

ANIMAL USE TRAINING SESSION – PIG

Participants in the Pig Animal Use Training Session, in writing or in speech, or by demonstration will be able to:

1. Demonstrate proper techniques for handling and restraint of pigs for routine procedures, i.e., physical examination, administration of medicine, and venipuncture.
2. Observe pigs for normal and abnormal physical and behavioral changes, (i.e., charging, diarrhea, lameness, etc.) and report such findings to the appropriate veterinary medical personnel.
3. Demonstrate the site and techniques for administration of medication by the following routes:
 - a. subcutaneous
 - b. intramuscular
 - c. intravenous
 - d. oral
4. Obtain blood samples from pigs and describe the advantages and disadvantages of different routes.
5. Discuss the appropriate methods of sedation and anesthesia (including agent, route, and monitoring).
6. Discuss indications and methods of providing analgesia.
7. Discuss appropriate methods of euthanasia.
8. Discuss appropriate location and techniques for survival surgery in pigs.

INTRODUCTORY DATA

1. Swine in Biomedical Research

Cardiovascular System

Electrical transmission and conduction
Myocardial infarcts
Patent ductus arteriosus
Hypertrophic and congestive cardiomyopathies
Cardiovascular surgery (transplantation, prosthetics)

Gastrointestinal System

Esophageal and gastric ulcers
Nutritional and metabolic studies
Atherosclerosis (spontaneous and induced)
GI surgery

Skin

Familial melanomas in Sinclair miniature swine
Transdermal drug delivery systems
Surgical models: Wound healing
 Skin flaps
 Grafts

Dental

2. Classification

Order: Artiodactyla
Family: Suidae
Genus: Sus

Common farm pig breeds:

Berkshire	Poland China
Chester White	Spotted Poland China
Duroc	Landrace
Hampshire	Tamworth
Hereford	Yorkshire
Pietrain	Sinclair

Miniature pig breeds:

Yucatan	Pitman-Moore
Hanford	Hormel
Gottingen	

3. Husbandry

A. Housing:

Pigs may be housed in stalls or in dog runs on solid floors bedded with shavings or on open flooring.

Lighting: 12 hours on and 12 hours off. (Pigs up to 30 days of age should have 24 hour lighting to encourage round the clock feeding.)

Temperature recommendations vary with age, breed, and weight:

Neonates:	32 - 35°C (Thus, neonates should be housed with heat lamps or mats.)
Weanlings:	25 - 27°C
Hanford minipigs:	17 - 20°C
Yucatan minipigs and micropigs	20 - 25°C

With younger pigs, it is especially important to remember that the ideal temperature must be at the **level** of the pig.

B. Feed and Water

Ad libitum water should be given by automatic watering device or water pan.

Diet recommendations at the University of Washington:

Nursing piglets and weanlings up to 4 weeks of age: "Litter milk" supplement ad libitum.

Weanlings 4 – 8 weeks:	"Starter Diet"
70 - 125 lbs. (>8 weeks):	"Grower Diet"
Adult pigs and those >125 lbs.:	"Maintenance Diet"
Adult minipigs:	"Minipig Chow"

Many commercial diets contain antibiotics.

4. Malignant Hyperthermia

Porcine Stress Syndrome

Genetic predisposition in Landrace, Pietrain, and Poland China breeds.

- Syndrome characterized by rapid increased rectal temperature (42 - 45°C), muscle rigidity, tachycardia, and metabolic acidosis.
- Precipitated by halothane, succinylcholine, curare, gallamine.

5. Selective Normative Data

A. Mini/Micro Pigs

1. Temperature:
 - Rectal temperature 39.0°C (+/- 0.2)*
 - Skin temperature 33.6°C (+/- 0.3)*
 - * Room temperature at pig level 20.6°C (+/- 0.76)
2. Oxygen Consumption: 6.22 ml/kg/min.
3. Heat Production: 1.01 Kcal/min.
4. Respiration Rate: 30 breaths/min.
5. Pulse: 100 – 150 beats/min.
Sites:
 - Sublingual artery (*ventral surface of the tongue*)
 - Medial saphenous artery (*medial aspect of the distal femur/proximal tibia*)
 - Brachial artery (*medial aspect of the humeroradial joint*)
6. Blood Pressure: 130 – 60/105 – 115 mmHg
(10-25kg)
Site: Tail; good correlation to the venous pressure
7. Litter size: 5-6

