

# Supplementary Materials: Pathology of Coronavirus Infections: A Review of Lesions in Animals in the One-Health Perspective

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**Table S1.** Coronavirus-associated diseases in animals and list of lesions in the main affected tissues. In black: Main lesions; in grey: Less frequently reported lesions. NR, not-reported; NHP, non-human primate.

Host species	Name of disease/condition	Viral genus, subgenus	Virus strains/name	Main extension of disease	Main involved tissues and associated lesions				
					Upper respiratory tract	Lower respiratory tract	Alimentary system	Nervous system	Hematopoietic and lymphatic systems/Urinary system
Pets Dog		Alphacoronavirus	Canine Enteric CoV type I and II	Localized			Mild enteritis with villous atrophy. Attenuated low cuboidal to squamous epithelial cells		Lymphoid depletion of Peyer's patches
		Alphacoronavirus	Canine Pantropic CoV type II-a	Systemic		Fibrino-hemorrhagic and necrotizing bronchopneumonia	Hemorrhagic lymphoplasmacytic enteritis with fibrosis,		Lymphoid depletion in spleen, thymus and lymph nodes and gut

						associated with perivascular and interstitial edema, vascular necrosis and emphysema	villus blunting, crypt ectasia or necrosis and submucosal and serosal edema Ileocecal intussusception		associated lymphoid tissue
		Betacoronavirus	Canine Respiratory CoV (CRCoV)	Localized	Mild rhinitis with loss of mucosal cilia	Mild tracheobronchitis and presence of peribronchiolar and perivascular lymphoid aggregates in lungs			
		Alphacoronavirus	Feline enteric CoV type I and II (FECV)	Localized			Catarrhal and/or hemorrhagic enteritis with villous fusion and atrophy and sloughing of mucosal epithelium		Lymphoid depletion of Peyer's patches
<b>Cat</b>	Feline Infectious Peritonitis (FIP)	Alphacoronavirus	Feline systemic CoV type I and II (FIPV)	Systemic		Pleuritis and pyogranulomatous interstitial pneumonia. Pleural effusions. Granulomatous pleuritis	Fibrinous and granulomatous peritonitis with serous protein-rich abdominal effusions. Pyogranulomatous enteritis and vasculitis	Ependymitis, periventriculitis meningoencephalitis with periarteritis, phlebitis, edema and periventricular reactive astrocytosis, and fibrin perivascular cuffs. Spongiosis and axonal spheroids in the white matter	Lymphoid depletion or focal pyogranulomatous lymphadenitis
<b>Rabbit</b>		Betacoronavirus	Rabbit Enteric CoV (RECoV)	Localized			Mild necrotizing enteritis with villous blunting, crypts hypertrophy, vacuolation of enterocytes and mucosal edema		
<b>Ferret</b>	Epizootic catarrhal enteritis	Alphacoronavirus, Minacovirus	Ferret enteric coronavirus (FRECV)	Localized			Necrotizing lymphocytic enteritis, with villus atrophy, fusion, and blunting		
Host species	Name of disease/conditio	Viral genus, subgenus	Virus strains/name	Main extension	Main involved tissues and associated lesions				
					Upper	Lower respiratory	Alimentary system	Nervous system	Hematopoietic and

