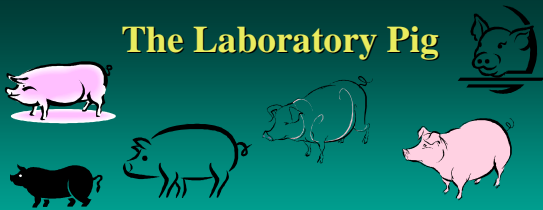


## The Laboratory Pig



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## Taxonomy

- Order – Artiodactyla (even-toed ungulates)
- Family – Suidae
- Genus / Species – *Sus scrofa*
- Dental Formula – (3/3, 1/1, 4/4, 3/3)2
- Life Span – 16 years

- Barrow – Immature male
- Gilt – Immature female
- Boar – Mature male
- Sow – Mature Female
- Stag – Castrated Male



## Miniature Swine

- Hanford
  - Similar look to domestic pig
  - 1 yr wt ~ 60 kg
  - Max wt ~ 80 kg
- Sinclair (S-1)
  - Derived from Hormel minipig
  - Melanomas model
  - 1 yr wt ~ 40 kg
  - Max wt 70 kg
- Yucatan
  - Hairless
  - Docile
  - Does well in group housing
  - 1 yr wt ~ 50 kg
  - Max wt 70-80 kg



## Miniature Swine

- Yucatan Micro
  - Hairless
  - Docile
  - VSD model
  - 1 yr wt ~ 40 kg
  - Max wt ~ 60 kg
- Ellegard Gottingen Minipigs
  - Smallest minipigs
  - 6 mo wt ~ 15 kg
  - Max adult wt ~ 35 kg
  - Barrier reared
  - SPF
  - Defined lineage



## Miscellaneous Breeds

- Yunan Banna
- Chinese Bama
- Meishan
- Vietnamese Pot-bellied
- Collared Peccary\* (Javelinas)
  - Family Tayassuidae
- Ossabaw
  - Metabolic Syndrome
  - Obesity
  - Type II Diabetes
  - Heart Disease



## Reproduction

- Estrus cycle – 21 days
- Gestation – 114 days (3 mos, 3 wks, 3 days)
- Litter size – 4 to 14
- Weaning – 4 to 6 weeks
- Mature – 4 to 6 months (female) and 5 to 6 months (male)
- Miniature pigs mature – 3 to 4 months

## Males

- Preputial diverticulum, sigmoid flexure and cork-screw shaped penis makes retrograde catheterization difficult
  - Urinary Catheterization of Male Swine, CM Hite, AALAS 2009
- Accessory sex glands similar to humans (vesicular, prostate, bulbourethral)

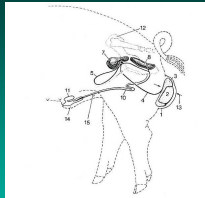
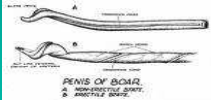


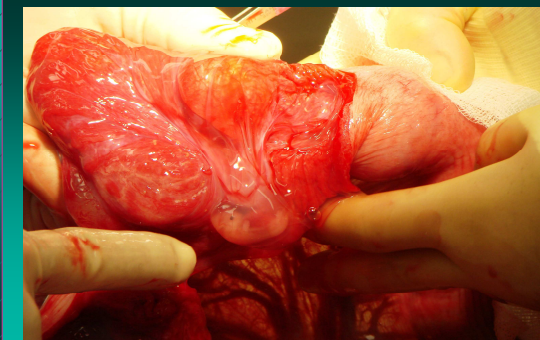
Fig. 40. Schema of boar's genital organs.

1 Scrotum; 2 Left testis; 3 Tail of epididymis; 4 Ductus deferens; 5 Bladder; 7 Vesicular gland covering the small body of the prostate gland; 8 Bulbourethral gland; 10 Penis; 11 Preputial diverticulum; 12 Right hip bone; 13 Level of cross section in Figure 41; 14 Prepuce; 15 Rudimentary nipple

From Essentials of Pig Anatomy, Sack, WO Veterinary Textbooks, Ithaca, NY 1982

## Females

- Bicornate uterus
- Diffuse epitheliochorial placentation prevents passage of maternal antibodies to the fetus
- Fetus hypogammaglobulinemic at birth
- Intestinal absorption of IG's w/in 3 hours
- Absorption ceases by 36 hours



## Occupational Health and Safety

- Allergies
  - Rare, but reported in farm workers
  - Contact dermatitis
- Injuries
  - Swine are inquisitive and can be aggressive
  - Will root and push, leading to falls
  - Bite or nibble on clothing / hands if given opportunity
  - Can be very large; lifting/moving requires proper safety precautions (lift with legs, not back, etc)

## Zoonotic Diseases

- Swine Influenza A (H1N1, H3N2)
  - Acute respiratory infection with fever, chills, muscle aches, pharyngitis, cough
  - Weight loss and poor growth
  - Generally has low mortality in pigs
  - CDC: US - 30% pigs have H1N1 Ab's; 50% of North-Cent Am pigs H1N1 Ab+
  - Swine vaccination: MaxiVac (H1N1) and Maxivac Excell 3 (H1N1 and H3N2)

