Swine Anatomy, Physiology, and Diseases
May 2012

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  • No warranty for accuracy
• No information presented is known to be specifically included in ACLAM Board examinations

Taxonomy

Animalia
  Chordata
  Mammalia
  Artiodactyla—even toed
  Suidae
  Sus
  Sus scrofa domestica

Terms

Piglet—young, before weaning
Shoat—weaned animal
Gilt—young female
Sow—sexually mature female
Boar—sexually mature male
Barrow—castrated male
Farrowing—parturition

Information from Dr. Judy Nielson, UNC

Commercial breeds
  bred for rapid growth
  size vs length of time
epiphyseal closure not complete until after 3 years
  variable health status

Mini/micropigs
  generally better health status when bred for research
  some strains are bred for specific research
  slower growing
  smaller size
Commercial Swine Breeds

Yorkshire
Landrace

Hampshire
Duroc
Poland China

Mini and Micro Breeds

Yucatan
- Dark, very little hair
- Wattles
- Line developed for ventricular septal defect

Sinclair Mini
- First mini developed (black)
- Come in different colors now
- Long pointy snout
- 20 kg at 5 months
- What tumor did original black ones get?

Malignant melanoma (regresses)
Göttingen pig
10-15 kg 5 mo
—originally bred at the University of Göttingen (Germany), from a crossing between the Minnesota minipig and the Vietnamese potbelly swine
—gyrencephalic, relatively large brain

what is the opposite of gyrencephalic?

lissencephalic

Ossabaw
Ossabaw Islands in GA
Tolerance to heat, humidity, food scarcity
Model of type II diabetes
Indiana University


<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Yucatan</th>
<th>Ossabaw</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Obesity</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>2. Insulin resistance</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>3. Glucose</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>4. Dyslipidemia</td>
<td>Yes</td>
<td>Yes</td>
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<td>5. Dyslipidemia (↑LDL/HDL)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>6. Hypertension</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>7. Cardiovascular disease, atherosclerosis</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>8. Small stature</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
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Your investigator in NC wants to ship some of his transgenic pigs to a collaborator in WV

What National Veterinary Accreditation Program (NVAP) level do you need to sign a health certificate?

How many hours of CE do you need for each renewal period?

Category II
6 hours
What gene is this pig expressing?

**pCAGG-EGFP positive piglet created by somatic cell nuclear transfer**


**Anatomy and Physiology**

Swine are true omnivores

Dental formula (permanent teeth)

\[2(1 \ 3/3, \ C \ 1/1, \ P \ 4/4, \ M \ 3/3)=44\]

Salivary glands large, consist of paired parotid, mandibular and sublingual glands

- Parotid gland
- Mandibular gland
- Sublingual gland
• Diffuse thymus
• Diffuse tonsils

The mesenteric vessels form a **vascular arcade** in the subserosa rather than in the mesentery as in other species.

- Stomach
  - cardiac - nonglandular (white)
  - fundus - glandular
  - diverticulum set off by spiral fold (line)
  - pylorus - torus pyloricus = fleshy mass (not tumor)

Mucus from Pig Stomachs Is Effective as Anti-Viral Agent: May Be Useful in Cosmetics and Baby Formula

ScienceDaily (Apr. 25, 2012)

Mucin biopolymers as broad-spectrum antiviral agents
Oliver Lieleg, Corinna Lieleg, Jesse Bloom, Christopher B Buck, and Katharina Ribbeck
Biomacromolecules, Just Accepted
Publication Date (Web): April 4, 2012 (Article)

http://pubs.acs.org/doi/pdfplus/10.1021/bm3001292

Stuffed Pig's Stomach (Hog Maw)
It might sound like an oddity, but pig stomach is so good. Ever since I can remember, it was my birthday dinner of choice. http://teriskitchen.com/padutch/pigstom.html

http://www.sinclairresearch.com/PDF%20Files/comparative%20anatomy%20of%20the%20pig%20%2806-2003%29.pdf

40-50 kg miniature pig heart about size human heart
Coronary system similar in anatomy and function to 90% humans
Develop atherogenic plaques over time (fed/not fed high fat diet)
Variations between breed and age of swine
blood pressure differences in breed and age

Male mixed-breed Landrace pigs (Sus scrofa domesticus; n = 17; age, 3 mo; weight, 30 to 42 kg) were used in this study. The pigs were supplied from a local commercial swine producer (FerjoSama, Aveiro, Portugal). Vaccinated and dewormed...