	n		of disease	respiratory tract	tract		lymphatic systems/ Urinary system			
<b>Pets</b>	<b>Ferret</b>	Ferret systemic coronavirus	Alphacoronavirus, Minacovirus	Ferret systemic coronavirus (FRSCV)	Systemic	Pyogranulomatous pneumonia	Pyogranulomatous enteritis (small intestine)	Severe pyogranulomatous leptomeningitis, chorioiditis, ependymitis, and encephalomyelitis, centered on vessels	Multifocal pyogranulomatous lymphadenitis	
	<b>Bovine</b>		Betacoronavirus	Bovine coronavirus (BCoV)	Systemic	Degeneration and necrosis of epithelial cells in nasal turbinates and trachea. Segmental hyperplasia of the tracheal epithelium, with replacement by cuboidal to flattened epithelium	Thickening of the pulmonary interstitium, necrosis of epithelial cells in bronchioles and pulmonary parenchyma, bronchointerstitial pneumonia with syncytia, hyperplasia of type II pneumocytes. Neutrophilic exudate	Acute severe mucohemorrhagic colitis; mucosal ulceration; compensatory hyperplasia, hemorrhages, microabscesses, vasculitis. Mild atrophic enteritis of small intestine	Mesenteric lymph nodes depletion and necrosis, moderate BALT hyperplasia	
	<b>Horse</b>		Betacoronavirus	Equine coronavirus (ECoV)	Systemic			Necrotizing jejunitis and ileitis with pseudomembranes formation and crypt microabscesses, microthrombosis, crypt enterocytes intracytoplasmic inclusion bodies, hemorrhages. haemorrhages.	Cerebral cortex Alzheimer Type II astrocytosis	Lymphocytolysis of Peyer's patches. Widespread petechial hemorrhages in the thymus
<b>Equine</b>	<b>Donkey</b>		Betacoronavirus	Equine coronavirus (ECoV)	Systemic	Pulmonary congestion and edema		Ulceration of oral mucosa and tongue		Lymphocytolysis of Peyer's patches
	<b>Swine</b>	Transmissible	Alphacoronavirus	Transmissible	Localized			Ascites, severe atrophic		

Host species	Name of disease/condition	Viral genus, subgenus	Virus strains/name	Main extension of disease	Main involved tissues and associated lesions				
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Swine	Porcine Epidemic Diarrhea (PED)	Alphacoronavirus	Porcine Epidemic Diarrhea virus (PEDV)	Localized			Acute severe atrophic jejunitis, crypt hyperplasia, enterocytes syncytia and necrosis, attenuation and cytoplasmic vacuolation of superficial enterocytes. Crypt epithelial cells hyperplasia		
		Deltacoronavirus	Porcine Deltacoronavirus (PDCoV)	Localized		Mild multifocal bronchial-to-bronchiolar-centric areas of non-suppurative interstitial pneumonia	Acute severe atrophic jejunitis and ileitis, epithelial syncytia. Villous atrophy, attenuation, blunting and fusion, vacuolated enterocytes in cecum and colon, crypts hyperplasia		
		Alphacoronavirus	Swine Acute Diarrhea Syndrome coronavirus (SADS-CoV)	Localized			Acute severe atrophic enteritis (small intestine)		
		Porcine Hemagglutinating Encephalomyelitis (PHE)	Betacoronavirus	PHE virus	Systemic			Myenteric plexus degeneration (stomach-pyloric glandular area)	Replication and damage of sensory neurons (peripheral ganglia and CNS), perivascular cuffing around Meissner and Auerbach ganglia in the muscle layer of the stomach, ganglioneuritis in the

Host species	Name of disease/condition	Viral genus, subgenus	Virus strains/name	Main extension of disease	Main involved tissues and associated lesions				
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		Alphacoronavirus	Porcine Respiratory Coronavirus (PRCV)	Localized		Interstitial pneumonia			trigeminal ganglion, non-suppurative encephalomyelitis. Satellitosis and gliosis in brainstem (in piglets)
Wild felids	Cheetah	Feline Infectious Peritonitis (FIP)	Feline coronavirus	Systemic			Gastric ulcers, erosive/necrotizing enteritis		Multifocal necrosis of spleen, thymus and lymph nodes
	Mountain lion	Feline Infectious Peritonitis (FIP)	Feline coronavirus	Systemic			Muscular necrosis and vasculitis in the intestine	Vacuolation of the neuropil with occasional axonal swelling of the posterior colliculus	
	African lion	Feline Infectious Peritonitis (FIP)	Feline coronavirus	Systemic				Dilated perivascular spaces mainly in the white matter	
	Wildcat		Feline coronavirus	Systemic		Patchy consolidation of the lungs	Thickening of the serosa surface of the intestine by fibrin and leucocytic inflammation	Vascular lesions in the meninges	
Wild ruminants	Several species of deer		BCoV-like coronavirus	Localized			Gastroenteritis		
	Waterbuck antelope	Winter dysentery	CoV's antigenically indistinguishable from BCoV	Localized			Gastroenteritis		
	Giraffe		BCoV-like coronavirus	Localized			Gastroenteritis		
	Llama		Betacoronavirus, Embecovirus	Localized			Gastroenteritis		

