as a function of amount of experience in later life.** *Journal of Psychosomatic Research* 16(1):71-73.
Descriptors: rat, environmental enrichment, isolation, learning.

Bernstein, L. (1973). **A study of some enriching variables in a free-environment for rats.** *Journal of Psychosomatic*

Research 17(2):85-88.
Descriptors: rat, space, visual enrichment, toys, running wheel, activity, learning.

Bernstein, L. (1979). **Hebb's claim of irreversibility in environmentally restricted rats.** *American Psychologist* 34(9):802-803.
Descriptors: rat, learning, problem solving, environmental enrichment.

Bhide, P.G. and K.S. Bedi (1985). **The effects of a 30 day period of environmental diversity on well-fed and previously undernourished rats: Neuronal and synaptic measures in the visual cortex (area 17).** *Journal of Comparative Neurology* 236(1):121-126.
NAL call number: QP351 J68
Descriptors: rat, fetus, neonate, adult, nutrition, visual cortex, histology.

Birke, L.I. and D. Sadler (1988). **Effects of modulating neonatal progestins and androgens on the development of play and other social behavior in the rat.** *Hormones and Behavior* 22(2):160-171.
NAL call number: QP801 H7H64
Descriptors: rat, male, female, testosterone anti-serum, progestin anti-serum, medroxyprogesterone.

Black, J.E., M. Polinsky, and W.T. Greenough (1989). **Progressive failure of cerebral angiogenesis supporting neural plasticity in aging rats.** *Neurobiology of Aging* (USA) 10(4):353-358.
Descriptors: rat, old, capillaries, synaptogenesis, visual cortex, toys.

Bokovin, A.G. and E.S. Petrov (1992). **Influence of perceptual experience on the agonistic behavior of rats bred in isolation.** *Zhurnal Vysshei Nervnoi Deyatel'nosti* 42(4):800-802.
Descriptors: rat, male, neonate, adult, behavior, social interactions.

Borg, E. and A.R. Moller (1978). **Noise and blood pressure: Effect of lifelong exposure in the rat.** *Acta Physiologica Scandinavia* 103: 340-342.
NAL call number: QP1 A2
Descriptors: rat, Sprague-Dawley, Wistar, Lancing horns, long term study.

Bowling, S.L., J.K. Rowlett, and M.T. Bardo (1993). **The effect of environmental enrichment on amphetamine-stimulated locomotor activity, dopamine synthesis, and dopamine release.** *Neuropharmacology* 32(9):885-893.
NAL call number: RM315 N4
Descriptors: rat, male, environmental enrichment, impoverished, nucleus accumbens, striatum, *in vivo*, *in vitro*.

Brain, P.F. (1992). **Understanding the behaviours of feral species may facilitate design of optimal living conditions for common laboratory rodents.** *Animal Technology*: *Journal of the Institute of Animal Technology* 43(2):99-105.
NAL call number: QL55 I5
Descriptors: welfare, housing, husbandry, rabbit, mouse, rat, gerbil, hamster, optimal living conditions.

Brenner, E., M. Mirmiran, H.B.M. Uylings, and J. Van Der Gugten (1985). **Growth and plasticity of cerebral cortex after central noradrenaline depletion.** *Experimental Neurology* 89(1):264-268.
NAL call number: RC231 E96
Descriptors: rat, Wistar, bilateral ICV injection, 6-hydroxydopamine, brain growth.

Buelke-Sam, J., P.A. Sullivan, C.A. Kimmel, and C.J. Nelson (1984). **Sex and strain differences in the developmental activity profile of the rat tested over clean vs. home cage bedding.** *Developmental Psychobiology* 17(1):67-77.
NAL call number: QP351 D4
Descriptors: rat, CD, Long-Evans, male, female, neonate, olfaction, behavior, hyperactivity.

Burgess, M.L., J.M. Davis, T.K. Borg, S.P. Wilson, W.A. Burgess, and J. Buggy (1993). **Exercise training alters cardiovascular and hormonal responses to intracranial self-stimulation.** *Journal of Applied Physiology* 75(2):863-869.
NAL call number: 447.8 J825

Descriptors: rat, male, endocrine system, treadmill, ventral tegmental area, lever pressing, adrenal, organ weights, body weight.

Burkhart, C.A. and J.L. Robinson (1978). **High rat pup mortality attributed to use of cedar wood shavings as bedding.** *Laboratory Animals* 12(4):221-222.
NAL call number: QL55 A1L3
Descriptors: rat, Sprague-Dawley, male, female, adult, neonate, bedding, corncobs, aspen shavings, cedar shavings, mortality.

Camel, J.E., G.S. Withers, and W.T. Greenough (1986). **Persistence of visual cortex dendritic alterations induced by postweaning exposure to a "superenriched" environment in rats.** *Behavioral Neuroscience* 100(6):810-813.
NAL call number: QP351 B45
Descriptors: rat, postweaning, toys, maze, barriers, occipital cortex, neuronal development.

Carughi, A., K.J. Carpenter, and M.C. Diamond (1989). **Effect of environmental enrichment during nutritional rehabilitation on body growth, blood parameters, and cerebral cortical development of rats.** *Journal of Nutrition* (USA) 119(12):2005-2016.
NAL call number: 389.8 J82
Descriptors: rat, male, neonate, malnutrition, dendrites, occipital cortex, toys.

Caul, W.F., B.J. Freeman, and D.C. Buchanan (1975). **Effects of differential rearing condition on heart rate conditioning and response suppression.** *Developmental Psychobiology* 8(1):63-68.
NAL call number: QP351 D4
Descriptors: rat, Sprague-Dawley, male, female, weanling, environmental enrichment, isolation.

Chaloupka, Z., J. Myslivecek, B. Semiginovsky, and J. Hassmannova (1971). **The effect of afferentation in early postnatal life on the formation of temporary connections and other properties of the brain.** *Activitas Nervosa Superior* 13(2):147-148.
Descriptors: rat, environmental enrichment, impoverished, neural activity.

Chao, H.M., D.C. Blanchard, R.J. Blanchard, B.S. McEwen, and R.R. Sakai (1993). **The effect of social stress on hippocampal gene expression.** *Molecular and Cellular Neurosciences* 4(6):543-548.
Descriptors: rat, male, female, visible burrows, dominance, interactions, behavior, neuroendocrine effects, corticosterone, glucocorticoid receptor, mineralocorticoid receptor, mRNA, growth-associated protein, preproenkephalin.

Chia-Hung, H., W. Ching-Hsien, J. Tz-Yi, and W.C. Su-Yu, (1976). **The effects of learning and environment on the rat's brain.** *Acta Psychologica Taiwanica* 18:25-30.
Descriptors: rat, cortex, environmental enrichment, learning, Hebb-Williams maze, methamphetamine, brain weight, acitivity.

Coburn, J.F. and R.D. Tarte (1976). **The effect of rearing environments on the contrafreeloading phenomenon in rats.** *Journal of the Experimental Analysis of Behavior* 26(2):289-294.
Descriptors: rat, Wistar, male, female, environmental enrichment, impoverishment, operant chambers, feed acquisition.

Cowie, S., S. Quintero, and N. McNaughton (1987). **Home cage and test apparatus artifacts in assessing behavioural effects of diazepam in rats.** *Psychopharmacology* 91(2):257-259.
Descriptors: rat, partial reinforcement, extinction effect, sodium amylobarbitone, chlordiazepoxide, anxiolytics.

Coyle, I.R. and G. Singer (1975). **The interactive effects of prenatal imipramine exposure and postnatal rearing conditions on behaviour and histology.** *Psychopharmacologia* 44(3):253-256.
Descriptors: rat, Wistar, male, female, weanling, imipramine, environmental enrichment, impoverished, brain histology, behavior.

Coyle, I.R. and G. Singer (1975). **The interaction of postweaning housing conditions and prenatal drug effects on**

behaviour. *Psychopharmacologia* 41(3):237-244.
Descriptors: rat, Wistar, male, female, weanling, imipramine, Vitamin A, environmental enrichment, impoverished, Henderson-type maze, swimming maze.

Crepeau, L.J. (1990). **The interactive influences of early handling, prior play exposure, acute stress, and sex on play behavior, exploration, and H-P-A reactivity in juvenile rats.** *Dissertation Abstracts International* 51(3-B):1133.
NAL call number: Z5055.U49D53
Descriptors: rat, adrenal glands, hypothalamo-pituitary-adrenal axis.

Crnic, L. (1983). **Effects of nutrition and environment on brain biochemistry and behavior.** *Developmental Psychobiology* 16(2):129-145.
NAL call number: QP351 D4
Descriptors: rat, Sprague-Dawley, female, malnutrition, environmental enrichment, behavior, open field, passive-avoidance performance.

Crnic, L.S. (1984). **Nutrition and mental development**. *American Journal of Mental Deficiency* 88(5):526-533.
Descriptors: rat, environmental enrichment, isolation, malnutrition, behavior, biochemical deficits.

Cummins, R.A., et al. (1973). **Environmentally-induced changes in the brains of elderly rats.** *Nature* 243(5409):516-518.
NAL call number: 472 N21
Descriptors: rat, Wistar, male, female, weanling, old, environmental enrichment, isolation, toys, maze, brain weight, behavior, plasticity.

Cummins, R.A., P.J. Livesey, and J.G. Evans (1977). **A developmental theory of environmental enrichment.** *Science* 197(4304):692-694.
NAL call number: 470 Sci2
Descriptors: rat, male, brain development, environmental enrichment, deprivation.

Dalrymple-Alford, J.C. and C.R. Kelche (1987). **Behavioral effects of differential postoperative housing after septal lesions made in weanling rats.** *Psychobiology* 15(3):255-260.
Descriptors: rat, male, weanling, behavior, open field, radial maze.

Dalrymple-Alford, J., C. Kelche, F. Eclancher, and B. Will (1988). **Preoperative enrichment and behavioral recovery in rats with septal lesions.** *Behavioral and Neural Biology* 49(3):361-373.
NAL call number: QH301 C63
Descriptors: rat, male, weaning, adult, behavior, open field, radial maze.

Davis, S.F. et al. (1975). **Contrafreeloading as a function of early environmental rearing conditions.** *Bulletin of the Psychonomic Society* 6(6):595-597.
Descriptors: rat, Holtzman, male, environmental enrichment, impoverished, feed acquisition, learning.

DeBlieux, P.M.C. (1993). **Exercise training improves cardiac performance in diabetic rats.** *Proceedings of the Society for Experimental Biology and Medicine* 203(2):209-213.
NAL call number: 442.9 S1
Descriptors: rat, female, cardiomyopathy, streptozotocin, diabetes mellitus, treadmill.

Dell, P.A. and F.D. Rose (1986). **The impairing effects of environmental impoverishment in rats: A cognitive deficit?** *IRCS Medical Science: Psychology and Psychiatry* 14(1-2):19-20.
Descriptors: rat, Hooded Lister, male, Hebb-Williams maze, learning activity, exploratory behavior.

Dell, P.A., and F.D. Rose (1987). **The role of environmentally induced brain changes in subserving behavioural function: An investigation in female rats postpartum.** *Medical Science Research* 15(16):959-960.
Descriptors: rat, female, virgin, pregnant, cortical depth, enrichment.

Dell, P.A. and F.D. Rose (1987). **Transfer of effects from environmentally enriched and impoverished female rats to future offspring.** *Physiology and Behavior* 39(2):187-190.
NAL call number: QP1 P4
Descriptors: rat, female, behavior, pre-pregnancy, pregnancy.

Deni, R., et al. (1982). **Effect of cross-litter pup and cage bedding changes on huddling in rat pups.** *Psychological Record* 32(4):543-549.
Descriptors: rat, Norway, male, female, neonate, contact behavior, ultrasonic vocalizations, olfaction.

Devenport, L., S. Dallas, C. Carpenter, and M.J. Renner (1992). **The relationship between adrenal steroids and enrichment-induced brain growth.** *Behavioral and Neural Biology* (USA) 58(1):45-50.
NAL call number: QH301 C63
Descriptors: rat, male, brain weight, adrenalectomy, corticosterone.

Diamond, M.C., R.E. Johnson, A.M. Protti, et al. (1985). **Plasticity in the 904-day-old male rat cerebral cortex.** *Experimental Neurology* 87(2):307-317.
NAL call number: RC321 E96
Descriptors: rat, Long-Evans, male, toys, frontal cortex, parietal cortex, occipital cortex, histology.

Diamond, M.C., et al. (1977). **Effects of aging and environment on the pyriform cortex, the occipital cortex and the hippocampus.** *Behavioral and Neural Biology* 20(3):325-336.
NAL call number: QH301 C63
Descriptors: rat, Long-Evans, male, neonates, old, brain thickness, brain development, memory.

Diamond, M.C., E.R. Greer, A. York, et al. (1987). **Rat cortical morphology following crowded-enriched conditions.** *Experimental Neurology* 96(2):241-247.
NAL call number: RC321 E96
Descriptors: rat, male, medial occipital cortex, toys, caging.

Domjan, M., R. Schorr, and M. Best (1977). **Early environmental influences on conditioned and unconditioned ingestional and locomotor activity.** *Developmental Psychobiology* 10(6):499-506.
NAL call number: QP351 D4
Descriptors: rat, Sprague-Dawley, post-weaning, socialization, isolation, handling, aversive stimuli, taste aversion, open field, gustatory-visceral sensory system, telereceptor-cutaneous sensory system.

Doty, B.A. (1972). **The effects of cage environment upon avoidance responding of aged rats.** *Journal of Gerontology* 27(3):358-360.
NAL call number: 447.8 J824
Descriptors: rat, Sprague-Dawley, old, environmental enrichment, impoverished, learning.

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Descriptors: rat, environmental enrichment, amphetamine, striatum.

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Descriptors: rat, Sprague-Dawley, impoverished housing, diet, cortex, neurons, body weight, size, motor pyramids, dendrites.

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Descriptors: rat, Holtzman-derived, male, female, environmental enrichment, isolation, shock thresholds, open field, behavior.

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Descriptors: rat, Long-Evans, perceptually enriched, socially enriched, impoverished, open field, learning, avoidance training, electric shock.

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Descriptors: rat, male, CD, sensorimotor cortex, exercise wheel, environmental enrichment.

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Descriptors: rat, male, isolation, socially reared, hyperactivity, fear, taste neophobia.

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Gogia, P.P., M. Brown, and S. Al-Obaidi (1993). **Hydrocortisone and exercise effects on articular cartilage in rats.** *Archives of Physical Medicine and Rehabilitation* 74(5):463-467.
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NAL call number: 500 N484
Descriptors: rat, Brattleboro, male, heterozygous, homozygous, diabetes insipidus, neocortex, telencephalon, diencephalon, hippocampus, brain size, age.

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NAL call number: Film S-1805
Descriptors: rat, Brattleboro, brain morphology.

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Descriptors: rat, male, female, environmental enrichment, isolation, impoverished, foster mothers, play.

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Descriptors: rat, Long-Evans, female, young, old, running wheels, aging, citrate synthase, hexokinase, heart, epitrochlearis, flexor digitorum brevis.

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Descriptors: rat, Long-Evans, female, pregnant, nonpregnant, brain thickness, environmental enrichment, sex, hormonal state.

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Descriptors: rat, male, female, housing, hormones, exploration.

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Descriptors: rats, rabbits, reptiles, zoo animals, farm animals, noise, housing, caging, burrows, nesting materials, social groups.

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Descriptors: rat, sensorimotor cortex, locomotor tasks.

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NAL call number: QP901 P4
Descriptors: rat, Wistar, post-weaning, environmental enrichment, impoverishment, choice test, morphine, cocaine, emotionality, conditionability, body weight.

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NAL call number: QP351 D4
Descriptors: rat, male, female, littermates, spatial relationships, access to resources, territorial, cover.

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NAL call number: QL750 B4
Descriptors: rat, male, weanling, isolation, social contact, rough-and-tumble play.

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NAL call number: QL750 E74
Descriptors: rat, male, female, young, rough-and-tumble play, duration.

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NAL call number: QP1 P4
Descriptors: rat, Long-Evans, male, open field, emergence test, maze, handling.

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NAL call number: QP1 P4
Descriptors: rat, male, female, caging, handling, behavior, adrenocortical system, olfaction, open field.

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NAL call number: 410 J822
Descriptors: rat, Norway, wild, domestic, environmental enrichment, open field, behavior, body, weight, genetic influences.

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NAL call number: QP351 D4
Descriptors: rat, weanling, family reared, peer, isolation, play, t-maze, rewards.

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Descriptors: rat, female, neonates, handling, Hebb-Williams maze, vision.

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NAL call number: QH301 C63
Descriptors: rat, Wistar, hippocampus, cortex, cell physiology, preweaning, postweaning, toys, multifamily groups, isolation.

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Descriptors: rat, female, isolation, socialization, visual discrimination, learning, appetitive behavior, cerebral cortex, dopamine.

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NAL call number: QP351 D4
Descriptors: rat, male, female, adult, environmental enrichment, running wheel, open field, maze, noxious stimuli.

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NAL call number: 447.8 J824
Descriptors: rat, Fischer 344, female, young, old, sedentary, treadmill, body weight, wall thickness, collagen, elastin.

Katz, H.B. and C.A. Davies (1982). **The effects of early under-nutrition and subsequent environment on morphological parameters of the rat brain.** *Behavioural Brain Research* 5(1):53-64.
Descriptors: rat, hooded Lister, male, undernourishment, brain growth spurt, forebrain, cortex, hippocampus, brain development.

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Descriptors: rat, Sprague-Dawley, male, emotionality, environmental enrichment, impoverished, handling, bedding, open field, activity.

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NAL call number: QP1 P4
Descriptors: rat, female, housing conditions, memory, radial maze.

Kelche, C. and B. Will (1982). **Effects of post-operative environments following dorsal hippocampal lesions on**

dendritic branching and spines in rat occipital cortex. *Brain Research* 245(1):107-115.
NAL call number: Film S-1779
Descriptors: rat, Long-Evans, male, bilateral hippocampal lesions, pyramidal cells, morphology, behavior.

Kelche, C. and B.E. Will (1978). **Effects of environment on functional recovery after hippocampal lesions in adult rats.** *Physiology and Behavior* 21(6):935-941.
NAL call number: QP1 P4
Descriptors: rat, August, male, learning, bilateral lesions, hippocampus, Hebb-Williams maze.

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Descriptors: rat, Holtzman, male, female, water consumption, food consumption, activity levels, open field, avoidance test, sex differences.

Kirby, R.J. (1970). **Early environmental experience and avoidance learning in the rat.** *Psychonomic Science* 19(1):30-31.
Descriptors: rat, Sprague-Dawley, weanling, environmental enrichment, impoverished, passive-avoidance problem, emotions.

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NAL call number: QP1 P4
Descriptors: rat, female, pregnant, foster mothers, male offspring, Hebb-Williams maze, postnatal learning.

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NAL call number: QP1 P4
Descriptors: rat, male, female, cat avoidance apparatus, stress, stomach, adrenal glands, thymus, defensive behavior.

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Descriptors: rat, Holtzman, male, female, neonate, caging, play, stress.

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Descriptors: rat, caging, physiology.

Kramer, K., H. Dijkstra, and A. Bast (1993). **Control of physical exercise of rats in a swimming basin.** *Physiology and Behavior* 53(2):271-276.
NAL call number: QP1 P4
Descriptors: rat, Wistar, male, swimming, exercise, superoxide dismutase, glutathione, diethyl maleate, emotions, maze, norepinephrine, epinephrine, lactate, stress.

Kuenzle, C.C. and A. Knusel (1974). **Mass training of rats in superenriched environment.** *Physiology and Behavior* 13(2):205-210.
NAL call number: QP1 P4
Descriptors: rat, male, apparatus, learning, maze, feed acquisition, water acquisition, behavior.

Larue-Achagiotis, C., C. Martin, P. Verger, M. Chabert, and J. Louis-Sylvestre (1993). **Effects of acute treadmill exercise and delayed access to food on food selection in rats.** *Physiology and Behavior* 53(2):403-408.

NAL call number: QP1 P4
Descriptors: rat, Wistar, male, total energy intake, nutrient self-selection, body weight, carbohydrates, protein, fat.

Latane, B. and D.C. Glass (1969). **Social and nonsocial attraction in rats.** *Journal of Personality and Social Psychology* 9(2, Pt. 1):142-146.
Descriptors: rat, Carworth, fear, open field, defecation, anesthetized rat, toy car, pair interaction, gregariousness.

Leah, J., H. Allardyce, and R. Cummins (1985). **Evoked cortical potential correlates of rearing environment in rats.** *Biological Psychology* 20(1):21-29.
NAL call number: QP351 B52
Descriptors: rat, Wistar, male, enriched environment, isolation.

LeFevre, J. and M.K. McClintock (1991). **Isolation accelerates reproductive senescence and alters its predictors in female rats.** *Hormones and Behavior* 25(2):258-272.
Descriptors: rat, Sprague-Dawley, female, aging, constant estrus, isolation, group rearing, lordosis reflex, ovarian steroids.

Liljequist, R., B.G. Henriksson, N. Latif, T. Pham, B. Winblad, and A.H. Mohammed (1993). **Subchronic MK-801 treatment to juvenile rats attenuates environmental enrichment effects on adult spatial learning.** *Behavioural Brain Research* 56(1):107-114.
Descriptors: rat, environmental enrichment, impoverished, NMDA receptor, open field, [^{3}H]MK-801 binding sites, cortex, learning, activity, cognitive changes.

Lore, R.K. (1969). **Pain avoidance behavior of rats reared in restricted and enriched environments.** *Developmental Psychology* 1(5):482-484.
NAL call number: BF712 D46
Descriptors: rat, Long-Evans, environmental enrichment, impoverished, candle, nose-flame contacts, emotions, perceptual deficits.

Louie, D.S. (1983). **The effects of an enriched environment on the consequences of lactational undernutrition on learning and on brain chemistry in rats.** *Dissertation Abstracts International* 44(1-B):117-118.
NAL call number: Z5055.U49D5
Descriptors: rat, undernutrition, learning, biochemistry.

Luciano, D. and R. Lore (1975). **Aggression and social experience in domesticated rats.** *Journal of Comparative and Physiological Psychology* 88(2):917-923.
NAL call number: 410 J822
Descriptors: rat, male, female, isolation socially reared, aggression, behavior, body weight, stress.

Mailloux, J.G., et al. (1974). **Effects of differential rearing on cortical evoked potentials of the albino rat.** *Journal of Comparative and Physiological Psychology* 87(3):475-480.
NAL call number: 410 J822
Descriptors: rat, Sprague-Dawley, weanling, visual enrichment, auditory enrichment, electrodes.

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Descriptors: rat, Wistar, Brown-Norway, male, environmental enrichment, behavioral tests.

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NAL call number: SF406 I46 1993
Descriptors: rat, handling, behavior, learning, aggressiveness, stress, fear, physiological responses.

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NAL call number: QH301 F3
Descriptors: rat, housing, cardiovascular system, abstract.

Menzaghi, F., S.C. Heinrichs, E. Merlo-Pich, F.J. Tilders, and G.F. Koob (1994). **Involvement of hypothalamic corticotropin-releasing factor neurons in behavioral responses to novelty in rats.** *Neuroscience Letters* 168(1-2):139-142.
NAL call number: QP351 N3
Descriptors: rat, paraventricular nucleus, locomotor activity, novel environments, housing, ricin A toxin, stress.

Mills, D.E., Y.S. Huang, M. Narce, and J.P. Poisson (1994). **Psychosocial stress, catecholamines, and essential fatty acid metabolism in rats.** *Proceedings of the Society for Experimental Biology and Medicine* 205(1):56-61.
NAL call number: 442.9 So1
Descriptors: rat, Wistar-Kyoto, normotensive, spontaneously hypertensive, Sprague-Dawley, epinephrine, isolation, group-reared, fatty acid desaturase.

Mirmiran, M., and H.B. Uylings (1983). **The environmental enrichment effect upon cortical growth is neutralized by concomitant pharmacological suppression of active sleep in female rats.** *Brain Research* 261(2):331-334.
Descriptors: rat, female, REM sleep, clonidine, brain weight, cortex.

