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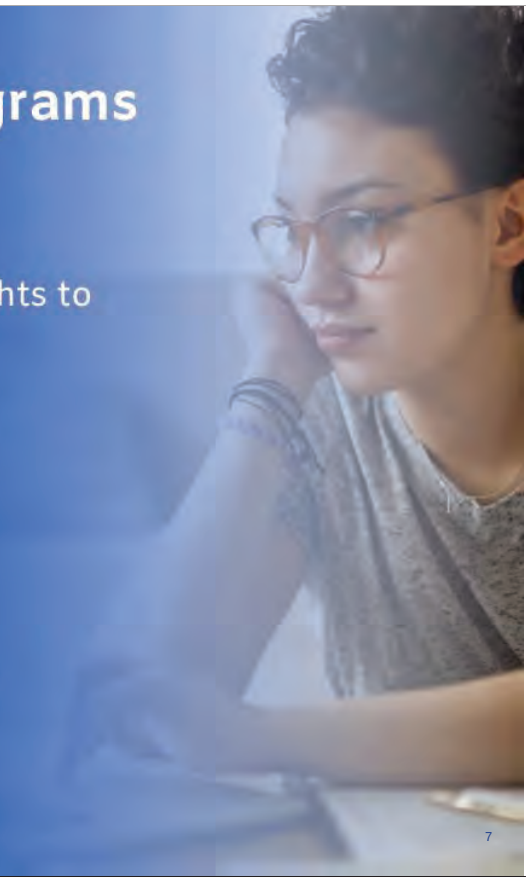



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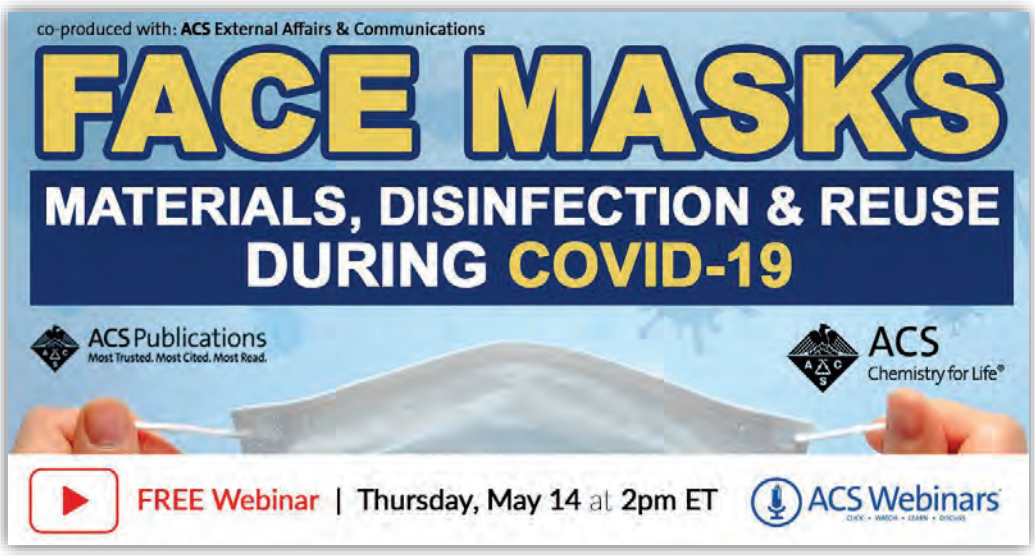


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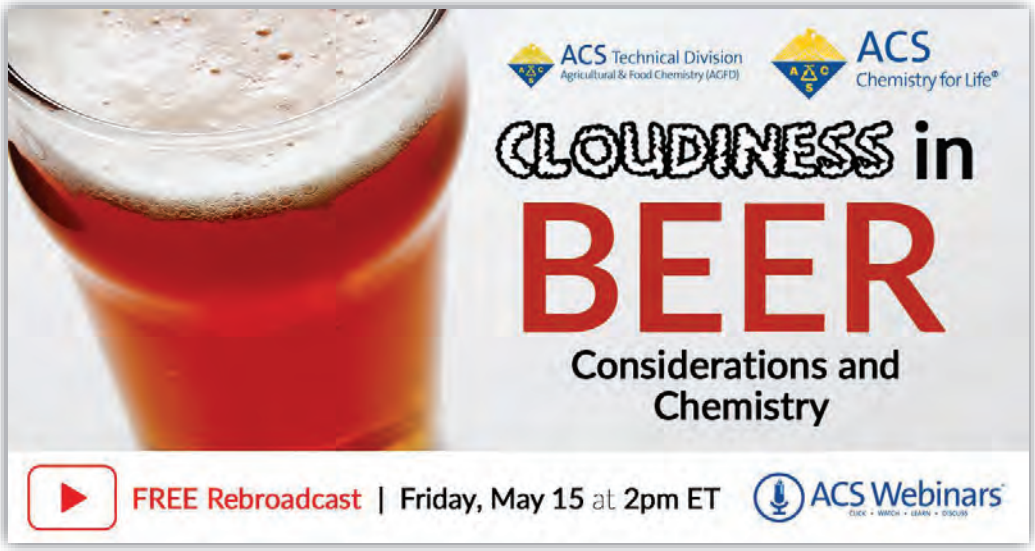


