

**UNIVERSITY OF MICHIGAN
METHODS OF EUTHANASIA BY SPECIES**

METHOD ¹	SPECIES											
	Amphibians	Birds	Cats	Dogs	Fish	Horses	Monkeys	Rabbits	Reptiles	Rodents and Other Small Animals	Ruminants	Swine
Barbiturates ²	A	A	A	A	A	A	A	A	A	A	A	A
Inhalant anesthetics ³	A	A	A	A	A	A	CA	A	A	A	A	A
Carbon dioxide ⁴	A	A	A	A	A	U	CA	A	A	A	U	A
Carbon monoxide ⁵	A	A	A	A	A	U	CA	A	A	A	U	CA
Microwave irradiation ⁶	U	U	U	U	U	U	U	U	U	A	U	U
Tricaine methanesulfonate ⁷	A	U	U	U	A	U	U	U	U	U	U	U
2-Phenoxyethanol ⁸	U	U	U	U	A	U	U	U	U	U	U	U
Benzocaine hydrochloride ⁹	A	U	U	U	A	U	U	U	U	U	U	U
Cervical dislocation ¹⁰	U	CA	U	U	U	U	U	CA	U	CA	U	U
Decapitation ¹¹	CA	CA	U	U	CA	U	U	CA	CA	CA	U	U

- ¹ Abbreviations **A = Acceptable.** Acceptable methods are recommended. Scientific justification for acceptable methods of euthanasia is not required.
CA = Conditionally Acceptable. Other methods are preferred. Scientific or other justification for conditionally acceptable methods of euthanasia is required.
U = Unacceptable Without Justification. The selection of any of these methods is strongly discouraged. However, there may be unusual circumstances that may lead an investigator to choose an unacceptable method. If you must use an unacceptable method, scientific or other justification is required.
For additional information on any method of euthanasia, request a copy of the 2000 Report of the AVMA Panel on Euthanasia (JAVMA 218(5):669-696, 2001) from the UCUCA Office.
- ² Intravenous injection is the preferred method for euthanasia of dogs, cats, other small animals, and horses. Intraperitoneal injection may be used in situations when an intravenous injection would be distressful or even dangerous. Intracardiac injection must only be used if the animal is heavily sedated, unconscious, or anesthetized.
- ³ In decreasing order of preference: halothane, enflurane, isoflurane, sevoflurane, methoxyflurane, and desflurane. The use of ether is conditionally acceptable and should only be used in carefully controlled situations in compliance with state and federal occupational health and safety regulations. The use of methoxyflurane for euthanasia in rodents is conditionally acceptable because it has a slow anesthetic induction and is accompanied by agitation. Although acceptable, the use of inhalant anesthetics in larger species is not recommended because of the cost and difficulty of administration.
- ⁴ Compressed gas in cylinders is the only recommended source of carbon dioxide because the inflow to the chamber can be regulated precisely. Flow rate should be 20% of chamber volume/minute. For neonates and immature animals, the time required for euthanasia may be prolonged.
- ⁵ Use compressed carbon monoxide gas. Special precautions must be used.
- ⁶ For use with small laboratory rodents only. Specially designed equipment must be used.
- ⁷ Fish and amphibians may be euthanized by immersion in a tank containing tricaine methanesulfonate at a concentration of 100-200 mg/liter of water for 10-20 minutes.
- ⁸ 2-phenoxyethanol is used at concentrations of 0.5-0.6 ml/L or 0.3-0.4 mg/L for euthanasia of fish. Fish should be left in solution for 10 minutes following cessation of opercular movement.
- ⁹ Fish and amphibians may be euthanized by immersion in a tank or recirculation system containing benzocaine hydrochloride at a concentration of >250 mg/liter of water for 10-20 minutes.
- ¹⁰ Manual cervical dislocation is conditionally acceptable in mice, rats weighing less than 200 gm, and rabbits weighing less than 1 kg. Cervical dislocation may be performed on larger rats and rabbits manually by an individual with demonstrated proficiency or if a mechanical dislocator is utilized.
- ¹¹ In amphibians, fish, and reptiles, decapitation should be followed by pithing both the brain and spinal cord.

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METHOD	SPECIES											
	Amphibians	Birds	Cats	Dogs	Fish	Horses	Monkeys	Rabbits	Reptiles	Rodents and Other Small Animals	Ruminants	Swine
Potassium chloride ¹²	A	A	A	A	A	A	A	A	A	A	A	A
Chloral hydrate ¹³	U	U	U	U	U	CA	U	U	U	U	CA	CA
Penetrating captive bolt	CA	U	U	CA	U	A	U	CA	CA	U	A	A
Gunshot	CA	A ¹⁴	U	U	U	CA	U	U	CA	U	CA	CA
Electrocution ¹⁵	U	U	U	CA	U	CA	U	U	U	U	CA	CA
Pithing ¹⁶	CA	U	U	U	U	U	U	U	CA	U	U	U
Thoracic compression	U	CA ¹⁷	U	U	U	U	U	U	U	U	U	U
Nitrogen, argon	U	CA	CA	CA	U	U	CA	CA	U	CA ¹⁸	U	U
Nitrous oxide	U	U	U	U	U	U	U	U	U	U	U	U
Exsanguination ¹⁴	U	U	U	U	U	U	U	U	U	U	U	U
Stunning ¹⁹	CA	U	U	U	CA	U	U	U	CA	U	U	U
Formalin	U	U	U	U	U	U	U	U	U	U	U	U
Chloroform ²⁰	U	U	U	U	U	U	U	U	U	U	U	U
Drowning	U	U	U	U	U	U	U	U	U	U	U	U
Hypothermia	U	U	U	U	U	U	U	U	U	U	U	U
Air embolism ¹⁴	U	U	U	U	U	U	U	U	U	U	U	U
Rapid freezing ¹⁴	U	U	U	U	U	U	U	U	U	U	U	U
Strychnine ¹⁴	U	U	U	U	U	U	U	U	U	U	U	U
Neuromuscular blocking agents (nicotine, magnesium sulfate, potassium chloride, all curariform agents) ¹³	U	U	U	U	U	U	U	U	U	U	U	U

¹² A surgical plane of anesthesia must be induced prior to using this method. Personnel performing this technique must be competent in inducing anesthesia and assessing anesthetic depth. The only acceptable routes of administration of KCl are IC and IV.

¹³ Horses, ruminants, and swine may be euthanized with chloral hydrate at dosages of 900 mg/kg intravenously. Sedate animal first and then give chloral hydrate intravenously.

¹⁴ Shotgun should be used for wild-bird collection.

¹⁵ This method is unacceptable as the sole method of euthanasia. However, if animals are first anesthetized or rendered unconscious by other means, this method may then be used.

¹⁶ May be used as sole method of euthanasia in species such as frogs with anatomic features that facilitate easy access to the central nervous system. In these species, both the brain and spinal cord must be pithed (i.e., double pithing). In all other species of amphibians and reptiles, pithing should be followed by decapitation.

¹⁷ Applicable in the field when other methods cannot be used.

¹⁸ When euthanizing rats, the oxygen concentration must be < 2% and the animal must be heavily sedated or anesthetized.

¹⁹ Stunning is unacceptable as a sole method of euthanasia. If performed properly, stunning will produce unconsciousness but must be followed by decapitation or pithing to ensure the animal's death.

²⁰ Chloroform is unacceptable for euthanasia. It is a known hepatotoxin and suspected carcinogen and is considered hazardous to humans.