UNIVERSITAT DE BARCELONA

Laboratory of Viruses Contaminants of Water and Food

Characteristics of SARS-CoV-2, as a water contaminant

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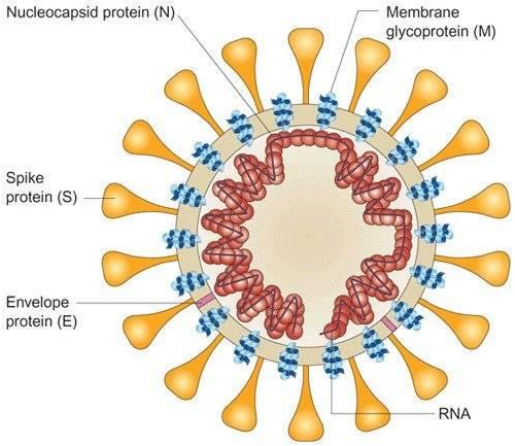
Human coronavirus

HCoV-OC43, HCoV-HKU1, HCoV-229E, HCoV-NL63, SARS-CoV and MERS-CoV;
SARS-CoV-2 is the seventh member of the coronavirus family that infects humans

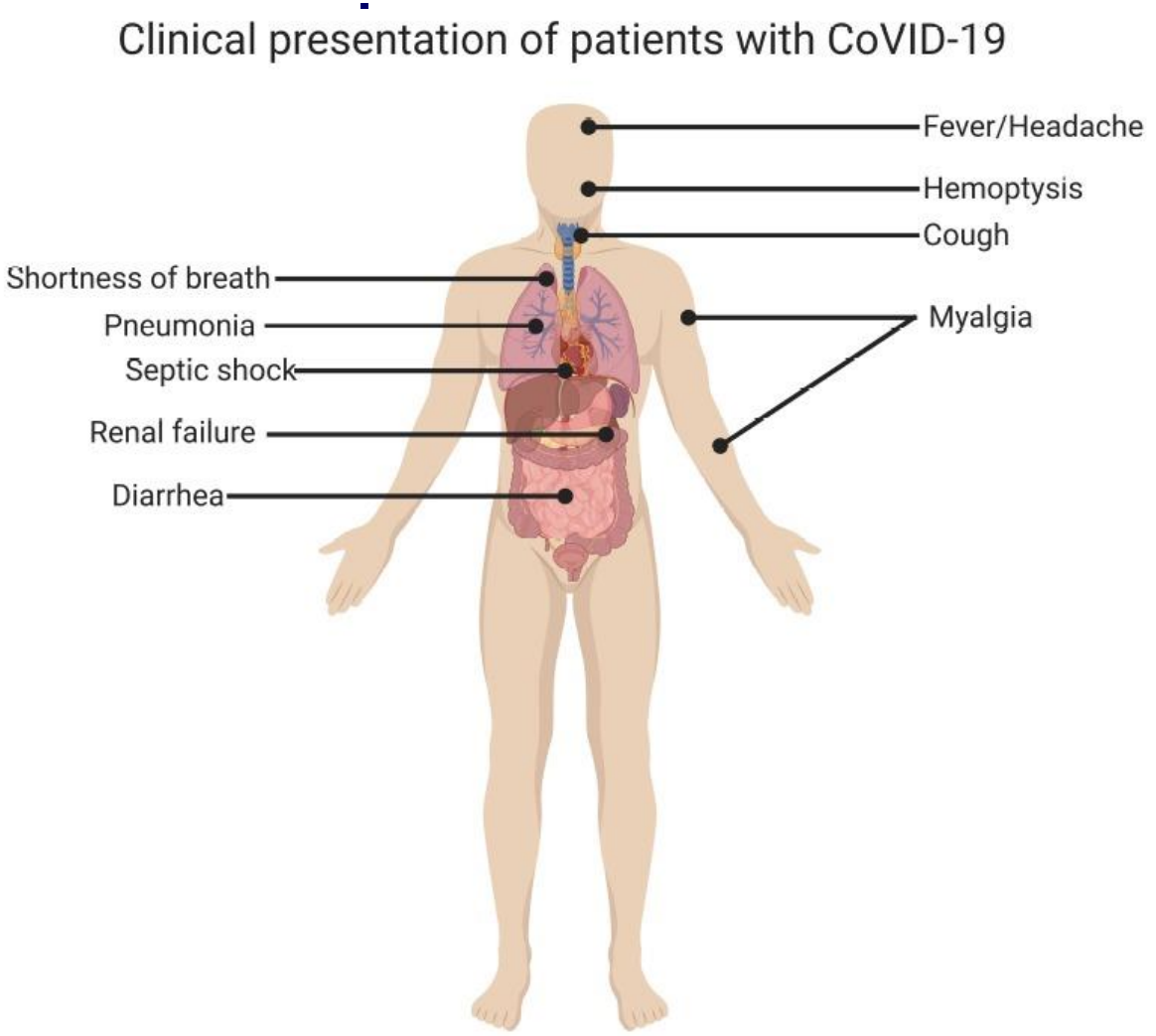


Coronaviridae, Betacoronavirus, SARS-CoV

Strain: Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)

COVID-19, a Public Health Emergency of International Concern (PHEIC)

- Primarily spreads through the respiratory tract, by droplets, respiratory secretions, and direct contact.
- Incubation period is 1–14 days, mostly 3–7 days. Median age of patients is 47–59 years.
- Patients above 80 years of age had an alarmingly high fatality rate of 14.8%.



Cascella M. et al. Features, Evaluation and Treatment Coronavirus (COVID-19) StatPearls.