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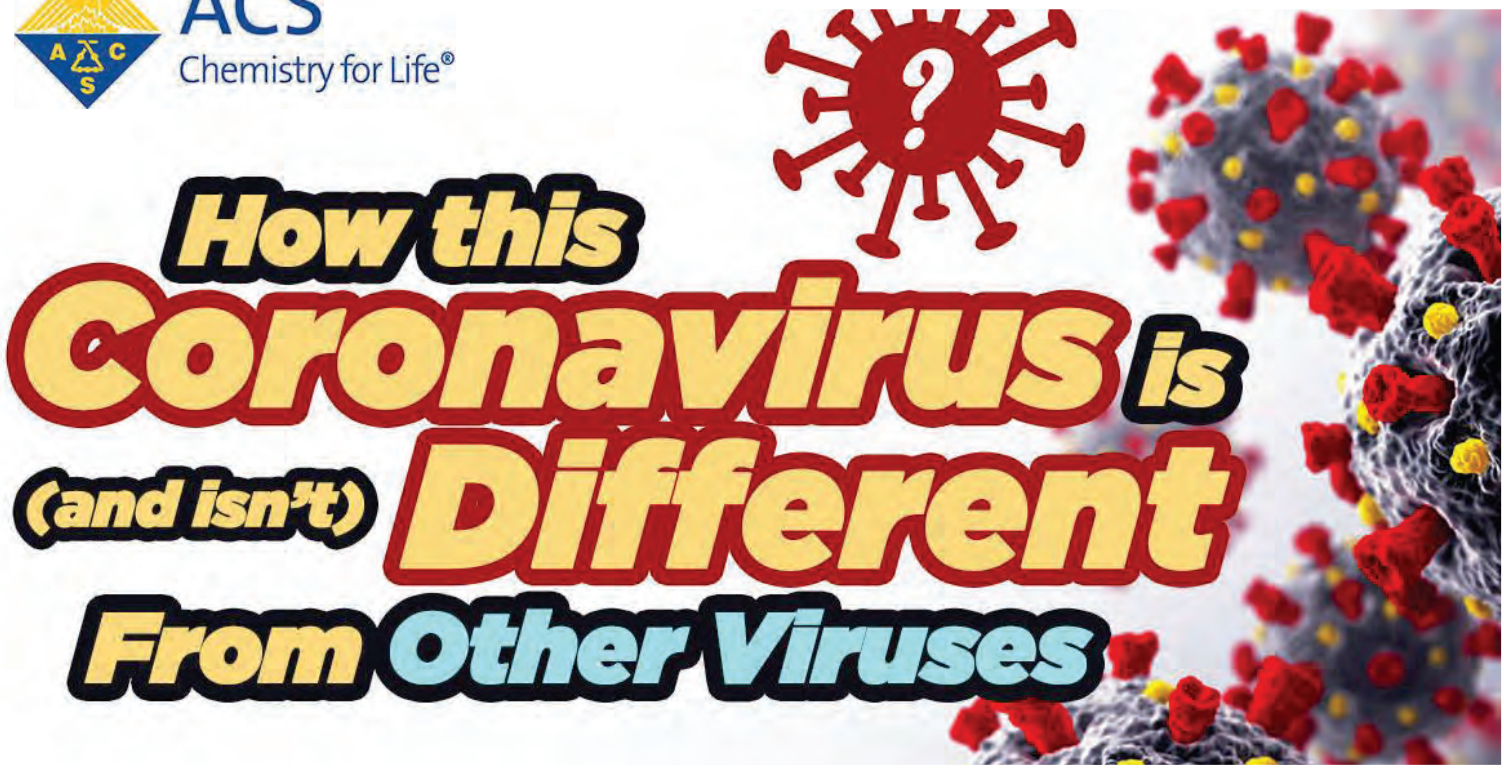


THIS ACS WEBINAR WILL BEGIN SHORTLY...



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## How this Coronavirus is (and isn't) Different from Other Viruses

**Brenda Hogue**
Professor, School of Life Sciences, Arizona State University and Associate Director of the Center for Immunotherapy, Vaccines and Virotherapy, The Biodesign Institute

**Kristin Omberg**
Group Leader, Chemical and Biological Signatures Science, Pacific Northwest National Laboratory

**Susan Morrissey**
Director of Communications, American Chemical Society

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Biodesign Center for
Immunotherapy, Vaccines and Virotherapy

# SARS-CoV-2

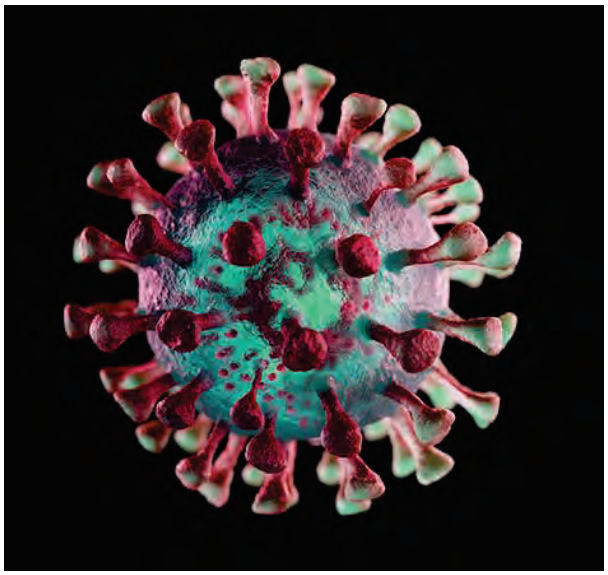
## How is it related to the larger coronavirus family

Brenda G. Hogue, Ph.D.
Professor
School of Life Sciences
Biodesign Institute
Center for Immunotherapy, Vaccines & Virotherapy
Center for Structural Discovery



## Coronavirus disease 2019 (COVID-19 )

- **How SARS-CoV-2 is related to the larger coronavirus family.**
- **How SARS-CoV-2 is transmitted and how people can become infected.**



(The Biodesign Institute - ASU)

# *Coronaviridae*

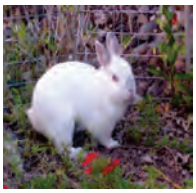






- Large family of RNA viruses
- Primarily enzootic infections in birds and mammals
- Diseases in humans and broad range of animals
- Numerous coronaviruses in bats worldwide



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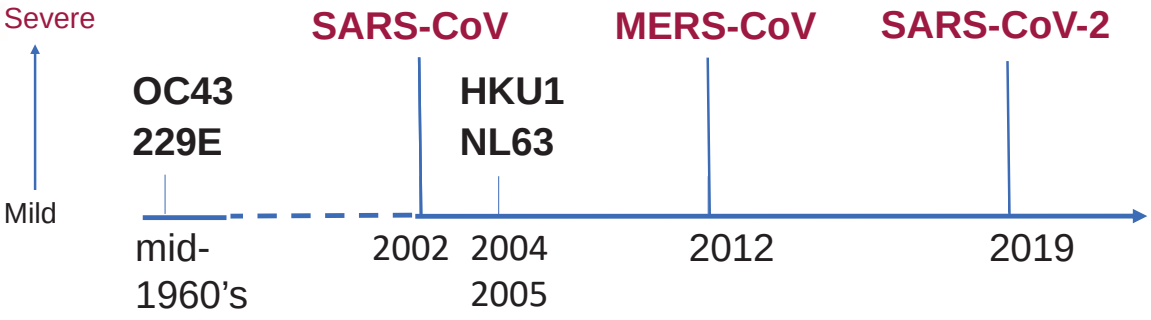
# Human Coronaviruses