Mitani, K. (1975). **Enhancement of general activity in the white rat through rearing in enriched environment.** *Annual of Animal Psychology* 24(2):73-85.
Descriptors: rat, male, environmental enrichment, cage size, toys, open field, activity, body weight, urination, defecation.

Mohamed, A.K., B. Winblad, T. Ebendal, and T. Larkfors (1990). **Environmental influence on behaviour and nerve growth factor in the brain.** *Brain Research* (Netherlands) 528(1):62-72.
NAL call number: Film S-1779
Descriptors: rat, Morris maze, nerve growth factor, septohippocampal pathway, Alzheimer's disease, environmental stimulation.

Mohammed, A.H., B.G. Henriksson, S. Soderstrom, T. Ebendal, T. Olsson, and J.R. Seckl (1993). **Environmental influences on the central nervous system and their implications for the aging rat.** *Behavioural Brain Research* 57(2):183-191.
Descriptors: rat, adult, old, neuronal plasticity, environmental enrichment, handling, glucocorticoid receptors, hippocampus, nerve growth factor.

Moore, C.L. and K.L. Power (1992). **Variation in maternal care and individual differences in play, exploration, and grooming of juvenile Norway rat offspring.** *Developmental Psychobiology* 25(3):165-182.
NAL call number: QP351 D4
Descriptors: rat, Norway, female, neonate, mothers, maternal anogenital licking, licking, time in nest, nursing, zinc sulfate, dietary saline.

Morgensen, J. (1991). **Influences of the rearing conditions on functional properties of the rat's prefrontal system.** *Behavioural Brain Research* (Netherlands) 42(2):135-142.
Descriptors: rat, male, visual pattern discrimination, maze, spatial delayed alternation, cortex.

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NAL call number: QP1 P4
Descriptors: rat, Wistar, male, weanling, isolation, socially reared, ascorbic acid, corticosterone, cortex, stress.

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NAL call number: QP1 P4
Descriptors: rat, Sprague-Dawley, female, adult, impulse noise, drinking, blood pressure.

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NAL call number: BF671 J6
Descriptors: rat, Wistar, female, behavior, Hebb-Williams maze, closed field.

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NAL call number: aHV4701 A952
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NAL call number: 410.9 P94
Descriptors: rat, rabbit, male, noise, adrenal gland, spleen, hematology, feed consumption, body weight, organ weight.

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NAL call number: Film S-1779
Descriptors: rat, preprosomatostatin-mRNA, impoverished, environmental enrichment, spatial learning, open field, locomotor activity, cortex, hypothalamus.

Nott, H.M.R. and R.M. Sibly (1993). **Response to novel food by rats: Effects of social rank.** *Crop Protection* 12(2):89-94.
NAL call number: SB599 C8
Descriptors: rat, dominant, subdominant, neophobia, feeding.

Oehler, J., M. Jahkel, and J. Schmidt (1987). **Neuronal transmitter sensitivity after social isolation in rats.** *Physiology and Behavior* 41(3):187-191.
NAL call number: QP1 P4
Descriptors: rat, Wistar, male, isolation, neurotransmitter, dopaminergic, noradrenergic, serotonergic.

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Ough, B.R., W.W. Beatty, and J. Khalili (1972). **Effects of isolated and enriched rearing on response inhibition.** *Psychonomic Science* 27(5):293-294.
Descriptors: rat, environmental enrichment, isolation, DRL-20 task, food reward, CRF.

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Descriptors: rat, female, weanling, environmental enrichment, social isolation, chemical vs. electrical lesions, learning.

Panksepp, J. (1981). **The ontogeny of play in rats.** *Developmental Psychobiology* 14(4):327-332.

NAL call number: QP351 D4
Descriptors: rat, Long-Evans, weaning, young, pinning behavior, isolation, dominance.

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NAL call number: QP901 P4
Descriptors: rat, male newborn, weanling, 6-OHDA, maturation, Lashley maze, Hebb-Williams maze.

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NAL call number: QP901 P4
Descriptors: rat, male, water maze, 6-OHDA, cognition.

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NAL call number: QP351 N3
Descriptors: rat, weanling, water maze, caudate, training.

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NAL call number: 410 J822
Descriptors: rat, Sprague-Dawley, female, weanling, adult, handling, avoidance learning, electric shock, memory.

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NAL call number: RG600 E27
Descriptors: rat, Sprague-Dawley, male, female, neonate, morphometrics, pyramidal neurons, dendrites, cortex, malnutrition.

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NAL call number: BF575 A3A57
Descriptors: rat, male, dominance, behavior, play.

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NAL call number: QP351 N3
Descriptors: rat, male, female, young, 6-hydroxydopamine, striatum, play fighting, allogrooming, sexual mounting.

Perez, V.J., B.B. Thach, and J.L. Palet (1978). **S-100 protein: Regional CNS concentrations in rats raised in different environments.** *Developmental Psychobiology* 11(4):301-308.
NAL call number: QP351 D4
Descriptors: rat, Holtzman, female, post-weaning, toys, cerebellum, brainstem, protein turnover.

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Descriptors: rat, male, female, environmental enrichment, active avoidance learning, muscarinic receptors, acetylcholinesterase, choline acetyltransferase.

Por, S.B., E.L. Bennett, and S.C. Bondy (1982). **Environmental enrichment and neurotransmitter receptors.** *Behavioral and Neural Biology* 34(2):132-140.
NAL call number: QH301 C63
Descriptors: rat, Berkeley S_1, binding assays, membrane fractions, cerebellum, subcortex, cortex.

Potegal, M. and D. Einon (1989). **Aggressive behaviors in adult rats deprived of playfighting experience as juveniles.** *Developmental Psychobiology* 22(2):159-172.
NAL call number: QP351 D4
Descriptors: rat, male, female, littermates, isolation, pairs, mouse-killing, intraspecific aggression, shock-induced fighting, thresholds.

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Descriptors: rat, adult, chemically induced micrencephaly, Hebb-Williams maze.

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NAL call number: BF712 D46
Descriptors: rat, female, pregnant, neonate, weanling, bovine growth hormone, reflex maturation, environmental enrichment, isolation, open field, Lashley III maze, shuttle box, learning.

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NAL call number: QL55 A1L3
Descriptors: rat, male, female, caging, bedding, floor type, ammonia, aerosols, temperature, humidity.

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NAL call number: QP351 D4
Descriptors: rat, Berkeley S1, brain weight, behavior, social factors.

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NAL call number: QP351 D4
Descriptors: rat, Sprague-Dawley, male, female, weanling, adult, orienting response, auditory stimulus, heart rate, isolation, socially reared.

Rieg, T.S., L.E. Doerries, J.G. O'Shea, and P.F. Aravich (1993). **Water deprivation produces an exercise-induced weight loss phenomenon in the rat.** *Physiology and Behavior* 53(3):607-610.
NAL call number: QP1 P4
Descriptors: rat, Sprague-Dawley, feed restriction, running wheel, body weight, exercise, anorexia nervosa, vasopressin, blood chemistry.

Riege, W.H. and H. Morimoto (1970). **Effects of chronic stress and differential environments upon brain weights and biogenic amine levels in rats.** *Journal of Comparative and Physiological Psychology* 71(3):396-404.
NAL call number: 410 J822
Descriptors: rat, Berkeley S_1, Fischer, tumbling stress, norepinephrine, dopamine, serotonin, environmental enrichment, impoverished, adrenal glands, cortex, hypothalamus, midbrain, brain weight.

Rinck, C. (1968). **The effect of enriched environment and handling on the learning of a visual discrimination task.** *Psychonomic Science* 12(7):317-318.
Descriptors: rat, environmental enrichment, impoverished, handling, emotionality, exploration.

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NAL call number: QP901 P4
Descriptors: rat, male, weanling, ethanol.

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NAL call number: QP901 P4
Descriptors: rat, male, weanling, isolation, water consumption.

Rockman, G.E., T.B. Borowski, and G.B. Glavin (1986). **The effects of environmental enrichment on voluntary ethanol consumption and stress ulcer formation in rats.** *Alcohol* 3(5):299-302.
Descriptors: rat, weanling, immobilization, ulcers.

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NAL call number: QH301 C63
Descriptors: rat, male, weanling, immobilization, ulcers.

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NAL call number: QP1 P4
Descriptors: rat, male, female, depression, emotional stress, physical stress, motor activity, exploration, corticosterone, prolactin.

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Descriptors: rat, prelesion performance vs. postlesion performance, water maze, escape response, bilateral occipital lesions.

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Rose, F.D., M.J. Davey, K. Al-Khamees, and E.A. Attree (1992). **General adaptive capacity and recovery of function following cortical damage in the rat.** *Medical Science Research* 20(10):359-360.
Descriptors: rat, bilateral lesions, occipital cortex, water maze, environmental enrichment, learning.

Rose, F.D., M.J. Davey, S. Love, and P.A. Dell (1987). **Environmental enrichment and recovery from contralateral sensory neglect in rats with large unilateral neocortical lesions.** *Behavioural and Brain Research* 24(3):195-202.
Descriptors: rat, compensation vs. recovery, bracelet removal test, postoperative.

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Descriptors: rat, male, Lister hooded, reward, behavior, operant learning.

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Descriptors: rat, male, open field test, attention test, grip test, new learning vs. established learning.

Rose, F.D., P.A. Dell, S. Love, and M.J. Davey (1988). **Environmental enrichment and recovery from a complex G0/No-Go reversal deficit in rats following large unilateral neocortical lesions.** *Behavioural Brain Research* 31(1):37-45.
Descriptors: rat, operant task, behavior, hemidecorticate deficit.

Rose, F.D. and P.J. Lamden (1983). **GO NO-GO learning in rats reared in enriched and impoverished environments.** *IRCS Medical Science: Psychology and Psychiatry* 11(5-6):433-434.
Descriptors: rat, Hooded Lister, male, auditory discrimination, learning.

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NAL call number: QP1 P4
Descriptors: rat, learning, lever-press training, response-contingent events.

Rose, F.D., S. Love, P.A. Dell, and M.J. Davey (1988). **Environmental attenuation of DRL performance in the rat following hemidecortication.** *Medical Science Research* 16(11):563-564.
Descriptors: rat, male, Skinner box, differential reinforcement, error inhibition.

Rosenzweig, M.R. and E.L. Bennett (1972). **Cerebral changes in rats exposed individually to an enriched environment.** *Journal of Comparative and Physiological Psychology* 80(2):304-313.
NAL call number: 410 J822
Descriptors: rat, Berkeley S_1, male, methamphetamine, brain weight, brain enzymes, light vs. dark.

Rosenzweig, M., E.L. Bennett, and M.C. Diamond (1972). **Cerebral effects of differential experience in hypophysectomized rats.** *Journal of Comparative and Physiological Psychology* 79(1):56-66.
NAL call number: 410 J822
Descriptors: rat, Fischer, Long-Evans, male, environmental enrichment, impoverished, brain weight, cortex, lesions, acetylcholinesterase, cholinesterase, pituitary.

Sanchez-Toscano, F., M.M. Sanchez, and J. Garzon (1991). **Changes in the number of dendritic spines in the medial preoptic area during a premature long-term social isolation in rats.** *Neuroscience Letters* 122(1):1-3.
NAL call number: QP351 N3
Descriptors: rat, male, neonates, premature weaning, Golgi study, dendrites, isolation, postsynaptic structures, stress.

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Descriptors: rat, female, learning, behavior.

Schaefer, G.J. and R.P. Michael (1991). **Housing conditions alter the acquisition of brain self-stimulation and**

locomotor activity in adult rats. *Physiology and Behavior* 49(3):635-638.
NAL call number: QP1 P4
Descriptors: rat, male, electrodes, medial forebrain bundle, lateral hypothalamus, group reared, isolation, handling, locomotion, unconditioned behavior.

Schmorrow, D.D. and R.E. Ulrich (1991). **Improving the housing and care of laboratory pigeons and rats.** *Humane Innovations and Alternatives* 5:299-305.
NAL call number: QL55 H8
Descriptors: rat, caging, space requirements, animal welfare.

Schuster, R., B.D. Berger, and H.H. Swanson (1994). **Cooperative social coordination and aggression: II. Effects of sex and housing among three strains of intact laboratory rats differing in aggressiveness.** *Quarterly Journal of Experimental Psychology (B):Comparative and Physiological Psychology* 46(4):367-390.
Descriptors: rat, S3, Charles River, Wistar, synchronized shuttling, pair housing, isolation, behavior, learning.

Schwandt, L.M. (1993). **Individual versus group housing affects nociception independently of housing status during development.** *Bulletin of the Psychonomic Society* 31(6):525-528.
Descriptors: rat, isolation, housing, pain reception, electric shock, stress-induced hypoalgesia, stress.

Selseth, K.J. and E.D. Kemble (1988). **Fluprazine hydrochloride decreases play behavior but not social grooming in juvenile male rats.** *Bulletin of the Psychonomic Society* 26(6):563-564.
Descriptors: rats, male, young, attack, male copulation, maternal behavior, fear.

Seybold, K.S., P. Wampler-Parsons, H.A. Murphy, R. Magee, and R.L. Port (1993). **Modest environmental enrichment improves cognitive performance of aged rats.** *Society for Neuroscience Abstracts* 19(1-3):600.
NAL call number: QP351 S6
Descriptors: rat, old, behavior, memory.

Sharp, P.E., C.A. Barnes, and B.L. McNaughton (1987). **Effects of aging on environmental modulation of hippocampal evoked responses.** *Behavioral Neuroscience* 101(2):170-178.
NAL call number: QP351 B45
Descriptors: rat, young, old, dentate gyrus, evoked responses.

Siegel, M.A. and R.A. Jensen (1986). **The effects of naloxone and cage size on social play and activity in isolated young rats.** *Behavioral and Neural Biology* 45(2):155-168.
NAL call number: QH301 C63
Descriptors: rat, Long-Evans, male, young, pinning behavior, socialization, activity, play behavior.

Sirevaag, A.M., J.E. Black, D. Shafron, and W.T. Greenough (1988). **Direct evidence that complex experience increases capillary branching and surface area in visual cortex of young rats.** *Developmental Brain Research* 43(2):299-304.
Descriptors: rat, adolescent, toys, enrichment, angiogenesis.

Siviy, S.M. and J. Panksepp (1987). **Sensory modulation of juvenile play in rats.** *Developmental Psychobiology* 20(1):39-55.
NAL call number: QP351 D4
Descriptors: rat, Long-Evans, somatosensory input, xylocaine, local anesthesia, dorsal body, pinning, play motivation.

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NAL call number: QP351 D4
Descriptors: rat, young, indirect calorimetry, energy expenditure, play, play restricted, body weight, feed consumption.

Slagle, R.W. (1969). **The effects of specialized environmental enrichment on brain and behavior of rats.** *Dissertation Abstracts* 29(9-B):3518.

NAL call number: Z5055.U49D53
Descriptors: rat, environmental enrichment.

Slentz, C.A. and J.O. Holloszy (1993). **Body composition of physically inactive and 25-month-old female rats.** *Mechanisms of Aging and Development* 69(3):161-166.
NAL call number: QP84 M4
Descriptors: rat, Long-Evans, female, isolation, running wheel, feed intake, body fat, body mass, body protein, body weight.

Smart, J.L., A.C. McMahon, R.F. Massey, G.-N.K. Akbar, and M.A. Warren (1990). **Evidence of non-maternally mediated acceleration of eye-opening in "enriched" artificially reared pups**. *Developmental Brain Research* (Netherlands) 56(1):141-143.
Descriptors: rat, neonates, eye-opening, gentling, social interaction, homing.

Smith, H.V. (1972). **Effects of environmental enrichment on open field activity and Hebb-Williams problem solving in rats.** *Journal of Comparative and Physiological Psychology* 80(1):163-168.
NAL call number: 410 J822
Descriptors: rat, Carworth Europe, male, female, impoverished, test order, activity, defecation, maze, exploration.

Sokolov, V.E. and S.A. Kvashnin (1993). **Play behavior in the Turkestan rat, *Rattus turkestanicus*.** *Zoologiceskij zurnal* 72(6):124-129.
NAL call number: 410 R92
Descriptors: rat, Turkestan, activity, dominance.

Sokolov, V.E. and S.A. Kvashnin (1993). **A comparative study of play behavior in 3 species of rattus (Rodentia, Muridae).** *Zoologichesky Zhurnal* 72(11):126-139.
NAL call number: 410 R92
Descriptors: rat, Norwegian, Black, Turkestan, male, female, age.

Sokolov, V.E. and S.A. Kvashnin (1993). **Play behavior in the black rat, *Rattus rattus*.** *Zoologiceskij zurnal* 72(5):132-141.
NAL call number: 410 R92
Descriptors: rat, Black, male, female, age, behavior, activity.

Speiler, K., P. Schoch, J.R. Martin, and W. Haefely (1993). **Environmental stimulation promotes changes in the distribution of phorbol ester receptors.** *Pharmacology, Biochemistry, and Behavior* 46(3):553-560.
NAL call number: QP901 P4
Descriptors: rat, female, protein kinase C, learning, memory, [^{3}H]-PDBu, receptor binding, cortex, hippocampus, radial maze, environmental enrichment.

Spencer, P.J., J.L. Mattsson, K.A. Johnson, and R.R. Albee (1993). **Neurotoxicity screening methods are sensitive to experimental history**. *International Journal of Psychophysiology* 14(1):5-19.
Descriptors: rat, exercise, handling, neurotoxicity, evoked potentials, motor activity, histopathology.

Strupp, B.J. and D.A. Levitsky (1984). **Social transmission of food preferences in adult hooded rats (*Rattus norvegicus*).** *Journal of Comparative Psychology* 98(3):257-266.
NAL call number: BF671 J6
Descriptors: rat, Long-Evans, hooded, male, social learning.

Sturgeon, R.D. and L.D. Reid (1971). **Rearing variations and Hebb-Williams maze performance.** *Psychological Reports* 29(2):571-580.
Descriptors: rat, hooded, male, weanling, young, environmental enrichment, impoverished, pretraining, problem solving.

Sucheki, D., P. Rosenfield, and S. Levine (1993). **Maternal regulation of the hypothalamic-pituitary-adrenal axis in**

the infant rat: The role of feeding and stroking. *Developmental Brain Research* 75(2):185-192.
Descriptors: rat, female, neonate, corticosterone, maternal separation, feeding, stroking.

Susser, E.R. and R.B. Wallace (1982). **The effects of environmental complexity on the hippocampal formation of the adult rat.** *Acta Neurobiologiae Experimentalis* 42(2):203-207.
NAL call number: 442.8 AC8
Descriptors: rat, Long-Evans, male, dorsal hippocampus, brain weight, granule cells, plasticity.

Swanson, H.H., et al. (1983). **Interaction between pre-weaning undernutrition and post-weaning environmental enrichment on somatic development and behaviour in male and female rats.** *Behavioural Processes* 8(1):1-20.
NAL call number: QL750 B4
Descriptors: rat, Wistar, male, female, neonate, young, growth, sexual maturation, behavior, brain weight, toys.

Swanson, H.H. and N.E. Van De Poll (1983). **Effects of an isolated or enriched environment after handling on sexual maturation and behavior in male and female rats.** *Journal of Reproduction and Fertility* 69:165-171.
NAL call number: 442.8 J8222
Descriptors: rat, Wistar, male, female, handling, toys, ladders, ropes, tubes, isolation, socially reared, behavior, sexual behavior, body weight, organ weight.

Symons, L.A. and R.C. Tees (1990). **An examination of the intramodal and intermodal behavioral consequences of long-term vibrissae removal in rats.** *Developmental Psychobiology* 23(8):849-867.
NAL call number: QP351 D4
Descriptors: rat, male, environmental enrichment, cauterization vs. plucking, tactile stimuli, visual stimuli.

Tachibana, T. (1979). **Effects of early nutritional and environmental conditions on later runway test behavior in rats.** *Japanese Psychological Research* 21(2):99-102.
Descriptors: rat, Sprague-Dawley, malnutrition, environmental enrichment, isolation, runway.

Tagney, J. (1973). **Sleep patterns related to rearing rats in enriched and impoverished environments.** *Brain Research* 53:353-361.
NAL call number: Film S-1779
Descriptors: rat, male, weanling, electro-oculogram, EEG, EMG, slow wave, REM.

Takahashi, L.K., C. Haglin, and N.H. Kalin (1992). **Prenatal stress potentiates stress-induced behavior and reduces the propensity to play in juvenile rats.** *Physiology and Behavior* 51(2):219-323.
NAL call number: QP1 P4
Descriptors: rat, male, female, siblings, juvenile, social play, foot shock, tonic immobility, corticosteroids.

Tanabe, G. (1972). **Remediating maze deficiencies by the use of environmental enrichment.** *Developmental Psychology* 7(2):224.
NAL call number: BF712 D46
Descriptors: rat, Wistar, male, female, pregnancy, lactation, malnutrition, isolation, learning.

Taylor, A.J., S. Gordon, and R.D. Tee (1994). **Influence of bedding, cage design, and stock density on rat urinary aeroallergen levels.** *American Journal of Industrial Medicine* 25(1):89.
Descriptors: rat, allergens, occupational exposure.

Thor, D.H. and W.R. Holloway (1984). **Developmental analyses of social play behavior in juvenile rats.** *Bulletin of the Psychonomic Society* 22(6):587-590.
Descriptors: rat, male, female, ontogenetic descriptions, rough and tumble play, sexual maturity, aggression.

Tobin, B.W., J.L. Beard, and W.L. Kenney (1993). **Exercise training alters feed efficiency and body composition in iron deficient rats.** *Medicine and Science in Sports and Exercise* 25(1):52-59.
Descriptors: rat, training, exercise, growth, diet.

Uylings, H.B., K. Kuypers, M.C. Diamond, W.A. Veltman (1978). **Effects of differential environments on plasticity of dendrites of cortical pyramidal neurons in adult rats.** *Experimental Neurology* 62(3):658-677.
NAL call number: RC321.E96
Descriptors: rat, male, Berkeley S_1, cortex, dendrites, length, branching, environmental enrichment.

Van Gool, W.A. and M. Mirmiran (1986). **Effects of aging and housing in an enriched environment on sleep-wake patterns in rats.** *Sleep* 9(2):335-347.
Descriptors: rat, male, adult, old, slow wave, desynchronized sleep, adaptation.

Van Gool, W.A., M. Mirmiran, and F. Van Haaren (1985). **Spatial memory and visual evoked potentials in young and old rats after housing in an enriched environment.** *Behavioral and Neural Biology* 44(3):454-469.
NAL call number: QH301 C63
Descriptors: rat, adult, old, radial maze, paired flashes, visual sensitivity, hippocampal changes.

Van Gool, W.A., H.F. Pronker, M. Mirmiran, and H.B.M. Uylings (1987). **Effect of housing in an enriched environment on the size of the cerebral cortex in young and old rats.** *Experimental Neurology* 96(1):225-232.
NAL call number: RC321 E96
Descriptors: rat, adult, old, caging, toys, cortical plasticity.

Van Haaren, F.P., and A. Van Hest (1987). **Old, but not worn out. [Oud, maar niet versleten.] Special Issue: The elderly and psychology.** *Psycholoog* 22(11):510-513.
Descriptors: rat, adult, aging, environmental enrichment, social deprivation, memory loss, problem solving, circadian activity.

Venable, N., V. Fernandez, E. Diaz, and T. Pinto-Hamuy (1989) **Effects of preweaning environmental enrichment on basilar dendrites of pyramidal neurons in occipital cortex: A Golgi study.** *Developmental Brain Research* 49(1):140-144.
Descriptors: rat, neonates, cortical dendrites, Golgi-Cox-Sholl stain.

Venable, N., T. Pinto-Hamuy, J.A. Arraztoa, M.T. Contador, A. Chellew, C. Peran, and X. Valenzuela (1988). **Greater efficacy of preweaning than postweaning environmental enrichment on maze learning in adult rats.** *Behavioural Brain Research* 31(1):89-92.
Descriptors: rat, adult, Hebb-Williams maze, development.

Vore, D.A. and D.R. Ottinger (1970). **Maternal food restriction: Effects on offspring development, learning, and a program of therapy.** *Developmental Psychology* 3(3, Pt.1):337-342.
NAL call number: BF712 D46
Descriptors: rat, Purdue Wistar, female, malnutrition, estrus, gestation, lactation, foster mothers, body weight, T-maze, Hebb-Williams maze.

