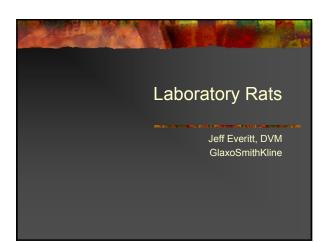
2011 TOPICS IN LABORATORY ANIMAL MEDICINE



Disclaimers

- This is not an ACLAM sanctioned presentation
- All information is deemed reliable and correct
 - No warranty for accuracy
- No information presented is known to be specifically included in ACLAM Board examinations



Objectives of talk

- Review some basics of rat biology
- Review some basic spontaneous rat models
- Cover a few diseases of rats
- Review some rat pathology
- Review some recent literature
- Not Comprehensive

THANK YOU!

- Pathology and LAS colleagues at GSK
- University of Missouri/Dr. Craig Franklin
- National Institute of Environmental Health Sciences
- Dr. Mary Grant
- Dr. Iris Bolton

Rats

- Rattus norvegicus
- Not just a big mouse
- Used frequently in toxicological, teratological, carcinogenesis, behavioral, nutritional, endocrinology, aging studies
- Huge physiology database
- Special strains for certain diseases such as diabetes mellitus, diabetes insipidus and hypertension
- GERS just beginning

Rat misc

- Susceptible to light induced retinopathies
- No gallbladder
- Duplex uterus
- Ad lib feeding shortens lifespan
- Coprophagic







What condition is depicted?

- Ringtail
- Lesion of young animals
- Annular constrictions with or without sloughing of tail
- Associated with high temperature and low humidity (<40%?) ???</p>



Coat color

- Albino
- Black-hooded
- Brown-hooded
- Fawn-hooded
- Non-agouti brown
- Rats were domesticated for show

Disease Models by	Indication
Indication	Relevant Models
Cardiovascular Disease	JCR, SHHF
Fasting Hyperglycemia	GK, Obese Prone Rat (OP-CD), Obese Resistant Rat (OR-CD), THE POUND MOUSE™, ZDF, ZSF1
Hypercholesterolemia	Dahl/SS, JCR, SHHF, SHR, SHROB, Stroke Prone SHR, THE POUND MOUSE™, ZDF, ZSF1, Zucker
Hyperinsulinemia	Dahl/SS, GK, JCR, Obese Prone Rat (OP-CD), Obese Resistant Rat (OR-CD), SHIHF, SHR, SHROB, Stroke Prone SHR, THE POUND MOUSE™, ZDF, ZSF1, Zucker
Hypertension	Dahl/SS, FHH, Obese Prone Rat (OP-CD), Obese Resistant Rat (OR-CD), SHR, SHHF, SHROB, Stroke Prone SHR, ZSF1
Hypertriglyceridemia	Dahl/SS, JCR, SHHF, Obese Prone Rat (OP-CD), Obese Resistant Rat (OR-CD), SHR, SHROB, Stroke Prone SHR, ZDF, ZSF1, Zucker
Insulin Resistance	Dahl/SS, GK, JCR, Obese Prone Rat (OP-CD), Obese Resistant Rat (OR-CD), SHHF, SHR, SHROB, Stroke Prone SHR, THE POUND MOUSE TH , ZDF, ZSF1, Zucker
Nephropathy	Dahl/SS, GK, JCR, SHHF, SHROB, Stroke Prone SHR, ZDF, ZSF1, Zucker
Non-Insulin Dependent Diabetes Mellitus (NIDDM)	GK, SHHF, ZDF, ZSF1
Obesity	JCR, Obese Mice ob/ob, Obese Prone Rat (OP- CD), SHHF, SHROB, THE POUND MOUSE™, ZDF, ZSF1, Zucker
Polycystic Kidney Disease	PCK