Lab Animal - 37, 8 (2008) Feasibility of the laryngeal tube airway for artificial ventilation in pigs and comparison with the laryngeal mask airway
Torsten Birkholz, Andrea Housched, Peter Kasauer, James Allen Buani, Dirk Labahn, & Joachim Schmidt

Name the condition as seen in A and C

Horner’s syndrome
- eyelid ptosis
- pupillary miosis
- facial anhydrosis

Located within carotid sheath (like dog, unlike humans)

Lungs
- right: cranial which is ventilated separately from rest lung. A bronchus cranial to bifurcation of the trachea
- middle cranial
- caudal accessory
- Left:
  - cranial
  - caudal
A Model of Hemorrhagic Shock and Acute Lung Injury in Landrace–Large White Swine

Landrace-large white swine, 19+/- 2 kg, 10-15 weeks age
Conventional microbiologic status

The typical cortex and medulla are reversed with the germinal centers being located in the interior of the gland
rhinoceros, dolphin and the elephant similar

Kidneys

The company uses pigs descended from a herd that was left isolated in the 1850s on an abandoned whaling station in the Auckland Islands, some 465 km (290 miles) south of New Zealand.

Reproductive
Sexual maturity 4-6 months miniatures
3-7 months others
Male:
corkscrew penis
preputial diverticulum
accessory glands
vesicular glands-most prominent
prostate
bulbo urethral
Female
21 day cycle
estrus 48 hours

The cells are taken from the brain tissue of newborn pigs from a special "clean" herd, because of the risks of diseases from modern pigs.

Contributions of large pig for renal ischemia-reperfusion and transplantation studies: the preclinical model.

Contribution of large pig for renal ischemia-reperfusion and transplantation studies: the preclinical model.
Giraud S, Favreau F, Chatoureau N, Thuillier R, Maiga S, Hauet T.
Pregnancy diagnosis
- failure to return to estrus 18-24 days after mating
- ultrasound 30 days
- progesterone >1ng/ml after 19 days gestation
- estrone sulfate 23-30 days gestation

Diffuse, epitheliochorial placenta

Gestation 114 days

Litter size
- 5-12/litter= commercial swine
- 4-6/litter= miniature swine

Neonate: require iron

Behavior
- Highly social and intelligent
- Poor eyesight, good sense of smell

Group housed
Bedding to aid natural rooting behavior

Enrichment devices

Lab Animal - 37, 9 (2008) The foraging ball as a quick and easy enrichment device for pigs (Sus scrofa)
Mary E. Huntsberry, Debbie Charles, Kristina M. Adams, James L. Weed

Lab Animal - 36, 3 (2007) A playroom as novel swine enrichment
Blair Casey, Dawn Abney & Evelyn Skoumbordis

Blood Collection
- Auricular
- Cephalic
- Saphenous
- Milk vein
- Jugular
- Cranial vena cava *

* On right side to avoid left phrenic nerve

Injection sites
- IM-hip, neck
- SQ-flank, neck
- IV-ear, femoral, cephalic, abdominal (milk)
Brucellosis suis
- Nonmotile, small gram negative aerobic bacillus/cocccobacillus
- Infertility, placentitis, metritis, abortion, orchitis
  - DDx: Parvo virus
    PRRV (porcine reproductive respiratory virus)
- Leptospirosis
  - Spondylitis weanling piglets
  - Zoonotic
  - Reportable

Leptospirosis
- Abortion (late-term) weak piglets
- kidney disease
- shed long periods
- DDx:
  - Brucellosis
  - Parvo
  - PRRV

Porcine Parovirus
Reproductive disease
- smaller litter, abortions
- deaths of a litter different ages
- delayed return to estrus
Antigen test

Porcine Reproductive Respiratory Syndrome
artronivus
Two phases
1) fever, anorexia, late term abortion
   - weak, stillborn pigs
   - no milk production
2) respiratory problems in post weanlings with diffuse enlargement of lymph nodes

Susceptibility marker found to PRRS. The marker is a quantitative trait locus, or QTL, on swine chromosome 4 that is associated with the animal’s resistance to PRRS virus infection.


Disease that manifests with exposure to these agents?
Porcine Stress Syndrome
Mutation in calcium-release channel protein (ryanodine receptor-RYR)
Autosomal recessive with variable penetrance
Landrace and Pietrain especially
Signs include: dyspnea, reddened skin, increased body temperature, cyanosis, muscle rigidity and collapse
Cull
Pre-treat with dantrolene (decreases release of calcium)

Stomach ulcers
pars esophaga area (stratified squamous)
Gastroguard

Disease that manifests with exposure to these agents?
Porcine Stress Syndrome

Newly received pig found appearing tense with ears erect. Before treatment could be initiated, pig went recumbent and paddled continuously so was euthanized.