Walker, J.P. (1973). **The effects of enriched environment and isolation upon catecholamine metabolism in various brain regions.** *Dissertation Abstracts International* 33(9-B):4497.
NAL call number: Z5055.U49D53
Descriptors: rat, hypothalamus, cerebellum, caudate nucleus.

Wallace, R.J. (1988). **Latency measures indicate new place neophobia in *Rattus* species.** *Behavioural Processes* 17(1):63-67.
NAL call number: QL750 B4
Descriptors: rat, novel places, exploration, home cage, lighting.

Weldon, D.A. and C.J. Smith (1979). **Superior colliculis lesions and environmental experience: Nonvisual effects on problem solving and locomotor activity.** *Physiology and Behavior* 23(1):159-165.
NAL call number: QP1 P4
Descriptors: rat, Long-Evans, bilateral lesions, environmental enrichment, closed field, open field, illumination, vision.

Wells, A.M. **The effect of dietary and environmental conditions on performance of rats in the Hebb-Williams maze.** *Dissertation Abstracts International* 32(1-B):600-601.
NAL call number: Z5055.U49D53
Descriptors: rat, neonate, environmental enrichment, impoverished.

Wells, A.M., C.R. Geist, and R.R. Zimmerman (1972). **Influence of environmental and nutritional factors on problem solving in the rat.** *Perceptual and Motor Skills* 35(1):235-244.
Descriptors: rat, Holtzman, male, neonate, foster mothers, dietary protein, environmental enrichment, spatial, visual, tactile, impoverished, Hebb-Williams maze.

Whishaw, I.Q., R.J. Sutherland, B. Kolb, and J.B. Becker (1986). **Effects of neonatal forebrain noradrenaline depletion on recovery from brain damage: Performance on a spatial navigation task as a function of age of surgery and postsurgical housing.** *Behavioral and Neural Biology* 46(3):285-307.
NAL call number: QH301 C63
Descriptors: rat, Long-Evans, neonate, adult, hemidecortication, noradrenaline, environmental enrichment.

Whishaw, I.Q., J.-A. Zaborowski, and B. Kolb (1984). **Postsurgical enrichment aids adult hemidecorticate rats on a spatial navigation task.** *Behavioral and Neural Biology* 42(2):183-190.
NAL call number: QP351 B45
Descriptors: rat, neonate, adult, cortex, Morris water maze, outdoors.

White, W.J. and A.M. Mans (1984). **Effect of bedding changes and room ventilation rates on blood and brain ammonia levels in normal rats and rats with portacaval shunts.** *Laboratory Animal Science* 34(1):49-52.
NAL call number: 410.9 P94
Descriptors: rat, Long-Evans, male, bedding, air pollution.

White, N.R. and R.J. Barfield (1989). **Playback of female rat ultrasonic vocalizations during sexual behavior.** *Physiology and Behavior* 45(2):229-233.
NAL call number: QP1 P4
Descriptors: rat, female, male, devocalized, intact, darting.

Widman, D.R., G.C. Abrahamsen, and R.A. Rosellini (1992). **Environmental enrichment: The influences of restricted daily exposure and subsequent exposure to uncontrollable stress.** *Physiology and Behavior* 51(2):309-318.
NAL call number: QP1 P4
Descriptors: rat, male, stress, operant tasks, pavlovian tasks, learning.

Widman, D.R. and R.A. Rosellini (1990). **Restricted daily exposure to environmental enrichment increases the diversity of exploration.** *Physiology and Behavior* 47(1):57-62.
NAL call number: QP1 P4
Descriptors: rat, male, object exploration test, environmental exposure.

Will, B.E., et al. (1977). **Relatively brief environmental enrichment aids recovery of learning capacity and alters brain measures after postweaning brain lesions in rats.** *Journal of Comparative and Physiological Psychology* 91 (1):33-50.
NAL call number: 410 J822
Descriptors: rat, Fischer, Berkeley S_1, male, bilateral lesions, occipital cortex, hippocampus, Hebb-Williams maze, methamphetamine, brain weight, RNA, DNA.

Will, B., C. Kelche, and F. Deluzarche (1981). **Effects of post-operative environment on functional recovery after entorhinal cortex lesions in the rat.** *Behavioral and Neural Biology* 33(3):303-316.
NAL call number: QH301 C63
Descriptors: rat, young, bilateral lesions, entorhinal cortex, Hebb-Williams maze, learning.

Will, B.E., F. Deluzarche, and C. Kelche (1983). **Does post-operative environment attenuate or exacerbate**

symptoms which follow hippocampal lesions in rats? *Behavioural Brain Research* 7(1):125-132.
Descriptors: rat, hooded, female, spontaneous alternation, hippocampus.

Witvitskaya, L.V. (1983). **DNA synthesis in the brain of rats bred in sensorily enriched or impoverished environment.** *Zhurnal Vysshei Nervnoi Deyatel'nosti* 33(4):773-775.
Descriptors: rat, deprivation, brain, biochemistry.

Wolffgram, J. and A. Heyne (1991). **Social behavior, dominance, and social deprivation of rats determine drug choice.** *Pharmacology, Biochemistry, and Behavior* 38(2):389-399.
Descriptors: rat, Wistar, male, adult, ethanol, diazepam, quinine, open field, isolation, group housing, activity, body weight.

Wong, P.T.P., T. Roach, and B. Osborne (1975). **A sand-digging apparatus for rats.** *Behavior Research Methods and Instrumentation* 7(1):34-36.
Descriptors: rat, recording device, digging behavior, time.

Wu, S.Y.C. (1973). **Effects of enriched environment and visual deprivation on development of brain in rat.** *Acta Psychologica Taiwanica* 15:154-160.
Descriptors: rat, Berkeley S_1, neonate, brain weight, cortex, superior colliculi, acetylcholinesterase, butyrylcholinesterase.

Yamamoto, Y., T. Nakaya, and S. Kato (1988). **Influences of early rearing environment on Hebb-Williams maze learning in the rat: A comparison among group/imposed rich stimulation, group/poor stimulation, and isolation/poor stimulation.** *Annual of Animal Psychology* 37(2):99-114.
Descriptors: rat, weanling, adolescent, sensory stimuli, Hebb-Williams maze, learning.

Yeterian, E.H. and W.A. Wilson (1976). **Cross-modal transfer in rats following different early environments.** *Bulletin of the Psychonomic Society* 7(6):551-553.
Descriptors: rat, black-hooded, male, weanling, cross-modal transfer, visual discrimination, learning.

Zendzian-Piotrowska, M. and J. Gorski (1993). **Metabolic adaptation to daily exercise of moderate intensity to exhaustion in the rat.** *European Journal of Applied Physiology and Occupational Physiology* 67(1):77-82.
Descriptors: rat, male, treadmill, training, body mass, feed intake, glycogen, muscle fibers, heart, diaphragm, liver, hypoglycemia, urea.

Zimmerberg-Glick, B. and M.B. Brett (1992). **Effects of early environmental experience on self-administration of amphetamine and barbital.** *Psychopharmacology* (Germany) 106(4):474-478.
Descriptors: rat, male, female, social isolation, self-administration, d-amphetamine sulfate, sodium barbital.

To: Top of Document | Introduction | Social Environment | Nutritional Environment | Sensory Environment | Psychological Environment | Physical Environment | Evaluation of an Enrichment Program | References | Rodent Bibliography: Gerbils and Hamsters, Guinea Pigs, Mice, Rats, Wild Rodents

Wild Rodents

Christisen, D.M. (1985). **Seasonal tenancy of artificial nest structures for tree squirrels.** *Transactions of the Missouri Academy of Science* 19:41-48.
NAL call number: QC180 A1M52
Descriptors: tree squirrels (*Sciurus sp.*), den boxes, tire nest structures, housing.

Cooper, J.J. and C.J. Nichol (1991). **Stereotypic behaviour affects environmental preference in bank voles, *Clethrionomys glareolus*.** *Animal Behaviour* 41(6):971-977.
NAL call number: 410 B77

Descriptors: bank vole, preference test, perception, aversive conditions.

Escherich, P.C. (1981). **Social biology of the bushy-tailed woodrat, *Neotoma cinerea*.** *Publications in Zoology* 110:132pp.
NAL call number: 500 C125Z v.110
Descriptors: Bushy-tailed wood rat, social behavior.

Faulkes, C.G. and D.H. Abbott (1993). **Evidence that primer pheromones do not cause social suppression of reproduction in male and female naked mole-rats (*Heterocephalus glaber*).** *Journal of Reproduction and Fertility* 99(1):225-230.
NAL call number: 442.8 J8222
Descriptors: naked mole-rats, male, female, chemical cues, reproductive suppression, olfactory cues, gustatory contact, luteal phase, androgens.

Murphey, R.M., J.S. Mariano, and F.A. Duarte (1985). **Behavioral observations in a capybara colony (*Hydrochoerus hydrochaeris*).** *Applied Animal Behaviour Science* 14(1):89-98.
NAL call number: QL750 A6
Descriptors: capybara, alarm response, flight or fight response, behavior.

Ödberg, F.O. (1987). **The influence of cage size and environmental enrichment on the development of stereotypies in bank voles (*Clethrionomys glareolus*).** *Behavioural Processes* 14(2):155-173.
Descriptors: bank voles, behavior, conflicts.

Renner, M.J. and M.R. Rosenzweig (1987). **The golden-mantled ground squirrel (*Spermophilus lateralis*) as a model for the effects of environmental enrichment in solitary animals.** *Developmental Psychobiology* 20(1):19-24.
NAL call number: QP351 D4
Descriptors: ground squirrel, brain weight, behavior, social factors.

Rushen, J. (1993). **The "coping" hypothesis of stereotypic behavior.** *Animal Behaviour* 45(3):613-615.
NAL call number: 410 B77
Descriptors: bank voles (*Clethrionomys glareolus*), environmental enrichment, impoverished, perceptions, adverse environments.

Shiga, J., K. Yamamoto, M. Ito, K. Koshimizu (1989). **Breeding and care for wild woodchucks (*Marmota monax*) by indoor and outdoor housing.** *Jikken Dobutsu* 38(2):155-158.
NAL call number: QL55 J55
Descriptors: woodchuck, Japanese, English abstract, housing, reproduction.

Vogt, F.D. and P. Kakooza (1993). **The influence of nest sharing on the expression of daily torpor in the white-footed mouse.** *Canadian Journal of Zoology* 71(7):1297-1302.
NAL call number: 470 C16D
Descriptors: white-footed mouse (*Peromyscus leucopus noveboracensis*), huddling, isolation, radiotelemetry, body temperature, frequency of torpor, euthermic.

Wallace, J. (1994). **Evolution of ground squirrel housing at Biosciences Animal Service, University of Alberta**. *Canadian Association for Laboratory Animal Science/ L'Association Canadienne pour la Technologie des Animaux de Laboratoire Newsletter* 28(4):109-118.
NAL call number: SF405.5 C36
Descriptors: ground squirrel, housing, social groups, burrows, nests, vocalization, visual communication, tactile communication, olfactory communication.

To: Top of Document | Introduction | Social Environment | Nutritional Environment | Sensory Environment | Psychological Environment | Physical Environment | Evaluation of an Enrichment Program | References | Rodent Bibliography: Gerbils and Hamsters, Guinea Pigs, Mice, Rats, Wild Rodents

The following links access other chapters in *Environmental Enrichment Information Resources for Laboratory Animals*:

[Main Contents] [Main Introduction] [How to Use This Document]
[Birds] [Laboratory Cat] [Dogs and Dog Housing] [Farm Animals] [Ferrets] [Rabbits] [Rodents]
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This page's URL is http://www.nal.usda.gov/awic/pubs/enrich/rodents.htm

Journal Listing
and
Subscription Information for Selected Publications

"Journal Listing" and "Subscription Information for Selected Publications" are chapters from: Smith, C.P. and V. Taylor (September 1995). **Environmental Enrichment Information Resources for Laboratory Animals: 1965 - 1995: Birds, Cats, Dogs, Farm Animals, Ferrets, Rabbits, and Rodents**. *AWIC Resource Series* No. 2. U.S. Department of Agriculture, Beltsville, MD and Universities Federation for Animal Welfare (UFAW), Potters Bar, Herts, UK, pp. 213-226.

This section is a listing of journals that appear in the bibliography. It is further categorized by species or class of animal with all entries appearing in alphabetical order. Each entry lists the journal title, place of publication, language, International Standard Serial Number (ISSN) listing, brief description of contents, the NAL Call Number (if available at NAL), and the electronic databases that index the journal.

During the production of this publication, we found ourselves routinely going to several publications because of their excellent coverage of environmental enrichment research or applied programs. Consequently, we felt it important to include information on how to subscribe to these publications.

The following links access other chapters in *Environmental Enrichment Information Resources for Laboratory Animals*:

[Main Contents] [Main Introduction] [How to Use This Document]
[Birds] [Laboratory Cat] [Dogs and Dog Housing] [Farm Animals] [Ferrets] [Rabbits] [Rodents]
[Journal Listing] [Subscription Information for Selected Publications] [Organizations] [Suppliers and Products]
[Common Devices and Programs] [Main Subject Index] [Document Delivery Information]

The following is a partial listing of journals that contain environmental enrichment and/or behavior articles covering the various species listed.

- Cats, Dogs, Rabbits
- Farm Animals
- Mice and Rats
- Subscription Information for Selected Publications

Cats, Dogs, Rabbits

Title: *American Journal of Veterinary Research* (American Veterinary Medical Association).
Place of Publication: United States, Illinois
Language: English
International Standard Serial Number: 0002-9645
Descriptors: veterinary medicine periodicals.
NAL Call Number: 41.8 Am3A
Databases Indexed In: AGRICOLA, CAB ABSTRACTS, AGRIS

Title: *Animal Behaviour* (Association for the Study of Animal Behaviour).
Place of Publication: United Kingdom, England
Language: English
International Standard Serial Number: 0003-3472
Descriptors: animal behavior periodicals.

NAL Call Number: 410 B77
Databases Indexed In: BIOSIS, PSYCINFO, PASCAL, AGRICOLA, CAB ABSTRACTS

Title: *Animal Technology* (Institute of Animal Technology).
Place of Publication: United Kingdom, Wales
Language: English
International Standard Serial Number: 0264-4754
Descriptors: laboratory animals periodicals.
NAL Call Number: QL55.I5
Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: *Animal Welfare* (Universities Federation for Animal Welfare)
Place of Publication: United Kingdom, England
Language: English
International Standard Serial Number: 0962-7286
Descriptors: animal welfare periodicals.
NAL Call Number: HV4701 A557
Databases Indexed In: CAB ABSTRACTS, BIOSIS PREVIEWS

Title: *Animal Welfare Information Center Newsletter* (United States Department of Agriculture)
Place of Publication: United States, Maryland
Language: English
International Standard Serial Number: 1050-561X
Descriptors: animal welfare periodicals.
NAL Call Number: aHV4701.A952
Databases Indexed In: AGRICOLA

Title: *Anthrozoos* (Delta Society).
Place of Publication: United States, New Hampshire
Language: English
International Standard Serial Number: 0892-7936
Descriptors: human animal relationships periodicals, pet owners psychology periodicals, animal behavior periodicals.
NAL Call Number: SF411.A57
Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: *Applied Animal Behaviour Science.*
Place of Publication: Netherlands
Language: English
International Standard Serial Number: 0168-1591
Descriptors: animal behavior periodicals, domestic animals periodicals.
NAL Call Number: QL750.A6
Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: *Companion Animal Practice.*
Place of Publication: United States, California
Language: English
International Standard Serial Number: 0894-9794
Descriptors: veterinary medicine periodicals, pets diseases periodicals, cats diseases periodicals.
NAL Call Number: SF981.C64
Databases Indexed In: CAB ABSTRACTS, AGRICOLA

Title: *Lab Animal.*
Place of Publication: United States, New York
Language: English

International Standard Serial Number: 0093-7355
Descriptors: laboratory animals periodicals.
NAL Call Number: QL55.A1L33
Databases Indexed In: AGRICOLA, AGRIS

Title: *Laboratory Animal Science* (American Association for Laboratory Animal Science).
Place of Publication: United States, Illinois
Language: English
International Standard Serial Number: 0023-6764
Descriptors: laboratory animals periodicals.
NAL Call Number: 410.9 P94
Databases Indexed In: CAB ABSTRACTS, AGRICOLA, AGRIS

Title: *The Veterinary Clinics of North America.*
Place of Publication: United States, Pennsylvania
Language: English
International Standard Serial Number: 0091-0279
Descriptors: veterinary medicine collected works.
NAL Call Number: SF601.V523
Databases Indexed In: MEDLINE, CAB ABSTRACTS, AGRICOLA

Title: *The Veterinary Record: Journal of the British Veterinary Association.*
Place of Publication: United Kingdom, England
Language: English
International Standard Serial Number: 0042-4900
Descriptors: veterinary medicine periodicals.
NAL Call Number: 41.8 V641
Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: *Veterinary Technician.*
Place of Publication: United States, New Jersey
Language: English
International Standard Serial Number: Invalid :0196-1764
Descriptors: allied health personnel periodicals, laboratory animal technicians periodicals, veterinary medicine periodicals.
NAL Call Number: SF406.A5
Databases Indexed In: CAB ABSTRACTS

To: Top of Document | Cats, Dogs, Rabbits | Farm Animals | Mice and Rats | Subscription Information for Selected Publications

Farm Animals

Title: *Animal Production* (British Society of Animal Production).
Place of Publication: United Kingdom, England
Language: English
International Standard Serial Number: 0003-3561
Descriptors: Livestock-Periodicals, Animal-Industry-Great-Britain
NAL Call Number: 49 An55
Databases Indexed In: AGRICOLA, AGRIS, CAB ABSTRACTS

Title: *Animal Welfare* (Universities Federation for Animal Welfare)
Place of Publication: United Kingdom, England

Language: English
International Standard Serial Number: 0962-7286
Descriptors: animal welfare periodicals.
NAL Call Number: HV4701 A557
Databases Indexed In: CAB ABSTRACTS, BIOSIS PREVIEWS

Title: *Animal Welfare Information Center Newsletter* (United States Department of Agriculture)
Place of Publication: United States, Maryland
Language: English
International Standard Serial Number: 1050-561X
Descriptors: animal welfare periodicals.
NAL Call Number: aHV4701.A952
Databases Indexed In: AGRICOLA

Title: *Applied Animal Behaviour Science.*
Place of Publication: Netherlands
Language: English
International Standard Serial Number: 0168-1591
Descriptors: animal behavior periodicals, domestic animals periodicals.
NAL Call Number: QL750.A6
Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: *British Poultry Science* (Poultry Education Association).
Place of Publication: United Kingdom, Scotland
Language: English
International Standard Serial Number: 0007-1668
Descriptors: poultry periodicals.
NAL Call Number: 47.8 B77
Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: *Canadian Journal of Animal Science* (Canadian Society of Animal Production).
Place of Publication: Canada, Ontario
Language: Includes Some Text in French, Abstracts in English and French
International Standard Serial Number: 0008-3984
Descriptors: animal industry periodicals.
NAL Call Number: 41.8 C163
Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: *Journal of Animal Science* (American Society of Animal Science).
Place of Publication: United States, Wisconsin
Language: English
International Standard Serial Number: 0021-8812
Descriptors: livestock periodicals, animal culture periodicals.
NAL Call Number: 49 J82
Databases Indexed In: AGRICOLA, AGRIS, CAB ABSTRACTS

Title: *Journal of Dairy Science* (American Dairy Science Association).
Place of Publication: United States, Pennsylvania
Language: English
International Standard Serial Number: 0022-0302
Descriptors: dairying periodicals.
NAL Call Number: 44.8 J822
Databases Indexed In: AGRICOLA, AGRIS, CAB ABSTRACTS

Title: *Poultry Science* (Poultry Science Association).
Place of Publication: United States, Illinois
Language: English
International Standard Serial Number: 0032-5791
Descriptors: poultry periodicals.
NAL Call Number: 47.8 Am33p
Databases Indexed In: AGRICOLA, AGRIS, CAB ABSTRACTS

To: Top of Document | Cats, Dogs, Rabbits | Farm Animals | Mice and Rats | Subscription Information for Selected Publications

Mice and Rats

Title: *Animal Behaviour* (Association for the Study of Animal Behaviour).
Place of Publication: United Kingdom, England
Language: English
International Standard Serial Number: 0003-3472
Descriptors: animal behavior periodicals.
NAL Call Number: 410 B77
Databases Indexed In: BIOSIS, PSYCINFO, PASCAL, AGRICOLA, CAB ABSTRACTS

Title: *Animal Technology* (Institute of Animal Technology).
Place of Publication: United Kingdom, Wales
Language: English
International Standard Serial Number: 0264-4754
Descriptors: laboratory animals periodicals.
NAL Call Number: Ql55.I5
Databases Indexed In: AGRICOLA, CAB ABSTRACTS

Title: *Animal Welfare* (Universities Federation for Animal Welfare)
Place of Publication: United Kingdom, England
Language: English
International Standard Serial Number: 0962-7286
Descriptors: animal welfare periodicals.
NAL Call Number: HV4701 A557
Databases Indexed In: CAB ABSTRACTS, BIOSIS PREVIEWS

Title: *Animal Welfare Information Center Newsletter* (United States Department of Agriculture)
Place of Publication: United States, Maryland
Language: English
International Standard Serial Number: 1050-561X
Descriptors: animal welfare periodicals.
NAL Call Number: aHV4701.A952
Databases Indexed In: AGRICOLA

Title: *Behavioral and Neural Biology.*
Place of Publication: United States, New York
Language: English
International Standard Serial Number: 0163-1047
Descriptors: animal behavior periodicals, neurobiology periodicals.
NAL Call Number: QH301.C63
Databases Indexed In: MEDLINE, BIOSIS, PASCAL, CAB ABSTRACTS

Title: *Behavioral Ecology and Sociobiology.*
Place of Publication: Germany
Language: English
International Standard Serial Number: 0340-5443
Descriptors: animal behavior periodicals, animal populations periodicals.
NAL Call Number: QL751.B4
Databases Indexed In: BIOSIS, PASCAL, AGRICOLA, CAB ABSTRACTS

Title: *Behavioral Neuroscience* (American Psychological Association).
Place of Publication: United States, District of Columbia
Language: English
International Standard Serial Number: 0735-7044
Descriptors: neuropsychology periodicals, psychology, physiological periodicals, animal behavior periodicals.
NAL Call Number: QP351.B45
Databases Indexed In: PSYCINFO, BIOSIS, PASCAL, MEDLINE, AGRICOLA, AGRIS, CAB ABSTRACTS

Title: *Behavioural Brain Research*
Place of Publication: Amsterdam, Netherlands
Language: English
International Standard Serial Number: 0166-4328
Descriptors:
NLM Number: W1 BE135DE
Databases Indexed In: BIOSIS, PSYCINFO

Title: *Biology of Behaviour* (Centre National Recherche Scientifique).
Place of Publication: France
Language: in English or French; Summaries in Both Languages
International Standard Serial Number: 0397-7153
Descriptors: animal behavior, human behavior.
NAL Call Number: Ql750.B52
Databases Indexed In: BIOSIS, PASCAL, CAB ABSTRACTS, AGRIS

Title: *Developmental Psychobiology.*
Place of Publication: United States, New York
Language: English
International Standard Serial Number: 0012-1630
Descriptors: developmental psychobiology periodicals, psychobiology periodicals.
NAL Call Number: QP351.D4
Databases Indexed In: MEDLINE, BIOSIS, PSYCINFO, PASCAL

Title: *Ethology*
Place of Publication: Germany, Berlin
Language: English and German
International Standard Serial Number: 0179-1613
Descriptors: Animal-Behavior-Periodicals, Psychology,-Comparative-Periodicals
NAL Call Number: QL750.E74
Databases Indexed In: LIFE SCIENCES, BIOSIS, PSYCINFO, AGRICOLA

Title: *Journal of Comparative and Physiological Psychology* (American Psychological Association).
Place of Publication: United States, District of Columbia
Language: English
International Standard Serial Number: 0021-9940
NAL Call Number: 410 J822
Databases Indexed In: BIOSIS, MEDLINE, SOCIAL SCISEARCH, CAB ABSTRACTS

Title: *Laboratory Animal Science* (American Association for Laboratory Animal Science).
Place of Publication: United States, Illinois
Language: English
International Standard Serial Number: 0023-6764
Descriptors: laboratory animals periodicals.
NAL Call Number: 410.9 P94
Databases Indexed In: CAB ABSTRACTS, AGRICOLA, AGRIS

Title: *Neuropharmacology.*
Place of Publication: United Kingdom, England
Language: English
International Standard Serial Number: 0028-3908
Descriptors: neuropharmacology periodicals.
NAL Call Number: RM315.N4
Databases Indexed In: BIOSIS, PSYCINFO

Title: *Pharmacology, Biochemistry and Behavior.*
Place of Publication: United States, New York
Language: English
International Standard Serial Number: 0091-3057
Descriptors: pharmacology periodicals, biological chemistry periodicals, toxicology periodicals.
NAL Call Number: QP901.P4
Databases Indexed In: PSYCINFO, CAB ABSTRACTS

Title: *Physiology and Behavior.*
Place of Publication: United States, New York
Language: English
International Standard Serial Number: 0031-9384
Descriptors: physiology periodicals, psychology, physiological periodicals.
NAL Call Number: QP1.P4
Databases Indexed In: MEDLINE, PASCAL, SOCIAL SCISEARCH, PSYCINFO, CAB ABSTRACTS

Title: *Psychological Record*
Country of Publication: United States, OH
Language: English
International Standard Serial Number: 0033-2933
Descriptors: psychology periodicals
NLM Number: W1 PS632
Databases Indexed In: PSYCINFO, SOCIAL SCISEARCH, BIOSIS

To: Top of Document | Cats, Dogs, Rabbits | Farm Animals | Mice and Rats | Subscription Information for Selected Publications

Subscription Information for Selected Publications

Animal Ethics Update
A quarterly newsletter for members of animal care and ethics committees published by the Animal Research Review Panel and the Animal Welfare Unit, New South Wales Agriculture, Australia. This publication contains a variety of information on animal welfare topics and practical suggestions for environmental enrichment programs. For information contact Rebecca Larkin, Editor, Animal Welfare Unit, NSW Agriculture, Locked Bag 21, Orange 2800, New South Wales, AUSTRALIA. Tel: (063) 91 3670, Fax: (063) 91 3570, e-mail: larkinr@agric.nsw.gov.au

Animal Keepers' Forum
Monthly journal of the American Association of Zoo Keepers, Inc. contains a regular feature--"Enrichment Options"--which highlights psychological stimulation, behavioral enrichment, activity manipulation, and occupational husbandry in zoo and aquarium environments. Subscription information can be obtained at 635 S.W. Gage Blvd., Topeka, KS (Kansas) 66606-2066 USA. Tel: 1-800-242-4519, Fax: (913) 273-1980.