Cardiovascular Models

DahlSall-Sensitive (DSS) Eat Noneneclature: SS/H1sdNoviG1 Orgine Inberd from congenic group of DahlSS rans (SS)H4id) from Dr. Theodore Kartz at LCSC Orginally derived from the Halan SSS colority. The Meddal Callbarg Vilconian in 1991. To Charles Kiver in 2001. Charles Registration of the Meddal Callbarg Vilconian in Charles Registration of the Meddal Callbarg Vilconian Longentophyl. The Statistica Callbarg Vilconian in Cardiac Hypertophyl. Heart Failure Caroliaci Hypertrophy, Heart Failure Reference Reg. 12 educes, 14, 185, Octobenet and characteristic debred stains of Data Islamathae and all enables tas. Ingestration P. 186-186. Chen, P. S. 6, 16, no. 7, 165, K. A. A. Anhaman, D. R. and Sanders PM, 1982. Hypertensis engineednessis in the DakRage carolical site of injay and effect of desity Largenize and institutation. Do Integration (31): 543–545. Catelog. Is not Sura, A., 2007. (Distinuity in 2015) gain expression in sub-analities and sub-mistics Dahl Anal. J. Approximation (32): 2215.

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CHARLES RIVER

Renal Models

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ahl/Salt-Sensitive (DSS) Rat

omenclature SSIPitidMow/CH http:/interestform.compeni.goup of Dahl/SS rats SSIPItid from Dr. Theodore Kurtz at UCSE. Originally ented from the Hatland SSI collosy. To the Medical ollege of Wisconsin in 1991. To Chatles River in 2001. Auracteristics: Nephropathy. Hypotension, Insulin Resiance, poprinulinemia, Hypotentylcordelmai, Hypetcholesterolemia, ardia: Hypertophy. Heat Falure

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SHEFE Rat Nonenceltures: SHHFFAccCOL4pp# Origin: Broyd stack for this colony was transferred to Dr. Sylva McCure at the University of Chicago Medical School in 1939, from the Jahozarov D Du Ez, Miller at Co.D. Seafe and Company: The animals were developed by backcrossing the SHRDB nat to the SHRN nat. To Genetic Mediel, Inc. In 1994, To Charles River in 2001. Characteristics co-Helphongthy: Company the Hart Fallure Hypertension, Okelity, Insulin Residance, Hyperintulinensia Theorem Status and Status and Status and Status and Status Memory and Status and Status and Status and Status and Memory and Status and Status and Status and Status and Memory and Status and Status and Status and Status and Memory and Status and Status and Status and Status and Memory and Status and Memory and Status and Memory and Status and S

SHROB Rat

SHRO Brat Nomenclatures SHROBKalCri-Lapv® Orgin: Originated in the laboratory of Dr. Simon Koletsky at Care Western Reserve Linkensky School of Medicine in 1960. Developed from a cores beeven as SHR Brands rat and a normotensive male Sprager Davley rat. To Genetic Andels, Inc. 1020. To Charles Rovin 2010. Characterkristics: Nephropathy, Hypertension, Synthome X, Obesky, Issuin Resistance, Hyperimaliumnia, Hypertrighvertidensia, Hypertolotesterolemia Hyper UtgyVCrtHHIIIA, 17 year Unternative transmission in a Whyperfitter of the second second

EKER Rat Model of Familial Cancer

Mutation in the TSC2 gene (Tuberous

- Sclerosis Complex) 100% develop renal tumors by 12 months
- Autosomal dominant disease



PC Rul wownedstater: CFLEXAL/ppr/ Orgin Destroyed in the Lakoratory of Dx. Cell Human at NHH to consing the SHOII result the UANY rat Destroyed Destroyed in the Lakoratory of Dx. Cell Human at NHH to consing the SHOII result. The UANY rat PLANETERISTIC Constraints, much Relatance, Hyperrolationesis, Hyperrolationstance, Hyperrolationstance, Alternative Constraints, Marcalada Indonesis, Naphopadary Alternative Constraints, Marcalada Indonesis, Naphopadary

ZDF Rat Nomenclature: ZDF/Crl-Leprⁱⁿ Origin: Originated in a colony of outbred Zucker teenclutere: 2015 Con-ignic Originate in a colory of outbred 2008s town-oratory of De. Walter Shaw at Eli Lilly Research Laboratori relianapolis, Indiana, To Dr. Julia Clark at the Indiana Weesly Medical School (IUNN) in 1977: To Dr. Richard Horison at IUNN in 1981, To Genetic Models, Inc. in 1991.