**Respiratory infections**

| Common Colds | | Severe Disease Risk | | | |
|---|---|---|---|---|---|
| OC43 | | SARS | 8,000 | 774 | ~10% |
| 229E | | MERS | 2,519 | 866 | ~30% |
| HKU1 | (Pneumonia) | SARS-2 | 4,174,651 | 285,945 | ~6.8% |
| NL63 | (Croup) | | Cases | Deaths | |

https://www.niaid.nih.gov/diseases-conditions/covid-19
https://coronavirus.jhu.edu/

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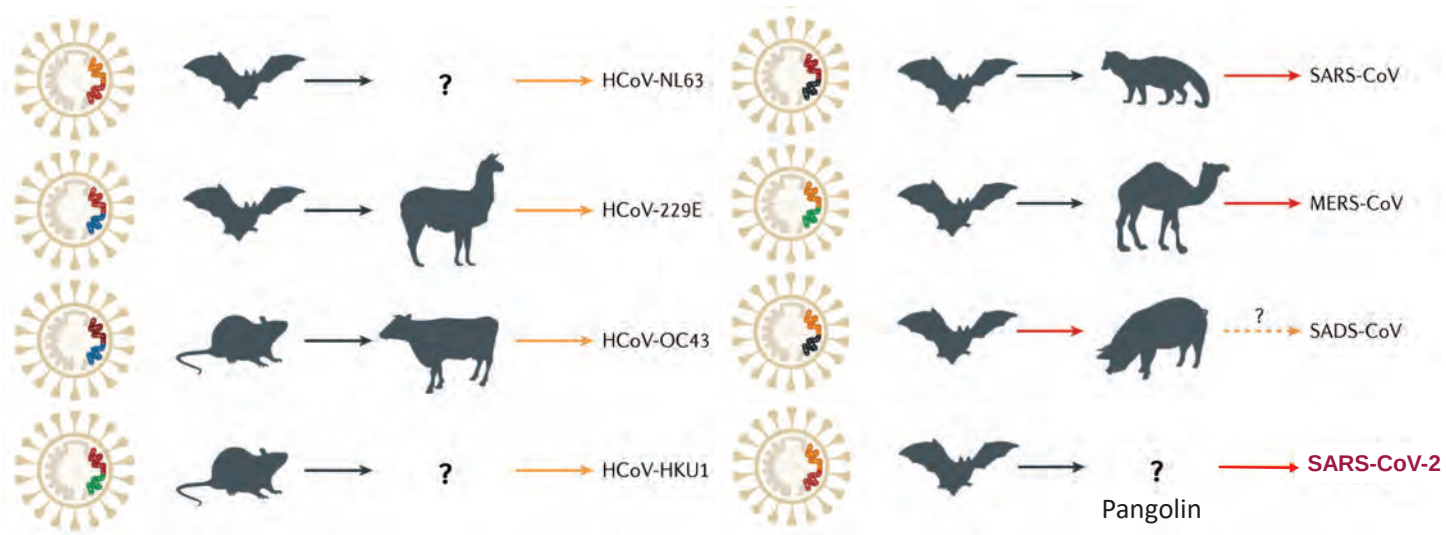
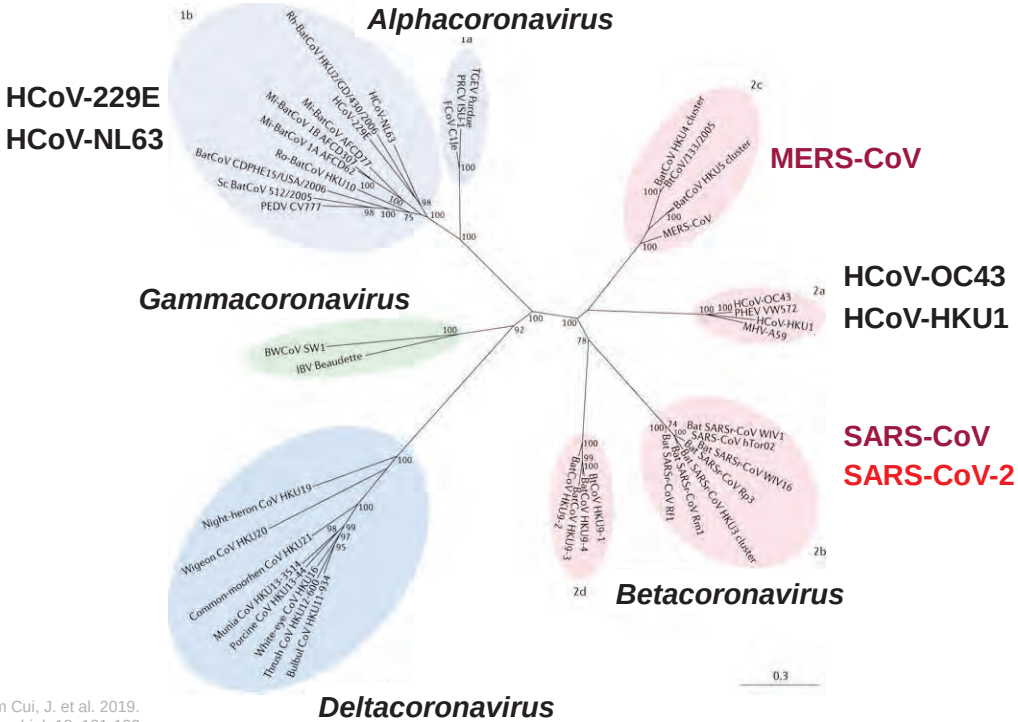
# Coronavirus emergence to infect humans




