



## Blood Collection

(Note: Navigation around this large pdf document is best accomplished using the bookmarks function.)

### 355.1 Preface

Blood collection (venipuncture, phlebotomy) is a common and important specimen collection procedure in the conduct of research. In many protocols, multiple blood draws are an important part of collecting and analyzing data. The Emory University Institutional Animal Care and Use Committee (IACUC) developed a policy to best enable blood collection while minimizing the potential for pain, unnecessary stress, distress or untoward effect in research animals. These are articulated by way of this general overview supplemented by companion documents appropriate to certain species.

The species-specific sections differentiate from the general standards in being more precise, and sometimes more adaptable, in considering the frequency and total number of blood collection events; maximum collectable volumes allowed based upon specific physiology; detailing allowable routes particular to each species; differentiating between terminal and survival circumstances; disclosing requirements for anesthesia or restraint; scientific qualifiers and addressing conditionally permissible methods or settings germane to a species. This list is not exhaustive and persons requiring information regarding the supplies and equipment needed, specifics of restraint or anesthesia, requirements for ancillary care, habituation requirements, application to study in the field and other information are encouraged to contact the Training Coordinators for their specific site.

- **DAR Training Request:** [http://www.dar.emory.edu/forms/training\\_wrkshp.php](http://www.dar.emory.edu/forms/training_wrkshp.php)
- **Yerkes National Primate Research Center Training:** Dhaval Vyas at [Dhaval.Vyas@emory.edu](mailto:Dhaval.Vyas@emory.edu), 404-727-9675

While it only takes about 24 hours for the lost fluid volume of blood to be restored, it takes longer to regeneratively replenish erythrocytes, platelets and other circulating factors. This is the rationale for recovery periods following blood draws (i.e., intervals between blood collection events) and the requirement for other details.

### 355.2 General Requirements

**355.2.1** Blood collection procedures must be appropriately documented in pertinent sections of the IACUC application and specifically approved by the IACUC.

**355.2.2** The protocol must include a description of all potential collection sites/methods, any surgical preparation (if applicable), the amount(s) to be withdrawn, the frequency of blood collection and/or interval between blood collection events, the total number of blood collection events planned per subject, and the type of restraint needed (including animal training techniques) for each species to be used. It is important to take into account the total blood volume yielded from the chosen blood collection technique when addressing the combination of frequency and volume of blood collection.

**355.2.3** If the protocol involves more than one species, blood collection procedures must be addressed for each species.

**355.2.4** The IACUC may require competency demonstration and/or training in the blood collection techniques necessary for the conduct of the work, as a condition of protocol approval.

**355.2.5** The standards and species-specific guidelines as detailed apply to adult subjects in apparent good health and normal body condition with an uneventful experimental history, an adequate plane of nutrition and under non-intensive blood collection schemes. In the case of subjects expected to not meet these criteria, the protocol must include a program of nursing or supportive care in light of subject factors, monitoring and intervening for wellbeing and good health, and in consideration of experimental need.

**355.2.6** To prevent complications associated with multiple blood collections such as anemia and the adverse effect it can have on experimental outcomes, any deviations to the policy will require IACUC review and approval based upon acceptable scientific justification.

### **355.3 General Standards**

**355.3.1** For optimal health and to prevent hypovolemic shock, physiological stress and death, blood draws should be limited to the lower end of the ranges provided. Maximum blood volumes should be taken only from healthy animals or as terminal procedures.

**355.3.2** No animal may be left unattended until hemostasis is achieved and, if applicable, it has recovered sufficiently from anesthesia.

**355.3.3** Although there may be species-specific differences, as a general rule the approximate blood volume of an animal is in the range of 6-8% of body weight (i.e., 60-80 ml/kg). In the case of species regulated under the federal Animal Welfare Act Regulations, the maximum blood volume recognized by USDA for each species in its "[Animal Welfare Inspection Guide](#)" are applied as follows:

- Cat: 66 ml/kg
- Dog: 86 ml/kg (USDA, 2013)
- Gerbil: 67 ml/kg (USDA, 2013)
- Goat: 70 ml/kg (USDA, 2013)
- Guinea pig: 75 ml/kg (USDA, 2013)
- Hamster: 78 ml/kg (USDA, 2013)
- Mouse: 80 ml/kg (USDA, 2013)
- Rat: 64 ml/kg (USDA, 2013)
- Sheep: 66 ml/kg (USDA, 2013)
- Swine: 65 ml/kg
- Rabbit: 62 ml/kg (USDA, 2013)
- Nonhuman primates: refer to specific guidelines

**355.3.4** For purposes of these guidelines, grams in body weight are equivalent to milliliters of blood. Each drop of blood is the equivalent of 0.1 ml.

**355.3.5** With the exception of nonhuman primates, addressed within the species-specific section, the maximum blood volume which can be safely removed from all other species for a one time sample without fluid replacement is 10% of the total circulating blood volume (CBV), in the range of 6-8 ml/kg, and as stipulated in “3” above.

- With fluid replacement, up to 15% of the CBV or approximately 12 ml/kg can be removed.
- In the case of fluid replacement therapy, for every 1 ml of blood collected, 3 ml of crystalloid fluids should be administered SC or slowly IV immediately thereafter. IV administration may be necessary under certain circumstances and requires appropriate skills and/or training.
- Fluid replacement therapy does not allow for blood collection more frequent than the established guidelines.

**355.3.6** Exsanguination may only be used as a terminal procedure under adequate anesthesia. It is possible for exsanguination to yield approximately half of the total circulating blood volume. This is equivalent to about 35 ml/kg, but varies depending upon species.

**355.3.7 Multiple Sample Collection**

**355.3.7.1** General: If the recommended maximum blood draw is performed, there are several published suggestions as well as regulatory guidance from USDA, where applicable, on how much time should elapse between blood draws. The Emory IACUC requires that where the maximum amount of blood is drawn on one occasion, a recovery period of at least 4 weeks between blood draws is necessary. For experiments that do not require the suggested maximum blood draw, blood can safely be drawn more frequently as detailed in the table below:

<b>Circulating Blood Volume</b>	<b>Body Weight Equivalent</b>	<b>Volume per Unit Body Weight</b>	<b>Recovery Time</b>	<b>Replacement Fluids</b>
15%	1.2%	12 ml/kg	4 weeks	Required
10%	0.8%	8 ml/kg	2 weeks	Recommended
7.5%	0.6%	6 ml/kg	1 week	Optional

**Calculations:** Mean species blood volume x body weight\* x volume per unit body weight = Maximum volume for a single sampling

\*Body weight should be measured precisely except for mice and gerbils where the approximate representative body weight in light of the age, gender and species may be used.

**355.3.7.2** Depending upon the combination of frequency and volume of collection, the IACUC may require monitoring for anemia and other health indicators or specific treatments.

**355.3.7.3** The use of vascular access ports are recommended when serial samples are required over a period of days or weeks. Animal training to facilitate blood collection may reduce stress for certain species during the procedure.

**355.3.8 Reference**

- [Animal Welfare Inspection Guide](#), United States Department of Agriculture. September 2013.

- Diehl K-H, R Hull, D Morton, et al. 2001. “A good practice guide to the administration of substances and removal of blood including routes and volumes”. J Appl Toxicol 21: 15-23.

### 355.4 Species-specific Guidance

(Note: Navigation around this large pdf document is best accomplished using the bookmarks function.)

#### 355.4.1 Birds

**355.4.1.1** The most frequently sampled sites for small birds are the brachial, jugular, and femoral veins. Toenail clipping can be residually painful, often results in skewed cell distributions, limits the amount of blood that can be collected and is not an approved method. While phlebotomy from the occipital sinus has been used historically in some domestic species (Zimmerman and Dhillon, 1985), it has not been demonstrated as a safe or useful technique in small or wild birds, risks damaging the brainstem, requires complicated restraint and methodology, and is not an allowable method.

**355.4.1.2** As with other species, the avian blood volume is approximately 6-8% of body weight (Campbell, 1994; Dein, 1986) and, also as with many other species, most healthy Passeriformes and Psittaciformes can lose 10% of the blood volume, or the equivalent of 1% of the body weight, without ill effects (Campbell, 1994; Djohosugito, et al, 1968; Sheldon, et al, 2008;) providing sufficient recovery time is allowed.

**355.4.1.3** As birds may be fractious and can be highly stressed during restraint, careful handling by skilled personnel is a requisite.

**355.4.1.4** For specific information on collection volumes and universal guidance, please refer to the preamble of this policy. In addition to these matters, for specific information on techniques, recommended supplies and equipment, and pre- and post-procedural care considerations, as well as to arrange for any training, please contact the Training Coordinator at the appropriate facility.