Histology of the brain

Most likely cause?
Pig found appearing tense with ears erect. Before treatment could be initiated, pig went recumbent and paddled continuously so was euthanized.

Histology of the brain

Most likely cause? Water deprivation/salt toxicity

DDx of signs:
- Pseudorabies
- Hog cholera
- Edema disease
- Streptococcus meningitis

Pseudorabies
- Mad cow itch
- Commercial swine free of it
- Concern in wild/feral swine
- Other species infected die, pigs can be carriers

Neonates—CNS signs, posterior paresis, death
Older (9 weeks or older)—more respiratory signs—sneeze, nasal discharge, cough (ddx: influenza, porcine respiratory corona virus)

Reportable, aim to eradicate

Edema disease-hemolytic E. coli
- Enterotoxemia (E. coli)
- Recently weaned
- Death, moribund, ataxia, stupor

Fibrinoid degeneration vessel (arrow)

Perivascular edema (the pink staining material at arrow head)

Ear of pig

Dog is now scratching

Found on scraping of pig
sarcoptic mange, Sarcoptes scabei
zoonotic

Name the louse?  Haematopinus suis
Is it sucking or chewing?  Sucking
Vector for  swine pox and Eperythrozoon suis

Greasy pig
Exudative epidermitis
Staphylococcus hyicus
Groin, axillae, behind ears and spreads

DDx:
acariasis
swine pox
ringworm
pityriasis rosea (now called porcine juvenile pustular psoriaform dermatitis)

Ringworm (uncommon)

Microsporum nanum

porcine juvenile pustular psoriaform dermatitis

Old name: pityriasis rosea
Partially hereditary
Not pruritic
Resolves 6-8 weeks
Can get secondary S. hyicus infections

http://www.aasv.org/shap/issues/v13n2/v13n2p86.html
http://www.labanimal.com/laban/journal/v38/n10/full/laban1009-320.html#B1
http://www.twomoonsvet.com/vetmedbooks/g/6500/5003/6500-5003.htm

Courtesy of Dr. Ranald D. A. Cameron
Lab Animal - 38, 7 (2009)
Blistering dermatosis in a Yucatan minipig
Gregory O. Voronin, William P. Porter & Zadok Ruben

1.5 year old Yucatan minipig
Castrated
Colony of six—only one with lesions
Been there 8 months
Pens sanitized every two weeks
Standard feed
Lesions along dorsal midline 1.5 cm


Punch biopsy of lesions
Cluster inflammatory cells
Diagnosis?

Spontaneous Bullous pemphigoid


From: Merck Manual, Courtesy of Dr. Ranald D. A. Cameron

A group of 2 1/2 month old feeder pigs are presented with non-pruritic keratinized skin lesions and mild lethargy. One severely affected animal is depressed and anorexic. What treatment is most appropriate for the presumptive diagnosis?

A - Spray with malathion (0.05%)
B - Supplement dietary zinc
C - Copper sulphate bath or sprays
D - Ivermectin SQ now, repeat in 2 weeks
E - High dose trimethoprim-sulfonamide 7-10 days
Zinc deficiency: parakeratosis
4-6 month old swine
Slower growth rate and skin lesions

In pigs, zinc deficiency causes parakeratosis. Zinc supplementation will resolve clinical signs.
Starter diets should contain 125 ppm zinc (and 0.9% calcium)
Grower diets should contain 75 ppm zinc (and 0.60-0.65% calcium)
Finisher diets should contain 50 ppm zinc (and 0.45 to 0.50% calcium)

DDx:
- greasy pig disease-younger, suckling pigs
- sarcoptic mange

Swine pox
usually 3-6 weeks of age
rarely fatal
midwest US
swine pox virus

Courtesy of Dr. Paul Gibbs

Differential for this lesion?
Bacterial septicemia-hog cholera, Salmonella
(cholera suis), Erysipelas, Streptococcus (suis)
Haemophilus
Haemophilus parasuis
opportunistic with swine influenza
DDx: Mycoplasma (M. hyorhinis) polyserositis, arthritis
Salmonella, Strept (suis), Erysipelus with septisic signs