Adapted from Cui, J. et al. 2019. Nat. Rev. Microbiol. 18: 181-192

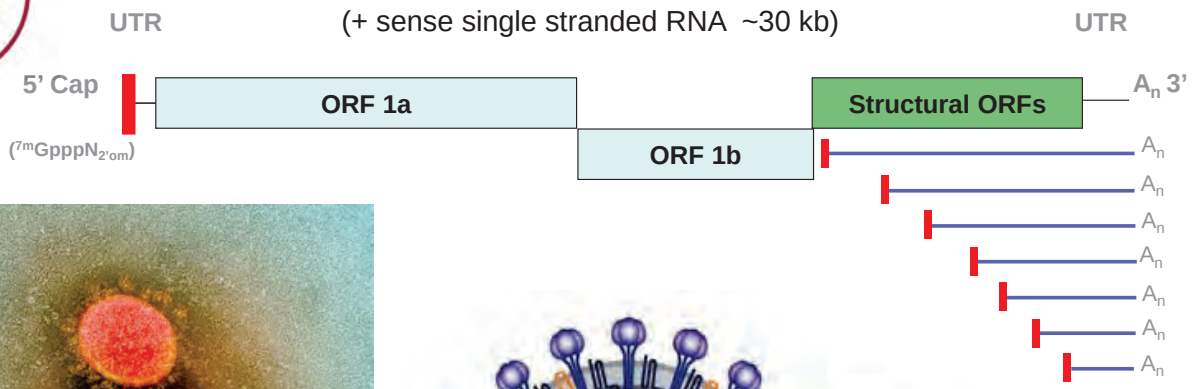


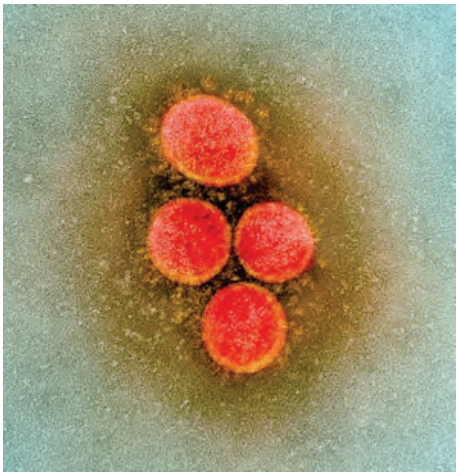
# Coronavirus phylogenetic relationships



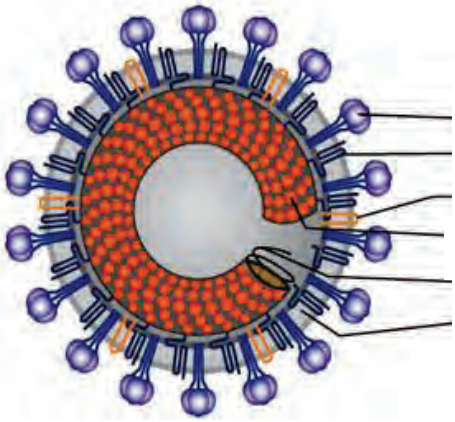

Adapted from Cui, J. et al. 2019. Nat. Rev. Microbiol. 18: 181-192

# Coronaviruses (CoVs)



(NIH NIAID-RML)

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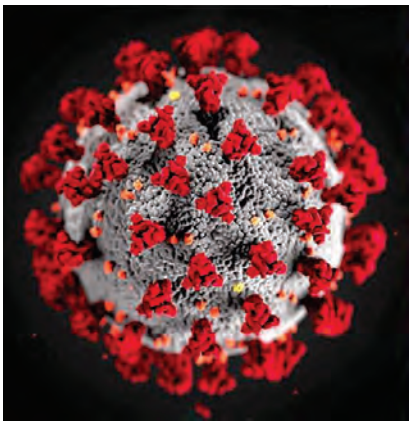
# SARS-CoV-2 Transmission



**Person-to-person spread**

- Close contact (within ~6 feet)
- Exhaled droplets (coughs, sneezing, talking)
- Aerosols
- Contaminated surfaces

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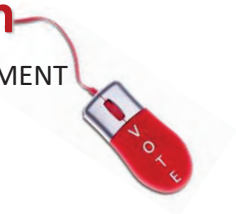
# Audience Challenge Question

ANSWER THE QUESTION ON BLUE SCREEN IN ONE MOMENT




**How does SARS-CoV-2 compare to the Measles and Influenza in regards to the average number of secondary cases from one infected individual?**

- SARS-CoV-2 is greater than the Measles
- SARS-CoV-2 and the Measles are about the same
- SARS-CoV-2 has 4-5 times more than Influenza
- Influenza has 3-4 times more than SARS-CoV-2
- SARS-CoV-2 has 2-3 times more than Influenza

** If your answer differs greatly from the choices above tell us in the chat!*

# Importance of the $R_0$

(reproduction number – average number of secondary cases from one infected individual)




Measles > SARS-CoV-2 > Influenza

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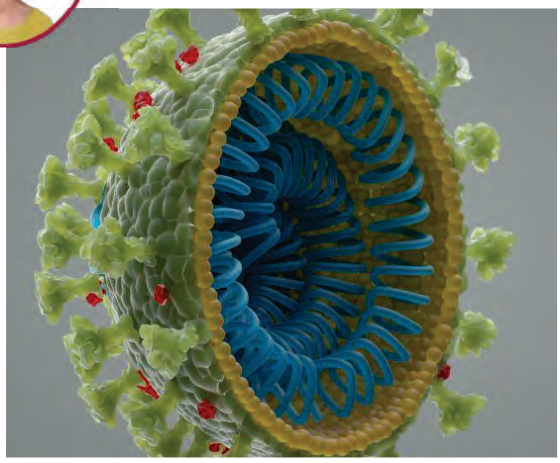
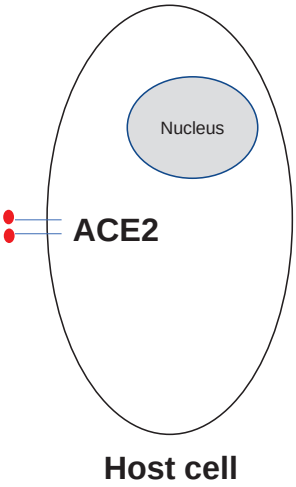
# How coronaviruses initiate infection of host cells



(Andriy Onufriyenko – Getty Image)


(Wrapp, D. 2020. Science 367:1260-1263)




