IACUC Guidance:	**TAMU-G-002**	Title:	**Guidelines on the use of Anesthesia and Analgesia**

Location	Effective Date	Review By
College Station/Dallas/Galveston/Kingsville	01/01/2025	12/31/2027
Houston	07/01/2022	03/31/2025

1. PURPOSE

1.1. To minimize pain and distress through the appropriate use of anesthetics and analgesics.

2. SCOPE

2.1. Applies to vertebrate animals used for research, teaching, or other related purposes under the oversight of the Texas A&M University IACUC.
2.2. Describes use of anesthetics and analgesics for research or teaching activities exclusive of clinical care.
2.3. The safe use of inhalant anesthesia, including machine calibration is discussed elsewhere. See TAMU-G-003.
2.4. Immersion anesthesia (MS222) is discussed elsewhere. See TAMU-G-021.
2.5. Performance of surgery is discussed elsewhere. See TAMU-G-013, TAMU-G-018, TAMU-G-022, TAMU-G-035 and/or TAMU-G-049, as applicable.

3. RESPONSIBILITY

3.1. The **PI should** consult the AV, or designee, regarding the selection of anesthetic agents/doses, as well as the plan for analgesia.
3.2. The **PI** is responsible for assuring the administration of drugs as indicated in the approved protocol.
3.3. The **PI** is responsible for assuring that research personnel receive appropriate training prior to performing any procedure.
3.4. The **AV** together with the **IACUC** will carefully evaluate any proposed use of neuromuscular blocking drugs.

4. DEFINITIONS AND/OR ACRONYMS

4.1. **Analgesia**: Provision of pain relief without loss of consciousness.
4.2. **Anesthesia**: Temporarily induces loss of sensation with or without loss of consciousness. Typically, does NOT provide adequate post-procedural pain relief.
4.3. **AUP:** Animal Use Protocol. Document submitted by the PI indicating the housing and procedures involving animals.
4.4. **AV:** Attending Veterinarian. Individual designated by Texas A&M University to fulfil the regulatory role of AV. May also describe veterinary staff who report directly to, and have delegated authority from, the AV.
4.5. Centrally administered support service for animal research and teaching programs at Texas A&M University:
  4.5.1. **ARU:** Animal Resource Unit supports the College of Dentistry vivarium
  4.5.2. **CMP**: Comparative Medicine Program supports the Texas A&M College Station campus
  4.5.3. **PAR:** Program for Animal Resources supports the Institute of Biosciences and Technology vivarium
  4.5.4. **PRF:** Pharmaceutical Research Facility supports the Kingsville Pharmaceutical Science Facility
  4.5.5. **Sea Life:** The Sea Life Facility supports the Galveston campus
4.6. **Hypoglycemia:** Metabolic condition in which blood sugar (glucose) concentrations fall below species-specific levels necessary to achieve homeostasis, with outcomes ranging from mild abnormalities to life-threatening emergency.
4.7. **Ileus:** Failure of the passage of intestinal contents, either mechanical (obstructive) or functional (paralytic). Can occur commonly after abdominal surgery, particularly when the intestines have been manipulated.
4.8. **Local Anesthesia:** Is a loss of sensation in a circumscribed area.
4.9. **Multimodal Anesthesia/Analgesia**: The administration of two or more anesthesia/analgesic drugs, that act by different mechanisms. Multi-modal regimens are designed to maximize the desired effects while minimizing those undesirable side effects that occur with over-reliance on a single agent.

4.10. **NSAID**: Nonsteroidal anti-inflammatory drug. Therapeutic drug class which reduces pain, decreases inflammation, decreases fever, and prevents blood clots.
4.11. Pharmacokinetic: The study of what the body does to the drug. This includes the movement of drug within the body from absorption, distribution, metabolism to elimination.
4.12. Pharmacodynamics: The study of what the drug does to the body. This includes the effects of the drug and mechanism of action.
4.13. **Preemptive Analgesia**: The administration of preoperative and/or intraoperative analgesia that is intended to take effect before the experience of pain.
4.14. **SAP:** Standard Administrative Procedure
4.15. **Surgical Anesthesia:** Is the stage/plane of general anesthesia that provides unconsciousness, muscular relaxation and analgesia sufficient for painless surgery.
4.16. **Transdermal Analgesia**: The delivery of pain relief through the skin surface.
4.17. **Tranquilization**: Is a state of behavioral change, wherein anxiety is relieved and the patient is relaxed (although aware of its surroundings).
4.18. **VVC:** Veterinary Verification and Consultation. Process by which the AV or designee confirms adherence to approved IACUC SOPs or Guidance documents. Does not apply to the Houston animal program.

