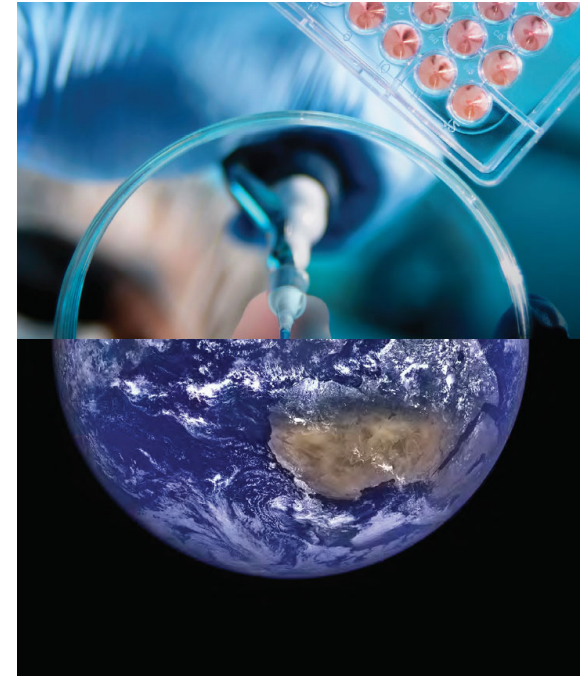
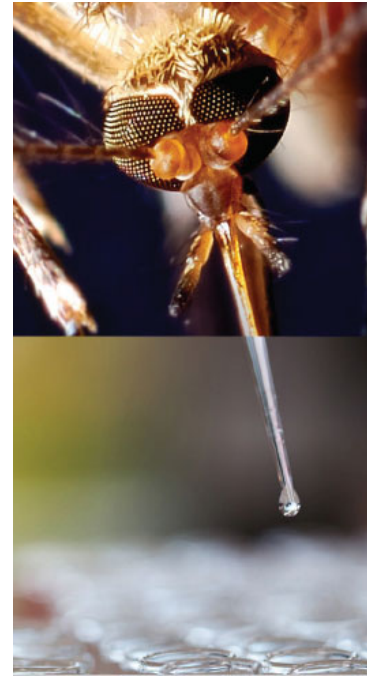
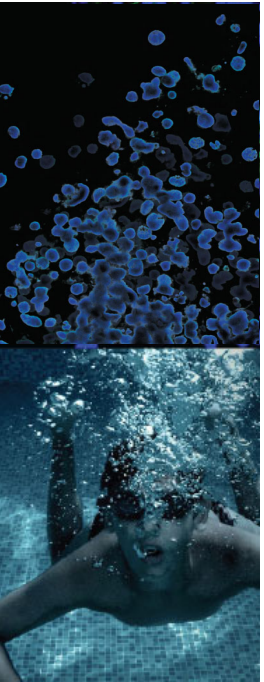