**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% |

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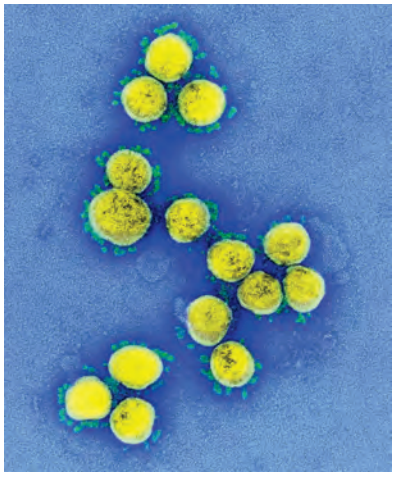
# Summary

- Coronaviruses (CoVs) are a large family of viruses that infect humans and animals.
- SARS-CoV-2 is a new member of the family, closely related to bat coronaviruses & SARS-CoV.
- SARS-CoV-2 and other human CoVs emerged from animal hosts.
- SARS-CoV-2 is transmitted primarily person-to-person.
- SARS-CoV & SARS-CoV-2 spike (S) proteins bind ACE2 for entry into cells.
- Spike (S) is the primary antibody target during infection.
- Spike is a major target for vaccine development.



(NIH NIAID-RML)

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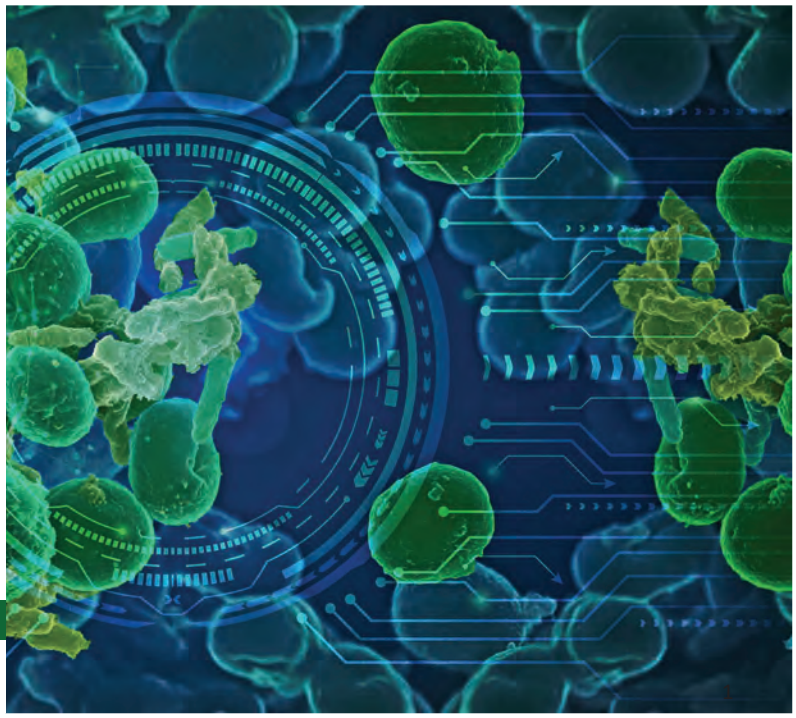
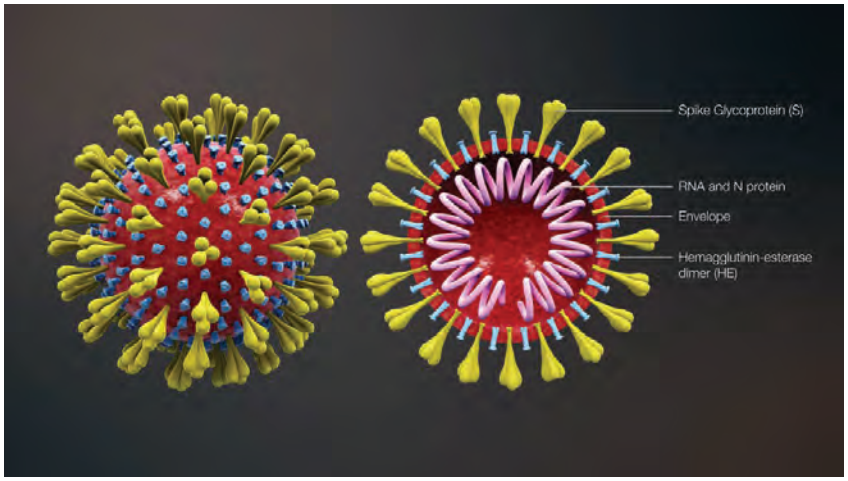
**Kristin M. Omberg, PhD**
Chemical & Biological Signatures Group
kristin.omberg@pnnl.gov

# SARS-CoV-2: Detection & Disinfection





Coronaviruses are enveloped, single-stranded RNA viruses

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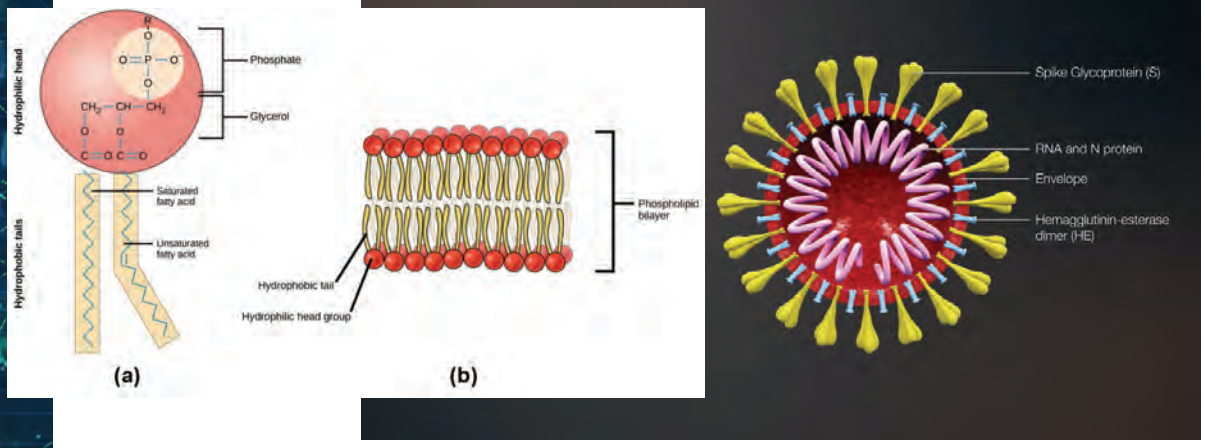


