

Diseases of Non-Human Primates

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12	SYSTEMIC DISEASES			
13	Systemic diseases to cover			
14	Alpha-herpesviruses			
15	Oral cavity	Vesicular and ulcerative glossitis, cheilitis, gingivitis	Macacine Herpesvirus-1	<p>Also called B virus, Cercopithecine herpesvirus-1. Enzootic among Asian macaques. All macaques should be considered positive. Persistent infection, with intermittent reactivation and shedding from sensory ganglia. Serology is useful screening tool. Usually inapparent, but if seen, lesions are typical of α-HV. Gross: vesicles or ulcers on mucous membranes, conjunctivitis. Immunosuppression worsens the lesions → systemic dissemination, widespread visceral necrosis. Histo: necrosis, cells at edge of lesion with large IN inclusions, occasional multinucleated syncytia</p> <p>ZOONOTIC. Can cause fatal encephalitis in humans, so use full PPE for all macaque necropsies.</p> <p>Can also cause disease in other monkeys (DaBrazza, owl, African green, patas monkeys, gibbons, marmosets) with variable mortality.</p>
16	Oral cavity	Vesicular and ulcerative glossitis, cheilitis, gingivitis		
17	Skin	Multifocal to coalescing ulcerative cheilitis and dermatitis		
18	Penis	Multifocal ulcerative posthitis		
19	Lung	Multifocal necrotizing interstitial pneumonia		
20	Liver	Multifocal necrotizing hepatitis		

21	Spleen	Multifocal necrosis		
22	Esophagus	Multifocal ulcerative/ necrotizing esophagitis		
23	Oral cavity/lip	Focal/multifocal ulceration	Herpesvirus papionis 2	Alphaherpesvirus of baboons analogous to Macacine herpesvirus-1 and human herpes simplex. Virus latency in ganglia. Vesicular lesions (if seen) as with other α -HV (and can have secondary bacterial infections). In general, remains localized to oral or genital regions.
24	Tongue	Multifocal to coalescing necroulcerative glossitis		
25	Penis	Ulceration		
26	Tongue	Multifocal to coalescing vesicular glossitis	Saimiriine herpesvirus 1	Endemic and latent in squirrel monkeys. Disseminated fatal disease with typical herpes-type lesions in tamarins, owl monkeys, marmosets +/- titi monkeys. <u>Don't mix species!!!</u> Gross: skin, oral and genital inflammation/vesicles/ulcers +/- necrosis in visceral organs Histo: foci of necrosis, IN inclusions DDx: Human herpes simplex 1
27	Liver	Multifocal necrotizing hepatitis with hemorrhage		
28	Liver, tongue	Multifocal necrotizing hepatitis Ulcerative glossitis	Human herpesvirus simplex 1	Latent and active infection common in humans. Human \leftrightarrow monkey transmission from active lesions. Causes herpes-type lesions in owl monkey, tree shrew, lemur, marmoset, tamarins, gibbon, chimp, cebus, callitrichids. Can be devastating in owl monkeys but is uncommon. Pathogenesis and lesions very similar to Saimiriine herpesvirus 1. Vet Pathol.2003;40(4):405-11.
29	Skin	Multifocal to coalescing papulovesicular dermatitis	Simian varicella virus (Cercopithecine herpesvirus 9)	Highly contagious for macaques, African greens and patas monkeys. Vesicular skin lesion is classic but dissemination can occur. Gross: maculopapular to hemorrhagic rash; necrosis and hemorrhage in liver, spleen, lymph nodes, GIT; interstitial pneumonia Histo: epithelial hyperplasia and balloon degeneration, vesicles/ulcers, necrosis, syncytia, IN inclusions Vet Pathol.2008;45(4):592-4 Comp Med.2016;66(2):150-153.
30	Skin	Multifocal to coalescing vesiculohemorrhagic dermatitis		
31	Skin	Multifocal to coalescing maculopapulovesicular dermatitis		
32	Liver, spleen	Multifocal hepatic and splenic necrosis		

33 Beta-herpesviruses				
34	Lung	Multifocal histiocytic interstitial pneumonia +/- hemorrhage	Rhesus cytomegalovirus (RhCMV, Macacine Herpesvirus-3)	<p>Related to human CMV. Latent infection and opportunistic with immunosuppression (SIV).</p> <p>Gross</p> <ul style="list-style-type: none"> - Necrosis and hemorrhage in multiple organs - Multifocal hemorrhagic and proliferative typhlocolitis - Interstitial pneumonia - CNS lesions more common in spinal cord than brain but can have meningoencephalitis. In brain, involves primarily leptomeninges and subjacent neuropil with perivascular cuffing, neutrophilic infiltrates, necrosis, fibrinous exudate, edema and viral inclusions <p>Histo: huge basophilic IN inclusions, neutrophils, +/- necrosis</p> <p>Facial neuritis (Vet Pathol.2015;52(1):217-223) in SIV+ rhesus, with infiltration and replacement of small-caliber nerves by inflammation. Macrophages contain IN inclusions; IHC+ for RhCMV.</p>
35	Small intestine	Segmental necrohemorrhagic and proliferative enteritis		
36	Spinal cord	Segmental (necro)hemorrhagic meningomyelitis and radiculoneuritis		
37	Face	Focally extensive lip ulceration		
38	Testes	Multifocal necrohemorrhagic orchitis		
39 Gamma-herpesviruses				
40	Spleen, liver, small intestine	Lymphoma (and abdominal effusion)	Saimiriine herpesvirus 2	<p>Also called Herpesvirus saimiri.</p> <p>Reservoir host: squirrel monkey, latent/subclinical infection of T cells. Non-pathogenic.</p> <p>Continuum of viral-induced lymphoproliferative disease with T-cell lymphoma in other NWM (marmosets, owl monkey, African green, howler, spider monkeys, tamarins) <u>Don't mix species!!!</u></p> <p>Leukocytosis can be >100,000.</p> <p>No viral inclusions on histo.</p>
41	Eye/Orbit	Retro-orbital lymphoma		
42	Kidney, lung, lymph nodes, small intestine	Lymphoma		
43 Retroviruses				
44	Small intestine, mesentery, peritoneum	Diffuse intestinal serosal fibromatosis	Retroperitoneal fibromatosis	<p>Sulawesi macaque, crab eating macaque, rhesus macaque.</p> <p>Coinfection by Simian Retrovirus type D serotype 2 (SRV-2) and Retroperitoneal Fibromatosis herpesvirus (RFHv, a gamma-HV).</p> <p>Fibrous proliferation starts around the mesenteric root. Localized forms start in ileum or ileocecal junction and generalized forms go throughout abdomen and thorax. Masses are composed of extremely vascular fibrous connective tissue. Can rarely manifest in the SQ.</p>
45	Small intestine, mesentery	Diffuse intestinal serosal fibromatosis	SRV-2 associated	
46	Subcutis	Subcutaneous fibromatosis		

47	Oral cavity/ maxilla	Necroulcerative gingivitis and maxillary osteomyelitis	NOMA SRV-2 associated	Polymicrobial infection (anaerobes and spirochetes) associated with Simian Retrovirus type D serotype 2 (SRV-2) and immunosuppression. Rapidly progressing and destructive necroulcerative gingivitis with osteolysis and necrosis of adjacent soft tissues.
48	Oral cavity/ mandible	Necroulcerative gingivitis and maxillary osteomyelitis		
49	Lymph nodes	Marked lymphoid hyperplasia	Simian lentivirus (SIV)	<p>Indigenous virus of African NHPs. Enzootic in many populations. Infection is common but disease is rare. Virus similarities with HIV. Virus targets lymphoid tissues and lymphoid hyperplasia is an early lesion of lentivirus infection in many species. Ultimately, a marked CD4 T cell depletion or lymphoproliferative disease is possible.</p> <p>Opportunistic infections (OI) common: Candida, MAIC, adenovirus, Cryptosporidium, Pneumocystis, CMV, Histoplasma, Trichomonas</p> <p>Lesions include</p> <ul style="list-style-type: none"> - Lymphoid hyperplasia, depletion, or proliferation - Maculopapular skin rash (chronic lesion) - Giant cell pneumonia of SIV – granulomatous interstitial pneumonia with giant cells (DDX <i>Pneumocystis carinii</i>, though often both are present) - Pulmonary thrombus/embolus – often seen with rhadinovirus (gamma-HV) coinfection; focal to segmental thickening of arterial intima and media with fragmentation of the internal elastic lamina in vessels throughout the body - Proliferative arteriopathy – intimal medial thickening of pulmonary vessels - Lymphoma (Vet Pathol.2008;45(6):914-921) – often associated with concurrent gammaherpesvirus infection (Macacine herpesvirus 4 or rhesus lymphocryptovirus); B cell origin; often starts as marked peripheral lymphadenopathy; common sites are nasal cavity, lymph nodes, GIT, kidney, CNS
50	Spleen	Diffuse white pulp (follicular) hyperplasia		
51	Skin	Multifocal to coalescing papular dermatitis		
52	Lung	Multifocal to coalescing granulomatous interstitial pneumonia		
53	Lung	Pulmonary thrombus/embolus with infarction		
54	Lung (fixed)	Multifocal pulmonary proliferative arteriopathy with pulmonary infarction		
55	Stomach	Gastric lymphoma		
56	Small intestine	Small intestine lymphoma		
57	Kidney, heart	Lymphoma	Simian T-Lymphotropic Virus type 1 (STLV-1)	Widespread in African NHPs, less frequent in Asian NHPs. Often asymptomatic, but epizootics of lymphoma in multiple organs reported in baboons. T cell origin. Leukemia is possible. Most common sites: lymph nodes, spleen, liver, skin, lung
58	Lymph nodes	Lymphoma		
59	Spleen	Lymphoma		

