

The University of Pennsylvania's Institutional Animal Care and Use Committee ([IACUC](#)) is charged with ensuring that all surgical facilities and procedures meet the criteria set by the federal regulations, including the Animal Welfare Act ([AWA](#)), the Animal Welfare Regulations ([AWR](#)), and the Public Health Service Policy ([PHS](#)). The PHS requires institutions to comply with the performance-based standards in the *Guide for the Care and Use of Laboratory Animals* ([Guide](#)).

[AWR 2.31 \(d\)\(ix\)](#)

“Activities that involve surgery include appropriate provision for pre-operative and post-operative care of the animals in accordance with established veterinary medical and nursing practices. All survival surgery will be performed using aseptic procedures, including surgical gloves, masks, sterile instruments, and aseptic techniques.”

The purpose of this guideline is to clarify the requirements of the Principal Investigator (PI) and the Institution concerning surgical procedures performed on rodents. All investigators, laboratories, and facilities performing surgery (survival and terminal) on rodent species must adhere to the minimum standards addressed in this IACUC guideline. Species typically studied at Penn that are relevant to this guideline include: mice, rats, gerbils, guinea pigs, and hamsters. Surgery involving USDA rodents (hamsters, gerbils, guinea pigs and other non-*Mus* and non-*Rattus* rodent species) may follow most procedures as for mice and rats (e.g. facilities), but there are specific requirements that are more consistent with large animal species (e.g. aseptic technique, instruments, documentation); these specific requirements are highlighted below in each section.

This guideline offers direction on the following topics:

- Definitions
- Pre-surgical approval and assessment
- Requirements of a surgical area and preparation of the surgeon, animal, and surgical instruments
- Aseptic technique
- Anesthetics and analgesics
- Monitoring the anesthetized patient
- Anesthetic and postoperative recovery
- Terminal Surgery
- Recordkeeping

DEFINITIONS

Survival surgery: any surgical procedure performed where the animal is expected to recover from anesthesia.

Survival surgery can be further differentiated into major and minor. ([Guide](#))

Major survival surgery penetrates and exposes a body cavity, produces substantial impairment of physical or physiological functions, or involves extensive tissue dissection or transection (e.g. laparotomy, thoracotomy, limb amputation).

Minor survival surgery does not expose a body cavity and causes little to no physical impairment (e.g. wound suturing, peripheral vessel cannulation, percutaneous biopsy).

IACUC Guideline RODENT SURGERY

Multiple survival surgeries: the situation in which a single animal undergoes more than one survival surgery (animal receives a surgical procedure, is recovered, receives another surgical procedure, and is again recovered).

Non-survival/Terminal surgery: any procedure in which the animal is euthanized prior to recovery from anesthesia. Consciousness is never regained after the animal is initially anesthetized.

PRE-SURGICAL APPROVAL AND ASSESSMENT

Before performing surgery on any species, the PI must obtain IACUC approval of the research activity. Attaining approval to perform surgery is at least a three-step process:

1. The Institution, during the IACUC review process, evaluates the **surgical training qualifications** of all participants on protocols involving surgical procedures. The PI assures and describes personnel qualifications.

Prior to IACUC approval of protocols and/or amendments to add personnel, the “Regulations and the IACUC” and “Species Specific Training” and “Aseptic Technique” must be completed through [Knowledge Link](#) and documented for personnel listed. As additional surgical training opportunities become available they may be required by the Institution. The PI is responsible for ensuring that personnel involved with anesthesia induction, monitoring of an anesthetized animal, direct surgical manipulation, or other advanced techniques are adequately trained and receive additional training if necessary. Please see the [IACUC Policy for Training Requirements](#). If there are any questions about surgical training or scheduling, please contact ULAR Training (ULAR-tr@pobox.upenn.edu).

2. The IACUC provides **protocol approval** of the surgical project.

Any surgical protocol is specifically assigned to a veterinarian for review, in addition to the primary IACUC-designated review. This “vet review” emphasizes the surgical procedure itself, anesthesia and analgesia regimen, and completeness of pre- and post-surgical care plan.

