

Designing for the Implementation of the 3Rs

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The Three Rs concept of Russell & Burch (1) has become a universal guiding principle for the ethical evaluation of animal-based research protocols. The principles of refinement, reduction, and replacement consist of methods for reducing the stress placed on experimental animals (2), obtaining comparable levels of information from the use of fewer animals in scientific procedures or for obtaining more information from the same number of animals, and for replacing experimental animals with non-sentient alternatives. Such methods use improved experimental design that eliminates contaminants and minimizes variables. Implementation of the 3Rs, while using the minimum number of animals without loss of valid data, leads to a reduction in animal use.

Since laboratory animals are living beings that are sentient and respond to scientific procedures, it is a challenge to improve experimental design in a manner that would control all variables. In fact, it has long been recognized that biological observations from animals are superimposed on a background of variability (4). The source of variables is from a triangular interplay of genetic, health, and environmental factors (see diagram below). For that reason, few papers refer to improved experimental designs and statistical analysis. Strategies such as use of in vitro systems wherever possible; detection of biological and/or behavioral alterations with videotape and behavioral assay; interpretation of data by software analysis of the investigated conditions (treatments, genetic condition, social status); use of pilot studies before undertaking large-scale experiments; and control of genetic and health variations by using inbred strains and healthy, pathogen-free animals (5) are among the types of improvements that can be made. Other approaches of refinement are the practice of bundling of activities (such as physical examination or vaccination), improving caging, providing novel environmental enrichment, using the most updated medical and research equipment, and finding alternatives to animal use. Methods of reduction require justification and careful planning of studies and optimally utilizing individual animals. Replacement of live animals, when acceptable, is possible with sacrificed animals, non-animal models, training videos, and online courses (6). This document reviews an animal facility design that advances the implementation of the 3Rs by controlling environmental factors such as temperature, relative humidity, and air composition for species-specific, optimal and stable environmental conditions. This type of design seeks to eliminate environmental contaminants and minimize variables.

Animal facility designers should be concerned about the 3R principles. In fact, realization of four performance goals in facilities design can help achieve the implementation of the 3Rs.

- Provide for the health, well-being, and welfare of the animals and their users



Figure 1.

- Facilitate animal research
- Minimize experimental variables
- Meet current and future needs, i.e. flexibility

Considering these four performance goals, the following criteria should be utilized in designing the animal facility.

1. Engineering controls should eliminate environmental contaminants and minimize variables (7).
2. Layout and equipment should facilitate traffic flow patterns, husbandry practices, experimental procedures, and sanitation processes.
3. Materials and finishes should be durable, impervious, and resistant to damage and chemicals.
4. Good indoor air quality should be available to the animals and their users at all times.
5. Room and cage ventilation should eliminate air recirculation and contaminants at the source.
6. Species-specific, optimal, and stable environmental conditions should be provided for all care and use activities.
7. Architecture and engineering controls should create barrier at facility, room, and cage levels.
8. Adequate space should be provided for animal procedures and for the purposes of bundling activities, conducting pilot studies, training care and use workers, and segregating clean and dirty activities.

The animal facility should be located to facilitate receipt of animals and supplies, removal of wastes, and access to users. The location should also preclude public access and animal and cage traffic through public areas. The facility should be situated such that reliable services (water, electricity, sewage disposal) and access to high quality air (exhaust air does not enter the facility or other buildings) are available.

There are 22 basic components of an animal facility where design improvements can advance the implementation of the 3Rs. These are listed below. In addition to these components, a designer considering implementation of the 3Rs should address functional adjacencies and traffic flow patterns between areas of an animal facility. Moreover, materials and finishes, plumbing, electrical, environmental monitoring systems, security, and safety equipment are all essential considerations when designing an animal facility. Finally, environmental conditions that are species-specific, optimal, and stable are the most important aspects of a well-designed facility, which can prevent introduction of contaminants and variables that can affect animals, personnel, environment, or research protocols.

I. The basic room/space components of an animal facility are:

- a. Animal holding rooms
- b. Janitorial closets
- c. Procedure rooms
- d. Necropsy
- e. Surgery area
- f. Personnel office and reception area
- g. Clean and dirty loading docks
- h. Personnel changing rooms
- i. Animal reception area(s)
- j. Laundry facilities
- k. Feed and bedding storage
- l. Toilets
- m. Waste storage
- n. Staff break and meeting room(s)
- o. Waste elimination area