60 Other Systemic Viruses				
61	Skin	Erythematous maculopapular dermatitis	Measles	<p>Morbillivirus of OWM and NWM. Variable species susceptibility (high in Colobus and callitrichids) but usually more severe in NWM. ZOONOTIC and can be acquired from human handlers.</p> <p>High morbidity, variable mortality. Viral dissemination from URT. C/S: resp difficulty, diarrhea, conjunctivitis, dehydration</p> <p>Gross: maculopapular rash on face, ventral abdomen, inner thighs, pulmonary consolidation; Koplik's spot on tongue; **fatal enterocolitis in NWM**</p> <p>Histo: IN and IC inclusions, multinucleated viral syncytia in multiple organs; interstitial pneumonia, lymphoid atrophy in late stages, encephalitis with neuronal and glial inclusions; necrohemorrhagic enterocolitis in NWM</p>
62	Tongue	Multifocal vesicular glossitis		
63	Lung	Diffuse acute necrotizing interstitial pneumonia		
64	Gingiva/ Oral mucosa	Multifocal to coalescing buccal hyperplasia and papillomas	Papillomavirus	<p>DNA virus. Natural infection of rhesus, cynos, colobus monkeys, chimpanzees, baboons. In chimps, focal epithelial hyperplasia can be due to papillomavirus related to human HPV13.</p> <p>Histo: massive hyperplasia of stratum spinosum and corneum, can see IN inclusions.</p> <p>Vet Pathol.2013;50(1):200-208.</p> <p>Vet Pathol.2011;48(3):731-736.</p> <p>Vet Pathol.2004;41(2):108-15.</p>
65	Skin	Cutaneous papillomas		
66	Vulva	Papillomas		
67	Vulva	Papillomas		
68	Penis	Papillomas		

69		Bacteria		
70	Eyelid	Multifocal lymphohistiocytic and necrotizing blepharitis with edema	<i>Mycobacterium tuberculosis</i>	<p>All NHPs susceptible, OWM develop more severe disease than NWM. "TB": <i>M. tuberculosis</i> (more common) or <i>M. bovis</i></p> <p>PPD skin test done on eyelid (inflammation, necrosis and edema if positive reactor). <i>M. avium</i>-infected animals will be weakly positive. Can also do ELISA-based Quantiferon test for IFNγ, especially for latent infections.</p> <p>Although the incidence is extremely rare in lab NHPs today, necropsy of all should include PPE. ZOONOTIC and can be acquired from <u>human handlers</u>.</p> <p>Transmission most often via inhalation but also possible via ingestion, bite wounds, contaminated equipment.</p> <p>TB granulomas can occur in any organ. Typically starts with granulomatous pneumonia that disseminates.</p> <p>#1 cause of infectious spondylitis in macaques.</p> <p>Gross: firm, yellow-white nodules varying in size that can be cavitory. Fibrous encapsulation and calcification are common.</p> <p>DDx: neoplasia, fungal, atypical forms of <i>M. avium</i> or <i>M. kansasii</i></p> <p>DDx in imported NHP: <i>Burkholderia pseudomallei</i> (Meliodosis)</p> <p>Vet Pathol.2018;55(1):8-10,14-26.</p> <p>Comp Med.2004;54(5):578-84.</p> <p>Comp Med.2017;67(4):368-375.</p>
71	Hilar lymph nodes	Necrogranulomatous to pyogranulomatous lymphadenitis		
72	Lung	Multifocal to coalescing granulomatous pneumonia and hilar granulomatous lymphadenitis		
73	Liver	Multifocal to coalescing granulomatous hepatitis		
74	Vertebrae (fixed)	Focally extensive granulomatous vertebral osteomyelitis with pathologic fracture and spinal cord compression		
75	Small intestine	Diffuse granulomatous (+/- hemorrhagic) enteritis	<i>Mycobacterium avium-intracellulare</i> complex (MAIC)	<p>MAIC comprised of <i>M. intracellulare</i> and <i>M. avium</i>. This is not tuberculosis! <i>M. avium</i> is far more common in immunosuppressed animals (and people). ZOONOTIC. Infection associated with immunosuppression in rhesus macaques (SIV or SRV-D).</p> <p>Primary enteric infection may disseminate.</p> <p>C/S : weight loss, diarrhea</p> <p>Gross: marked thickening of intestines, hepatosplenomegaly</p> <p>Histo: numerous acid-fast bacilli in OWM (rare to find in NWM infections); scattered lymphocytic aggregates composed mostly of B cells are characteristic</p>
76	Mesenteric lymph nodes	Diffuse granulomatous lymphangitis and lymphadenitis		
77	Lung	Diffuse granulomatous pneumonia		
78	Spleen	Diffuse granulomatous splenitis		

79	Heart	Diffuse fibrino-suppurative epicarditis and pericarditis	<i>Streptococcus pneumoniae</i>	<p>Normal commensal of the nasopharynx of healthy macaques. Opportunistic pathogen that can cause acute sepsis with fibrinous pneumonia/pleuritis, pericarditis, meningitis and arthritis. Outbreaks aren't common, but spontaneous cases are seen. #1 cause of bacterial meningitis in young rhesus, usually with sepsis. *If abundant fibrin in a body cavity, consider <i>Streptococcus</i>. *</p> <p>Common Lesions</p> <ul style="list-style-type: none"> - Arthritis – thick yellow exudate in the joint space and thickened joint capsules; DDx: gram-negative bacteria - Meningitis - yellow exudate beneath leptomeninges and often also marked congestion of meningeal capillaries
80	Stifle	Diffuse fibrino-suppurative arthritis		
81	Brain, meninges	Fibrinosuppurative meningitis +/- hemorrhage		
82	Lung	Diffuse fibrino-suppurative pneumonia		
83	Brain, meninges	Focally extensive suppurative meningitis/ meningoencephalitis	<i>Klebsiella pneumoniae</i>	<p>Severe infection, often fatal sepsis. Often after stress, shipping. Abscesses due to prominent bacterial capsule (strains without capsule are less pathogenic). Common bacteria to cause meningitis in NHP, humans. Lung resembles shipping fever in other species and can also have mucopurulent oculonasal discharge. **Can affect air sacs**</p> <ul style="list-style-type: none"> - Several species of NHP have air sacs (OWM, apes). Infection often by gram-negatives. <i>K.pneumoniae</i> is a common isolate.
84	Air sac	Necrosuppurative/ fibrinous air sacculitis		
85	Lung	Acute fibrino- or necrosuppurative pneumonia		
86	Large intestine	Necrohemorrhagic and ulcerative colitis	<i>Shigella</i> spp	<p>Disease of man and captive NHPs (mostly OWM). ZOONOTIC. Four serogroup: <i>S. flexneri</i>, <i>S. boydii</i>, <i>S. dysenteriae</i>, <i>S. sonnei</i> Lesions in colon +/- stomach (skips SI). Mucosal hemorrhage and multifocal ulceration. Thickening of GIT wall due to edema. *Red inflamed colon in NHP – think <i>Shigella</i>.*</p> <p>Histo: necrosuppurative inflammation, crypt abscesses, thrombosis of submucosal vessels</p> <p>Other lesions</p> <ul style="list-style-type: none"> - Clin path – marked neutropenia - Gingivitis – seen in colonies with endemic Shigellosis; chronic carrier state; lesion generally NOT linked to concurrent colitis; gums are red, eroded but no root exposure or bone invasion - Aseptic arthritis – due to delayed hypersensitivity; swollen and inflamed joints; neutrophilic inflammation <p>DDx (colon): <i>Campylobacter</i>, <i>S. typhimurium</i>, <i>Brachyspira pilosocoli</i> DDx (gingiva): gram negatives (<i>Borrelia vincentii</i>, <i>Fusobacterium</i> sp)</p>
87	Large intestine	Necrohemorrhagic and ulcerative colitis with pseudomembrane		
88	Stomach	Diffuse hemorrhagic and erosive/ulcerative gastritis		
89	Gingiva	Necroulcerative gingivitis with gingival recession and dental plaque		
90	Joint space	Arthritis		

91	Liver	Multifocal to coalescing necrosuppurative hepatitis	<i>Yersinia</i> spp	<i>Y.pseudotuberculosis</i> or <i>Y. enterocolitica</i> . OWM and NWM. Systemic disease affecting GIT, liver, hematology lymphatic organs. ZOONOTIC . Spread by oral route (usually associated with feed contamination by rodents or birds). Bacteria into lymphatics (usually via Peyer's patches) → systemic circulation → necrosis/necrosuppurative foci/abscess in multiple organs. Classic lesions: hepatic and splenic necrosis, mesenteric lymphadenopathy, ulcerative enterocolitis Gross: diffuse, usually superficial, necrotizing enteritis and colitis, often with a fibrinonecrotic membrane Histo: necrosis with large gram negative bacteria colonies DDx: <i>Shigella</i> (unlike <i>Shigella</i> , <i>Yersinia</i> affects SI and LI)
92	Spleen	Multifocal to coalescing necrosuppurative splenitis		
93	Small intestine	Diffuse fibrinous and necrohemorrhagic enteritis		
94	Colon	Diffuse fibrinous and necrohemorrhagic colitis		
95	Spleen	Multifocal splenic necrosis	Tularemia (<i>Francisella tularensis</i>)	Several outbreaks in outdoor colonies of macaques have been reported, and tularemia can be spread by rodents, blood-sucking arthropods and contaminated water. The disease mimics that in humans with necrosis in multiple organs (especially hematology lymphatic) and pneumonia. ZOONOTIC . Important DDx for hepatic necrosis, especially in NHP housed outdoors (also DDx: Yersiniosis) Comp Med.2012;62(4):316-321.
96	Lymph node	Necrotizing lymphadenitis		
97	Liver	Multifocal necrotizing hepatitis		
98	Heart (fixed)	Endocarditis	<i>Staphylococcus aureus</i>	Normal commensal flora in skin and nasopharynx. Most common cause of pyogenic infections. Common lesions include dermatitis, endocarditis, abscesses, bronchopneumonia. Can result in septicemia, especially if immunosuppressed. DDx for meningoencephalitis: <i>E.coli</i> , <i>Corynebacterium</i>
99	Liver	Hepatic abscess		
100	Brain, meninges	Suppurative meningoencephalitis		
101	Brain, meninges	Suppurative meningoencephalitis		
102	Kidney	Multifocal to coalescing suppurative pyelonephritis		
103	Skin	Chronic ulcerative cellulitis	Methicillin resistant <i>Staphylococcus aureus</i> (MRSA)	Has been identified in captive and experimental NHPs (in association with cranial implant chambers). DDx: leprosy