5. GUIDELINES OR PROCEDURE

5.1. Selection of agent(s) depends on many factors.
5.1.1. The ideal anesthetic/analgesic regimen will:
5.1.1.1. Provide preemptive analgesia
5.1.1.2. Provide pre-procedural tranquilization as appropriate for the species.
5.1.1.3. Include the administration of an anticholinergic to protect cardiovascular function during anesthesia, as needed.
5.1.1.4. Be precisely titratable to assure that animals receive adequate anesthesia to block pain sensation, and/or to produce unconsciousness, and to produce immobility without experiencing hemodynamic instability or life-threatening anesthetic overdoses.
5.1.1.5. Not interfere with the study that the animals are on.
5.1.1.6. Not result in excessive undesirable post-operative side-effects.
5.1.1.7. Not cause pain or distress on induction or recovery.
5.1.1.8. Be compatible with available equipment and available medications.

5.2. Drug Doses and Frequency of Administration
5.2.1. Anesthetics are always titrated to effect. It is not acceptable to conduct surgical procedures unless the animal is fully anesthetized.
5.2.2. Drugs must be listed in the protocol with approximate dose ranges (e.g. 2.0-3.5 mg/kg), frequency and routes of administration, and frequency and method of monitoring.
5.2.3. For analgesia, note that “analgesia as needed” is not acceptable and that details concerning frequency and monitoring must be provided in the AUP.
5.2.4. Caution is required for overnight pain management.
5.2.4.1. Consider long-acting analgesia such as extended-release formulations
5.2.4.2. Consider multimodal analgesia
5.2.4.3. Consult the AV (or designee) for species specific recommendations

5.3. Manipulating the drinking water to deliver analgesia is discouraged:
5.3.1. Providing analgesic in the drinking water as the only source of analgesia is discouraged. Analgesics may change the taste and consistency of the water causing the animals to reduce the amount of water consumed leading to dehydration and limited consumption of the pain medication.

5.3.2. Rodents drink the majority of the water consumed in the dark cycle and the painful procedure may have occurred many hours previously leading to a large gap in comfort.
5.3.3. Analgesics should not be provided in the water of group housed animals.

5.4. Procedural Analgesia Examples

Procedural Pain	Examples	Frequency of Analgesic Administration	Analgesic Recommendation
Mild	Punch biopsy	Once	Local anesthetic +/- NSAID
Moderate	Craniotomy	24 hours	Local anesthetic + NSAID or Opioid
Severe	Laparotomy	3 days	Local anesthetic with both NSAID and Opioid

5.5. Anesthesia
5.5.1. A proper method of anesthesia must be selected based on veterinary consultation and protocol approval must be obtained.
5.5.2. Generally, inhaled anesthetics (e.g., isoflurane) are recommended for long procedures that would otherwise require multiple administrations of an injectable anesthetic (e.g., ketamine/xylazine).
5.5.2.1. Appendix 1 indicates doses for a variety of species; however, doses can vary widely, as pharmacokinetic and pharmacodynamics information may be limited, and drug effects can vary further with sex and strain in some species. Consult with the AV or designee for assistance.
5.5.3. Recently shipped animals should be given a period to acclimate to their new surroundings. General practice is to allow a 3-7 day acclimation period before initiating an anesthetic event.
5.5.4. Perform a pre-anesthetic evaluation to ensure the animal is healthy before anesthesia administration.
5.5.4.1. Obtaining an accurate weight is essential for appropriate drug administration,
5.5.5. Anesthesia may require pre-procedural fasting, as appropriate for the species and as indicated in the approved AUP. Consult with the AV (or designee) for species-specific info.
5.5.6. Anesthesia should be complete, resulting in loss of consciousness (unless local anesthesia only), hyporeflexia, and muscle relaxation with lack of response to painful stimuli.
5.5.7. Paralytic drugs are not anesthetics and may **not** be used without anesthesia. See TAMU-G-011 Guidelines on the Use of Neuromuscular Blockers
5.5.8. Euthanasia solution is only to be used during humane termination of an animal's life. Any other use is contrary to the label instructions. **Euthanasia solution is not to be used as an anesthetic** for survival or non-survival procedures, unless justified in the AUP and approved by the IACUC.

