Animal Source

PSU Animal Resource Program

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The Basics of Magnetic Resonance Imaging

Since the first image of a living object, a clam, was produced in 1973 magnetic resonance imaging (MRI) has developed into an important tool in both diagnostic clinical medicine and biomedical research. Although most people are familiar with the use of MRI, few understand the complex technology behind it. What follows is, in simplified terms, a short primer on how MRI works. For more detailed information please refer to the references at the end of the article.

The typical MRI machine contains a horizontal tube that is surrounded by a magnetic field when the machine is turned on. The object to be scanned is placed inside the tube and positioned in the center of the magnetic field. The magnetic field is (most commonly) created using a superconducting magnet in which coils of wire are immersed in liquid helium at extremely low temperatures. When an electric current is passed through the wires a stable, uniform magnetic field is created inside the tube. The intense magnetic field causes hydrogen protons (within biological material) to align themselves parallel to the magnetic field.

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Visit the ARP website at www.research.psu.edu/arp for answers to your animal use questions

Magnetic Resonance Microscopy Research Resources

Magnetic resonance microscopy (MRM) is a variation on traditional magnetic resonance imaging that allows detailed three-dimensional studies of very small specimens in a nondestructive manner. The resolution of MRM images are thousands of times greater than MRI clinical scans. This and the use of unique contrast mechanisms enable the researcher to visualize anatomical structures without sectioning and the artifacts associated with traditional histology. MRM researchers are also working to perfect techniques to allow MRM imaging of live animals.

The **Center for In Vivo Microscopy (CIVM)** at Duke University is a National Institutes of Health (NIH) National Center for Research Resources available for investigators that want to use MRM in their research. Their website is http://wwwcivm.mc.duke.edu/civmFacility/L2Facility.html.

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Inside this issue:

Reducing Aggression in Group Housed Male Mice

Adult male mice often fight and injure other males when housed together. Certain inbred strains of mice may be especially aggressive as a result of selective breeding for certain behavioral traits or as an unintended side effect. The sense of smell is important in mouse social behavior and odor cues are used to recognize other mice and advertise social status. Nevison *et al*. 2000 showed that inbred mice can have difficulty recognizing individuals of the same strain due to abnormal similarities in odor cues between families within the strain. This may lead to increased aggression due to altered social behavior.

Whatever the cause, these aggressive tendencies have forced many researchers to house male mice individually. Unfortunately, this results in excessive use of caging supplies and increased labor for the care and husbandry of these mice. In addition, preference tests indicate that male mice prefer social housing to individual housing, regardless of the level of aggression and social status.

In some cases, individual housing may be the only way to avoid injury in male mice. However, as reported in Van Loo, *et al* 2003 selected alterations of standard housing and husbandry procedures may significantly reduce aggression and allow peaceable group housing of male mice. These include:

1. Group size – Studies have shown that the optimum number of male mice per cage is three. Groups of two or more than three result in significantly more aggressive behavior. A group size of three allows diffusion of aggressive behavior by the dominant mouse to more than one subordinate mouse and also lets the two subordinate mice provide social support for each other.
2. Cage size – Increasing cage size seems to have either no effect or results in increased levels of aggression between males. However, overcrowding may lead to increased stress in mice.
3. Environmental enrichment – The presence of nesting material appears to decrease aggressive behavior in male mice. The presence of rigid structures (shelters) actually increased aggressive behavior in some studies. It is theorized that the nesting material encourages non-aggressive activity and allows the mice some control over their environment.
4. Cage cleaning – The transfer of used *nesting* material when changing bedding reduces the aggressive behavior that often follows cage changing in group housed mice. The transfer of bedding soiled with urine or feces may increase post-changing aggression. Soiled bedding material may harbor odor cues from feces and urine that mice perceive as threatening or otherwise aggression eliciting while the used nesting material does not.
5. Increasing stress leads to increasing levels of aggression. Investigators should attempt to minimize the number and duration of stressful experimental procedures mice are exposed to.

The information in this article was taken from: Male management: Coping with aggression problems in male laboratory mice. Van Loo PL, Van Zutphen LF, and Baumans V. *Laboratory Animals* (2003) **37**, 300-313.

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The MRI machine then directs radio frequency (RF) pulses toward the object within the tube. For the purposes of scanning biological material, RF pulses specific to hydrogen protons are used. The RF pulses cause some of the hydrogen protons within the object to spin at a particular frequency, in a particular direction. At the same time three small gradient magnets within the machine turn on and off rapidly to modify small sections of the main magnetic field. When the RF pulse is turned off, the hydrogen protons release energy that provides a signal that is sent to a computer system and converted into an image on film. Tissues of differing structure and composition within the object being scanned respond differently to the magnetic modifications and release different signals when the RF pulse is turned off. The variation in signals allows the computer to reconstruct images that provide detailed contrast between normal and abnormal tissue.

A major advantage of MRI over other imaging systems is its ability to create images of an object in any plane. In addition, the excellent contrast available with MRI allows visualization of tissue variations and abnormalities that is much enhanced compared to imaging systems such as computerized tomography and ultrasound. There are few side effects and/or hazards related to the magnetic field and RF pulses used in MRI. The main hazard associated with MRI lies in the strength of the magnet itself. Metal objects in the scan room will be pulled toward the magnetic resonance machine and can become dangerous projectiles. Many medical implants also contain metal and may be damaged or moved out of place when exposed to the magnetic field.

References:

1. How MRI Works. Gould TA. http://electronics.howstuffworks.com/mri.htm/printable
2. Magnetic Resonance Imaging - A Window into the Human Body. Feeney J. http://www.nimr.mrc.ac.uk/MillHillEssays/1996/mri.htm
3. Magnetic Resonance Imaging Nets Two the 2003 N http://faculty.washington.edu/chudler/nobel03.html

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The Visible Mouse Project (http://tvmouse.compmed.ucdavis.edu/) website presents images of mouse anatomy created by MRI and computerized tomography. The site includes QuickTime movies of whole mouse MRI slices and MRI slices integrated with histology sections of the same tissue. Pathology of genetically engineered mice is emphasized and a virtual mouse necropsy is available to guide viewers through the steps of a mouse necropsy.

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The Animal Resource Program (ARP) is committed to providing PSU faculty, staff and students with high quality, cost-effective research animal resources. In addition to suitable housing facilities and animal husbandry services for animals used in biomedical research, ARP provides veterinary and diagnostic services, personnel training and expertise in laboratory animal technology and medicine. ARP veterinarians are also available to participate in collaborative research projects with PSU investigators. Areas of interest include animal behavior and welfare, infectious disease, and pathology.

Rodent Surgery Workshop February 20, 2004

ARP will again be offering a Rodent Surgery Workshop from 1-4 pm on February 20, 2004 for interested graduate students, faculty and research staff. The workshop will be held in the CBL surgical suite. No prior surgical experience is necessary. To maximize the time class members have for surgical practice participants will be asked to view basic training materials on CD prior to the workshop.

Please call 865-1495 to register to attend. Attendance is limited to ten participants. Please register at least one week prior to the class date to allow time to view the CD training material. The CD's are available at the ARP office.