104 Nutritional				
105	Subcutis	Necrosis and mineralization (saponification) of fat	Fatal fasting syndrome of obese macaques	Also known as fatal fatty liver syndrome. Poorly understood metabolic syndrome of macaques. Due to anorexia and weight loss (for any reason) in an obese animal. Risk factors include females, older age, stress. Lipid will be present in multiple organs. Pancreatitis and serous atrophy of fat also possible.
106	Liver	Hepatic lipidosis		
107	Kidney	Diffuse acute renal tubular lipidosis and necrosis		
108	Maxilla	Diffuse osteopenia with fibrous replacement	Fibrous osteodystrophy	Nutritional (or renal) secondary hyperparathyroidism. Almost always nutritional origin – Vit D3 deficiency and/or low Ca/high phosphorus diets. Historically associated with commercial diets with Vit D2 as the sole source of Vitamin D (Vit D3 is required to prevent hypocalcemia). Low Ca → increased PTH secretion → increased osteoclastic resorption of bone. Marmosets – high requirement for Vit D3; commonly develop lameness and fractures Lesions: marked proliferation of fibrous tissue in marrow space, thin cortices, easily bendable bones, widespread osteoclastic resorption Vet Pathol.2015;52(5):883-893.
109	Ribs	Diffuse osteopenia with fibrous replacement		
110	Carpus	Focally extensive peri-articular hemorrhage	Scurvy (Hypovitaminosis C)	Lack of L-gulonolactone oxidase (required for L-gulonolactone conversion to L-ascorbic acid) AND decreased dietary Vit C → decreased hydroxylation of proline/lysine → decreased cross linking of fibrillar collagen → weak cartilage; decreased osteoid (microfractures); increased blood vessel fragility with hemorrhage (usually periarticular); loose attachment of periosteum to bone (tooth loss) C/S: joint pain, epiphyseal fractures, gingival swelling, periodontal disease Gross: periarticular hemorrhage common; cephalohematoma in squirrel monkey is pathognomonic
111	Gingiva	Focally extensive gingival hemorrhage +/- tooth loss		
112	Skull	Cephalohematoma (subperiosteal hemorrhage)		
113	Skull	Cephalohematoma (subperiosteal hemorrhage)		

114	Ribs	Rickets	Diffuse costochondral osteochondrodysplasia	<p>Abnormal endochondral ossification and defective bone formation with inadequate mineralization of developing cartilaginous and osseous matrix.</p> <p>Most frequently due to deficiencies of Vit D and phosphorous.</p> <p>Gross: rachitic rosary (costochondral knobbing) due to thickened growth plates. Costochondral junctions unstable due to lack of osteoid mineralization. Flaring of metaphyses due to deposition of woven bone to stabilize physes.</p> <p>Histo: failure of mineralization of growth plate with retained cartilage cores; may have microfractures or lesions consistent with secondary fibrous osteodystrophy (especially in marmosets)</p> <p>Vet Pathol.2011;48(2):389-407.</p>
115	Skin	Multifocal to coalescing necrotizing dermatitis	White monkey syndrome in infant baboons	<p>Associated with Zn toxicosis – high Zn levels from poor cage design (galvanized metal and concrete cages).</p> <p>C/S: dehydration, emaciation, diarrhea, ischemic necrosis of distal extremities</p> <p>Clin path: pancytopenia (severe anemia), atypical myelomonocytic proliferation of bone marrow, high serum Zn, low serum Cu, Vit D, bone-specific ALP</p> <p>Gross: hypopigmentation, alopecia, dermatitis and ischemic necrosis dermatitis of extremities</p>
116	Skin	Multifocal to coalescing necrotizing dermatitis		
117	Other Systemic Diseases			
118	Stomach	Multifocal necrotizing/ulcerative gastritis	<i>Entamoeba histolytica</i> (Amoebiasis)	<p>Important enteric protozoal pathogen in NHP and humans.</p> <p><u>ZOONOTIC.</u></p> <p>In leaf-eating monkeys (Colobus), stomach is primary site of infection. Heavy infections may result in protracted diarrhea, chronic colitis. Can have fatal gastric ulcers and dissemination to the liver via portal system → secondary abscesses in brain, liver, lung (DDx: tumor, TB, mycosis)</p> <p>Histo: Trophozoites form colonies that extend into submucosa +/- muscular wall, typical bottle/flask shaped ulcers; may see trophozoites with PAS stain</p> <p>DDx: <i>Clostridium</i> spp, flagellates</p>
119	Brain	Abscess		
120	Liver	Multifocal granulomatous hepatitis		

121	Lung, thorax	Pyogranulomatous to granulomatous pneumonia	<i>Coccidioides</i> spp	<i>C.immitis</i> or <i>C.posadasii</i> . Endemic in parts of TX, AZ, NM and central/southern CA. The endosporulating yeast form of <i>C.immitis</i> is larger than any other common yeast. Transmission via inhalation of arthrospores. Immunosuppression will predispose to disease and systemic dissemination. Affected organs: lungs (#1), vertebrae, abdominal organs, skin/SQ C/S: dyspnea, lethargy, locomotion abnormalities Histo: granulomatous inflammation accompanied by fungal spherules variably undergoing endosporulation Comp Med.2017;67(5):452-455. Vet Pathol.2018;55(6):905-915.
122	Skin	Pyogranulomatous panniculitis +/- necrosis		
123	Liver	Amyloidosis	Amyloidosis	Common systemic disease and cause of death in young to middle-aged NHPs. Secondary or reactive systemic amyloidosis with deposition of AA amyloid seen as result of chronic inflammatory diseases (most often chronic colitis in macaque). Less clear association with inflammatory disease in marmosets. C/S (if intestine involvement): chronic diarrhea, hypoproteinemia Gross: dull waxy texture of affected organ, hepatosplenomegaly, thickened intestinal wall Deposition in intestinal villi → villar blunting, eventual crypt loss → villous necrosis and erosions Associated with colonic vascular wall amyloid deposition in systemic amyloidosis. Characteristic targetoid lesion of central ulceration and adjacent slightly raised and hemorrhagic mucosa. Unlike other species, kidney is not a common target in NHP systemic amyloidosis (more often liver, spleen, intestine, adrenal). Macaques can deposit amyloid in renal medullary interstitium (similar to cats and exotic ungulates). Can have pancreatic amyloidosis due to Islet associated polypeptide precursor (IAPP) similar to cats and humans, and unrelated to systemic secondary amyloidosis. Seen more commonly in obese animals and animals with impaired glucose tolerance. Vet Pathol. 2005;42(2):117-24. Vet Pathol. 2016;53(2):399-416.
124	Kidney	Amyloidosis		
125	Spleen	Amyloidosis		
126	Gall bladder	Amyloidosis		
127	Small intestine	Enteric amyloidosis +/- erosions		
128	Large intestine	Colonic amyloidosis with focal ulceration		

129 CARDIOVASCULAR				
130	Heart	Diffuse hypertrophy of the left ventricular free wall and interventricular septum +/- fibrosis	Hypertrophic cardiomyopathy (HCM)	<i>Aotus</i> (owl) monkeys are well-known for heart disease, which is part of the "Aotus triad" (with nephropathy and hemolytic anemia). HCM is a diastolic ventricular disorder with decreased ventricular filling. Histo: hypertrophied myocytes haphazardly arranged +/- fibrosis
131	Heart	Diffuse concentric hypertrophy of the left ventricular free wall and interventricular septum	Left ventricular hypertrophy	162 cases (90 female, 72 male) of idiopathic LV hypertrophy in rhesus identified at CNPRC. Pedigree analyses gave strong genetic predisposition. 74 (mostly young adults) presented for sudden death (>50% of these with recent history of sedation or intraspecific aggression). Subtle karyomegaly and increased cardiac myocyte diameter on histo. Potential model for human HCM? Comp Med.2016;66(2):162-169. Comp Med.2016;66(4):333-342.
132	Heart	Marked left and right ventricular dilatation	Dilated cardiomyopathy (DCM)	Histo: Biventricular cardiac fibrosis with myofiber loss and fibrosis Rhesus: DCM can be a complication of chronic SIV; pathology includes lymphocytic myocarditis and coronary arteriopathy Tamarin: likely cause is genetics Apes: DCM and sudden death due to arrhythmias is well-known
133	Heart	Marked left and right ventricular dilatation	DCM due to chronic <i>Trypanosoma cruzi</i> myocarditis	<i>T. cruzi</i> (Chagas disease) is endemic in southern US. ZOONOTIC. Consider as cause of chronic myocarditis in NHPs housed outside (recent outbreaks in TX). Schizonts are frequent in acute cases – with time, they are fewer and non-suppurative inflammation and myocardial loss increases. Comp Med.2016;66(4):323-328.
134	Heart	Lymphoplasmacytic myocarditis with intramyocytic protozoal schizonts		
135	Heart	Multifocal lymphocytic necrotizing myocarditis	Encephalomyocarditis virus (EMCV)	Picornavirus that affects multiple species including rodents, swine, elephants. History of disease at zoos (southern US). Epizootics seen in both OWM and NWM (most frequently seen in baboons). Contaminated food/water or feeding "pinkies" (rodent reservoir) may be cause of outbreaks. Virus affects endothelial cells; no CNS lesions in NHPs. C/S: very short course of clinical signs, if any Gross: hydropericardium +/- ascites, pleural transudate, pulmonary edema (oral/nasal froth) Histo: acute myocardial necrosis with suppurative to non-suppurative inflammation Definitive diagnosis requires culture DDx: coxackie virus, trypanosomiasis, toxoplasmosis, <i>Strep</i> , <i>Klebsiella</i> Vet Pathol.2012;49(2):386-392.