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# Viruses are commonly detected two ways

- Nucleic acid sequence
  - Whole genome sequencing
  - Polymerase chain reaction
- Proteins
  - Immunoassay
    - Enzyme-linked immunosorbent assay (ELISA)
    - Lateral flow assay
  - Agglutination

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→ Detects the virus's nucleic acid

→ Detects the host's immune response



# Viruses are commonly detected two ways

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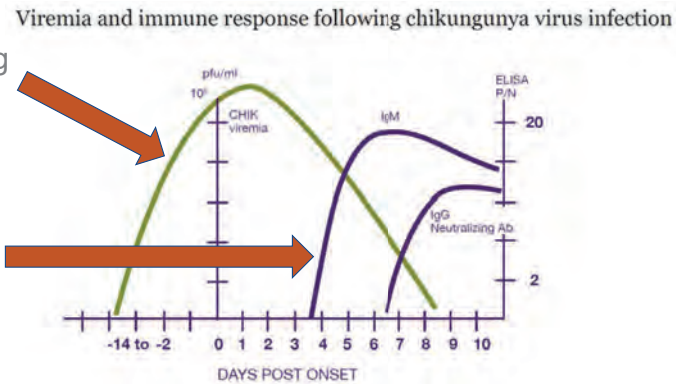
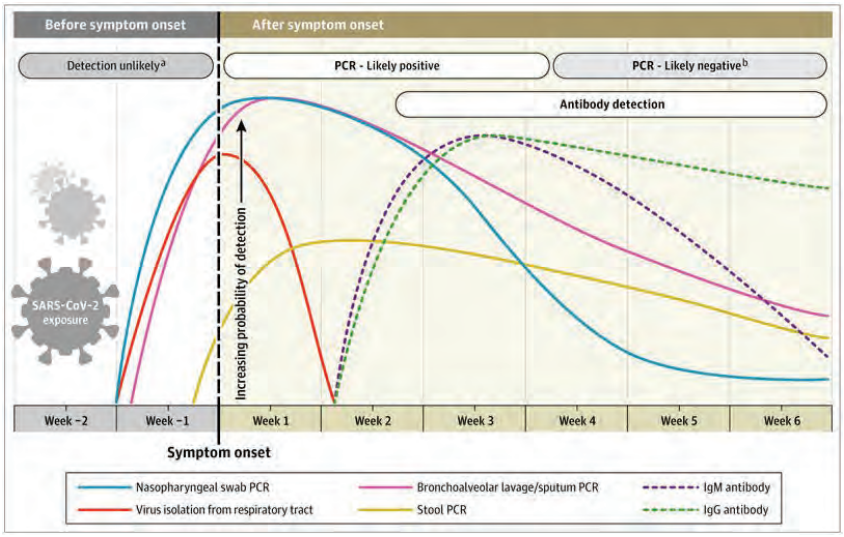



Image source: CDC, Division of Vector-Borne Diseases, Arboviral Diseases Branch

## Estimated variation in diagnostic tests for SARS-CoV-2 relative to symptom onset




Sethuraman N, Jeremiah SS, Ryo A. Interpreting Diagnostic Tests for SARS-CoV-2. *JAMA.* Published online May 06, 2020. doi:10.1001/jama.2020.8259



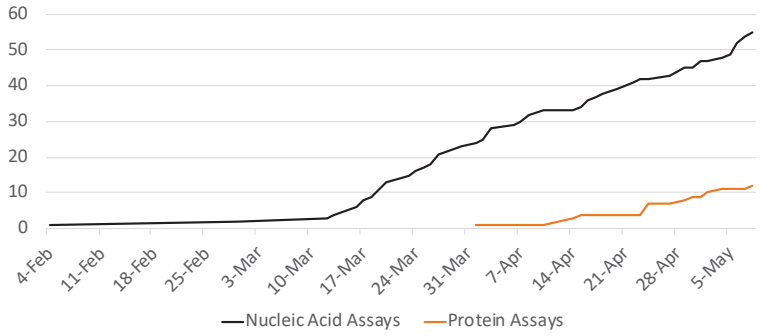
## Question for the audience?

- Since January, US public health labs have run more than _____ the number of clinical tests run in a normal influenza (flu) season.

A. half
B. 2x
C. 5x
D. 8x
E. 10x

# The number of authorized assays is growing

- February 4, 2020: First nucleic acid (PCR) assay authorized by FDA for emergency use
- April 1, 2020: First immunoassay authorized for emergency use






# ...but testing capacity lags...

Los Angeles Times

Newsletter: Coronavirus testing remains a weak spot

The Washington Post

Politics

Trump plays down coronavirus testing as U.S. falls far short of level scientists say is needed

CNN health Food Fitn

It can still be hard to get a coronavirus test -- and that's not the only problem

By Dr. Sanjay Gupta, CNN Chief Medical Correspondent

Updated 9:38 AM ET, Sun May 10, 2020

# US: >800,000 PCR tests since January 18

- US state and local public health labs report 808,000 in 6 months
- >10x number of flu tests performed by state and local public health each year

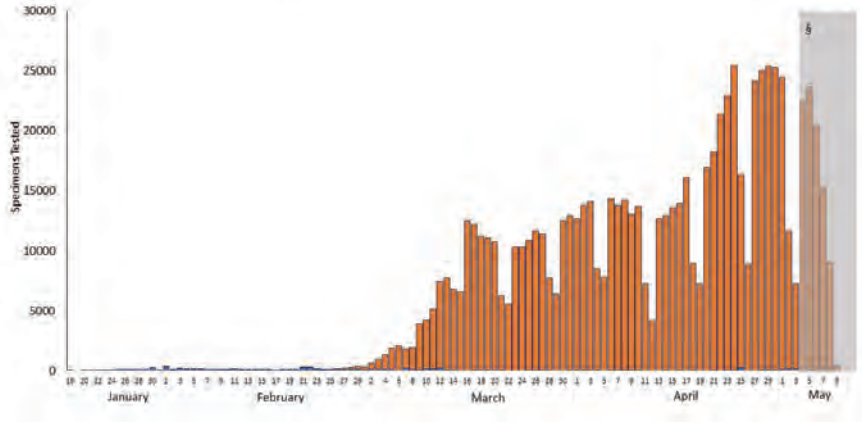



Image source: https://www.cdc.gov/coronavirus/2019-ncov/cases-updates/testing-in-us.html, May 11, 2020