https://www.ncbi.nlm.nih.gov/books/NBK554776/

SARS-CoV-2 excretion during COVID-19

- ✓ **SARS-CoV-2 is excreted in stools also in absence of gastrointestinal symptoms**.
  - Duration of viral excretion may be in some cases more than 5 weeks in stool samples. Careful hand and toilet disinfection is required.
  - Disease severity was not neither associated with extended duration of faecal sample viral RNA positivity.

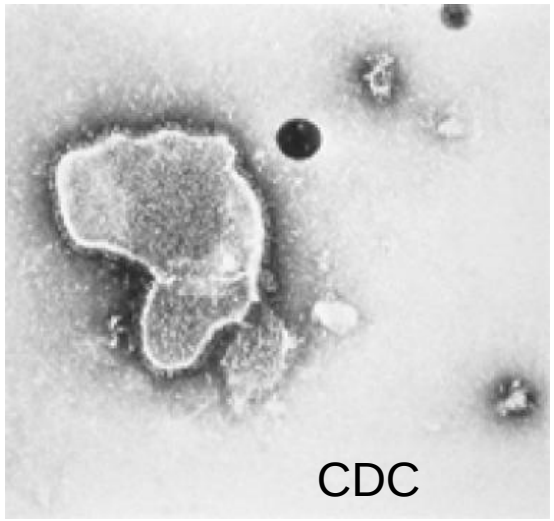
- ✓ **Live virus have been isolated in stool samples.**
  - From patients who did not have diarrhea.
  - However most virus in feces may be no longer infectious based on the failure of all attempts to isolate the virus from positive RT-PCR specimens collected in convalescent patients in other studies.

(Wu et al. Prolonged presence of SARS-CoV-2 viral RNA in faecal samples www. thelancet.com/gastrohep https://doi.org/10.1016/S2468-1253(20)30083-2)

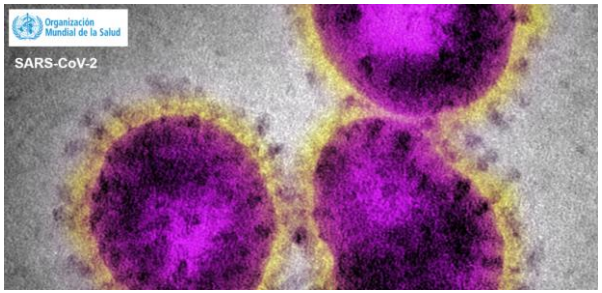
Examples of viruses with lipid envelope detected in feces