The use of a single animal for multiple survival surgeries must be scientifically justified and essential for the research project. Protocols involving multiple survival surgeries are reviewed and approved on a case-by-case basis by the IACUC ([Guide](#)) ([AWR 2.31 \(d\)\(x\)](#)). As part of the “Survival Surgery” procedure in ARIES, please select “yes” for “Multiple survival surgery?” in the associated questions if at least one animal on the protocol undergoes multiple survival surgeries. Then provide an explanation or justification why multiple survival surgeries are necessary. If all animals assigned to the protocol will undergo just one survival surgery procedure, to be eventually followed by a terminal surgery or euthanasia, then select “no” for “Multiple survival surgery?” in the associated questions.

3. IACUC members evaluate the location and provide **surgical location approval** for rodent survival surgeries. Mouse and rat terminal surgery locations are initially approved by the Office of Animal Welfare compliance staff.

If all aspects of the surgical manipulation and care of the animal occur in a ULAR-operated facility (including pre, peri, and post-operative care), then approval of the protocol includes surgical location approval.

IACUC Guideline RODENT SURGERY

If the procedures are planned to be performed in a non-ULAR operated facility (such as lab space or satellite facility), then the protocol must include the specific room the procedures are to take place and a justification as to why a ULAR procedure room is unsuitable for the surgical procedure. The location must then be evaluated and approved by IACUC members. This site evaluation occurs independently of the IACUC protocol review process and must be specifically scheduled by the PI or senior research staff through contacting the Office of Animal Welfare (OAW) Compliance Staff at 215-898-2615.

No surgical procedures may be performed on an animal until the IACUC protocol and the surgical location have been approved. All personnel must be properly trained and listed on the IACUC protocol.

SURVIVAL SURGERY **REQUIREMENTS OF A SURGICAL AREA**

Survival surgery must be performed using aseptic technique in an approved surgery area containing space for surgical support, animal prep, surgeon's scrub, the operating area, and post-operative recovery. The area should be dedicated to surgery and related activities, and managed to minimize contamination from other activities conducted in the room at other times. These areas should be designed to minimize traffic flow and separate nonsurgical activities from the surgical procedure in the operating room. The separation is best achieved by physical barriers but may also be achieved by distance between areas or by the timing of appropriate cleaning and disinfection between activities ([Guide](#)). This area must be kept clean before, during, and after surgeries.

Separated Facilities

PIs and research staff are strongly encouraged to perform survival surgery in the main animal facility's procedure rooms. If performing survival surgery in a vivarium procedure room is not possible, then the following items should be considered for your laboratory space.

- The working surface (e.g. bench top, hood, etc.) and surrounding equipment (e.g. shelves, chairs, etc.) should be constructed of materials that are easily sanitizable.
- The specific surgical area should not be located under air vents to minimize contamination and reduce the risk of postoperative infection.
- The immediate area should not be cluttered or used for storage of equipment unrelated to the surgical procedure. Storage containers should be easily sanitizable. Cardboard and Styrofoam should be avoided.
- Surgery on rodents does not require a dedicated facility ([AWR 2.31](#)). Survival surgery, including those involving USDA rodents, may be performed in adequately organized and maintained laboratory areas, separated from other laboratory activities. This area should not be adjacent to a high traffic through way—an alcove or otherwise limited use area should be considered.

Surgical Support

Surgical support areas are intended for washing, sterilizing, and storing instruments and supplies ([Guide](#)). Sink areas should clean and free of rust. Instruments should be stored in suitable containers to keep them clean and in good condition. Laboratories must have the capability to sterilize surgical equipment, e.g. access to autoclaves, plasma sterilizers, etc.

