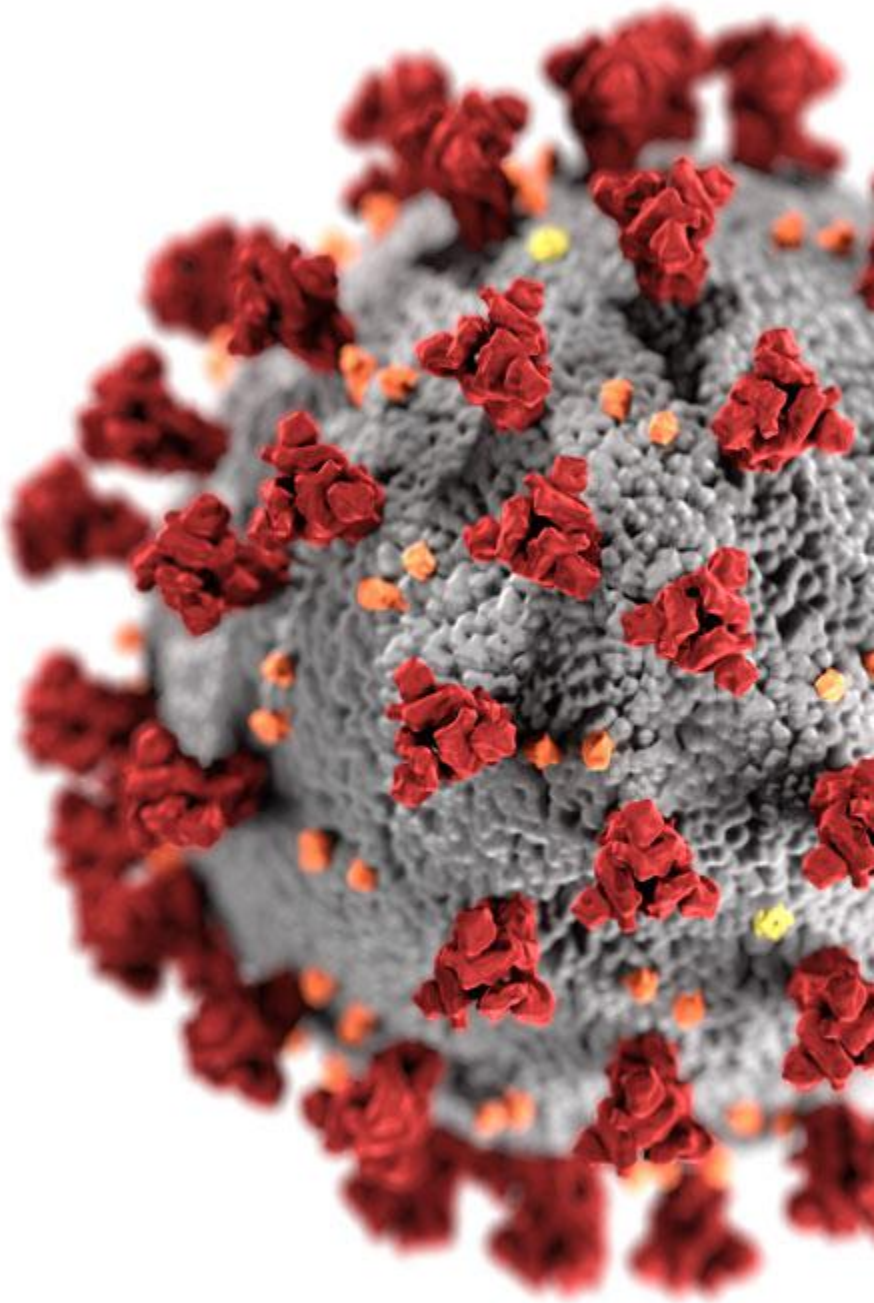
Coronavirus SARS-CoV-2



Institute for Microbiology and Immunology
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COVID-19, Corona virus disease 2019