RNA

DNA



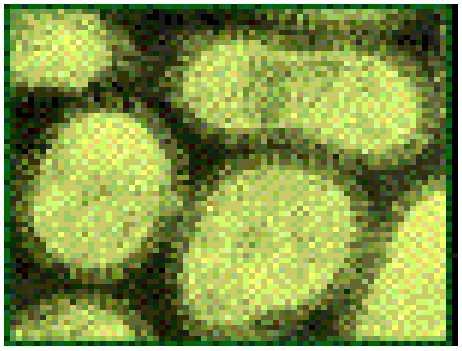
Respiratory Syncitial virus



Coronavirus, Sars-CoV-2

Herpesvirus

Influenzavirus



Stability in water

- ✓ **Human coronavirus 229E were found to be very stable at 4ºC** in tap water comparable to poliovirus 1, however poliovirus 1 was more stable at higher temperatures and in wastewater.

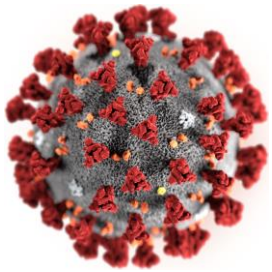
- ✓ **SARS-CoV-2 remained viable in aerosols** throughout the duration of a experiment (3 hours), similar to that observed with SARS-CoV-1.

- ✓ **SARS-CoV-2 highly stable in a wide-range of pH** values at room temperature, 60 min, pH3-10.

Aerosol and Surface Stability of SARS-CoV-2 as Compared with SARS-CoV-1. Doremalen, et al. N Engl J Med, DOI: 10.1056/NEJMc2004973

Survival of Coronaviruses in Water and Wastewater. Gundy et al. Food Environ Virol (2009) 1:10–14.