IACUC Guideline RODENT SURGERY

Animal Preparation

Attention should be given to maintain a clean operating area at all times. Therefore, the preparation of the animal (e.g. clipping of fur, intubation, etc.) should not be done in the immediate operating area. There should be a separate but adjacent area where the animal will be physically prepared to undergo a surgical procedure. This area may double as a recovery area after conducting proper cleaning procedures.

Surgeon's Scrub

Surgeons and surgical assistants must wash their hands with an antibacterial soap prior to initiating the surgical procedure. To avoid contamination with aerosols released during scrubbing, this surgeon prep area should be separated from the operating area ([Guide](#)).

Operating Area

Operating areas must be kept clean; items that are not easily sanitized (e.g. rusty equipment, cardboard boxes, etc.) should not be in this area. The area should be sanitized between animals.

Minimize Contamination

"Inadequate or improper technique may lead to subclinical infections that can cause adverse physiologic and behavioral responses affecting surgical success, animal well-being, and research results" ([Guide](#)). The entire surgical area must be maintained in such a manner as to reduce risk of subclinical infections in the animal patient. Cleanliness is an essential and integral part of the surgical process. Standard operating procedures should be developed and used to ensure the surgical area is routinely cleaned and sanitized.

ASEPTIC TECHNIQUE

*"Aseptic technique is used to reduce microbial contamination to the lowest possible practical level and includes preparation of the **patient, surgeon, and instruments**"* ([Guide](#)). All survival surgical procedures should follow the general principles of asepsis, including the use of surgical gloves, mask, sterile instruments, and aseptic technique ([Guide](#), [AWR 2.31](#)).

Patient

How the surgeon or assistants will prepare the animal should be described in the "description" field of the [ARIES](#) Survival Surgery procedure. Preparing the animal for surgery is at least a two-step process:

1. Animal Preparation
 - Remove the hair (clip, depilatory cream) in a wide area around the intended surgical site.
 - Clean the hair and any other gross debris from the skin with an alcohol pad.
 - If clippers are used, please ensure any fur is removed and the clippers are cleaned after each day.
2. In the Operating Area
 - The animal must be properly secured to the operating table e.g. tying with gauze, umbilical tape, or other suitable restraint. "Pinning" (use of pins or hypodermic needles) of live animals for survival and non-survival surgeries is **PROHIBITED**.
 - Disinfect the area with appropriate surgical scrub. Iodophors (e.g. Betadine) or chlorohexidines (e.g. Nolvasan) should be used, and alternated with alcohol for three rounds of scrub. Alcohol alone is NOT an appropriate disinfectant.
 - Sterile drape should be placed over the animal. Transparent drapes are recommended in order to continuously monitor breathing. "Press 'n' Seal®" wrap may be used in place of a sterile drape. These have been shown to be nearly sterile when taken directly from the packaging, are clear to allow good patient monitoring and visualization, and help to support thermoregulation by creating a

IACUC Guideline RODENT SURGERY

sealed barrier around the patient ([UT-San Antonio](#)). Using this method, the surgical incision can be made directly through the wrap and patient's skin.

Surgeon and Surgical Assistant(s)

All personnel taking part in the surgery must:

- Wear clean lab coat, scrubs, or appropriate disposable gown.
- Wear appropriate face mask.
- Wash hands with antiseptic soap.
- Wear sterile gloves.
- Move carefully to avoid contamination of the surgical location.

Gloves must be replaced if aseptic technique is disrupted, e.g. touching the isoflurane vaporizer with the sterile gloves, moving the animal with sterile gloves, etc. With proper planning, simple survival rodent surgeries may be performed by one person. If this cannot be accomplished because of the complexity of the procedure, then in order to consistently maintain aseptic technique, there must be a surgical assistant or anesthetist who is trained to perform such tasks that would interfere with proper aseptic technique. If it is necessary for the surgeon to leave the surgical area during a procedure, then s/he must re-glove again before resuming surgery.