B. Farm Pigs

1. Rectal Temperature:
 - Piglets (farm) 39.0 - 40.5°C
 - Adult (farm) 38.5 - 40.0°C
2. Heart Rate 60 - 80 beats/min.
3. Respiratory Rate 8 - 18 breaths/min.
4. Sexual Maturity 7 - 9 months
5. Estrus Cycle Frequency 18 - 24 days
6. Duration of Estrus 2 – 3 days
7. Gestation Period 115 days
8. Litter Size 9-10
9. Weaning Age 6-8 weeks (with prestarter ration and warmth)

NORMAL VALUES

	Hematological Value	Range
RBC (x 1,000,000/cubic mm)	7.62	+/- 0.69
Hgb (g/dl)	13.00	+/- 1.40
Hct. (ml%)	42.70	+/- 5.90
Sed. rate (mm/hr)	4.90	+/- 0.60
Platelets (x 1,000 cubic mm)	306.00	+/- 77.00
WBC (x 1,000 cubic mm)	16.40	+/- 1.80
Neutrophils (%)	30.00	+/- 9.00
Eosinophils (%)	4.20	+/- 1.00
Basophils (%)	1.10	+/- 0.90
Lymphocytes (%)	61.60	+/- 11.20
Monocytes (%)	3.50	+/- 1.60

WEIGHT

Weight (Kg): Varies widely with breed, gender, diet, and feed consumption

Age	Domestic Pig	Minipig	Micropig (CRL)
Newborn	0.9 - 1.4	NA	NA
3 Months	20 - 40	10 - 12	7 - 9
5 Months	100	30	19
8 Months	250 - 410	70 - 75	19

BIOCHEMICAL PARAMETERS

	MALE	FEMALE
Bilirubin (mg/dl)	0.20	0.15
Cholesterol (mg/dl)	154.00	151.00
Creatinine (mg/dl)	1.85	1.70
Glucose (mg/dl)	85.00	90.00
Urea nitrogen (mg/dl)	16.00	14.50
Uric acid (mg/dl)	1.22	1.15
Sodium (mEq/l)	142.00	149.00
Potassium (mEq/l)	5.60	6.20
Chloride (mEq/l)	100.00	105.00
Biocarbonate (mEq/l)	30.60	29.80
Phosphorus (mg/dl)	7.50	8.40
Calcium (mg/dl)	9.65	11.10
Magnesium (mg/dl)	1.60	2.80
Total Protein (g/dl)	4.9 – 7.0	
Albumen (g/dl)	2.8 – 5.0	
SGOT (IU/l)	10.0 – 37	
SGPT (IU/l)	15.0 – 36.0	
Alk phos (IU/l)	75.0 – 225.0	
CPK (IU/l)	3.0 – 650.0	
LDH (IU/l)	262.0 – 412.0	
Triglycerides (mg/dl)	56.0 – 103.0	

LABORATORY OUTLINE

1. **Physical Examination:**

- A. Always observe respiratory rate, anal discharge, lameness, etc. prior to attempting to catch the animal.
- B. Measurable parameters – Food and water intake, weight, temperature, blood counts, etc.

2. **Handling and Restraint:**

Always handle pigs firmly, but gently. Be prepared for vocalization.

- A. Manual Restraint: Leg lift (dangerous in larger pigs)
 Mouth snare
 V-trough
 Sling
 Squeeze board or panel (preferred method in many situations)

1. Slinging Procedure:

Place sling at entrance of room or pen in which pig is held, and move pig into the sling by hand or with panel. Unnecessary roughness should be avoided, as most pigs will accept sling restraint if the procedure is done quickly and without trouble. Slings should be done firmly, gently, and as quickly as possible once animal is approached for restraint.

One-person technique – Fasten wire panel to front of the sling prior to moving pig into sling. Move pig into sling and crank up quickly. Remove side panels and maneuver legs into appropriate leg holes and tie legs. Do not tie tight unless pig is struggling.

Two-person technique – Leave front of sling open and place second person in front. When pig enters sling, have that person put hands on pig's head or ears to stabilize and keep animal still. Crank up as quickly as possible, and proceed as described above.

Most pigs do not struggle in the sling. Restraining ropes attached to the legs should be adequately tied to prevent escape, but not excessively tight. Permanent damage to the soundness of the animals result from prolonged over-restraint by ropes tied too tight for an extended period of time. ropes should be ¼" nylon, 6 feet in length. Place soft bandage padding around ropes for long procedures.

- B. Chemical Restraint See Anesthesia and Sedation.