Metabolic Models

The obsex condition appeared sportaneously in the sin of Dr. Theodore and Dr. Lois Zucker maintained at statory of Comparative Pathology in Stow, MA. Colonies abilished at many institutions from this suckess colony. les River Laboratories in 1985 from a research colory erfarisco: Obsetty, Insulin Resistance, Hyperinsulinemia, dycordiemia, Hypercholdestrobenia, Metabolic Syndrome glyceridenia, Hypercholesterolemia, Metabolic Syndrome Zalez, LM, and Zalez TJ, 1966, fing a new matterin internati, Hend S2 273–295. mil. You (2016) (2016) (2016) (2017) (2017) (2017) mil. You (2016) (2017) (2017) (2017) (2017) (2017) (2015) Hyperminishinghendert informaziler sanfaction in the obme Zacker sat matholic syndrome. Mitrodisaktor, 12(0):303–392.

91 Rat omendature: Cri.25F1-Japa^A Lepr^P reiford between a ZDF female and SHHF male reiford at Centels: Models, Ibc. To Charles River in 2001. Inaccretriktics: Obesity, Type 2 Dateste, Isualin Resilance, spectnosino, Hyperinadiama, Hypertrighcendamia, procholescoberta, Conguster Hent Faluur, Rephropath Control (2007), Conguster Hent Faluu

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What type of hooded rat is this?

- Fawn hooded rat
- What types of abnormalities does
 - this rat have?
 - Abnormal platelet function
 - Hypertension



What hooded rat is agouti with a white belly and feet?

ACI

 Genitourinary abnormalities
 Absent, hypoplastic or cystic kidneys
 Sometimes associated with an absent or defective uterine horn or atrophic testes on the same side



Other Hooded Rats...

- What is the LEC rat?
- Long Evans Cinnamon
- What abnormality does this rat exhibit?
 Hepatitis

Other Hooded Rats...

degeneration?

RCS

What hooded rat develops retinal

RCS (Royal College of Surgeons)

Carries gene for retinal dystrophy.

Overproduction of rhodopsin and

progressive loss of photoreceptor cells beginning in third postnatal week.

- Fulminant hepatitis and jaundice at four months of age.
- About 50% of animals die within 1 week of onset of clinical signs.
- Survivors develop hepatocellular carcinoma after 1-1.5 years.
- Model for Wilson's disease. Also think Bedlington Terrier.

White/Albino Rats and Their Abnormalities...

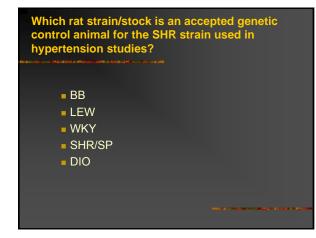
- What albino rat is a model for Type 1 Diabetes?
 BB
- Outbred Wistar rats at Bio-Breeding Labs.
- Abrupt onset of diabetes 60-120d age.
- Lymphocytic insulitis, destruction of pancreatic beta cells.
- Males > Females.



White/Albino Rats and Their Abnormalities...

- What abnormality is exhibited by the SHR rat?
 - Hypertension
- Spontaneously Hypertensive Rat.
- Develop hypertension spontaneously at 7-15 weeks.







Which rat strain/stock is an accepted genetic control animal for the SHR strain used in hypertension studies?