5.6. Drug Administration Record(s)
5.6.1. Administration of all drugs (dose, route, frequency) must be recorded. Depending on the species, records may be kept in the animal's individual medical record, or in laboratory records and on postoperative cage cards provided by CMP/ARU/PAR/PRF.
5.6.2. Any animal undergoing sedation or anesthesia must have an anesthetic record (excludes momentary pain and distress ameliorated by topical anesthesia such as EMLA cream prior to venipuncture, or topical ophthalmic anesthetic prior to assessment of intraocular pressure).
5.6.3. Where surgical procedures are performed, the anesthesia and surgical records may be combined to fulfil expectations for both anesthesia and surgical record keeping.
5.6.4. The anesthetic record should minimally contain:
5.6.4.1. Date, Protocol Number, Name/Type of Procedure, Species and Animal (or cage identifier)
5.6.4.2. Anesthetist's name(s) and name(s) of any assistants
5.6.4.3. Completion of a pre-anesthetic evaluation
5.6.4.4. All Drugs administered: Name of drug, dose, route and frequency of administration
5.6.4.4.1. When DEA controlled substances are used, the anesthetic record and the controlled substance logs should match.

5.6.4.5. Indication of anesthetic depth prior to painful procedure(s)
5.6.4.6. Event times or total time under anesthesia
5.6.4.7. A notation of any complication or abnormalities identified
5.6.4.8. Method and time of euthanasia (if applicable).
5.6.4.8.1. Note: For catastrophic complications under an anesthesia (that results in loss of consciousness), include an AVMA-approved method of euthanasia (in the approved protocol) that can be carried out without recovery from anesthesia
5.6.5. For sedation/anesthetic events of more than 15-minute duration, the record should also include anesthesia monitoring parameters.
5.6.5.1. The goal of anesthetic monitoring should be to maintain cardiovascular homeostasis and core body temperature.
5.6.5.2. Assessment of the animal's physiologic condition and plane of anesthesia must occur at least every 15 minutes throughout the procedure and be documented in the anesthesia record.
5.6.5.3. At a minimum, anesthetic depth, heart rate, and respiratory rate should be recorded (unless collection of such data are not appropriate for that species).
5.6.5.4. Anesthetic depth may be monitored in a number of ways (*e.g.*, respiration rate, corneal reflex, absence of a response from painful stimuli) and may vary depending upon the species and anesthetic agent used.
5.6.5.5. Parameters that may be monitored during anesthesia include (as specific to the species):
5.6.5.5.1. Response to painful stimuli (e.g. toe pinch)
5.6.5.5.2. Body temperature
5.6.5.5.3. Heart rate
5.6.5.5.4. Respiratory rate
5.6.5.5.5. Oxygen saturation
5.6.5.5.6. Color of mucous membranes
5.6.5.5.7. The following may also be monitored for rabbits and larger species:
5.6.5.5.7.1. Expired CO2
5.6.5.5.7.2. Capillary refill time
5.6.5.5.7.3. Jaw tone
5.6.5.5.7.4. Palpebral reflex

5.7. Commonly Used Anesthetics and Analgesics:
5.7.1. See Appendix 1 for species specific recommendations

5.8. Hypothermia
5.8.1. Mouse and rat pups up to 6 days of age may be anesthetized by hypothermia when inhalant anesthetic is not feasible.
5.8.1.1. Hypothermia induction: Place the pup in a latex/nitrile glove finger (or similar barrier) and immerse the glove finger in crushed ice and water (2-3°C or 35-37°F) up to the level of the head so that the head of the pup is visible. Anesthesia induction takes 5-8 minutes.
5.8.1.2. Remove the pup from the ice bath and place on a re-freezable ice pack. A piece of gauze or cloth should prevent direct contact of the pup's skin with the freezable ice pack. Duration of anesthesia on an ice pack is 15 minutes maximum.

5.9. Sedation/Anesthetic Recovery
5.9.1. Ensure uneventful recovery from sedation/anesthesia by performing continuous observation of the animal until it has righted itself (becomes sternal) and is ambulating or swimming normally.
5.9.2. Ensure animal recovery environment doesn't pose risk of injury:
5.9.2.1. Provide soft resting surface (if applicable to species)
5.9.2.2. Rodents recovering in cages, should have the cage placed half on/half off the heat source.

5.9.3. For recovery from hypothermia, rapid warming should be avoided. Pups can be placed in a small incubator (32-35°C or 90-95°F) for gradual warming over 20-30 minutes. Once warmed for this time, circulating warm water blankets can be used until mobile where complete recovery takes 30-60 minutes. Once mobile, pups may be mingled with the litter to aid in covering the procedure smells on the pup then the litter returned to the dam.