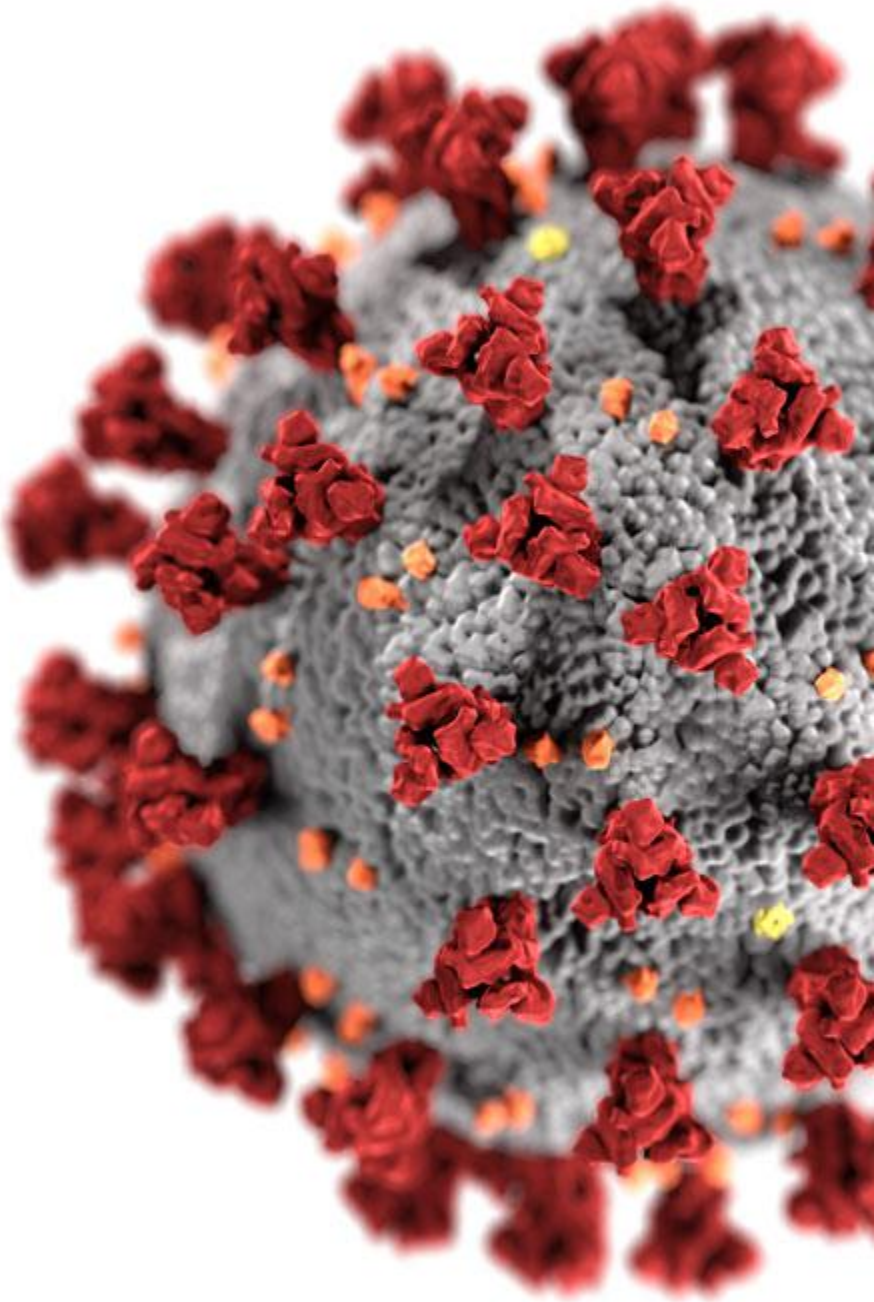
caused by SARS-CoV-2

CoV, Family of RNA viruses able to

infect animals and humans

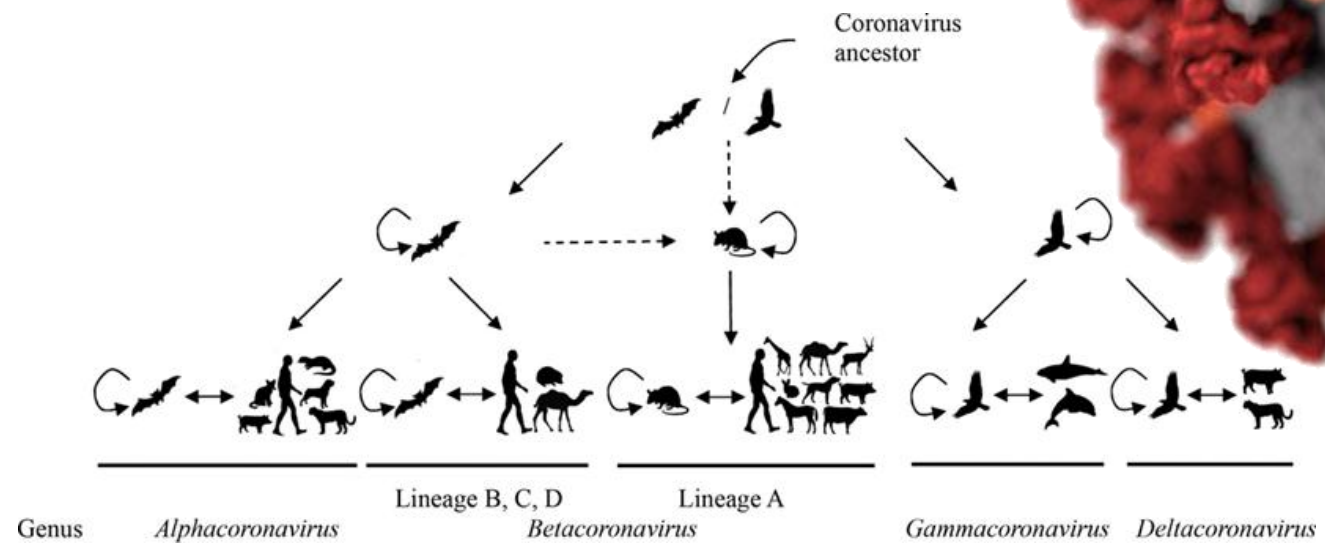
SARS-CoV-2, Severe acute respiratory

syndrome coronavirus 2

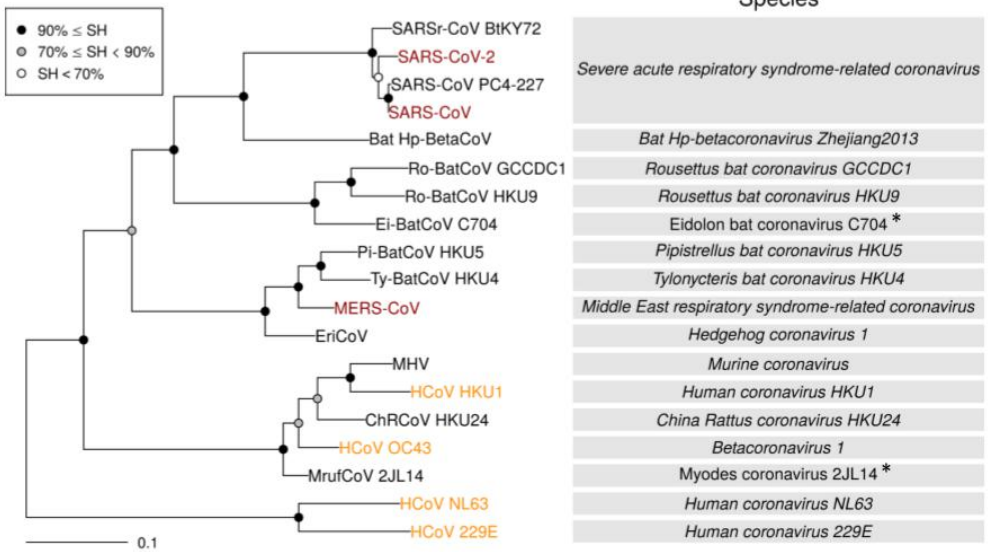


Family of viruses known as coronaviruses:

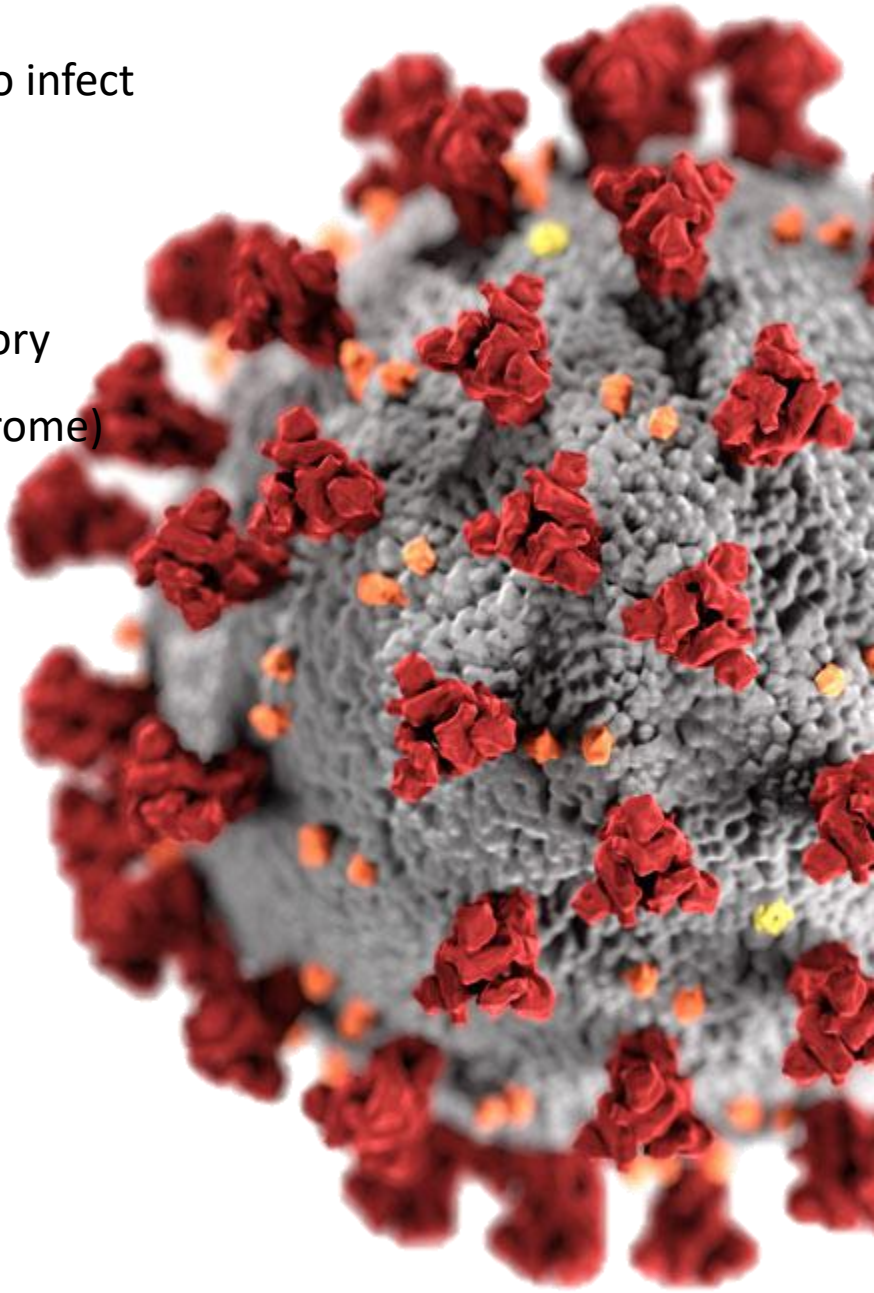
- ✓ named for the crown-like spikes on their surfaces,
- ✓ infect mostly bats, pigs and small mammals.



- ✓ Seven strains including SARS-CoV-2 are known to infect humans.
- ✓ Four of those strains cause common colds.
- ✓ Three others cause: SARS (severe acute respiratory syndrome), MERS (Middle East respiratory syndrome) and COVID-19.



Species
Severe acute respiratory syndrome-related coronavirus
Bat Hp-betacoronavirus Zhejiang2013
Rousettus bat coronavirus GCCDC1
Rousettus bat coronavirus HKU9
Eidolon bat coronavirus C704 *
Pipistrellus bat coronavirus HKU5
Tylonycteris bat coronavirus HKU4
Middle East respiratory syndrome-related coronavirus
Hedgehog coronavirus 1
Murine coronavirus
Human coronavirus HKU1
China Rattus coronavirus HKU24
Betacoronavirus 1
Myodes coronavirus 2JL14 *
Human coronavirus NL63
Human coronavirus 229E



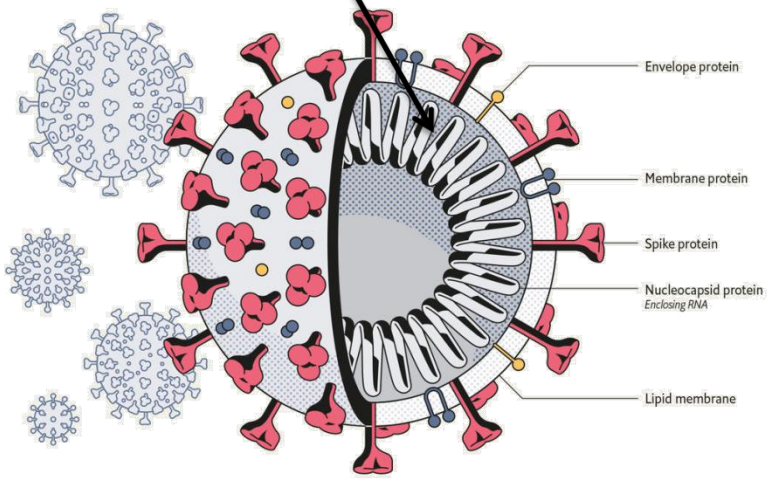
Alexander E. Gorbalenya et.al, Severe acute respiratory syndrome-related coronavirus: The species and its viruses – a statement of the Coronavirus Study Group