Alpaca		Betacoronavirus, Embecovirus	Alpaca (beta) coronavirus (ACoV)	Systemic		Respiratory disease, undescribed lesions	Gastroenteritis		
		Alphacoronavirus, Duvinacovirus	Alpaca (alpha) coronavirus (ACoV)	Localized		Respiratory disease, undescribed lesions			
Dromedary camel		Betacoronavirus, Embecovirus	Dromedary camel coronavirus UAE- HKU-23 (DcCoV UAE-HKU23)	Localized			Gastroenteritis		
		Betacoronavirus, Merbecovirus	MERS-related CoV	Localized	Mild upper respiratory tract infection				
Host species	Name of disease/condition	Viral genus, subgenus	Virus strains/name	Main extension of disease	Main involved tissues and associated lesions				
					Upper respiratory tract	Lower respiratory tract	Alimentary system	Nervous system	Hematopoietic and lymphatic systems/ Urinary system
Wild ruminants	Water buffalo	Betacoronavirus, Embecovirus	Bubaline coronavirus (BuCoV)	Localized			Severe gastroenteritis, with congestion and hemorrhages		Enlargement of the mesenteric lymph nodes
	Elk (wapiti)		BCoV-like coronavirus	Systemic		Interstitial pneumonia with syncytia formation	Enteritis with syncytia formation		
	Musk oxen, Sitatunga, Wisent, Himalayan tahr, Nyala	Winter dysentery		BCoV-like coronavirus	Localized		Severe bloody diarrhea		
Other wild animals	American and European mink	Alphacoronavirus, Minacovirus	Mink	Mink coronavirus 1	Localized		Severe acute catarrhal gastroenteritis		
				SARS-CoV-2	Localized		Diffuse interstitial pneumonia with hyperemia, alveolar damage, and atelectasis		

	<b>European and Italian wolf</b>		Canine enteric coronaviruses	Localized					No lesions described	
	<b>Red fox</b>		SARS-like CoV	Systemic					No lesions described	
			Canine CoV	Localized					Mild, self-limiting enteritis	
	<b>Raccoon</b>	Alphacoronavirus-1	SARS-like CoV	Systemic		Mild bronchopneumonia			Fibrinous gastroenteritis of small intestine, and diffuse blunting and fusion of intestinal villi	
	<b>Eurasian otter</b>		Canine CoV	Localized					Mild, self-limiting enteritis	
	<b>Common genet</b>		Canine CoV	Localized					Mild, self-limiting enteritis	
	<b>Masked palm civet</b>		SARS-like CoV	NR					No lesions described	
	<b>Spotted hyena</b>	Alphacoronavirus	Feline CoV type II and Canine CoV	NR					No lesions described	
	<b>Silver-backed jackal</b>	Alphacoronavirus		NR					No lesions described	
	<b>Host species</b>	<b>Name of disease/condition</b>	<b>Viral genus, subgenus</b>	<b>Virus strains/name</b>	<b>Main extension of disease</b>	<b>Main involved tissues and associated lesions</b>				
						<b>Upper respiratory tract</b>	<b>Lower respiratory tract</b>	<b>Alimentary system</b>	<b>Nervous system</b>	<b>Hematopoietic and lymphatic systems/ Urinary system</b>
<b>Other wild animals</b>	<b>European hedgehog</b>			Hedgehog coronavirus 1 (Erinaceus CoV, EriCoV)	NR					No lesions described
	<b>Amur hedgehog</b>			Erinaceus amurensis hedgehog coronavirus HKU31 (Ea-HedCoV HKU31)	NR					No lesions described
	<b>Asian house shrew</b>	Alphacoronavirus		Wénchéng shrew coronavirus (WESV)	NR					No lesions described