Animal Technology
A journal published three times a year by the Institute of Animal Technology. Routinely features short articles, technical notes, or reviews pertaining to enriched housing/caging options or enrichment strategies for various laboratory and farm animals including birds and other non-mammalian species. G.E. Ward, Editor, School of Molecular and Medical Biosciences, University of Wales College of Cardiff, P.O. Box 911, Cardiff , Wales CF1 1ST, UK.

Animal Welfare
Quarterly journal produced by Universities Federation for Animal Welfare. "Brings together the results of scientific research and technical studies related to the welfare of animals kept on farms, in laboratories, as companions, in zoos or managed in the wild." Often includes enrichment articles. Subscription information can be obtained from UFAW, 8 Hamilton Close, South Mimms, Potters Bar, Herts, England EN6 3QD, UK. Tel: 01707 658202, Fax: 01707 649279.

Applied Animal Behaviour Science
This journal deals with the behaviour of domesticated and utilized animals. The principal subjects include farm animals (including poultry) and companion animals. Other species covered include rabbits and fur-bearing animals, deer, and animals in forms of confinement such as zoos, safari parks, and other forms of display. Laboratory animals are occasionally included. Requests regarding subscriptions may be sent to Elsevier Science B.V., Journal Department, P.O. Box 211, 1000 AE Amsterdam, THE NETHERLANDS. Tel: 31-20-4853642, Fax: 31-20-4853598. In the USA and Canada, write to Elsevier Science Inc., Journal Information Center, 655 Avenue of the Americas, New York, NY (New York) 10010, USA. Tel: (212) 633-3750, Fax: (212) 633-3764, Telex: 420-643 AEP UI.

Guide to the Care and Use of Experimental Animals Volume 1, 2nd edition
Published by the Canadian Council on Animal Care in 1993. This publication contains a 40 page section on the social and behavioral requirements of experimental animals including wildlife kept in a laboratory setting. Other sections discuss facilities, th e physical environment, occupational health and safety, surgical standards, control of pain, anesthesia, euthanasia, and guidelines for the use of animals in neuroscience research. To obtain a copy of this guide, write to Canadian Council on Animal Care, 1000-151 Slater Street, Ottawa, Ontario K1P 5H3, CANADA.

Lab Animal
This journal is published 11 times a year and emphasizes proper management and care of laboratory animals. It routinely contains articles dealing with environmental enrichment techniques and occasionally devotes an issue to the topic. Last issue of the year is the next year's *Lab Animals Buyers Guide.* Send subscription orders to *Lab Animal* Subscriptions Department, P.O. Box 1710, Riverton, NJ (New Jersey) 08077-7310 USA, Tel: (212) 726-9200.

Laboratory Animals: The International Journal of Laboratory Animal Science and Welfare
The official journal of the Laboratory Animal Science Association, Gesellschaft für Versuchstierkunde, Nederlandse Vereniging voor Proefdierkunde, Schweizerische Gesellschaft für Versuchstierkunde, and the Federation of European Laboratory Animal Science Associations. A quarterly publication devoted to the "advancement of public education in laboratory animal science, technology, and welfare.... The Editorial Board wishes to give especial encouragement to papers describing work which... represents a significant refinement in methodology, leading to improvements in the welfare or well-being of the animals used." Subscription orders should be sent to Publications Subscription Department, Royal Society of Medicine Press Ltd., 1 Wimpole Street, London, England W1M 8AE, UK. Articles should be sent to Editorial Manager, *Laboratory Animals*, Royal Society of Medicine Press Ltd., 1 Wimpole Street, London, England W1M 8AE, UK. Tel: 071-290-2923.

The Shape of Enrichment
A quarterly bulletin featuring ideas for environmental and behavioral enrichment written mostly by zoo and aquarium researchers, keepers, and trainers. Topics covered include design and evaluation of enrichment devices and programs.

To subscribe write to *The Shape of Enrichment*, 1650 Minden Dr., San Diego, CA (California) 92111-7124 USA. Tel: (619) 231-1515, ext. 4272 or (619) 279-4273, Fax: (619) 279-4208.

To: Top of Document | Cats, Dogs, Rabbits | Farm Animals | Mice and Rats | Subscription Information for Selected Publications

The following links access other chapters in *Environmental Enrichment Information Resources for Laboratory Animals*:

[Main Contents] [Main Introduction] [How to Use This Document]
[Birds] [Laboratory Cat] [Dogs and Dog Housing] [Farm Animals] [Ferrets] [Rabbits] [Rodents]
[Journal Listing] [Subscription Information for Selected Publications] [Organizations] [Suppliers and Products]
[Common Devices and Programs] [Main Subject Index] [Document Delivery Information]

The Animal Welfare Information Center
U.S. Department of Agriculture
Agricultural Research Service
National Agricultural Library
10301 Baltimore Ave.
Beltsville, MD 20705-2351

Phone: (301) 504-6212
FAX: (301) 504-7125
E-mail: awic@nal.usda.gov

Policies and Links

August 11, 1998
This page's URL is http://www.nal.usda.gov/awic/pubs/enrich/journals.htm

Organizations

"Organizations" is a chapter from: Smith, C.P. and V. Taylor (September 1995). **Environmental Enrichment Information Resources for Laboratory Animals: 1965 - 1995: Birds, Cats, Dogs, Farm Animals, Ferrets, Rabbits, and Rodents**. *AWIC Resource Series* No. 2. U.S. Department of Agriculture, Beltsville, MD and Universities Federation for Animal Welfare (UFAW), Potters Bar, Herts, UK, pp. 227-236.

There are many organizations that produce extremely useful materials for their members and other interested parties. In this section, organized by world regions, you will find information on how to contact these organizations via a variety of electronic means and that old standby, the postal service. You will also find World Wide Web addresses for those organizations that have posted homepages on the Web. However, readers are cautioned that because the WEB is a very dynamic media, these addresses may change. You will also find information on the type of organization, the resources or services offered, requestor priority, and fees (if any).

The following links access other chapters in *Environmental Enrichment Information Resources for Laboratory Animals*:

[Main Contents] [Main Introduction] [How to Use This Document]
[Birds] [Laboratory Cat] [Dogs and Dog Housing] [Farm Animals] [Ferrets] [Rabbits] [Rodents]
[Journal Listing] [Subscription Information for Selected Publications] [Organizations] [Suppliers and Products]
[Common Devices and Programs] [Main Subject Index] [Document Delivery Information]

North American Resources

- American Association for Laboratory Animal Science (AALAS)
- American Society of Laboratory Animal Practitioners
- Animal Welfare Information Center (AWIC)
- Canadian Association for Laboratory Animal Science
  L'Association Canadienne Pour La Technologies des Animaux de Laboratoire
- Canadian Council on Animal Care (CCAC)
- Institute of Laboratory Animal Resources (ILAR)
- National Library of Medicine (NLM)
- Scientists Center for Animal Welfare (SCAW)
- The Shape of Enrichment Video Library

European, Asian, and Australian Resources

- Australian and New Zealand Council for the Care of Animals in Research and Teaching, Limited (ANZCCART)
- British Laboratory Animals Veterinary Association
- Federation of European Laboratory Animal Science Associations (FELASA)
- Gesellschaft für Versuchstierkunde
  Society for Laboratory Animal Science (GV-SOLAS)
- Institute of Animal Technology
- Institut für Labortierkunde der Universität Zürich
  Institute of Laboratory Animal Science
- Japanese Association for Laboratory Animal Science (JALAS)
- Laboratory Animal Science Assoc. (LASA)
- Nederlandse Vereniging voor Proefdierkunde (NVP)
- Scandinavian Federation for Laboratory Animal Science
- Schweizerische Gesellschaft für Versuchstierkunde (SGV)
  Société Suisse pour la Science des Animaux de Laboratoire
  Swiss Laboratory Animal Science Association
- Universities Federation for Animal Welfare

North American Resources:

American Association for Laboratory Animal Science (AALAS)
70 Timber Creek Drive
Cordova, TN (Tennessee) 38018, USA

TELEPHONE: (901) 754-8620
FAX: (901) 753-0046
E-MAIL: info@aalas.org
WORLD WIDE WEB: **http://www.aalas.org**
CONTACT: Michael Sondag, Executive Director
TYPE OF INSTITUTION/ORGANIZATION: Non-profit, professional
RESOURCES/SERVICES: International in scope. Serves as a clearinghouse for collection and exchange of information on all phases of laboratory animal care and management, use and procurement of laboratory animals used in biomedical research. Educational materials, guides, and audiovisuals. Hold annual meetings that have workshops or seminars on environmental enrichment. Publish *Contemporary Topics* - a bimonthly journal with an expanded peer reviewed section on topics such as clinical management and husbandry. Also publish Laboratory Animal - a monthly, peer reviewed journal covering a diverse array of applied and experimental topics in the laboratory animal sciences.
REQUESTOR: Anyone.
COSTS: Charge for materials (members are charged a lower rate).

American Society of Laboratory Animal Practitioners
University of Texas Medical School
6431 Fannin Street, Room 1132
Houston, TX (Texas) 77030, USA

TELEPHONE: (713) 792-5127
FAX: (713) 792-5127
E-MAIL: bgoodwin@admin4.hsc.uth.tmc.edu
CONTACT: Bradford S. Goodwin, Jr., Secretary-Treasurer
TYPE OF INSTITUTION/ORGANIZATION: Private group of veterinarians
RESOURCES/SERVICES: Personal knowledge of veterinarians.
REQUESTOR: Anyone.
COSTS: None.

Animal Welfare Information Center (AWIC)
Agricultural Research Service
National Agricultural Library
10301 Baltimore Boulevard
Beltsville, MD (Maryland) 20705, USA

TELEPHONE: (301) 504-6212
FAX: (301) 504-7125
E-MAIL: awic@nal.usda.gov
WORLD WIDE WEB: http://www.nal.usda.gov/awic
CONTACT: Jean Larson, Coordinator
TYPE OF INSTITUTION/ORGANIZATION: Public, non-profit, government agency
RESOURCES/SERVICES: Vast collection of serials, monographs, and audiovisuals within the National Agricultural Library (NAL). Documents may be borrowed through an interlibrary loan. For more information on document delivery, contact (301) 504-5755. The Center performs brief complimentary searches of AGRICOLA and other relevant databases. The Center can also assist you in formulating your own database searches, provides conference facilities and

host training sessions, and can make available speakers and/or a tabletop exhibit for training sessions, conferences, and workshops. The Center produces bibliographies on topics such as stress, analgesia, animal testing alternatives, training materials and other relevant topics to animal welfare. Publishes the *Animal Welfare Information Center Newsletter*.
REQUESTOR: Anyone.
COSTS: All publications are available for free; literature searches on a cost recovery basis; NAL may charge for certain services such as providing photocopies, document delivery, etc.

Canadian Association for Laboratory Animal Science
L'Association Canadienne Pour La Technologies des Animaux de Laboratoire
c/o CALAS National Office
Biosciences Animal Service
University of Alberta
Edmonton, Alberta T6G 2E9, CANADA

TELEPHONE: (403) 492-5193
FAX: (403) 492-7257
E-MAIL: dmckay@gpu.srv.ualberta.ca
CONTACT: Donald McKay
TYPE OF INSTITUTION/ORGANIZATION: Non-profit, professional
RESOURCES/SERVICES: Produces educational materials, videos, and a monthly newsletter (CALAS/ACTAL Newsletter). Hold annual meetings with workshops, seminars, and poster sessions.
REQUESTOR: Laboratory animal professionals.
COSTS: Vary according to materials.

Canadian Council on Animal Care (CCAC)
350 Albert Street, Suite 315
Ottawa, Ontario K1R 1B1, CANADA

TELEPHONE: (613) 238-4031
FAX: (613) 238-2837
E-MAIL: lroach@bart.ccac.ca
CONTACT: Dr. James Wong, Director of Assessments
TYPE OF INSTITUTION/ORGANIZATION: Private, non-profit
RESOURCES/SERVICES: Establishment and enforcement of standards and guidelines (in Canada) concerning the use of animals in research, testing and teaching. Maintain active, expert committees on all aspects of animal care and use. The Council's program is based on its major publication "Guide to the Care and Use of Experimental Animals," Volume 1, 2nd Edition (1993) and Volume 2 (1984). Within these two documents the subject of environmental enrichment is addressed. CCAC conducts workshops and training courses on various aspects of the care and use of experimental animals, as well as the training of personnel working with these animals. The Council addresses alternative methods and conducts a course on tissue culture. Semi-annually publishes the newsletter, *Resource*.
REQUESTOR: Anyone.
COSTS: Vary according to materials.

Institute of Laboratory Animal Resources (ILAR)
National Academy of Sciences
2101 Constitution Avenue, N.W.
Washington, D.C. (District of Columbia) 20418, USA

TELEPHONE: (202) 334-2590
FAX: (202) 334-1687
E-MAIL: twolfle@nas.edu

CONTACT: Tom Wolfle
TYPE OF INSTITUTION/ORGANIZATION: ILAR is a unit of the National Research Council's (NRC) Commission on Life Sciences (CLS). The NRC in the working arm of the National Academy of Sciences (NAS), a private, non-governmental, non-profit o rganization.
RESOURCES/SERVICES: Information on a wide variety of topics related to laboratory animals and emerging adjuncts and alternatives to animal use. Assignments of genetic identification for unique colonies. Guidelines that assist in the implementation of national policies or laws. Information to teachers and students about animals in science and careers in biology. ILAR's information database, which is published as *Animals for Research: A Directory of Sources.* This assists scientists in locating specific animals and models, including nonhuman primates. Produce *ILAR NEWS* - a quarterly journal, available free-of-charge to institutional animal care and use committees, scientists, and veterinarians. Reports specific to nonhuman primates such as *Laboratory Animal Management: Nonhuman Primates*. A study on the well-being of nonhuman primates is currently underway by an ILAR committee. Manage *Animal Models and Genetic Stocks Information Exchange Program.*
REQUESTOR: Anyone.
COSTS: Vary according to materials.

National Library of Medicine (NLM)
8600 Rockville Pike
Bethesda, Maryland 20894, USA

TELEPHONE: (301) 496-6095 or 1-800-272-4787
FAX: (301) 402-1384
E-MAIL: ref@nlm.nih.gov
WORLD WIDE WEB: http://www.nlm.nih.gov/
TYPE OF INSTITUTION/ORGANIZATION: Public
RESOURCES/SERVICES: Library - extensive collection of serials, monographs, audiovisuals can be accessed by anyone. Computer based systems of information retrieval include MEDLARS, MEDLINE, CANCERLIT, AVLINE, TOXLINE, and Grateful Med.
REQUESTOR: Anyone.
COSTS: $7.00 for each filled interlibrary loan.

Scientists Center for Animal Welfare (SCAW)
Golden Triangle Building One
7833 Walker Drive, Suite 340
Greenbelt, Maryland 20770, USA

TELEPHONE: (301) 345-3500
FAX: (301) 345-3503
CONTACT: Lee Krulisch, Executive Director
TYPE OF INSTITUTION/ORGANIZATION: Private, non-profit
RESOURCES/SERVICES: Publications, including conference proceedings, training manuals, and materials from other organizations. Publications - *Canine Research Environment* and *Well-Being of Nonhuman Primates in Research.* Each contains proceedings from conferences sponsored by SCAW.
REQUESTOR: Anyone.
COSTS: Some services are free, others are fee-for-services basis.

The Shape of Enrichment, Inc.
1650 Minden Dr.
San Diego, CA 92111-7124, USA
E-MAIL:shape@enrichment.org
WORLD WIDE WEB: http://www.enrichment.org/

TYPE OF INSTITUTION/ORGANIZATION: Volunteer, non-profit.
RESOURCES/SERVICES: Loans videos of environmental enrichment programs currently in place in different zoos, aquariums, etc. around the country. Videos cover a variety of animals. **Donations of videos are encouraged.**

European, Asian, and Australian Resources:

Australian and New Zealand Council for the Care of Animals in Research and Teaching, Limited (ANZCCART)

P.O. Box 19
Glen Osmond SA 5064
AUSTRALIA

P.O. Box 598
5064 Wellington
NEW ZEALAND

TELEPHONE: 61-08-303-7393 (Australia) 64-04-472-7421(New Zealand)
FAX: 61-08-303-7113 (Australia) 64-04-473-1841(New Zealand)
E-MAIL:anzccart@waite.adelaide.edu.au
WORLD WIDE WEB: http://www.adelaide.edu.au/ANZCCART/
CONTACT: R.M. Baker
TYPE OF INSTITUTION/ORGANIZATION: private, non-profit
RESOURCES/SERVICES: Quarterly newsletter, and other publications on euthanasia, animal care and use committees, wellbeing of research animals, alternatives for undergraduate education, laboratory animal surveys, tumour cell lines available in Australia, humane care and use of animals in research, and animal pain.
REQUESTOR: Anyone.
COSTS: Vary according to materials.

British Laboratory Animals Veterinary Association
Honorary Secretary
C/O Site Services Department
Zeneca Pharmaceuticals
Mereside, Alderly Park
Macclesfield, Cheshire 5K10 4TG, UK

TELEPHONE: 01625 513536
FAX: 01625 583074
CONTACT: D. Whitaker, Honorary Secretary
TYPE OF INSTITUTION/ORGANIZATION: Professional
RESOURCES/SERVICES: Slide programs on lab animal diseases, training materials, speakers notes and slides (eg., surgery and anaesthesia), and access to expert advice.
REQUESTOR: Veterinary surgeons with interests in laboratory animal health and welfare.
COSTS: None.

Federation of European Laboratory Animal Science Associations (FELASA)
BCM Box 2989
London WC1N 3XX, UK

CONTACT: P. Hardy, Secretary
TYPE OF INSTITUTION/ORGANIZATION: Professional
RESOURCES/SERVICES: Co-sponsor of *Laboratory Animals: The International Journal of Laboratory Animal Science and Welfare.* Sponsors annual animal welfare symposiums.

REQUESTOR: Laboratory animal users.
COSTS: Vary according to materials.

Gesellschaft für Versuchstierkunde
Society for Laboratory Animal Science (GV-SOLAS)
C/O Institut für Versuchstierkunde
Pauwelstrasse, D-52074 Aachen
GERMANY

CONTACT: C. Herweg, Secretary
TYPE OF INSTITUTION/ORGANIZATION: Professional
RESOURCES/SERVICES: Co-sponsor of *Laboratory Animals: The International Journal of Laboratory Animal Science and Welfare*.
REQUESTOR: Laboratory animal users.
COSTS: Vary according to materials.

Institute of Animal Technology
c/o University of Liverpool
Faculty of Medicine
Biomedical Services
P.O. Box 147
Liverpool, England L69 3BX, UK

CONTACT: P.A. Hynes, Honorary Secretary
TYPE OF INSTITUTION/ORGANIZATION: Professional
RESOURCES/SERVICES: Publishes the quarterly journal *Animal Technology* and the monthly *Bulletin of the Institute of Animal Technology* (Phil Ruddock, Editor, 5 South Parade, Summertown, Oxford OX2 7JL, UK; Tel: 01737 247666). Videos and training manuals on humane care and handling, information on animal welfare.
REQUESTOR: Laboratory animal users.
COSTS: Vary according to material.

Institut für Labortierkunde der Universität Zürich
Institute of Laboratory Animal Science
University of Zurich
Winterthurerstrasse 190
8057 Zurich, SWITZERLAND

TELEPHONE: 01 257 11 11 or 01 257 54 51
FAX: 01 257 57 03
CONTACT: Prof. Dr. med. vet. Peter E. Thomann, Director
WORLD WIDE WEB: http://www.unizh.ch/labtier/
TYPE OF INSTITUTION/ORGANIZATION: University
RESOURCES/SERVICES: Provides classes and training courses for technicians, students and postgraduates. Breeds rats and mice, offers diagnostic services for rodents and rabbits, offers in vitro production of monoclonal antibodies, and operates a consulting service to answer questions relating to the care of laboratory animals. Most information on Web site is in German.
REQUESTOR: Laboratory animal users.
COSTS: Vary according to material.

Japanese Association for Laboratory Animal Science (JALAS)

2-8-10 Iwamotocho
Chiyoda-ku
Tokyo 101, JAPAN

TELEPHONE/ FAX: 03-3865-1475
RESOURCES: Publishes the quarterly journal *Experimental Animals.*
COSTS: Price of one issue is 2,500 yen (US $25) for non-member individual.

Laboratory Animal Science Assoc. (LASA)
P.O. Box 3993
Tamworth, Staffs B78 3QU, UK

TELEPHONE: 01827 260036
FAX: 01827 260036
CONTACT: B.R. Howard, Honorary Secretary
RESOURCES/SERVICES: Co-sponsor of *Laboratory Animals: The International Journal of Laboratory Animal Science and Welfare.*

Nederlandse Vereniging voor Proefdierkunde (NVP)
Dutch Association for Laboratory Animal Science
C/O Agricultural University Wageningen
CKP, P.O. Box 8129, 6700 EV
Wageningen, THE NETHERLANDS

CONTACT: F.A.R. van den Brock, Secretary
TYPE OF ORGANIZATION: Professional
RESOURCES/SERVICES: Co-sponsor of *Laboratory Animals: The International Journal of Laboratory Animal Science and Welfare.*

Scandinavian Federation for Laboratory Animal Science
Enheten för försöksdjursvetenskap och service
Medicinska Forskningsrådet
Box 7151
S-103 88 Stockholm, SWEDEN

TELEPHONE: +46 8454 4281/77
FAX: +46 8454 4303
CONTACT: Barbro Salomonsson
TYPE OF INSTITUTION/ORGANIZATION: Professional
RESOURCES: Publishes the quarterly journal *Scandinavian Journal of Laboratory Animal Science.* Conducts annual meetings and publishes conference papers and abstracts in its journal.
COSTS: Journal subscriptions are Dkr. 250/individual; library subscriptions are Dkr. 600 + postage.