5.10. Supportive Care Includes:

5.10.1. Keeping the animal warm and dry (if applicable to species).

5.10.1.1. Thermoregulatory support is expected during anesthesia and recovery for procedures resulting in loss of consciousness lasting longer than 15 minutes (as appropriate per species and location), unless otherwise approved in the AUP.

5.10.1.2. **CAUTION**: Use of heat lamps and non-thermoregulating electric heating pads can result in severe burns or hyperthermia in animals. The use of safer equipment such as a circulating water blanket or isothermic pad is required, unless otherwise described in the approved AUP.

5.10.2. Fluid administration while under anesthesia and during recovery as specified in the AUP or as directed by the AV/designee

5.10.3. Ensuring a full recovery from anesthesia. Where applicable to the type of anesthesia, this includes return of consciousness, return of reflexes, (including the ability to protect the airway), sternally recumbent or ambulatory, stable vital signs, able to eat/drink, safe in the environment, and comfortable (adequate analgesia and nursing care per protocol).

5.10.4. Keeping animals recovering consciousness isolated in a dark, quiet area. Animals may be returned to the housing area after fully recovered from anesthesia with appropriate signage on the cage/stall/pen/tank etc. indicating they have been anesthetized.

5.10.4.1. It is recommended that the animals be monitored for an **additional** 30 minutes (after regaining consciousness) before being returned to the animal housing room.

5.10.5. For recovery from local anesthesia (without loss of consciousness):

5.10.5.1. Ambulatory animals may be returned to the original housing area after fully recovered from the procedure with appropriate signage on the cage/stall/pen/tank etc. indicating they have been anesthetized. Monitor animals once returned to standard housing for an additional 30 minutes after conclusion of the procedure conducted under local anesthesia.

5.10.5.1.1. Where possible, it is recommended that recovered animals having undergone local anesthesia be monitored in a sick pen, or similar, for an **additional** 30 minutes, before being returned to the herd.

5.10.6. Timely wound care, as specified in the protocol or as directed by the AV/designee

5.10.7. Providing supplemental, highly palatable foods or treats post-procedurally

5.10.8. Provision of timely analgesia administration as described in the approved AUP, or provided by the AV or designee.

5.11. Chronic Pain

5.11.1. Can be more challenging to alleviate than post-procedural pain.

6. RECORDS

6.1. Research records, including drug administration records, must be maintained consistent with Texas A&M University Standard Administrative Procedures (SAPS) 15.99.03.M1.03. and 29.01.03.M0.01

7. EXCEPTIONS

7.1. The PI may request an exception to the above standards by describing the departure in the AUP

7.2. For programmatic exceptions, the facility director or manager may submit a request for the exception using TAMU-F-013

7.3. **NOTE**: Requests for exceptions to thermoregulatory requirements to allow for the use of "less safe" technology must include a description of continuous observation of the animal and address how the temperature will be monitored to ensure the safety of the animal.

8. REFERENCES, MATERIALS, AND/OR ADDITIONAL INFORMATION

8.1. References:

8.1.1. Carpenter, J.W. (2005). Exotic Animal Formulary. (3rd Ed.). Philadelphia, PA: Elsevier Saunders.
8.1.2. Foley et al. Clinical Management of Pain in Rodents. Comp Med 2019
8.1.3. Oakleaf, M. & K. Mama. (2020) Clinician's Brief. Anesthesia Considerations in Small Mammals.
8.1.4. Schlapp G et al. Administration of the nonsteroidal anti-inflammatory drug tolfenamic acid at embryo transfer improves maintenance of pregnancy and embryo survival in recipient mice. J Assist Reprod Genet. 2015;32(2):271-275.
8.1.5. Thurmon, J.C., Tranquilli, W.J., Benson, G.J. (Editors). (1996). Lumb and Jones' Veterinary Anesthesia, 3rd Edition. Baltimore, Maryland: Williams & Wilkins.
8.1.6. Hawk, C.T., Leary, S., & Morris, T. (2005). Formulary for Laboratory Animals. (3rd Ed.). Ames, Iowa: Blackwell Publishing
8.1.7. Principles and Practice of Veterinary Technology, Fourth Edition: Margi Sirois (2017)
8.1.8. Regulatory Considerations for Using Pharmaceutical Products in Research Involving Laboratory Animals 2015. https://olaw.nih.gov/sites/default/files/150604_seminar_transcript.pdf

8.2. Resources:

8.2.1. For more information the selection and use of anesthesia and analgesia, please contact:
8.2.1.1. CMP at (979) 845-7433
8.2.1.2. ARU: at (214) 828-8149
8.2.1.3. PAR: at (713) 677-7471
8.2.1.4. PRF: at (361) 221-0770
8.2.1.5. Sea Life Facility : at (409) 740-4574