E (envelope) protein

S (spike) protein

M (membrane) protein

ss +RNA genome



Manuel Bortoletti

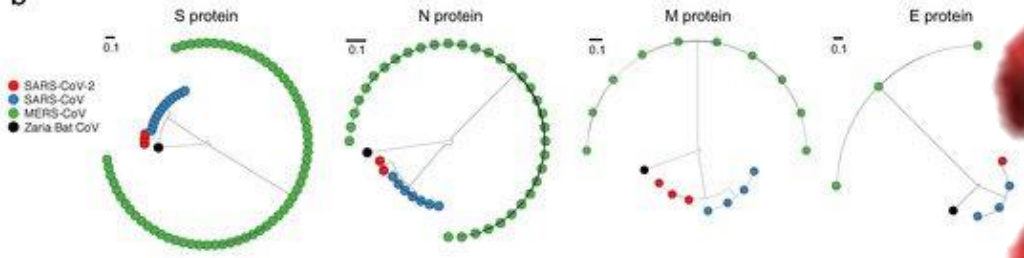
Comparison with SARS and MERS

a

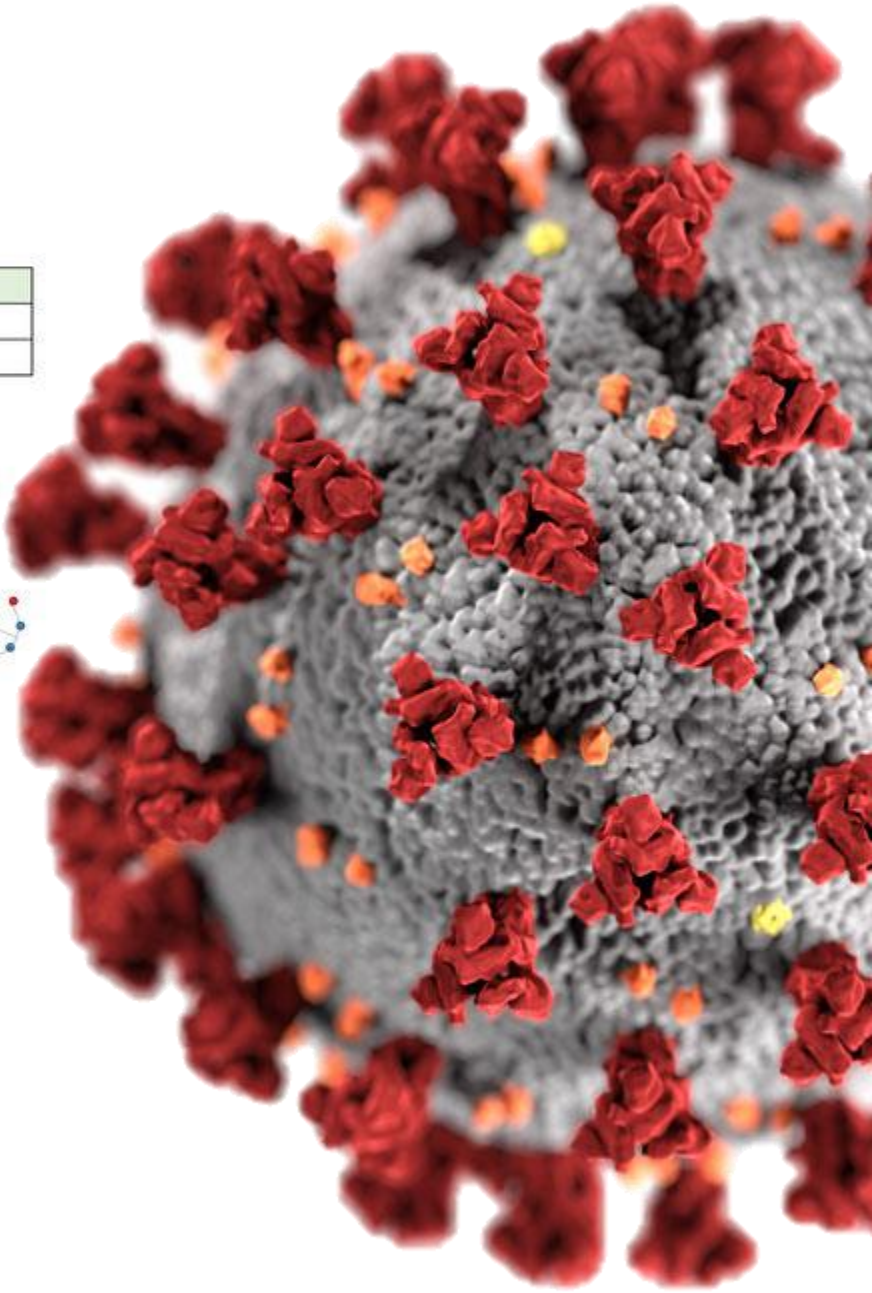
Percentage sequence identity with SARS-CoV-2

	S protein	N protein	M protein	E protein
SARS-CoV	76.0%	90.6%	90.1%	94.7%
MERS-CoV	29.4%	45.9%	39.2%	34.1%

b



Ahmed, S.F.; Quadeer, A.A.; McKay, M.R. Preliminary Identification of Potential Vaccine Targets for the COVID-19 Coronavirus (SARS-CoV-2) Based on SARS-CoV Immunological Studies. Viruses 2020, 12, 254.