Schweizerische Gesellschaft für Versuchstierkunde (SGV)
Société Suisse pour la Science des Animaux de Laboratoire
Swiss Laboratory Animal Science Association
c/o RCC Registration and Consulting Co.
Landstrasse 33
4452 Itingen, SWITZERLAND

CONTACT: Ludwig G. Ullmann, Secretary or Dr. Marianne Geiser Kamber, President (e-mail: geiser@ana.unibe.ch)

WORLD WIDE WEB: WORLD WIDE WEB: http://www.unizh.ch/labtier/
RESOURCES/SERVICES: Co-sponsor of *Laboratory Animals*, an international journal devoted to issues surrounding the care and use of laboratory animals. Sponsors seminars and conferences and publishes the resulting papers and abstracts.
REQUESTOR: Laboratory animal users.
COSTS: Vary according to material.

Universities Federation for Animal Welfare
8 Hamilton Close
South Mimms, Potters Bar,
Hertfordshire, EN6 3QD, UK

TELEPHONE: 01707-658202
FAX: 01707-649279
E-MAIL: trevor.poole@ucl.ac.uk
CONTACT: Victoria Taylor, Development Officer
TYPE OF INSTITUTION/ORGANIZATION: Private, charitable
RESOURCES/SERVICES: Publications, reprints, videos, educational brochures, and advisory services. Publishes a quarterly scientific journal entitled *Animal Welfare*, which brings together information from zoos, laboratories, farms, wild, and companion animals.
REQUESTOR: Anyone.
COSTS: Vary according to materials. Annual subscriptions to the journal *Animal Welfare* cost £50/US$100.

To: Top of Document

The following links access other chapters in *Environmental Enrichment Information Resources for Laboratory Animals*:

[Main Contents] [Main Introduction] [How to Use This Document]
[Birds] [Laboratory Cat] [Dogs and Dog Housing] [Farm Animals] [Ferrets] [Rabbits] [Rodents]
[Journal Listing] [Subscription Information for Selected Publications] [Organizations] [Suppliers and Products]
[Common Devices and Programs] [Main Subject Index] [Document Delivery Information]

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U.S. Department of Agriculture
Agricultural Research Service
National Agricultural Library
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Beltsville, MD 20705-2351

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FAX: (301) 504-7125
E-mail: awic@nal.usda.gov

Policies and Links

August 11, 1998
This page's URL is http://www.nal.usda.gov/awic/pubs/enrich/orgs.htm

Suppliers and Products

"Suppliers and Products" is a chapter from: Smith, C.P. and V. Taylor (September 1995). **Environmental Enrichment Information Resources for Laboratory Animals: 1965 - 1995: Birds, Cats, Dogs, Farm Animals, Ferrets, Rabbits, and Rodents**. *AWIC Resource Series* No. 2. U.S. Department of Agriculture, Beltsville, MD and Universities Federation for Animal Welfare (UFAW), Potters Bar, Herts, UK, pp. 237-242.

To make it even easier for you to develop enrichment programs, we have put together a lengthy, but by no means exhaustive, listing of commercial vendors and the enrichment products they supply. This listing include items as diverse as plastic tubes or tunnels for rodents to electric netting for free range chickens. All contact information is current as of September 1, 1995. Please note that "800" telephone numbers for U.S. companies may not be reached by all countries.

The following links access AWIC and other chapters in this publication:

[AWIC] [Main Contents] [Main Introduction] [How to Use This Document]
[Birds] [Laboratory Cat] [Dogs and Dog Housing] [Farm Animals] [Ferrets] [Rabbits] [Rodents]
[Journal Listing] [Subscription Information for Selected Publications] [Organizations] [Suppliers and Products]
[Common Devices and Programs] [Main Subject Index] [Document Delivery Information]

Agri-Engineering, Inc. 2600 College Avenue, Goshen, IN (Indiana) 46526, USA. Tel: (219) 533-0497 or (800) 447-2751 (USA only).
Manufacturer of Plastic Piggy Playballs.

Ancare Corp. 2647 Grand Ave., P.O. Box 814, Bellmore, NY (New York) 11710-0814, USA. Tel: (800) 645-6379, Fax: (516) 781-4937.
Supplier of Nestlets, a rodent nesting material.

B & K Universal Ltd. The Field Station, Grimston Aldborough Hull, North Humberside HU11 4QE, UK. Tel: 01964 527555, Fax: 01964 527006.
Product line includes:

- disposable cardboard tubes for smaller mammals
- wooden chew blocks for rabbits and guinea pigs
- Beekay Litterite bedding
- different shaped food treats for primates

Big Dutchman International GmbH. P.O. Box 1163, D-49360 Vechta, GERMANY. Tel: +49 4447 8010, Fax: +49 4447 801237.
Manufacturer of Gather-all Breeder Nest System that is designed to safely handle eggs from the bird to the collection belt while providing comfort to the hen.

Bio-Serv. P.O. Box 450, Frenchtown, NJ (New Jersey) 08825, USA.Tel: (800) 473-2155, Fax: (800) 473-2167.
Manufacturer or distributor of a variety of environmental enrichment products for dogs, swine, rabbits, and primates.
Product line includes:

- **Dogs**
  - Pen Pals which are treats developed to enhance socialization programs
  - Certified Rawhide Bone is designed for toxicology labs performing strict diet studies. The bone is assayed and chemically screened to ensure it is 100 percent rawhide. The bone helps control tartar and serves as an enrichment tool.
  - distributer for Kong toys for dogs

- **Swine**
  - Oinkers which are treats developed to reduce stress associated with handling and other procedures
  - P.R.A.N.G. which is an oral rehydrator useful in post-operative care
  - distributor of Kong toys for swine

- **Rabbits**
  - Rabbit Stix which are treats containing papain to help prevent hairballs
  - distributor of Kong toys for rabbits

Booda Products, Inc. 26707 Agoura Road, Suite 110, Calabasas, CA (California) 91302, USA. Tel: (818) 878-3900, Fax: (818) 878-3909.
Makers of a variety of toys for dogs, cats, and birds. Product line includes:

- **Dogs**
  - rope tugs with different attached objects for chewing and pulling provide for dental health
  - Booda Velvets which are chew toys made from corn-derived products

- **Cats**
  - rope toys
  - scratching posts and mats
  - cat furniture
  - litter boxes

- **Birds**
  - perches for all cage sizes

Boomer Ball. 24171 West Route 120, Grayslake, IL (Illinois) 60030, USA. Tel: (703) 546-6125 or (800) 858-9529.
Makers of non-toxic, heavy-duty, polyethylene plastic balls, mazes, ice floes and other devices. For use with small mammals to large carnivores and apes.
Product line includes:

- Boomer Ball--intended for soccer-style play, to encourage healthful exercise as an alternative to destructive chewing, pacing, and other undesirable behaviors. The ball has a rigid sidewall which is resistant, but not impervious, to chewing and scratching. The roughened surface on a used ball may be smoothed with a carpenter's rasp, file, or rough sandpaper. The ball is hollow, and the 10 inch and 20 inch diameter balls have a screw-out plug which allows insertion of pebbles, bells, etc. to produce a n enticing noise, or sand or water to add weight.

- Ferret and Small Animal Ball--a 10" diameter ball for use in cages for chinchillas, guinea pigs, ferrets, and hedgehogs. The ball provides a maze-like play area with plenty of ventilation if the animal chooses to sleep inside the ball.

- Ferret Hide "N" Seek Maze Logs--a 16" long, 4 ½ diameter log-shaped tube with 4" openings at each end and two 4" openings on the side. The units can be snapped together to form unlimited maze configurations for small animals, such as ferrets, chinchillas, and guinea pigs and other small rodents.

- Bobbins--a round, hollow, spool-shaped, heavy polyethylene play/exercise toy for larger breeds of dogs and exotic animals.

Braden Industries. P.O. Box 2010, Sulphur Springs, TX (Texas) 75483, USA. Tel: (903) 439-3233 or (800) 272-3361 (US only), Fax: (903) 439-1814.
Manufacturer of the Braden Start Dry Feed Bottle that allows calves to be weaned to dry feed by suckling a rubber nipple and receiving pelletted feed rather than liquid.

Britz-Heidbrink, Inc. P.O. Box 1179, Wheatland, WY (Wyoming) 82201-1179, USA. Tel: (307) 322-4040, Fax: (307) 322-4141.

Produces animal housing systems that include "enrichment panels" that use color, noise reduction, thermal neutral surfaces, and opportunities for animal exploration.

Eisers. 360 Kiwanis Boulevard, Hazelton, PA (Pennsylvania) 18201, USA. Tel: (800) 526-6987 (USA only) or (717) 450-6130, Fax: (800) 680-3926 (USA only) or (717) 455-1593.
Manufacturer and distributor of the Giant Stallmate Apple, a scented toy for horses and pigs, and the Equi-Ball, a toy for horses.

Ethical, Inc. 216 First Street, Newark, NJ (New Jersey) 07107, USA. Tel: (201) 484-1000.
Manufacturer of solid vinyl chew toys for dogs and Squish balls for cats.

Jansen Engineering and Construction Company. Mercuriusweg 25, 3771 NC Barneveld, THE NETHERLANDS. Tel: +31 3420 21020, Fax: +31 03420 21019.
Manufacturer of Jansen automatic roll-away nests for hens. The shape, color, and floor material of the nest have been chosen according to the latest research in bird behavior.

K.L.A.S.S. 4960 Almaden Expressway, Suite 233, San Jose, CA (California) 95118, USA. Tel: (408) 266-1235.
Distributor of environmental enrichment products including Kong Toys, Boomer Balls, Nylabone, mouse nesting box, and a variety of easily sanitized play objects for birds, cats, dogs, ferrets, pigs, and primates. Product line includes:

- **Birds** (all items made of acrylic)
  - rattles, swings, log 'n' chain, playring, hoops, chains, playhouse, mirrors, ladders and other toys
- **Cats**
  - Bizzy Kitty Home Entertainment Center
  - Sokker ball made of plastic
  - mini-Sox
  - Sparkel ball
- **Dogs, Pigs, and Primates**
  - Kong Toys in all varieties and shapes
  - Nylabone products such as plaque attacker dental ball, all sizes of nylabones, gumabones, nylarings, tug toys, rubber knots, and gumaballs.
- **Ferrets**
  - Ferret Ball

Landmeco A/S. DK-6870 Ølgod, DENMARK. Tel: +45 75 24 55 11, Fax: +45 75 24 43 53.
Manufacturer of the Landmeco Nest. Each roll-away nest contains six nest pads that provide the hens with a warm and comfortable laying area.

Wm. Lillico & Son (Wonham Mill) Ltd. Wonham Mill, Betchworth, Surrey, RH3 7AD, UK. Tel: 01737 247666, Fax: 01737 246783.
Produces a variety of forage mixes and is a distributer of Boomer Balls and the Scanbur A/S rabbit cage. Other products include:

- honey and sunflower rolls for rabbits
- paper wool for nesting, fine paper shavings for bedding or nesting, and Enviro-Dri which is a comfortable bedding designed specifically for large animals, canines, and primates.

P.J. Murphy Forest Products Corp. P.O. Box 300, 150 River Rd., Montville, NJ (New Jersey) 07045, USA.Tel: (201) 316-0800, Fax: (201) 316-9455.
Produces "Sani-Chips" animal bedding. Hardwood and softwood products are available.

Nylabone Products. Third Avenue and Union St, Neptune, NJ (New Jersey) 07753, USA. Tel: (908) 988-8400.

Manufacturer of Nylabone, Nylaballs, Gumabone Plaque Attacker, Gumabone tugs, and Gumadisc Flying Disc chew toys for dogs and other animals.

David Nunn Ltd. Station Yard, Hadnall, Shrewsbury, Shropshire SY4 3DD, UK. Tel: 0939 210555, Mobile: 0836 224691.
Distributors of Sundown Livestock Bedding and Environmental Straw Products. Poultry bedding is available in 25 kg poly-wrapped bales of de-dusted, sterilized straw.

R.J. Patchett, Ltd. Queensbury, Bradford, Yorkshire BD13 1DS, UK. Tel: 0274 882331, Fax: 0274 816362.
Manufacturer of laying cages with perch frames designed to meet EC welfare requirements. Also make nest boxes.

Primate Products. 1755 East Bayshore Rd., Suite 28A, Redwood City, CA (California) 94063, USA. Tel: (415) 368-0663, Fax: (415) 368-0665.
Produces "Kong Toys" which are autoclavable hollow toys that are durable enough to withstand rough handling and biting. They can also be filled with treats. Recommended for primates, canines, pigs, and rodents.

Rappa Fencing Ltd. Steepleton Hill, Stockbridge, Hampshire SO20 6JE, UK. Tel: 01264 810665, Fax: 01264 810079.
Manufacturer of eight- line electric fence system designed specifically for free range poultry.

Renco. Unit K1A, Bath Road Trading Estate, Stroud, Glos, England GL5 3QF, UK. Tel: 01453 752154, Fax: 01453 752155.
Manufacturer of electric netting for free range poultry. Offers protection from predators and provides bird control.

Scanbur A/S. Gl. Lellingegård, Bakkeleddet 9, Lellinge, DK-4600 Køge, DENMARK. Tel: +45 56 82 02 21 or 020 79 52 44 (Sweden only), Fax: +45 56 82 14 05.
Manufacturer of environmentally enriched caging systems for rabbits. Allows for single, pair, or group housing of rabbits. This cage system increases the possibility of exercise and physical activity. Rabbits can obtain social contact with fellow rabbits, and they can retire and hide whenever they want to. Each cage contains a resting shelf and shelter. Scandinavian distributor for Special Diet Services.

Shepherd Specialty Papers. P.O. Box 804, Kalamazoo, MI (Michigan) 49005, USA. Tel: (616) 324-3017 or (800) 382-5001(USA only) , Fax: (616) 324-3026 or (800) 222-5170 (USA only) .
Manufacturer of ALPHA-dri (alpha cellulose) which is a loose animal bedding of precisely defined composition. Also produce Enviro-Dri which is a bedding developed for pen-housed primates, large animals, and canines. Enviro-Dri is also recommended for the nesting of all animals.

Société Parisiennes des Sciures. 33, rue de Gode, 95100 Argenteuil, FRANCE. Tel: 39 80 15 09, Fax: 39 80 66 64, Telex: 688214 F.
Distributor of Litalabo bedding for laboratory animals.

Special Diet Services. P.O. Box 705, Witham, Essex, CM8 3AD, UK. Tel: 01376 511260, Fax: 01376 511247.
Manufacturers of diets in mixed shapes and sizes.

Tapvei. 73600 Kaavi, FINLAND. Tel: +358 71 688 88 99, Fax: +358 71 663 234.
Manufacturer of Tapvei bedding, bedding dispensers and waste removal systems, items for cage enrichment and Aspen bricks for dogs, rabbits, and rodents.

To: Top of Document

The following links access other chapters in *Environmental Enrichment Information Resources for Laboratory Animals*:

[Main Contents] [Main Introduction] [How to Use This Document]
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Common Enrichment Devices and Programs

- Introduction
- Birds
- Cats
- Dogs
- Farm Animals: Cattle, Horses, Sheep and Goats, Swine
- Ferrets
- Rabbits
- Rodents: Gerbils and Hamsters, Guinea Pigs, Mice, Rats, Wild Rodents

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"Common Enrichment Devices and Programs" is a chapter from: Smith, C.P. and V. Taylor (September 1995). **Environmental Enrichment Information Resources for Laboratory Animals: 1965 - 1995: Birds, Cats, Dogs, Farm Animals, Ferrets, Rabbits, and Rodents**. *AWIC Resource Series* No. 2. U.S. Department of Agriculture, Beltsville, MD and Universities Federation for Animal Welfare (UFAW), Potters Bar, Herts, UK, pp. 243-246.

In an effort to show the wide variety of items or strategies commonly employed in enrichment programs, we searched through articles for toys, devices, feed items, socialization programs, etc. and listed them according to the species or class of animal for which they are used.

The following links access AWIC and other chapters in this publication:

[AWIC] [Main Contents] [Main Introduction] [How to Use This Document]
[Birds] [Laboratory Cat] [Dogs and Dog Housing] [Farm Animals] [Ferrets] [Rabbits] [Rodents]
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Birds

Balls (leather, rubber, plastic or tennis)
Cage space to allow wing flapping
Cocoa husks
Colored objects
Dustbaths
Foraging litter or substrate
Grain blocks
Litter
Mirrors
Music
Nest building material
Nest boxes
Operant feeders (singly housed birds)
Pecking targets
Perches
Pre-formed nests
Roll-away nest box
Roosting shelves
Shredded paper
Social groups
Straw substrate

Wood shavings

Cats

Balls
Bedding materials
Bells
Catnip toys
Climbing frames
Colony housing
Sheepskin mice
Perches
Climbing poles
Human interaction
Movable toys
Music
Puzzle boxes
Elevated resting spaces
Ropes
Scratching posts
Shelves
Social housing
Stuffed toys
Vertical space
Viewing panels

Dogs

Balls
Bedding
Bones
Chew toys
Exercise
Gumabone chews
Human interaction
Knotted cloth
Novel objects
Nylabone frisbees
Nylabones
Plastic decoys
Rawhide
Resting boards
Ropes
Socialization
Tug toys
Walks

Farm Animals

Cattle

Bedding
Fitting barriers
Human-Animal Interaction
Manipulable objects
Novel objects
Operant Food Devices
Social Housing

Horses

Foraging material
Grazing areas
Hanging Balls
Human-animal interaction
Novel objects
Social housing
Substrates (straw, wood shavings, etc.)

Sheep and Goats

Social or natural grouping
Bedding or substrate (straw)
Mirrors
Climbing structures (rocks or wood structures)

Swine

Balls
Bedding (straw, wood chips)
Chains
Edinburgh Foodball
Forage material (hay)
Free-range
Group housing
Heated floor mats
Hoses
Human-animal interaction
Knotted cloth
Manipulatable devices
Music
Novel objects
Plastic jugs
Pre-formed nests
Ropes
Scented plastic apples
Substrates (straw, wood chips, sand, etc)
Tires
Turn-around farrowing crate

Ferrets

Balls

Bite cups
Crickets
Foraging devices
Fur covered movable toys
Hide-and-seek tunnels
Mazes
Moving prey-models
Music
Nest boxes
Plastic burrows
PVC tubes
Shelters
Swimming pans

Rabbits

Balls
Bedding (straw, wood chips)
Burrows
Free range
Fresh fruits or vegetables
Gnawing objects
Group housing
Hide-boxes
Manipulatable objects (wood)
Music
Nest boxes
Nesting material
Pair housing (except adult males)
PVC pipe
Resting shelf
Roughage or Forage (hay, straw)
Varied diet

Rodents

Bedding
Burrows
Cage dividers
Climbing accessories
Climbing frame
Exercise devices (running wheels)
Film canisters
Foraging devices
Funnel
Gnaw blocks or sticks
Group or social housing (not hamsters or adult males)
Hide boxes
Ladders
Mazes
Music
Nest boxes or nest-building material - (hay, tissues, or wood-wool)

Platforms
PVC pipe
Ramps
Shelves
Shuttle box
Tubes
Tunnels

To: Top of Document

The following links access other chapters in *Environmental Enrichment Information Resources for Laboratory Animals*:

[Main Contents] [Main Introduction] [How to Use This Document]
[Birds] [Laboratory Cat] [Dogs and Dog Housing] [Farm Animals] [Ferrets] [Rabbits] [Rodents]
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Environmental Enrichment Information Resources for Laboratory Animals: Subject Index

Note:
The index for the publication was generated primarily from the descriptors that accompany each entry. In some instances, index words may have been taken from the title. Because people are more likely to be interested in a particular animal, indexes were generated for each species or class covered. The number associated with each index term corresponds to the *printed page number* on which the index term can be found. Although the page numbers referenced in this index refer to the original printed publication, the subject terms may be helpful when searching text in the electronic version. Each subhead also is linked to the chapter and bibliography related to that topic.

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[Main Contents] [Main Introduction] [How to Use This Document]
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To: Top of Document | About this index | Birds | Cats | Dogs | Farm Animals: Cattle, Horses, Sheep and Goats, Swine | Ferrets | Rabbits | Rodents: Hamsters and Gerbils, Guinea Pigs, Mice, Rats, Wild Rodents

Birds

- **Environmental Enrichment for Birds**
  by Christine Nicol, Bristol University, pages 1-4
- **Bird Bibliography**, pages 5-26

acoustic enrichment 11
activity 3, 9, 14, 18, 19, 22-24
adaptation 5, 8, 13
age 13, 17, 20, 24
aggression 9, 17, 21
alleviate 13, 14
alternative system 19
alternative systems 6, 17
animal awareness 25
antibody titers 11
apparatus 10
approach 11
artificial selection 13
aviary 2, 3, 19, 21, 23, 24
avoidance 8, 14, 20

- behavior 8, 20

battery cage 2, 5, 7-9, 11, 15-17, 21-24
beak trimming 7, 16, 17, 23
behavior 1-3, 5-25

- agonistic 20
- avoidance 8, 20

- play 11
- resting 12

bibliography 5, 16, 23
biomedical research 1, 23
bird density 9, 12, 21
bird-human interaction 14
blocking 11
blood lipids 11
body weight 7, 8, 11, 12, 15, 20
bone strength 2, 6, 19
breast blisters 15
breeding 11, 14, 25
breeds 8
broiler 11, 15, 18, 20, 22

- breeders 22
- chicks 11, 12

budgerigar 1, 11, 19, 25
cage 1-3, 5-24

- area 19
- bar 22
- density 5, 9, 18, 20
- design 5, 17, 24
- enrichment 8
- get-away 24
- height 19
- modified 22
- nest 22
- partition 9, 21
- reared 5
- shallow 10
- shapes 5, 12
- size 6, 15, 21
- space 18, 21
- wire 9

caged 8, 10, 14, 15, 20, 21, 23
canary 3, 15
cannibalism 13, 16
captivity 9
carbohydrates 11
care 1, 9, 15
catching 2
chickens 2, 5, 8, 15, 17
chicks 11-14, 16, 21
choice 22
claw 24
cockatiels 17
cockatoo 21
colony size 12, 21
color 7, 16, 25

comfort 5, 12, 19, 24
comparison 15, 19, 23
competitive 9
confinement 7, 12
consequences 5, 8, 13
corticosteroids 8-9
corticosterone 9, 10, 16, 23
corticotropin 16
Coturnix coturnix japonica (Japanese quail) 14, 16, 23
crowding 6, 12, 16
debeaking 7, 23
deep litter 6, 7, 12, 15, 17, 19
demand elasticity 10
density 5, 6, 8-12, 15, 18, 20, 21, 24 deprivation 19
design 5, 6, 9, 11, 17, 18, 22, 24
dietary diversity 13
disease 7, 15
displacement 24
domestic fowl 1, 2, 13, 18, 20
dominance 9, 13, 15, 20, 21

- rank 9

drinking 5, 17, 24
dustbath 1, 5, 6, 20, 24
egg 3, 5-8, 10, 13, 17, 18, 21-23, 25

- production 5-8, 10, 13, 18, 21
- quality 6, 17, 25

embryology 20
endocrinology 16
enrichment 1, 2, 8, 10, 11, 13-15, 17, 18, 20-22, 24
environment 1, 2, 5, 8, 11, 18-20, 23
environmental