8.3. Texas A&M University Standard Administrative Procedures (SAPs)

8.3.1. 15.99.03.M1.03 The Responsible Stewardship of Research Data
8.3.2. 29.01.03.M0.01 Security of Electronic Information Resources

8.4. IACUC/AWO Documents

8.4.1. TAMU-F-013 Request for Programmatic Exception from Animal Welfare Standards
8.4.2. TAMU-G-003 Guidelines for the Safe Use of Inhalant Anesthesia
8.4.3. TAMU-G-011 Guidelines on the Use of Neuromuscular Blockers
8.4.4. TAMU-G-013 Guidelines for Survival Surgical Procedures in Rodents
8.4.5. TAMU-G-018 Guidelines for Survival Surgical Procedures in Non-Rodent Mammals
8.4.6. TAMU-G-021 Guidelines for Preparing MS222
8.4.7. TAMU-G-022 Guidelines on the Performance of Non-Survival Surgery
8.4.8. TAMU-G-035 Guidelines for Performing Surgery in Fish
8.4.9. TAMU-G-049 Guidelines for Performing Surgery in Amphibians and Reptiles

8.5. Resources:

8.5.1. TAMU-F-006 Non-Surgical Anesthesia record
8.5.2. TAMU-F-010 Non-Surgical Analgesia Record

8.6. Acknowledgement

8.6.1. The document was partially adapted using materials from the University of Colorado, California, Berkeley, Boston, Kentucky, and West Virginia Universities.

9. HISTORY

Effective Date	Version #	Description
07/18/2019	000	College Station/Galveston: New format and updated content. Replaces previous draft document entitled, "Anesthesia and Analgesia" 6-20-2013
12/16/2019	001	Houston/Kingsville: New format and updated content. Replaces IBT-222
01/21/2020	002	Dallas: New format and updated content. Replaces CD-222
03/24/2022	003	College Station/Dallas/Galveston: Merging of Dallas animal care and use program with College Station/Galveston
04/01/2022	004	College Station/Dallas/Galveston: Renewal; updated Definitions, References & Formulary. Added Resources, exceptions section, hypothermia, recovery descriptions and clarified recordkeeping expectations. Reviewed and approved via email.
05/01/2022	005	Houston/Kingsville: Renewal; updated Definitions, References & Formulary. Added Resources, exceptions section, hypothermia, recovery descriptions and clarified recordkeeping expectations. Reviewed and approved via email.
07/01/2022	006	College Station/Dallas/Galveston: Clarification related to use of muscle relaxants. Reviewed and approved via email.
07/01/2022	007	Houston/Kingsville: Clarification related to use of muscle relaxants. Reviewed and approved via email.
10/20/2022	008	College Station/Dallas/Galveston/Kingsville: Merging of Kingsville animal care and use program with College Station/Dallas/Galveston.
01/01/2025	009	College Station/Dallas/Galveston/Kingsville: Renewal; updated scope, responsibility, definitions and references sections; addition of records section; updated appendix 1 to clarify use of isoflurane for open-drop method. (NOTE: changed items In current version have only been approved by the College Station/Dallas/ Galveston/Kingsville IACUC.)

Appendix 1: Anesthetic and Analgesic Formulary

These charts are adapted from Anesthesia and Analgesia in Laboratory Animals 2nd Edition (2008), Exotic Animal Formulary 4th Edition (2012), and Laboratory Animal Anesthesia 3rd Edition (2009)

Contact the AV (or designee) for assistance with species, drugs, doses, and routes of administration not described in the tables below.

Rodent Anesthesia: In order of preference (*=controlled substance) (npg=non-pharmaceutical grade)

Agent	Species	Dose Range	Route of Admin	Considerations
Isoflurane	Mice	4% induction 0.5-2.5% maintenance Open-drop method: 20%v/v isoflurane in propylene glycol	Inhaled	Quick recovery and induction, able to closely control plane of anesthesia Open-drop method: Use of isoflurane anesthesia without propylene glycol dilution is unacceptable, as the vapor pressure of isoflurane will lead to lethal accumulations of anesthetic in the vapor phase.
	Neonatal mice	2-4% induction 0.5-2.5% maintenance	Inhaled	
	Rats	4% induction 0.5-2.5% maintenance Open-drop method: 30%v/v isoflurane in propylene glycol	Inhaled	
Sevoflurane	Mice	5% induction 2-2.5% maintenance	Inhaled	Quick recovery and induction, able to closely control plane of anesthesia
	Rats	5% induction 2-2.5% maintenance	Inhaled	
Ketamine*/Xylazine	Mice	90-150mg/kg (K) and 7.5-16mg/kg (X)	IP	20-30 min anesthesia Bradycardia, Xylazine is reversible Good for long term procedures such as imaging
	Rats	40-80 mg/kg (K) and 5-10 mg/kg (X)	IP	
Ketamine*/Xylazine/ Acepromazine	Mice	100mg/kg (K) and 2.5mg/kg (X) and 2.5mg/kg (A)	IP	20-30 min anesthesia Bradycardia, Xylazine is reversible Rapid, long acting sedation and analgesia