SARS-CoV-2 in sewage

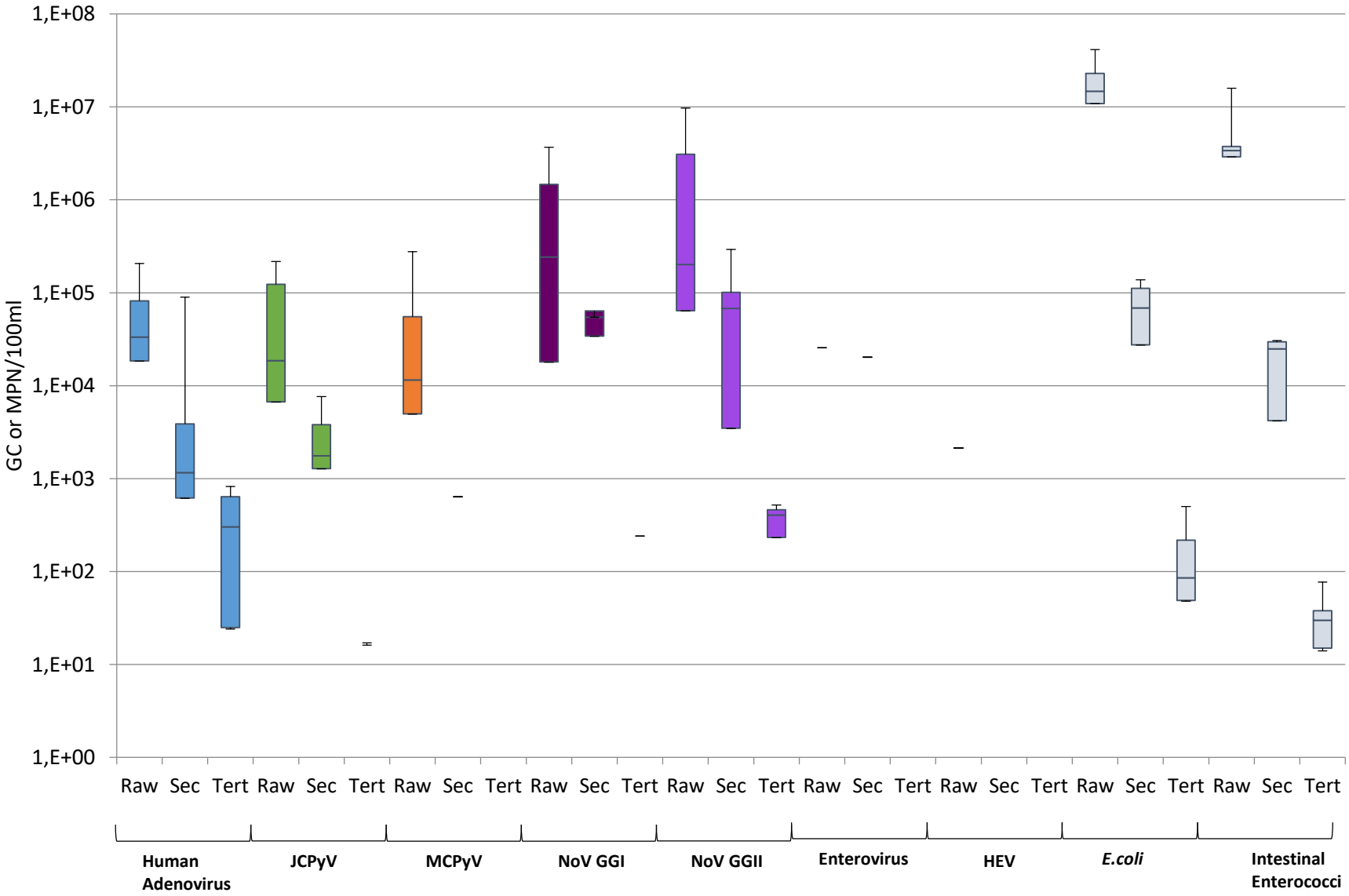


1. **SARS-CoV-2 has been detected in urban sewage**

2. SARS-CoV was detected in sewage from hospitals although there was **no live SARS-CoV detected**. In **seeded sewage, SARS-CoV could survive for 14 days at 4 °C, 2 days at 20 °C**.

3. The hydrophobicity of the viral envelope makes coronaviruses less soluble in water and with higher tendency to adhere to the solids.

Viruses in a wastewater treatment plant producing reclaimed water (wetland)



Viruses in urban sewage by Target Enrichment Metagenomics

	Viral sequence reads			
	Viral read count		Breadth genome coverage (%)	
Viral species	Target Enrichment	High Throughput	Target Enrichment	High Throughput
Aichivirus A	23372	33	89,86	22,05
Betapapillomavirus 2	24	0	15,47	0
BK polyomavirus	829	0	79,89	0
Enterovirus A	725	233	57,33	61,12
Enterovirus B	902	0	44,00	0
Enterovirus C	2098	0	62,10	0
Human mastadenovirus A	343	0	14,22	0
Human mastadenovirus F	1333	0	34,66	0
Human polyomavirus 6	79	0	10,88	0
JC polyomavirus	714	237	77,37	93,82
Mamastrovirus 1	83857	64	99,25	30,45
Norwalk virus	1820	8	88,72	11,73
Orthohepevirus A	781	0	24,21	0
Rotavirus A	423	0	38,64	0
Sapporo virus	421	10	62,07	57,33
WU polyomavirus	17	0	10,96	0

Enveloped viruses are not detected in urban sewage using VirCapSeq-VERT, the probe library included oligonucleotides (1,993,176 oligonucleotides) that selectively hybridize to genomes of vertebrate viruses.

Conclusions

- Fecal excretion, environmental contamination, and fomites might contribute to viral transmission.
- SARS-CoV-2 infectious particles in sewage could survive, if similar to SARS-CoV-1, about 14 days in sewage at 4 °C, and 2 days at 20 °C.
- Aerosol contamination from fecal wastes of COVID-19 must be controlled, specially at low temperatures.
- The available information indicates that infectious SARS-CoV-2 would be less abundant in sewage than other known enteric viruses and less resistant in water treatments in WWTP or DWTP.
- Available international guidelines for water treatment and reuse considering viral pathogens should be efficient for protecting against SARS-CoV-2.

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http://www.ub.edu/microbiologia_virology/en