136	Heart	Myocardial fibrosis	Myocardial fibrosis	Spontaneous cardiac pathology is common in aged rhesus macaques – most common is myocardial fibrosis. Gross: areas or streaks of white in the myocardium
137	Subcutis	Edema	Heart failure	Dependent edema (abdomen, lower limbs, prepuce) is most common manifestation of heart failure in macaques. DDx: edema due to septicemia
138	Heart (fixed)	Right atrial thrombi	Chronic heart failure	This animal had a history of chronic heart failure. Cardiac thrombi have been identified in aging chimpanzees. J Med Primatol.2017; 46(5): 271–290.
139	Mitral valves	Fibrinosuppurative valvulitis	Vegetative valvular endocarditis	Can see in association with SIV. DDx: <i>Strep</i> , <i>Staph</i> , <i>E. coli</i> , etc. Vet Pathol.2016; 53(2):399-416.
140	Mitral valve	Nodular fibromyxomatous degeneration	Endocardiosis	Common aging change in macaque, ape. Most common in mitral valve. Vet Pathol.2016;53(2):399-416.
141	Mitral valve	Nodular fibromyxomatous degeneration		
142	Aorta; aorta at iliac bifurcation	Multifocal fatty streaks and atherosclerotic plaques	Atherosclerosis	Most common in baboons, rhesus, squirrel monkeys, cynos and African green monkeys. Rhesus generally considered more resistant to atherosclerosis than cynos. Risk: aging, high fat diet, lack of exercise, hepatic disease, genetics C/S: often none DDx: arteriosclerosis
143	Heart, arteries	Coronary artery atherosclerosis with myocardial infarction/fibrosis		
144	Basilar artery	Atherosclerosis		
145	Ascending aorta	Aortic dissection	Aortic dissection	This animal died unexpectedly due to cardiac tamponade. Aortic dissection is characterized by pooling of blood between and along the laminar planes of the vascular media, with formation of a blood-filled channel within aortic wall. Comp Med.2011;61(2):176–181. Vet Pathol.2016;53(2):250-276.
146	ENDOCRINE			
147	Adrenal gland	Multifocal necrosis and hemorrhage	Waterhouse-Friedrichsen-like syndrome	Consistent with gram-negative septicemia (endotoxin kills endothelial cells).
149	Adrenal gland	Pheochromocytoma	Pheochromocytoma	Most common endocrine neoplasm in NWM. Less common in OWM. Vet Pathol.2009;46(6):1221-9. Vet Pathol.2016;53(6):1259-1263.
150	Adrenal gland	Pheochromocytoma		

151	Pituitary gland	Cyst	Cyst	Aged animal. No C/S. J Toxicol Pathol.2012;25(1):63–101.
152	Pituitary gland	Adenoma	Adenoma	Aged animal. Vet Pathol.2006;43:484–493.
153	GASTROINTESTINAL TRACT			
154	Palate	Palatoschisis	Cleft palate	Spontaneous in rhesus and squirrel monkey; inducible with corticosteroids. Most common sequela: aspiration
155	Oral cavity/ Hard palate	Multifocal to coalescing necrotizing and hyperkeratotic stomatitis	<i>Candida albicans</i>	Associated with immunosuppression: SIV and/or SRV, infants, geriatric animals
156	Gingiva	Gingival hyperplasia +/- tooth loss	Hormonally induced	Baboon: idiopathic OR result of estrogen suppression and pregnancy Rhesus: associated with pregnancy
157	Tooth	Retained canine tooth	Retained canine tooth	Canine tooth is especially susceptible to retention.
158	Tooth	Subgingival fracture of maxillary canine	Trauma	Look for potential tooth root abscess – often see swelling below the orbit
159	Esophagus	Multifocal to coalescing erosive and hyperplastic esophagitis	Gastroesophageal reflux	Common in baboons and macaques. Histo: epithelial hyperplasia
160	Esophagus	Focally extensive esophageal ulceration with stricture	Ulceration with secondary stricture/stenosis	Can occur with chronic or severe gastroesophageal reflux disease.
161	Esophagus	Multifocal to coalescing necrotizing and hyperkeratotic esophagitis with pseudomembrane	<i>Candida albicans</i>	Common saprophytic agent that colonizes mucosal surfaces (oral, esophageal). Typically in young or debilitated animals (SIV+). Prolonged antibiotics may predispose. Rarely disseminates. Histo: epithelial proliferation with mat of pseudohyphae and inflammation/exudate covering surface
162	Esophagus	Esophageal nematodiasis	<i>Gongylonema sp.</i>	<i>G. pulchrum</i> or <i>G. macrogubernaculum</i> . Spirurid nematode seen in both OWM and NWM. Sites: oral and esophageal mucosa IH: cockroach Gross: proliferative and irregular surface Histo: nematode within epithelium; usually minimal inflammation
163	Esophagus	Squamous cell carcinoma	Squamous cell carcinoma	One of the most frequent primary locations for SCC in NHPs (other frequent sites are oral cavity, skin, perineum and uterus/cervix).
164	Esophagus	Leiomyoma	Leiomyoma	Common in GIT of old primates.
165	Gastro-esophageal junction	Leiomyomas	Leiomyomas	Reported as incidental in an aged chimpanzee. DDx: gastrointestinal stromal tumor (c-kit + on IHC) Comp Med.2014;64(3):230-233.

166	Stomach	Acute gastric dilatation	Bloat	Dilatation without volvulus. OWM and NWM. Pathogenesis not well understood in many cases (may be post prandial, associated with activity, underlying disease, anesthesia/feed restriction and then access, excess water intake, prolonged antibiotics, shipping, changes in husbandry, <i>C. perfringens</i> and rapid gas production).
167	Stomach	Focally extensive proliferative gastritis with trichobezoar	Trichobezoar	Japanese macaques and baboons have increased incidence. May be associated with trichotillomania, abnormal or excessive grooming.
168	Stomach	Focally extensive gastric infarction	Gastric infarct	Associated with massive tissue trauma/DIC. Histo: microthrombi in gastric microvasculature Vet Path.1996;33(2):171-175.
169	Stomach	Ulcerative gastritis	Ulcerative gastritis	DDx: <i>Helicobacter</i> (drills), <i>Clostridium</i> , amoeba, flagellates (colobus)
170	Stomach	Diffuse proliferative gastritis	<i>Helicobacter</i> spp	<i>H.pylori</i> , <i>H. heilmanni</i> or <i>H.nemestrinae</i> . Rhesus, cynomolgus and pigtail macaques can be infected. Infection more common than disease. Histo: Lymphocytic atrophic gastritis with silver-positive spiral bacteria
171	Stomach	Nodular gastric hyperplasia	<i>Nochtia nochtii</i>	Trichostrongyle of Asian macaques. Causes benign inflammatory polyps. Gross: mass-like lesion in pylorus with intralesional small (<1cm) red threadlike nematode
172	Stomach	Focally extensive proliferative and ulcerative eosinophilic gastritis	<i>Physaloptera</i> spp	<i>P. tumefaciens</i> or <i>P.dilatata</i> . Spirurid parasite of OWM. Requires IH and paratenic host. Lives in stomach lumen with head embedded in the mucosa. More common in rhesus than <i>Nochtia</i> and nematodes are much larger and white. Gross: large white nematode attached to gastric mucosa Histo: multifocal eosinophilic gastritis +/- proliferation, ulceration
173	Stomach	Gastric mucosal hyperplasia	Hyperplastic foveolar gastropathy	Spontaneous occurrence in the baboon. Gross: giant mucosal folds or nodules Histo similar to gastropathies in humans: hyperplasia of the foveolar epithelium +/- lymphocytes In Vivo.1996;10(5):507-10.
174	Stomach	Carcinoma	Carcinoma	Uncommon spontaneous tumor. Can be experimentally induced with carcinogen (ethyl-nitro-nitrosoguanidine) or <i>H.pylori</i> infection.
175	Small intestine	Focal pyloric congestion and hemorrhage	Simian Hemorrhagic Fever	Arterivirus causing extensive GI hemorrhage, lymphoid necrosis. DDx: filoviruses, arenaviruses.