Understanding COVID-19: A Global Pandemic

Britany Tang, BS
Microbiologist, ATCC

Credible Leads to Incredible™

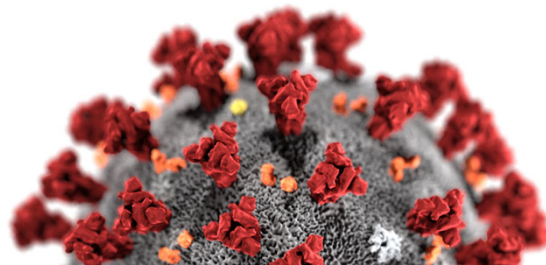
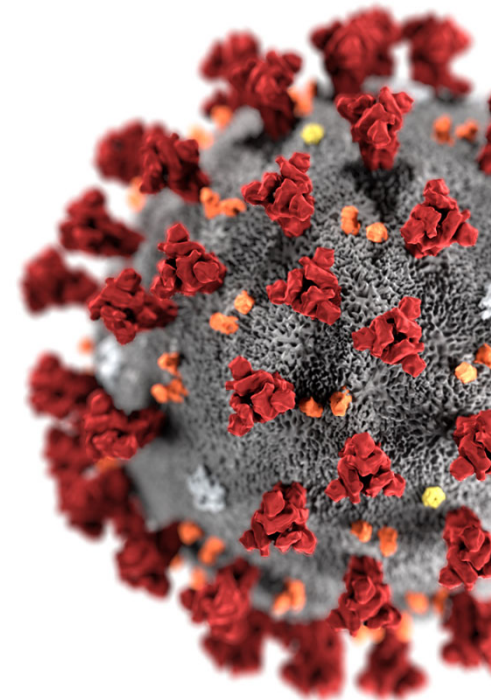
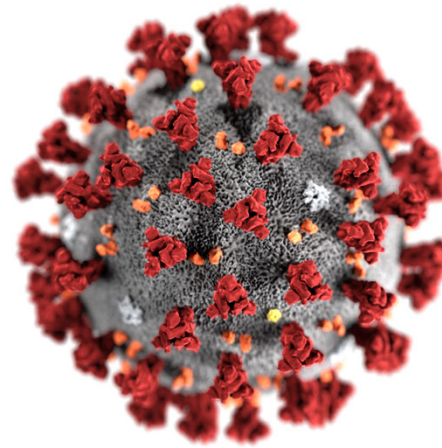
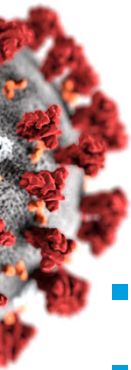


About ATCC

- Founded in 1925, ATCC is a non-profit organization with HQ in Manassas, VA, and an R&D and Services center in Gaithersburg, MD
- World's largest, most diverse biological materials and information resource for microbes – the “*gold standard*”
- Innovative R&D company featuring gene editing, microbiome, NGS, advanced models
- cGMP biorepository
- Partner with government, industry, and academia
- Leading global supplier of authenticated cell lines, viral and microbial standards
- Sales and distribution in 150 countries, 19 international distributors
- Talented team of 450+ employees, over one-third with advanced degrees

Agenda

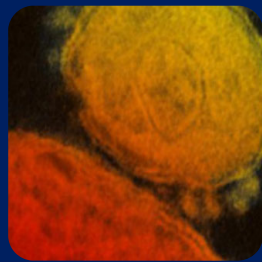
- What is COVID-19 and SARS-CoV-2?
- What are coronaviruses?
- Diagnostics
- Vaccines
- Therapeutics
- ATCC solutions