- **DAR Training Request:** [http://www.dar.emory.edu/forms/training\\_wrkshp.php](http://www.dar.emory.edu/forms/training_wrkshp.php)

#### 355.4.1.5 Table 1: Survival Blood Collection

Collection Site	Advantages	Disadvantages
<b>Brachial (alar, ulnar) vein</b>	<ul style="list-style-type: none"> <li>• Anesthesia not necessary</li> <li>• Easily accessed</li> <li>• Repeated collection possible</li> </ul>	<ul style="list-style-type: none"> <li>• Requires two persons</li> <li>• Hematoma formation common</li> </ul>
<b>Right side Jugular vein</b> **preferred method**	<ul style="list-style-type: none"> <li>• Anesthesia not necessary</li> <li>• Easily accessed</li> <li>• Yields large quantities</li> <li>• Pure blood sample possible</li> <li>• Can be done with one person</li> </ul>	<ul style="list-style-type: none"> <li>• Requires physical restraint</li> <li>• Hematoma is a risk</li> <li>• Not easy for left handed individuals</li> </ul>
<b>Femoral vein</b> (punctured at knee level)	<ul style="list-style-type: none"> <li>• Anesthesia not necessary</li> </ul>	<ul style="list-style-type: none"> <li>• Requires two persons</li> <li>• Yields small volumes</li> </ul>

<b>Medial metatarsal vein</b>	<ul style="list-style-type: none"> <li>• Hematoma formation is rare</li> <li>• Can be done with one person</li> </ul>	<ul style="list-style-type: none"> <li>• General or local anesthesia may be necessary</li> <li>• Yields only small volumes</li> <li>• Not useful in small birds</li> </ul>
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**355.4.1.6 Table 2: Non-survival Blood Collection**

*Note that any survival method listed above may be used as a terminal method as well.*

<b>Collection Site</b>	<b>Advantages</b>	<b>Disadvantages</b>
<b>Cardiac Puncture/cardiocentesis</b>	<ul style="list-style-type: none"> <li>• Allows for maximum blood volume collection</li> </ul>	<ul style="list-style-type: none"> <li>• Nonsurvival procedure only</li> <li>• Requires anesthesia</li> </ul>
<b>Decapitation</b>	<ul style="list-style-type: none"> <li>• Allows for large volumes of mixed blood to be collected.</li> </ul>	<ul style="list-style-type: none"> <li>• Sample may be contaminated</li> <li>• Aesthetically displeasing</li> <li>• Special equipment necessary</li> </ul>
<b>Occipital sinus</b>	<ul style="list-style-type: none"> <li>• May yield moderate samples in the hands of a skilled operator</li> </ul>	<ul style="list-style-type: none"> <li>• Training required</li> <li>• Anesthesia mandatory</li> </ul>
<b>Exsanguination from surgically accessed internal vessels</b>	<ul style="list-style-type: none"> <li>• Allows for maximum blood volume collection</li> <li>• Sterile samples possible</li> </ul>	<ul style="list-style-type: none"> <li>• Nonsurvival procedure only</li> <li>• Requires surgical approach</li> <li>• Requires anesthesia</li> </ul>

**355.4.1.7 References**

- Campbell TW. 1994. Hematology. In Ritchie BW, Harrison GJ, Harrison LR (Eds. ): *Avian Medicine: Principles and Application*. Wingers Publishing Inc. , Lake Worth, FL, pp176-198 (accessed on the www at: <http://www.harrisonsbirdfoods.com/avmed/ampa/9.pdf>)
- Dein JF. 1986. Hematology. In Harrison GJ and Harrison LR (Eds.): *Clinical avian medicine and surgery*. W. B. Saunders Company, Philadelphia, PA, pp. 174-191.
- Dein JF. 2002. *Blood collection in birds: Re-edited 1989 National Wildlife Health Research Center Video*, HSGS. <http://www.wdin.org/multimedia.jsp?type=videos>
- Djojogugito AM, B Folkow, and AGB Kovach. 1968. *The mechanisms behind the rapid blood volume restoration after hemorrhage in birds*. Acta Physiol Scand 74: 114-22.
- Sheldon SD, EH Chin, and SA Gill. Schmaltz G. Newman AEM. Soma KK. 2008. *Effects of blood collection on wild birds: an update*. J Avian Biol 39(4): 369-78.
- Zimmerman NG and AS Dhillon. 1985. *Blood sampling from the venous occipital sinus of birds*. Poultry Science. 64(10):1859-62, 1985.

### 355.4.2 Cats

**355.4.2 .1** The cephalic and jugular veins are the most common vessels used with the medial saphenous vein and the femoral vessels also possible depending upon the skill of the operators, tractability of the subject, and degree of restraint required. Cardiac puncture is only allowed under anesthesia as a terminal procedure.

**355.4.2 .2** Cats, with the exception of especially fractious animals, can typically be manually restrained for blood collection. It is helpful to have one person restrain the animal while the other collects the sample.

**355.4.2 .3** Circulating blood volume: 47 - 66 ml/kg - the high range up to 80 ml/kg is not applicable to cats.

**355.4.2 .4** For universal guidance, please refer to the preamble of this policy. In addition, for specific information on techniques, recommended supplies and equipment, and pre- and post-procedural care considerations, as well as to arrange for any training, please contact the Training Coordinator at the appropriate facility.

- **DAR Training Request:** [http://www.dar.emory.edu/forms/training\\_wrkshp.php](http://www.dar.emory.edu/forms/training_wrkshp.php)

#### 355.4.2 .5 Table 1: Survival Blood Collection

Vessel	Advantages	Disadvantages
<b>Jugular vein</b>	<ul style="list-style-type: none"> <li>• &gt;10ml volume can be collected from this site</li> </ul>	<ul style="list-style-type: none"> <li>• This site is not recommended for cats with clotting abnormalities</li> </ul>
<b>Cephalic vein</b>	<ul style="list-style-type: none"> <li>• Useful for moderate volumes, e.g. 1-3 ml</li> </ul>	<ul style="list-style-type: none"> <li>• Vessel may be small</li> <li>• Large volumes may be difficult to obtain</li> </ul>
<b>Femoral vessels</b>	<ul style="list-style-type: none"> <li>• Moderate to large volumes may be attained</li> <li>• It is possible to obtain arterial blood for blood-gas analysis</li> </ul>	<ul style="list-style-type: none"> <li>• A blind stick is required.</li> <li>• Risk of internal hematoma</li> <li>• Not recommended for cats with clotting abnormalities</li> </ul>
<b>Medial saphenous vein</b>	<ul style="list-style-type: none"> <li>• Increased distance from the jaw/teeth may increase safety for personnel</li> </ul>	<ul style="list-style-type: none"> <li>• Useful for collections &lt; 3ml</li> </ul>

**355.4.2.6 Table 2: Non-survival Blood Collection**

*Note that any survival method listed above may be used as a means to collect blood at euthanasia.*

Collection Site	Advantages	Disadvantages
<b>Cardiac puncture/cardiocentesis</b>	<ul style="list-style-type: none"> <li>• Allows for maximum blood volume collection</li> </ul>	<ul style="list-style-type: none"> <li>• Nonsurvival procedure only</li> <li>• Requires anesthesia</li> </ul>
<b>Aorta, caudal vena cava or other internal vessel by surgical approach</b>	<ul style="list-style-type: none"> <li>• Allows for maximum blood collection</li> <li>• Sterile sample possible</li> </ul>	<ul style="list-style-type: none"> <li>• Nonsurvival procedure only</li> <li>• Requires anesthesia</li> <li>• Requires surgical approach</li> </ul>

**355.4.2 .7 References**

- Lockhart J, K Wilson and C Lanman. 2013. *The effects of operant training on blood collection for domestic cats.* Appl Anim Behav Sci 143:128-134.

**355.4.3 Dogs**

**355.4.3 .1** Dogs are very smart and sociable, and it is usually possible to collect blood while the animal is awake, especially if positive reinforcement training is used. In general, two people are required to collect blood- 1 to restrain the dog and 1 to perform venipuncture.

**355.4.3 .2** The cephalic and jugular veins are the most common vessels used with lateral saphenous and femoral vessels also may be used depending upon the skill of the operators, tractability of the subject, and degree of restraint required.

**355.4.3 .3** Cardiac puncture is only allowed under anesthesia as a terminal procedure.

**355.4.3 .4** For specific information on collection volumes and universal guidance, please refer to the preamble of this policy. In addition to these matters, for specific information on techniques, recommended supplies and equipment, and pre- and post-procedural care considerations, as well as to arrange for any training, please contact the Training Coordinator at the appropriate facility.

- **DAR Training Request:** [http://www.dar.emory.edu/forms/training\\_wrkshp.php](http://www.dar.emory.edu/forms/training_wrkshp.php)

**355.4.3 .5 Table 1: Survival Blood Collection**

Collection Site	Advantages	Disadvantages
<b>Cephalic Vein</b>	<ul style="list-style-type: none"> <li>• Anesthesia not necessary</li> <li>• Easily accessed</li> <li>• Repeated collection possible</li> <li>• Can be used for small to moderate volume collection</li> </ul>	<ul style="list-style-type: none"> <li>• Requires 2 people</li> </ul>

Collection Site	Advantages	Disadvantages
<b>Lateral Saphenous Vein</b>	<ul style="list-style-type: none"> <li>• Anesthesia not required</li> <li>• Repeated sampling possible</li> </ul>	<ul style="list-style-type: none"> <li>• Yields smaller volume</li> <li>• Vessel is mobile and friable.</li> <li>• Hematoma risk</li> <li>• May require 2 people</li> </ul>
<b>Jugular Vein</b>	<ul style="list-style-type: none"> <li>• Moderate to large volumes can be collected</li> <li>• Anesthesia not required</li> </ul>	<ul style="list-style-type: none"> <li>• Sedation may be necessary for fractious animals</li> <li>• Requires 2 people and some specialized training</li> </ul>
<b>Femoral vein/artery</b>	<ul style="list-style-type: none"> <li>• Moderate to large volumes can be collected</li> </ul>	<ul style="list-style-type: none"> <li>• Anesthesia may be required</li> <li>• Hematoma is a risk.</li> <li>• Internal vessel laceration is a risk.</li> </ul>
<b>Carpal Pad / Ear Pinna</b>	<ul style="list-style-type: none"> <li>• Possible refinement for frequent, repeated sampling (such as for daily blood glucose measurements)</li> <li>• Anesthesia not required</li> <li>• Can be done by 1 person</li> </ul>	<ul style="list-style-type: none"> <li>• Will only yield a few drops</li> </ul>

### 355.4.3 .6 Table 2: Non-survival Blood Collection

*Note that any survival method listed above may be used as a terminal method as well.*

Collection Site	Advantages	Disadvantages
<b>Cardiac puncture/cardiocentesis</b>	<ul style="list-style-type: none"> <li>• Allows for maximum blood volume collection</li> </ul>	<ul style="list-style-type: none"> <li>• Nonsurvival procedure only</li> <li>• Requires anesthesia</li> </ul>
<b>Aorta, caudal vena cava or other internal vessel by surgical approach</b>	<ul style="list-style-type: none"> <li>• Allows for maximum blood collection</li> <li>• Sterile sample possible</li> </ul>	<ul style="list-style-type: none"> <li>• Nonsurvival procedure only</li> <li>• Requires anesthesia</li> <li>• Requires surgical approach</li> </ul>

### 355.4.3 .7 References

- Borin-Crivellenti S, LZ Crivellenti, and M Tinucci-Costa. 2012. *The carpal pad as an alternative sampling site for blood glucose testing in dogs.* J Small Animal Pract 53: 684-6.
- Diehl KB, R Hall, D Morton, et al. 2001. *A good practice guide to the administration of substances and removal of blood, including routes and volumes.* J Appl Toxicol 21: 15-23.
- NC3Rs microsite: <http://www.nc3rs.org.uk/bloodsamplingmicrosite/page.asp?id=313>



### 355.4.4 Frogs

**355.4.4.1 Quantity of blood collection recommended:** While the literature suggests a range of blood that can be safely removed in healthy frogs is 50% of the blood at one time (about 5% of the body mass), it's recommended that collection be limited to 60-80ml/kg body weight.