176	Small intestine	Diffuse catarrhal enteritis with cestode	<i>Bertiella studeri</i> (Enteric cestodiasis)	ZOONOTIC. Often subclinical with segments identified in feces. Occasionally, severe infection may be associated with diarrhea, abdominal pain and weight loss. IH: orbatid mite
177	Small intestine	Adenocarcinoma	Adenocarcinoma	#1 malignant neoplasm in rhesus, especially in aged animals. Most common location: ileocecolic junction. Gross: circumferential or nodular thickening of intestinal wall with lumen constriction; napkin ring lesion (stricture) Common marmoset is also prone to ACA of the duodenum/proximal jejunum (typically invasive with lymph node mets) Vet Pathol.2010;47(5):969-976.
178	Small intestine	Gastrointestinal stromal tumor	Gastrointestinal stromal tumor	Diagnosis based on IHC+ for CD117. DDx: ACA
179	Large intestine	Chronic-active erosive and proliferative lymphoplasmacytic typhlocolitis	Chronic colitis of macaques	Often no pathogen cultured but can be associated with prior infections with <i>Shigella</i> spp, <i>Campylobacter jejuni</i> . C/S: marked weight loss Gross: flaccid, hyperemic bowel loops with fluid content +/- torsion, intussusception, obstruction (if scarring) Histo: marked separation and replacement of colonic glands by lymphocytes, histiocytes There is also a chronic colitis of tamarins with multifocal to coalescing necrotizing/ulcerative colitis.
180	Large intestine	Chronic cicatrizing ulcerative colitis (post-inflammatory stricture)		
181	Large intestine	Diffuse necrotizing and lymphocytic colitis	<i>Campylobacter</i> spp	<i>C. jejuni</i> or <i>C. coli</i> . Consider second after <i>Shigella</i> . ZOONOTIC. Comp Med.2014;64(6):496-500.
182	Large intestine	Diffuse necrotizing and lymphocytic colitis		
183	Large intestine	Necrohemorrhagic colitis	<i>Salmonella</i> spp	<i>Salmonella enterica</i> serotype typhimurium or enteritidis. Consider along with <i>Shigella</i> and <i>Campylobacter</i> . ZOONOTIC.
184	Large intestine	Multifocal to coalescing pyogranulomatous colitis	<i>Rhodococcus equi</i>	Opportunistic infection with SIV or Type D retrovirus. Granulomas often have a raised red rim.

185	Large intestine	Subserosal granulomatous colitis with hemorrhage	<i>Oesophagostomum bifurcum</i>	Strongylid. Common in African OWM. ZOONOTIC. Direct life cycle – ingested larvae develop into 4 th stage in LI gut wall (granulomatous nodules); adults live on mucosal surface. Ectopic nodules in peritoneum, kidney, liver and lung due to distant migration C/S: insignificant usually but nodules may rupture and cause peritonitis Gross: small dark brown/block nodules on colonic serosa Histo: pyogranulomatous inflammation +/- eosinophils with central larvae NWM: similar parasite (<i>Molineus torulosis</i>) forms similar SI subserosal granulomas.
186	Large intestine	Multifocal to coalescing eosinophilic colitis with acanthocephalans	<i>Prosthenorchis</i> spp	<i>P.elegans</i> or <i>P.spirula</i> . Thorny headed worm. Common in NWM. Adults found in ileum, cecum, proximal colon - <i>P.elegans</i> : cecum, colon - <i>P.spirula</i> : terminal ileum IH: cockroaches and beetles Heavy infestations may cause mechanical blockage; burrowing in mucosa can cause perforation and peritonitis C/S: weight loss, intussusception, rectal prolapse Gross: large, pseudosegmented, white, firmly attached to mucosa Histo: thin outer tegument, pseudocoelom, thick hypodermis, outer circular and inner longitudinal muscles; transmural granulomatous inflammation; peritonitis if proboscis perforates colon wall
187	Large intestine	Diffuse catarrhal and proliferative colitis	<i>Trichuris trichuria</i>	Whipworms. Present in cecum and proximal colon. Incite minimal to no inflammation, even though heads are embedded in the mucosa. ZOONOTIC.
188	Large intestine	Colonic diverticulosis	Colonic diverticulosis	Common in macaques as a result of low-fiber diet, relaxation of intestinal smooth muscle with age, and possibly genetics. Entire length of colon can be affected with diverticuli usually on mesenteric side. Filled with masses of ingesta and hair. May perforate if severe and long-standing but inflammation and muscular hypertrophy are uncommon. Vet Pathol.2016;53(2):399-416.
189	Large intestine	Colonic diverticulitis	Colonic diverticulitis	Uncommon sequel to diverticulosis. Painful inflammatory condition associated with entrapment of food particles within diverticula. Comp Med.2000;50(4):452-454.

190	Large intestine	Megacolon	Atresia ani	Congenital. Gross: distended abdomen and colon +/- perforation, peritonitis Comp Med.2019;69(2):151-154.
191	Large intestine	Megacolon with blind-ended rectal sac		
192	Rectum	Rectal prolapse	Chronic diarrhea +/- stress	Common clinical issue in juvenile macaques. Often associated with chronic diarrhea (<i>Shigella</i> , <i>Campylobacter jejuni</i>) +/- stress.
193	Cecum	Adenocarcinoma	Adenocarcinoma (+/- carcinomatosis)	#1 neoplasm of macaques (see above). Cecum and ascending colon most commonly. Carcinomatosis can occur in up to 30%. Metastasis not common but can spread locally and to lungs. Possible sequela: stricture with acquired megacolon. C/S: severe weight loss, anorexia, hematochezia, intermittent episodes of bloating, hypoalbuminemia Gross: ulcerative to proliferative; some are mucin-producing ("bubbly" appearance of serosal surface) Histo: transmural invasion, signet ring cells and mucin are common ***Well-known in cotton-top tamarin, often after chronic colitis. Animal model for human colonic adenocarcinoma.** Vet Pathol.2015;52(4):732-740. Vet Pathol.2016;53(2):399-416.
194	Large intestine	Adenocarcinoma		
195	Large intestine	Adenocarcinoma		
196	Abdominal cavity	Adenocarcinoma with carcinomatosis		
197	Mesentery	Carcinomatosis		
198	Abdominal cavity	Multifocally extensive peritoneal multilocular hydatid cysts	<i>Echinococcus</i> spp	<i>E. multilocularis</i> or <i>E. granulosa</i> . ZOONOTIC . Affects Asian macaques. Cyst is intermediate tissue stage; adults use canid DH. Hydatid cysts are found in liver or lung. Cysts are unilocular and lined by a germinal layer which produces multiple brood capsules; within each brood capsule are multiple protoscolices; wall is thick and laminated. Occasionally cysts may rupture and protoscolices are released into abdomen (hydatid sand). Continued growth of parasitic cysts can cause death.
199	Abdominal cavity	Catarrhal peritonitis with nematodes	Filariasis	African OWM: <i>Dirofilaria</i> , <i>Edesonfilaria</i> NWM: <i>Dipetalonema</i> , <i>Masonella</i> Larvae found in the blood; adults can be found in peritoneal cavity or SQ. Typically cause no problems. Rarely, <i>Edesonfilaria</i> has been associated with retroperitoneal masses.

200	Mesentery	Eosinophilic and granulomatous peritonitis with pentastomes	Pentastomiasis	<i>Linguatula</i> spp, <i>Armillifer</i> spp, <i>Porocephalus</i> spp. Parasitic arthropods. NHP is IH for larval nymph. Encysted nymphs are usually incidental (adults found in respiratory tract of monkey-eating snakes). <i>Linguatula</i> spp: Tongue worms. Adults infect canines. <i>Armillifer armillatus</i> (most common), <i>Porocephalus</i> spp: both are common in OWM, <i>Porocephalus</i> most common in NWM. Adults often infect reptiles (snakes). Gross: C-shaped parasite in peritoneal (or pleural, pericardial) cavity; minimal associated inflammation
201	Omentum	Myxoid liposarcoma	Myxoid liposarcoma	Spontaneous and found incidentally. Recurred following surgical removal and caused severe transperitoneal sarcomatosis. Similar behavior and prognosis as human disease. Comp Med.2018;68(4):308-313.
202	HEMATOPOIETIC			
203	Spleen (fixed)	Diffuse perifollicular hemorrhage and red pulp fibrin deposition	Simian Hemorrhagic Fever	Togavirus. Sporadic outbreaks in US NHP colonies. Subclinical in patas (reservoir host), lethal only in macaques (up to 100% mortality). Transmission is contact or aerosol between macaques; requires blood or body fluid for transmission between patas and macaques. C/S: fever, anorexia, depression, facial edema, epistaxis, SQ hemorrhage, markedly elevated LDH Gross: petechiae on mucosae and serosae, hemorrhage in anterior duodenum, splenomegaly, hemorrhagic ring around lymphoid follicles in spleen, DIC Histo: lymphoid necrosis and hemorrhage, vasculitis, lymphohistiocytic meningoencephalitis, spleen (fibrin in red pulp, hemorrhage in white pulp marginal zones) DDx: other viral hemorrhagic disease (Marburg, Ebola, Yellow Fever, Kyasanur Forest disease)
204	Spleen	Hemangiosarcoma	Hemangiosarcoma	Rhesus <1yr old. Disseminated masses in skin, SQ, muscle, and spleen (spleen was only visceral organ affected). Comp Med.2016;66(3):246-253.
205	INTEGUMENT			
206	Sex skin	Normal sex skin under estrogenic influence	Normal sex skin under estrogenic influence	Female OWM. Extends to flanks, caudal thighs, brow ridge. Also note ischial callosities.
207	Scent gland	Normal	Normal	Owl monkey. Normal skin scent gland.
208	Perineum/sex skin	Multifocal to coalescing eosinophilic dermatitis with epidermal hyperplasia	Syphilis (<i>Treponema pallidum</i>)	Wild olive baboons in Africa have been infected with <i>Treponema pallidum</i> . Vet Pathol.2012;49(2):292-303.

