



Respiratory Viruses

Coronaviruses

Medical and Public Health Microbiology

S. M. Munsaka, BSc., MSc., PhD

Department of Biomedical Sciences

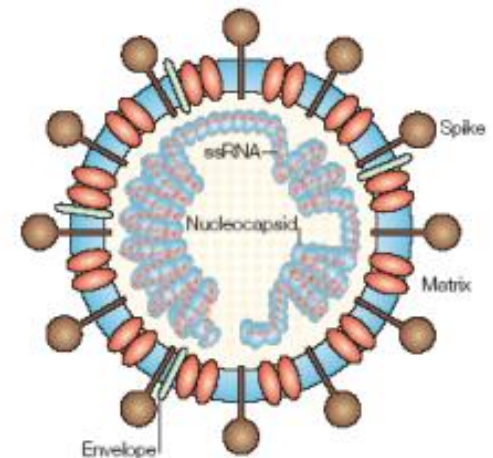
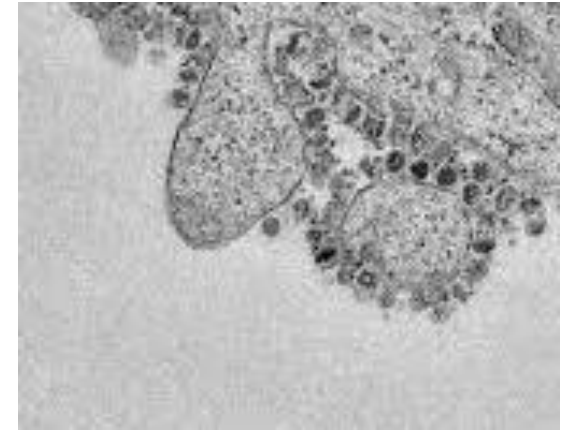
School of Health Sciences

University of Zambia

June 2020

Coronaviruses

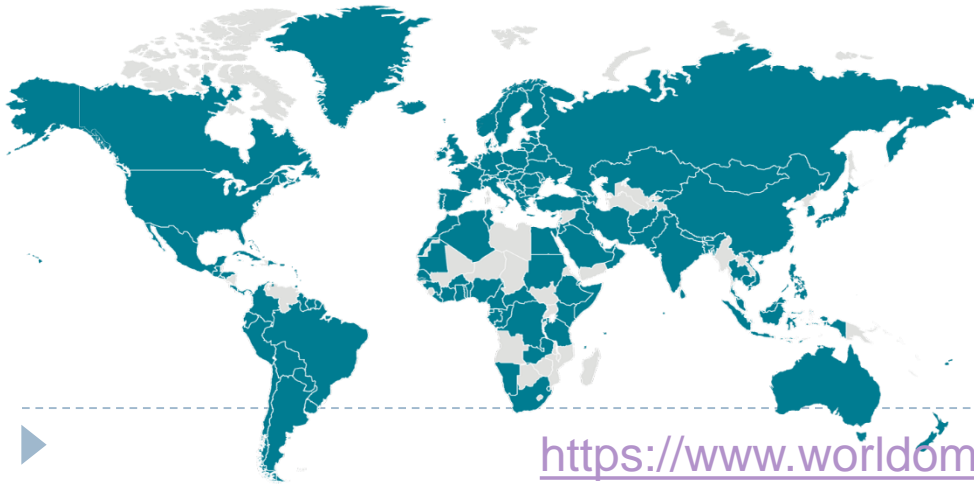
- Enveloped helical **RNA** viruses (80-130nm)
- Associated with upper respiratory tract infections and common cold
- Discovered in the 1960s in birds
- Severe acute respiratory syndrome in 2003 (SARS-Cov) and Middle Eastern Respiratory Syndrome in 2012 (MERS-Cov)
- Current Wuhan (7th), China outbreak (Novel Covid-19) or 2019-nCov or SARS-CoV-2