Agent	Species	Dose Range	Route of Admin	Considerations
Ketamine*/Medetomidine	Mice	50-75mg/kg (K) and 1-10mg/kg (M)	IP	Light anesthesia 20-30 min Medetomadine is reversible Good for restraint for minor procedures
	Rats	60mg/kg (K) and 0.4mg/kg (M)	IP	
Ketamine*/Midazolam*	Mice	100mg/kg (K) and 5mg/kg (M)	IP	Light anesthesia 20-30 minutes Midazolam is reversible
	Rats	75mg/kg (K) and 5mg/kg (M)	IP	
Ketamine*/ Diazepam*	Mice	100mg/kg (K) and 5mg/kg (D)	IP	Light anesthesia 20-30 minutes Minimal respiratory cardiovascular depression, Diazepam is reversible
	Rats	40mg/kg (K) and 5mg/kg (D)	IP	
Fentanyl*/Medetomidine	Rats	300ug/kg (F) and 200ug/kg (M)	IP	60-70 min anesthesia, Good muscle relaxation, Reversible
ACCEPTABLE WITH JUSTIFICATION				
Sodium pentobarbital*	Mice	30-90mg/kg	IP	Minimal analgesic effects, narrow safety margin
	Rats	30-60mg/kg	IP	
Thiobarbital (Inactin)*[npg]	Mice	80mg/kg	IP	60-240 min anesthesia, variable response seen between different strains
Thiopental	Mice	30-40mg/kg	IV	5-15 min anesthesia. Irritant if injected IP
	Rats	30mg/kg	IV	
2,2,2 Tribromoethanol (Avertin)[npg]	Mice	240mg/kg	IP	15-45 min anesthesia, rapid recovery, decomposition of stored solutions can result in severe IP irritation, peritonitis, abdominal adhesion can form
Chloral hydrate[npg]	Mice	400mg/kg	IP	Light anesthesia for 30min, poor analgesic properties, post anesthetic ileus, used in pharmacological studies
	Rats	400mg/kg	IP	
α chloralose[npg]	Mice	100-120mg/kg	IP	Non recovery only. stable, long lasting light anesthesia, prolonged induction and recovery, little analgesia, minimal cardiovascular and respiratory effects, used in physiologic experiments
Ethyl carbamate (Urethane) [npg]	Mice	1000mg/kg	IP	Non recovery only 360-480 min anesthesia, minimal cardiovascular and respiratory depression, carcinogen, autonomic reflexes are preserved
	Rats	1000-1500 mg/kg	IP	
Ethyl carbamate (Urethane) [npg] / α chloralose[npg]	Rats	250-400 mg/kg prior to AC dose	IP	

Rodent Analgesia: In alphabetical order (*= controlled substance) brand name in parenthesis.