Salmonella choleraesuis
mostly pig adapted-disease in immunocompromised humans
acute septisemia in swine
death with cyanotic skin, hemorrhagic lymph nodes and spleen,
fluid filled lungs
DDx: other septisemia Erysipelothrix rhusiopathiae,
Streptococcus suis, or Actinobacillus suis, A. pleuropneumoniae,
edema disease (E. coli), mulberry heart disease, hog cholera

Streptococcus suis
Meningitis, arthritis, sepsis, and endocarditis
Post weaning, growing pigs (5-16 weeks age)
Alpha hemolytic Streptococcus suis
Zoonotic
Suppurative meningitis, polyarthritis
Fibrinous bronchopneumonia

Other diseases of xenotransplantation concern:
Cytomegalovirus
Hepatitis E
EMCV-encephalomyocarditis virus
Gamma lymphotropic herpes virus

Differential Diagnoses?
Salmonella (S. typhisuis)
Hog cholera
2 day old piglet; gas distended stomach and fibrinous necrohemorrhagic enteritis—what do you suspect?

Clostridium perfringens C

Differential Diagnoses for Neonatal Diarrhea

Clostridial enteritis (C. perfringes Type C)—death, necrotic, hemorrhagic diarrhea
TGE—coronavirus—profuse watery diarrhea, mortality high in pigs less than one week of age
Coccidiosis (Isospera suis)
Rotavirus
E. coli (colibacillosis)

Post weaning enteritis
Salmonella
TGE
Swine dysentery— Brachyspira hyodysenteriae
Colibacillosis—enteropathic E. coli
Porcine Proliferative Enteritis
Whipworms (Trichuris suis)

Porcine Proliferative Enteritis
Lawsonia intracellularis
Intestine/colon
Acute death, mucoid/hemorrhagic diarrhea
R/O: Salmonella, Whipworms
**Stephanurus dentatus**
Kidney worm
Egg found in urine

Lesions from migrating kidney worm

**Metastrongylus**
M. Elongatus
Earthworm = intermediate host

**Swine Influenza**
new animals in herd
high morbidity, low mortality
dx: bacterial pneumonia
signs: fever, conjunctivitis, barking cough, open mouth breathing, reluctant to move
resolves 5-7 days
Zoonotic!

**Name the condition.**

**Name 3 bacterial agents implicated in the cause**

**Name the condition.**
Atropic rhinitis

**Name 3 bacterial agents implicated in the cause**
Pasturella multocida
Bordetella bronchiseptica
Haemophilus parasuis
Mycoplasma hyopneumoniae

Usually older pigs (3-6 months)
PRRS-virus is known to aggravate M. hyopneumoniae
Secondary bacterial infections common

Actinobacillus pleuropneumoniae

Fibropurulent pneumonia
Older (8-16 weeks)
Acute-fever, labored breathing, inactivity
Peracute-death
Chronic-cough, decreased weight gain

What product/factor is required to grow this agent in vitro?

Factor V or Nicotinamide adenine dinucleotide (NAD)
Can co-culture with Staph aureus (which produces NAD)—what results when colonies of this agent are grown near beta toxigenic S. aureus?

What is the etiologic diagnosis?

Mycoplasmosis
M. hyorhinis
Polyserositis and Arthritis

Serofibrinous arthritis
Seen towards end of weaning
Vasculitis, erythema
Kidneys congested with white foci

What is the condition?
Porcine dermatitis and nephropathy syndrome

What is the suspected agent?
Porcine Circovirus 2

Porcine Circovirus II
- pneumonia
- wasting, anemia
8-20 weeks age

Red, wet, heavy lungs

Pigs difficulty breathy
Necropsy: pulmonary edema
Feed looks like this.

What is your top differential?
Fumonisin toxicosis
Mycotoxin of Fusarium spp
You see these lesions in a swine colony. What are you going to do? What diseases are you thinking of?

All vesicular diseases reportable

Foot and Mouth Disease
- Heart lesions, cloven hoofed exotic
- Aphthovirus

Swine Vesicular Disease
- Anticovirus
- Only swine

Vesicular Stomatitis
- Vesicular virus
- Endemic, zoonotic

Vesicular Exanthema
- Virus indistinguishable from VE has been found in what species causing what disease?

Vesicular Exanthema
- Virus indistinguishable has been found in what species causing what disease?

San Miguel sea lion virus disease
- Isolated from throat and rectal swabs from 4-mo-old California sea lion pups, weaning northern fur seal pups, and nursing northern elephant seal pups.
- Isolated from commercial seal meat produced in Alaska and some kind of fish
- SMSV isolated from both fish and marine mammals is capable of producing VES in pigs.