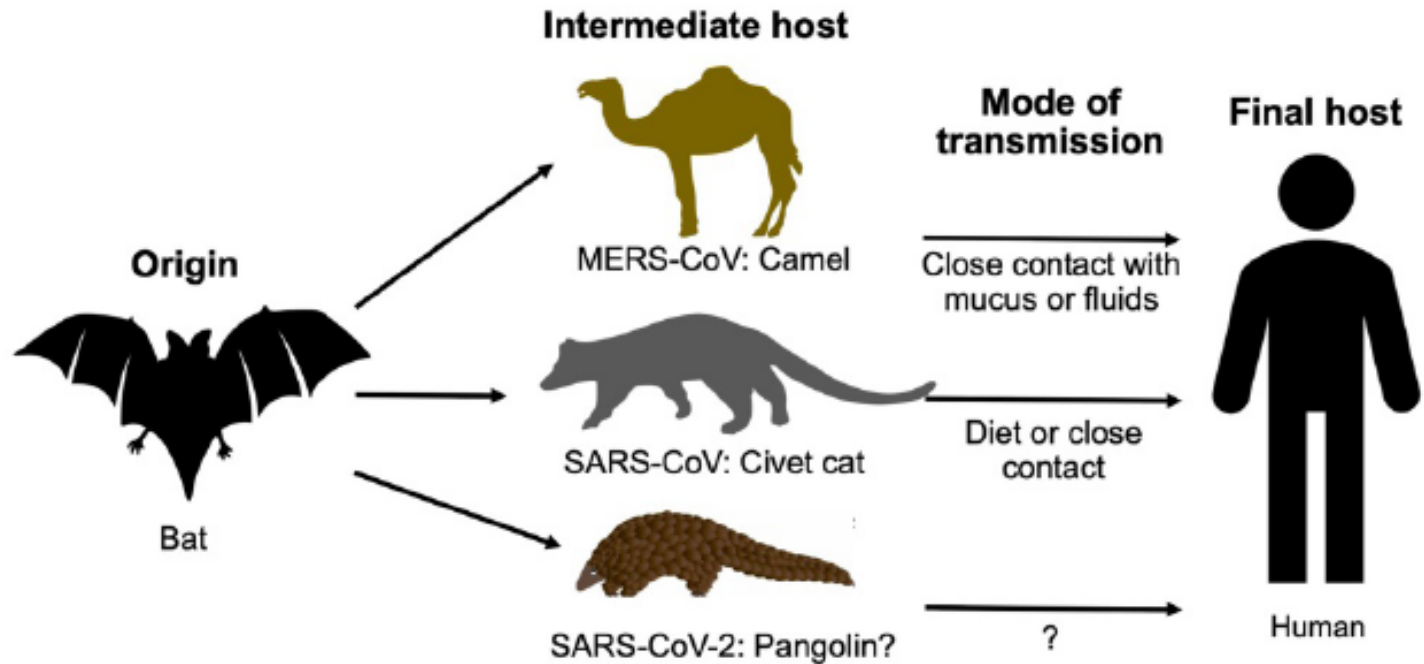
Latin *corona*, meaning "crown"

Wuhan Coronavirus (2019-nCov)

- COVID-19 outbreak in Wuhan, China had some link to a large seafood and live animal market, **suggesting animal-to-person spread** (Hampton T. Bats may be SARS reservoir. *JAMA*. 2005)
- Later, a growing number of patients reportedly did not have exposure to animal markets, indicating **person-to-person** spread.
- In March 2020, WHO has declared COVID as a Pandemic (Global Epidemic)