- BB
- LEW
- WKY (Wistar Kyoto)
- SHR/SP
- DIO

References:

- Belanger et al. 2003. Effect of hypertension on reproductive organ weights in various strains of rats. Contemp Top Lab Anim Sci 42(6):39-41.
- Fox JG, Anderson LC, Loew FM, Quimby FW, eds. 2002. Laboratory Animal Medicine, 2nd
 edition. Academic Press, San Diego, CA. Chapter 4 Biology and Diseases of Rats, p. 122.
 Charles River Laboratories Research Models and Services 2006 US Catalog, page 10.

Gunn Rats

- Model for Crigler-Najjar Syndrome
- Abnormality
 - Hyperbilirubinemia (unconjugated)

 - Jaundice
 Lacks UDP Glucuronyl Transferase in Liver



What rat was developed from Sprague-Dawley stock selected for sodium chloride-induced hypertension?

- Dahl Salt Sensitive (DSS)
- Dahl Salt Resistant (DSR)





BUF Rats

- Strain exhibits autoimmune thyroiditis?
- Autoimmune thyroiditis:
 - Spontaneous

 - After ingestion of 3-methylcolanthrene
 100% after neonatal thymectomy



The Zucker rat is a model for which of the following diseases or conditions?

- Obesity
- Type I diabetes
- Diabetes insipidus
- Prostate adenocarcinoma
- Jaundice

Reference:

Fox JG, Anderson LC, Loew FM, Quimby FW, eds. 2002. Laboratory Animal Medic 2rd edition. Academic Press: San Diego, CA. Chapter 4 – Biology and Diseases of Rats, p. 122 (Table I).

Spotting Lethal Mutant

- Model for Hirschsprungs Disease?
- Aganglionic Megacolon
- Recessive sl/sl
- (Chromosome 15)
- White coat with pigmented spot on head





The Zucker rat is a model for which of the following diseases or conditions?

- Obesity
- Type I diabetes
- Diabetes insipidus
- Prostate adenocarcinoma
- Jaundice

How do these animals differ with respect to auditory sensitivity?



Comparative Medicine 55(1)Feb2005;12-23

What type of rat is this?

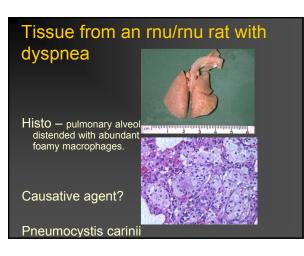


- Brown Norway (BN)
 What type of renal disease is exhibited by BN rats?
 - Brown Norway
 Hydronephrosis
 - What type of urinary tract disease does BN/Rij rats develop?
 - Spontaneous Ureter Tumors

Athymic Nude Rat

- Nude mutation: Spontaneous autosomal recessive mutation in the forkhead box N1 gene (*Foxn1^{mu}*) on chromosome 10
- rnu/rnu (homozygous), rnu /+ (heterozygous)
- Hairless, failed development of the thymic anlage → lack of thymic T-cell development





What type of rat is this?

- Nude Rat
- What is the gene symbol for the nude rat?
 - rnu/rnu (Rowett Hooded)
 - rnu^{nz} (Albino New Zealand)
- rnu/rnu exhibit cyclic hair growth ______
- T-cell deficient



Tissue from an rnu/rnu rat with diarrhea

Describe lesions

 Inflammation of large and small intestine and hyperplasia of mesenteric lymph nodes

Causative agent?

- Always include Helicobacter sp with proliferative disease of large bowel
- H. bilis



Athymic Nude Rat: Infectious Disease

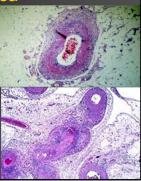
- Bacterial agents
 - Mycoplasma pulmonis (bronchopneumonia with bronchiectasis, bacterial/viral coinfections common)
 - Clostridium piliformis (Tyzzer's disease. Necrotizing typhicoclitis with dissemination to liver, lymph nodes, and heart. Intracytoplasmic groups of rod-shaped bacteria)
- Viral agents
 - Sendai virus (paramyxovirus. Proliferative interstitial pneumonia leads to mortality in Nude rats. Persistent carrier state)
- Mycotic agents
 - Pneumocystis carinii