**355.4.4.2** For universal guidance, please refer to the preamble of this policy. In addition, for specific information on techniques, recommended supplies and equipment, and pre- and post-procedural care considerations, as well as to arrange for any training, please contact the Training Coordinator at the appropriate facility.

- **DAR Training Request:** [http://www.dar.emory.edu/forms/training\\_wrkshp.php](http://www.dar.emory.edu/forms/training_wrkshp.php)

**355.4.4.3** To protect the integrity of the mucus layer, gloves should be powder-free, non-talc latex or nitrile gloves pre-moistened with tank water.

#### **355.4.4.4 Site of Collection**

For survival blood collections, the following guidelines refer to the sites and procedures most frequently used: a) ventral abdominal vein; b) femoral vein; c) lingual vein. A list of the issues that should guide the choice of blood collection route(s) is provided below in Table 1 and Table 2.

**355.4.4.5** *Xenopus* spp., unlike most other amphibians, lack a tongue. This and other anatomical limitations make it challenging to use antemortem blood collection routes other than survival cardiocentesis. For all other species, the heart is only approved as a non-survival method and requires anesthesia for blood collection.

**355.4.4.6 Table 1: Survival Blood Collection**

Collection Site	Advantages	Disadvantages
<b>Ventral abdominal</b>	<ul style="list-style-type: none"> <li>• Anesthesia not required</li> <li>• Repeated collection possible when experienced</li> </ul>	<ul style="list-style-type: none"> <li>• Needle should be &lt;27g</li> <li>• Number of attempts should be limited to twice at any one time-point to minimize risk of internal damage</li> </ul>
<b>Femoral vein</b>	<ul style="list-style-type: none"> <li>• Anesthesia not required</li> <li>• Repeated collection possible when experienced</li> </ul>	<ul style="list-style-type: none"> <li>• Special preparation of skin required</li> <li>• Needle should be &lt;27g</li> </ul>

Collection Site	Advantages	Disadvantages
<b>Lingual</b>	<ul style="list-style-type: none"> <li>Anesthesia not required</li> <li>Repeated collection possible when experienced</li> </ul>	<ul style="list-style-type: none"> <li>Needle should be &lt;27g</li> <li>Not possible in Xenopus</li> <li>Limit to one stick per side of tongue per collection attempt</li> <li>Contamination likely</li> <li></li> </ul>
<b>Cardiac puncture/cardiocentesis</b> Requires specific and plausible scientific justification and case-by-case IACUC approval as well as competency assessment/training.	<ul style="list-style-type: none"> <li>Allowed only in Xenopus as a survival procedure</li> <li>Sterile sample possible</li> </ul>	<ul style="list-style-type: none"> <li>Anesthesia required</li> <li>Special preparation of the skin is necessary.</li> <li>High risk of postphlebotomy complications or mortality</li> </ul>

**355.4.4.7 Table 2: Non-survival Blood Collection**

*Note that any survival method listed above may be used as a terminal method as well.*

Collection Site	Advantages	Disadvantages
<b>Heart</b>	<ul style="list-style-type: none"> <li>Allows for maximum blood volume collection</li> <li>Sterile sample possible</li> </ul>	<ul style="list-style-type: none"> <li>Animal must be anesthetized</li> <li>Special preparation of skin required</li> <li>Needle should be &lt;23g unless the animal is more than 100g weight</li> </ul>

**355.4.4.8 References**

- [http://www.nwhc.usgs.gov/publications/amphibian\\_research\\_procedures/blood\\_samples.jsp](http://www.nwhc.usgs.gov/publications/amphibian_research_procedures/blood_samples.jsp)
- EJ Gentz. 2007. *Medicine and surgery of amphibians*. ILAR J. 48(3):255-9.

**355.4.5 Gerbils**

**355.4.5.1** For specific information on collection volumes and universal guidance, please refer to the preamble of this policy. In addition to these matters, for specific information on techniques, recommended supplies and equipment, and pre- and post-procedural care considerations, as well as to arrange for any training, please contact the Training Coordinator at the appropriate facility.

- DAR Training Request:** [http://www.dar.emory.edu/forms/training\\_wrkshp.php](http://www.dar.emory.edu/forms/training_wrkshp.php)

**355.4.5.2** The lateral saphenous and jugular veins are the most commonly used, with lateral tail vein and the retro-orbital plexus also used. A list of the considerations that should guide the choice of survival blood collection route(s) is provided in Table 1. Note that any survival method listed above may be used as a terminal method as well.

**355.4.5.3 TABLE 1: Survival blood collection**

<b>Collection Site</b>	<b>Advantages</b>	<b>Disadvantages</b>
<b>Lateral Saphenous Vein</b>	<ul style="list-style-type: none"> <li>• Anesthesia not required</li> <li>• Repeated bleeding possible by removal of the scab or blood can be collected into syringe</li> </ul>	<ul style="list-style-type: none"> <li>• Yields only small quantities</li> <li>• Requires restraint</li> </ul>
<b>Lateral Tail Vein</b>	<ul style="list-style-type: none"> <li>• Anesthesia not required but may aid collection</li> <li>• Repeated bleeding possible by removal of the scab</li> </ul>	<ul style="list-style-type: none"> <li>• Yields only small quantities</li> <li>• Requires restraint</li> <li>• Tail degloving is a risk if proper handling not followed</li> </ul>
<b>Retro-orbital Sinus</b> Requires specific and plausible scientific justification and case-by-case IACUC approval as well as competency assessment/training	<ul style="list-style-type: none"> <li>• Yields moderate to large volume of blood</li> <li>• Rapid</li> <li>• Sterile sample collection possible</li> </ul>	<ul style="list-style-type: none"> <li>• Anesthesia is required</li> <li>• Is a discouraged technique due to high risk of injury to the eye and surrounding structures</li> <li>• 2 blood collection per eye maximum (alternate eye)</li> <li>• 2 weeks minimum between successive bleeds on an eye.</li> </ul>
<b>Jugular Vein</b>	<ul style="list-style-type: none"> <li>• Allows larger volume collection</li> </ul>	<ul style="list-style-type: none"> <li>• Requires anesthesia</li> <li>• Yields a large sample so should not be used for frequent small sampling or serial sampling</li> </ul>

**355.4.5.4 TABLE 2: Non Survival blood collection**

*Note that any survival method listed above may be used as a terminal method as well.*

<b>Collection Site</b>	<b>Advantages</b>	<b>Disadvantages</b>
<b>Cardiac puncture/cardiocentesis</b>	<ul style="list-style-type: none"> <li>• Allows for maximum blood volume collection</li> </ul>	<ul style="list-style-type: none"> <li>• Non survival procedure only</li> <li>• Anesthesia is required</li> </ul>
<b>Aorta or Caudal Vena Cava</b>	<ul style="list-style-type: none"> <li>• Allows for maximum blood volume collection</li> <li>• Sterile sample possible</li> </ul>	<ul style="list-style-type: none"> <li>• Non survival procedure only</li> <li>• Anesthesia is required</li> <li>• Requires surgical approach (laparotomy)</li> </ul>

### 355.4.5.5 References

- The Laboratory Rabbit, Guinea Pig, Hamster, and Other Rodents. (Suckow MA, Stevens KA, and Wilson RP Eds). Elsevier 2012.
- Joslin JO. 2009. *Blood collection techniques in exotic small mammals*. Journal of Exotic Pet Medicine. 18(2): 117-139.
- NC3Rs microsite: <http://www.nc3rs.org.uk/bloodsamplingmicrosite/page.asp?id=313>
- Parasuraman S, R Raveendran, and R Kesavan. 2010. *Blood sample collection in small laboratory animals*. J Pharmacol Pharmacother. 1(2): 87–93.
- Donovan J and P Brown. 2006. *Blood collection*. *Care and Handling of Laboratory Animals in Current Protocols in Immunology*. John Wiley & Sons, Inc, pp. 1.7.1-1.7.9.
- Alworth LC, LM Kelly, TL Cooper, and GW Salyards. 2006. *Unassisted blood collection from unanesthetized rats and gerbils*. Lab Animal. 41(6): 155-156.

### 355.4.6 Guinea Pigs

**355.4.6.1** Blood sampling in guinea pigs can be difficult. The site chosen for venipuncture depends on the size of animal, expertise of handler and phlebotomist, and volume of blood required.

**355.4.6.2** For specific information on collection volumes and universal guidance, please refer to the preamble of this policy. In addition to these matters, for specific information on techniques, recommended supplies and equipment, and pre- and post-procedural care considerations, as well as to arrange for any training, please contact the Training Coordinator at the appropriate facility.

- **DAR Training Request:** [http://www.dar.emory.edu/forms/training\\_wrkshp.php](http://www.dar.emory.edu/forms/training_wrkshp.php)

**355.4.6.3** A list of the considerations that should guide the choice of survival blood collection route(s) is provided in Table 1. Note that any survival method listed may be used as a terminal method as well.