Origin of Coronaviruses

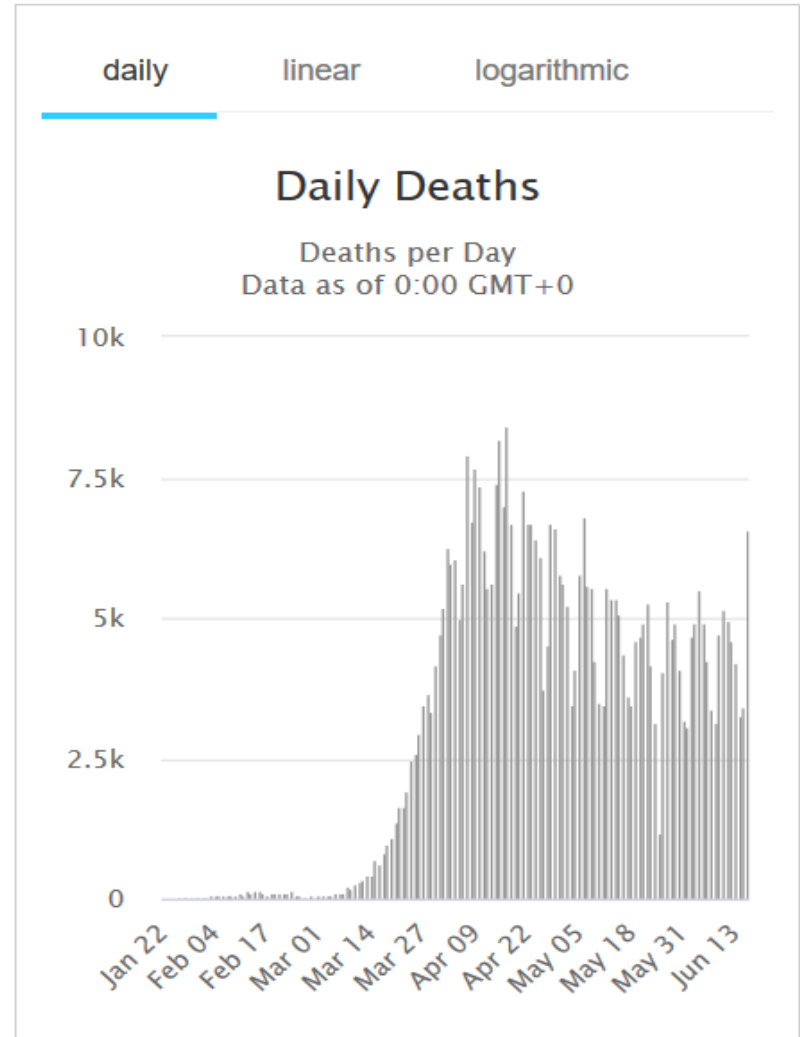
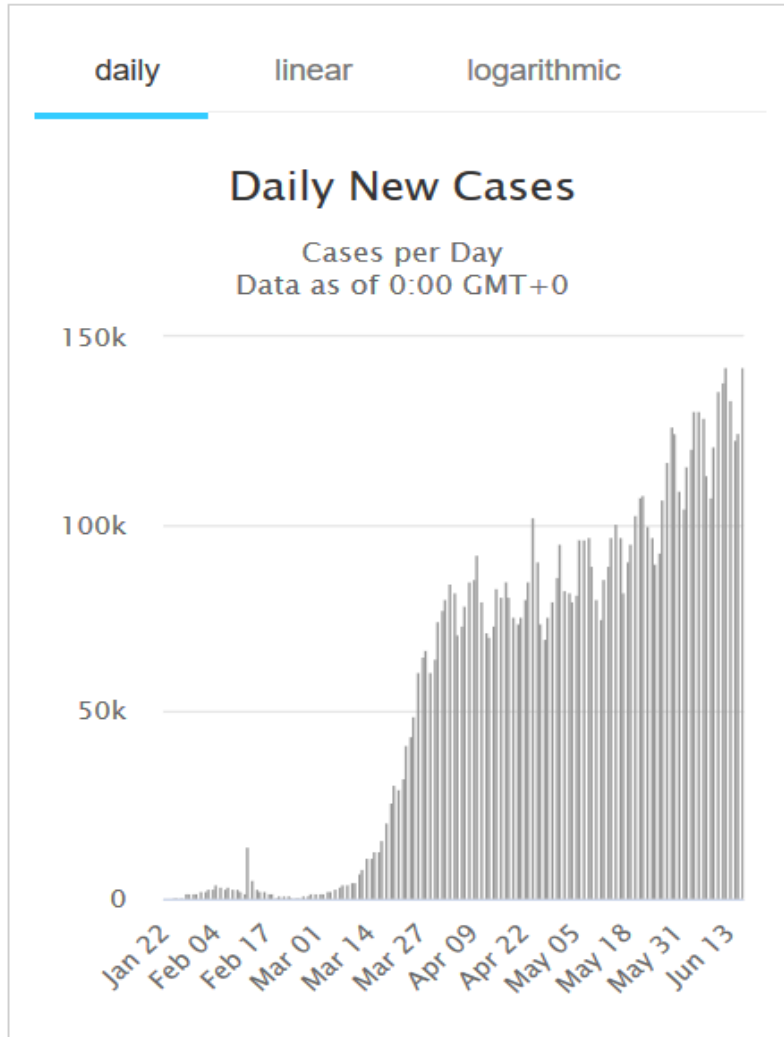


The origins and intermediate hosts of SARS-CoV-2, SARS-CoV, and MERS-CoV.





COVID-19 Epidemiology



COVID-19 Epidemiology

| All | | | | | | | | | | | | | |
|---------------|------------------------|-------------|-----------|--------------|------------|-----------------|--------------|-------------------|-------------------|----------------|-------------|---------------|---------------|
| Europe | | | | | | | | | | | | | |
| North America | | | | | | | | | | | | | |
| Asia | | | | | | | | | | | | | |
| South America | | | | | | | | | | | | | |
| Africa | | | | | | | | | | | | | |
| Oceania | | | | | | | | | | | | | |
| # | Country, Other | Total Cases | New Cases | Total Deaths | New Deaths | Total Recovered | Active Cases | Serious, Critical | Tot Cases/ 1M pop | Deaths/ 1M pop | Total Tests | Tests/ 1M pop | Population |
| | World | 8,295,803 | +44,579 | 446,770 | +1,582 | 4,347,331 | 3,501,702 | 54,526 | 1,064 | 57.3 | | | |
| 1 | USA | 2,209,231 | +831 | 119,158 | +26 | 903,136 | 1,186,937 | 16,695 | 6,676 | 360 | 25,730,914 | 77,754 | 330,928,170 |
| 2 | Brazil | 928,834 | | 45,456 | | 477,364 | 406,014 | 8,318 | 4,371 | 214 | 1,709,468 | 8,045 | 212,500,470 |
| 3 | Russia | 553,301 | +7,843 | 7,478 | +194 | 304,342 | 241,481 | 2,300 | 3,791 | 51 | 15,679,724 | 107,445 | 145,932,234 |
| 4 | India | 355,060 | +899 | 11,922 | +1 | 187,718 | 155,420 | 8,944 | 257 | 9 | 6,084,256 | 4,411 | 1,379,455,941 |
| 5 | UK | 298,136 | | 41,969 | | N/A | N/A | 395 | 4,393 | 618 | 6,981,493 | 102,862 | 67,872,439 |
| 6 | Spain | 291,408 | | 27,136 | | N/A | N/A | 617 | 6,233 | 580 | 4,826,516 | 103,232 | 46,754,133 |