VELOCITY OF THE VIRUS

For the first 1,000 people to be infected,

MERS took **903 days or 2.5 years**

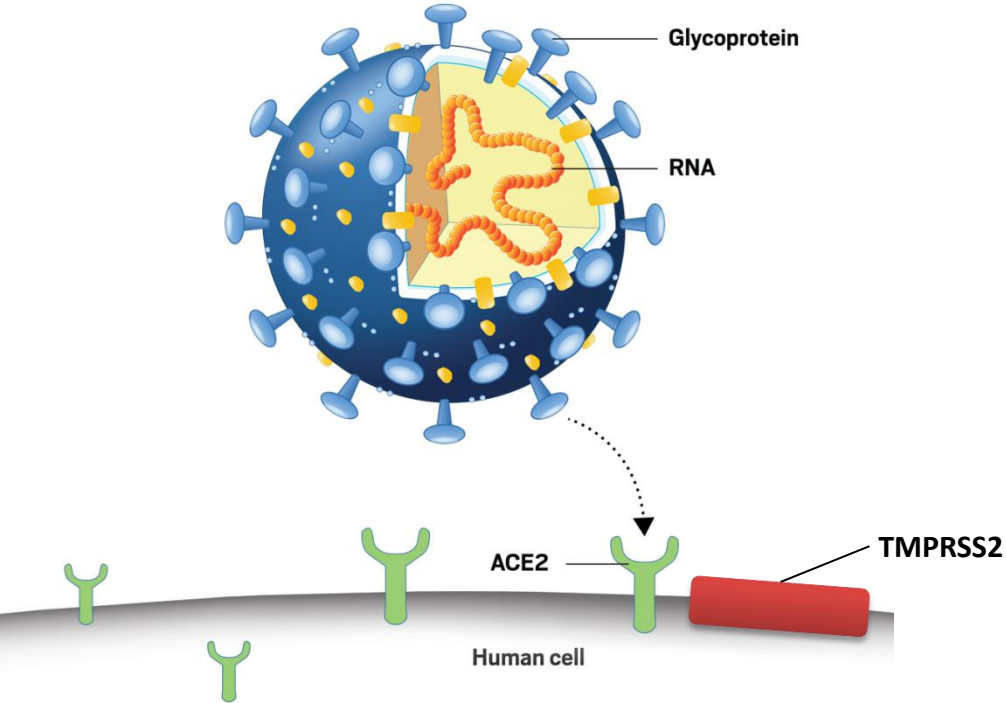
SARS took **130 days**

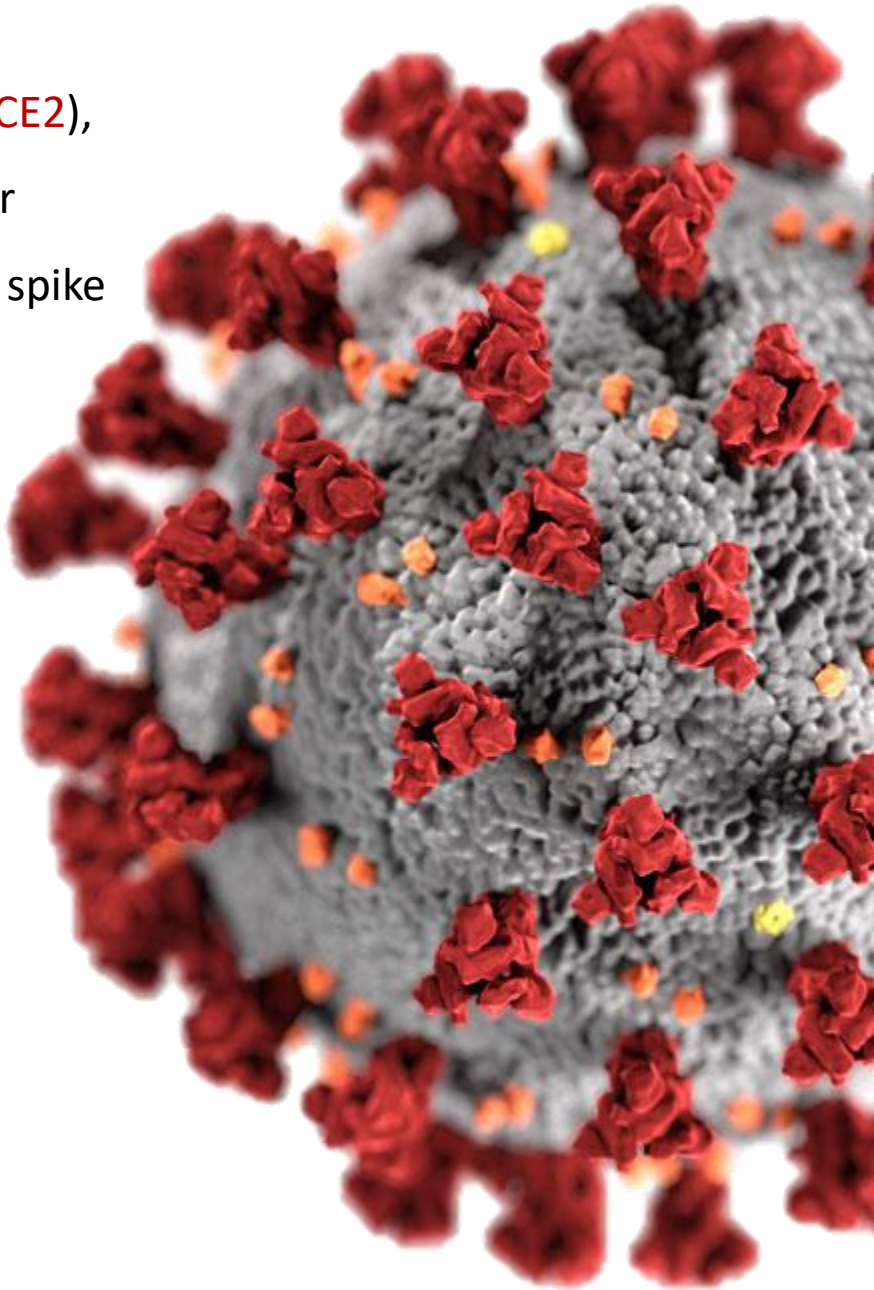
and the new coronavirus took **48 days**

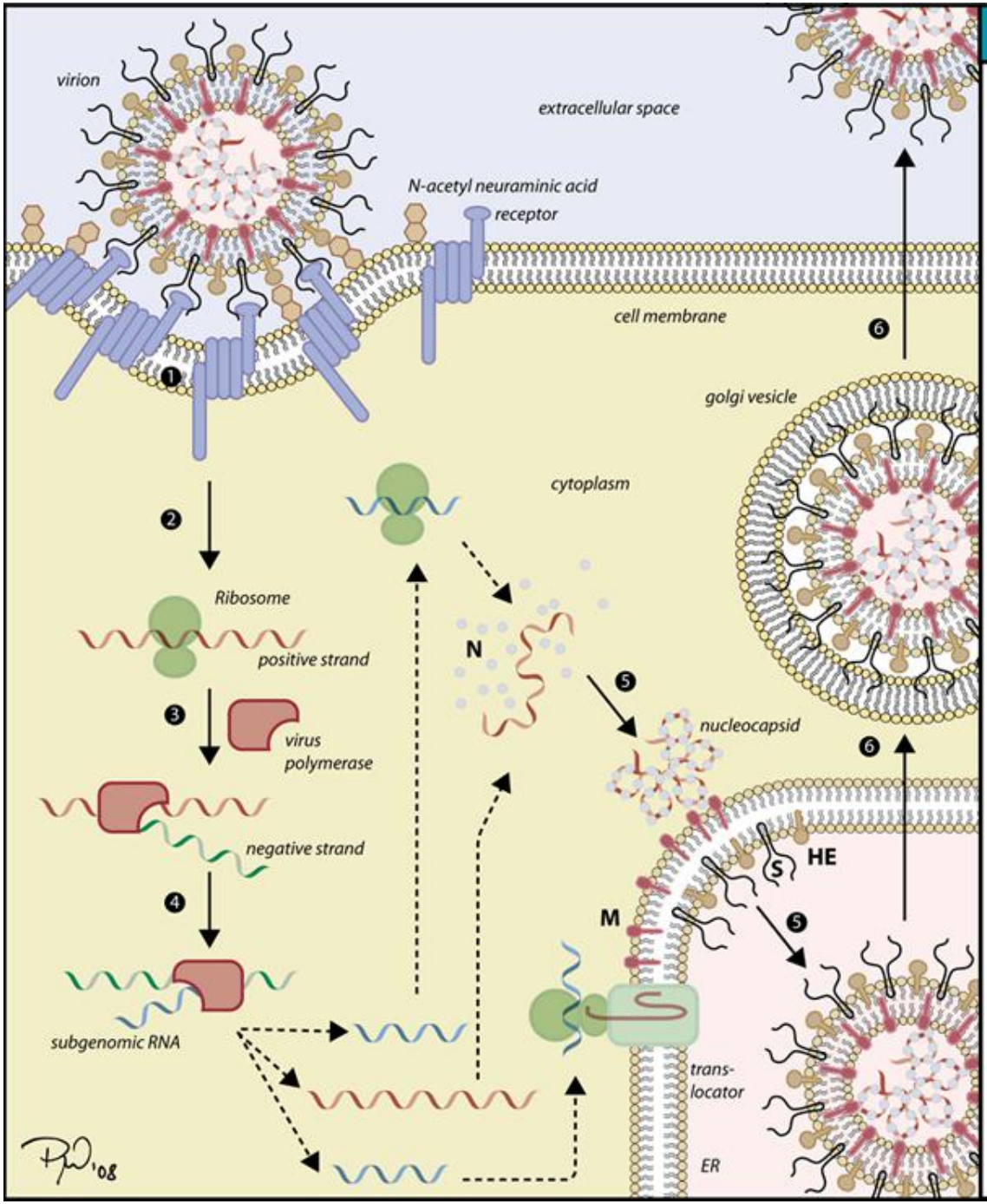
✓Receptor: Angiotensin-converting enzyme 2 (ACE2),

✓Spike protein of SARS-CoV-2 binds to a receptor potentially ten times more tightly than does the spike protein in the SARS virus,

✓Enzyme TMPRSS2, which belongs to the serine protease family, helps the virion enter.







Replication of Coronavirus

1 With their S-protein, coronaviruses bind on cell surface molecules such as the metalloprotease »amino-peptidase N«. Viruses, which accessorily have the HE-protein, can also bind on N-acetyl neuraminic acid that serves as a co-receptor.

2 So far, it is not clear whether the virus get into the host cell by fusion of viral and cell membrane or by receptor mediated endocytosis in that the virus is in-corporated via an endosome, which is subsequently acidified by proton pumps. In that case, the virus have to escape destruction and transport to the lysosome.

3 Since coronaviruses have a single positive stranded RNA genome, they can directly produce their proteins and new genomes in the cytoplasm. At first, the virus synthesize its RNA polymerase that only recognizes and produces viral RNAs. This enzyme synthesize the minus strand using the positive strand as template.

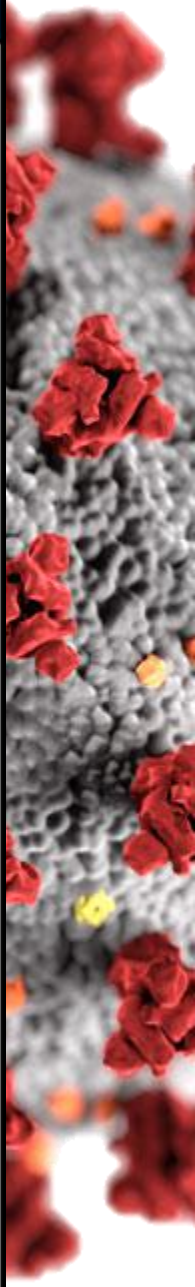
4 Subsequently, this negative strand serves as template to transcribe smaller subgenomic positive RNAs which are used to synthezise all other proteins. Furthermore, this negative strand serves for replication of new positive stranded RNA genomes.

5 The protein N binds genomic RNA and the protein M is integrated into the membrane of the endoplasmatic reticulum (ER) like the envelope proteins S and HE. After binding, assembled nucleocapsids with helical twisted RNA budd into the ER lumen and are encased with its membrane.

6 These viral progeny are finally transported by golgi vesicles to the cell membrane and are exocytosed into the extracellular space.

Not drawn to scale! Not all cellular compartments and enzymes are shown. Colors: positive strand RNA (red), negative strand RNA (green), subgenomic RNAs (blue).

Based on: Lai MM, Cavanagh D (1997). The molecular biology of coronavirus. Adv. Virus Res (48) 1-100.



„Everything that happens twice will surely happen a third time“, Paulo Coelho.