3. Methods of Identification:

Ear tag, ear notch, tattoo

4. Drug Administration Techniques and Blood Sampling:

- A. Subcutaneous - neck, flank
B. Intramuscular - neck, back of rear leg (pigs in general resist injections in the neck less than in the leg)
C. Intravascular - marginal ear vein:

1. Venipuncture for infusion or withdrawal of small quantities of blood.
 - a. Select butterfly infusion set with a 3/4" needle, 19-21 gauge and a 12" tubing.
 - b. Prep ear with 70% alcohol using care to protect the animal's eyes from excess run-off or splashing of alcohol.
 - c. Occlude vein with finger pressure on the proximal end of ear and insert needle, bevel up.

2. Catheterization of Ear Veins – see appendix A
 - a. Select catheter. 22 gauge intracatheters can be secured more easily than butterflies.
 - b. Prep ear with alcohol and "raise up" selected vein.
 - c. Insert needles and pass catheter through needle at least 6.0" into vein.

jugular (+/- cutdown: jugular cutdowns can be difficult in pigs)

cephalic and saphenous veins on young animals

cranial vena cava: *see diagram p.14*

Scrub neck area to be used for venipuncture with surgical soap or dilute Betadine. Select appropriate needle for pig:

Pig Size

Needle Size

10 lbs.	21 Gauge 1.0 - 1.5"
10 - 60 lbs.	20 Ga. 1.5"
60 – 120 lbs.	18 - 19 Ga. 2.0"
120 lbs.	18 - 19 Ga. 2.0 - 3.0"

Samples should be drawn from the pre-cava via a stick just lateral to the breastbone. Variation approach (for pigs with excessively fat necks) should be toward the pig's right side. In swine the phrenic nerve lies in the left neck area, and trauma to that nerve can cause respiratory paralysis.

Following withdrawal of the needle, hard pressure should be briefly applied to the area from which the sample was taken. Observe for bleeding, and continue pressure until it has ceased. Use extra caution with very young pigs, as they tend to bleed more profusely than more mature animals.

5. Anesthesia and Sedation

IT IS CRITICAL TO DISCUSS CHOICES OF ANESTHETICS AND SPECIFIC MONITORING METHODS WITH VETERINARY MEDICAL/TECHNICAL STAFF BEFORE ANESTHETIZING ANIMALS; THIS IS A COMPLEX TOPIC DESERVING OF FAR MORE DETAIL AND TIME THAN ALLOWED IN A SESSION LIKE TODAY'S.

A. Anesthesia

For <10 kg pigs: Atrophine (0.5 mg/kg) 15 minutes before Ketamine (20 – 35 mg/kg) and Rompun (2 –5 mg/kg) IM Acepromazine (1.1 mg/kg), Ketamine (22 mg/kg) and Atropine (0.5 mg/kg) IM followed with 2.5% Thiamylal IV if necessary to intubate.

Inhalation anesthetics: Isoflurane has become a favorite at UW.

See Appendix – Anesthetics for additional anesthetic protocols.

B. Endotracheal Intubation

Premedicate with Acepromazine (1.1 mg/kg), Ketamine (22.mg/kg), Atropine (0.5 mg/kg) IM. See anesthesia section and appendix for additional combinations.

Place animal in dorsal recumbency for intubation with head and neck fully extended. **The larynx should be sprayed with a topical anesthetic while being visualized with a laryngoscope.** This is done to avoid

laryngospasms. Cetacain spray is commonly used. The presence of the laryngeal diverticulum may necessitate rotating during insertion.

C. Pulse Monitoring Sites

Brachial Artery – medial aspect of humeroradial joint
Saphenous Artery* - medial aspect of distal femur ***FAVORITE**
Sublingual artery – ventral surface of tongue
Auricular – ear

D. Monitoring Depth of Anesthesia

Dependent upon anesthetic agents used.

Absence of leg reflex: in response to pinch to the coronary band of the hoof – indicative of depth of anesthesia

Laxity of jaw

Heart rate and blood pressure

6. Analgesia:

Buprenorphine 0.005 – 0.01 mg/kg IM q 12 hr

7. Euthanasia:

Anesthetic overdose:

Administration and routes of other agents described in other sources

Pentobarbital – 90 mg/kg IV

Other methods – Please see the Report of the AVMA Panel on Euthanasia

Procedure for Catheterization of Anterior Vena Cava in the Sling

Preparation:

Prepare the neck area the same as for venipuncture.