| All | | | | | | | | | | | | | |
|---------------|------------------------------|-------------|-----------|--------------|------------|-----------------|--------------|-------------------|-------------------|----------------|-------------|---------------|-------------|
| Europe | | | | | | | | | | | | | |
| North America | | | | | | | | | | | | | |
| Asia | | | | | | | | | | | | | |
| South America | | | | | | | | | | | | | |
| Africa | | | | | | | | | | | | | |
| Oceania | | | | | | | | | | | | | |
| # | Country, Other | Total Cases | New Cases | Total Deaths | New Deaths | Total Recovered | Active Cases | Serious, Critical | Tot Cases/ 1M pop | Deaths/ 1M pop | Total Tests | Tests/ 1M pop | Population |
| | Africa | 262,479 | +898 | 7,056 | +30 | 121,596 | 133,827 | 494 | | | | | |
| 1 | South Africa | 76,334 | | 1,625 | | 42,063 | 32,646 | 208 | 1,288 | 27 | 1,172,513 | 19,780 | 59,277,377 |
| 2 | Egypt | 47,856 | | 1,766 | | 12,730 | 33,360 | 41 | 468 | 17 | 135,000 | 1,320 | 102,247,168 |
| 3 | Nigeria | 17,148 | | 455 | | 5,623 | 11,070 | 7 | 83 | 2 | 96,402 | 468 | 205,892,211 |
| 4 | Ghana | 12,193 | | 58 | | 4,326 | 7,809 | 6 | 393 | 2 | 255,971 | 8,246 | 31,042,920 |
| 5 | Algeria | 11,147 | | 788 | | 7,842 | 2,517 | 39 | 254 | 18 | | | 43,815,597 |
| 6 | Cameroon | 9,864 | | 276 | | 5,570 | 4,018 | 28 | 372 | 10 | | | 26,513,830 |