Instruments and surgical materials

It is extremely important to ensure that all instruments are appropriate for surgery

- All instruments must be cleaned and sterilized prior to the beginning of each surgical session. Alcohol alone is NOT a sterilant. Examples of methods of sterilization include steam autoclave, gas (e.g. ethylene oxide), and plasma sterilization.
- Cold sterilization (e.g. Cidex) of surgical instruments must strictly follow manufacturer instructions. The [FDA](#) lists specific cold sterilants and the necessary conditions to be considered a sterilant or a disinfectant. Rinse with sterile water or sterile saline before using on an anesthetized animal.
- For mice and rats, if instruments are to be used for multiple surgeries in a single session, they must be sterilized between animals. Hot bead sterilizers are recommended in these cases.
- For USDA rodents, just as in larger USDA species, a new pack of sterile instruments must be used for each animal. Hot bead sterilizers are not suitable, but consideration may be given to cold sterilization following the manufacturers' instructions. New autoclaved, gas sterilized, or plasma sterilized packs are should be used for each animal.
- Do **not** use dull or rusted surgical instruments or those not manufactured for surgical use.
- The use of expired surgical materials for survival surgeries is not consistent with acceptable veterinary practice or care ([NIH OLAW FAQ F.5](#)).

For any surgical procedure to be successful, steps must be taken to ensure that that the animal is properly prepared for surgery, the surgeons are outfitted appropriately, and the surgical instruments are sterilized.

ANESTHETICS AND ANALGESICS

When writing a procedure, one must provide appropriate relief of pain/distress while maintaining the integrity of the research. Every surgical IACUC protocol **must** describe a clear plan for providing **in-date, pharmaceutical grade injectable or inhalation anesthetics** and a description of how and when **analgesics** will be administered. In order to provide flexibility when performing the procedure, it is recommended to include more than one appropriate option for the anesthetic and analgesic regimens.

IACUC Guideline RODENT SURGERY

In-Date, Pharmaceutical Grade Compounds

“OLAW and the USDA agree that pharmaceutical-grade substances, when available, must be used to avoid toxicity or side effects that threaten the health and welfare of vertebrate animals...” ([NIH OLAW FAQ F.4](#)). Expired drugs or materials may not be used in any laboratory animals, and expired materials cannot be used, regardless of the species, for survival surgeries. See the IACUC [Policy on the Use of Expired Drugs and Materials in Laboratory Animals](#) and the IACUC [Policy on the Use of Non-Pharmaceutical Grade Compounds](#) for more details.

Injectable Anesthetics

Animals should be weighed prior to surgery to calculate the appropriate dose of anesthetics for the intended route of administration. Contact a [ULAR Veterinarian](#) or consult the [Mouse and Rat Anesthesia and Analgesia Recommendations](#) IACUC guideline for suggested drugs, doses, and route of administration.

Inhalation Anesthetics

Inhalant anesthesia is the preferred method of general anesthesia for rodents. Vaporizers must be used to deliver inhalant anesthetics to rodents. Anesthetics must be scavenged with appropriate devices or methods. Isoflurane vaporizers are available in most ULAR procedure rooms. Contact [ULAR Training](#) for assistance if personnel require training in using an anesthesia machine. Also, anesthesia machines should be maintained in good working condition and regularly recertified. Please refer to the IACUC Guideline for [Anesthetic Vaporizers & Gas Scavenging](#) for more information. **The use of bell jars is prohibited for delivering anesthetics for any surgical procedure.**

Analgesics

Surgery is considered a painful procedure; therefore **administration of analgesics is required for any animal that undergoes a surgical procedure**. Analgesics must be administered before an animal is expected to be painful, not after significant signs of pain are noted. The goal is to have every animal patient maintained post-surgically in a pain-free state. Animals given pre-operative analgesia often require less anesthetic to reach a surgical plane, and thus may be more stable anesthetic patients. Pre-emptive analgesia is recommended. The analgesic options available to investigators are very varied and certain drugs may provide better pain relief for patients undergoing certain procedures. Contact a [ULAR Veterinarian](#) or consult the [Mouse and Rat Anesthesia and Analgesia Recommendations](#) IACUC guideline for suggested drugs and doses that will best suit the surgical research model.