CDC 2019-Novel Coronavirus (2019-nCoV)
Real-Time RT-PCR Diagnostic Panel

For Emergency Use Only

Instructions for Use

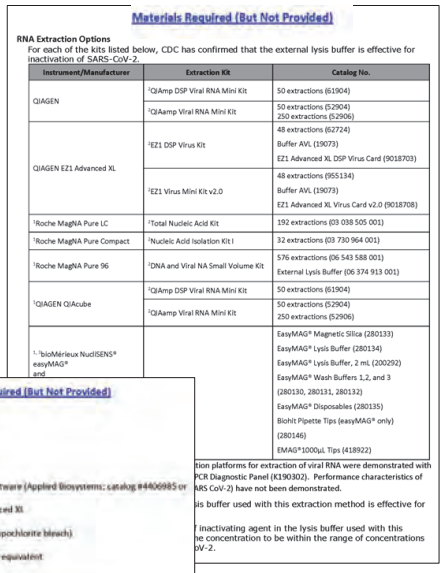
Catalog # 2019-nCoVEUA-01
1000 reactions

For *In-vitro* Diagnostic (IVD) Use

Rx Only

Centers for Disease Control and Prevention
Division of Viral Diseases
1600 Clifton Rd NE
Atlanta GA 30329

CDC



**Materials Required (But Not Provided)**

RNA Extraction Options
For each of the kits listed below, CDC has confirmed that the external lysis buffer is effective for inactivation of SARS-CoV-2.

| Instrument/Manufacturer | Extraction Kit | Catalog No. |
|---|---|---|
| QIAGEN | [1]QIAmp DSP Viral RNA Mini Kit | 50 extractions (61904) |
| | [2]QIAamp Viral RNA Mini Kit | 50 extractions (52904)<br>250 extractions (52906) |
| QIAGEN EZ1 Advanced XL | [1]EZ1 DSP Virus Kit | 48 extractions (62724)<br>Buffer AVL (19073)<br>EZ1 Advanced XL DSP Virus Card (9018703) |
| | [1]EZ1 Virus Mini Kit v2.0 | 48 extractions (955134)<br>Buffer AVL (19073)<br>EZ1 Advanced XL Virus Card v2.0 (9018708) |
| [1]Roche MagNA Pure LC | [2]Total Nucleic Acid Kit | 192 extractions (03 038 505 001) |
| [1]Roche MagNA Pure Compact | [2]Nucleic Acid Isolation Kit I | 32 extractions (03 730 964 001) |
| [1]Roche MagNA Pure 96 | [2]DNA and Viral NA Small Volume Kit | 576 extractions (06 543 588 001)<br>External Lysis Buffer (06 374 913 001) |
| [1]QIAGEN QIAcube | [1]QIAmp DSP Viral RNA Mini Kit | 50 extractions (61904) |
| | [2]QIAamp Viral RNA Mini Kit | 50 extractions (52904)<br>250 extractions (52906) |
| [1, 2]bioMérieux NucliSENS® easyMAG® and | | EasyMAG® Magnetic Silica (280133)<br>EasyMAG® Lysis Buffer (280134)<br>EasyMAG® Lysis Buffer, 2 mL (200292)<br>EasyMAG® Wash Buffers 1,2, and 3 (280130, 280131, 280132)<br>EasyMAG® Disposables (280135)<br>BioHit Pipette Tips (easyMAG® only) (280146)<br>EMAG®1000µL Tips (418922) |

tion platforms for extraction of viral RNA were demonstrated with PCR Diagnostic Panel (K190302). Performance characteristics of ARS CoV-2) have not been demonstrated.

is buffer used with this extraction method is effective for

inactivating agent in the lysis buffer used with this he concentration to be within the range of concentrations oV-2.

**Equipment and Consumables Required (But Not Provided)**

- Vortex mixer
- Microcentrifuge
- Micropipettes (2 or 10 µL, 200 µL and 1000 µL)
- Multichannel micropipettes (5-50 µl)
- Racks for 1.5 mL microcentrifuge tubes
- 2 x 96-well -20°C cold blocks
- 7500 Fast Dx Real-Time PCR Systems with SDS 1.4 software (Applied Biosystems; catalog #4406985 or #4406984)
- Extraction systems (instruments): QIAGEN EZ1 Advanced XL
- Molecular grade water, nuclease-free
- 10% bleach (1:10 dilution of commercial 5.25-6.0% hypochlorite bleach)
- DNAZap™ (Ambion, cat. #AM9890) or equivalent
- RNAse AwayTM (Fisher Scientific; cat. #21-236-21) or equivalent
- Disposable powder-free gloves and surgical gowns
- Aerosol barrier pipette tips
- 1.5 mL microcentrifuge tubes (DNase/RNase free)
- 0.2 mL PCR reaction plates (Applied Biosystems; catalog #4346906 or #4366932)
- MicroAmp Optical 8-cap Strips (Applied Biosystems; catalog #4323032)

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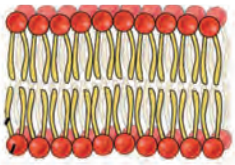

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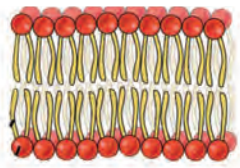

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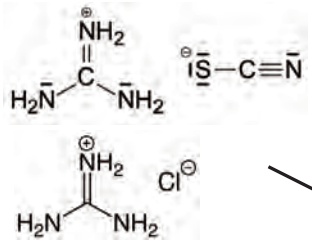