209	Skin	Multifocal coalescing granulomatous dermatitis and ulceration	Leprosy (<i>Mycobacterium leprae</i>)	Chimps, sooty mangabeys (animal model) and experimental in rhesus, African green. ZOONOTIC . Lesions appear first on areas with lowest temperature – hands feet, genitals, face. Often nerve involvement. Enhanced by SIV. Histo: vacuolated lipid-laden “lepra cells” scattered throughout histiocytic infiltrate and contain numerous acid-fast bacilli.
210	Skin	Multifocal coalescing granulomatous dermatitis and ulceration with depigmentation		
211	Skin	Multifocal coalescing granulomatous dermatitis		
212	Skin	Multifocal to coalescing proliferative and ulcerative dermatitis	Monkeypox	OWM and NWM both susceptible. Reservoir host is African arboreal rodents. 2003 outbreak associated with prairie dogs. Skin lesions of proliferative keratinocytes with hydropic degeneration, progress to vesicles, then umbilication. Eosinophilic IC inclusions (Guarnieri bodies). Disseminated disease may occur to multiple organs, causing death. ZOONOTIC .
213	Skin (elbow)	Focal subcutaneous proliferative dermatitis	Yabapox	Affects both Asian and African monkeys. ZOONOTIC . Virus infects histiocytes → SQ nodules. Histo: sheets of histiocytic cells in the dermis that contain numerous IC inclusions
214	Skin (face)	Hemorrhagic to pustular dermatitis	Cowpox	Acute disease results in erosive stomatitis and pharyngitis. Skin lesions composed of proliferative keratinocytes with hydropic degeneration. Rarely progress to vesicles. Eosinophilic IC inclusions (Guarnieri bodies). Disseminated disease may occur, causing death. Rarely ZOONOTIC . Vet Pathol.2006;43:212-8. Emerg Inf Dis.2006;12:1005-07.
215	Skin	Pyogranulomatous dermatitis	<i>Histoplasma capsulatum</i> var <i>duboisii</i>	African form of histoplasmosis. Reported in man and baboons. Transmission via ingestion, inhalation or direct skin inoculation from soil. Discrete elevated cutaneous lesions, range from papules to pustules. Lesions are primarily on extremities and rarely invasive to underlying bone (causing osteolysis). Regional lymph nodes draining cutaneous lesions may be enlarged. Pyogranulomatous inflammation with multinucleated giant cells. Large form 8-15 micron yeast with thick wall (<i>H.capsulatum</i> 2-4um, thin wall). Single buds with narrow-based attachment. *Can be mistaken for <i>Blastomyces</i> on histo
216	Skin	Pyogranulomatous dermatitis with ulceration		
217	Skin	Pyogranulomatous dermatitis with ulceration		
218	Skin	Pyogranulomatous dermatitis		

219	Skin	Cutaneous depigmentation	<i>Anatrichosoma</i> spp (Anatrichosomiasis)	These nematodes are usually seen in tunnels in the nasal mucosa. Females live in epithelium and males in deep SQ. Can cause cutaneous larval migrans.
220	Skin	Depigmentation and hyperplasia of perinasal skin Focally extensive hyperplastic rhinitis		
221	Skin (abdomen)	Subcutaneous <i>Spirometra</i>	<i>Spirometra</i> spp	Infection caused by larvae of <i>Spirometra</i> tapeworms. Affects OMW and NWM. Can be found anywhere encapsulated and clinically silent (incidental). White, ribbon-like and variable in size.
222	Subcutis	Focally extensive subcutaneous calcification	Calcinosis circumscripta	Reported in macaques and marmoset. Ectopic mineralization.
223	Skin (face)	Bilaterally symmetric cutaneous hyperkeratosis	Paraneoplastic syndrome	Rare. This case was associated with metastatic pancreatic carcinoma. Histo: orthokeratotic hyperkeratosis, acanthosis, superficial lymphoplasmacytic dermatitis, rare intracorneal pustules Vet Pathol.2016;53(2):399-416.
224	Body wall	Multicentric lipomas	Multicentric lipomas	Common in primates. Can be difficult to completely excise.
225	Subcutis (umbilical area)	Liposarcoma, well-differentiated	Liposarcoma, well-differentiated	First report of liposarcoma in a bonnet macaque. 28yr old with rapidly growing, ulcerated, subcutaneous mass in umbilical region. No signs of recurrence for at least 18 months after excision. Comp Med.2017;67(2):176-179.
226	Subcutis/perineum	Myxofibroma	Myxofibroma	Reported in perineal region of female baboons. Note gelatinous appearance. Histo: poorly circumscribed mass of spindle/stellate neoplastic cells with abundant vascular/myxomatous matrix
227	Sex skin	Squamous cell carcinoma	Squamous cell carcinoma	Common neoplasm of baboon perineal area. Often initially diagnosed as traumatic ulceration. Comp Med.2016;66(2):154-161.
228	Sex skin	Squamous cell carcinoma		
229	Sex skin	Carcinoma	Carcinoma	This case was diagnosed as a poorly differentiated carcinoma. IHC+ for both cytokeratin and vimentin. Mets to inguinal lymph node. Comp Med.2016;66(2):154-161.
230	Inguinal lymph nodes	Carcinoma		
231	Skin	Hemangiosarcoma	Hemangiosarcoma	Rhesus <1yr old. Disseminated masses (skin, SQ, muscle, spleen was only visceral organ affected).
232	Mammary gland	Mammary adenocarcinoma	Mammary adenocarcinoma	Somewhat common in lemurs, not so much in other primates. Comp Med.2014;64(4):314-322.

233 LIVER AND GALL BLADDER				
234	Skin (face)	Icterus	Icterus	In cotton-top tamarin, consider Callitrichid hepatitis (arenavirus). Causes lymphocytic choriomeningitis in humans, and transmission is the result of feeding affected “pinkie” mice. Gross: icterus, hepatosplenomegaly, pleural and epicardial effusions Histo: multifocal hepatic necrosis with Councilman-like bodies
235	Gingiva	Icterus		
236	Liver	Hepatic necrosis (midzonal to massive) and lipidosis	Yellow Fever (Yellow Fever virus)	Flavivirus that causes extensive midzonal necrosis in the liver (marked icterus), acute tubular necrosis, and lymphoid necrosis in spleen, lymph nodes. ZOONOTIC . Histo: hepatocyte necrosis with IC autophagosomes (apoptotic “Councilman” body)
237	Liver	Diffuse hepatic hemosiderosis (hepatic pigmentation)	Malaria (<i>Plasmodium</i> sp)	<i>Plasmodium cynomolgi</i> , <i>P. knowlesi</i> , <i>P. inui</i> , <i>P. fragile</i> , or <i>P. coatneyi</i> . Mixed infectious possible. ZOONOTIC . Malarial pigment is seen in erythrocytes and ring (trophozoite) form seen in peripheral blood. Clin path (if severe): anemia, thrombocytopenia, acidosis, hypoglycemia Gross: liver, lung, and spleen are gray/dark brown, and blood is thin. In severe cases, can have pallor, hemoglobinuria and DIC. Histo: malarial hemazoin pigment deposition in Kupffer cells, macrophage proliferation, lipidosis, centrilobular necrosis secondary to red cell destruction Vet Pathol.2015;52(6):998-1011.
238	Liver	Eosinophilic granulomatous hepatitis with protozoal merocysts	<i>Hepatocystis kochi</i>	Most common malarial parasite in African NHPs but usually asymptomatic. Infects up to 75% of OWM in endemic areas (not in NWM). Transmitted by Culicoides midges. Erythrocytic and extra-erythrocytic stages. Sporozoites migrate to liver and form merocysts → cysts rupture and release merozoites → form trophozoites in RBCs. Ruptured cysts → eosinophilic granulomas, liver scars. Gross: yellow- green granulomas and clear walled merocysts; mineralization and fibrosis if cyst rupture Histo: cysts with thin hyaline capsule, peripheral rim of round merozoites, central space with eosinophilic, flocculent material; inflammation ranges from little to granulomatous/eosinophilic
239	Liver	Multiple biliary cysts	Biliary cysts	Ductal plate malformations are occasionally seen.
240	Liver	Hepatocellular carcinoma	Hepatocellular carcinoma	In the chimpanzee, often associated with coinfection (viral hepatitis, schistosomiasis). In the lemur, common and readily mets to lung. Comp Med.2018;68(3):233-238. Comp Med.2013;63(5):448-453. Vet Pathol.2010;47(2):306-311.
241	Liver	Hepatocellular carcinoma		