## Zoonotic Diseases

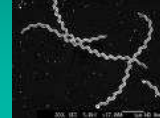
- Swine Flu (H1N1/09)
  - 2009: 1.6 Mill cases in 54 countries & 44,000 deaths in US
  - H1N1/09 subtype (human, avian, swine strains)
  - Originated in Veracruz, Mexico
  - May 2009 Natural infection: Human to swine transmission in Canadian herd
  - June 2009: WHO Pandemic (1<sup>st</sup> in 41 yrs)
  - Transmission: contact w/ viral particles through coughing, sneezing, touching
  - June 2010: vaccine developed by Novartis, GSK & Sanofi-Aventis
  - EU study: swine trans for 4 cycles of naïve pigs w/ peak shedding at 3-6 days

## Zoonotic Diseases

- Vesicular Stomatitis
  - RNA virus
  - Transmission through aerosol and direct contact
  - Fever, headache, retro-orbital pain
- Hepatitis E
  - 23% of swine practitioners positive for Hep E
  - Recent studies suggest pigs as a possible reservoir
  - Fecal-oral transmission in pigs
  - Direct contact in humans, ingestion of raw pig liver

## Zoonotic Diseases

- Erysipelothrix rhusiopathiae (Diamond skin disease)
  - Localized swelling, burning, itching pain (dermatitis)
  - Transmitted via direct contact or excreta
- Brucella suis
  - Fever, chills, myalgia
  - Can lead to arthritis and endocarditis
- Campylobacter jejuni, E. coli, Salmonella
  - Fecal/oral transmission
  - Gastroenteritis
- Streptococcosis (S. Suis)
  - Transmitted via direct contact
  - Arthritis, fever, meningitis
- Leptospria spp.
  - Transmitted via direct contact with urine
  - Hepatomegaly, jaundice, renal disease



## Zoonotic Diseases

- Balantidium coli
  - Fecal/oral transmission
  - Immunosuppressed individuals may develop hemorrhagic diarrhea, dysentery, hepatic abscessation, death
- Giardia lamblia



## Husbandry

- Housing
  - Commercial producers
    - Indoor or outdoor pens
    - Concrete or slatted flooring
    - "All in, all out"
  - Research Facilities
    - Individual pens
    - Concrete floor w/ or w/o wood shavings, slatted floors or vinyl coated metal above 6" floor drains
    - Slippery surfaces cause lamenesses, femoral luxations
    - Slatted floors / concrete surfaces should have a medium grit for traction



## Husbandry/Housing

- Hard surfaces can produce lameness due to poor claw conformation causing sore fetlocks / pasterns
- Appropriately sized extruded metal (2 x 3 cm) and slatted floors (0.5-0.75 cm) prevent foot injuries
- Standard dog runs can be interchangeable with pigs
- Alleys can be used to direct pigs
- Sides tall enough to prevent jumping over (greater than 4')

## Husbandry/Housing

- Gestation crates
  - 7' x 2'
  - Used for ~ 60-70% of sows in the US
  - Banned in FL, AZ, OR, MI, ME, CA; Sweden, UK; EU by 2013
  - Smithfield Foods, largest US pork producer, to phase out use over 10yrs
  - Group housed
    - Aggression, competition, foot lesions, decreased body condition, increased losses
    - Increased serum CK due to activity and fighting
- Farrowing crates
  - 1.5' troughs for piglets



### Housing/Behavioral

- Social animals, prefer to be pair or group housed
- Place food / water end of pen; dunging pattern at opposite end
- Use automatic water readily
- Rooting behaviors satisfied with wood shavings, plastic or bowling balls



### Housing/Behavioral

- Very destructive: sturdy materials for pens
- Dominance established by fighting, especially in large boards
- Animals should be of equal size when housed together
- Chains, hoses, etc. for chewing

### Nutrition

- Food provided in feed troughs attached to pens or in pans
- Agricultural production diets formulated for rapid growth and may have unwanted additives such as antibiotics
- Require 100-300 kcal/kg/day
- Feed about 1.5%-3% body weight / day
- Water ad lib; require 0.2L/kg/day

### Handling

- Pigs respond to positive reinforcement, gentle handling / movement rather than forceful, aggressive handling
- Pigs will follow each other
  - Alleyways / hurdle boards help guide/move animals
  - Large production facilities designed with this in mind

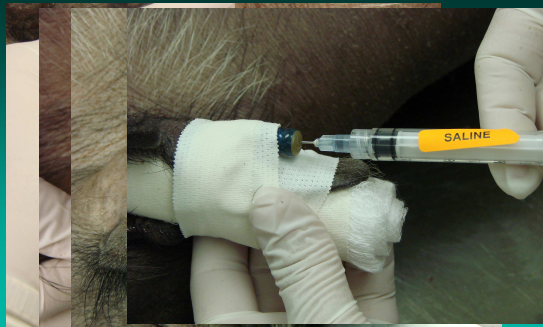
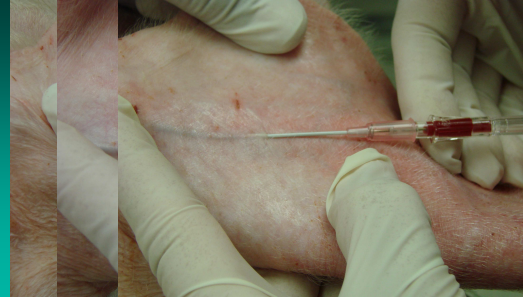
### Handling