Agent	Species	Dose Range	Route of Admin	Considerations
Buprenorphine (Buprenex)*	Mice	0.01-0.05 mg/kg	SC, 3-4x daily (every 8-12 hours)	Opioid, moderate post-surgical pain, If placed in drinking water must monitor water intake and efficacy
		1.1mM in DMSO	Topical	
	Rats	0.05-0.5 mg/kg	SC,IP, 3-4x daily	
		0.4 mg/kg	PO	
Buprenorphine XR *(EthiqaXR extended release)	Mice	3.25 mg/kg	SC Every 72 hours	Opioid
	Rats	0.65 mg/kg		
Butorphanol*	Mice	5 mg/kg	SC	Opioid, 1-2hrs analgesia, minor pain
	Rats	2 mg/kg	SC	
Carprofen (Rimadyl)	Mice	5-10 mg/kg	SC, 1-2x daily	NSAID, length of analgesia is dose dependent
	Rats	5-15 mg/kg	SC, 1-2x daily	
Fentanyl*	Mice	0.025-0.6 mg/kg	SC	Opioid, moderate post-surgical pain, short acting, monitor water intake and efficacy if placed in drinking water
	Rats	0.01-1.0 mg/kg	SC	
		2.0-4.0 g/day	PO	
Flunixin meglumine (Banamine)	Mice	4.0-11 mg/kg	IV, 1-2x daily	NSAID, mild anti-inflammatory effects, not for post-surgical pain
Ketoprofen (Ketofen)	Mice	2-5 mg/kg	SC, 1x daily	NSAID
	Rats	5-15 mg/kg	SC, 1x daily	
		10-20 mg/kg	IP, 1x daily	
Lidocaine (Xylocaine)	Rats	0.67-1.3 mg/kg/hr CRI	SC pump	Local anesthetic
Lidocaine/ Buprenorphine*	Mice	0.44 mM and 0.18 mM in DMSO	Topical	Local anesthetic
Meloxicam (Metacam)	Mice	5-10mg/kg	SC, PO, 1x daily	NSAID
	Rats	1.0-4.0 mg/kg	SC, IP, 1x daily	
Morphine*	Mice	10 mg/kg	SC	Opioid, short acting (~4hrs)
		6.1 mM in DMSO	Topical	
Tolfedine	Mice	1mg/kg	SC, once	NSAID, At embryo transfer

RABBITS

Rabbit Pre-Medicant: In order of preference

Agent	Dose Range	Route of Admin	Considerations

Acepromazine	0.25-1.0mg/kg	IM	Anti-anxiety
Xylazine	1-5mg/kg	IM, SC	α2 agonist, CNS depression and muscle relaxant, can cause bradycardia
Medetomidine	0.25mg/kg	IM	α2 agonist, CNS depression and muscle relaxant, can cause bradycardia
Diazepam	1-5mg/kg	IM	Benzodiazepine, muscle relaxant
Midazolam	1-2mg/kg	IM	Benzodiazepine, muscle relaxant

Rabbit Anesthesia: In order of preference (*=controlled substance)

Agent	Dose range	Route of Admin	Considerations
Isoflurane	4% induction 0.5-2.5% maintenance	Inhaled	Quick recovery and induction, able to closely control plane of anesthesia, odor of gas is objectionable to animals-monitor respiratory rate
Sevoflurane	5% induction 2-2.5% maintenance	Inhaled	Quick recovery and induction, able to closely control plane of anesthesia, odor of gas is objectionable to animals-monitor respiratory rate
Ketamine*/Xylazine	35mg/kg (K) and 5mg/kg (X)	IM	20-40 minutes, Bradycardia, Xylazine is reversible
	10mg/kg (K) and 3mg/kg (X)	IV	20-30 minutes
Ketamine*/Xylazine/ Acepromazine	35mg/kg (K) and 5mg/kg (X) and 1.0mg/kg (A)	IM	45-75 minutes, Bradycardia, Xylazine is reversible Rapid, long acting sedation and analgesia
Ketamine*/Medetomidine	15mg/kg (K) and 0.25mg/kg (M)	IM	20-30 min, Medetomadine is reversible
Ketamine*/Midazolam*	30mg/kg (K) and 0.2mg/kg (M)	IM	May not produce surgical-plane anesthesia for major procedures, but may be useful for restraint.
Ketamine*/ Diazepam*	25mg/kg (K) and 5mg/kg (M)	IM	20-30 min, Minimal respiratory cardiovascular depression, Diazepam is reversible

Rodent Analgesia: In alphabetical order (brand name in parenthesis).

Agent	Dose Range	Route of Admin and Frequency	Considerations
Buprenorphine	0.01-0.05 mg/kg	IM,SC q 8-12hrs	Opioid, moderate post-surgical pain
Butorphanol	0.1-0.5mg/kg	IM, SC q 4-6hrs	Opioid, minor pain
Carprofen	4mg/kg	SC, 1x daily	NSAID
	1-2.2mg/kg	PO, 2x daily	
Flunixin meglumine (Banamine)	1.0mg/kg	IM,SC, 1-2x daily	NSAID, do not administer longer than 3 days, mild anti-inflammatory effects, not for post-surgical pain
Ketoprofen	1-3mg/kg	IM, SC, 1-2x daily	NSAID
Meloxicam	0.3mg/kg	SC, PO, 1x daily	NSAID

Guinea Pig

Guinea Pig Anesthesia:

