HAMSTERS

*Mesocricetus auratus* – Syrian or Golden, 44 chromosomes; originated from a single litter in 1930s, genetically homozygous, limited MHC repertoire, accepts reciprocal tissue transplants, prone to oncogenic viruses (hamster polyoma, SV40, human adenoviruses), and prone to serious enteric microbial infections.

*Cricetulus griseus* – Chinese or Gray, 22 chromosomes; few endogenous viral sequences, so used for cytogenetic studies; cultured cells for mutagenic and carcinogenic studies.

Strains – Bio 2.4 agouti, benign prostatic hypertrophy; Bio 14.6 acromelanic, cardiomyopathy; LSH golden, gentle; MHA dental carries; PD4 large, placid disposition.

ANATOMIC FEATURES & NORMATIVE BIOLOGY

Paired flank glands – sebaceous glands, melanocytes, terminal hair follicles; costovertebral, scent, territorial marker; more prominent in males, conversion of testosterone to dihydrotestosterone.

Brown fat – prominent depots between scapula, around axilla, neck, adrenals and kidneys.

Buccal pouches – immunologically privileged site accepts xenografts (historical use), store and transport food.

Gastrointestinal – distinct constriction between forestomach and glandular stomach resulting in two blind sacs; four ileoceccolic valves, including semilunar valve that separates apical & basal cecum; paneth cells (exocrine serous cells), basophillic cytoplasm with brightly eosinophillic apical cytoplasmic granules at base of small intestinal crypts.

Respiratory – no bronchioles.

Cardiovascular – accessible sino-atrial node and purkinje network for conduction evaluations.

Genitourinary – gestation of 15-18 days; copious post-ovulatory vaginal discharge; estrous cycle will not resume until post-weaning, (no post-partum mating); tropheoblasts often found within mesometrial arterial vessels; single, long renal papillae extends into each ureter, water-conservation.

Mammary – seven pairs of glands.

Adrenal glands – large in male Syrians due to 3x enlarged zona reticularis.

Hematopoietic – common polychromasia and moderate anisocytosis of erythrocytes; WBC 5-10,000/ml³, 60-75% lymphocytes, heterophillic (neutrophils with eosinophillic granules).

Behavior – solitary, aggressive, particularly pregnant or lactating females (larger than males); cannibalism common in primiparous females; hibernation, estivation.

VIRAL DISEASES

DNA VIRUSES

PAPOVAVIRUS

Etiology: Hamster polyoma virus, Papoviridae, polyomavirus subgroup; Hamster transmissible lymphoma and keratinizing skin tumors.

Transmission: infected urine contaminated environment; multisystemic infection with persistence in kidney and shedding in urine.

Clinical: epizootic of lymphoma with incidence up to 80% 4-30 wks following exposure, variable incidence of trichoepitheliomas, followed by enzootic, clinically silent infection with persistent viruria.

Pathology: lymphomas arising within mesenteric, axillary and cervical lymph nodes, lymphomas do not have infectious virus, but contain viral DNA; keratinizing hair follicle-origin trichoepitheliomas with replicating virus on face and feet.

Ddx: proliferative ileitis, *Demodex* folliculitis.

Significance: possible epizootic; enzootic infection cannot be eliminated; hamster is uniquely sensitive to the oncogenic effects of DNA viruses beyond the neonatal period.

OTHER DNA VIRUSES

Adenovirus – hamsters <4 wks of age have antibodies to MAD-2 (K87), and large, amphophilic, intranuclear inclusions in enterocytes of villi of the jejunum and ileum, nonpathogenic, asymptomatic.

Cytomegalovirus – intranuclear and intracytoplasmic herpetic inclusions with cytopemegaly in acinar epithelium of submaxillary salivary glands, host specific.
Parvovirus – Hamster Parvovirus (HaPV) closely related to MPV-1, epizootic with high mortality resulting in dental and facial deformities, malformed and missing incisors, domed calvaria; seroconversion to Toolan H-1 virus without disease also possible (caution: the acronym HaPV is also occasionally used to refer to hamster polyoma virus).

RNA VIRUSES

LYMPHOCYTIC CHORIOMENINGITIS
Etiology: Arenaviridae, LCMV.
Transmission: saliva or urine contaminated environment; oronasal mucosa & skin abrasion routes; congenital; contaminated biologics; cage-to-cage aerosols not an important means of spread; wide host range; principal natural reservoir host is the wild mouse.
Clinical: asymptomatic clearance or persistent viremia, viruria for months; wasting possible.
Pathology: possible vasculitis, glomerulitis, lymphocytic infiltration in liver, lung, spleen, meninges, brain.
Significance: LCM virus-infected urine of hamsters are primary source of zoonosis, with sequelae varying from asymptomatic, influenza-like symptoms, rare meningoencephalomyelitis.

PNEUMONIA VIRUS OF MICE
Etiology: Paramyxoviridae, PVM.
Transmission: hamsters, rats, and mice naturally infected.
Clinical: typically subclinical, self-limiting, seroconversion.
Pathology: none typically, but interstitial pneumonitis with consolidation possible.
Significance: unknown.