242	Gall bladder	Cholelithiasis with diffuse epithelial hyperplasia and cholecystitis	Cholelithiasis	Relatively common in baboons (about 1% have choleliths at necropsy), rare in macaques. Higher frequency in females. Gall stones are cholesterol type.
243	Liver, gall bladder	Severe cholecystitis with numerous choleliths Dilation of cystic duct and common bile duct Severe hepatic degeneration and necrosis with cholestasis	Cholelithiasis (secondary to bacterial nidus?)	Adult female squirrel monkey with weight loss, marked increases in hepatic enzymes and bilirubin and hypoalbuminemia. Gross thickening and distension of the gallbladder, cystic duct, and common bile duct and >50 black gallstones that cultured positive for <i>E.coli</i> and <i>Proteus</i> spp. Histology of severe chronic-active cholecystitis, hepatic degeneration and necrosis and cholestasis. Comp Med. 2016;66(1):63-67.
244	Liver, gall bladder	Proliferative choledochitis, cholangitis and cholecystitis	<i>Cryptosporidium parvum</i>	ZOONOTIC. Can be present in intestines and then extend into hepatobiliary tree, causing sclerosing cholangitis. Can also cause respiratory lesions (trachea, bronchi) or rarely conjunctivitis. DDx: <i>Enterocytozoon bieneusi</i> (both are opportunistic infections of SIV and grossly indistinguishable from each other)
245	Liver, gall bladder	Proliferative choledochitis and cholangitis		
246	Liver, gall bladder, common bile duct	Proliferative choledochitis, cholangitis and cholecystitis	<i>Enterocytozoon bieneusi</i>	Common microsporidian, especially in immunosuppressed. Occurs with severe CD4 T cell depletion. C/S: severe diarrhea, wasting, icterus, hepatomegaly Histo: proliferative and non-suppurative choledochitis, cholecystitis and sclerosing cholangiohepatitis; exfoliation of individual biliary epithelial cells is a key finding Demonstrate organisms via Gram stain, Giemsa stain or IHC. DDx: <i>Cryptosporidium parvum</i> (both are opportunistic infections of SIV and grossly indistinguishable from each other) Vet Pathol.1998;35(4):292-6. Am J Pathol.1997;150(4):1395-1405
247	Liver, gall bladder, common bile duct	Proliferative choledochitis, cholangitis and cholecystitis		
248	Bile duct	Catarrhal choledochitis with intraductal adult trematode	<i>Athesmia foxi</i> (Biliary trematodiasis)	Parasitizes the bile ducts of capuchins, squirrel monkeys, marmosets, Titi monkeys. Cholangiectasis, biliary obstruction, biliary stasis due to mechanical blockage of bile ducts (no hepatic parenchymal damage from migration). Histo: Lack of pseudocoelom, vitellarian glands, and brown eggs are characteristic features.

249 MUSCULOSKELETAL				
250	Skeletal muscle	Multiple muscle sarcocysts	<i>Sarcocystis</i> spp	<i>S.kornei</i> , <i>S.nesbitti</i> , <i>S.suihominis</i> and more unnamed species in both OWM and NWM. Seen in up to 20% of wild-caught NHPs. Transmission via ingestion of infected feces. Cysts most often in skeletal muscle, rarely in cardiac. In most cases, cysts are intact (no inflammation) but traumatized cysts incite focal histiocytic inflammation and/or necrosis.
251	Hindlimbs	Arthrogryposis	Arthrogryposis	Congenital joint contracture involving two or more joints.
252	Forelimbs	Polydactyly	Polydactyly	Rare spontaneous lesion. J Med Primatol.2002;31(2):98-103.
253	Sternum	Pectus excavatum	Pectus excavatum	Congenital deformity of anterior chest wall. Several ribs and sternum grow abnormally → caved-in or sunken appearance of the chest.
254	Spine	Spondylosis	Spondylosis	Fusion of lumbar vertebral bodies and articular facet joints. Vet Pathol.2016;53(2):399-416.
255	Stifle (femur)	Severe loss of articular cartilage, with eburnation, osteophytes, and synovial proliferation	Chronic osteoarthritis	Age related degenerative processes. Common in older large primates in long bones and in all primates in vertebrae. Vet Pathol.2016;53(2):399-416.
256	Stifle (femur)	Multifocal degeneration, eburnation and cartilage erosion; osteophyte formation on condyles		
257	Stifle	Multifocal to coalescing articular cartilage erosion with subchondral bone eburnation	Erosive arthritis	In rhesus, reactive arthritis can occur secondary to enteric infections. Starts as sterile necrosuppurative synovitis with enthesitis and tendonitis.
258	Mandible	Fibrosarcoma	Fibrosarcoma	Uncommon. Confirmed on histology.
259	Head, lungs	Osteosarcoma	Osteosarcoma	Uncommon spontaneous tumor. Appendicular skeleton or head (skull or mandible). Mets (especially to lung) possible. Comp Med.2015;65(2):144-149.
260 NEURO				
261	Brain	Hydrocephalus	Hydrocephalus	Common lesion with birth hypoxia. Can also be experimentally induced (intra-theal dextran, Comp Med.2018;68(3):227-232). Gross: depression of cerebral cortex, ventricular dilation with loss of adjacent brain tissue
262	Brain	Hydrocephalus		

263	Brain	Hematoma	Hematoma	DDx: stroke (cardiovascular disease), trauma, neoplasia (hemangiosarcoma, melanoma), pigmented fungus
264	Brain	Progressive multifocal leukoencephalopathy (PML)	Simian virus 40 (SV40)	Polyomavirus. Common asymptomatic infection of all macaque species. Can see lesions if immunocompromised (SIV+). Multifocal demyelination and gliosis throughout white matter due to infection of oligodendrocytes, large IN inclusions. Also can see chronic interstitial nephritis or pneumonitis. J Neuropathol Exp Neurol.2015;74(11):1071–1076.
265	Brain	Meningoencephalitis	Baboon orthoreovirus	Associated with meningitis, encephalitis, and myelitis in captive baboons but is often subclinical. Consider as a DDX for non-suppurative meningoencephalomyelitis in baboons. Vet Pathol.2014;51(3):641-650.
266	Brain	Multifocal necrohemorrhagic meningoencephalitis	<i>Balamuthia</i> sp. (Amoebic encephalitis)	Transmission via contaminated water source. Affects CNS and eyes: necrosis, hemorrhage, pyogranulomatous inflammation DDx: <i>Nigleria</i> , <i>Acanthamoeba</i>
267	Brain	Multifocal necrohemorrhagic meningoencephalitis		
268	Brain	Larval cyst	Cerebral cysticercosis	ZOONOTIC. DDx: <i>Cysticercus cellulosae</i> or <i>Taenia solium</i>
269	Brain	Multiple larval (cysticercus) cysts	<i>Taenia solium</i>	Gross: round, thick-walled, fluid-filled cysts in lung, muscle, brain Histo: cysticercus made of a scolex (arrow with *) created via invagination of cyst wall (arrow head) and surrounded by a bladder (arrow). Molecular analysis identified <i>Taenia solium</i> . Comp Med.2016;66(6):499–502.
270	Brain	Multifocal cerebral intravascular venous thrombi (+/- cerebral hemorrhage and necrosis)	Cerebral venous thrombosis	Rare sequela of hypercoagulable state, possibly due to dehydration. Affects white matter preferentially. Histo: fibrin thrombi, perivascular hemorrhage, necrosis of adjacent white or grey matter with siderosis
271	Brain, spinal cord	White matter hemorrhage and necrosis	Experimental autoimmune encephalomyelitis (EAE)	NHP models exist for human idiopathic inflammatory demyelinating diseases (IIDD) of the CNS (most common chronic IIDD is multiple sclerosis). EAE is a commonly used animal model to study the pathophysiology of IIDD. Vet Pathol.2018;55(1):27-41.
272	Brain	Oligodendroglioma	Oligodendroglioma	Rare. Have been reported in macaques co-infected with SV40 and SIV.

273	Brain	Glioblastoma multiforme	Radiation-induced tumor	Incidence of spontaneous brain tumors in NHPs is low, but radiation-induced glioblastoma multiforme in rhesus and baboons is reported. Histo: cellular pleomorphism, high mitotic rate, regions of coagulation necrosis, and endothelial proliferation. Comp Med.2004;54(3):327-32.
274	REPRODUCTIVE			
275	Uterus	Normal	Normal	
276	Uterus	Hypoplasia	Hypoplasia	In humans, can be due to pubertal failure/hypogonadism.
277	Diaphragm, thoracic and abdominal serosa	Ectopic endometrial tissue	Endometriosis	Common in OWM, especially baboons and rhesus. Ectopic endometrial tissue. Peri-uterine locations most common but may occur throughout abdomen or thorax. Posterior cul-de-sac (between uterus and colon) is a common site in women. In abdomen, can be associated with fibrous adhesions. Average age of detection: 15-16yr. Increased incidence in captive-reared animals. Risk factors: retrograde menstruation, estradiol implants, radiation, hysterotomy, stress, defective immune response C/S: ab pain, cyclic anorexia, weight loss, irregular cycling and infertility, constipation, anemia Possible sequelae: blockage of ureters, compromise of GIT lumen, hemoperitoneum (rupture of endometriotic cysts) Histo: endometrial glandular epithelium surrounded by uterine stroma Vet Pathol.2012;49(4):636-641. Vet Pathol.2016;53(2):399-416. Comp Med.2017;67(3):277-280.
278	Abdomen	Hemoperitoneum		
279	Uterus	"Chocolate cysts"		
280	Abdomen	Decidualized endometriosis		Decidua is the superficial portion of endometrium that transforms under influence of progesterone to nourish early embryo in pregnancy. Deciduosis is foci of deciduae outside the uterus; seen in ~100% of human pregnancies and described in both OWM and NWM with pregnancy and/or treatment with exogenous progestins. Gross: fibrous adhesions between omentum and abdominal organs, causing mass of rough, fused intestinal loops with irregular serosa Histo: epithelial-lined cysts and decidualized stromal cells (large, polyhedral, IHC+ for vimentin, CD10, ER, PR). Vet Pathol. 2016;53(6):1252-1258. Comp Med.2014;64(2):148-156.