Animals must be anesthetized during any surgical procedure and be provided appropriate analgesics to be maintained in a pain-free state.

MONITORING THE ANESTHETIZED PATIENT

“Careful monitoring and timely attention to problems increase the likelihood of a successful surgical outcome” ([Guide](#)). Careful surgical monitoring includes **confirmation of anesthetic depth, maintenance of anesthesia, and monitoring of vital signs**. Animals must be continuously monitored and the observation must be documented every 10 minutes. Documentation of monitoring may not be necessary for procedures lasting less than 10 minutes.

IACUC Guideline RODENT SURGERY

Confirmation of Anesthesia Depth

The animal must be maintained at an appropriate depth of anesthesia beginning immediately before the surgical procedure is initiated, through the conclusion of the procedure, and until the post-operative analgesics should have taken effect. For most species, the following techniques can be used to ascertain that the animal is appropriately anesthetized. Multiple parameters should be interpreted together, as different drugs may affect these systems and responses differently.

- Toe pinch. Brief pinching of the web of skin between toes or claws with fingers. Firmly pinching multiple toes should not elicit a withdrawal response from an animal at a surgical depth of anesthesia.
- Palpebral reflex. Gently tapping the medial canthus of the animal's eye should not elicit a blink or eye flutter. This technique is not always reliable in all animals.
- Corneal reflex. Touching the edge of the cornea with a gauge sponge or cotton swab will produce a good reflex if the patient is too light on anesthesia. Movement of the eyelids is an indication that the depth of anesthesia is not sufficient to do surgery.
- Vital signs. Heart rate and respiratory rate may increase if anesthetic depth becomes too light.

Maintenance of Anesthesia

Each animal responds slightly differently when under anesthesia, therefore it may be necessary to modify your use of anesthetics during the procedure. ***All routinely used anesthesia options must be described in the IACUC protocol.*** Anesthetists must be trained in not only delivering the anesthetic to the patient, but also in identifying anesthetic related problems.

- Increases and decreases in vital signs may require modifications in anesthetic dosing.
- If, at any time, an animal begins to respond to pain or attain an anesthetic depth that is too light, stop the procedure and adjust the inhalant anesthetic level or give a supplemental dose of injectable anesthetics. Re-confirm anesthetic depth before resuming work.
- Animals must be continually monitored by the anesthetist providing appropriate anesthesia and life support for the duration of the procedure. ***Anesthetized animals should NEVER be left alone during the procedure.***
- In order to maintain sterility during complex surgical procedures and to properly monitor the animals, it may be necessary to include a second person in the procedure—a surgical assistant or anesthetist.

Monitoring Vital Signs

The anesthetist should continuously monitor the animal patient's basic physiological function for the duration of the procedure—from induction through recovery. The following vital signs should be monitored during all procedures involving mice, rats, hamsters, and gerbils (see [Rodent Anesthesia Record Template](#) for a suggested template):

- Respiratory Rate (RR) can be assessed by watching the rising and falling of the chest. Subjective changes should be addressed by alter the depth of anesthesia.
- Body temperature should be maintained near normal during surgical procedures.
 - Hypothermia often occurs due to anesthesia-induced vasodilation and from surgery via opened body cavities.
 - During any surgical procedure, the animal's body temperature should be maintained by a heat lamp, a [covered] recirculating water heating pad or forced-air warming (Bair-Hugger).
 - [ULAR Veterinarians](#) may assist in choosing an appropriate method for your species.

Guinea pigs' (and other USDA covered rodents') vital signs should be documented using the [ULAR anesthesia sheet](#), or a similar template, including heart rate (HR), RR, and body temperature every 5-10 minutes. Pulse oximetry is recommended.

IACUC Guideline RODENT SURGERY

Please see Appendix 1 for normal vital signs of unanesthetized laboratory rodents.