SENDAI VIRUS
Etiology: Sendai virus.
Transmission: hamsters, rats, and mice naturally infected.
Clinical: asymptomatic, relatively widespread seroconversion.
Pathology: experimental exposure results in rhinitis, tracheitis, bronchitis, bronchoalveolitis.
Significance: unknown prevalence of clinical disease.

BACTERIAL DISEASES

PROLIFERATIVE ILEITIS
Etiology: Lawsonia intracellularis; cannot be grown on artificial medium.
Transmission: rapidly spread among weanlings, 3-5 weeks of age, resistant after 12 weeks; wide host range of susceptibility.
Clinical: epizootic fetid, watery diarrhea, abdominal distension, rectal prolapse or intussusception frequently occur; 20-60% morbidity, mortality reaching 90%.
Pathology: abrupt, segmentally thickened, congested, roughened terminal ileum; hyperplasia of crypt and villous epithelium, elongation and fusion of villi, downward extension and penetration of crypts through lamina propria; crypt microabscesses; pyogranulomatous inflammation; prominent serosal nodules, fibrinous peritoneal adhesions; PAS or Steiner’s or Warthin-Starry silver stains show numerous small slightly-curved intracellular bacilli within apical cytoplasm of hyperplastic enterocytes, and macrophages with PAS-positive granules in lamina propria and submucosa.
Ddx: Tyzzer’s, salmonellosis, AAEC, coliforms, giardiasis.
Significance: sporadic.

TYZZER’S DISEASE
Etiology: Clostridium piliforme, gram-negative, spore-forming, obligate intracellular, long, pleomorphic, beaded bacilli; cultured in embryonated eggs.
Transmission: spore-contaminated feed, bedding, environment; wide host range of susceptibility.
Clinical: asymptomatic to epizootic, weanlings more likely affected, various contributing factors, watery, foamy yellow diarrhea; affected areas are edematous, dilated with fluid contents.
Pathology: variable distribution of lesions involving lower ileum, cecum, colon, liver, and heart; edema of the lamina propria, PMN infiltrate potentially extending through the tunica muscularis, villous blunting and crypt hyperplasia, necrotizing ileitis with effacement of mucosal architecture; multifocal, coagulative hepatic necrosis; focal, granulomatous, necrotizing myocarditis; bundles of filamentous, intracytoplasmic bacilli visualized at periphery of lesions using Warthin-Starry silver or Giemsa stains.
Ddx: proliferative ileitis, salmonellosis, coliforms, AAEC.
Significance: interspecies transmission possible.
ESCHERICHIA COLI
**Etiology:** enteropathogenic strains 1056, 1126, 4165
**Transmission:** oral, weanlings.
**Clinical:** diarrhea, yellow to dark red ileum lumenal content.
**Pathology:** ileum, blunting and fusion of villi, sloughing of enterocytes, infiltration of lamina propria by PMN; occasionally typhilitis, colitis with intussusception possible; reactive mesenteric lymph nodes; focal coagulative hepatic necrosis possible; gastric ulcers variably possible.
**Ddx:** proliferative ileitis, salmonellosis, clostridial enterocolitis.
**Significance:** primary, or secondary infection contributing to proliferative ileitis.

SALMONELLOSIS
**Etiology:** *Salmonella enteritidis* serotypes *typhimurium* & *enteritidis*.
**Transmission:** contaminated feed, bedding, and environment; Syrian hamsters are very susceptible.
**Clinical:** dyspnea, acute epizootics with high mortality.
**Pathology:** patchy foci of pulmonary congestion, hemorrhage, interstitial pneumonia, and pulmonary vein phlebothrombosis; foci of necrosis of liver and spleen, embolic glomerular lesions; acute epizootics may lack enteric signs or lesions.
**Ddx:** Tyzzer's, coliforms.
**Significance:** possible interspecies transmission; possible zoonosis; hamsters more susceptible than other species.

ANTIBIOTIC ASSOCIATED ENTEROCOLITIS
**Etiology:** *Clostridium difficile* overgrowth 2-10 days following oral or parenteral antibiotic administration; lincomycin, clindamycin, ampicillin, vancomycin, erythromycin, cephalosporins, gentamicin, penicillin eliminate protective gram negative anaerobes, *Lactobacillus* and *Bacteroides*.
**Clinical:** acute, profuse diarrhea with high mortality; distended, fluid-filled cecum, with hemorrhage.
**Pathology:** mild typhlitis to acute pseudomembranous typhlitis; hemorrhage and effacement of mucousal epithelium; terminal ileum and colon may be involved.
**Ddx:** salmonellosis, coliforms, Tyzzer's.
**Significance:** acute enteritis with mortality possible with *C. difficile* without prior antibiotic therapy.

CAMPYLOBACTER
**Etiology:** *Campylobacter fetus ssp. Jejuni*
**Transmission:** subclinically infected hamsters shed for months.
**Clinical:** asymptomatic to watery diarrhea; adults most frequently affected.
**Pathology:** cecum and colon primarily involved.
**Significance:** may be contributing pathogen to proliferative ileitis; possible zoonosis.