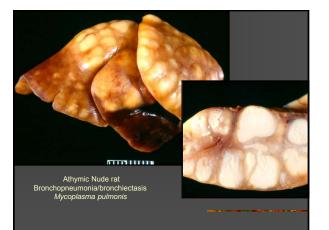
Periarteritis Nodosa

Mesentery

- Medial hypertrophyInflammatory infiltrates
- around affected vessels

 Inflammatory cells in
- perivascular fat (steatitis)Some arteries have
- fibrinoid degeneration and/or thrombi





What anesthetic combination was most frequently associated with corneal lesions in rats in a recent study?

- anten and Marianti a Photoscope a Without Honey and
- Ketamine and xylazine (60 mg/kg and 12 mg/kg)



What condition is depicted in these slides?

- Polyarteritis Nodosa (Periarteritis Nodosa): Mesenteric
- Small-Med sized arteries become swollen and damaged
- Immune-mediated disease
- Mesenteric, pancreatic, spermatic arteries





What stocks or strains of rats were more likely to develop corneal lesions after anesthesia with ketamine/xylazine?

 Wistar and Fischer 344 were the most likely (F 344 was the worst). Long Evans were intermediate in likelihood, and SD and Lewis had low likelihood

What condition is depicted?

- Rat on the left is normal
- Rat on the right is
- abnormal
- Ameliogenesis imperfecta Underdevelopment of enamel-forming ameloblasts

 - Inherited through autosomal single recessive gene (ami)



What condition is depicted?



Urolithiasis-Hydronephrosis

What condition is depicted?

Malocclusion





What are some clinical signs of urolithiasis in rats?

Hematuria, red-stained bedding, redstained or wet pelage, sensitivity to touch in the abdominal area, swollen or palpable kidneys or bladder, unkempt fur, anorexia, reduced urination, reduced water intake, unexpected weight gain or loss



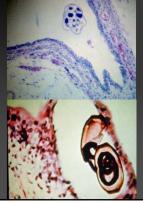
Unilateral cataract

Diet-induced urolithiasis

- Rats fed basal diet substituted with choline chloride failed to develop urinary calculi.
- Rats fed basal diet containing FCC grade of choline bitartrate developed urinary calculi.
- Rats fed basal diet containing USP grade choline bitartrate failed to develop urinary calculi.
- P-glycoprotein inhibitor treated rats had significantly reduced risk of developing urinary calculi.

Comparative Medicine 53(4)Aug2003;444-7.

Trichosomoides crassicauda



- Females in urinary bladder, ureters and renal pelvis.
- Small male worms live and are parasitic in the uterus or vagina of the adult female.
- Eggs passed in urine, infection by ingestion of embryonated egg. Eggs hatch in stomach, larvae enter bloodstream then to urinary tract.
- Primary infection from dams to pups prior to weaning.
- Proliferative changes in mucosa neoplasia?

Pituitary Tumor

- Pituitary Chromophobe Adenoma
- Vast majority of pituitary tumors in rats
- May have prominent hemorrhagic areas
- Generally well circumscribed and compress adjacent brain tissue (head tilt?)
- Females>Males



What condition is depicted in this slide?

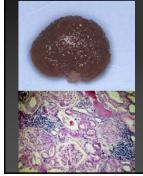
- Renal Aplasia
- What rat strains exhibit renal abnormalities?
 - ACI often lacks right kidney



BN/BiRij – bladder and ureter tumors



Chronic Progressive Nephropathy



- Gross description
 - Small pale firm kidneys
 - Rough or pitted surface
 - Numerous small foci/cysts
 - Interstitial inflammation
 - Thickened bm
 - Glomerular changes
 - Proteinaceus casts

Major age-associated lesions in rats

- Neoplasms (mammary, pituitary, adrenal)
- Chronic progressive nephropathy
- Myocardial degeneration
- Polyradiculoneuropathy

What is denicted? Benign fibroadenoma



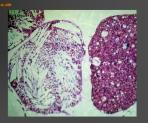
(most common tumor of rats)

- Can occur anywhere there is mammary tissue
- Hyperplastic fibrous and glandular tissue

10

Name the tissue and give the histological description...