- control 22, 25
- enrichment 1, 2, 8, 10, 11, 13-15, 17, 18, 21, 22
- stimulation 20

environmental

- control 22, 25
- enrichment 1, 2, 8, 10, 11, 13-15, 17, 18, 21, 22

exercise 2, 7
experiential

- factors 13
- units 11

exploratory activity 19
facilities 5
familiarity 25
farm 25

fear 2, 8, 10, 11, 13, 14, 16, 18, 20, 21
feather 8, 16, 23

- condition 18
- loss 8
- pecking 3, 7, 20, 24
- scores 17

feed

- access 2, 15
- consumption 5, 7, 15, 17
- efficiency 7, 15, 17, 18
- restriction 22
- trough 22

feeder 5, 10
feeder size 10
feeding 7-9, 11, 15, 18, 19, 22, 24

- activity 9, 22
- behavior 9, 22

feelings 25
fiberglass screen 20
field methods 20
filial preference 7
flock management 11
flock 6, 11
floor

- area 19
- pen 1, 5, 8, 11, 16-18, 20
- rearing 18
- slat 6
- space 5, 6, 10, 17, 24
- type 6, 7, 23

flying activity 3
food 1-3, 13-15, 21

- access 15
- neophobia 13

foot condition 8
foraging 1-3, 6, 10, 22
fowl 1, 2, 13, 18, 20, 24
gain-to-food ratio 14
galliformes 1
Gallus domesticus 9, 14, 20, 21
genetic 8, 9, 11, 13, 14, 17, 18, 21

- factors 13
- stocks 9
- strain 8

get-away cage system 24
group 3, 6, 8, 10, 12, 13, 19, 21, 22, 24

- housing 3, 19, 21, 22
- size 6, 8, 10, 12, 24

growth 5, 12-14, 17, 20, 23
habituation 2, 10, 14, 20
handler influence 11
handling 8, 13, 14, 18, 19, 21, 23
hand-rearing 15
Hans Kier System 20
head 24
hen 2-3, 5-12, 14-24
heritability 17
heterophil-lymphocyte ratio 12
hormones 10
housing 1-3, 5-12, 15, 16, 19-22, 24, 200

- density 6, 20, 24

humans 11, 21
human contact 10
husbandry 16, 22, 23
illumination 20, 24, 25 immobility 8, 9, 13, 14, 16, 18, 20
immunosuppression 12
imprint 11, 16
industry 12, 18
injury 2, 20, 21
isolation 3, 19, 21
Japanese quail (*Coturnix coturnix japonica*) 7, 10, 14, 18, 23
laboratories 1, 5
laboratory methods 15
layers 10, 17, 18, 20, 21, 23, 24

- performance 12

laying 1-3, 5-11, 15-24

- hens 2, 3, 5-7, 9, 11, 15-24

learning 1, 11, 12, 16
light 1, 20, 23
litter 2, 6, 7, 12, 15, 17, 19, 22-24

- reared 22

livability 18
lumination 11
mammals 15
management 11, 15, 16, 23, 25
mating opportunity 23
mesh size 18
mortality 7, 9, 10, 16-18, 21, 24

motivation 10, 12, 19, 20, 22
music 2, 11
natural behavior 1
neck 24
nervousness 18
nest 2-3, 5-7, 12, 17, 21-24

- box 3, 6, 17, 24
- building 12
- disturbance 21
- lining 21
- material 12
- pad 7
- site 12
- sites 5, 6

nesting 1, 3, 6, 12, 17, 19, 25
novel 13, 14, 19

- object 14
- objects 14

observer effect 10
ontogeny 13
open field 14
operant conditioning 10
opioid receptor 22
pairing intervals 23
Parrot 15, 16
partitions 2, 9, 21
passerine 1, 15
pattern 16
peat 24
pecking 3, 7, 8, 15-16, 18-22, 24

- targets 18

pens 1, 5, 11, 16
perception 16
perch 2-3, 5-7, 15, 17-18, 24

- preference 6
- space 6

performance 2, 7, 9-14, 18, 23
pheasants 23
photoperiod 20, 23
physiology 1, 11, 16
pigeons (*Columba livia*) 1, 12
plasma growth hormone 14
plumage 17, 20, 24
pre-laying

- behavior 5, 21, 22

preference 6, 7, 9, 10, 12, 16, 17, 19-21
previous experience 13
pre-laying behavior 5, 21, 22
primates 15
production 5-11, 13, 15, 18, 20, 21, 23
productivity 8, 9, 11, 15, 18, 21
prolactin 14
Psittaciformes 21
psychology 14-16, 21
pullets 5, 7, 8, 13, 16, 23
quail 1-3, 7, 10, 14, 16, 18, 20, 23
range 10
rearing environment 11, 18, 20
reproduction 7, 17, 23
restrictive environments 1
ring-necked pheasant 23
rollaway

- hollow 5
- nest box 6

sand 24
seed

- preferences 21
- size 21

sex 13, 14, 17
shape 10, 12, 21
social 1, 3, 9-11, 15, 17, 19-22, 25

- behavior 15, 17, 21
- cues 25
- dominance 21
- environments 15
- groups 1, 3, 10, 11
- interactions 22
- isolation 3, 19, 21
- organization 20
- proximity 25

socialization 13
solid versus wire cage 9
space 2, 3, 5, 6, 10, 12, 15, 17-19, 21, 24

- requirements 200

spatial

- allowance 19
- restriction 1, 3, 19

statistical design 11
stereotypies 15
stimuli 2, 7, 15-16, 20, 25

stocking density 6, 11
strain 8, 11, 13, 14
stress 8, 10-13, 16, 17, 20, 22, 23
submission 9
substrate 5, 7, 11, 18, 20
suffering 9
surface area 12
thyroid hormones 10
tier housing system 11, 14
time 19
timidity 14
toe 24
tonic immobility 8, 9, 13, 14, 16, 18, 20
toys 11
transport 18, 23
trauma 21, 24
turkey 12, 17
vocalizations 14
water 5, 10, 22

- provision 22
- restriction 5

waterer 5, 10
waterfowl 9
weight gain 14, 16, 17
welfare 1-3, 5, 6, 8-16, 19, 22-24
well-being 2, 10, 15, 18, 21
White Leghorn 5, 8, 9, 13, 16, 18
wild 1, 15, 20
wildlife 20, 21
wild birds 20
wire floor 6, 23

To: Top of Document | About this index | Birds | Cats | Dogs | Farm Animals: Cattle, Horses, Sheep and Goats, Swine | Ferrets | Rabbits | Rodents: Hamsters and Gerbils, Guinea Pigs, Mice, Rats, Wild Rodents

Cats

- **Enriching the Environment of the Laboratory Cat**
  by Sandra McCune, University of Cambridge, pages 27-34
- **Cat Bibliography**, pages 35-42

acoustic stimulation 40
ACTH 36
activity budget 40
adapt 27
aggression 27, 28, 30, 32, 35, 38, 39, 41
alley cats vs. cage-reared 41
attention 36
balls 36
behavior 27, 29-32, 35-41

- approach 40

- communicative 35
- conflict 39
- differences 38
- hiding 36
- locomotor 39
- modification 37
- predatory 35-38
- sexual 37, 39
- towards prey 38

behavioral development 35
bells 36
blood proteins 38
boredom 27
breeding colony 31
cage 27, 29, 30, 32, 38, 40, 41
caged 29, 32, 36
caretaking routine 36
catnip 36, 37
cat-human relationship 29, 35
cerebral cortex 38, 41
circling 39
climbing 37

- frame 39
- poles 28

cognition 36, 40
colony cats 32, 35, 38-40
colony cats vs. pet cats 38
color photos 35
communication 29
contact latency 40
cortisol 36
cotton tugs 36
critical period 38
cues 40
decoys 36
development 32, 35-41
discrimination learning 40
diseases 36
dog 41
drugs 37
early experience 36-39
environmental enrichment 28, 30, 32, 33, 36, 40
environments 27, 30, 40, 41
ethogram 33
ethology 33, 41
exercise 35-37
exhibit 40
experimenter 40
fearfulness 27
feeding

- maternal 35

Felis bengalensis 30, 40
Felis catus 31, 36, 39
Felis viverrina 40
feral cats 31, 32
food 28, 31, 40
friendly 29, 38, 40

- responses to humans 38

games 36
gamma-globulins 38
grief 35
grooming 37, 39
gumabone tug 36
gumadisc 36
habituate 29
hair 37
handler 40
handling 29, 32, 38
haplorhini 38
head rubbing 40
hear 27
hematology 38
housing 27-29, 31, 35, 38-41
human

- pet bonding 41
- rearing 39

hunting 35-37
indoor

- pen 39
- tree 37

intelligence 38
jump 37
kitten 29, 31, 36, 39-41
laboratory 27, 30-32, 35, 36, 38-41

- conditions 39

learning 35, 36, 38, 40, 41
lesions 41
live prey 40
locomotor play 39
maternal rearing 39
mating 36
memory 38
metabolic rate 39
mother-offspring interactions 37
novel objects 31, 32
nylabone frisbee 36

object 35, 36, 39

- permanence 36
- play 35, 39

olfactory system 27
ontogeny 36, 39, 40
orientation 36, 40
perch 37
pets 30, 33, 41
physiology 32, 38, 41
play 28, 30, 35-41
polydipsia 39
predation 35
predatory behavior 35-38
preference 38
prey 37, 38, 40
prior experience 36
problem solving 36
psychological stressors 30
psychology 31, 36, 40
psychomotor performance 36
puppy 41
recall 36
relationships 29, 33, 35, 36, 41
reproductive hormones 36
research colony vs. pet cats 38
resting boards 35
reward 40
ropes 28
safety 37
saliva 37
scratching

- device 37
- post 28, 29, 35, 36

see 27
senses 27, 35, 37, 41
sensory

- abilities 35
- deprivation 40

sheepskin mice 36
shelving 28
skin 37
sleep 37
smell 27
social

- behavior 27, 35, 38, 41
- bonds 38
- development 41

enrichment 27, 29
- environment 29, 37
- housing 35
- play 35, 36, 39

socialization 29, 32, 35, 38, 39
space 28, 40

- perception 40

stress 29, 36, 40
technical personnel 38
time 28, 29, 39, 41
timid 28, 29
toys 28, 35, 36, 39

- balls 36
- bells 36
- gumabone tug 36
- object play 35, 39
- sheepskin mice 36

tree trunks 35
tunnel 37
vices 41
vision 40
visual

- cortex 38
- perception 38

vocalizations 39, 40
vomerosensory 27
weaning 39
welfare 30, 32, 33, 35, 36, 38, 39, 41
whirling 39
young 41

To: Top of Document | About this index | Birds | Cats | Dogs | Farm Animals: Cattle, Horses, Sheep and Goats, Swine | Ferrets | Rabbits | Rodents: Hamsters and Gerbils, Guinea Pigs, Mice, Rats, Wild Rodents

Dogs

- **Dogs and Dog Housing**
  by Robert Hubrecht, UFAW, pages 43-48
- **Dog Bibliography**, pages 49-62

ACTH 50
activity

- measurements 58
- patterns 54, 55

adaptation 53, 59

age differences 59
aggression 45, 49, 53, 54, 56-58
Alsatian 51
amateurs' manuals 56
Animal Welfare Act 50, 54, 56
atropine 60
avoidance 52, 57
balls 51
barking 44, 47, 57
beagles 45, 46, 49, 50, 58, 59
bedding 49
behavior 43, 47, 49-58, 60-62

- agonistic 53, 58
- competitive 56
- deviant 51
- exploratory 62
- feeding 50, 56
- mating 54
- measurements 51
- modification 52, 57, 60
- patterns 56
- spatial 58
- stereotypic 57
- therapy 61

bells 51 bibliography 49, 60
biochemical measurements 54
biting 57
blood

- chemical 58
- circulation 60
- serum 53

body weight 56, 58
bonding 50, 52, 57, 60, 61
bradycardia 60
breeding 46, 50, 52, 53

- colony 53

breed differences 45, 57
building 56
cage 44, 45, 47, 49, 50, 52-56, 58-60

- confinement 58, 60
- density 55
- design 49
- size 45, 47, 49, 52, 54-56, 58

Canis lupus 43, 46, 53
care 44, 46, 47, 49, 50, 52-54, 61
case report 57
chemical 49, 58

chews 45, 55
circadian activity 56
confinement

- effects 52
- systems 51

construction 56, 60
contact 44, 55, 58, 59
control 44, 62
coping 59
cortisol 50
cotton tugs 51
crowding 52, 58
dark 59
decoys 51
differential rearing 54, 62
dingo 50, 51
disease susceptibility 60
dissertation 58, 59
distress 50, 58, 59

- vocalizations 58

dog owner's book 53
domestication 43, 45, 46, 53
dominance 51, 57, 58, 62

- hierarchy 51

early

- experience 51
- separation 60

eating 56, 58
economics 49
education 59
EKG 51
electrocardiograph 54
electroencephalography 49
electrophysiology 49
elimination 56
enrichment 44-47, 50, 51, 55-57
environment 43-45, 49-53, 55-58, 60-62
environmental

- conditions 56
- enrichment 44, 46, 47, 50, 51, 55-57
- stress 58

enzymes 56, 58
ethology 46, 51-54, 58, 62
eustress 50
examinations 54

exercise 44-47, 49-53, 55-58, 60, 61
experimental design 51
exploratory behavior 62
facilities 43, 54
factors 52, 53
familiarity 57
fear 53
feeding 50, 56
feed intake 56
feral 43, 50
fighting 44
food 45, 56, 58, 61

- rewards 61

fur quality 56
games 53
genetics 47, 57, 60
genotype 52
glucocorticoids 50
grooming 57

- excessive 57

guidelines 54
guinea pig 53
gumabone 51
gumabone tug 51
gumadisc 51
hand-rearing 62
handling 52, 57, 60
heart rate 60
hematologic 54
hemoglobin 56
history 54
housing 43-47, 49-56, 59-62
human

- contact 44, 55, 58
- interaction 49, 61
- isolation 52
- presence 60
- sex differences 57

husbandry 43-46, 49, 50, 52-54, 56, 59, 60
hydrocortisone 51, 53
identification 52
infanticide 51
infants 57
intra-species 52
isolation 46, 49, 52, 54, 57, 58
kennels 45, 47, 49, 55, 57, 60
kinetic energy 59
knotted towel 61

laboratory 44-47, 49, 52-56, 58, 60-62

- management 54
- rearing 53

legislation 50, 53, 59
light 59
litter-rearing 62
locomotor activity 62
lycaon 53
lying 45, 54
lymphocyte

- transformation 50

management 47, 50, 54, 56, 58, 61
minerals 56
mortality 60
mouse 53
movements 59
muscle 51, 58

- enzyme 51

musculoskeletal system 58
neurochemical 49
novel 43, 62
nutrition 60
nylabone 51
nylabone frisbee 51
ontogeny 62
ophthalmic 54
packed cell volume 56
pens 45, 52, 54
pets 56, 58, 59
pet supplies 56
petting 60
physical

- activity 52, 58
- conditioning 59
- fitness 51

physiology 56, 60, 62
plasma 56
plastic bottles 61
plastic chain 51
play 45, 49, 57
playthings 56, 57
policy 54, 61
polydipsia 57
posture 57
poultry 52
primates 50, 52, 59
psychology 57, 59

puppies 43, 47, 51, 53, 57, 60-61, 62
rabbit 53
rat 53
rearing 49, 52-54, 57, 62
recognition 52
red blood cell counts 56
regulations 47, 54, 55, 59
regulatory issues 60
relationships 57
reproduction 50
responses to environment 57
resting

- area 52
- boards 49

rhythms 56
rodents 50, 52
selective breeding 46, 52
sensory isolation 57
separation 49, 58-60

- distress 58, 59
- stress 60

service dogs 51
sex 53, 57

- differences 53, 57

sheepskin mice 51
shelters 55
Shetland Sheepdogs 58, 59
sitting 54
sleeping 45, 54
social

- attachment 59
- behavior 43, 50, 51, 53, 55, 57
- density 51
- dominance 57
- housing 49
- interaction 49, 54
- isolation 52, 57
- organization 53, 62
- stimulation 52

socialization 44, 47, 50-52, 54, 55, 57, 59, 61, 62

- intra-species 52
- period 44, 57, 62
- session 55
- with humans 59

space 45, 54, 56, 58

- recommendations 56
- requirements 54

spatial behavior 58
standards 50, 61, 62
standard values 60
standing 54
stereotypies 52, 55, 57
stimuli 53
stimulus 62
stone chewing 57
stress 50, 53, 58-61
stress psychology 59
substrates 56
susceptibility 53, 60
swine 51
tameness score 56
Telomians 58, 59
temperament 45, 46, 52, 61

- testing 61

tongue injury 57
toys 53, 55, 57, 58, 61

- balls 51
- bells 51
- chews 45, 55
- cotton tugs 51
- gumabone 51
- gumabone tug 51
- gumadisc 51
- knotted towel 61
- nylabone 51
- nylabone frisbee 51
- plastic bottles 61
- playthings 56, 57

tongue injury 57
training 51, 59, 60

- methods 51

T-touch 60
weight gain 54, 60
welfare 43, 45-47, 49-56, 59-62
well-being

- psychic 54
- psychological 52, 61

wellbeing 46, 47, 50, 54, 55, 59, 61
wolves 43, 46, 57
wool sucking 57

young 54, 58
zootechny 60

To: Top of Document | About this index | Birds | Cats | Dogs | Farm Animals: Cattle, Horses, Sheep and Goats, Swine | Ferrets | Rabbits | Rodents: Hamsters and Gerbils, Guinea Pigs, Mice, Rats, Wild Rodents

Farm Animals

- **Enrichment for Farm Animals**
  by Michael C. Appleby, University of Edinburgh, pages 63-68
- **Farm Animal Bibliography: General**, pages 69-72

Cattle

- **Enrichment for Farm Animals**
  by Michael C. Appleby, University of Edinburgh, pages 63-68
- **Farm Animal Bibliography: General**, pages 69-72
- **Farm Animal Bibliography: Cattle**, pages 73-78

adrenal cortex hormones 73
age 78
aggression 77
altruism 76
anesthesia 73
bedding 75, 76
beef cattle 73, 74, 77
beef cows 76, 77
behavior 69-71, 73-78
bibliography 73
bulls 77
calves 73-76, 78
calving 75, 77

- interval 75

care 73
chutes 70, 78
comfort 76
comparison 75, 76
conception 64
confinement 74-76
construction 76
corrals 78
cortex 73
cortisol 73, 75, 76
costs 76
cost benefit analysis 76
cows 73-77
crates 74
cubicles 76
dairy 73-77

- cows 64, 75-77

- herds 76

design 74-76
dominance 76
economics 76, 77
economic impact 75
enclosures 78
enrichment 77
environment 73, 75-77
environmental factors 73
ethograms 76
extensive livestock farming 75
facilities 73, 78
fear 77
feeding 70, 76, 77
fencing 74
flooring 70, 76, 78
footing 77
grooming 76
guidelines 74
handling 69, 73-75, 77, 78
heart rate 74
housing 73-78

- alternative 77
- calf 76

dry-lot 75

- group 74,76
- isolated 74

human-animal bond 77
humane 73
husbandry 73-77
hygiene 76
immune response 73
injuries 74
intensive livestock farming 75
interaction 76, 77
isolation 64
kinship 76
literature review 76
litter 76
livestock 75, 76
management 73, 76, 77
microclimate 75, 78
milk

- production 75
- quality 75

milking interval 75
movement 74
paddock drainage 77
pain 75

pasture 76
pathogen transmission 74, 75
pens 74, 75, 78
perception 74
performance 75-78
physiology 75
pigs 77
plasma cortisol 73
polling 73
preference 74
preputial sucking 74
production 75, 77
psychology 74
rearing 74, 75, 78
resting behavior 76
restraint 69
review 73, 76
sheep 75
simmental 77
size 74
slatted floors 76, 78
social

- behavior 75-78
- interaction 76
- stress 76
- structure 76

socialization 76
space requirements 74, 75
stables 78
stalls 74
steer 73, 75, 77
stereotypies 75
stress 73-78

- management 70, 73
- response 73, 74

surveys 74
transport 70, 73, 74
veal calves 73, 74, 78
vision 74
weight loss 74
welfare 73-77
wellbeing 73, 75

To: Top of Document | Using this index | Birds | Cats | Dogs | Farm Animals: Cattle , Horses, Sheep and Goats, Swine | Ferrets | Rabbits | Rodents: Hamsters and Gerbils, Guinea Pigs, Mice, Rats, Wild Rodents

Horses

- **Enrichment for Farm Animals**
  by Michael C. Appleby, University of Edinburgh, pages 63-68

- **Farm Animal Bibliography: General**, pages 69-72
- **Farm Animal Bibliography: Horses**, pages 79-86

activity 80, 82
adaptation 80, 84
adrenal glands 83
age differences 83
aggression 80
ammonia 85
Asiatic wild horse (*Equus przewalskii*) 80
avoidance 79
bedding 81
behavior 71, 79-85

- feeding 81, 82
- maternal 84
- mating 79, 81

bibliography 84
blood plasma 83
body

- awareness 85
- recognition 85

boredom 85
care 80, 83, 84
colt 79
comfort 79, 85
comparative study 79
concentration 83
conditioning 71, 80, 81
confinement 81, 83, 84
cortisol 83
design 84
device 83
disease 83
domestication 80
domestic horses 79
early handling 83
enrichment 83
environment 79, 81, 83-85
Equus caballus 79, 80, 82, 84
exercise 80, 82, 83
experience 80
facilities 82
feeding 81-83

- activity 82
- behavior 65, 66, 81, 82

feral horses 79
field size 82
fillies 79

flight distance 79
flooring 84
foals 79-81, 83, 85
foraging 83
grazing 79, 81, 82
grooming 79, 80
group

- dynamics 82
- interaction 81
- size 82

haematology 83
haemoglobin 83
handling 79, 80, 83-85
health 80, 85
heart rate 80
herd structure 79
horses 79-85, 87
housing 80-84
design 84
open 82, 83
human-animal bond 79, 85
humane 80
humidity 85
husbandry 80, 82, 84, 85
hydrocortisone 83
immune response 83
immunity 83
interaction 79, 81
isolation 83, 84
laboratory 83
learning 80, 81, 83-85

- ability 80, 84

lighting 81, 85
livestock 82, 83
lymphocyte transformation 83
management 81-83, 85
mares 79, 81, 83
maternal behavior 84
mating behavior 79, 81
metabolic changes 85
mitogens 83
mutual confidence 79
natural environment 79, 85
needs 82, 85
neuroleptics 84
newborn 81
novel stimuli 80
operant conditioning 81
pasture 81, 82
physical environment 81

plasma cortisol 83
play 79, 80
ponies 79, 80, 81, 83
preferences 79, 81, 82
Przewalski horses 82
psychobiology 79
psychology 81, 84
racehorses 79
rearing 85
reinforcement 83
repetition 85
review 84
running 80
saddle horses 82
safety 79
semi-natural environment 85
sex differences 79
shelter 85
size 80, 82
social

- behavior 80-82, 84, 85
- environment 81, 84
- interaction 79, 80
- isolation 83
- structure 84

socialization 80, 83, 84
solitary confinement 81
space 80-82, 84

- requirements 80, 82

sports 79, 84
stables 85
stalls 83
stereotypies 81
straw 81
stress 80, 81, 83-85
substrate 79, 81
temperature 84, 85
control 84
thyroid hormones 83
time allocation 81
training 80, 81, 83-85
transport 84
treatment 80
ventilation 84
vices 81, 85
weaning 83
welfare 79-85
wellbeing 80
wild

- animals 80
- burros 84
- horses 84

wood shavings 81
work animals 82
zoo 82

To: Top of Document | About this index | Birds | Cats | Dogs | Farm Animals: Cattle, Horses, Sheep and Goats, Swine | Ferrets | Rabbits | Rodents: Hamsters and Gerbils, Guinea Pigs, Mice, Rats, Wild Rodents

Sheep and Goats

- **Enrichment for Farm Animals**
  by Michael C. Appleby, University of Edinburgh, pages 63-68
- **Farm Animal Bibliography: General**, pages 69-72
- **Farm Animal Bibliography: Sheep and Goats**, pages 87-92

activity 90
adaptation 87, 90
age 90, 91
Alpine goat 87
anesthesia 91
aversiveness 88
avoidance 89
bedding 88
behavior 87-91
bibliography 87
blood