**355.4.6.4 TABLE 1 (Survival blood collection)**

Collection Site	Advantages	Disadvantages
<b>Marginal Ear Vein</b>	<ul style="list-style-type: none"> <li>• Easy to perform</li> <li>• Does not require anesthesia</li> </ul>	<ul style="list-style-type: none"> <li>• Yields a small volume</li> </ul>
<b>Lateral Saphenous Vein</b>	<ul style="list-style-type: none"> <li>• Anesthesia not required</li> <li>• Repeated bleeding possible by removal of the scab with blood collected into a syringe</li> </ul>	<ul style="list-style-type: none"> <li>• Yields only small quantities</li> <li>• Requires proper restraint; may require 2 people</li> </ul>

<b>Cephalic and Tarsal Veins</b>	<ul style="list-style-type: none"> <li>Anesthesia not required</li> <li>Repeated bleeding possible by removal of the scab</li> </ul>	<ul style="list-style-type: none"> <li>Yields only small quantities</li> <li>Requires proper restraint; may require 2 people</li> <li>Bruising and hemorrhage can be complications</li> </ul>
<b>Jugular Vein</b>	<ul style="list-style-type: none"> <li>Allows larger volume collection</li> </ul>	<ul style="list-style-type: none"> <li>Requires anesthesia</li> <li>Requires some specialized training</li> <li>Proper restraint is essential; 2 people required</li> <li>Yields a large sample so should not be used for frequent small sampling or serial sampling</li> </ul>
<b>Cranial Vena Cava</b>	<ul style="list-style-type: none"> <li>Allows larger volume collection</li> </ul>	<ul style="list-style-type: none"> <li>Anesthesia is required</li> <li>Cardiac puncture is a risk</li> <li>Requires specialized training and proper restraint</li> </ul>
<b>Femoral Vein</b>	<ul style="list-style-type: none"> <li>Allows larger volume collection</li> </ul>	<ul style="list-style-type: none"> <li>Requires anesthesia</li> <li>Requires some specialized training</li> </ul>

#### 355.4.6.5 TABLE 2 (Non Survival blood collection)

*Note that any survival method listed above may be used as a terminal method as well.*

<b>Collection Site</b>	<b>Advantages</b>	<b>Disadvantages</b>
<b>Cardiac puncture/cardiocentesis</b>	<ul style="list-style-type: none"> <li>Allows for maximum blood volume collection</li> </ul>	<ul style="list-style-type: none"> <li>Non survival procedure only</li> <li>Anesthesia is required</li> </ul>
<b>Aorta or Caudal Vena Cava</b>	<ul style="list-style-type: none"> <li>Allows for maximum blood volume collection</li> <li>Sterile sample possible</li> </ul>	<ul style="list-style-type: none"> <li>Non survival procedure only</li> <li>Anesthesia is required</li> <li>Requires surgical approach (laparotomy)</li> </ul>
<b>Decapitation</b>	<ul style="list-style-type: none"> <li>Allows for large volumes of mixed blood to be collected</li> </ul>	<ul style="list-style-type: none"> <li>Sample may be contaminated</li> <li>Aesthetically displeasing</li> <li>Special equipment and training necessary</li> <li>Potentially hazardous for operator</li> </ul>

#### 355.4.6.6 References

- Huneker RB. 2012. Guinea Pigs: Basic experimental methods. In: The Laboratory Rabbit, Guinea Pig, Hamster, and Other Rodents. (Suckow MA, Stevens KA, and Wilson RP Eds). Elsevier, pp. 621-37. 2012.

- Joslin JO. *Blood collection techniques in exotic small mammals*. Journal of Exotic Pet Medicine. April 2009 18(2): 117-139.
- NC3Rs microsite: <http://www.nc3rs.org.uk/bloodsamplingmicrosite/page.asp?id=313>
- Parasuraman S, R Raveendran, and R Kesavan. 2010. *Blood sample collection in small laboratory animals*. J Pharmacol Pharmacother. 1(2): 87–93.
- AALAS Learning Library:  
<https://www.aalaslearninglibrary.org/demo/course2.asp?strKeyID=0ACBFBD6-5731-4666-9A99-EA18AE711493-0&Library=10&Track=11&Series=17&Course=259&Lesson=2464>

### 355.4.7 Hamsters

**355.4.7.1** Hamsters tend to be more aggressive than mice, but can be successfully restrained manually or by using a restraint tube for blood collection.

**355.4.7.2** For specific information on collection volumes and universal guidance, please refer to the preamble of this policy. In addition to these matters, for specific information on techniques, recommended supplies and equipment, and pre- and post-procedural care considerations, as well as to arrange for any training, please contact the Training Coordinator at the appropriate facility.

- **DAR Training Request:** [http://www.dar.emory.edu/forms/training\\_wrkshp.php](http://www.dar.emory.edu/forms/training_wrkshp.php)

**355.4.7.3** A list of the considerations that should guide the choice of survival blood collection route(s) is provided in Table 1. Note that any survival method listed may be used as a terminal method as well.

**355.4.7.4 TABLE 1 (Survival blood collection)**

Collection Site	Advantages	Disadvantages
<b>Lateral Saphenous Vein</b>	<ul style="list-style-type: none"> <li>• Anesthesia not required</li> <li>• Repeated bleeding possible by removal of the scab with blood collected into a syringe</li> </ul>	<ul style="list-style-type: none"> <li>• Yields only small quantities</li> <li>• Requires proper restraint</li> </ul>
<b>Cephalic Vein</b>	<ul style="list-style-type: none"> <li>• Anesthesia not required</li> <li>• Repeated bleeding possible by removal of the scab</li> </ul>	<ul style="list-style-type: none"> <li>• Yields only small quantities</li> <li>• Requires proper restraint; may require 2 people</li> </ul>
<b>Sublingual Vein</b>	<ul style="list-style-type: none"> <li>• Can be good for small volumes</li> </ul>	<ul style="list-style-type: none"> <li>• Anesthesia required</li> <li>• Requires 2 people for proper restraint</li> </ul>

Collection Site	Advantages	Disadvantages
<b>Retro-orbital Sinus</b> Requires specific and plausible scientific justification and case-by-case IACUC approval as well as competency assessment/training.	<ul style="list-style-type: none"> <li>• Yields moderate to large volume of blood</li> <li>• Rapid</li> <li>• Sterile sample collection possible</li> </ul>	<ul style="list-style-type: none"> <li>• Anesthesia is required</li> <li>• Is a discouraged technique due to high risk of injury to the eye and surrounding structures</li> <li>• 2 blood collection per eye maximum (alternate eye)</li> <li>• 2 weeks minimum between successive bleeds on an eye.</li> </ul>
<b>Jugular Vein</b>	<ul style="list-style-type: none"> <li>• Allows larger volume collection</li> </ul>	<ul style="list-style-type: none"> <li>• Requires anesthesia</li> <li>• Requires some specialized training</li> <li>• Yields a large sample so should not be used for frequent small sampling or serial sampling</li> </ul>
<b>Cranial Vena Cava</b>	<ul style="list-style-type: none"> <li>• Allows larger volume collection</li> </ul>	<ul style="list-style-type: none"> <li>• Anesthesia is required</li> <li>• Cardiac puncture is a risk</li> <li>• Requires specialized training and proper restraint</li> </ul>

#### 355.4.7.5 TABLE 2 (Non Survival blood collection)

*Note that any survival method listed above may be used as a terminal method as well.*

Collection Site	Advantages	Disadvantages
<b>Cardiac puncture/cardiocentesis</b>	<ul style="list-style-type: none"> <li>• Allows for maximum blood volume collection</li> </ul>	<ul style="list-style-type: none"> <li>• Non survival procedure only</li> <li>• Anesthesia is required</li> </ul>
<b>Aorta or Caudal Vena Cava</b>	<ul style="list-style-type: none"> <li>• Allows for maximum blood volume collection</li> <li>• Sterile sample possible</li> </ul>	<ul style="list-style-type: none"> <li>• Non survival procedure only</li> <li>• Anesthesia is required</li> <li>• Requires surgical approach (laparotomy)</li> </ul>

#### 355.4.7.6 References

- Animal Welfare Inspection Guide. United States Department of Agriculture. September 2013. Accessed on the www on 3/18/2014 at: [http://www.aphis.usda.gov/animal\\_welfare/downloads/Inspection%20Guide%20-%20November%202013.pdf](http://www.aphis.usda.gov/animal_welfare/downloads/Inspection%20Guide%20-%20November%202013.pdf).
- Donovan J and P Brown. 2006. *Blood collection. Care and Handling of Laboratory Animals in Current Protocols in Immunology*. John Wiley & Sons, Inc. 1.7.1-1.7.9.

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### 355.4.8 Mice

**355.4.8.1** The following guidelines refer to the most frequently used survival sampling sites for mice: a) submandibular vein; b) tail vein/artery; c) saphenous vein and d) jugular vein. The description and guidelines for less common survival bleeding sites requiring specific scientific justification and case-by-case IACUC approval, such as sublingual vein, penile vein, femoral artery, tail tip removal and dorsal pedal vein, are available upon request from the respective Training Coordinators. The use of the retro-orbital plexus requires plausible specific scientific justification, demonstration of competency, and case-by-case IACUC approval.

**355.4.8.2** For specific information on collection volumes and universal guidance, please refer to the preamble of this policy. In addition to these matters, for specific information on techniques, recommended supplies and equipment, and pre- and post-procedural care considerations, as well as to arrange for any training, please contact the Training Coordinator at the appropriate facility.

- **DAR Training Request:** [http://www.dar.emory.edu/forms/training\\_wrkshp.php](http://www.dar.emory.edu/forms/training_wrkshp.php)
- **Yerkes National Primate Research Center Training:** Dhaval Vyas at [Dhaval.Vyas@emory.edu](mailto:Dhaval.Vyas@emory.edu), 404-727-9675

**355.4.8.3** A list of the considerations that should guide the choice of survival blood collection route(s) is provided in Table 1. Note that any survival method listed may be used as a terminal method as well.