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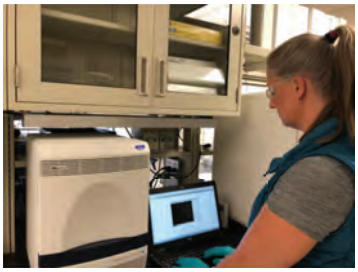
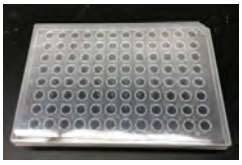
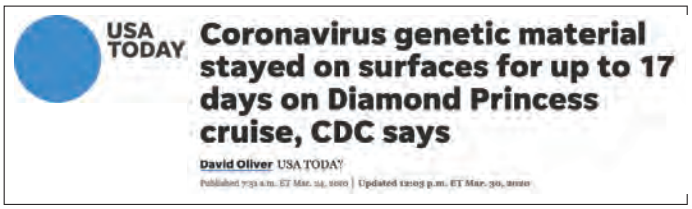
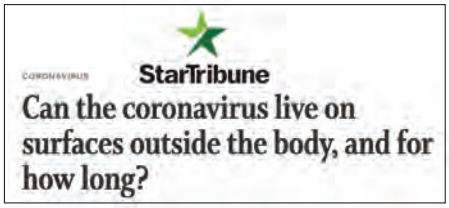


# Persistence & Disinfection



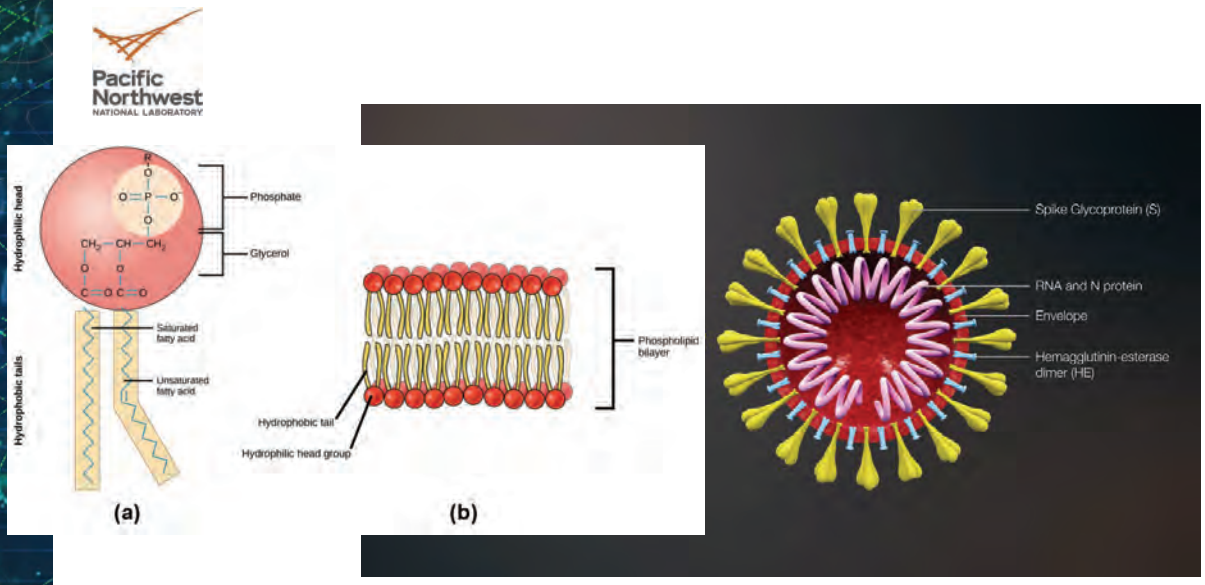


- Presence of nucleic acid ≠ presence of infectious virus
- Detection of infectious virus requires culture at BSL-3



# Question for the audience

- True or False: enveloped viruses are harder to inactivate than non-enveloped viruses.
  - True
  - False

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# How long does SARS-CoV-2 persist on surfaces?

- Viral persistence dependent upon
  - Temperature
  - Relative humidity
  - Ultraviolet light
  - Surface (e.g., stainless steel, plastic, wood)
  - Deposition liquid (e.g., saliva, mucus)

# How long does SARS-CoV-2 persist on surfaces?

- Viral persistence dependent upon
  - Temperature
    - ↑ temperature = ↓ viability
  - Relative humidity
    - ↑ relative humidity = ↓ viability
  - Ultraviolet light
    - ↑ UV = ↓ viability
  - Surface (e.g., stainless steel, plastic, wood)
    - No significant difference between stainless and plastic
  - Deposition liquid (e.g., saliva, mucous)

- Half-lives of hours, consistent with other enveloped viruses



# Disinfection

- 70% ethanol (hand sanitizer, 2 min contact): >99%
- 70% isopropyl alcohol (alcohol prep pads, 30 sec contact): >96%
- 1:20 household bleach (30 sec – 5 min contact): >96%

- Hydrogen peroxide, Lysol spray, peracetic acid, acidified bleach, quaternary ammonium cleaner (commonly used in hospital settings) under evaluation

- Updated periodically at https://www.dhs.gov/publication/st-master-question-list-covid-19

- Soap is harder to evaluate in a controlled study
- Wash your hands anyway!

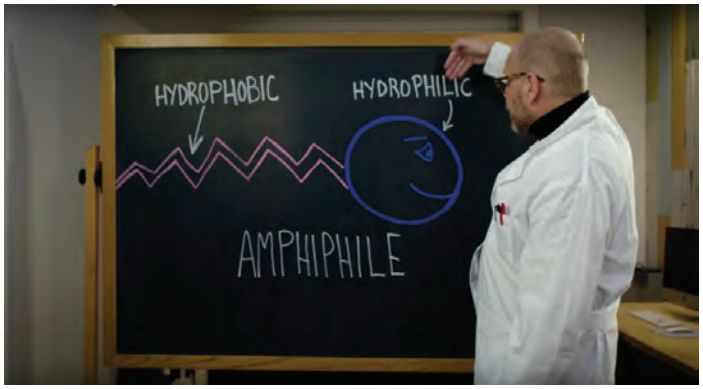


Image source: Alton Brown's YouTube Channel



# Thank you

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- A review of past outbreaks with focus on lessons learned
- How drug discovery can affect the process and timelines for discovering vaccines

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**Moderator:** Laura Cassiday, American Chemical Society

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- What types of fabrics and household cloth are effective in particle filtration and why
- The basics of particle filtration and data on filtration efficiencies as a function of size for common fabrics that are used in cloth masks
- How to disinfect N95 masks and how many times you can do it without reducing filtration efficiency

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- How the raw materials and processes influence the clarity of beer
- What is the technological approach to ensuring the desired clarity every time

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