- plasma 88, 91
- withdrawal 63

Border Leicester sheep 88
calcium 88
castration 91
cattle 89
clustering 89
comparison 88
corticosteroid 89, 90
cortisol 87, 89, 91
crate design 87
cubicles 88
dairy 87, 89, 90
design 87
dexamethasone 88
docking 91
environment 87, 89, 90
environmental temperature 87
erythrocytes 88
ewe replacement 90
experience 88, 89, 91
fear 87-89
feed

- consumption 89
- intake 87
- preferences 71, 91

flight distance 88, 89
flooring 70, 87, 88
food selection 87
genetics 87, 90, 91
goats 87-90
grazing 91
growth 88, 89
handling 69, 87-91
heart rate 65, 87-89
housing 87-90
human-animal bond 89, 90
husbandry 87
hydrocortisone 91
hypocalcemia 88
isolation 64, 87, 90, 91
kids 88
lambing 88, 90
lambs 88-91
lidocaine 91
locomotor activity 90
lying 88
metobolic rate 65
mirrors 91
naloxone 91
noise 91
Nubian goat 87
pain 89, 91
parturition 88
pens 70, 88
pen-mates 90
performance 87, 88
physiology 87, 89, 90
plasma corticosteroid 90
potassium 88
preference testing 88
preferences 71, 91
production 87-90
psychobiology 89, 90
psychology 90
rams 88
restraint 63, 66, 69
rearing 88-90

- environment 90
- experience 89

sexual behavior 88
sheep 87-91, 93
social

- affinities 90
- behavior 88-90
- environment 87
- isolation 87, 90

socialization 90
sodium 88
space 88, 89
spatial behavior 88
stereotypies 89
straw bedding 88
stress 70, 87-91

- physiology 90

temperament 89, 90
temperature control 87
transport 69, 70, 87
treatment 88
ventilation 87
vocalization 87, 89, 90
welfare 87-89
wellbeing 89

To: Top of Document | About this index | Birds | Cats | Dogs | Farm Animals: Cattle, Horses, Sheep and Goats, Swine | Ferrets | Rabbits | Rodents: Hamsters and Gerbils, Guinea Pigs, Mice, Rats, Wild Rodents

Swine

- **Enrichment for Farm Animals**
  by Michael C. Appleby, University of Edinburgh, pages 63-68
- **Farm Animal Bibliography: General**, pages 69-72
- **Farm Animal Bibliography: Swine**, pages 93-112

ACTH 98
activity 93, 94, 100, 104, 106
adaptation 101
adrenal response 107
age 106, 110, 111

- differences 106

aggression 93, 95, 96, 106, 109, 110
amphetamines 111
artificially fed 105
automatic feeding 99
automation 100
barrow 101
bedding 94, 97-100, 109
behavior 71, 93-112

- aggressive 108, 109
- agonistic 65, 111
- breeding 103

- exploratory 97
- natural 99
- nesting 95
- sexual 103
- social 71, 96, 104-106, 110, 111
- spatial 105
- stereotypic 65

behavioral

- effects 94, 97
- frequency 106
- needs 104
- response 102

bibliography 93, 110, 111
biomedical use 110
blood

- chemistry 107
- sampling 63, 109

boars 100, 107, 111
body weight 100
breeding 99, 100, 102, 103

- behavior 103

building material 103
cage 96
cage-stalls 96
cardiovascular response 110
care 101, 106, 110
catecholaminergic systems 111
cattle 109
chewing 93, 99, 100
chronic implants 109
cloth 112
comparative study 108
comparison 93, 97, 98
computerized feeding system 111
conditioning 112
confinement unit 109
coping 99
cortex 101
corticosteroid 95, 96, 101-103, 107
cortisol 96, 98, 99, 107
costs 103
cows 109
crates 93, 108
crate design 111
crowding 103, 112
curiosity 112
defecation area 105

density 93, 95, 112
design 96, 101, 106, 109, 111, 112
device 104, 112
dexamethasone 98
dietary supplement 103
disease 110
diurnal 101
dominance 104, 108
early handling 102
earth substrate 93
economics 109
Edinburgh Foodball 112
endorphins 99
enrichment 69, 93, 95, 97-99, 101, 104, 108-110, 112

- devices 101

environment 94-97, 101, 103, 104, 106-111
environmental

- control 95, 104
- factors 95, 108

excitability 101
expanded metal flooring 99
experimenter influence 102
exploration 93, 105, 106, 110, 112
exploratory behavior 97
facilities 111
family pens 104
farm 93, 94
farrowing 94, 95, 99, 102, 108

- crate 108
- pens 99

fear 101, 102, 109, 110
feed

- consumption 111
- conversion 94, 97, 99
- dispensers 66, 100, 112
- intake 64, 101, 110
- preference 71
- restriction 65

feeding 94, 96, 97, 99, 104, 109, 111

- activity 94

floor 93, 95, 98, 99, 105, 108

- expanded metal 99
- levels 108
- preferences 99

- slatted 97, 98, 100
- space 105, 108
- type 105

flooring 93, 97, 106, 111
food presentation 99
football 104
foraging 93, 112
free range 100
gilt 98, 100, 101, 103, 104, 107, 112
gonadotropin 111
Gottingen miniature swine 100
group

- feeding 104
- housing 95-97, 99, 100, 111, 112
- mixing 111
- size 100, 112

groups 93, 96, 97, 100-102, 106, 109, 111
growth 94, 96-98, 102, 103, 107-109, 111

- rate 94, 97, 98, 103, 107, 111
- handler 95

handling 66, 67, 70, 95, 100-104, 107, 109, 110
health 99, 108, 109
heat preference 95
hiding area 108
hormones 63
housing 71, 93-112

- alternative 104, 109, 110
- individual 99
- intensive 98, 108

human-animal

- bond 97, 102, 103, 109
- contact 63
- interaction 95

husbandry 93, 94, 97-101, 103, 106, 110
hydrocortisone 103, 107
hygiene 101
immune response 106, 108
individuals 102, 111
injuries 97, 98, 106
intensive husbandry 98, 99, 106
interaction 95-97, 104, 109
isolation 100, 105, 110, 111
laboratory 95, 97
learning 71, 105, 106, 112
legislation 105
light 95

lighting 105
literature review 106
litter 93, 94, 97-100, 102, 103

- size 93, 100

livestock 94, 97, 108, 112
loaders 108
locomotion 102, 111
lying 94, 95, 105
management 106, 109
manipulanda 104, 108, 112
manipulation 94
manual dispensing 93
mating 103, 111

- behavior 111

meat

- quality 97, 99
- yield 99

miniature swine 100
milk production 93
motivation 95, 108
movement 102
natural behavior 99
needs 100, 104
nesting behavior 95
nest building 95, 102
neurobiology 112
newborn 99
noise 93, 110
novel

- diet 106
- objects 104

novel objects 104
nutrition 109
operant conditioning 112
parturition 94
patting 102
pen 70, 93-95, 98, 99, 101, 104, 106

- design 96, 101
- shape 95, 112

performance 93, 94, 101, 104, 106, 107, 109, 110
physical environment 95
physiology 95, 96, 99, 103, 107, 110
piglets 93, 94, 101-103, 105
pigs 93-112
plasma cortisol 107

play 93, 101, 112
postweaning interval 109
preference 93-95, 105, 106, 108, 110

- testing 95, 105, 108, 110
- tests 106, 108

preferences 95, 99
pregnancy 93, 96, 99, 109

- statistics 96

prepartum behavior 112
production 93-98, 100, 102-104, 106, 107, 109, 112
psychological needs 100, 104
raised decks 100
ramps 108
rearing 101, 105, 107, 109, 111

- environment 101

reinforcement 95
reproduction 99, 102, 103, 106
reproductive

- effects 101
- status 103

restraint 63, 93, 106, 110
restricted feeding 97, 109
review 94, 96, 106
rooting 100, 104
seasonal cycles 111
self-dispensing 93, 94
sensory restriction 101
sexual behavior 103
siblings 106
size 93, 96, 100, 105, 106, 108, 112
skin lesion 96
slatted floors 97, 100
slaughter 110
social

- activity 100, 104
- behavior 71, 96, 104-106, 110, 111
- environment 103, 111
- groups 100
- interaction 93, 96, 97, 104,100, 108
- isolation 111
- stress 112
- structure 111

socialization 98, 102, 103, 105, 109, 110
soundness 111
sows 94, 95, 97-100, 102, 104, 105, 107-109, 111, 112

sow-fed piglets 105
space 93, 98, 102-105, 107, 108, 112
space requirements 104, 107, 108, 112
spatial behavior 105
stalls 96-98, 106, 112
stall-design 96
standards 100
stereotypies 99, 111
stimulation 101
stocking density 93
stock people 102
Straw-Flow 93, 94
straw 93-95, 97-100, 102-105, 109, 112

- bedding 97, 100, 109
- enrichment 95

stress 66, 93, 95-97, 99, 101-103, 106-112

- factors 107, 108
- response 95, 96

stroking 102
substrate 93, 94, 97, 98, 105
suckling behavior 93
swine 93-103, 105, 107-111, 113
temperament 101
temperature 93, 99, 111

- control 93, 111

testosterone 111
tether 95, 96, 98, 99, 106, 112

- stalls 95, 98

thesis 105
tire 104
toys 64, 66, 67, 97, 100, 101, 107, 109
traction 99
transponders 111
transport 70, 101, 110
ventilation 93, 111
vertical chain 104
vibration 110
vocalizations 93
weaning 99, 105
weight gain 98, 101, 104, 106, 108
welfare 93-107, 109-112
wellbeing 95, 104, 108

To: Top of Document | About this index | Birds | Cats | Dogs | Farm Animals: Cattle, Horses, Sheep and Goats, Swine | Ferrets | Rabbits | Rodents: Hamsters and Gerbils, Guinea Pigs, Mice, Rats, Wild Rodents

Ferrets

- **The Effects of Environmental Enrichment in Ferrets**
  by Dorothy Einon, University College, London, pages 113-116
- **Ferret Bibliography**, pages 117-126

abnormal behavior 118, 125
activity 113, 115, 118-120, 122, 124-126
age factors 125
aggression 113, 117, 125
anesthesia 118
animal welfare 117, 124
bank vole 120
behavior 113, 114, 117-126

- exploratory 118, 120, 124
- feeding 121, 122
- hybrid 124
- hyperactive 118
- play 118, 122, 123, 125
- pre-copulation 123
- social 71, 121, 122
- stereotypic 118

bibliography 117, 119
biology 117, 119, 120
biting 114, 124, 125
black-footed 120
body weight 114, 121-123
breeding 113, 114, 120, 121, 123, 126
cages 114, 117, 120, 125
captivity 113, 114, 119
care 117, 119, 124, 126
cat 123, 124
chicken 121
chinchillas 117
circadian rhythms 119, 126
circulatory system 120
communication 118
cortisol 120
courtship 123, 126
coypus 117
development 113, 115, 120, 122
diet 119, 120, 122-124, 126
diseases 119, 124
dog 120, 124
dummy prey 117
endocrine

- control 125
- system 126

environment 113, 114, 116, 120, 123

environmental

- enrichment 113, 119
- factors 124

exploration 114, 116, 118, 119, 120, 124, 126
feeding 118, 119, 121-123

- behavior 121, 122
- zones 123

female 114, 117-126
ferret-polecat hybrid 119, 125, 126
food preferences 120
foxes 117
gonadectomy 119
grooming 121
group activity 118
growth 125
guidelines 124
handling 117, 121, 123-125
health 114, 117
hiding place 123
housing 114, 115, 117-123, 125
hunting 119, 124
husbandry 114, 117, 119, 120, 123-125
hybrid behavior 124
hyperactive 118
isolation 114, 118, 121
learning 113-116, 124, 126
light 120
low vs. high frequency sound 123
male 114, 117-126
maze 114, 124, 126
mink 115, 117, 118, 120, 121, 123-125
mouse 123
mustelids 114, 118, 120, 123-125
neonates 120
nest boxes 120, 123
nursing 122
nutrition 118, 119
otters 119
pelt quality 114, 122, 125
personality 122
pet 124
physiology 115, 117, 119, 123
play 113, 114, 116-126

- behavior 118, 122, 123, 125
- prepubertal 125

polecat 113, 115-118, 119, 121-126
predation 113, 120, 122
prey 114, 115, 117, 120, 122

- catching 114, 117

pre-copulation behavior 123
rabbit 119, 123
rat 113, 116, 121, 123
reproduction 118-120, 123, 125
restraint 118
restricted movement 125
rodents 119
running 119
scent marking 125
seasons 113, 118, 121, 122
sex differences 117, 123
shelter 123
skeletal changes 114, 125
skin biting 114, 125
social

- behavior 71, 121, 122
- groups 118, 121, 122, 124, 125
- interaction 113, 119, 120, 124
- organization 125

sound 115, 123
space 114, 123, 125
starvation 118
stereotypic behavior 118
stocking rate 117
Stone marten 123
stress 113, 114, 117, 118, 120, 121
stunning 117
tactile stimuli 117
toys 114, 118, 121, 125
tubes 126
visual stimuli 117
weanling 119-121
weasel 118, 120, 122
wheel-running 119
wildlife 122
zoo animals 122

To: Top of Document | Using this index | Birds | Cats | Dogs | Farm Animals: Cattle, Horses, Sheep and Goats, Swine | Ferrets | Rabbits | Rodents: Hamsters and Gerbils, Guinea Pigs, Mice, Rats, Wild Rodents

Rabbits

- **Rabbits**
  by Debbie Gunn and David Morton, University of Birmingham, pages 127-132
- **Rabbit Bibliography**, pages 133-144

acoustic

- environment 137

stimulus 136

activity 129, 132-136, 138, 139, 143
adaptation 129, 138
affiliative behavior 138
age 129, 136, 142
aggression 132, 134, 136, 138
agonism 136
ambient temperature 137, 139
androstenedione 136
artificial appliances 134
avoidance 142
back-bone distortions 129
bar-biting 128
bedding 139-141
behavior 127, 128, 130-143

- chewing 137
- feeding 135
- flehmen 134
- investigatory 141
- maintenance 141
- natural 140
- normal 133
- reproductive 140
- resting 135
- sleeping 135
- social 127, 133-134, 136-139, 141
- spacing 143
- stereotyped 135, 140

behavioral 127-129, 134-136

- repertoire 128, 134, 135

bone 129, 141, 142
boredom 128-130, 132
breeding 127, 129, 132, 133, 136, 138, 140-142

- groups 127, 129, 142

breeds 140
bricks 137
building 129, 139
burrows 127, 137
cage 128-130, 132-140-142

- activity 135
- colony 136
- design 133
- odor 142
- outside 138
- space 139

caging 128, 129, 137, 139, 141, 142
care 129, 131, 133, 135, 141
catecholamine 135
chemical cues 134
chemosignals 137
chewing behaviors 137
Chinchilla 139, 141
chinning 138
chin marking 137
chronobiology 138
circadian activity 139
code

- of practice 131
- of recommendations 133

colony management 143
comfort 141
commercial housing 142
communal nest box 136
confinement 136
consumption 138, 142
corticotropin 136
costs 140
cottontail rabbits (*Sylvilagus floridanus*) 134
cottontail rabbits 134, 135
critical period 143
crowding 142
daily activity 135
defecation 127, 138
defense 138
density 136, 140, 142
development 133
developmental 142, 143
diet 128, 130, 136, 139
disease 139
distance 127, 143
diurnal 127, 137, 138
domestic 127, 132, 134, 137-139, 142, 143
domestication 138
dominance 127, 134, 136, 138
dopamine 135
economic 128, 139, 140
enrichment 130-132, 134, 136, 137, 140-143

- devices 141
- objects 131, 134, 137

environment 127-130, 135-137
environmental

- change 138
- control 134, 141
- enrichment 130, 134, 136, 137, 140, 143

noise 136, 138
- stress 137

equipment 142
estradiol 133, 136
estrus 138
ethology 132, 138
exercise 129, 137, 142, 143
exploration 139
exploratory activity 136, 143
exposure to male 138
fear 141
feeding 127, 128, 135, 137, 139

- behavior 135

feed restriction 138
female 127, 130, 134, 136, 137
ferrets 140
fertility 140
floor

- area 128, 142
- pens 129, 130, 134, 137, 139

food 138, 140, 142

- consumption 142
- intake 138

foraging 127, 129, 134
free-range 143
genetics 135, 137, 141, 142
gerbil 134
gestation 133
grooming 129
group 127, 129, 130, 134, 137, 140, 142

- composition 133
- housing 130, 132, 134, 139, 140, 142, 143
- sizes 139

guidelines 139
habituation 141
hamster 134
handling 132, 133, 135, 137, 138, 140, 141, 143
health 128, 129, 136, 138, 140
hierarchy 134
housing 127-143

- group 127-143
- paired 129, 131, 134, 137, 142

human interaction 141
humidity 128, 140

husbandry 127, 128, 130, 131, 133, 134, 136, 138-143
hypoplasia 141, 142
illumination 135, 137
individual cages 138, 141
industry 142
infancy 135, 143
infarction 138
intermale activity 136
intestinal

- rupture 137
- stasis 129, 131, 137

investigatory behavior 141
isolation 128, 133, 135
labor 140
legislation 142
Lepus capensis syriacus 142
lighting 128, 140
litters 141
litter size 140
locomotor activity 135, 138, 139, 141
maintenance behavior 141
male 127, 134, 136, 138
management 130, 133, 136, 138, 139, 143

- system 138

maternal presence 142
mouse 134
movement 128, 129, 141
nest

- area 142
- box 136
- communal 136

nesting 135-137, 142
neurotransmitter 135
New Zealand White 130, 131, 134, 137, 139, 141
nocturnal 138
noise 136-138, 140
norepinephrine 135
normal behavior 133
nulliparous 138
odors 134
odor preferences 142
oestrus 137
open-field test 143
opioid peptides 135
osteoporosis 129
outside cages 138
paddock system 136
paired housing 129, 131, 134, 137, 142

pens 129, 130, 132, 134, 138, 139, 141
pheromone 134
photoperiod 135, 137, 138
physiological 135, 137, 140

- effects 135
- response 137

plastic cages 139
population density 136
preference 135, 137, 142

- testing 142

production 133, 138, 139
productivity 129, 136
progesterone 133
psychological needs 136
psychology 135, 138, 143
pup area 142
PVC pipe 134
rat 134
rats 137, 140
rearing activities 128
refinement 130, 140
reproductive behavior 140
resting

- behavior 135
- periods 135

rodents 134, 140, 141
sandy lop rabbits 130, 134
scent-marking 134
season 139
secretion 134
selective breeding 136
semi-natural conditions 139
sexual 130, 133, 137, 138, 142

- activity 133
- behavior 138, 142
- display 137

single 128, 131, 134, 137, 139, 142, 143

- caging 128, 139, 142
- housing 134, 137, 143

slaughter 133
sleep 135, 136
social 127-129, 131-139, 141-143

- activity 135, 138, 143
- behavior 127, 133-134, 136-139, 141

- contact 134, 143
- isolation 128, 133
- display 138
- groups 134, 137, 142
- interactions 136
- isolation 128, 133
- peers 134
- relationships 142, 143

solitary housing 133, 134
space 128, 134, 139

- allocation 139

spatial

- behavior 138, 139
- conditions 142
- needs 137

stereotyped behavior 128, 130, 131, 135, 139-141, 142
stimulation 128, 129, 135
stimuli 135
straw bedding 139
stress 129, 131, 136-141
stressors 136
submission 136
suffering 128, 131
systems 138, 139, 141
temperature 128, 137, 139, 140
testosterone 133, 136
time of day 135
tonic pain 136
transport 139
trauma 136
travel 139
ultrasound 140
urine 134
ventilation 128, 140
vertebrae 141, 142
warrens 127
water 133, 138
weight

- gain 142
- loss 129

welfare 127-135, 139, 140, 142
wellbeing 128, 129, 139
wild 127, 129, 131, 132, 138
wire-floor 139

Rodents

- **Environmental Enrichment in Rodents**
  by Heleen A. van de Weerd and Vera Baumans, Utrecht University, pages 145-150
- **Rodent Bibliography: Gerbils and Hamsters**, pages 151-154
- **Rodent Bibliography: Guinea Pigs**, pages 155-156
- **Rodent Bibliography: Mice**, pages 157-168
- **Rodent Bibliography: Rats**, pages 169-210
- **Rodent Bibliography: Wild Rodents**, pages 211-212

Hamsters and Gerbils

- **Environmental Enrichment in Rodents**
  by Heleen A. van de Weerd and Vera Baumans, Utrecht University, pages 145-150
- **Rodent Bibliography: Gerbils and Hamsters**, pages 151-154

body 151-153

- fat 151
- mass 153
- temperature 153
- weight 151, 152

abstract 152
activity 151
adolescent 152
adrenal 152
adult 151-153
age 152
ambient temperature 153
bedding 151
behavior 151-153

- foraging 151
- motor 152
- solitary 146

brain 151
cages 152, 153
caging 151
cortisol 152
crowding 152
development 152, 153
dominance 153
environmental enrichment 146, 148, 151, 152
fat 151
female 151-153
fighting 152, 153
food 146, 151
gerbil 151, 152
golden hamster 153
gonadectomized 153
group housing 146, 151, 152

growth 151, 152
hamster 151-153
handling 151
housing 146, 151-153
isolation 151-153
lifespan 151
litter size 153
locomotor activity 151
male 151-153
Meriones unguiculatus 151, 152
Mongolian gerbil 152
mouse 151
neural 152
novel objects 151
odors 151-153
old 151
olfaction 153
outdoor 151, 152
pairs 153
pheromones 153
play 152, 153

- fighting 152, 153

preference test 153
pregnancy 153
reproduction 152
running wheel 153
sex 152
size 153
social 146, 151, 152

- environment 152
- interaction 152
- isolation 152

socialization 151
somatic growth 152
strain

- Golden 151-153
- Siberian 153
- Syrian Golden 153

submission 153
temperature 153
testes weight 152
testosterone 152
toys 152
vaginal 152
weanling 152, 153
weight 151, 152
welfare 151, 153
wire 152

young 153

To: Top of Document | Using this index | Birds | Cats | Dogs | Farm Animals: Cattle , Horses, Sheep and Goats, Swine | Ferrets | Rabbits | Rodents: Hamsters and Gerbils, Guinea Pigs, Mice, Rats, Wild Rodents

Guinea Pigs

- **Environmental Enrichment in Rodents**
  by Heleen A. van de Weerd and Vera Baumans, Utrecht University, pages 145-150
- **Rodent Bibliography: Guinea Pigs**, pages 155-156

body weight 156
activity 155, 156
adult 156
bedding 156
behavior 155, 156

- agonistic 155
- exploratory 155
- open field 155

cage 156
care 155, 156
communication 155
cortisol 156
domestic 155
dominance 155
female 155, 156
gerbil 155
gnawing 147
hamster 155
housing 149, 155
isolation 155, 156
lactating 155
male 155, 156
maternal 155, 156
mouse 155
neonate 155
neural 155
noise 155, 156
nonpregnant 155
nonvocal sounds 155
observations 155
open-field 155
play 155
pregnancy 155
reproduction 156
separation 156
silence 155
social isolation 155
softwood sticks 147
space 156
spatial 156
virgin 155

vocalizations 155
weanling 156
weight 156
welfare 155
young 156

To: Top of Document | About this index | Birds | Cats | Dogs | Farm Animals: Cattle, Horses, Sheep and Goats, Swine | Ferrets | Rabbits | Rodents: Hamsters and Gerbils, Guinea Pigs, Mice, Rats, Wild Rodents

Mice

- **Environmental Enrichment in Rodents**
  by Heleen A. van de Weerd and Vera Baumans, Utrecht University, pages 145-150
- **Rodent Bibliography: Mice**, pages 157-168

body 157, 161, 163, 164, 166-168

- weight 157, 163, 164, 166-168

abstract 164
activity 157-159, 161, 163-166
adrenal 157-159, 164

- gland 157, 164

adult 165
affiliative behavior 166
age 161, 168
aging 159, 163
ambient temperature 168
ammonia 160
anthropocentric view 164
anti-psychotic drugs 168
apparatus 158
autoimmune disease 166
aversive