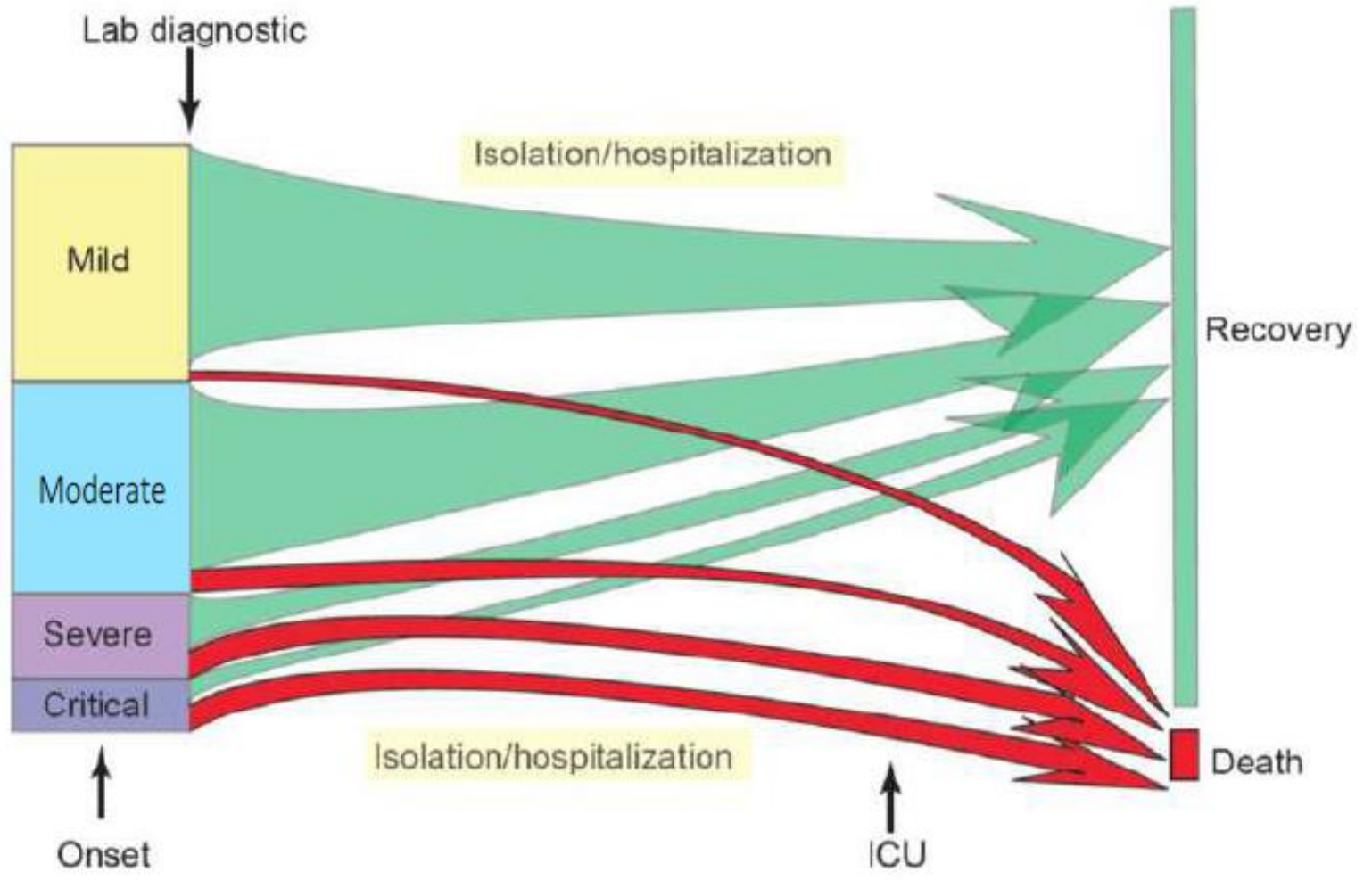


Figure 5. Pattern of disease progression for COVID-19 in China

COVID-19 Fatality Rate by AGE:

***Death Rate** = (number of deaths / number of cases) = **probability of dying if infected by the virus (%)**.

This probability differs depending on the age group. The percentages shown below **do not have to add up to 100%**, as they **do NOT represent share of deaths by age group**. Rather, it represents, for a person in a given age group, the **risk of dying** if infected with COVID-19.

| AGE | DEATH RATE confirmed cases | DEATH RATE all cases |
|-----------------|----------------------------|----------------------|
| 80+ years old | 21.9% | 14.8% |
| 70-79 years old | | 8.0% |
| 60-69 years old | | 3.6% |
| 50-59 years old | | 1.3% |
| 40-49 years old | | 0.4% |
| 30-39 years old | | 0.2% |
| 20-29 years old | | 0.2% |
| 10-19 years old | | 0.2% |
| 0-9 years old | | no fatalities |

COVID-19 Fatality Rate by SEX:

***Death Rate** = (number of deaths / number of cases) = **probabi**

This probability differs depending on sex. When reading these n **smoking** in China is much more prevalent among males. Smoki complications.

| SEX | DEATH RATE confirmed cases | DEATH RATE all cases |
|--------|----------------------------|----------------------|
| Male | 4.7% | 2.8% |
| Female | 2.8% | 1.7% |

***Death Rate** = (number of deaths / number of cases) = **probabi**

The percentages **do not have to add up to 100%**, as they do N

Pre-existing medical conditions (comorbidities)

Patients who reported no pre-existing ("comorbid") medical conditions had a case fatality rate of 0.9%.

Pre-existing illnesses that put patients at higher risk of dying from a COVID-19 infection are:

COVID-19 Fatality Rate by COMORBIDITY:

***Death Rate** = (number of deaths / number of cases) = **probability of dying if infected by the virus** (%).

This probability differs depending on pre-existing condition. The percentage shown below does **NOT** represent in any way the share of deaths by pre-existing condition. Rather, it represents, for a patient with a given pre-existing condition, the **risk of dying** if infected by COVID-19.

| PRE-EXISTING CONDITION | DEATH RATE confirmed cases | DEATH RATE all cases |
|------------------------------------|-------------------------------|-------------------------|
| Cardiovascular disease | 13.2% | 10.5% |
| Diabetes | 9.2% | 7.3% |
| Chronic respiratory disease | 8.0% | 6.3% |
| Hypertension | 8.4% | 6.0% |
| Cancer | 7.6% | 5.6% |
| <i>no pre-existing conditions</i> | | 0.9% |

Typical Symptoms

- COVID-19 typically causes flu-like symptoms including a fever, cough and fatigue.
- In some patients - particularly the elderly and others with other chronic health conditions - these symptoms can develop into pneumonia, with chest tightness, chest pain, and shortness of breath.
- It seems to **start with a fever, followed by a dry cough.**
- **After a week, it can lead to shortness of breath,** with about 20% of patients requiring hospital treatment.