NHP	Chimpanzee (wild)		Betacoronavirus 1	Human coronavirus (HCoV) OC43	Localized	Respiratory disease, undescribed lesions				
	Marine mammals	Beluga whale		Beluga whale coronavirus SW1 (BWCoV-SW1)	Localized	Respiratory disease, undescribed lesions				
		Indo-Pacific bottlenose dolphin			Bottlenose dolphin CoV (BdCoV) HKU22	NR	No lesions described			
Lab animals	Mouse		Betacoronavirus, Embecovirus	Mouse hepatitis virus (MHV) polytropic	Systemic	Necrosis of olfactory epithelium	Interstitial pneumonia	Nasoencephalitis, necrotizing meningoencephalitis, demyelination, axonal loss, syncytia	Necrosis of spleen, lymph nodes, thymus, GALT, bone marrow; syncytia of parenchymal and endothelial cells	
				Mouse hepatitis virus (MHV) enterotropic	Systemic			Encephalitis	Lymphocytic syncytia in mesenteric lymph nodes	
	Rat		Betacoronavirus, Embecovirus	Sialodacryoadenitis virus (SDAV)	Systemic	Necrotizing rhinitis, laryngitis	Necrotizing tracheitis, bronchitis and bronchiolitis, interstitial pneumonia	Necrotizing sialoadenitis	Necrotizing encephalitis	
<b>Main involved tissues and associated lesions</b>										
	<b>Host species</b>	<b>Name of disease/condition</b>	<b>Viral genus, subgenus</b>	<b>Virus strains/name</b>	<b>Main extension of disease</b>	<b>Upper respiratory tract</b>	<b>Lower respiratory tract</b>	<b>Alimentary system</b>	<b>Nervous system</b>	<b>Hematopoietic and lymphatic systems/Urinary system</b>
Lab animals	Rat			Parker's rat coronavirus (PRC)	Systemic		Necrotizing tracheitis, interstitial pneumonia			
	Guinea pigs	Coronavirus-like syndrome	Unknown		Localized			Necrotizing enteritis, blunting and fusion of villi, syncytia of enterocytes		
Fish	White bream		Bafinivirus	White bream virus	Systemic		Gills hemorrhages			Congestion and hemorrhages



Reptiles	Cyprinids		Bafinivirus		Systemic		Gills hemorrhages			
	Nile crocodiles		Unknown		NR				No lesions described	
Avian species	Chicken	Infectious bronchitis	Gammacoronavirus, Igacovirus	Infectious bronchitis virus (mainly M41) (IBV)	Localized	Catarrhal rhinitis, laryngitis	Catarrhal tracheitis and bronchitis, catarrhal pneumonia, catarrhal or fibrinous airsacculitis	Perivascular lymphocytic cuffing, degenerated neurons, satellitosis and neuronophagia	Interstitial lymphocytic and heterophilic nephritis, hemorrhages, tubular degeneration and necrosis, edema of Bowman's capsule, and dilated renal tubules with urate crystals and casts	
	Pheasant	Pheasant corona-virus-associated nephritis or Pheasant coronavirus nephritis or Pheasant urolithiasis	Gammacoronavirus, Igacovirus	Pheasant CoV (IBV-like)	Localized		Tracheitis		Interstitial nephritis	
	Pigeon		Gammacoronavirus, Igacovirus	Pigeon CoV	Systemic		Lung lesions	Pancreatitis		
	Turkey		Gammacoronavirus	Turkey CoV	Localized			Severe enteritis		
	Guinea fowl		Gmmacoronavirus	Guinea fowl CoV	Localized			Severe enteritis		
	Quail		Gammacoronavirus	Quail CoV (IBV-like)	Localized	Laryngitis	Bronchitis and pneumonia		Renal disease, undescribed lesions	
	Green-cheeked amazon parrot		Gammacoronavirus		Localized			Dilation of proventricolus		
	Host species	Name of disease/condition	Viral genus, subgenus	Virus strains/name	Main extension of disease	Main involved tissues and associated lesions				
						Upper respiratory tract	Lower respiratory tract	Alimentary system	Nervous system	Hematopoietic and lymphatic systems/Urinary system
Avian species	Greylag geese		Gammacoronavirus		NR				No lesions described	
	Mallard duck		Gammacoronavirus		NR				No lesions described	