- response 159
- stimuli 157

BALB/CJ 165
bedding 147, 160-162, 165-167
behavior 157-168

- affiliative166
- agonistic 146, 159, 164
- exploratory 157
- nesting 147, 162
- play 166
- social 146, 165, 166

behaviorally deficient mutant 161
biochemistry 163

bottles 167
brain 157-159, 162, 163, 165-167

- chemistry 167
- stem 159, 163
- weight 159

breeding 160
cage 157, 159-164, 167

- size 147, 163

caging 157-159, 161, 162, 164
care 162, 165
cellulose 162, 166
cerebellum 159, 163
cerebral

- cortex 160, 167

chlordiazepoxide 168
complexity 157, 159
copulation 168
cortex 159, 160, 163, 167
cortical

- depth 159, 167

corticosteroids 160
cytolytic 161
darkness 157
defecation 157, 163, 164
depression 168
deprivation 160
development 159, 165
diencephalon 159
diet 166
dietary proteins 165
discrimination tasks 159
dominance 159, 161-164
dwarf mice 158
electric shock 157
emotionality 157, 159
enrichment 157-164, 166, 167
environmental 157, 159-164, 166, 167

- complexity 157
- enrichment 145- 148, 157, 159-164, 166, 167

ethanol 167
exercise wheel 165
exploration 159, 160, 163, 164, 166
fat 161
feed 166
female 157, 160, 162, 163, 165-168

fetal 162
fighting 162-164
food competition 157, 164
genetic variance 161
genotype 161, 163, 164
gerbil 158
gestation 168
glands 159
grooming 159
group

- housing 165
- reared 162

growth 161
habituation 158
hamster 158
handling 146, 157, 160
handling-reactivity test 160
hardwoods 166
hemocyanin 162
Hepa-1 166
heterogenous 159, 160
high fat content 161
hippocampus 163
hoarding 163, 164, 166
housing 157, 158, 160-162, 165-168

- conditions 157
- group 146, 148, 149

ICR 160, 162, 165
ICR-albino 160
IgG 162
IgM 162
imipramine 168
immobility 168
immunity 162, 165
impoverished 160, 162
inbred 158-160, 162, 163, 165, 166

- strain 158, 160

isolation 158, 159, 161-166, 168
learning 157, 158, 160, 166, 167
lesions 160
litter size 160
liver 160, 162, 165

- enzymes 165
- metabolism 165

locomotor

- activity 158

male 157-168
maturation 167
maze 158-160, 166, 167
memory 163
methods 165
mice (*Mus domesticus*) 159
Morris

- water maze 167

mouse hepatoma cell line 166
mycotoxins 165
neonate 159, 164
nesting 147, 162
neural 158, 159, 165
neuronal

- development 159
- plasticity 160

noise 161, 168
novel environment 165
nutrition 167
objects 164
occipital cortex 159
odors 161
old 163, 167
olfaction 159, 161, 162, 164
open field 157-160, 163-164
pair housing 166
pairs 160
partitions 159
passive 163
physiological responses 157
plasticity 160
play 164, 166

- behavior 166

Plexiglas 163
post-weaning 158
preference test 157
pregnant 162, 165, 167
prostate 157
receptor binding 163
reproduction 158, 168
reserpine 168
running wheel 158, 163-164
septal lesions 160
sex 162
shelter 157

- drinking bottles 147

- plastic tubes 147

shuttlebox 166
size 160, 163
sleeping area 147
social 157, 158, 161, 163, 165, 166, 168

- behavior 146, 165, 166
- interactions 166
- isolation 168

socialization 159
space 160
spatial 158, 166

- maze 166

spontaneous alternation 158
standard 162
strain

- A/J 164
- B6D2F2 167
- BALB/c 159, 160, 162, 163, 165, 166
- Binghamton 160
- BXSB 157
- C3H-AVY FB 167
- C3H/HeJ 164
- C57BL 166
- C57BL/6 162, 163
- C57B1/6J 163, 165, 167
- C57BL/10J 164
- CBA/J 163
- CD 159, 160, 166
- CD-1 159, 160, 166
- CF-1 166
- CFLP 164
- DW/Orl-dw 158
- HA-ICR Swiss 162
- ICR 165
- ICR-albino 160
- New Zealand Black 166
- NIH 165
- outbred CD-1 166
- Quackenbush albino 159
- ST/bJ 163
- Swiss 157, 159, 162, 165, 168
- Swiss albino 165
- Swiss CD-1 159
- Swiss Webster 168
- SWJ/Jac 162
- TO 160
- Wistar 163

stress 157, 159, 161
striatum 163
strychnine 159
submission 162, 164
surface texture 163
swimming 159, 168
Swiss 157, 159, 162, 165, 168
tasks 159, 163, 167
telencephalon 159
temperature 158, 161, 168
testes 157
toys 167
tumors 161, 167
visual cortex 160
water

- consumption 163
- maze 160, 167

weaning 158, 167
weanling 158-162, 164, 166, 168
weight 157, 159, 160, 163, 164, 166-168
welfare 158, 162, 164
wire 163
wood shavings 165
young 159, 163, 168

To: Top of Document | About this index | Birds | Cats | Dogs | Farm Animals: Cattle, Horses, Sheep and Goats, Swine | Ferrets | Rabbits | Rodents: Hamsters and Gerbils, Guinea Pigs, Mice, Rats, Wild Rodents

Rats

- **Environmental Enrichment in Rodents**
  by Heleen A. van de Weerd and Vera Baumans, Utrecht University, pages 145-150
- **Rodent Bibliography: Rats**, pages 169-210

body 172, 178, 179, 183-185, 187, 188, 190, 191, 196, 199, 201, 203-205, 208, 209

- fat 201
- mass 201, 209
- protein 201
- weight 172, 178, 179, 183-185, 187, 188, 190, 191, 196, 199, 201, 203, 205, 208

abstract 169, 178, 181, 184, 189, 193
acetylcholinesterase 170, 177, 185, 194, 199, 208
acquisition 173, 175, 187, 199
active avoidance task 177
activity 169-173, 175, 176, 181, 184-186, 188-191, 193, 194, 197, 199-202, 205, 206, 208
adolescent 200, 208
adrenal 172, 174, 175, 180, 187, 191, 196, 202
adrenalectomy 175
adrenal gland 191
adrenocortical system 183
adult 170-172, 174, 177, 179, 181, 185, 186, 188, 190-196, 199, 202-208

aeroallergen levels 204
aerosols 195
age 181, 185, 202, 206
aging 171, 176, 180, 181, 188, 190, 200, 201, 204, 205
agonistic 171
allergens 204
allogrooming 194
alpha male 179
aminooxyacetic acid 182
ammonia 195, 207
amphetamine 171, 177, 179, 209
amygdaloid lesions 186
amylobarbitone 173
angiogenesis 171, 200
anogenital licking 190
anti-serum 170
anxiolytics 173
apparatus 173, 178, 187, 208
ataxia 182
attack 200
attention test 198
auditory discrimination 198
aversive stimuli 176
avoidance

- learning 186, 193, 194
- training 180

barriers 172
bedding 172, 175, 178, 185, 193, 195, 199, 204, 207

- cedar wood shavings 172
- behavior 169-204, 206-208
- consummatory 186
- contact 175
- defensive 187
- digging 208
- exploratory 175, 178, 182
- unconditioned 199

behavioral tests 189
bilateral

- hippocampal lesions 186
- ICV injection 171
- lesions 186, 197, 206-208
- occipital lesions 197

binding assays 195
biochemistry 174, 178, 183, 188, 193, 196, 197, 202, 208
black rat 198
black-hooded rat 209
blood

parameters 172
- pressure 171, 191

boredom 179
bracelet removal test 198
brain 169-171, 173-178, 180-182, 184-186, 188, 190-203, 205-208

- chemistry 188
- damage 197, 206
- development 174, 176, 185
- enzymes 199
- growth 171, 175, 178, 185
- morphology 181
- thickness 176, 182
- weight 170, 173-175, 178, 190, 195, 196, 199, 203, 207, 208

brainstem 194
buproprion 191
burrows 173, 182
butyrylcholinesterase 208
cage 169, 172, 173, 175, 176, 179, 190, 193, 200, 204, 206

- size 147, 179, 190, 200

caging 169, 176, 182, 183, 187, 189, 195, 199, 205
candle 188
capillaries 171
carbohydrates 187
cardiomyopathy 175
cardiovascular system 189
care 176, 179, 183, 189, 190, 199
cat avoidance apparatus 187
caudate

- nucleus 193, 206

cell physiology 184
cerebellum 178, 194, 195, 206
cerebral

- artery 184
- blood flow 180
- cortex 171, 176, 185, 205

cerebrum 170
chlordiazepoxide 173
choice test 183
cholinesterase 170, 199
choline acetyltransferase 193, 194
circadian activity 205
citrate synthase 181
clonidine 190
closed field 191, 206
cocaine 179, 183
cognition 181, 193

cognitive changes 188
collagen 185
complexity 184, 195, 203
constant estrus 188
copulation 200
cortex 170-173, 176, 178, 180, 182, 184-186, 188, 190, 191, 194-197, 199, 200, 202, 204, 205, 207, 208
cortical

- dendrites 205
- depth 175, 182
- plasticity 205

corticosteroids 204
corticosterone 173, 175, 190, 197, 202
cross-modal 209
darting 207
deafness 182
defecation 187, 190, 201
defense 177
dendrites 172, 178, 194, 199, 204, 205
dentate gyrus 200
depletion 171, 177, 191, 193, 206
depression 197
deprivation 174, 180, 183, 194, 196, 205, 208
development 170, 172, 174, 176, 181, 185, 194, 200, 201, 203, 205, 208
devocalized 207
diabetes 175, 181
diaphragm 209
diazepam 173, 208
diencephalon 181
diet 178, 196, 204
dietary saline 190
diethyl maleate 187
differential reinforcement 198
dismutase 187
domestic 184
dominance 173, 179, 192, 194, 201, 208
dominant 192
dopamine 169, 171, 177, 185, 193, 194, 196
dopaminergic agonists 179
dopamine synthesis 171
dorsal body 201
dorsal hippocampus 203
DRL-20 task 192
d-amphetamine sulfate 209
EEG 203
elastin 185
electric shock 179, 180, 193, 200
electrodes 189, 199
electro-oculogram 203
emergence test 183
EMG 203
emotionality 147, 183, 185, 189, 191, 196
emotional stress 197

emotions 186-188
endocrine system 172
energy expenditure 201
enriched 169, 175, 176, 178-181, 183, 184, 188, 190-196, 198, 199, 201, 203-206, 208

- environment 169, 178, 179, 184, 188, 190, 193, 194-196, 199, 203-206, 208

enriched-impoverished experience 193
entorhinal cortex 208
environmental 169-207, 209

- complexity 195, 203
- enrichment 169-207
- impoverishment 175, 193

epinephrine 187, 189
epitrochlearis 181
escape response 197
estrus 188, 205
ethanol 185, 196, 197, 208
evoked 177, 188, 189, 200, 202, 205

- responses 200

exercise 172, 175, 176, 180, 184, 185, 187, 196, 202, 204, 209

- wheel 180

exploration 174, 180, 182, 185, 186, 190, 196, 197, 201, 206, 207
extinction 173
eye-opening 201
family reared 184
fat 187, 201
fatty acid desaturase 189
fear 180, 187, 189, 200
feed 173, 175, 179, 184, 187, 191, 196, 201, 204, 209

- acquisition 173, 175, 187
- consumption 179, 191, 201
- intake 184, 201, 209
- restriction 196

feeding 183, 192, 202
female 169, 170, 172-175, 179-188, 190-197, 199, 201-205, 207-209
femoral 180
fetal 185
fetus 170
field activity 201
fighting 194, 195
fimbria-fornix lesions 177, 185, 186
flexor 181
floor type 195
food 146-148, 186, 187, 192, 202, 205

- earned 146

foot shock 204
forebrain 177, 185, 191, 193, 199, 206
foster mothers 181, 186, 205, 206
frontal cortex 176
genetic influences 184
gentling 201
gerbil 171
gestation 205
glands 174, 187, 196
glucocorticoid

- receptor 173, 192
- receptors 190

glutathione 187
glycogen 209
gnawing 176
Golgi-Cox-Sholl stain 205
Golgi-Cox-Sholl stain 205
Golgi study 178, 199, 205
granule cells 203
gregariousness 187
grip test 198
grooming 190, 200
group

- housing 200, 208
- reared 189, 199
- rearing 188

groups 169, 176, 182, 184
growth 171-173, 175, 178, 185, 190, 192, 195, 203, 204

- associated protein 173
- spurt 185

hamster 171
handling 146, 169, 174, 176, 177, 181, 183-185, 189, 190, 193, 196, 199, 202, 203
heart 172, 181, 196, 209
Hebb-Williams maze 173, 175, 184, 186, 191, 193, 195, 196, 202, 205-208
hemidecorticate deficit 198
hemidecortication 198, 206
hexokinase 181
hippocampal lesions 177, 186, 208
hippocampus 176-178, 181, 184-186, 190, 192, 194, 202, 203, 207, 208
histology 170, 173, 176
homing 201
homozygous 181
hooded rat 202
hormonal state 182
hormones 170, 182, 188
housing 169, 171, 173, 174, 178, 180, 182, 185-187, 189, 199, 200, 204-206, 208

- conditions 173, 185, 186, 199

- group 146, 149, 200, 208

huddling 175
humidity 195
hydroxydopamine 171, 193, 194
hyperactivity 172, 180
hypertensive 189, 193
hypoglycemia 209
illumination 147, 206
imipramine 173
immobility 177, 204
immobilization 197
impoverished 170, 171, 173, 175, 176, 178-181, 185, 186, 188, 191, 193, 195, 196, 198, 199, 201-203, 206, 208

- housing 178

indirect calorimetry 201
insulin 169
intake 184, 187, 196, 197, 201, 209
in vitro 171
isolation 169-172, 174, 176-185, 188-190, 192, 195-197, 199-201, 203, 204, 206, 208, 209
juvenile 174, 182, 184, 188, 190, 200, 201, 204
kanamycin 182
knees 180
lactate 187
lactation 204, 205
Lashley III maze 181, 195
lateral hypothalamus 199
learning 169, 170, 173, 175-181, 184-189, 191-200, 202, 204, 205, 207-209
length 204
lesions 174, 177, 182, 185, 186, 192, 197-199, 206-208
lever-press training 198
licking 190
littermates 183, 195
litter size 187
liver 184, 209
locomotion 199
locomotor

- activity 171, 176, 189, 191, 199, 206
- tasks 182

lordosis reflex 188
male 169-177, 179-204, 206-209

- newborn 193
- offspring 186

malnutrition 172, 174, 194, 203-205
maternal 186, 190, 200, 202, 205
maturation 193-195, 203
maze 172-175, 178, 180-187, 190, 191, 193-197, 201, 202, 204-208
medial

- forebrain bundle 199

- occipital cortex 176

medroxyprogesterone 170
mellitus 175
membrane fractions 195
memory 176-178, 180, 181, 185, 186, 193, 194, 200, 202, 205

- loss 205
- tasks 177

methamphetamine 173, 199, 207
methods 182, 183, 198, 202, 208
micrencephaly 195
midbrain 196
mineralocorticoid receptor 173, 192
morphine 183
Morris

- maze 182, 190
- water maze 207

mothers 181, 186, 190, 205, 206
motivation 184, 201
motor pyramids 178, 194
motor tasks 177
mouse 171, 195
mRNA 173, 178, 191
muscarinic receptors 194
muscle fibers 209
neocortex 177, 181
neonate 170-172, 175-177, 178, 184,187, 190, 191, 193-195, 199, 201-202, 203, 205-208
neophobia 180, 183, 192, 206
nerve growth factor 190, 192
nest 147, 169, 176, 182, 190

- building 176

neural 171, 173-176, 180, 182, 184, 195, 197, 200, 205-208
neurobehavioral plasticity 193
neuroendocrine effects 173
neuronal

- development 172
- plasticity 190
- transmitter 192

neurons 178, 189, 194, 204, 205
neurotoxicity 202
noise 169, 171, 180, 182, 191
nonpregnant 182
noradrenaline 171, 177, 206
norepinephrine 187, 191, 193, 196
normotensive 189
novel environments 180, 189
noxious stimuli 185

nucleus accumbens 171, 177
nursing 190
nutrient self-selection 187
nutrition 170, 172, 174, 178, 185
object exploration test 207
observations 195
occipital cortex 172, 176, 178, 186, 197, 205, 207
occupational exposure 204
odors 179
old 171, 174, 176, 181, 185, 190, 200, 201, 204, 205
olfaction 172, 175, 183
ontogenetic descriptions 204
open field 174, 176, 179, 180, 183-188, 190, 191, 195, 198-199, 201, 206, 208
operant

- chambers 173
- procedure 179
- task 198, 207
- order 201

organ weights 172
ovarian steroids 188
pain reception 200
pair

- housing 200
- interaction 187

paired flashes 205
pairs 177, 195
paraventricular nucleus 189
parietal 176
passive 174, 186

- avoidance problem 186

pavlovian tasks 207
peer 184
perceptually enriched 180
physiological responses 189
pinning behavior 192, 200
plasticity 171, 174, 176, 184, 190, 193, 203-205
play 170, 174, 181-184, 187, 190, 192, 194, 200-202, 204

- behavior 174, 187, 200-202, 204
- fighting 194
- motivation 201
- restricted 201
- rough-and-tumble 183, 201

plucking 203
postlesion performance 197
postnatal 173, 177, 181, 182, 186, 194
postsynaptic structures 199
postweaning 172, 173, 176, 179, 182-184, 193-194, 203, 205, 207

predation 186
preference test 179
pregnancy 175, 182, 204
pregnant 175, 182, 186, 195
prelesion performance 197
premature weaning 199
preproenkephalin 173
preprosomatostatin-mRNA 191
pretraining 202
pre-pregnancy 175
problem-solving 184, 191
progestin 170
protein 173, 187, 194, 201, 202, 206

- kinase C 194, 202
- kinase 194, 202
- turnover 194

pups 175, 201
quinine 208
radial maze 174, 186, 202, 205
receptor binding 202
recording device 208
red blood cells 184
reflex maturation 195
reinforcement 173, 198
REM sleep 190
reproduction 178, 203
response-contingent events 198
reward 192, 198
ricin A toxin 189
running wheel 170, 176, 185, 193, 196, 201
sedentary 185
self-administration 183, 209
sensorimotor cortex 180, 182
sensory stimuli 189, 208
separation 202
septal lesions 174
serotonin 196
sex 172, 174, 182, 186, 187, 200
sexual

- maturity 204
- mounting 194

shock thresholds 179
shuttlebox 177, 178, 186, 195

- avoidance 178, 186

siblings 204
size 177-179, 181, 185, 187, 190, 200, 205
Skinner box 198
social 169-171, 173, 176, 177, 182-184, 187, 188, 190, 192, 195, 199-202, 204, 205, 208, 209

- behavior 146, 170, 208
- contact 183
- groups 169, 176, 182
- interaction 171, 195, 201
- isolation 169, 184, 190, 192, 199, 209
- play 182-184, 200, 204
- threat 177

socialization 176, 179, 185, 200
sodium 173, 209

- barbital 209

space 170, 187, 189, 199

- requirements 199

spatial 177, 178, 183, 188, 190-192, 205-207

- learning 188, 191, 192
- relationships 183

spontaneous alternation 186, 208
stomach 187
straight alley 181
strain

- Berkeley-S1 170, 178, 195, 196, 199, 204, 207, 208
- Brattleboro 181
- Brown-Norway 189
- Carworth 187, 201
- CD 172, 180
- Charles River 200
- Fischer 184, 185, 196, 199, 207
- Fischer 344 185
- Holtzman 175, 179, 186, 187, 194, 206
- Holtzman-derived 179
- hooded 175, 179, 185, 198, 202, 208, 209
- Hooded Lister 175, 185, 198
- Lister hooded 198
- Long-Evans 172, 176, 177, 179-183, 186, 188, 192, 199-203, 206, 207
- Norway 175, 184, 189, 190
- Norwegian 202
- Purdue Wistar 205
- RHA-Verh 181
- RLA-Verh 181
- S3 200
- Sprague-Dawley 169, 171, 172, 174, 176-178, 180, 185, 186, 188, 189, 191, 193, 194, 196, 203
- Turkestan 201, 202
- Wistar 169, 171, 173, 174, 179, 183, 184, 187-193, 200, 203-205, 208
- Wistar-Kyoto 189, 193

streptozotocin 175

stress 169, 173, 174, 180, 183, 187-191, 193, 196, 197, 199, 200, 204, 207
striatum 169, 171, 177, 194
stroking 202
subcortex 178, 195
subdominant 192
subordinate male 194
superior colliculi 208
superoxide dismutase 187
swimming 173, 187

- maze 173

synaptogenesis 171
tactile stimuli 203
tasks 177, 182, 207
taste 176, 180

- aversion 176

telencephalon 181
temperature 195
testosterone 170
testosterone anti-serum 170
thymus 187
time 190, 208
tonic immobility 177, 204
total energy intake 187
toys 170-172, 174, 176, 179, 184, 187, 190, 194, 200, 203, 205
training 172, 175, 180, 185, 187, 193, 195, 198, 204, 209
transcription factor 192
treadmill 172, 175, 180, 185, 187, 209
T-maze 180, 184, 205
ulcers 197
ultrasonic vocalizations 175, 207
undernutrition 185, 188, 203
urea 209
urination 190
urine 179
ventral 172
virgin 175
vision 184, 206
visual

- cortex 170-172, 200
- discrimination 185, 196, 209
- enrichment 170, 189
- pattern discrimination 190
- stimuli 203

Vitamin A 173
Vitamin B1 196
vocalizations 175, 191, 207
wall thickness 185
water

- acquisition 187
- consumption 179, 186, 191, 197
- control 147
- deprivation 196
- maze 178, 193, 194, 197, 207

weaning 174, 176, 183, 192, 194, 199, 203
weanling 169, 172-174, 179, 183, 184, 186, 189, 190, 192, 193, 195-197, 202, 203, 208, 209
weight 170, 172-175, 178, 179, 183-185, 187, 188, 190, 191, 195, 196, 199, 201, 203, 205, 207, 208
welfare 169, 171, 176, 191, 199
wellbeing 189, 191
wild 184
wire 195
Wistar-Kyoto 189, 193
wood shavings 172
xylocaine 201
young 169, 177, 179, 181-183, 185, 190, 192, 194, 200-203, 205, 208
zinc sulfate 190

To: Top of Document | About this index | Birds | Cats | Dogs | Farm Animals: Cattle, Horses, Sheep and Goats, Swine | Ferrets | Rabbits | Rodents: Hamsters and Gerbils, Guinea Pigs, Mice, Rats, Wild Rodents

Wild Rodents

- **Environmental Enrichment in Rodents**
  by Heleen A. van de Weerd and Vera Baumans, Utrecht University, pages 145-150
- **Rodent Bibliography: Wild Rodents**, pages 211-212

body temperature 212
abstract 212
adverse environments 212
alarm response 211
bank voles (*Clethrionomys glareolus*) 145, 211, 212
behavior 145, 211, 212
brain weight 211
breeding 212
burrows 212
bushy-tailed woodrat (*Neotoma cinerea*) 211
cage size 149, 211
capybara (*Hydrochoerus hydrochaeris*) 211
care 212
chemical cues 211
communication 212
conflicts 211
den boxes 211
development 211
environmental enrichment 149, 211, 212
euthermic 212
female 211
flight or fight response 211
frequency of torpor 212
ground squirrel (*Spermophilus lateralis*) 211, 212
groups 212

housing 211, 212
huddling 212
Hydrochoerus hydrochaeris 211
impoverished 212
isolation 212
male 211
mouse 212
naked mole-rats 211
nest 211, 212
observations 211
outdoor 212
perception 211, 212
pheromones 211
preference test 211
radiotelemetry 212
reproduction 211, 212
size 211
social 211, 212

- behavior 211
- groups 212

stereotypies 211
strain

- BALB/cj 211
- Golden 211

temperature 212
tree squirrels (*Sciurus sp.*) 211
vocalization 212
weight 211
white-footed mouse 212
woodchuck 212

Go to:

[AWIC] [Top of Document] [Using this index] [Main Contents] [Main Introduction] [How to Use This Document]
[Birds] [Laboratory Cat] [Dogs and Dog Housing] [Farm Animals] [Ferrets] [Rabbits] [Rodents]
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