- Snares (commercial, rope, chain)
  - Used rarely for difficult to handle or large domestic pigs
- Panepinto sling
  - Monitoring conscious pigs / minor procedures (blood collection, stomach tubing, physical exam)
  - Sling restraint in untrained pigs can be stressful
- Can train through socialization and handling
  - Rough handling increases corticosteroid concentrations
- Some pigs (minipigs) docile, need little training
- Prefer sweets / pediatric oral medications
- Marshmallows, candy bars used for oral dosing

### Techniques

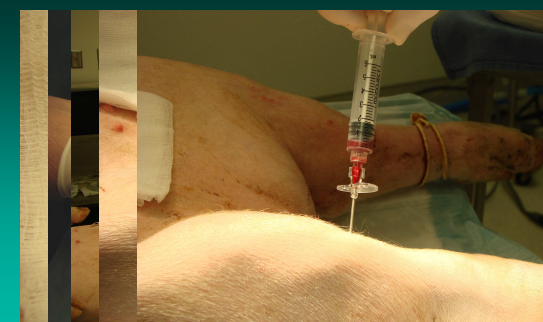
- Blood collection
  - Auricular (Ear) veins (cath to Jug v.)
  - Cranial vena cava (R side avoids vagus)
  - External jugular (lies deep with int. jugular)
  - Lateral saphenous vein
  - Cephalic vein (fixed, so no rolling)
  - Brachiocephalic vein
  - Femoral vein (deep to artery)
  - Tail vein
  - Superficial Cranial Epigastric vein
    - Cranial abdominal vein
    - More prominent in cranial aspect of mammary chain





## Techniques

- Intramuscular injections
  - Butterfly catheter
  - Caudal thigh muscles
  - Lateral neck muscles
  - Lumbar muscles (small volume)
- Subcutaneous injections
  - Neck area behind the ear, flank fold (for fluid therapy)
- Interosseous (IO) needle placement



## Induction/Restraint

- Sedatives
  - Restraint, sedation, balanced anesthesia
  - Medetomidine 20-80 ug/kg SC, IM, IV
    - Dexmedetomidine (few refs – 10-20 ug/kg IM, IV)
    - Atipamezole 0.1-0.2 mg/kg IM, IV
  - Xylazine 1.0-2.0 mg/kg IM, SC
    - Yohimbine 50-100 ug/kg IM, IV
  - Diazepam 0.5-10 mg/kg IM or SC
  - Midazolam 0.1-0.5 mg/kg IM, IV, IN
  - Acepromazine 0.1-0.5 mg/kg IM

## Induction/Restraint

- Injectable anesthesia
  - Ketamine 10-30 mg/kg
    - Most reliable sedation with some analgesia
    - Used with ace, xylazine, medetomidine, midazolam
  - Ketamine 20-30 mg/kg with Ace 1.1 mg/kg
    - Good muscle relaxation; used for short procedures and/or restraint
  - Azaperone 2-4 mg/kg
    - Stresnil, Suicalm
    - Neuroleptic agent used primarily in UK and Europe

## Injectable Anesthesia

- Ketamine 20 mg/kg with Xylazine 2 mg/kg
  - Use with atropine due to potential cardiac arrhythmia (heart block)
  - Reverse with yohimbine
- Ketamine 1 mg/kg with Medetomidine 0.1 mg/kg
  - Dexmedetomidine 0.05 mg/kg
  - Good analgesia
  - Fewer CV side effects
  - Reverse with atipamezole
- Ketamine 20 mg/kg with Diazepam 2 mg/kg
  - Few CV effects
  - Good muscle relaxation

## Injectable Anesthesia

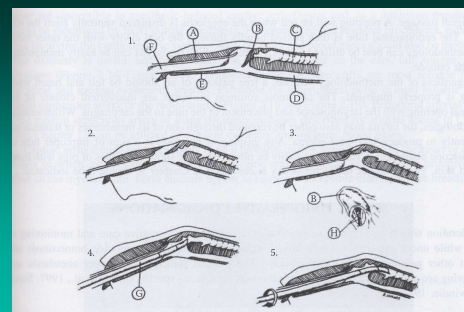
- Telazol 4.4 mg/kg with Ketamine 2.2 mg/kg and Xylazine 2.2 mg/kg
  - Mix 250 mg each Ketamine and Xylazine added to 500 mg Telazol vial
  - Total is 50 mg/ml ketamine, 50 mg/ml xylazine and 100 mg/ml telazol dosed at 1 ml/50 lbs IM
  - Smaller volume used for larger pigs
  - This is associated with CV depression and may not be suitable for CV studies

## Anesthesia

- Intubation
  - Difficult due to small jaw opening, long snout, large bulbous tongue
  - Angle of the pharynx to the larynx
  - Laryngospasm
  - Pharyngeal diverticulum
  - Airway smaller than anticipated based on size

## Anesthesia

- Place laryngoscope blade at 45° angle to neck
- Free epiglottis from the soft palate
- Can use stylet with a 30° bend to help rotate/direct the tip after placement into proximal larynx
- Rotate tube as gently pushed forward avoiding the diverticulum



★ Reprinted with permission from *Swine in the Laboratory* - M. Swindle, ed.