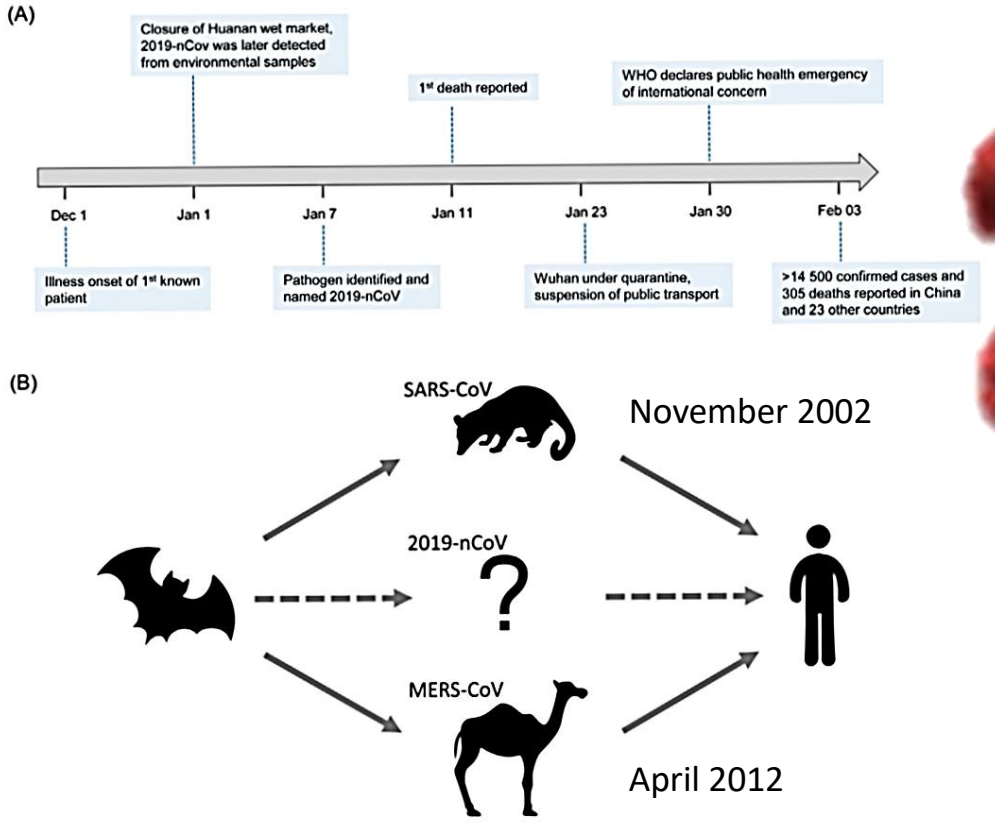
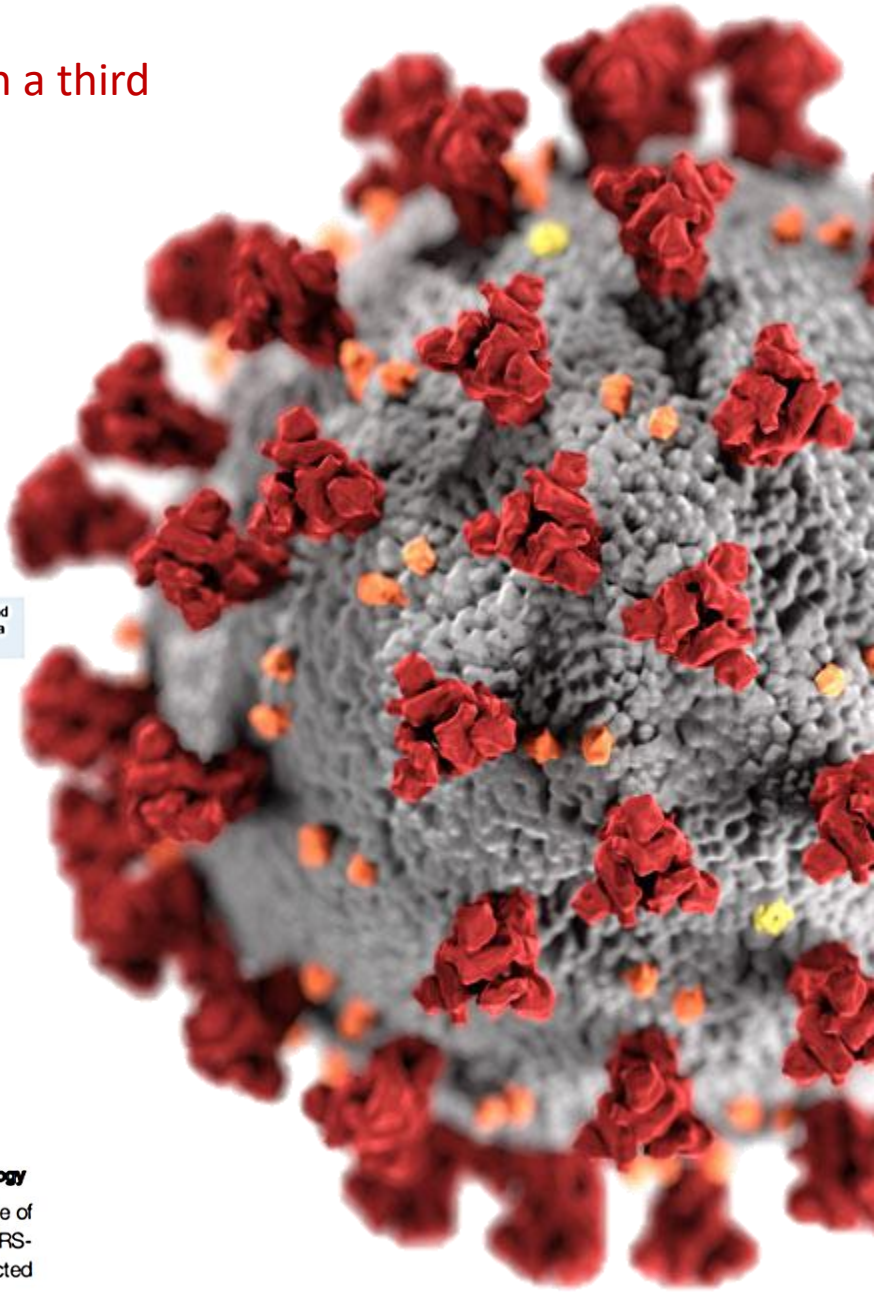


Figure 1. The Possible Interspecies Transmission Route and Timeline of 2019-nCoV. (A) Timeline of major events in the 2019-nCoV outbreak. (B) Potential interspecies transmission routes of SARS-CoV, MERS-CoV, and 2019-nCoV. The question mark and broken line denote unknown intermediate host and suspected transmission.



Coronaviruses: From Animals to Humans

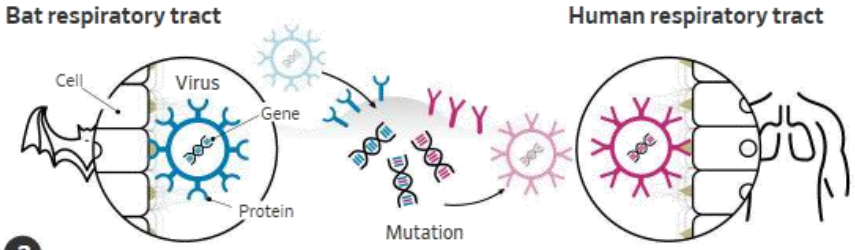
Researchers aren't sure how the novel coronavirus first infected people in China, but the viruses that cause SARS and MERS, which originated in bats, provide clues.

1

Proteins on the outer shell of the virus allow it to latch onto cells in the host's respiratory tract. The proteins' shapes are determined by the virus's genes.

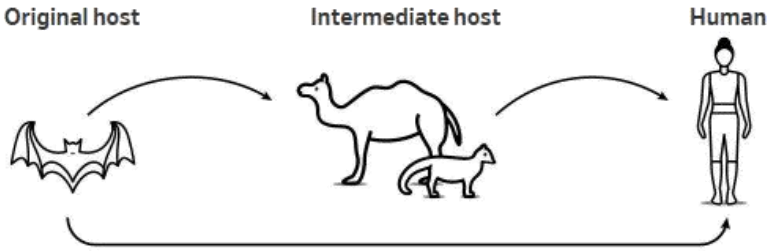
2

To infect new hosts, the virus's genes undergo mutations that alter its surface proteins, allowing them to latch onto the cells of new species.



3

In the case of SARS, the virus jumped from bats to civet cats before gaining the ability to infect humans. In the case of MERS, camels served as the intermediate host.