- Tissue
- Lumbosacral spinal nerve root
- Histological description
 Nerve root on the right
 - appears normal
 - Nerve root on the left severe degeneration
 - Cholesterol clefts



What is the most common testicular tumor in rats?

- Interstitial Cell Tumor
 Although these tumors may become very large, most appear benign
- What strain has high spontaneous occurrence of this tumor type?
 - **F**344

What structure and condition are depicted?

Structure
Zymbal's Gland

, ear canal

Zymbal's Gland Tumor
 Usually present as an ulcerated mass within or just below the external



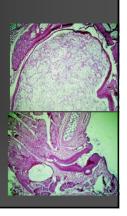
What condition is depicted?



Keratoacanthoma

Zymbal's Glands

- Modified sebaceous glands
- Surround external ear canal
 Tumors can be induced by a variety of carcinogenic compounds
- Tumors may be either sebaceous or squamous or admixtures



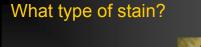
What diagnostic technique is depicted?

- Nasal Swab
- What type of swab is used?
 Calgi (calcium alginate) swab
- CAR Bacillus PCR done on nasal swab
 - Advantage can detect infection in younger rats (>=3wks) before colonization of lung occurs





Mycoplasma pulmonis What media is used to culture this organism? Dutch Agar PPLO (Pleuropneumonia-like Organisms) broth Hayflecks, SP4 In what other sites can this organism be found? Genital tract (uterus,



- Silver stain
- Bacteria densely clustered at ciliated surface of respiratory epithelium
- Organisms
 - Gram negative
 - Motile
 - Non-spore forming
 - Gliding bacteria



What is this mite?

ovary, oviduct)

- Tropical Rat Mite
- Genus and Species? Ornithonyssus bacoti
- What diseases can be
- carried by this mite? Murine Typhus
 - Rickettsial Diseases

Which of the following

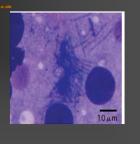
- Q Fever
- Plague



What organism is this?

- Hint: Gram + Rods (Chinese letters)
- Corynebacterium kutscheri
- Hematogenous spread
- Where do you culture for this organism? Oral cavity (carry here)Cervical LN

 - Liver ?
 - Brain ?
 - Kidney ?



Ornithonyssus bacoti, the tropical rat mite?

• The mite has a life cycle of 28 days from egg to egg production

is a chara

- The protonymph stage has been shown to survive for 43 days without food
- The principle host is *Mus musculus*
- A single female can lay as many as 1400 eggs during its 90-day lifecycle



Which of the following is a characteristic of Ornithonyssus bacoti, the tropical rat mite?

- The mite has a life cycle of 28 days from egg to egg production
- The protonymph stage has been shown to survive for 43 days without food
- The principle host is *Mus musculus*
- A single female can lay as many as 1400 eggs during its 90-day lifecycle

Which of the following neoplasms represents the majority of mammary tumors described in older rats?

- Endothelioma
- Adenocarcinoma
- Lymphosarcoma
- Fibroadenoma
- Histiocytoma

Other Rat Mites...

- Genus and Species of the Spiny Rat Mite?
 Laelaps echidninus
- What is this mite a vector for?
 - Hepatozoon muris
- Genus and Species for Ear Mange Mite?
 - Notoedres muris

Which of the following neoplasms represents the majority of mammary tumors described in older rats?

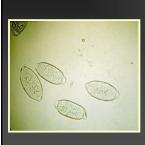
- Endothelioma
- Adenocarcinoma
- Lymphosarcoma
- Fibroadenoma
- Histiocytoma

What condition is depicted?