## Intravenous Agents

- Sodium Thiopental (6-30 mg/kg)
  - Thiobarbiturates metabolized by kidney not liver
  - Used for long-term anesthesia; flushed out of the system by intravenous fluids
  - Thiopental can use as continuous infusion 3-30 mg/kg/hr IV
- Pentobarbital (20-40 mg/kg)
  - Used for non-survival procedures but thiopental preferred.
- Propofol (0.8-1.6 mg/kg)
  - Used primarily for anesthesia induction
  - Can be used for long term sedation 14-20 mg/kg/hr
  - Should not be used as sole agent - weak analgesic

## Inhalant Agents

- Halothane
  - Was good anesthetic with good analgesia; production discontinued
  - Predisposes to MH and arrhythmias
- Isoflurane (MAC 1.2%)
  - Best sole agent available
  - Piglets / small adults masked for induction
- Sevoflurane (MAC 2.5%)
  - Ultrashort acting; used in some cases
  - Care taken regarding monitoring of anesthetic plane
  - Cost can be prohibitive
- Nitrous Oxide
  - Swine resistant to analgesic effects, not used as sole agent
  - Occasionally used for second gas effect

## Anesthesia Monitoring

- Palpebral / pupillary eye reflexes are not reliable indication of anesthesia depth
- Better indication is jaw tone, response to pain (interdigital or ear pinch), spontaneous movement and increases in HR, RR
- Monitor TPR minimum
  - 5-15 min intervals
  - Anesthesia record helps with adverse events

## Anesthesia Monitoring

### Cardiovascular

1. Pulse
  - brachial artery (medial aspect of humeroradial junction)
  - saphenous artery (medial aspect of distal femur)
  - sublingual artery
2. Pulse Oximetry
  - Probe placement can be on the tongue, tail, ear, lateral digit
  - placement may need to be adjusted during the case
3. ECG
  - tachycardia, PVC's, AV block, etc.
4. NIBP and IBP (central ear art, medial saphenous art)

## Anesthesia Monitoring

### Respiratory Function

1. Capnography
  - pigs produce large volume of moisture / heat
  - probes need to be monitored
2. Blood gases
  - central ear artery, medial saphenous artery
3. Auscultation

### Temperature

1. Minipigs especially prone to hypothermia
2. Cover with blankets
3. Circulating water blankets
4. Heated surgical tables
5. Bair Huggers (convection air) for extreme hypothermia
6. Heat lamps, drapes and blankets in pen post op

## Post Op Care

- Post-op pain determined by
  - Incisional / Surgical site pain (guarding)
  - Abnormal posture / behavior
  - Rough hair coat
  - Expression
  - Lethargy or varied activity level
    - Active if approached; observe at a distance
  - Animals that are eating, drinking, normal behavior
    - Analgesics may not be necessary (local / institutional pain score)

## Analgesics

- Local / Regional nerve blocks
  - Marcaine
  - Lidocaine
- NSAIDS
  - Used for mild pain or as adjunct analgesia with opioids
  - Used as pre-emptive analgesics
    1. Aspirin (10-20 mg/kg) (oral or suppository)
    2. Phenylbutazone (4-8 mg/kg)
    3. Tylenol (15 mg/kg suppository)
    4. Carprofen (2-4 mg/kg)
    5. Meloxicam (.4 mg/kg)

## Opioid Analgesics

- Relatively resistant to narcotic analgesics; short acting
- Fentanyl (.02-.05 mg/kg) and Oxymorphone (0.15 mg/kg)
    - Last only a few hours
    - Fentanyl (30-50 ug/kg/hr) and Sufentanyl (10-15 ug/kg/hr) can be used as continuous infusion
  - Fentanyl patches (3-5 ug/kg/hr)
    - Can have varying results based on breed, age, location of patch, presence of moisture / heat and type of procedure.
  - Buprenorphine (0.01-0.1 mg/kg BID) / Butorphanol (0.1-0.3 mg/kg QID)
    - Analgesics of choice for most procedures
    - Lower doses of buprenorphine (0.005-0.01) used pre-emptively for adjunct analgesia

## Analgesics of Choice

- Buprenorphine pre-med 30-60 mins prior to surgery
- Continued q 8-12 hrs depending on procedure
- NSAID's given as adjunct analgesia evening of surgery
- Buprenorphine and / or NSAIDS continued for 24-72 hrs depending on procedures and pain assessment

## Anesthetic Complications

### A. Malignant Hyperthermia (MH)

1. Similar autosomal dominant metabolic disorder to man
2. Pietrain, Poland China, Landrace breeds
3. Occurrence related to blood groups H, A and O
4. Porcine Calcium Channel mutation
  - Hal gene locus for mutation with 843 as nucleotide of single point mutation
    - Hal 1843n – normal
    - Hal 1843mm – monomutant / heterozygous (1 in 5 domestic pigs)
    - Hal 1843dm – dimutant or homozygous (1% of domestic pigs)
  - Defect in Ca release mechanism results in continuous dumping of Ca causing prolonged muscle contractions.

