MERS and SARS CoV

	MERS	SARS
Family	*Coronaviridae*	*Coronaviridae*
Genus	*Betacoronavirus*	*Betacoronavirus*
Species	Middle East respiratory syndrome-related coronavirus	Severe acute respiratory syndrome-related coronavirus
History	First isolated in 2012	First isolated in 2003
Properties	The evolutionary rate for the coding region of the MERS-CoV viral genome is estimated to be 1.12 X 10-3 substit-utions per site per year; however, there is limited evidence of adaptation to human transmission in MERS-CoV lineages [Footnote 4].	Unlike most coronaviruses with narrow host ranges, SARS-CoV is able to infect cell cultures other than the natural host species and closely related species [Footnote 6][Footnote 9].
Pathogenicity and toxicity	Clinical symptoms of MERS-CoV infection in humans range from asymptomatic or mild respiratory illness in the upper respiratory tract to severe acute pneumonia. A rapid progression to acute lung injury and acute respiratory distress syndrome, followed by septic shock, multi-organ failure and death has been reported. Patients experience flu-like symptoms such as fever, sore throat, non-productive cough, chills, chest pain, headache, muscle pain, and difficulty breathing. Gastrointestinal symptoms, including abdominal pain, vomiting, and diarrhea, may also occur [Footnote 2][Footnote 5]. Other extrapulmonary manifestations may present, such as acute kidney injury, liver enzyme malfunctions, or reduced lymphocyte and/or platelet count [Footnote 6]. Since MERS-CoV infection was first reported to the World Health Organization in September 2012, there have been more than 2000 cases, with a case fatality rate (CFR) of approximately 35% [Footnote 7]. Numbers continue to increase. The CFR is known to increase with age.	Most common initial symptoms include a fever greater than 38°C [Footnote 1][Footnote 2], often accompanied by myalgia, malaise, chills, headache, diarrhea, a non-productive cough, shortness of breath, and rigor [Footnote 1][Footnote 7][Footnote 8][Footnote 12]. After 2 to 7 days, this is followed by respiratory symptoms such as a dry cough, shortness of breath, difficulty breathing, or hypoxia [Footnote 1][Footnote 2][Footnote 12]. In some cases, the respiratory symptoms become increasingly severe, and patients require oxygen support and mechanical ventilation [Footnote 1][Footnote 12]. Similar to other cases of atypical pneumonia, physical signs upon chest examination are minimal compared with radiological findings, which typically show ground-glass opacities and focal consolidations [Footnote 1]. Diarrhea is the most common extra-pulmonary manifestation [Footnote 13], followed by hepatic dysfunction, dizziness, abnormal urinalysis, petechiae, myositis, neuromuscular abnormalities, and epileptic fits [Footnote 1]. The case-fatality rate is 9.6% [Footnote 2][Footnote 12][Footnote 14]; however, in patients over 65 years of age, this rate exceeds 50% [Footnote 6][Footnote 12][Footnote 15]. Attack rates, defined as the proportion of those who become ill in an exposed population initially free from disease, of over 50% have been reported in

		hospitals [Footnote 16][Footnote 17]. While infections in children appear to be milder than those in adults [Footnote 18], SARS in pregnant women carries a significant risk of mortality [Footnote 19][Footnote 20].
Communicability	MERS-CoV human-to-human transmission is not sustained; however, the virus can be shed during coughing and from excretions from the lower respiratory tract and has been shown to spread between humans in health care facilities [Footnote 3][Footnote 14][Footnote 15]. Spreading of the virus between patients and health care workers in nosocomial settings, or between family members, is likely to occur via large droplet aerosols and direct contact, but airborne or fomite transmission is also possible since the virus can persist on inanimate surfaces [Footnote 16]. MERS-CoV viral RNA can also persist in nasal discharge, blood, urine, vomit or saliva, feces, and urine, suggesting that direct intimate or casual contact may lead to transmission of the virus [Footnote 5][Footnote 14]. Camel-to-camel spread is believed to contribute to maintenance of MERS-CoV infection in these animals [Footnote 5].	Person-to-person transmission (direct mucous membrane contact (eyes, nose, and mouth) with infectious respiratory droplets and/or direct contact with infected body fluids) and/or through exposure to contaminated fomites [Footnote 7][Footnote 10][Footnote 27][Footnote 28]. The virus preferably spreads via respiratory droplets over a close distance [Footnote 27][Footnote 29]. Other possible modes of transmission include through inhalation of infectious aerosols, blood transfusions, or by sharps injuries [Footnote 27][Footnote 28]. Communicability is at its greatest in severely ill patients or those experiencing rapid clinical deterioration. Transmission usually occurs after onset of clinical signs and symptoms (on or after the 5th day of illness on average), which coincides with peak viral load in nasopharyngeal secretions around the 10th day of illness [Footnote 1][Footnote 12][Footnote 13]. The maximum period of communicability is 21 days [Footnote 12].