- View of tympanic bullae
- Right and left bullae appear to have whitish material in them.
 Otitis media
- Causative agent?
- M. pulmonis
 - P. pneumotropica



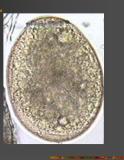
Double Operculated Eggs



- Dioctophyma renale
- Anatrichosoma
- Capillaria
- Trichuris
- Prosthenorchis
- Trichosomoides

Single Operculated Eggs

- Fasciola
- Paragonimus
- Diphylobothrium
- Athesmia
- Gastrodiscoides



What conditions are depicted? Top photo Squinting Photophobia Cervical swelling Bottom photo Exophthalmos Cloudy cornea

Name the tissue and give the histological description...

- Tissue Liver
- Histological description Diffuse sinusoidal infiltrate, large



- cells
- Prominent nucleus

Diagnosis?

Rat Leukemia

Very common in aged F344

Large Granular Lymphocytic Leukemia

Formerly called Mononuclear Cell Leukemia/ Fischer

• Can involve virtually any organ in the body (commonly

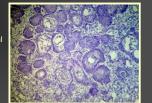
splenomegaly, hepatomegaly, lymphadenopathy)

• Large granule lymphocytes are of NK cell origin.

Name the tissue and give the histological description...

Tissue

- Glandular tissue Parotid,Harderian, Submandibular, Exorbital Lacrimal
- Histological description
- Inflammatory infiltrateInterstitial edema
- Necrosis of ducts
- Squamous metaplasia



Diagnosis?

•Sialodacryoadenitis virus (SDAV) •Coronavirus •Affects serous or mixed glands •Which salivary gland spared?

Sublingual salivary gland

- Morbidity high, mortality low Animals infected and immune
- within 3-5 weeks.
- Stop breeding for 6-8 wks





Rat bite fever can be caused by *Streptobacillus moniliformis* or what other organism?

- Bartonella henselae
- Spirillum minus
- Staphylococcus aureus
- Brucella rattus
- Pasturella multocida

Tyzzer's Disease

- Clostridium piliforme
- Flaccid dilatation especially ileum
- ("Triad") hepatitis, myocarditis, enteritis
- Fecal-oral transmission by spores
- Demonstration of intracellular organism in tissues: Steiner/Warthin-Starry, Giemsa and Methylene Blue.

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Choral Hydrate

- Hypnotic
- Short acting light anesthesia
- Poor analgesia
- Irritating to peritoneum
- Causes adynamic ileus in rats when given IP

What condition is depicted?

- Abdominal swelling
- Rule outs:
 - Ascites
 - OrganomegalyNeoplasia
 - Adynamic lleus (megacolon)
- What are possible causes
 - of megacolon?
 - Tyzzer's Disease
 - Chloral hydrate

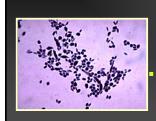


Give the gross description...

Gross:

- Fibropurulent pleuritis, pericariditis, and pneumonia
- May also see:
 - Suppurative arthritis
 - Meningitis
 - SplenitisOrchitis
- Infarcts
- Spleen
- Testes
- Diagnosis?

Streptococcus pneumoniae



Histopathology

- Characteristic organisms
- Tissue impression smear gram stain (grams + in pairs)

Culture:

- Blood agar (10% CO₂)
 Optochin inhibition
- (ethylhydrocupreine)Quellung reaction
- Capsular types 2, 3, 19

Conscious Telemetered Rat CV Model

All of the following blood vessels can be used for intravenous injections in the rat EXCEPT?

- Dorsal metatarsal vein
- Sublingual vein
- Brachial vein
- Penile vein
- Lateral tail vein

Reference:

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 Fox JG, Anderson LC, Loew FM, Quimby FW, eds. 2002. Laboratory Animal Medic 2rd edition. Academic Press: San Diego, CA. Chapter 23 – Techniques of Experimentation, pp. 1009-1010, 1012.

Miniature DSI Rat Pressure Transmitter

itive Cath

Lesions of Pneumocystis in Immunocompetent Rats

Expt. inocidated