**355.4.8.4 TABLE 1 (Survival blood collection)**

Collection Site	Advantages	Disadvantages
<b>Submandibular Sampling</b>	<ul style="list-style-type: none"> <li>• Preferred blood collection method</li> <li>• Maximum allowable sample volume with minimal trauma</li> <li>• Sterile sample collection possible</li> </ul>	<ul style="list-style-type: none"> <li>• Must be securely restrained</li> <li>• Require some specialized training</li> <li>• Yields a large sample so should not be used for frequent small sampling/repeated serial sampling</li> </ul>



Collection Site	Advantages	Disadvantages
<p><b>Saphenous Sampling (medial or lateral approach)</b></p>	<ul style="list-style-type: none"> <li>• Anesthesia not required</li> <li>• Excellent technique for serial blood sampling</li> <li>• Moderate volume of blood can be collected</li> </ul>	<ul style="list-style-type: none"> <li>• Requires some specialized training</li> <li>• Specialized equipment required</li> </ul>
<p><b>Jugular</b></p>	<ul style="list-style-type: none"> <li>• Maximum volume of blood can be collected</li> <li>• Result in high quality sample</li> <li>• Sterile sample possible</li> </ul>	<ul style="list-style-type: none"> <li>• Can be performed without anesthesia, however the use of anesthesia facilitates the procedure</li> <li>• Requires some specialized training</li> <li>• Specialized equipment required</li> <li>• Yields a large sample so should not be used for frequent small sampling/repeated serial sampling</li> </ul>
<p><b>Lateral Tail Vein or Ventral/Dorsal Artery Sampling (incision)</b></p>	<ul style="list-style-type: none"> <li>• Anesthesia not required</li> <li>• Repeated bleeding possible by removal of the scab</li> <li>• Vein is easily accessed</li> <li>• Sterile sample collection possible</li> </ul>	<ul style="list-style-type: none"> <li>• Must be securely restrained</li> <li>• Yields only small quantities</li> <li>• Some specialized equipment needed</li> </ul>
<p><b>Tail tip amputation</b> Segmental tail amputation is only allowed under very special circumstances when scientifically justified. Please contact Training Coordinator or Veterinary staff.</p>	<ul style="list-style-type: none"> <li>• Serial blood sampling is possible via scab removal.</li> <li>• Anesthesia may not be required</li> </ul>	<ul style="list-style-type: none"> <li>• Requires restraint</li> <li>• Only 1-2 mm length single amputation allowed</li> <li>• Yields only a few drops of blood.</li> </ul>

Collection Site	Advantages	Disadvantages
<b>Retro-orbital Sinus</b> Requires specific and plausible scientific justification and case-by-case IACUC approval as well as competency assessment/training.	<ul style="list-style-type: none"> <li>• Yields moderate to large volume of blood</li> <li>• Rapid</li> <li>• Sterile sample collection possible</li> </ul>	<ul style="list-style-type: none"> <li>• Anesthesia is required</li> <li>• Is a discouraged technique due to high risk of injury to the eye and surrounding structures</li> <li>• 2 blood collections per eye maximum (eyes must be alternated between collections)</li> <li>• 2 weeks minimum between successive bleeds on an eye.</li> </ul>

**355.4.8.5** The following guidelines refer to the most frequently used non survival sampling sites for mice: a) Retro-orbital plexus; b) cardiac puncture; c) axillary plexus cut down, d) aorta or vena cava and e) decapitation.

A list of the issues that should guide the choice of non-survival blood collection route(s) is provided in Table 2.

**355.4.8.6 TABLE 2 (Non Survival blood collection)**

*Note that any survival method listed above may be used as a means to collect blood at euthanasia.*

Collection Site	Advantages	Disadvantages
<b>Decapitation</b>	<ul style="list-style-type: none"> <li>• Allows for large volumes of mixed blood to be collected</li> </ul>	<ul style="list-style-type: none"> <li>• Sample may be contaminated</li> <li>• Aesthetically displeasing</li> <li>• Special equipment necessary</li> <li>• Potentially hazardous for operator</li> </ul>
<b>Cardiac puncture/cardiocentesis</b>	<ul style="list-style-type: none"> <li>• Allows for maximum blood volume collection</li> </ul>	<ul style="list-style-type: none"> <li>• Non survival procedure only</li> <li>• Anesthesia is required</li> </ul>
<b>Retro-orbital Sinus</b>	<ul style="list-style-type: none"> <li>• Yields moderate to large volume of blood collected</li> </ul>	<ul style="list-style-type: none"> <li>• Anesthesia is required</li> </ul>
<b>Axillary plexus cut down</b>	<ul style="list-style-type: none"> <li>• Yields moderate to large volume of blood collected</li> </ul>	<ul style="list-style-type: none"> <li>• Non survival procedure only</li> <li>• Anesthesia is required</li> </ul>

Collection Site	Advantages	Disadvantages
<b>Aorta or Vena cava</b>	<ul style="list-style-type: none"> <li>• Allows for maximum blood volume collection</li> <li>• Sterile sample possible</li> </ul>	<ul style="list-style-type: none"> <li>• Non survival procedure only</li> <li>• Anesthesia is required</li> <li>• Requires surgical approach (laparotomy)</li> </ul>

### 355.4.8.7 References

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- Abatan OI, KB Welch, and Nemzek. 2008. *Evaluation of saphenous venipuncture and modified tail-clip blood collection in mice*. J Am Assoc Lab Anim Sci 47(3):8-15.
- BVA/FRAME/RSPCA/UFAW Joint Working Group on Refinement. 1993. Removal of blood from laboratory mammals and birds. First report of the BVA/FRAME/RSPCA/UFAW Joint Working Group on Refinement. Lab Anim 27(1):1-22.
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- Hem A, AJ Smith, and P Solberg. 1998. *Saphenous vein puncture for blood sampling of the mouse, rat, hamster, gerbil, guinea pig, ferret and mink*. Lab Anim 32(4):364-368.
- Hoff J. 2000. *Method of Blood Collection in the Mouse*. Lab Anim 29 (10): 47-53.
- National Institutes of Health. *Guidelines for survival bleeding of rats and mice*. Found on the www on 10/14/2013 at: [http://oacu.od.nih.gov/ARAC/documents/Rodent\\_Bleeding.pdf](http://oacu.od.nih.gov/ARAC/documents/Rodent_Bleeding.pdf)
- Nemzek JA, GL Bolgos, BA Williams, and DG Remick. 2001. *Differences in normal values for murine white blood cell counts and other hematological parameters based on sampling site*. Inflamm Res 50(10):523-527.
- Shirasaki Y, Y Ito, M Kikuchi, Y Imamura, and T Hayashi. 2012. *Validation studies on blood collection from the jugular vein of conscious mice*. J Am Assoc Lab Anim Sci 51(3):345-351.

### **355.4.9 Nonhuman Primates**

#### **355.4.9.1 Nonhuman Primates (other than Mangabey)**

**355.4.9.1.1** This Policy provides guidelines for safe blood withdrawal from non-human primates (NHP) and takes into account the blood volume to body weight ratio measured in milliliters of blood to kilogram of body weight. These guidelines are for normal healthy animals and animals who are aged, stressed, have spontaneous or experimental disease or females that are menstruating may not tolerate blood collections at maximum volumes.

For specific information on techniques, recommended supplies and equipment, and pre- and post-procedural care considerations, as well as to arrange for training, please contact:

Training Coordinator

Yerkes National Primate Research Center Training

Dhaval Vyas

[Dhaval.Vyas@emory.edu](mailto:Dhaval.Vyas@emory.edu)

404-727-9675

For specific information on animal training techniques, please contact:

Behavioral Management Department

Yerkes National Primate Research Center

Mollie Bloomsmith

[mabloom@emory.edu](mailto:mabloom@emory.edu)

404-727-8809

#### **355.4.9.1.2 Restraint during blood collection**

Instruction for blood collection and restraint procedures can be obtained from the Yerkes veterinary department. Instruction on applying animal training techniques for blood collection and restraint can be obtained from the behavioral management department.

Blood collection from NHP is most often performed while animals are restrained with chemical anesthesia. If smaller volumes are needed, NHP may be trained to cooperate by presenting a limb or other site for conscious sampling using techniques such as acclimation, desensitization and positive reinforcement training.

A list of the considerations that should guide the choice of survival blood collection route(s) is provided in Table 1.

**355.4.9.1.3 TABLE 1 (Survival blood collection)**

<b>Collection Site</b>	<b>Advantages</b>	<b>Disadvantages</b>
<b>Femoral</b>	<ul style="list-style-type: none"> <li>• Preferred blood collection method</li> <li>• Maximum allowable sample volume with minimal trauma</li> <li>• Sterile sample collection is possible</li> </ul>	<ul style="list-style-type: none"> <li>• Requires “blind stick” based on anatomical landmarks</li> <li>• Requires anesthesia</li> <li>• Requires specialized training</li> </ul>
<b>Saphenous</b>	<ul style="list-style-type: none"> <li>• Site can be used for conscious blood collection</li> <li>• Sterile sample collection possible</li> <li>• Vein is easily visible</li> </ul>	<ul style="list-style-type: none"> <li>• Yields small quantities (&lt;5ml)</li> <li>• Must be securely restrained (conscious collection)</li> <li>• Animal requires specialized training (conscious collection)</li> <li>• Personnel requires specialized training (conscious collection)</li> </ul>
<b>Cephalic</b>	<ul style="list-style-type: none"> <li>• Sterile sample collection is possible</li> </ul>	<ul style="list-style-type: none"> <li>• Yields small quantities (&lt;5ml)</li> <li>• Requires anesthesia</li> </ul>
<b>Ear/Digit</b>	<ul style="list-style-type: none"> <li>• Site can be used for conscious blood collection</li> <li>• Minimal trauma</li> </ul>	<ul style="list-style-type: none"> <li>• Yields small quantities (few drops)</li> <li>• Animal requires specialized training (conscious collection)</li> <li>• Personnel requires specialized training (conscious collection)</li> </ul>

**355.4.9.1.4** The typical sites for blood collection include the femoral, saphenous, and cephalic veins. The saphenous vein is the site used for conscious sampling of small amounts (<5ml) of blood. If larger volumes are needed, the flow rates in the cephalic or saphenous veins are usually inadequate to prevent the vein from collapsing. Bleeding from the femoral vein requires a "blind stick" based on anatomical landmarks in that the femoral vein is not normally visible subcutaneously. All blood collection techniques require training and competence but conscious collections also require extensive training of the animal as well. Conscious sampling is currently only recommended for chimpanzees, macaques and New World Primates.

#### **355.4.9.1.5 General Considerations**

Calculation of a safe, maximum blood draw that has been used successfully in non-human primates is the 10%-10% rule, which states that the maximal blood sample size is 10% of a blood volume estimated to be 10% of the animal's body weight. The maximum blood collection (see Table 2) volume allowed is 10ml/kg for adult macaques and 6ml/kg for macaques less than 4 months old and adult new world monkeys based on the most recent lean body weight.