Infectious dose	Unknown	Unknown
Incubation period	1 to 14 days (5 to 7 days). Patients with MERS-CoV pneumonia experience viral shedding for 2 to 4 weeks.	2 to 16 days (10 days). The rate of viral shedding from nasopharynx, stool, and urine samples progressively declines from day 10 to 21 after onset of symptoms.
Reservoir	MERS-CoV is believed to have originated in African bats, and then subsequently infected dromedary camels, both of which display little to no overt symptoms of infection [Footnote 16]. Camels in Africa and the Arabian Peninsula have displayed seropositive rates as high as 80 to 90% [Footnote 2][Footnote 22][Footnote 33].	Bats are the origin and natural reservoir for SARS-CoV [Footnote 43]. Chinese Horseshoe Bat (*Rhinolophus* spp.) is considered the most likely candidate since SARS-CoV-like viruses having a high degree of sequence homology with SARS-CoV were found in these animals [Footnote 38][Footnote 39][Footnote 44][Footnote 45][Footnote 46].
Natural host(s)	Camels are considered intermediate hosts for MERS-CoV [Footnote 23]. Goats have also been suggested as potential intermediate hosts given that cell lines derived from these animals can effectively replicate the virus [Footnote 16].	Natural hosts include humans, Himalayan palm civets (*Paguma larvata*), racoon dogs (*Nyctereutes procyonoides*), Chinese ferret badgers (*Melogale moschata*), cats, and pigs [Footnote 3][Footnote 4][Footnote 38][Footnote 39].

Zoonosis	From dromedary camels to humans [Footnote 34]. Bats are considered an unlikely source of zoonosis due to their limited exposure to humans [Footnote 2].	Most likely from Himalayan palm civets (*Paguma larvata*) to humans [Footnote 4][Footnote 38]. Progenitor SARS-CoV in the bat reservoir is unlikely to be able to infect humans. Rapid viral evolution in an intermediate host, such as the civet, is believed to occur in order for the virus to adapt and infect humans [Footnote 38].
Vectors	None	None
Drug susceptibility	There are no existing drugs that specifically target MERS-CoV	Unknown.
Susceptibility to disinfectants	Susceptible to the following disinfection measures known to inactivate SARS-CoV: 5 minute contact with household bleach [Footnote 39], ice-cold acetone (90 seconds), ice-cold acetone/methanol mixture (40:60, 10 minutes), 70% ethanol (10 minutes), 100% ethanol (5 minutes), paraformaldehyde (2 minutes), and glutaraldehyde (2 minutes) [Footnote 40]. Commonly used brands of hand disinfectants also inactivate SARS-CoV (30 seconds) [Footnote 40]. Disinfection methodologies should be validated to ensure efficacy for MERS-CoV.	Inactivated by common disinfection measures such as a 5 minute contact with household bleach [Footnote 28], ice-cold acetone (90 seconds), ice-cold acetone/methanol mixture (40:60, 10 minutes), 70% ethanol (10 minutes), 100% ethanol (5 minutes), paraformaldehyde (2 minutes), and glutaraldehyde (2 minutes) [Footnote 48]. Commonly used brands of hand disinfectants also inactivate SARS-CoV (30 seconds) [Footnote 48].
Physical inactivation	A 30 minute heat treatment at 63°C removed all infectious virus from dromedary camel milk samples containing MERS-CoV [Footnote 41]. 65°C for 15 minutes or 56°C for 30 minutes completely inactivates the virus [Footnote 42].	Sensitive to heat (60°C for 30 minutes) [Footnote 48], and UV radiation (60 minutes) [Footnote 49].