Major areas in scientific research to combat the pandemic



**Understanding the disease
(COVID-19)**



**Understanding the infectious
agent (SARS-CoV-2)**



Diagnostics

Detection & Surveillance



**Development of
Prophylactics**

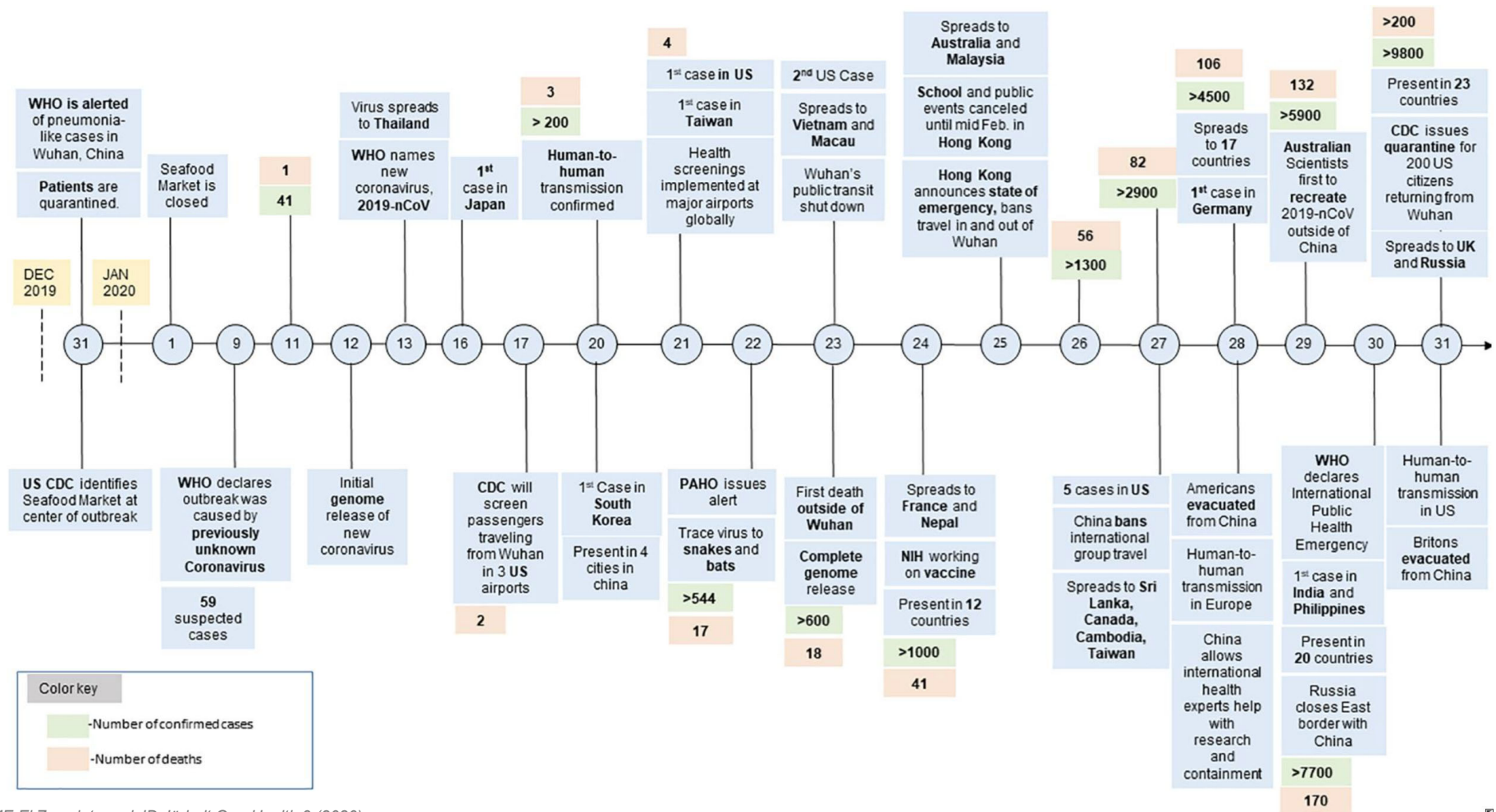
Vaccines



**Development of
Therapeutics**

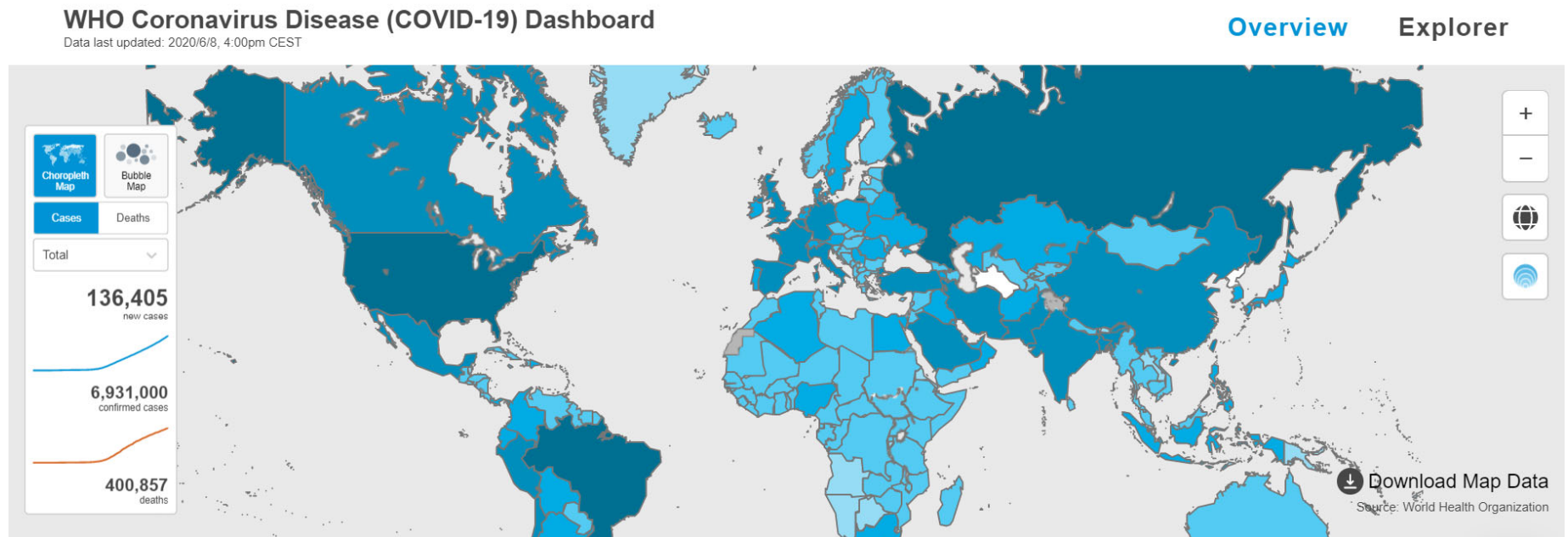
Antiviral drugs

COVID-19 timeline