## Anesthetic Complications

5. Mutation not identified in miniature pigs
6. Precipitated by succinylcholine, curare, gallamine, halothane (4-10%)
7. Rectal temperature 104-110 F (40-43 C), metabolic acidosis, muscle rigidity, tachycardia
8. Dantrolene (5 mg/kg) used as prophylaxis; decreases Ca release while allowing normal Ca uptake
9. Treatment - discontinue procedure / anesthesia
  - administer O2 flush to clear halothane
  - administer NaHCO3 to prevent acidosis

## Anesthetic Complications

### B. Non malignant hyperthermia

1. Similar syndrome seen during post operative recovery
2. Symptoms occur after surgery rather than at induction
3. High temps (104-108 F); muscle tremors; fatal if left untreated
4. Treatment
  - adequate analgesia; Buprenex also produces hypothermia
  - sedation may help (acepromazine)
  - Tylenol suppository (10-15 mg/kg)
  - Alcohol baths, packing in ice, cold water bath
  - Dipyrone (20 mg/kg) IM in refractory cases – compounded by Wegdewood Pharmacy ([www.wegdewoodpharmacy.com](http://www.wegdewoodpharmacy.com)).

## Anesthetic Complications

### C. Cardiac arrhythmias

1. Fatal arrhythmias triggered by anesthetics (alpha-2 adrenergics) or cardiac manipulation (catheterizations, open heart procedures)
2. Minipigs thought to be not as susceptible as commercial swine
3. PVC's and V-fib seen during cardiac catheterization; can lead to asystole if not corrected
4. Atropine should be administered prior to induction to prevent bradycardia associated with vagal stimulation

## Anesthetic Complications

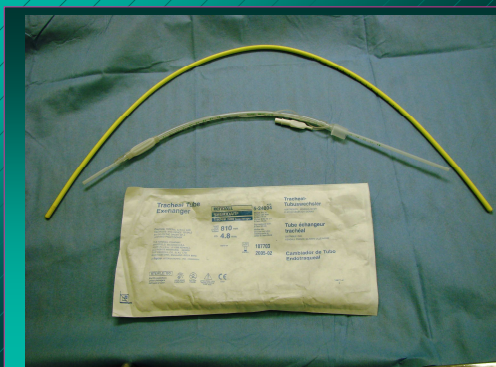
### C. Cardiac arrhythmias

5. If PVC's seen or as preemptive prior to cardiac surgery
  - Lidocaine (2-4 mg/kg) IV bolus then IV drip (30-50 ug/kg/hr)
  - Amiodarone (10-12 mg/kg then 0.05 mg/kg/hr IV) used in lieu of Bretylium
7. External defibrillation at 200-400 Ws
8. Asystole:
  - Epinephrine 1-3 cc's 1:1000 IV, IC, ET
  - Lateral chest compressions
  - Repeat atropine
  - NaHCO<sub>3</sub>
  - Lidocaine, amiodarone

## Anesthetic Complications

### ■ Laryngospasm

- Should monitor pulse oximetry if possible
- Pigs should be extubated when they have a strong chewing reflex and sternal
- Should be ready to reintubate if necessary and have oxygen support ready if needed
- Tube exchanger used to assist in difficult / laryngospasm cases

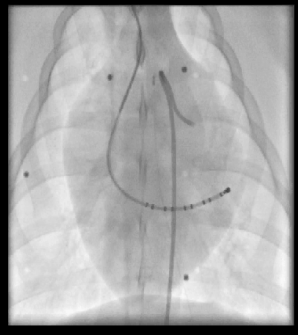
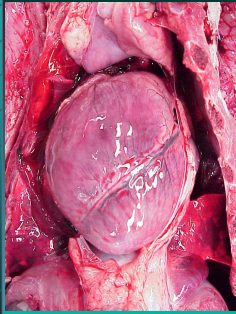


## Anatomy / Models

### 1. Cardiovascular

- a. Coronary blood supply, blood supply to conduction system, wound healing almost identical to humans
- b. Pigs and humans are "right" heart dominant
  - sinus node supplied by RCA rather than LCX (dog)
- c. Aorta - true vasa vasorum like humans and healing is similar
- d. Left azygous vein enters coronary sinus and drains the intercostals
- e. CO about the same as humans but pulmonary pressures higher
- f. Free-running Purkinje system invades myocardium more deeply
- g. Pigs tolerate mid-sternotomy due to high cartilage content in sternum





## Anatomy / Models

h. Very little coronary collateralization but develops following myocardial infarction

- dogs - significant collaterals, difficult to produce ischemia
- ruminants - less collateralization, sparse collaterals after MI