OTHER
*Corynebacterium kutscheri* – hamster as reservoir host.

*Francisella tularensis* – single report, high mortality in breeding colony.

*Pasteurella pneumotropica, Streptococcus pneumoniae, Mycoplasma pulmonis* – isolated from hamsters with respiratory disease, but primary roles not definitively established.

(No spontaneous mycotic infections of concern.)

ECTOPARASITIC DISEASES

DEMODEX ACARIASIS
**Etiology:** *Demodex criceti* and *aurati*
**Transmission:** dam to sucklings; relatively common; species specific.
**Clinical:** low pathogenicity, rare clinical signs; nonpruritic alopecia, dry, scaly scabs over back, neck and hindquarters; males have larger mite loads.
**Pathology:** *D. criceti* in epidermal “pits”, or *D. aurati* in hair follicles and canals of the sebaceous glands.
**Ddx:** other rare mite infestations by *Notoedres notoedres* that burrows in stratum corneum of ears, nose, feet, and perianal area.
ENDOPARASITIC DISEASES

GIARDIASIS
Etiology: *Giardia muris*
Transmission: ingestion of cysts.
Clinical: asymptomatic, diarrhea in aged hamsters with concomitant amyloidosis.
Pathology: enterotyphlocolitis, diffuse lymphoplasmacytic infiltration of lamina propria, gross mural thickening of ileum and cecum; pear-shaped organisms with rolling-tumbling movement; Giemsa-stained wet mounts, flotation, Lugol's iodine-stained smears.
Ddx: host to many other enteric protozoans such as *Spironucleus muris* and *Cryptosporidia*, both nonpathogenic flagellates.
Significance: interspecies transmission possible.

PINWORMS
Etiology: *Syphacia mesocriceti* or more commonly *S. obvelata* (mouse)
Dx: cellophane, floats, direct large intestinal life cycle, eggs deposited on perineum, asymmetrical eggs.
Significance: interspecies transmission; disseminated eggs survive for weeks in environment.

TAPEWORMS
Etiology: *Hymenolepis nana, Hymenolepis diminuta*
Clinical: common; asymptomatic, perhaps most significant endoparasite of hamsters.
Pathology: typically direct 1-16 day life cycle with cercocystis in villi; possible indirect 20-30 day life cycle with arthropod intermediate host (e.g., flour beetle or flea); *H. diminuta* requires arthropod intermediate host, rare in laboratory setting.
Dx: eggs with 3 distinctive “hooks” in fecal or crush preparations; adult *H. nana* are smaller and in lower small intestine, *H. diminuta* are larger and in upper small intestine.
Significance: interspecies transmission and zoonosis possible.

*Spironucleus muris* – common enteric protozoan with dubious nonpathogenic nature (also referred to as *Hexamita muris*).

DISEASES OF AGING

Glomerulonephropathy – also referred to as Hamster Nephrosis, Arteriolar Nephrosclerosis; requires further study; associated with high dietary protein, chronic viral infection (i.e., LCMV); important cause of morbidity and mortality in aged hamsters; thickened glomerular basement membranes, dilated and degenerating tubules, proteinaceous casts, interstitial fibrosis, concurrent amyloid deposition; amyloidosis.

Amyloidosis – important cause of renal insufficiency; frequent observation in liver, kidney, and adrenals of aged, especially females, >1 year age; PAS-positive hyalin-like depositions in vessel walls of portal triads, glomeruli, and adrenal cortex; Congo red or thioflavin T.

Atrial Thrombosis - common, females; associated with amyloidosis; left auricle and atrium.

Polycystic disease – failure of fusion of intralobular and interlobular ducts, or failure of disappearance of superfluous bile ducts; multiple hepatic cysts; also seen in epididymis, seminal vesicles, pancreas, endometrium; incidental, up to 75% in some colonies.

NEOPLASMS

Relatively low incidence of spontaneous neoplasms reported, approximately 4% incidence in some colonies, majority of tumors are endocrine, alimentary and benign; adrenocortical adenomas are frequently recorded. Newborn Hamsters are used to screen for potentially oncogenic viruses. Cutaneous Lymphoma not associated with Hamster Papova Virus (HaPV) resembling mycosis fungoides in humans has also been reported.

OTHER DISORDERS
**Hemorrhagic Encephalopathy** – vitamin E deficiency in dams resulting in capillary bed degeneration in young; (also known as Spontaneous Hemorrhagic Necrosis of the CNS, SHN); stillborn late trimester fetal or weak neonatal hamsters with symmetrical, subependymal vascular degeneration in forebrain, with edema and hemorrhage in adjacent neuropil; most extensive in proencephalon.

**Diabetes mellitus** – recessive disorder of Chinese inbred lines; islet involution.

**Bedding associated dermatitis** – wood shavings; granulomatous dermatitis of the footpads, digits, legs.