- For non-obese pigs under 100 lbs., a 16 gauge thin wall, 2.0" needle is best. For heavier or obese pigs, longer needles, as needed should be used, but do not increase the gauge. For minimal trauma to the animal in case of sudden movement, plus to minimize chance of hitting an artery, **use shortest needle** possible.
- With known bleeders (animals with poor clotting ability), or pigs with questionable pre-cava location, locate vessel with a 20 gauge needle prior to entry with catheterization needle.
- If a pig is particularly sensitive to the needle, prep area with Lidocaine or other local anesthesia prior to catheterization.
- For young animals weighing less than 50 lbs., utilize an 18 gauge 1.5" needle and catheter set. Methodology for cannulation should be applied as described above.
- Prepare flushing syringe and saline, withdrawal syringe, sampling syringes and catheter prior to catheterization and mark each.

1. Flushing saline: To flush catheter during catheterization and later during experiment, use 10,000 units Heparin/250 cc saline solution. Designate one syringe for flushing.
2. Withdrawal syringe: Used to withdraw solution and blood prior to each sample.
3. Sampling syringes: Should be labeled and set up ahead according to protocol requirements. Monovettes available from Sarstedt are recommended, especially when manpower is limited. They serve as both syringe and centrifuge tube and can be obtained pretreated with various types of anti-coagulants if desired.
4. Catheter: Should be cut into 33 –36" length and marked approximately 8" from end with permanent marker. Fill with germicide or

alcohol solution and place in the solution at least 10 – 15 minutes prior to use. Insert stub-end 18 gauge needle into end and connect the flush syringe.

- Clean hands. The person catheterizing should keep both hands clean prior to inserting the catheter. Hang a clean towel on the sling for easy access during the procedure.

Catheterization of the Pre-Cava

Puncture vein and insert catheter through needle until mark is just outside needle hub. Check for patency by withdrawing flush syringe. If blood flow is good, pull needle out and remove from catheter. Attach catheter to skin with a small butterfly (made from adhesive) and one or two sutures with a cutting suture needle.

Flush catheter thoroughly with flush solution and proceed with experiment.

SELECTED REFERENCES

1. Breese, EC, Dodman, NH: Xylazine-Ketamine-Oxymorphone: An Injectable Anesthetic Combination in Swine. J Am Vet Med Assoc, 184: 182-3, 1984.
2. Bustad, LK, McClellan, RV: Swine in Biomedical Research, Richland, WA: Pacific Northwest Laboratory, 1966 (out of print; 1986 Tumbleson edition available).
3. Calne, RY, Bitter-Suermann, H, Davis, DR, et al: Orthotopic Heart Transplantation in the Pig, Nature, 247: 140-42, 1974.
4. Ellendorff, F, Parvizi, N, Elsaesser, F, Smidt, D: The Miniature Pig as an Animal Model in Endocrine and Neuroendocrine Studies of Reproduction, Lab Anim Sci, 27: 822-30, 1977.
5. Glausser, EM: Advantages of Piglets as Experimental Animals in Pediatric Research. Exp Med Surg 24: 181-90, 1966.
6. Livaditis, A, Jonsson, L: The Piglet in Experimental Pediatric Surgery, Z Versuchstierkd, 21: 78-82, 1979.
7. Mount, LE, Ingram, DL: The Pig as a Laboratory Animal, NY: Academic Press, 1971 (out of print).
8. Noakes, DE, Cranwell, PD: Some Experimental Surgical Techniques on the Alimentary Tract of Young Pigs. Res Vet Sci, 22: 243-50, 1977.
9. Pond, WG, Houpt, KA: The Biology of the Pig, Ithaca, NY: Comstock Publishing Associates, 1978 (Address: Cornell University Press, 124 Roberts Place, Ithaca, NY 14850).
10. Riebold, TW, Goble, DO, Geiser, DR: Large Animal Anesthesia: Principles and Techniques, Ames, Iowa: Iowa State University Press, 1982 (Address: Ames, Iowa 50010).
11. Russell, JM, Webb, RT, Boyce, WH: Intrarenal Surgery, Animal Model I, Invest Urol, 19: 123-25, 1981.
12. Sack, WO: Essentials of Pig Anatomy, Ithaca, NY: Veterinary Textbooks, 1982. (Address: 36 Woodcrest Avenue, Ithaca, NY 14850).
13. Swindle, MM: Basic Surgical Exercises Using Swine, CT: Greenwood Press, 1983. (Address: 88 Post Road West, P.O. Box 5007, Westport, CT 06881)
14. Swindle, MM: Swine as Replacements for Dogs in the Surgical Teaching and Research Laboratory, Lab Anim Sci, 34: 383-85, 1984.
15. Swindle, MM, Adams, RJ (Editors): Experimental Surgery and Philosophy: Induced Animal Models of Human Disease, NY: Elsevier Scientific Press, 1987.
16. Swindle, MM: Anesthesia in Swine, Charles River Technical Bulletin, 3:3, 1985.
17. Swindle, MM: Comparative Anatomy of the Pig, Charles River Technical Bulletin, 1986, in print.
18. Swindle, MM, Horneffer, PJ, Gardner, TJ, et al: Anatomic and Anesthetic Considerations in Experimental Cardiopulmonary Surgery in Swine, Lab Anim Sci, Vol. 36, No. 4, August, 1986.
19. Swindle, MM, Panepinto, LM (Guest Editors): Swine in Biomedical and Surgical Research (special issue). Lab Anim Sci, Vol. 36, No. 4, Aug. 1986.
20. Tumbleson, ME, Kalish, PR: Some Biochemical and Hematological Parameters in Crossbred Swine from Birth Through 8 Weeks of Age, Can J Comp Med, 36: 202-9, 1972.
21. Tumbleson, ME (Editor): Swine in Biomedical Research, NY: Plenum Publishers, 1986.
22. White, DJ, Lunney, J: Transplantation in Pigs, Transplant Proc, 11: 1170-73, 1979.