281	Uterus	Marked endometrial proliferation	Medroxy-progesterone acetate	Longitudinal section of uterus, cervix (*), proximal vagina with markedly proliferative endometrium. This animal was treated with medroxy-progesterone acetate for birth control. Vet Pathol.2016;53(2):399-416.
282	Uterus	Endometrial polyp	Endometrial polyp	Arise from basal epithelium of the endometrium and responsive to estrogen. Increased incidence with age. Histo: stromal endometrial tissue with interspersed glands
283	Uterus, cervix	Leiomyoma	Leiomyoma	Common in uterus of old NHPs. Thought to be hormonally controlled (estrogen promoting growth, progesterone inhibiting). Often incidental. Abnormal bleeding patterns during menses, incontinence if compresses urinary bladder, dystocia are possible. Histo: bundles of interlacing and intersecting spindle cells Vet Pathol.2016;53(2):425-435. Comp Med.2012;62(6):543-545.
284	Uterus	Leiomyoma		
285	Uterus	Leiomyoma		
286	Uterus	Uterine tumor resembling ovarian sex cord tumors (UTROSCT)	Uterine tumor resembling ovarian sex cord tumors (UTROSCT)	Uterine tumors resembling ovarian sex cord tumors (UTROSCTs) are rare uterine neoplasms that exhibit prominent sex cord-like differentiation. Here, all were incidental discoveries in myometrium. Histo: well-demarcated neoplasms; cuboidal to columnar cells in sheets, nests, cords, trabeculae; occasional Call-Exner-like bodies IHC+: WT-1 IHC- : calretinin, CD99, desmin Vet Pathol.2018;55(5):753-758.
287	Uterus, abdomen	Disseminated endometrial stromal sarcoma and endometriosis	Endometrial stromal sarcoma	Uncommon in humans. Endometrial stromal sarcoma can arise from sites of endometriosis and often presents clinically as intestinal obstruction, similar to the presentation in this macaque. C/S: acute abdominal distension and tympany Gross: severe colonic distension, widespread peritoneal adhesions Histo: serosal fibrovascular proliferative tissue containing foci of endometriosis IHC+: CD10, Wilm tumor 1, ER, PR Comp Med.2018;68(5):403-410.
288	Cervix	Polyp	Polyp	Reported in baboons and macaques. J Med Primatol.2009;38(4):257-262. Toxicol Pathol.2013;41:1016-1027.
289	Cervix	Carcinoma	Carcinoma	Rhesus papillomavirus type D is associated with vaginal and cervical papillomas, dysplasia, and invasive cervical carcinomas.
290	Ovary	Ovarian cyst	Ovarian cyst	Common in aged animals. J Med Primatol.2010;39(3):170-176.
291	Ovary	Ovarian cyst		

292	Ovary	Granulosa cell tumor	Granulosa cell tumor	Uncommon but #1 malignant ovarian neoplasm. Can be functional (estrogen secreting) → uterine hyperplasia. Vet Pathol.2012;49(5):834-838.
293	Ovary	Teratoma	Teratoma	Uncommon but #1 benign ovarian neoplasm.
294	Placenta	Normal	Normal	Crab-eating macaque. Normal bi-discoid placenta.
295	Placenta	Normal	Normal	Baboon. Neonatal death is not uncommon in NHPs (poor maternal instincts, maternal trauma of stillborn or weak neonates).
296	Placenta	Twins	Twins	Usually one or both born dead or rejected.
297	Placenta	Infarct	Infarct	DDx: vascular abnormalities, hypertension
298	Placenta	Placentitis	<i>Streptococcus viridans</i>	Well-recognized cause of placentitis in NHPs. Commensal bacteria generally of low pathogenicity.
299	Placenta	Multifocal to coalescing necrotizing placentitis	<i>Listeria monocytogenes</i>	Pregnant rhesus is animal model for listeriosis. ZOONOTIC. Infection of maternal placenta → fetus aborted relatively quickly (sepsis, most severe in lungs); mothers may recover at this point. Stillborn fetuses: granulomatous pneumonia, necrotizing hepatitis Gram stain: bacteria scattered in necrotic tissue (don't form large colonies)
300	Placenta, aborted fetus, fetal lung (fixed)	Multifocal to coalescing necrotizing placentitis Multifocal to coalescing granulomatous pneumonia		
301	Testis	Carcinomatosis of tunica vaginalis	Carcinomatosis of tunica vaginalis	Spread of colonic adenocarcinoma from peritoneal cavity.
302	Penis	Hypospadias	Hypospadias	Birth defect of the urethra in which the urinary opening is not at the usual location on the head of the penis.
303	RESPIRATORY			
304	Nasal cavity	Epistaxis	<i>Moraxella carrarhalis</i> (Bloody nose syndrome in macaques)	Commensal in humans and NHP. Causes problems in winter months mostly, but also occurs in summer in buildings (very contagious). Possibly associated with low humidity. Causes epistaxis and sneezing blood +/- peri-orbital swelling. Generally clears in a couple of weeks.
305	Lung	Bronchopneumonia	Aspiration	Inhalation of oropharyngeal or gastric contents into lower airways. Can cause severe respiratory distress, secondary bacterial infection.
306	Lung	Multifocal to coalescing fibrinonecrotic pneumonia	<i>Corynebacteria ulcerans</i>	Closely related to <i>C. diphtheria</i> . Can also cause pleuropneumonia.
307	Lung	Bronchopneumonia	<i>Bordetella bronchiseptica</i>	High mortality, low morbidity in NWM and OWM. Causes vague signs of pulmonary disease (deep dry cough, variable dyspnea).
308	Lung	Diffuse interstitial pneumonia	Influenza	OWM, NWM and apes susceptible. Spread by aerosol or direct contact exposure from infected humans.

				C/S: cough, depression, anorexia, conjunctivitis, mucopurulent nasal discharge (most often self-limiting). Rare cases of mortality associated with secondary pathogens. Vet Pathol.2010;47(6):1040-1047.
309	Lung	Multifocal to coalescing necrotizing interstitial pneumonia and bronchiolitis	Adenovirus	1997 outbreak of adenoviral pneumonia in baboons resembled adenoviral pneumonia in other species. Necrosis of bronchiolar epithelium → lobular atelectasis.
310	Lung	Multifocal to diffuse histiocytic (granulomatous) pneumonia	<i>Pneumocystis carinii</i>	Infection usually due to immunosuppression (often SIV+). C/S: tachypnea and dyspnea at rest; usually no cough Gross: nodular form and a diffuse form; lungs are firm, tan, and do not collapse Histo: interstitial pneumonia (alveoli filled with granulomatous inflammation); type II pneumocyte hyperplasia; organism appears as foamy eosinophilic material GMS or other silver stain demonstrates cell wall of trophozoites and cyst forms. IHC also available. DDx: Giant cell pneumonia of SIV
311	Lung	Multifocal to diffuse histiocytic (granulomatous) pneumonia		
312	Lung	Multifocal to diffuse histiocytic (granulomatous) pneumonia		
313	Lung	Multifocal to coalescing granulomatous and eosinophilic bronchiolitis with bronchiectasis, subpleural bullae and mite pigment	<i>Pneumonyssus simicola</i>	Lung mite. Historically common parasite of wild-caught OWM. Direct life cycle/direct transmission (oro-nasal, mother to offspring). Bronchiole remodeled by the presence of the mite. Potential confounder of experimental work. No C/S unless severe infestation. Gross: dilated bronchioles (“mite houses” can contain up to 20 mites) golden-brown pigment, raised translucent bullae Histo: bullae, eosinophilic granulomatous bronchiolitis, smooth muscle hyperplasia, bronchiectasis, luminal mites (chitinous exoskeleton, jointed appendages with skeletal muscle), macrophages with brown pigment (refractile with polarized light) Mite pigment and bronchiectasis may remain for long periods following treatment Vet Pathol.2016;53(2):399-416.
314	Lung	Multifocal to coalescing granulomatous and eosinophilic bronchiolitis with bronchiectasis		
315	Lung	Multifocal to coalescing granulomatous and eosinophilic bronchiolitis with bronchiectasis and mite pigment		

316	Lung	Acute right cranial and middle lung lobe torsion	Lung lobe torsion	Predisposing conditions: trauma, neoplasia, pulmonary disease, previous thoracic surgery, diaphragmatic hernia C/S: acute dyspnea, tachypnea, pleural effusion Comp Med.2018;68(4):314-318.
317	Lung	Metastatic carcinoma	Metastatic carcinoma	Primary was a cervical carcinoma. Usually don't see pulmonary mets from colonic carcinomas.
318	URINARY			
319	Kidney	Peri-renal hemorrhage	Peri-renal hemorrhage	Potential causes: trauma, vasculitis, aneurysm, tumor, etc
320	Kidney	Diffuse acute tubular necrosis with pigment	Pigmentary (myoglobinuric) nephrosis	Common in captive rhesus due to high incidence of intraspecific trauma with crushing muscle injury. Rhabdomyolysis leads to myoglobinemia and myoglobinuria. Mgb is toxic to glomeruli and precipitates in the tubules → obstruction, tubular necrosis. Often results in renal failure, so fluid therapy is a crucial part of clinical management. Clin path: high CK, hyperkalemia, dark urine with granular casts, urine positive for blood Gross: pale swollen kidneys with dark medullas (myoglobin)
321	Kidney	Polycystic kidney	Polycystic kidney	Rare reports in neonates.
322	Kidney	Hydronephrosis with urolithiasis	Urolithiasis	Uroliths are infrequent but reported. Often composed of calcium carbonate. Can result in urinary obstruction.
323	Kidney, ureters	Hydroureters, hydronephrosis	Endometriosis	Foci of endometriosis affecting the ureters can result in occlusion/stricture → hydroureter and hydronephrosis.
324	Kidney	Chronic interstitial nephritis	Familial hyperostosis and chronic renal disease of black lemurs	Same lesions as aged kidney in other mammals.
325	Kidney	Chronic bilateral interstitial fibrosis with interstitial nephritis	Chronic kidney disease	Interstitial nephritis followed by fibrosis and mineralization. Can be grossly enlarged rather than shrunken. DDx: amyloid, lymphoma
326	Kidney	Nephroblastoma/ Wilms Tumor	Nephroblastoma/ Wilms Tumor	Origin: embryonic remnants of immature kidney.
327	THE END			
328	REFERENCES			
329	REFERENCES			
330	REFERENCES			