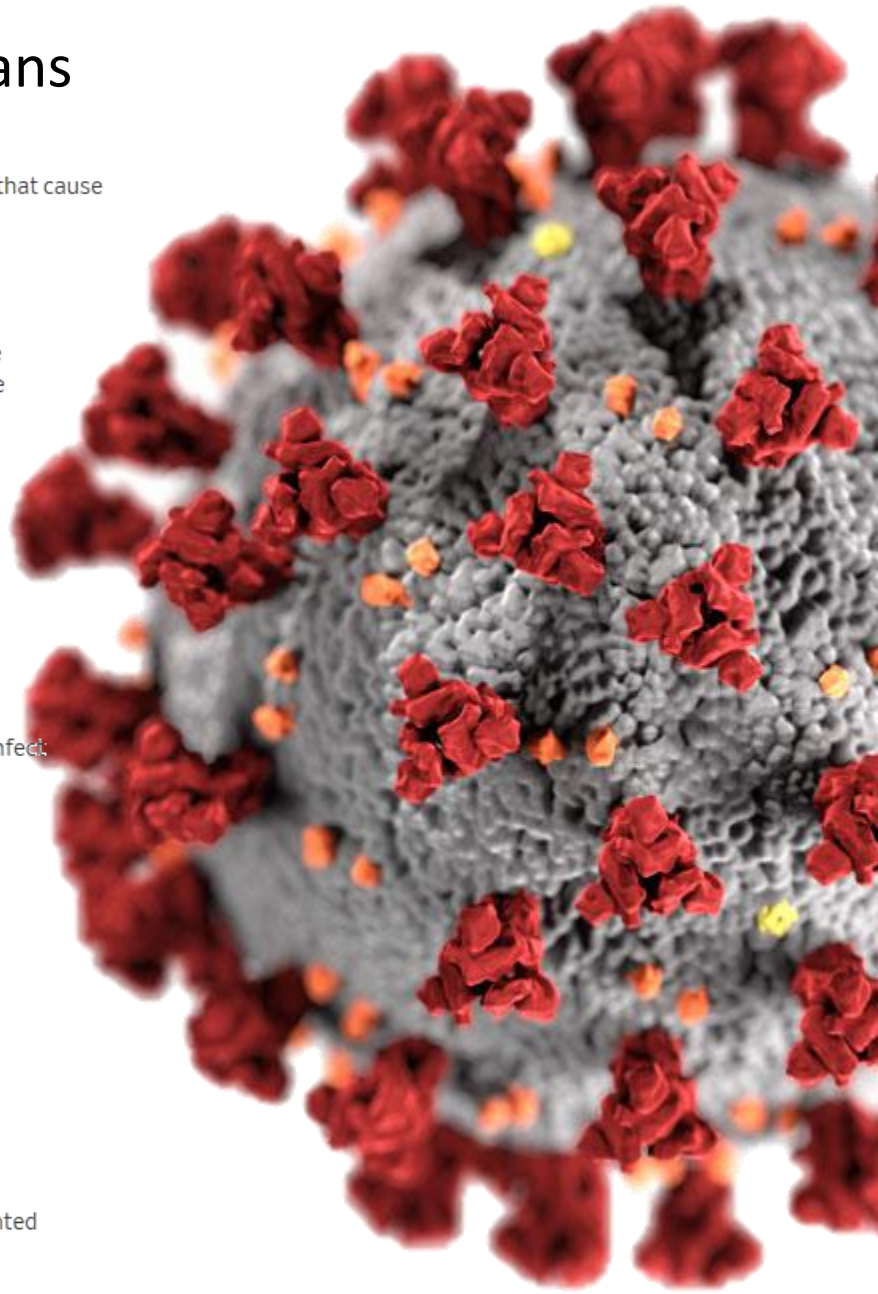


4

Coronaviruses can also jump directly to humans, without mutating or passing through an intermediate species.

5

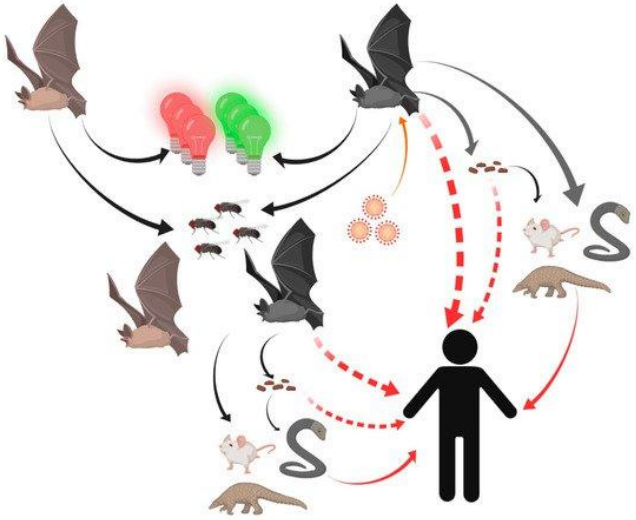
Researchers have found the novel coronavirus likely originated in bats, but haven't pinpointed the source of transmission to humans.

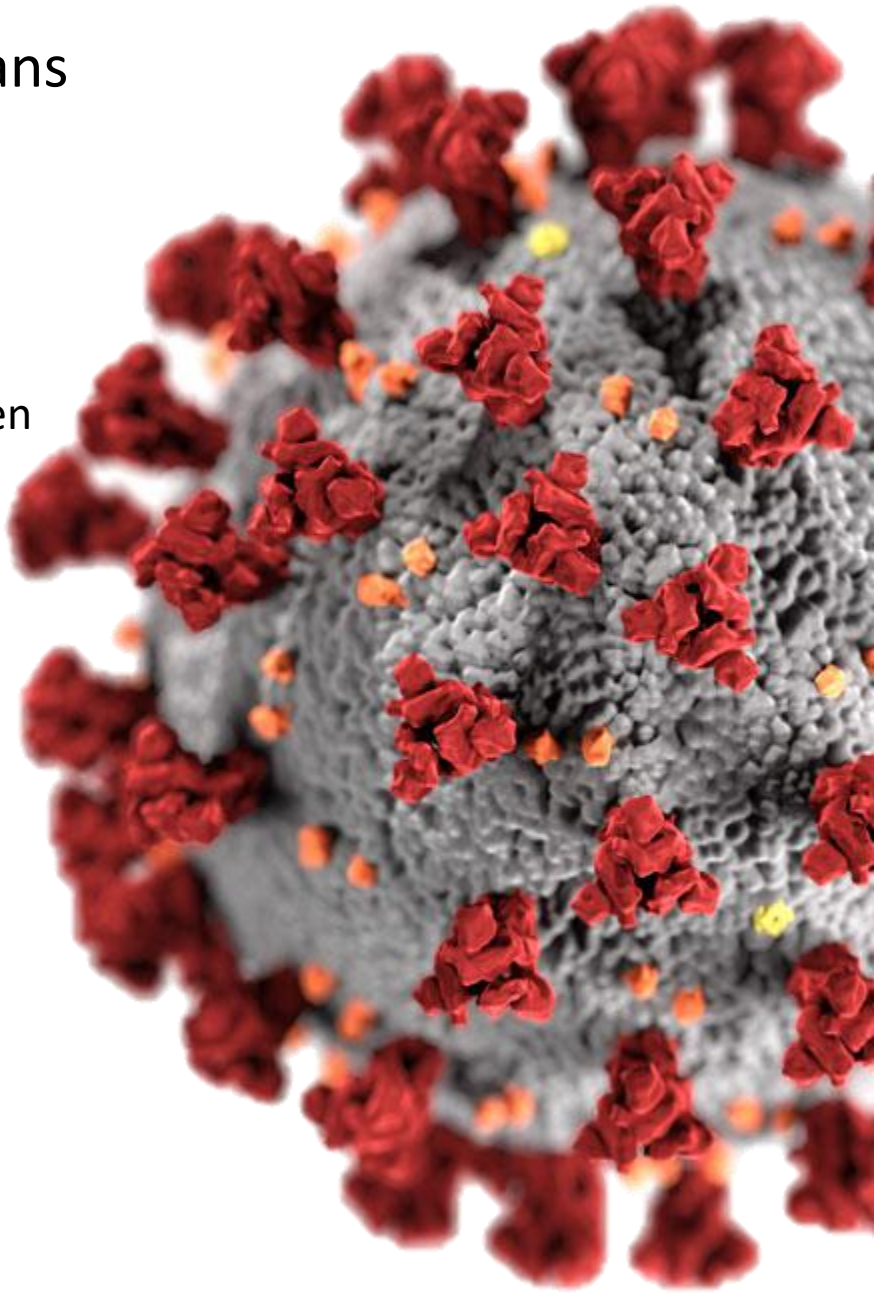


Source: Timothy Sheahan, University of North Carolina
Alberto Cervantes and Josh Ulick /THE WALL STREET JOURNAL