Guinea Pig Anesthetic	Dose range	Route of Admin	Considerations
Isoflurane	4% induction 0.5-2.5% maintenance	Inhaled	Quick recovery and induction, able to closely control plane of anesthesia, odor of gas is objectionable to animals-monitor respiratory rate
Sevoflurane	5% induction 2-2.5% maintenance	Inhaled	Quick recovery and induction, able to closely control plane of anesthesia, odor of gas is objectionable to animals-monitor respiratory rate
Ketamine*/Xylazine	20-40mg/kg (K) and 2mg/kg (X)	IM, IP	Non-surgical anesthesia Bradycardia, Xylazine is reversible
	40mg/kg (K) and 5mg/kg (X)	IM, IP	30 minutes surgical anesthesia
Ketamine*/Xylazine/ Acepromazine	40mg/kg (K) and 5mg/kg (X) and 1.0mg/kg (A)	IM,IP	45-120 minutes, Bradycardia, Xylazine is reversible Rapid, long acting sedation and analgesia
Ketamine*/Medetomidine	40mg/kg (K) and 0.5mg/kg (M)	IP	30-40 min, Medetomadine is reversible
Ketamine*/ Diazepam*	20-40mg/kg (K) and 5mg/kg (D)	IM	30-45 min, Minimal respiratory cardiovascular depression, Diazepam is reversible
Telazol	20-40mg/kg	IM,IP	

Guinea Pig Analgesia (brand name in parentheses):			
Guinea Pig Analgesic	**Dose Range**	**Route of Administration and Frequency**	**Considerations**
Buprenorphine	0.05 mg/kg	IP,IM,SC q 8-12hrs	Opioid, moderate post-surgical pain
Butorphanol	0.4-2mg/kg	IP,IM, SC q 4-6hrs	Opioid, minor pain
Carprofen	1-4mg/kg	PO, SC, 1x daily	NSAID
Flunixin meglumine (Banamine)	2.5mg/kg	IM, 1-2x daily	NSAID, mild anti-inflammatory effects, not for post-surgical pain
Ketoprofen	1mg/kg	IM, SC, 1-2x daily	NSAID
Meloxicam	0.5mg/kg	SC, PO, 1x daily	NSAID

Dogs (Dallas only)

Dog Anesthesia:			
Dog Anesthetic	**Dose Range**	**Indications**	**Duration (min)**
Ketamine/Xylazine	1.1-2.2 mg/kg (K) and 0.1-0.2 mg/kg IM (X)	Minor surgical procedures	20-30
Isoflurane	3-4% for induction; followed by 1-2% for maintenance	Maintenance dose depends on other drugs given and level of surgical stimulation	Until removed
Atropine sulfate SA (Pre-anesthetic)	0.03-0.06 mg/kg	Decreases salivary secretions and vagal activity	

Dog Analgesia:	
Dog analgesics	**Dosage**
Buprenorphine Hydrochloride	0.01 – 0.02mg/kg SC q12h, prn (for pain)
Butorphanol Tartrate	0.2– 0.4mg/kg SC or IM, q4h
Ketoprofen	1-2 mg/kg, IM, SC
Nalbuphine	0.5-2 mg/kg SC, IM, IV, q 5-12 hr
Ibuprofen	10mg/kg PO, q24h. Best if dissolved in food

Dog Sedation:	
Dog Tranquilizers	Dosage
Acepromazine Maleate	0.1 – 0.5mg/kg IM, SC, prn, or 0.25-1.0mg/lb PO, prn

Dog Tranquilizer: Trazodone

Animal Weight	Trazodone Starting Dose Range. Given for 3 days.	Trazodone Target Dose	Trazodone Maximum Daily Dose
<5kg	12.5 mg q8-24h	25mg	75mg
Up to 10 kg (22 lb)	25 mg q8-24h	50mg	150mg
11 – 20 kg (23 - 44 lb)	50 mg q12-24h	100mg	300mg
21 – 40 kg (45 – 80 lb)	100 mg q12-24h	200mg	600mg
>41kg (89 lb)	100mg q12-24h	200 – 300mg	600+mg

Additional Anesthetic Doses* (DALLAS only):

	Species	Dose	Route
Ketamine/Xylazine	Mice	90-120 mg/kg and 7.5-16 10mg/kg	IM/IP
	Rats	40-120 mg/kg and 5-10mg/kg	IM/IP

*Adapted from Source: Formulary for Laboratory Animals: 2nd Edition

Hamsters (Dallas, Houston, Kingsville only)

Hamster Anesthesia:

Hamster Anesthetic	Dose Range	Indications	Duration (min)
Isoflurane	3-4% for induction; followed by 1-2% for maintenance	Minor surgical procedures	Until removed