Notably, the COVID-19 infection **rarely seems to cause a runny nose**, sneezing, or sore throat (these symptoms have been observed in only about 5% of patients). **Sore throat, sneezing, and stuffy nose are most often signs of a cold.**



Typical Symptoms

- **80.9% of infections are mild** (with flu-like symptoms) and **can recover at home.**
- **13.8% are severe**, developing severe diseases including **pneumonia** and **shortness of breath.**
- **4.7% as critical** and can include: **respiratory failure, septic shock,** and **multi-organ failure.**
- in about **2%** of reported cases the virus is fatal.
- Risk of death increases the older you are. (**Median age is over 80yrs**)
- Relatively few cases are seen among children.

Incubation Period

- Symptoms of COVID-19 may appear in as few as 2 days or as long as 14 (estimated ranges vary from 2-10 days, 2-14 days, and 10-14 days,)
- During incubation the virus is contagious but the patient does not display any symptom (*asymptomatic transmission*).



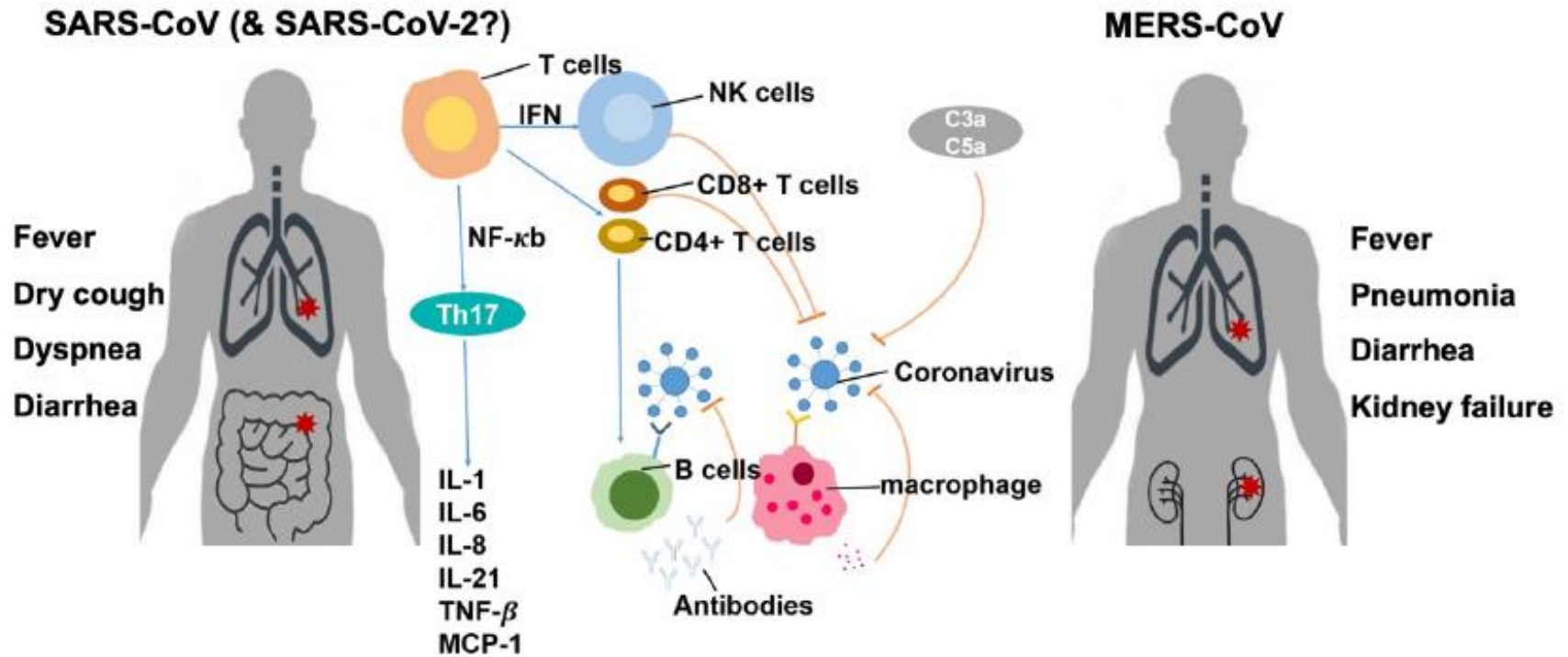
Transmission of COVID-19

- Person-to-person
 - Between people who are in close contact with one another (within about 6 feet).
 - Through **respiratory droplets** produced when an infected person coughs or sneezes.
 - These droplets can land in the mouths or noses of people who are nearby or possibly be inhaled into the lungs.
- It may be possible that a person can get COVID-19 by touching a surface or object that has the virus on it and then touching their own mouth, nose, or possibly their eyes, but this is not thought to be the main way the virus spreads.
- Faecal-oral transmission? (*Zhang et al Emerg Microbes Infect.* 2020)