Coronaviruses: From Animals to Humans

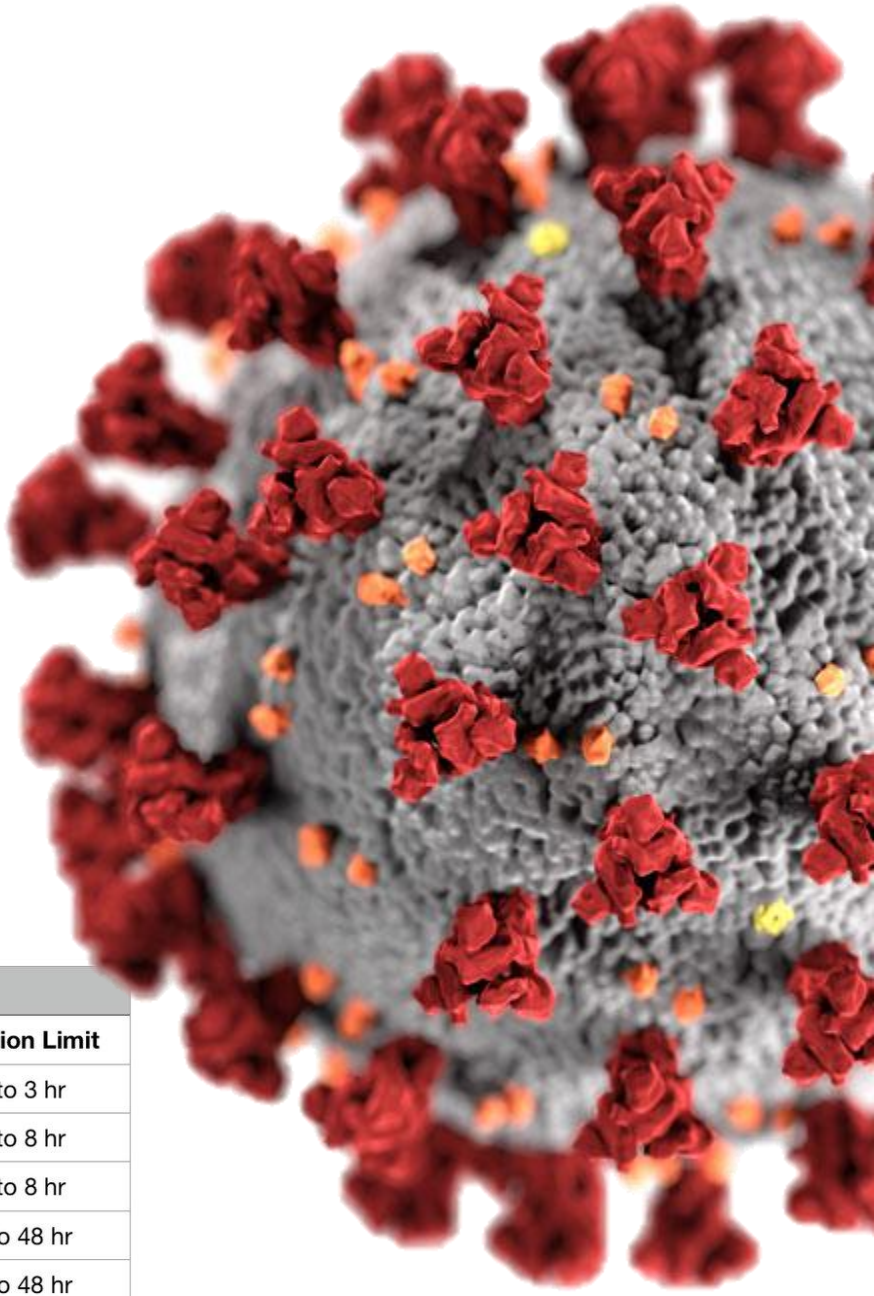
- ✓ Potential transmission routes for SARS-CoV-2 to humans.
- ✓ Bats carrying SARS-CoV-2 were attracted by green or red lights and settled into insect-rich areas.
- ✓ Transmittion to humans: directly or spread to intermediate hosts (bamboo rats, snakes, and pangolins) through bats' saliva, urine, and feces.





Coronavirus stability

- ✓ In aerosol up to 3 hours.
- ✓ On copper up to 4 hours.
- ✓ On cardboard up to 24 hours.
- ✓ On plastic and stainless steel up to 2-3 days.

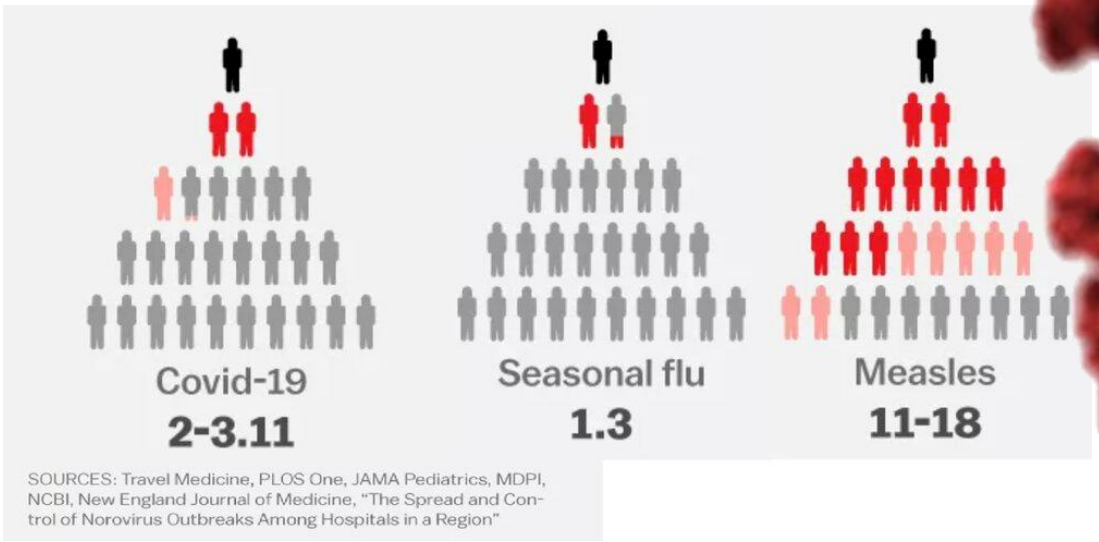


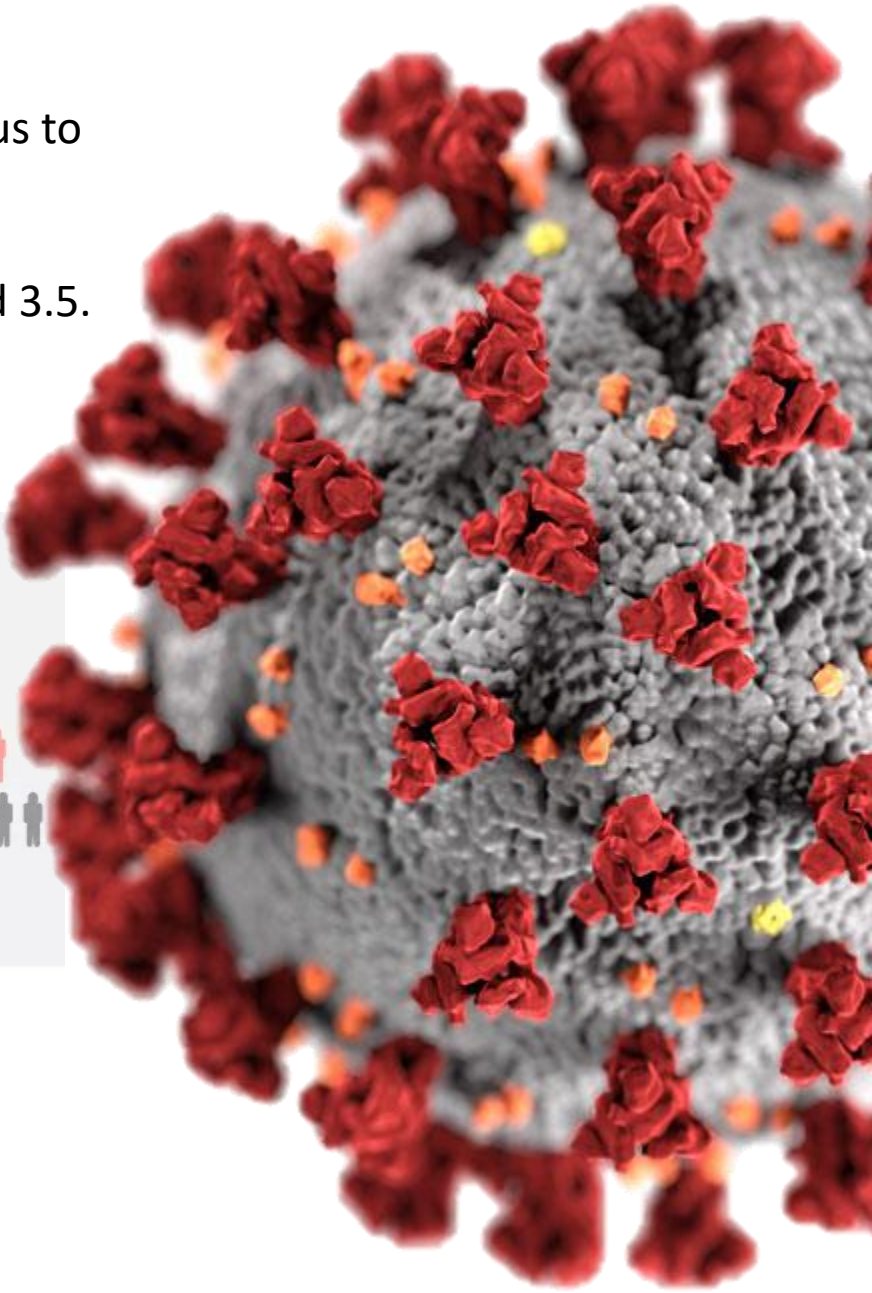
Stability of Infectious Virus

	SARS-CoV-2		SARS-CoV-1	
	Half Life, Hours	Detection Limit	Half Life, Hours	Detection Limit
Aerosol	2.74	Up to 3 hr	2.74	Up to 3 hr
Copper	3.4	Up to 4 hr	3.76	Up to 8 hr
Cardboard	8.45	Up to 24 hr	1.74	Up to 8 hr
Steel	13.1	Up to 48 hr	9.77	Up to 48 hr
Plastic	15.9	Up to 72 hr	17.7	Up to 48 hr

Aerosol and surface stability of HCoV-19 (SARS-CoV-2) compared to SARS-CoV-1
Neeltje van Doremalen, Trenton Bushmaker, Dylan Morris, Myndi Holbrook, Amandine Gamble, Brandi Williamson, Azaibi Tamin, Jennifer Harcourt, Natalie Thornburg, Susan Gerber, Jamie Lloyd-Smith, Emmie de Wit, Vincent Munster

- ✓ Each infected person has transmitted the virus to about 2.6 others
- ✓ The range of transmission is between 1.5 and 3.5.