Survival outside host	MERS-CoV can persist in the environment for 24 to 48 hours under temperature and relative humidity (RH) conditions ranging from 20-30°C and 30-80%, respectively. Viability of aerosolized MERS-CoV at 20°C and 40% RH decreases slightly by 7%, but has been shown to drop by 89% at 70% RH [Footnote 14][Footnote 31]. The virus is stable in camel breast milk for up to 72 hours at 4°C, but viral titers rapidly lose infectivity when stored at 22°C for 48 hours [Footnote 41].	Can survive for 4 days in diarrheal stool samples with an alkaline pH [Footnote 12][Footnote 28][Footnote 48], more than 7 days in respiratory secretions at room temperature, for at least 4 days in undiluted urine, feces and human serum at room temperature [Footnote 28][Footnote 49], up to 9 days in suspension, 60 hours in soil/water, more than a day on hard surfaces such as glass and metal [Footnote 48][Footnote 49], up to 48 hours on plastic surfaces [Footnote 6], and 6 days in dried state [Footnote 48]. The virus does not survive well after drying on paper, but lasts longer on disposable, compared to cotton, gowns [Footnote 28].
Surveillance	There are no specific symptoms that can accurately confirm a MERS-CoV infection; however, MERS-CoV viral RNA can be detected in respiratory tract specimens	None of the symptoms of SARS can be used to differentiate SARS from other causes of pneumonia or respiratory illness; therefore, laboratory confirmation is

	during the acute phase of illness using qRT-PCR. MERS-CoV can be identified using ELISA to detect virus-specific antibodies in serum samples collected 2 to 3 weeks after disease onset. This method requires two different specific genomic segments for diagnosis. MERS-CoV can also be identified using a positive immunofluorescence and/or microneutralization test Footnote 2.	the only form of diagnosis Footnote 1Footnote 51. A positive viral culture from a respiratory, fecal, urine, or tissue specimen, or a fourfold rise in neutralising antibody titer taken upon admission and 28 days afterward is the most definitive evidence of SARS infection Footnote 1. Rapid detection of nucleic acid by RT-PCR or antigen by ELISA can be used as alternatives Footnote 34Footnote 52. Immunofluorescence, microneutralisation Footnote 37, electron microscopy, and chest radiography Footnote 18Footnote 31 can also be used to diagnose SARS-CoV. Epidemiological features such as exposure to known SARS case-patients or SARS-affected areas may help in early recognition of infection Footnote 51.
First aid/treatment	Supportive care is used for MERS-CoV patients since there are no specific therapies that currently exist Footnote 46; however, if administered early on during infection, interferon-α2b, interferon-α2 and ribivarin may reduce viral load titer in patient lungs and lessen damage Footnote 2. Passive immunotherapy with convalescent patient plasma or MERS-CoV specific antibodies has also been suggested as a possible therapeutic option based on its ability to reduce the odds of mortality by 75% when administered to patients suffering from severe acute respiratory infections Footnote 47. Certain antiviral drugs are under review for possible clinical use, including Lopinavir, chloroquine, chlorpromazine, mycophenolic acid, and nitazoxanide Footnote 2. No treatment for infected animals has been reported.	Clinical management of SARS relies largely upon supportive care Footnote 1. Ribavirin, corticosteroids, lopinavir, ritonavir, type 1 interferon, intravenous immunoglobulin, and SARS convalescent plasma have all been used by physicians to treat SARS, but it is not possible to determine whether the treatments actually benefited patients during the SARS outbreak Footnote 53. There are no reports of treatment undertaken for infected animals.
Immunization	There are no MERS-CoV vaccines currently approved for human use Footnote 46; however, inactivated, live attenuated virus, viral vector, protein subunit, and DNA vaccines are all in various stages of preclinical development Footnote 2Footnote 48. One DNA vaccine based on the full length viral Spike (S) protein of the virus has reached Phase I clinical trials Footnote 20.	Several inactivated vaccine candidates have been developed but they are not currently available for human use due to major safety concerns Footnote 2. Some vaccines in development have only been tested in animal models without clear evidence of protection from disease Footnote 54. Other vaccines have proven successful in reducing viral replication in animal models; however, these animals do not express all of the clinical signs and lethality of SARS-CoV observed in infected humans Footnote 55Footnote 56.
Prophylaxis	The use of monoclonal antibodies (LCA60) isolated from memory B cells of patients infected with MERS-CoV may	No known post-exposure prophylaxis Footnote 2Footnote 57.

	prove effective as both a pre- and post-exposure prophylaxis [Footnote 49]. A neutralizing human antibody (m336) may also help prevent MERS-CoV infection when given before exposure [Footnote 50]. These treatments are not yet approved for clinical use [Footnote 46].	