Pathogenesis of SARS-CoV-2

- **Entry:** The envelope spike (S) glycoprotein binds to its cellular receptors angiotensin-converting enzyme 2 (ACE2)

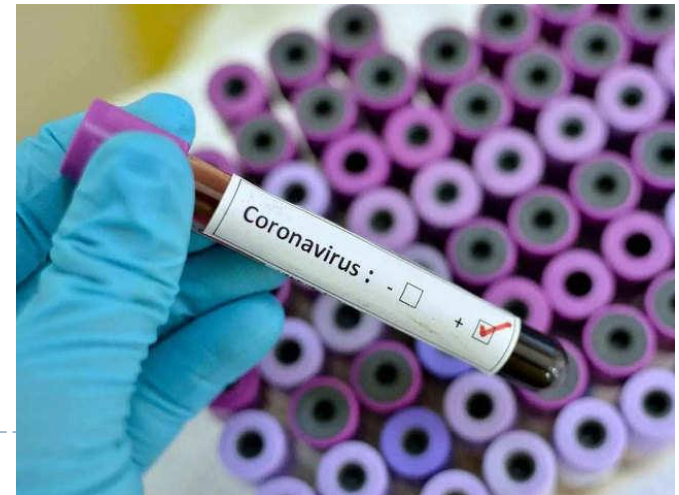
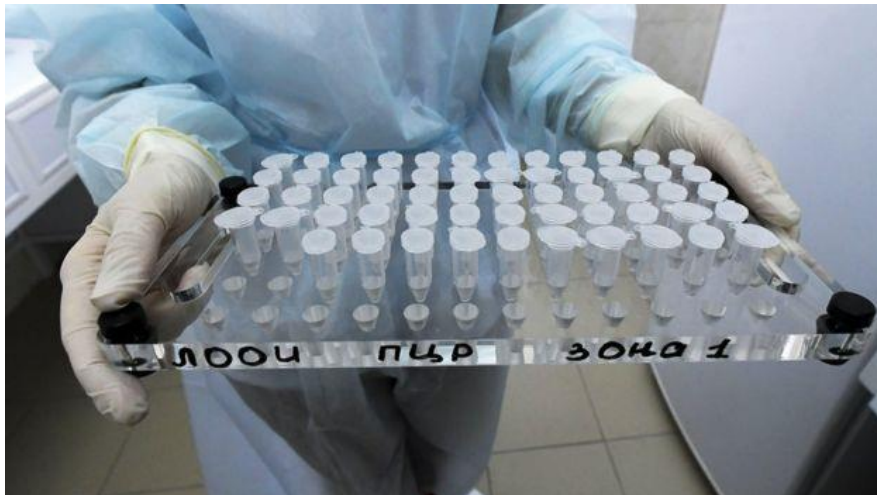


Immune response of the host to coronavirus infection [4, 32-34].

- **Pathology:** desquamation of pneumocytes, hyaline membrane formation, and interstitial lymphocyte infiltration, and multinucleated syncytial cells in the lungs of a patient who died of the disease, coagulopathy, consistent with the pathology of viral infection and ARDS

Diagnosis/Testing for COVID-19

- Available in Zambia
 - UTH and UNZA (School of Vet)
- Detection of RNA from nasal or throat
 - RT-PCR



Treatment of COVID-19

- **Supportive care**
 - Ventilation

- **Symptomatic**
 - Paracetamol (Panadol)
 - (Do not use Ibuprofen[Brufen or Brustan])

- **Drug trials**
 - Remdesivir
 - Chloroquine
 - Hydroxychloroquine
 - Favipilavir (Approved in China)
 - Kaletra [ritonavir+lopinavir] (South Korea)