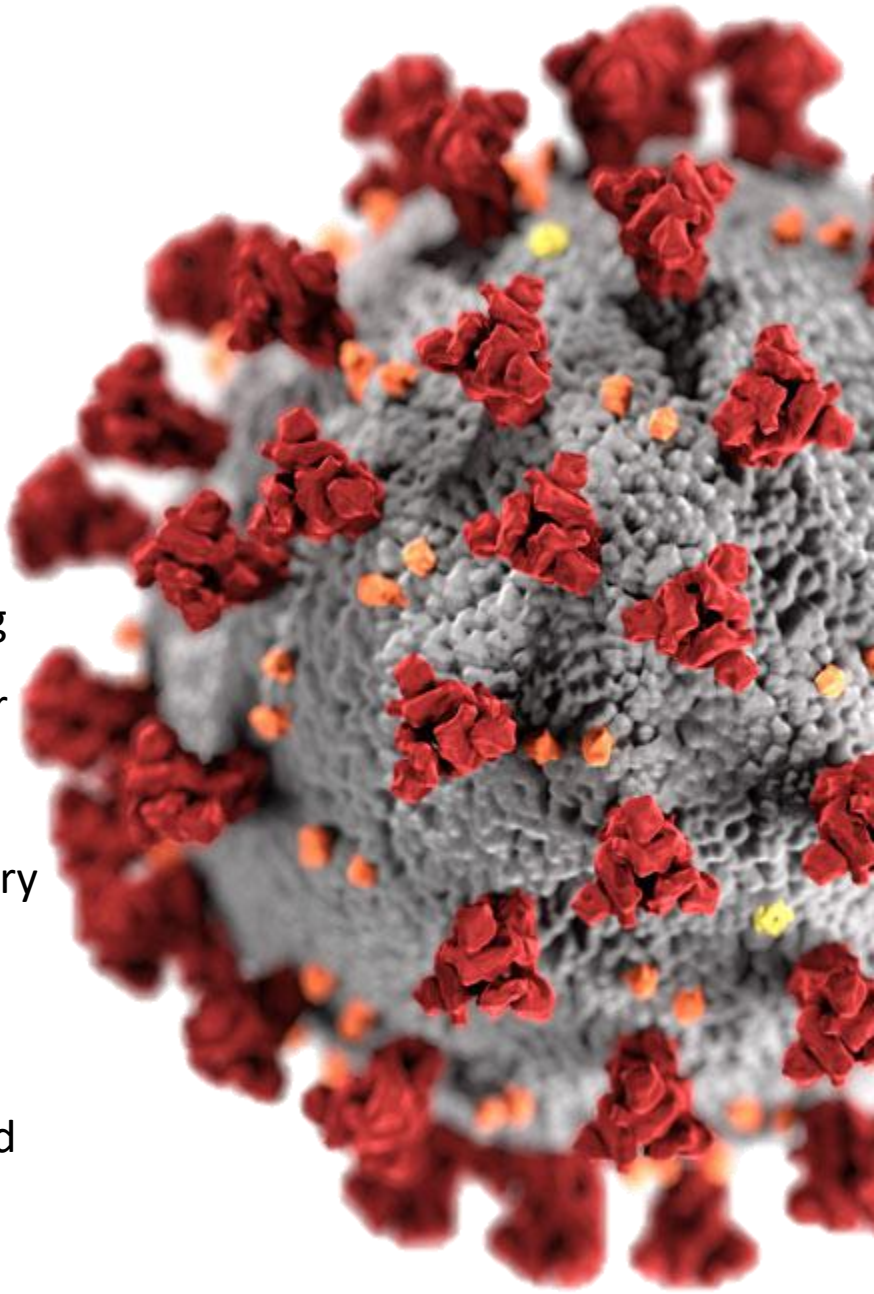




- ✓ Incubation period is between 1-14 days, aproximately 5.2

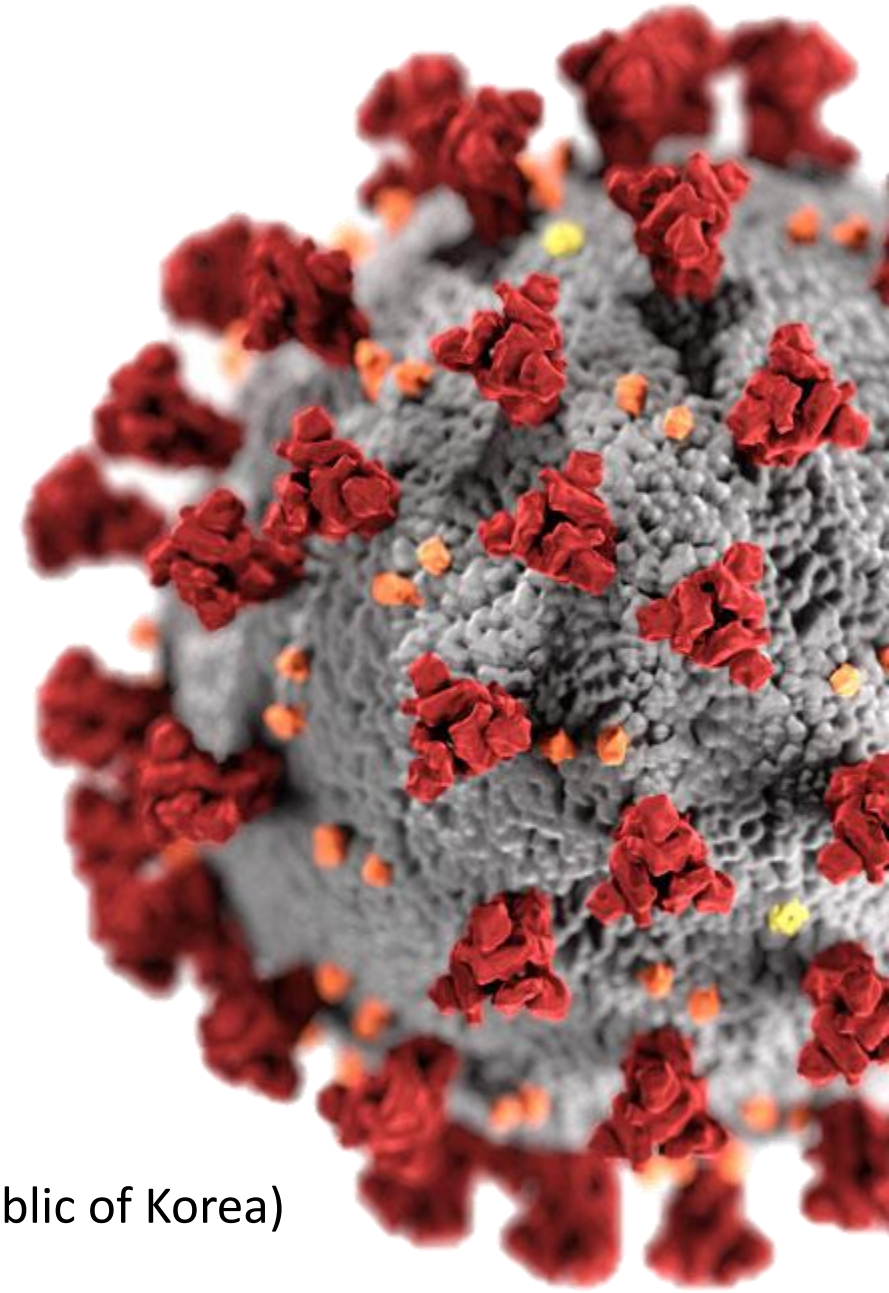
Diagnosting testing

- ✓ Reverse-transcriptase PCR tests
- ✓ Primers and probes designed to detect a variety of targets in the SARS-CoV-2
- ✓ Biosafety cabinet BSL-2 for molecular testing
- ✓ Multiple specimen types, at minimum: upper respiratory specimens (nasopharyngeal and oropharyngeal swab) and/or lower respiratory specimens (sputum and/or endotracheal aspirate or bronchoalveolar lavage)
- ✓ Additionally, virus has been detected in blood and stool
- ✓ Serological tests are in development



SITUATION IN NUMBERS:

5th March 2020.



SARS-CoV-2: total confirmed cases 153 517

COVID-19: 5735 deaths

143 countries (China, Italy, Spain, Iran, Republic of Korea)