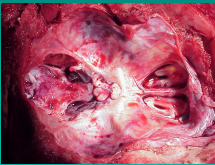
i. Models:

- Atherosclerosis; plaque morphology similar to humans
- coronary blood flow
- Myocardial infarct / ischemia
- cardiac transplant
- vascular repair
- cardiac pacemakers
- hypertrophic cardiomyopathy

## Anatomy / Models

J. External jugular vein is large and located at about the same depth as the carotid artery.

K. Have rostral epidural rete mirabile (arteriole system similar to ruminants) at distal internal carotid artery just prior to entering cerebrovascular system



## Anatomy / Models

### 2. Gastrointestinal

- Physiologically similar - true omnivores with similar food preferences
- Torus pyloricus - muscular outpouching of stomach near the pylorus
- spiral colon - portion of the cecum, ascending, transverse and proximal descending colon; two longitudinal muscular bands (tenia) on proximal colon (three on cecum).
- vascular arcades of the small intestine form in the muscularis mucosa rather than the mesentery as in humans

## Anatomy / Models

### 3. Pancreas

- Has 2 separate lobes with one retroperitoneal (same as man)
  - Surgical dissection from duodenum possible because loose pancreaticoduodenal artery that serves as major blood supply
  - Adhered to cranial mesenteric vein
  - Single pancreatic duct enters distal and separate from bile duct
  - Diabetes model produced by surgical and chemical means and pancreatic transplant
- Yucatan - single IV dose of Alloxan induces acute diabetes

## Anatomy / Models

### 4. Renal

- Left kidney is cranial while right sits caudal
- Multipapillate kidney with true calyces and similar physiology (most similar to humans)
- Blood supply is longitudinal rather than transverse so avascular plane for surgery is transverse; used for hemi-nephrectomies / transplants
- Hydronephrosis, renal hypertension, vesicoureteral reflux also studied
- Only 3% of nephrons are long looped (man 14% and dog 100%) and creatinine is resorbed from proximal tubules (vs. secreted in man and NHP)

## Anatomy / Models

### 5. Skin

- a. Fixed skin has similar histological appearance and physiological function
- b. Used for wound healing, skin flaps and burn research

### 6. Liver (5 lobes)

- a. Gross anatomy similar to human but histologically more fibrous with septate appearance
- b. Bile duct is separate from the pancreatic duct
- c. Standard model for hepatic Tx

## Anatomy / Models

### 7. Endocrine

- a. Thyroid located on midline of the trachea at level of the thoracic inlet rather than associated with the larynx
- b. Parathyroids associated with the thymus rather than the thyroid
- c. Thymus located in the neck rather than the thorax and extends up the larynx
- d. Right adrenal gland is adhered to the caudal vena cava and adrenalectomy is not possible without damaging it

From Swine in the Laboratory, 2<sup>nd</sup> Ed., M. Swindle, Ed.

## Respiratory Diseases of Swine

- Mycoplasmosis hyopneumoniae
- Actinobacillus pleuropneumonia (APP)
- Swine Influenza (SI)
- Porcine Reproductive and Respiratory Syndrome (PRRS) Virus (PRRSV)
- Circovirus (PCV2)
- Pasteurellosis
- Verminous Pneumonia (Thumps)

## Respiratory Diseases of Swine

- Mycoplasmosis hyopneumoniae
  1. Endemic in domestic herds (Enzootic Pneumonia – EP)
  2. Severity varies with environmental factors / stress
  3. Concurrent infections with Pasteurella, PRRS, SI
  4. Chronic progressive pneumonia, non-productive cough
    - high morbidity, low mortality, few deaths in pigs 4-6 mos
  5. Commercial vaccines, tetracycline, tylosin, lincomycin

## Respiratory Diseases of Swine

- Actinobacillus pleuropneumonia (APP)  
(req's "X" factor - culture w/ S.aureus colonies (satellitng) or on chocolate agar)

1. Widespread, severity, morb / mort varies w/ environment, stress
2. Usually triggered by PRRS or SI
3. Carried in tonsils / URT; trans by droplets; survives few day
4. Peracute - fever, anorexia, depression and death in 24 hours
  - Acute - fever, depression, anorexia, severe resp. signs
  - Chronic – low fever, cough, unthrifty, secondary bact inf's
5. Purulent bronchopneumonia with fibrinous pleurisy
6. TX: Ceftiofur (Exceed), Florfenicol (Nuflor), tulathromycin (Draxxin), commercial vaccines available

## Respiratory Diseases of Swine

- Swine Influenza (SI)

1. Type A influenza virus – zoonotic
2. Most common strains H1N1, H1N2 and H3N2
3. Associated w/ shipping; seen in late fall / early winter
4. Carrier state common; rapid onset, high morbidity, low mortality
5. Lethargy, fever, dyspnea, coughing, anorexia; recovery in days
6. Infections (APP, EP, PRRS, Past) occur so antibiotics initiated.
7. Lobar atelectasis, bronchitis, alveolar necrosis, interstitial pneumonia
8. TX: supportive, vaccinate, Ceftiofur
9. Prevention: H1N1/H3N2 vaccine available (MaxiVac Excell3)