SELECTED REFERENCES

General Characteristics and Miscellaneous

Panepinto, L.M., Phillips, R.W., and Will, D.H. The Yucatan Miniature Pig as a Laboratory Animal. Lab. Anim. Sci. 28: 308-313, 1978.

Panepinto, L.M., and Phillips, R.W. Genetic Selection for Small Body Size in the Yucatan Miniature Pig. Lab. Anim. Sci. 31: 403-404, 1981.

Zambraski, E.J. and Fuchs, B. Resting Metabolism of Yucatan Miniature Swine. Lab. Anim. Sci. 30: 51-53, 1980.

Laboratory Methodology

University of Washington
Department of Comparative Medicine

Terris, J.M. and Simmonds, R.C. Description of a Swine Metabolism Unit for Long-Term Studies. Lab. Anim. Sci. 32: 302-303, 1982.

Panepinto, L.M., Phillips, R.W., et al. Comfortable, Minimum-Stress Methods of Laboratory Restraint for the Yucatan Minipig. Lab. Anim. Sci., 33: 95-97, 1983.

Panepinto, L.M., Phillips, R.W. The Yucatan Miniature Pig and Minimum-Stress Methodology in the Laboratory. Proc. International Symp. Lab. Anim. Sci., ICLAS, S. 217; Onic, Verlag, 1985.

Hand, M.S., Phillips, R.W., Miller, C.W., Mason, R.A. and Lumb, W.V. A Method for Quantitation of Hepatic, Pancreatic and Intestinal Function in Conscious Yucatan Miniature Swine. Lab. Anim. Sci. 31: 728-731, 1982.

Terris, J.M. and Simmonds, R.C. A Portable Confinement Unit for Swine. Lab. Anim. Sci. 32: 410, 1982.

Panepinto, L.M. Character and Management of Miniature Swine. Swine in Cardiovascular Research, Stanton and Mersmann, eds., 1985.

Cardiovascular

Sanders, M., White F.C., Peterson, R.M. and Bloor, C.M. Characteristics of Coronary Blood Flow and Transmural Distribution in Miniature Pigs. Amer. J. Physiol. 235: H601-H609, 1978.

Bloor, C.M. and White, C. Coronary Collateral Circulation in the Pig: Correlation of Collateral Flow with Coronary Bed Size. Basic Res. Cardiol. 76: 189-196, 1981.

Singh, S., White, F.C. and Bloor, C.M. Myocardial Morphometric Characteristics in Swine. Cir. Res. 49: 434-441, 1981.

Diabetes

Panepinto, L.M., Phillips, R.W., Westmoreland, N. and Cleek, J.L. Influence of Genetics and Diet on the Development of Diabetes in Yucatan Miniature Swine. J. Nutr., 112: 2307-2313, 1982.

Gastrointestinal Function and Nutrition

Bjorkman, O., Crump, M. and Phillips, R.W. Intestinal Metabolism of Orally Administered Glucose and Fructose in Yucatan Miniature Swine. J. of Nutrition. 114: 1413-1420, 1984.

Atherosclerosis and Related Research

Reitman, J.S. and Mahley, R.W. Changes Induced in the Lipoproteins of Yucatan Miniature Swine by Cholesterol Feeding. Biochem. Biophys. Acta. 575: 446, 1979.

Reitman, J.S., Mahley, R.W. and Fry, D.L. Yucatan Miniature Swine as a Model for Diet-Induced Atherosclerosis. Atherosclerosis. 43: 119-132, 1982.