Laboratory-acquired infections	There are no known cases of MERS-CoV laboratory-acquired infections [Footnote 51].	Four incidents have been reported to date. The first case occurred in Singapore in September 2003 when a 27 year old graduate student contracted SARS while working with West Nile virus in a culture laboratory where SARS-CoV was being maintained [Footnote 34]. The second case occurred in December 2003 in Taiwan when a 44 year old researcher contracted the disease while testing herbal remedies against SARS-CoV [Footnote 35]. The third and fourth cases occurred in China in late-March to mid-April 2004 when 2 CDC workers developed SARS after improperly inactivating a batch of SARS virus in the laboratory [Footnote 36]. Each case was attributed to poor understanding or lack of safety procedures while working with SARS-CoV.
Sources/ specimens	MERS-CoV RNA has been detected in the human respiratory tract (tracheal aspirates and sputum), nasal discharge, serum, blood, urine, vomit, saliva, feces, and urine [Footnote 5][Footnote 52]. In infected animals, the virus has been recovered from nasal swabs, oropharyngeal swabs, blood samples, raw camel milk and bronchoalveolar lavage [Footnote 2][Footnote 9][Footnote 53].	Respiratory secretions, faeces, blood, urine, lung biopsy tissue, and tears of infected individuals [Footnote 1][Footnote 8][Footnote 27][Footnote 31][Footnote 52].
Primary hazards	The primary route of exposure to MERS-CoV is not well-defined but inhalation of airborne or aerosolized infectious material, either from infected humans or animals, is believed to be the main source of infection [Footnote 16]. Exposure to infectious material on fomites has also been considered likely [Footnote 13][Footnote 45]. Camels can become naturally infected through direct contact with large droplets or fomite transmission [Footnote 8]. Camels are believed to have originally become infected by bats, and have had the virus circulating between them for over 20 years [Footnote 54].	Droplet exposure of the mucous membranes of the eye, nose and/or mouth, inhalation of infectious aerosols, and ingestion [Footnote 1][Footnote 10]

Risk group	Risk Group 3 Human Pathogen and Risk Group 3 Animal Pathogen.	Risk Group 3 Human Pathogen [Footnote 58] and Risk Group 1 Animal Pathogen. SARS-CoV is a Security Sensitive Biological Agent (SSBA).
Containment	BSL3/CL3 for all *in vitro* propagative and *in vivo* activities. Non-propagative diagnostic or clinical activities can be conducted at BSL2/CL2 with additional biosafety requirements.	BSL3/CL3 requirements outlined should be followed. Note that there are additional security requirements, such as obtaining a Human Pathogens and Toxins Act Security Clearance, for work involving SSBAs.
Protective clothing	The applicable CL3 requirements for personal protective equipment should be followed. Based on a local risk assessment, appropriate hand, foot, head, body, eye/face, and respiratory protection should be identified, and the PPE requirements for the containment zone should be documented in Standard Operating Procedures.	The applicable CL3 requirements for personal protective equipment should be followed. Based on a local risk assessment, appropriate hand, foot, head, body, eye/face, and respiratory protection should be identified, and the PPE requirements for the containment zone should be documented in Standard Operating Procedures.
Spills	Allow aerosols to settle. Wearing protective clothing, gently cover the spill with absorbent paper towel and apply suitable disinfectant, starting at the perimeter and working towards the centre. Allow sufficient contact time before clean up [Footnote 55].	Allow aerosols to settle. Wearing protective clothing, gently cover the spill with absorbent paper towel and apply suitable disinfectant, starting at the perimeter and working towards the centre. Allow sufficient contact time before clean up.
Disposal	All materials/substances that have come in contact with the infectious agent should be completely decontaminated before they are removed from the containment zone. This can be achieved by using a decontamination method that has been demonstrated to be effective against the infectious material, such as chemical disinfectants, autoclaving, irradiation, incineration, an effluent treatment system, or gaseous decontamination [Footnote 55].	All materials/substances that have come in contact with the infectious agent should be completely decontaminated before they are removed from the containment zone. This can be achieved by using a decontamination method that has been demonstrated to be effective against the infectious material, such as chemical disinfectants, autoclaving, irradiation, incineration, an effluent treatment system, or gaseous decontamination.
Storage	The applicable BSL3/CL3 requirements for storage should be followed. Containers of infectious material or toxins stored outside the containment zone should be labelled, leakproof, impact resistant, and kept in locked storage equipment and within an area with limited access [Footnote 56].	The applicable BSL3/CL3 requirements for storage should be followed. Containers of infectious material or toxins stored outside the containment zone should be labelled, leakproof, impact resistant, and kept in locked storage equipment and within an area with limited access [Footnote 59].