## Respiratory Diseases of Swine

### ■ Porcine Reproductive and Respiratory Syndrome (PRRS) Virus (PRRSV)

1. First seen in US -1987 ; Europe - 1990
2. Single-stranded RNA virus of the Arteriviridae Family
3. Transmission - direct contact, aerosolization (2 miles); AI
4. Virus isolated in urine, nasal and rectal swabs and semen.
5. Replicates in alveolar macrophages
6. Inappetence / resp distress affecting all ages, cyanotic ears
7. High mortality in neonatal / weaned pigs
8. Poor conception rates, increased abortions, stillborns.
7. Vaccines available: prevent clinical disease in an outbreak or protect PRRS neg animals introduced into PRRS pos herds

## Respiratory Diseases of Swine

### ■ Circovirus (PCV2)

1. PMWS - Postweaning multisystemic wasting syndrome  
PDNS - Porcine dermatitis and nephropathy syndrome  
PRDC - Porcine respiratory disease complex
2. 1974 - PCV1 identified as non-disease causing agent  
1991 - nursery pigs - loss of body condition, enlarged lymph nodes, difficulty breathing, diarrhea, pale skin, and jaundice (PMWS)  
1997 - PCV2 isolated from these outbreaks, PMWS now worldwide
3. PCV2 - small, non-enveloped, circular DNA virus only affecting pigs.
4. PCV2 is stable, resistant to common disinfectants.
5. Macrophages - lung, tonsil, spleen, lymph nodes contain virus
6. Infection results in the lymphocytes depletion (tonsils, lymph nodes).

## Respiratory Diseases of Swine

### ■ Circovirus (PCV2)

7. Majority of farms PCV2 seropositive but few show signs of disease
8. Co-infection with PCV2 and PRRS result in severe form of PMWS
9. Porcine dermatitis and nephropathy syndrome (PDNS).  
- Pigs alert, non-feverish  
- Dime-sized, ulcerative, raised lesions on skin - flank, rear legs, and belly  
- May be fatal or spontaneously recover w/o treatment  
- Kidneys enlarged, pale w/ pinpoint hemorrhages on surface
10. In U.S., PCV2 causes Porcine respiratory disease complex (PRDC)
11. Co-infections w/ P. multocida, SI, PRRS virus, or M. hyopneumoniae result in prolonged, severe respiratory disease outbreaks.
12. Vaccines: Suvaxyn PCV2 (Fort Dodge) and Ingelvac CircoFLEX (Boehringer)

## Respiratory Diseases of Swine

### ■ Pasteurellosis

1. P. multocida common with M. hyopneumoniae, PRRS and APP
2. Bronchopneumonia, pericarditis, pleuritis, fibrinous pneumonia
3. Causes atrophic rhinitis with B. bronchisepticum

### ■ Verminous Pneumonia (Thumps)

1. Migrating larvae of Ascaris suum,
2. Metastrongylus elongatus (lungworms) - large white parasites, adults in the bronchi and bronchioles

## GI Diseases of Swine

### ■ Transmissible gastroenteritis (TGE)

1. Coronavirus; Starlings may be a mechanical vector
2. Epizootic - high morb / mort in suckling pigs w/ anorexia, vomiting, diarrhea
3. Enzootic - persistent infection due to addition of susceptible pigs; signs milder, less mortality due to maternal antibody protection
4. Gastric and SI distension w/gas, fluid; villous atrophy
5. DDX: colibacillosis, rotavirus

## GI Diseases of Swine

### ■ Colibacillosis

1. E. coli strains K88, K99, 987P
2. K88 attachment to mucosal cells; causes neonatal disease; produces 2 enterotoxins (heat labile and heat stable)
3. neonatal colibacillosis - enterotoxic hypersecretory diarrhea; watery diarrhea in first 3 weeks, dehydration and death;
4. TX: supportive and AB's

## GI Diseases of Swine

### ▪ Rotavirus

1. common infection, present in most herds
2. severity related to immune status, other infections (*E. coli*, TGE)
3. "white scours" in 1-8 week old pigs; usually mild and self-limiting;
4. TX: supportive, self-limiting

## GI Diseases of Swine

### ▪ Coccidiosis

1. *Eimeria* spp., *Isospora suis*
2. suckling pigs affected for 4-6 days, morb high, mort low
3. DX: fecal float (may not be reliable if not shedding)
4. TX: amprolium, sulfas
5. controlled through sanitation

## GI Diseases of Swine

### ▪ Swine Dysentery

1. *Brachyspira* (Serpulina) *hyodysenteriae*
2. Weanling pigs (8-14 weeks) high morb, low mort
3. Mucohemorrhagic diarrhea, fever, dehydration, acidosis, electrolyte imbalances, death; asymptomatic carriers possible
8. DDX: *E. coli* hemorrhagic enteritis seen in young pigs vs. swine dysentery seen in weanlings