A well-trained anesthetist with experience with the species under investigation must continuously monitor the animal's vital signs and maintain the surgical patient at an appropriate plane of anesthesia throughout the surgical procedure.

ANESTHETIC AND POSTOPERATIVE RECOVERY

*“An important component of postsurgical care is observation of the animal and intervention as necessary during recovery from anesthesia and surgery. The intensity of monitoring will vary with the species and the procedure and might be greater during the **immediate anesthetic recovery** period than the **postoperative recovery** period.”* ([Guide](#)).

Immediate Recovery Period

“Particular attention should be given to thermoregulation, cardiovascular and respiratory function, and postoperative pain or discomfort during recovery from anesthesia” ([Guide](#)). The immediate recovery period may last from minutes to hours.

- Animals should be placed into a clean recovery area (with clean paper towel on bedding) in sternal or lateral recumbency. Sternal recumbency is preferred.
- During anesthetic recovery, the animal's body temperature should be supported with an appropriate, well-maintained heating device (e.g. recirculating water heating pad, or heat lamp). To avoid burning, be cautious that the heating device is not too hot or too close to the animal. If a heat lamp is used, the rodent cage should be covered with a solid lid (e.g. microisolator top). There should always be a cooler location in the enclosure to which the animal can escape if they become too warm.
- Recovering animals should not be in the enclosure with awake animals.
- Personnel monitoring recovery of animals must remain in the same room as the animals at all times. Only when animals have regained all postural reflexes and are ambulatory (can walk well on their own) should they be left alone in their regular, freshly-cleaned housing. ***Animals must be specifically assessed at least every 10 minutes until they have completely recovered from anesthesia.***
- Recovered animals must be returned to the facility housing room when alert and active.

Long Term Recovery Period

“After anesthetic recovery, monitoring is often less intense but should include attention to basic biologic functions of intake and elimination and behavioral signs of postoperative pain” ([Guide](#)). Depending on the surgical procedure, the postoperative recovery period may last from days to weeks.

- During the post-surgical period, animals must be appropriately monitored for signs of pain and/or distress. In most species, signs of pain include decreased activity, abnormal posture, increased attention to surgical site, and gait abnormalities.
- The cardinal signs of infection including heat, swelling, redness, pain, and/or exudation. Consult a [ULAR Veterinarian](#) for any abnormal medical condition.
- The frequency and length of observation may depend on the degree of invasiveness of the procedure and the individual animal. A written plan of observation must be outlined in the IACUC protocol for each procedure proposed. The IACUC recommends the PI or the lab staff ***observe animals at least daily for a minimum of three days*** following major procedures.
- The IACUC protocol must fully and clearly describe the clinical signs expected to be observed following the surgical procedure and the **humane endpoints** that may necessitate euthanasia or other removal

IACUC Guideline RODENT SURGERY

from the study. Please refer to the IACUC guideline [Monitoring and Humane Endpoints for Laboratory Animals](#) for more information.

- If the health of the animal is questionable, a ULAR veterinarian should be notified for treatment recommendations.
- The attending veterinarian or designee retains the authority to change post-operative care as necessary to ensure the comfort of the animal ([USDA Policy #3](#)). The IACUC supports the professional judgment of ULAR veterinarians. The Attending Veterinarian has direct or delegated program authority and responsibility for activities involving all animals at the institution as defined under the Animal Welfare Act and PHS policy. At Penn, the Attending Veterinarian is the Director of ULAR.
- The IACUC requires that peri/preoperative and postoperative analgesics are used for all major invasive procedures, and for any procedures that have the potential for causing pain in laboratory animals ([USDA Policy 11](#)). Contact a [ULAR Veterinarian](#) or consult the [Mouse and Rat Anesthesia and Analgesia Recommendations](#) IACUC guideline for recommended analgesic agents.

After surgery, animals must be monitored and given appropriate veterinary treatment during anesthetic and postoperative recovery.