**355.4.9.1.6** When all blood components are not needed, blood samples may exceed the calculated limits if the plasma or red cells are returned to the animal after separation, along with appropriate fluid replacement. This has to be determined in consultation with the veterinary department.

**355.4.9.1.7 TABLE 2 (Maximum blood volume allowed)**

<b>Species</b>	<b>Max Blood volume</b>	<b>Time range *</b>	<b>Special Considerations<sup>@</sup></b>
Macaques and Chimpanzees >4 months of age	10ml/kg	Total amount collected over 28 days	Max amount may be reduced to 6-8ml/kg
Macaques and Chimpanzees <4 months of age and adult New world monkeys	6ml/kg	Total amount collected over 28 days	Max amount may be reduced per veterinary direction

**\* Blood can be collected over a 28 day rolling cycle that will start at a predetermined start date period that should be documented and accessible to the PI, research resources and the veterinary department. The 28 day period is not restricted to a calendar month so that in the case of maximum blood collection, the amount of blood collected on day 29 must be less than or equal to the amount collected on day 1.**

**<sup>@</sup> The maximum blood volume for collection is contingent on Hct or/and Hgb, health status, age, and time of female cycle. Animals who are aged, stressed, have spontaneous or experimental disease or females that are menstruating may not tolerate blood collections at maximum volumes.**

**355.4.9.1.8 Monitoring of animals**

**355.4.9.1.8.1** The blood collection site should be closely monitored for complete hemostasis throughout and after the recovery period to ensure hemostasis is complete.

**355.4.9.1.8.2** By monitoring the hematocrit (Hct) and/or hemoglobin (Hgb), it is possible to evaluate whether the animal has sufficiently recovered from a single or sequential blood draws. An acute blood loss can cause hypovolemic shock, physiological stress or even death. Sequential blood sampling that occurs too frequently may result in anemia. The amount of blood collected is also contingent upon the animal’s health status determined by the veterinarian. The volume may be decreased to 6-8ml/kg based on spontaneous or experimental disease or in menstruating females.

**355.4.9.1.8.3** Anemic animals will be treated based on the anemic status and according to veterinary recommendation.

- The blood collection site should be checked frequently during recovery and especially when the animal is returned to the cage.
- The animal should be checked again the following morning and closely monitored for any signs of abnormality at that time.

Hct level and/or	Hgb level	Anemic Status
25-30%	8.5-10g/dl	Mild
20-25%	8.0-8.5g/dl	Moderate
<20%	<8.0g/dl	Severe

**355.4.9.1.8.4** Animals with concurrent illness may not fall within described classifications, and will be evaluated by a veterinarian for treatment. Veterinary assessment may warrant decreased blood collection volumes until the anemia improves or resolves.

**355.4.9.1.8.5** If anemia develops the investigator should review the blood collection volumes with a veterinarian prior to the next blood collection.

### **355.4.9.2 Blood Collection Guidelines (Mangabey)**

#### **355.4.9.2.1 Restraint during blood collection**

A supervisor must approve all personnel from research resources and colony management before collecting blood samples from mangabeys. All mangabeys must be anesthetized prior to blood collection.

#### **355.4.9.2.2 Approved methods and sites for blood collection**

The typical sites for collection include the femoral, saphenous, and cephalic veins. The saphenous and cephalic veins are the site used for sampling of small amounts (3-5) of blood. If larger volumes are needed, the femoral vein should be used. Bleeding from the femoral vein requires a "blind stick" in that the femoral vein is not normally visible.

- The standard needle size should be 22G. If a larger needle is absolutely essential it should not exceed 20G
- The needle for the vacutainer should be no longer than 1" in length.
- Whenever possible the saphenous vein should be used for collections. (i.e. for small volumes of <5ml)
- Whenever feasible a butterfly blood collection set should be used to collect multiple tubes from one animal
- The phlebotomist should alternate between the left and right side when collecting from the femoral vein at different time points. This should be clearly documented and recorded in a manner that is accessible on a central animal records system.
- Individuals should only attempt 2 needle sticks total with minimal "fishing for the vein" on an animal before seeking assistance from another experienced individual.
- Upon completion of routine blood collection or attempted collection with some bleeding the site should be "held off" with manual pressure for a minimum of **5 minutes** that is counted with a timer to ensure hemostasis is complete.
- If the following conditions occur during blood collections then the site should be held off with manual pressure for a minimum of **10 minutes** that is counted with a timer to ensure hemostasis is complete.
  - If a larger gauge needle is used for collections
  - If a large volume of blood is collected
  - If an arterial stick is suspected.
  - If the collection had any complications

#### **355.4.9.2.3 TABLE 3 (Maximum blood volume allowed)**

Species	Max Blood Volume	Time Range	Special Considerations <sup>@</sup>
Mangabey	10ml/kg	Total amount collected over 28 days	Max amount may be reduced per veterinary direction

<sup>@</sup> **The maximum blood volume for collection is contingent on Hct or/and Hbg, health status, age, and time of female cycle. Animals who are aged, stressed, have spontaneous or experimental disease or females that are menstruating may not tolerate blood collections at maximum volumes.**

#### 355.4.9.2.4 Monitoring of Animals

The blood collection site of the animal should be closely monitored for complete hemostasis throughout and after the recovery period to ensure hemostasis is complete.

- The leg should be checked frequently during recovery and especially when the animal is returned to the cage.
- The leg should be checked again 2-4 hours after recovery.
- The leg should be checked again the following morning and the animal closely monitored for any signs of lameness at that time.

**355.4.9.2.5** Mangabeys over 16 years of age are considered at higher risk for complications and will have additional collection restraints

- Mangabeys over 16 years of age should only have large research blood collections once every 2 months
- Mangabeys over 16 years of age will be limited to 30mls of blood collection at a single time point, regardless of body weight

#### 355.4.9.2.6 References:

- The Oregon Health and Science University. Animal Care and Use Program Policies & Procedures
- [http://labanimals.awionline.org/Lab\\_animals/biblio/la-refin.htm](http://labanimals.awionline.org/Lab_animals/biblio/la-refin.htm)
- <http://www.iacuc.ucsf.edu/Proc/awMaccoll.asp>
- <http://www.ahc.umn.edu/rar/blood.html>
- <https://www.citiprogram.org/members/learnersII/moduletext.asp?strKeyID=A39C00B2-248...>
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- Fox James G., Anderson L, et al. 2002. Laboratory Animal Medicine, second edition

### 355.4.10 Rabbits

**355.4.10.1** The most common method of survival blood collection is to access the central artery of the ear. The most common terminal techniques are also exsanguination via central artery of the ear, cardiocentesis, or surgical access of an internal vessel.



**355.4.10.2** The guidelines in Table 1 refer to the most frequently used survival collection sites for rabbits:

- The use of topical compounds or techniques that may enhance the volume of blood collected from the ear requires approval from the Animal Care and Use Committee.
- For universal guidance, please refer to the preamble of this policy.
- For the most specific information on techniques, including those requiring specific scientific justification and case-by-case IACUC approval, recommended supplies and equipment, and pre- and post-procedural care considerations, please contact the Training Coordinator at the appropriate facility.

- **DAR Training Request:** [http://www.dar.emory.edu/forms/training\\_wrkshp.php](http://www.dar.emory.edu/forms/training_wrkshp.php)

- Rabbits are highly prone to back injuries. For safe handling of subject, training of the operators and conditioning of non-sedated rabbit is required for restraint and sample collection.

**355.4.10.3 Circulating blood volume**

Some evidence suggests the safe maximum circulating blood volume is 56 ml/kg (Harkness and Wagner, 1989; McLaughlin and Fish, 1994; Suckow, et al, 2002) although USDA recognizes 62 ml/kg.

**355.4.10.4** Blood collection limits for rabbits are 7 ml/kg every 3 weeks (USDA, 2013).

**355.4.10.5** Where the IACUC approves > 7 ml /kg/month cumulative, non-terminal blood collection, the rabbit should be monitored regularly for distress minimally checking the hematocrit prior to blood collection to ensure that it is in the normal 30-50% range (USDA, 2013).

**355.4.10.6** For universal guidance, please refer to the preamble of this policy. For specific information on techniques, recommended supplies and equipment, and pre- and post-procedural care considerations, as well as to arrange for any training, please contact the Training Coordinator at the appropriate facility.

- **DAR Training Request:** [http://www.dar.emory.edu/forms/training\\_wrkshp.php](http://www.dar.emory.edu/forms/training_wrkshp.php)

**355.4.10.7 TABLE 1 (Survival blood collection)**

Collection Site	Advantages	Disadvantages
<b>Ear Arteries and Veins</b>	<ul style="list-style-type: none"> <li>• A preferred blood collection method</li> <li>• Both artery and vein easily accessible from the dorsal ear</li> <li>• Sterile sample collection possible</li> <li>• Blood-gas analysis and direct blood pressure measurement possible</li> <li>• Anesthesia not required</li> <li>• Catheterization possible</li> </ul>	<ul style="list-style-type: none"> <li>• Requires some specialized training</li> <li>• Can obtain small volumes (0.1-5.0mls)</li> </ul>

Collection Site	Advantages	Disadvantages
<b>Indwelling Catheters</b>	<ul style="list-style-type: none"> <li>• Anesthesia not required for sample collection after catheter implantation</li> <li>• Repeated collections possible</li> <li>• Port is easily accessed</li> <li>• Sterile sample collection possible</li> <li>• Excellent technique for serial blood sampling</li> <li>• Yields potentially large quantities</li> </ul>	<ul style="list-style-type: none"> <li>• Requires specialized training</li> <li>• Surgery is required for deep implantation of catheter</li> <li>• Specialized equipment needed</li> </ul>
<b>Jugular</b>	<ul style="list-style-type: none"> <li>• Large volume of blood can be collected</li> <li>• Result in high quality sample</li> <li>• Sterile sample possible</li> </ul>	<ul style="list-style-type: none"> <li>• The use of anesthesia facilitates the procedure and is preferred</li> <li>• Requires some specialized training</li> <li>• Requires two people</li> <li>• Yields a large sample so should not be used for frequent small sampling/repeated serial sampling</li> </ul>
<b>Saphenous Vein</b>	<ul style="list-style-type: none"> <li>• Especially useful for small subjects where the vein is larger than the aural vessels.</li> <li>• Can be done without anesthesia.</li> <li>• Reasonable blood volumes can be obtained (<math>\leq 3</math> ml)</li> <li>• Sterile sample possible</li> <li>• Catheterization possible</li> </ul>	<ul style="list-style-type: none"> <li>• Lateral recumbency for vein access requires specialized training</li> <li>• Anesthesia/sedation are advised unless the rabbit is conditioned to handling and/or the procedure</li> <li>• Vein is fragile; hematoma risk</li> </ul>

**355.4.10.8 The guidelines in Table 2 refer to the most frequently used non-survival sampling sites for rabbits:** Both techniques (Cardiac puncture and carotid artery) require specific and plausible scientific justification and case-by-case IACUC approval as well as competency assessment/training. A list of issues that should guide the choice of non-survival blood collection routes is provided. All techniques described in the survival section can be performed as non-survival procedures.