## GI Diseases of Swine

### ▪ Salmonellosis

1. *S. choleraesuis*, *S. typhimurium*, *S. derby*
2. Infection from contaminated food / water
3. Latent carriers common
4. all ages susc; growing pigs (> 8wks) more often infected
5. acute infections (weanlings) - septicemia, death, low morb, high mort; splenomegaly, hepatomegaly, icterus, gastroenteritis, vascular thrombosis  
chronic infections - wasting, diarrhea, dehydration; gray ulcers w/ pseudomembranes in cecum, colon, ileum; thickened intestinal walls, mesenteric lymphadenopathy
6. Zoonotic potential



## Parasitic Diseases of Swine

- Stomach
  - *Hyoststrongylus rubidus* (red stomach worm)
- Small intestine
  - *Ascaris suum* (Large roundworm)
  - *Strongyloides ransomi* (intestinal threadworm)
  - *Macrocanthorhynchus hirudinaceus* (Thorny Headed worm)
  - *Trichinella spiralis*
- Large intestine
  - *Trichuris suis* (Whipworm)
  - *Oesophagostomum* spp. (Nodular Worm)
  - *Balantidium coli* (protozoan)
- Lungs
  - *Metastrongylus* spp
- Kidney
  - *Stephanurus dentatus* (Kidney Worm)

## Musculoskeletal Diseases

### ▪ *Hemophilus parasuis* (Glasser's Disease)

- Acute to peracute onset
- Fever, lethargy, anorexia, peripheral cyanosis
- Dyspnea, friction rubs, "dog sitting"
- Painful joints, carpus / tarsus most common
- Pleuritis, pericarditis, peritonitis, fibrinopurulent serositis and arthritis, meningoencephalitis

### ▪ *Mycoplasma hyosynoviae*

- Organism in nasopharynx; Asymptomatic
- Acute septicemia may resolve but persist in joint spaces
- Non-suppurative polyarthritis, w/o fever
- Piglets most susc.; acutely lame 3-10 days; chronic lameness variable

## Musculoskeletal Diseases

### ■ Erysipelothrix rhusiopathia (Erysipelas)

- Isolated from healthy pig spleen, tonsils, gallbladder, GIT
- Carrier pigs are reservoir and pasture / pen soil can harbor organism for weeks
- Acute septicemia in suckling pigs with sudden death
- Fever, arthritis, skin discoloration (diamond-skin lesions) erythema, purple discoloration of the ears
- Tips of ears, tail may become necrotic and slough
- Can develop chronic arthritis / vegetative valvular endocarditis

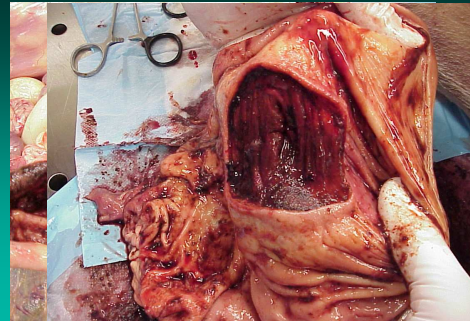
## Musculoskeletal Diseases



## Miscellaneous Diseases

### ■ Gastric Ulcers (pars oesophagea)

- Gastric secretion / acidity affected by vagal stimulation
- Acts on parietal cells (inc. gastrin / dec pH) and adrenal (inc. epinephrine secretion w/ indirect mucosal effect)
- Stress, bact. infection, parasites, diet (pelleted, finely ground feed)
- All breeds, ages and both sexes affected
- Peracute - found dead after massive intragastric hemorrhage
  - Acute - pallor, anemia, weakness, melena, tachypnea
  - Chronic- microcytic anemia, anorexia, melena, wt. loss
- e. Fluids, blood, calcium (helps clotting / depresses gastric secretions); Cimetadine (Tagamet), Famotidine (Pepcid), Sucralfate (Carafate)



## Miscellaneous Diseases

### ■ Vitamin E Deficiency

- Mulberry Heart Disease and Hepatosis Dietetica
- Caused by Vitamin E and Se deficiency
- Distended pericardial sac with straw-colored fluid and fibrin
- Hemorrhage throughout myocardium, necrosis and fibrin thrombi in the capillaries
- SQ edema with transudate in thorax and abdomen; fibrin strands adhere to the liver, which has diffuse irregular foci of necrosis and hemorrhage

## Miscellaneous Diseases

### ■ Salt Poisoning

- Water deprived pigs or salt toxicity
- Inc. thirst, pruritus, ataxia, head pressing, seizures
- Circulating eosinophils migrate to cerebrovascular / meninges collecting around vessels in 48 hrs
- Na ions accumulate in brain tissues; when water is available, migration of water to tissues with high Na concentrations
- Cerebral edema, increased intracranial pressure, eosinophilic meningoencephalitis



## Miscellaneous Diseases

### ■ Pityriasis rosea

- Skin lesions resemble ringworm but scrapings and cultures are negative
- Occurs in suckling pigs and young pigs (10-14 wks)
- Lesions on ventral abdomen but can spread to other areas
- Circular lesions coalesce leaving normal skin surrounded by narrow zone of raised erythematous scaly skin
- Spontaneous recovery occurs in 6-8 weeks