TERMINAL SURGERY

For non-survival surgery on most mice and rats, the use of aseptic technique and dedicated facilities are encouraged, but not required. **At a minimum, the surgical site should be clipped, the surgeon should wear gloves, and the instruments and surrounding area should be clean.** Terminal surgeries not performed in a dedicated ULAR facility must be performed in a clean area, free of clutter, and using sanitary practices. For non-survival procedures of extended duration, attention to aseptic technique may be more important in order to ensure stability of the model and a successful outcome ([Guide](#)).

Please see the above sections for [anesthetics and analgesics](#), and [monitoring the anesthetized patient](#), as these still apply in terminal procedures.

- Expired drugs and materials may be used for terminal procedures, however, **expired anesthetics, analgesics, or euthanasia solutions may not be used at any time for non-survival surgery.** Pharmaceutical grade substances are expected to be used if available, even in terminal procedures. ([USDA Policy #3](#))
- A surgical plane of anesthesia must be confirmed prior to initiating the procedure and must be maintained for the duration of surgery until the animal is euthanized.
- Monitoring must be documented every ten minutes for all surgical procedures including terminal procedures. Documentation of monitoring may not be necessary for procedures lasting less than ten minutes. Monitoring should include confirmation of anesthetic depth, induction/maintenance of anesthesia, and monitoring of vital signs. For terminal procedures, the monitoring document must also include the method of euthanasia, consistent with the current [AVMA euthanasia guidelines](#), and the method of confirmation of death.

RECORDKEEPING

The [USDA](#) and [PHS](#) require proper documentation of animal care and use to assess compliance with research protocols and clinical care procedures. Surgical records for rodents may be kept in laboratory notebooks, binders, or computer databases. Please ensure the following records are legible, organized, and available upon request. A group of mice, rats, gerbils, and hamsters may be documented on a single surgical record. Guinea

**IACUC Guideline
RODENT SURGERY**

pigs should have individual surgical and post-operative records. Associated with this guideline are templates of acceptable logs for surgical and postoperative documentation.

- Surgical or procedural records. These should include the protocol number, animal identification, date of surgery, surgeon’s initials, weight of animal prior to surgery, anesthesia and dose, procedure title or brief description, any deviations from the approved procedure (i.e. supplemental doses of anesthetics), pre- or intra-operative analgesics, and the time returned to the facility.
- Post-operative records. These should include the protocol number, animal identification, and initials of individuals making observations, date of observation, a comment on the general condition and health of animal, analgesics and/or other medications given. The specific date, time, and amount (in mg) of the analgesics administered should be written into the animal’s (or group’s) post-op record.
- For either survival or terminal surgeries, the Rodent Anesthesia Record Template is available on the IACUC website and may be modified to meet the needs of the study. Terminal surgical records must also include the method of euthanasia and confirmation method (i.e., exsanguination, bilateral thoracotomy, etc.).

Appendix 1. **Vital signs for common rodent laboratory animal species (ACLAM 2002) under normal and anesthetized conditions.** Heart rate and respiratory rate in an anesthetized animal will vary depending on the method of anesthesia.

SPECIES	TEMPERATURE	RESPIRATORY RATE	HEART RATE
MICE	96.6 - 99.7 F (35.8 - 37.4 C)	90 - 220 per minute	328 - 780 per minute
RATS	96.6 - 99.5 F (35.9 - 37.5 C)	66 - 144 per minute	250 - 600 per minute
GUINEA PIGS	98.6 - 103.1 F (37 - 39.5 C)	42 - 104 per minute	230 - 320 per minute
HAMSTERS	98.6 - 100.4 F (37 - 38 C)	35 - 120 per minute	250 - 600 per minute
GERBILS	96.3 - 102.7 F (35.7- 39.3 C)	70 - 120 per minute	260 - 600 per minute

Mouse Respiratory Rate and Heart Rates under different anesthetics		
Anesthetic	Respiratory Rate	Heart Rate
Isoflurane	42-92 per minute	474-578 per minute
Ketamine/Xylazine/Acepromazine	189-229 per minute	264-336 per minute