**355.4.10.9 TABLE 2 (Non-survival blood collection)**

Note that any survival method listed above may be used as a terminal method as well.

Collection Site	Advantages	Disadvantages
<b>Carotid Artery</b> Requires specific and plausible scientific justification and case-by-case IACUC approval as well as competency assessment/training.	<ul style="list-style-type: none"> <li>• Large volume of blood can be collected</li> <li>• Sterile sample collection possible</li> </ul>	<ul style="list-style-type: none"> <li>• Non survival procedure only</li> <li>• General anesthesia is required</li> <li>• Requires surgical approach</li> </ul>
<b>Cardiac puncture/cardiocentesis</b> Requires specific and plausible scientific justification and case-by-case IACUC approval as well as competency assessment/training.	<ul style="list-style-type: none"> <li>• Yields maximum volume of blood</li> <li>• Rapid</li> <li>• Sterile sample collection possible</li> </ul>	<ul style="list-style-type: none"> <li>• Non survival procedure only</li> <li>• General anesthesia is required</li> </ul>

**355.4.10.10 References**

- Animal Welfare Inspection Guide. United States Department of Agriculture. September 2013. Accessed on the www on 3/18/2014 at: [http://www.aphis.usda.gov/animal\\_welfare/downloads/Inspection%20Guide%20-%20November%202013.pdf](http://www.aphis.usda.gov/animal_welfare/downloads/Inspection%20Guide%20-%20November%202013.pdf).
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**355.4.11 Rats**

**355.4.11.1** The most frequently used survival sampling sites for rats not requiring surgical intervention are lateral tail vein, lateral saphenous vein, jugular vein, anterior vena cava, ventral tail artery, and tail tip snip. The use of the retro-orbital plexus requires plausible, specific scientific justification, demonstration of competency, and case-by-case IACUC approval.

**355.4.11.2** For specific information on collection volumes and universal guidance, please refer to the preamble of this policy. In addition to these matters, for specific information on techniques, recommended supplies and equipment, and pre- and post-procedural care considerations, as well as to arrange for any training, please contact the Training Coordinator at the appropriate facility.

- **DAR Training Request:** [http://www.dar.emory.edu/forms/training\\_wrkshp.php](http://www.dar.emory.edu/forms/training_wrkshp.php)
- **Yerkes National Primate Research Center Training:** Dhaval Vyas at [Dhaval.Vyas@emory.edu](mailto:Dhaval.Vyas@emory.edu), 404-727-9675

**355.4.11.3** A list of the issues that should guide the choice of blood collection route(s) is provided in the two tables below with Table 1 for survival collections and Table 2 for terminal phlebotomy. Note that any survival method listed may be used as a terminal method as well.

**355.4.11.4 Table 1: Survival Blood Collection**

<b>Collection Site</b>	<b>Advantages</b>	<b>Disadvantages</b>
<b>Lateral tail vein nick</b>	<ul style="list-style-type: none"> <li>• Anesthesia not necessary</li> <li>• Easily accessed</li> <li>• Repeated collection possible</li> <li>• Needle or lancet used</li> </ul>	<ul style="list-style-type: none"> <li>• Requires restraint device</li> <li>• Yields only small quantities</li> <li>• Tail warming may be needed</li> <li>• Special equipment may be needed</li> </ul>
<b>Lateral saphenous vein</b>	<ul style="list-style-type: none"> <li>• Anesthesia not required</li> <li>• Repeated sampling possible</li> <li>• Moderate volumes can be obtained</li> </ul>	<ul style="list-style-type: none"> <li>• Variable sample quality/quantity of sample</li> <li>• Special equipment needed</li> </ul>
<b>Ventral tail artery puncture</b>	<ul style="list-style-type: none"> <li>• Yields moderate volumes</li> </ul>	<ul style="list-style-type: none"> <li>• General anesthesia may be necessary</li> <li>• Special equipment may be needed</li> </ul>
<b>Jugular vein and anterior vena cava</b>	<ul style="list-style-type: none"> <li>• Medium to large volumes can be collected.</li> <li>• Results in high quality sample</li> <li>• Sterile samples possible</li> </ul>	<ul style="list-style-type: none"> <li>• Not useful for repeated purposes</li> <li>• General anesthesia required</li> </ul>
<b>Sublingual vein</b>	<ul style="list-style-type: none"> <li>• Allows for repeated sampling, even same day.</li> <li>• Yields moderate volumes</li> </ul>	<ul style="list-style-type: none"> <li>• Requires anesthesia</li> <li>• Training necessary</li> <li>• May risk sublingual hematoma</li> </ul>

<p><b>Retro-orbital Sinus</b> Requires specific and plausible scientific justification and case-by-case IACUC approval as well as competency assessment/training.</p>	<ul style="list-style-type: none"> <li>• Yields moderate to large volume of blood</li> <li>• Rapid</li> <li>• Sterile sample collection possible</li> <li>• Use of lateral or medial canthus is possible.</li> </ul>	<ul style="list-style-type: none"> <li>• Anesthesia is required</li> <li>• Is a discouraged technique due to high risk of injury to the eye and surrounding structures</li> <li>• 2 blood collections per eye maximum (eyes must be alternates between collections)</li> <li>• 2 weeks minimum between successive bleeds on an eye.</li> </ul>
<p><b>Tail tip amputation</b> Segmental tail amputation is only allowed under very special circumstances when scientifically justified. Please contact Training Coordinator or Veterinary staff</p>	<ul style="list-style-type: none"> <li>• Anesthesia not necessary</li> <li>• Allows for sequential sampling by removal of the scab at the tail tip.</li> </ul>	<ul style="list-style-type: none"> <li>• Requires restraint</li> <li>• Only 1-2 mm length single amputation allowed</li> <li>• Yields only a few drops of blood.</li> </ul>

**355.4.11.5** The following guidelines refer to the most frequently used non survival sampling sites for rats: a) cardiac puncture; b) abdominal surgical approach to the caudal vena cava; c) axillary plexus cut down, and d) decapitation. A list of the issues that should guide the choice of non-survival blood collection route(s) is provided in Table 2.

**355.4.11.6 Table 2: Non-survival Blood Collection**

*Note that any survival method listed above may be used as a terminal method as well.*

<b>Collection Site</b>	<b>Advantages</b>	<b>Disadvantages</b>
<b>Cardiac Puncture/cardiocentesis</b>	<ul style="list-style-type: none"> <li>• Allows for maximum blood volume collection</li> <li>•</li> </ul>	<ul style="list-style-type: none"> <li>• Nonsurvival procedure only</li> <li>• Requires anesthesia</li> </ul>
<b>Caudal vena cava</b>	<ul style="list-style-type: none"> <li>• Allows for maximum blood volume collection</li> <li>• Sterile samples possible</li> <li>•</li> </ul>	<ul style="list-style-type: none"> <li>• Nonsurvival procedure only</li> <li>• Requires surgical approach</li> <li>• Requires anesthesia</li> </ul>
<b>Axillary plexus cut down</b>	<ul style="list-style-type: none"> <li>• Yields relative large volumes</li> </ul>	<ul style="list-style-type: none"> <li>• Nonsurvival procedure only</li> <li>• Sample may be contaminated</li> </ul>
<b>Decapitation</b>	<ul style="list-style-type: none"> <li>• Allows for large volumes of mixed blood to be collected.</li> </ul>	<ul style="list-style-type: none"> <li>• Sample may be contaminated</li> <li>• Aesthetically displeasing</li> <li>• Special equipment necessary</li> </ul>

**355.4.11.7 References**

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### 355.4.12 Sheep

#### 355.4.12.1 Restraint

Sheep are fairly docile animals and generally can be physically restrained for blood collection. It is recommended to have one person restrain the animal while the other collects the blood.

For universal guidance, please refer to the preamble of this policy. In addition, for specific information on techniques, recommended supplies and equipment, and pre- and post-procedural care considerations, please contact the Training Coordinator at the appropriate facility.