 - Passive Immune Therapy



Table 1 Common and potent antiviral drugs

| Status | Drugs | Action mode | Anti-infective mechanism | Target diseases | Ref. |
|---|---------------------------|---|---|--|--------------|
| Approved | Lopinavir/ Ritonavir | Protease inhibitors | Inhibiting HIV-1 protease for protein cleavage, resulting in non-infectious, immature viral particles | HIV/AIDS, SARS, MERS | [83–85] |
| Approved, Investigational, Vet approved | Chloroquine | 9-aminoquinolin | Increasing endosomal pH, immunomodulating, autophagy inhibitors | Malaria, autoimmune disease | [79–82] |
| Experimental | Remdesivir (GS-5734) | Nucleotide analogue prodrug | Interfering with virus post-entry | Ebola, SARS, MERS (A wide array of RNA viruses) | [76, 88, 89] |
| Investigational | Nafamostat | Synthetic serine protease inhibitor | Prevents membrane fusion by reducing the release of cathepsin B; anticoagulant activities | Influenza, MERS, Ebola | [90, 91] |
| Approved | Ribavirin | Synthetic guanosine nucleoside | Interfering with the synthesis of viral mRNA (a broad-spectrum activity against several RNA and DNA viruses) | HCV, SARS, MERS | [92–94] |
| Approved | Oseltamivir | Neuraminidase inhibitor | Inhibiting the activity of the viral neuraminidase enzyme, preventing budding from the host cell, viral replication, and infectivity | Influenza viruses A | [95, 96] |
| Approved | Penciclovir/ Acyclovir | Nucleoside analog | A synthetic acyclic guanine derivative, resulting in chain termination | HSV, VZV | [97] |
| Approved, Investigational | Ganciclovir | Nucleoside analog | Potent inhibitor of the Herpesvirus family including cytomegalovirus | AIDS-associated cytomegalovirus infections | [98] |
| Investigational | Favipiravir (T-705) | Nucleoside analog: Viral RNA polymerase inhibitor | Acting on viral genetic copying to prevent its reproduction, without affecting host cellular RNA or DNA synthesis | Ebola, influenza A(H1N1) | [99–101] |
| Approved, Investigational, Vet approved | Nitazoxanide | Antiprotozoal agent | Modulating the survival, growth, and proliferation of a range of extracellular and intracellular protozoa, helminths, anaerobic and microaerophilic bacteria, viruses | A wide range of viruses including human/animal coronaviruses | [102–104] |

Guo et al (2020). The origin, transmission and clinical therapies on coronavirus disease 2019 (COVID-19) outbreak - an update on the status. *Military Medical Research*, 7(1), 11.

SARS Cov-2 (COVID-19) Vaccine

- No vaccine yet
- Numerous clinical trials have started
- No results yet

<https://www.who.int/publications/m/item/draft-landscape-of-covid-19-candidate-vaccines>



First Person Injected With Trial
Coronavirus Vaccine In Seattle, USA



What to do when you are ill

- **Stay home**
- **Cover coughs and sneezes**
 - **Cover your mouth and nose** with a tissue when you cough or sneeze or use the inside of your elbow.
 - **Throw used tissues** in the trash.
 - Immediately **wash your hands** with soap and water for at least 20 sec. If soap and water are not readily available, clean your hands with a hand sanitizer that contains at least 60% alcohol. **[Methylated spirit + Glycerin]**
- **Wear a facemask if you are sick**
 - **If you are NOT sick:** You do not need to wear a facemask unless you are caring for someone who is sick (and they are not able to wear a facemask).
- **Clean and disinfect**
 - **Clean AND disinfect frequently touched surfaces daily.** This includes tables, doorknobs, light switches, countertops, handles, desks, phones, keyboards, toilets, faucets, and sinks.
 - **If surfaces are dirty, clean them:** Use detergent or soap and water prior to disinfection.

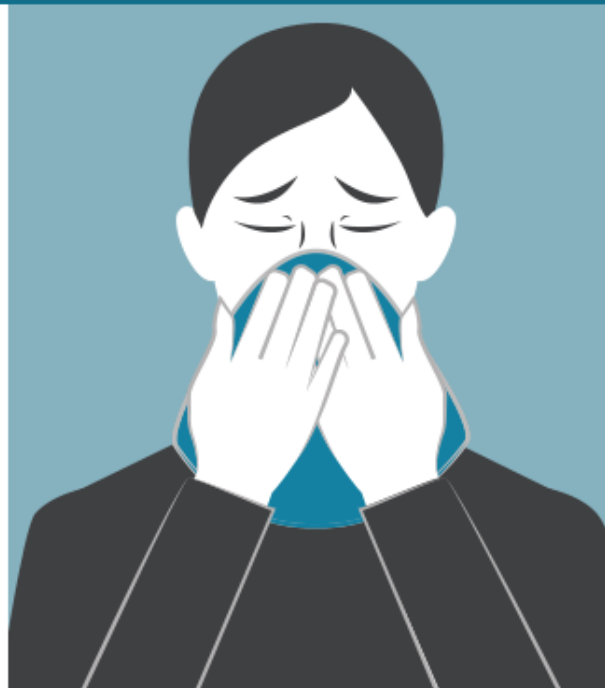


Prevention of COVID-19

Coronavirus: What you need to do



**Wash your
hands**



**Use a tissue
for coughs**



**Avoid touching
your face**



End

Questions