- DAR training request: [http://www.dar.emory.edu/forms/training\\_wrkshp.php](http://www.dar.emory.edu/forms/training_wrkshp.php)

#### 355.4.12.2 Table 1: Survival Blood Collection

Vessel	Advantages	Disadvantages
<b>Jugular vein</b>	<ul style="list-style-type: none"> <li>• &gt;20ml volume can be collected from this site.</li> <li>• Most common and reliable collection site.</li> </ul>	
<b>Cephalic vein</b>	<ul style="list-style-type: none"> <li>• Easily accessed, particularly by those with experience with the vessel in dogs.</li> <li>• Repeated collection possible</li> <li>• Catheterization is possible</li> </ul>	<ul style="list-style-type: none"> <li>• Smaller volumes can be collected from this site.</li> <li>• Restraint may require multiple handlers</li> <li>• May require anesthesia for adequate restraint.</li> </ul>

#### 355.4.12.3 Table 2: Non-survival Blood Collection

*Note that any survival method listed above may be used as a terminal method as well.*

Collection Site	Advantages	Disadvantages
<b>Cardiac Puncture/cardiocentesis</b>	<ul style="list-style-type: none"> <li>• Allows for maximum blood volume collection</li> </ul>	<ul style="list-style-type: none"> <li>• Nonsurvival procedure only</li> <li>• Requires anesthesia</li> </ul>
<b>Aorta, caudal vena cava or other internal vessel by surgical approach</b>	<ul style="list-style-type: none"> <li>• Allows for maximum blood collection</li> <li>• Sterile sample possible</li> </ul>	<ul style="list-style-type: none"> <li>• Nonsurvival procedure only</li> <li>• Requires anesthesia</li> <li>• Requires surgical approach</li> </ul>

#### 355.4.12.4 References

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### 355.4.13 Swine

#### 355.4.13.1 Restraint

Physical restraint can be stressful to swine that are unconditioned to human handling. Additionally, it may be physically challenging and dangerous to manually restrain large swine. Consequently, short-term chemical restraint is typically preferred for blood collection in order to reduce stress on both the animal and personnel, facilitate smooth collection of the sample, and reduce the risk of vascular trauma. An exception to this rule of thumb is that small to medium sized swine can be physically restrained in a sling apparatus. When using a sling, swine must first be acclimated to the device, otherwise animals may struggle and quickly become stressed. Very small swine may also be manually restrained in the handler’s arms.

**355.4.13.2 Refinements:** The use of vascular access ports are recommended when serial samples are required over a period of days or weeks.

**355.4.13.3** For universal guidance, please refer to the preamble of this policy. In addition, for specific information on techniques, recommended supplies and equipment, and pre- and post-procedural care considerations, as well as to arrange for training, please contact the Training Coordinator at the appropriate facility.

- DAR Training Request: [http://www.dar.emory.edu/forms/training\\_wrkshp.php](http://www.dar.emory.edu/forms/training_wrkshp.php)

**355.4.13.4 Table 1: Site of Collection**

Vessel	Advantages	Disadvantages
<b>Cranial vena cava</b>	<ul style="list-style-type: none"> <li>• &gt;20ml volume can be collected from this site</li> </ul>	<ul style="list-style-type: none"> <li>• Must be taken from the right side to avoid injury to the vagus nerve and thoracic duct.</li> <li>• This is a blind technique requiring additional training.</li> <li>• One week recommended between collections due to the propensity for hematomas at this site.</li> </ul>
<b>Jugular vein</b>	<ul style="list-style-type: none"> <li>• Up to 20ml can be collected from this site</li> </ul>	<ul style="list-style-type: none"> <li>• This is a blind technique requiring additional training.</li> </ul>
<b>Lateral saphenous vein</b>	<ul style="list-style-type: none"> <li>• Useful on smaller pigs where the vessel is more easily visible</li> </ul>	<ul style="list-style-type: none"> <li>• &lt;5ml volumes can be collected from this site</li> <li>• Requires sedation</li> </ul>
<b>Marginal ear vein</b>	<ul style="list-style-type: none"> <li>• May be used for serial collections over a short period by alternating ears and moving the puncture site successively towards the ear base</li> </ul>	<ul style="list-style-type: none"> <li>• &lt;2ml volumes can be collected from this site</li> <li>• Requires sedation/anesthesia</li> </ul>

**355.4.13.5 Table 2: Non-survival Blood Collection**



*Note that any survival method listed above may be used as a terminal method as well.*

Collection Site	Advantages	Disadvantages
<b>Cardiac Puncture/cardiocentesis</b>	<ul style="list-style-type: none"> <li>Allows for maximum blood volume collection</li> </ul>	<ul style="list-style-type: none"> <li>Nonsurvival procedure only</li> <li>Requires anesthesia</li> </ul>
<b>Aorta, caudal vena cava or other internal vessel by surgical approach</b>	<ul style="list-style-type: none"> <li>Allows for maximum blood collection</li> </ul>	<ul style="list-style-type: none"> <li>Nonsurvival procedure only</li> <li>Requires anesthesia</li> <li>Requires surgical approach</li> </ul>

**355.4.13.6 References**

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**355.4.14 Voles**

**355.4.14.1** Voles tend to be more aggressive than mice, but can be successfully restrained manually by properly trained, experienced personnel or by using a restraint tube for blood collection.

**355.4.14.2** For specific information on collection volumes and universal guidance, please refer to the preamble of this policy. In addition to these matters, for specific information on techniques, recommended supplies and equipment, and pre- and post-procedural care considerations, as well as to arrange for training, please contact the Training Coordinator at the appropriate facility.

- DAR Training Request: [http://www.dar.emory.edu/forms/training\\_wrkshp.php](http://www.dar.emory.edu/forms/training_wrkshp.php)
- Yerkes National Primate Research Center Training: Dhaval Vyas at [Dhaval.Vyas@emory.edu](mailto:Dhaval.Vyas@emory.edu), 404-727-9675

**355.4.14.3** A list of the considerations that should guide the choice of survival blood collection route(s) is provided in Table 1. Note that any survival method may be used as a terminal method as well.

**355.4.14.4 TABLE 1 (Survival blood collection)**

<b>Collection Site</b>	<b>Advantages</b>	<b>Disadvantages</b>
<b>Lateral Saphenous Vein</b>	<ul style="list-style-type: none"> <li>• Anesthesia not required</li> <li>• Repeated bleeding possible by removal of the scab</li> <li>• Small to moderate volume of blood can be collected</li> </ul>	<ul style="list-style-type: none"> <li>• Requires some specialized training</li> <li>• Requires proper restraint and restrainer</li> </ul>
<b>Submandibular Vein</b>	<ul style="list-style-type: none"> <li>• In theory, offers the potential for large volumes and sterile samples.</li> </ul>	<ul style="list-style-type: none"> <li>• Not yet demonstrated to be a useful technique in voles.</li> <li>• Will require secure restraint and specialized training</li> <li>• Volumes yielded maybe in excess of need.</li> </ul>
<b>Sublingual Vein</b>	<ul style="list-style-type: none"> <li>• Good for small volumes</li> </ul>	<ul style="list-style-type: none"> <li>• Anesthesia required</li> <li>• Requires 2 people for proper collection</li> <li>• Excessive bleeding is common; proper hemostasis must be ensured</li> </ul>
<p><b>Retro-orbital Sinus</b></p> <p>Requires specific and plausible scientific justification and case-by-case IACUC approval as well as competency assessment/training.</p>	<ul style="list-style-type: none"> <li>• Yields moderate to large volume of blood</li> <li>• Rapid</li> <li>• Sterile sample collection possible</li> </ul>	<ul style="list-style-type: none"> <li>• Anesthesia is required</li> <li>• Is a discouraged technique due to high risk of injury to the eye and surrounding structures</li> <li>• 2 blood collections per eye maximum (must alternate eye between collections)</li> <li>• 2 weeks minimum between successive bleeds on an eye.</li> </ul>
<b>Jugular Vein</b>	<ul style="list-style-type: none"> <li>• Allows larger volume collection</li> <li>• Result in high quality sample</li> <li>• Sterile sample possible</li> </ul>	<ul style="list-style-type: none"> <li>• Requires anesthesia</li> <li>• Requires specialized training</li> <li>• Not suitable for frequent small samplings or serial sampling due to potential for vascular damage</li> </ul>

**355.4.14.5 TABLE 2 (Non Survival blood collection)**

*Note that any survival method listed above may be used as a terminal method as well.*

<b>Collection Site</b>	<b>Advantages</b>	<b>Disadvantages</b>
<b>Cardiac puncture/cardiocentesis</b>	<ul style="list-style-type: none"> <li>• Allows for maximum blood volume collection</li> <li>• Sterile sample is possible</li> </ul>	<ul style="list-style-type: none"> <li>• Anesthesia is required</li> </ul>
<b>Aorta or Caudal Vena Cava</b>	<ul style="list-style-type: none"> <li>• Allows for maximum blood volume collection</li> <li>• Sterile sample possible</li> </ul>	<ul style="list-style-type: none"> <li>• Anesthesia is required</li> <li>• Requires surgical approach (laparotomy)</li> </ul>
<b>Decapitation</b>	<ul style="list-style-type: none"> <li>• Allows for large volumes of blood to be collected</li> </ul>	<ul style="list-style-type: none"> <li>• Deep level of anesthesia is required or can be done immediately after euthanasia</li> <li>• Sample may be contaminated and mixed.</li> <li>• Aesthetically displeasing</li> <li>• Special equipment and training necessary</li> <li>• Potentially hazardous for operator</li> <li>• Low throughput technique</li> </ul>
<b>Retro-orbital Sinus</b>	<ul style="list-style-type: none"> <li>• Allows for moderate to large volume of blood to be collected</li> </ul>	<ul style="list-style-type: none"> <li>• Anesthesia is required</li> </ul>
<b>Axillary plexus cut down</b>	<ul style="list-style-type: none"> <li>• Allows for moderate to large volume of blood to be collected</li> </ul>	<ul style="list-style-type: none"> <li>• Non survival procedure only</li> <li>• Anesthesia is required</li> </ul>

**355.4.14.6 References**

- Clarke, JR. 1999. *Voles*. In: The UFAW Handbook on The Care and Management of Laboratory Animals (Poole T and English P, eds). 7<sup>th</sup> edition, volume 1, pp. 331-344.
- Donnelly, TM and Quimby, FW. 2002. *Biology and Diseases of Other Rodents*. In: Laboratory Animal Medicine (Fox JG, Anderson LC, Loew FM and FW Quimby, eds.), Academic Press, New York, pp. 279-281.
- Donovan J and P Brown. 2006. *Blood collection. Care and Handling of Laboratory Animals in Current Protocols in Immunology*. John Wiley & Sons, Inc, pp. 1.7.1-1.7.9.
- Joslin JO. 2009. *Blood collection techniques in exotic small mammals*. Journal of Exotic Pet Medicine. 18(2): 117-139.
- NC3Rs microsite: <http://www.nc3rs.org.uk/bloodsamplingmicrosite/page.asp?id=313>

### **355.6 Property Documents**

Authored by: IACUC Blood Collection Subcommittee

Administering Division/Department: IACUC Office

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