Epidemiology

- There are 215 countries, areas, or territories with cases
- More than 6.9 million cases of COVID-19 and 400,000 deaths have been reported to WHO

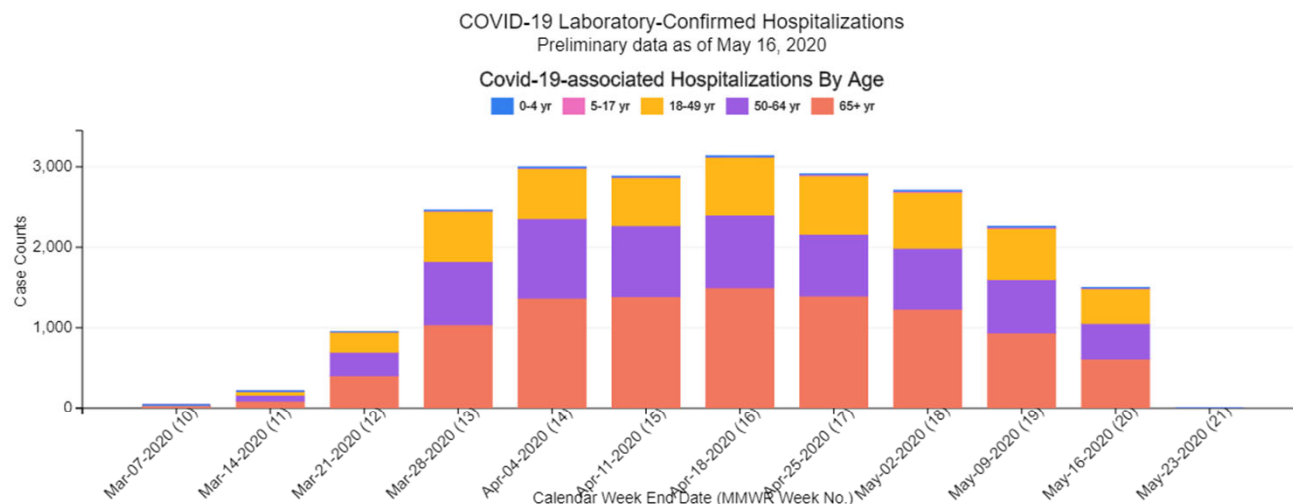


Globally, as of **4:00pm CEST, 8 June 2020**, there have been **6,931,000 confirmed cases** of COVID-19, including **400,857 deaths**, reported to WHO.



Epidemiology

Risk factors: age groups



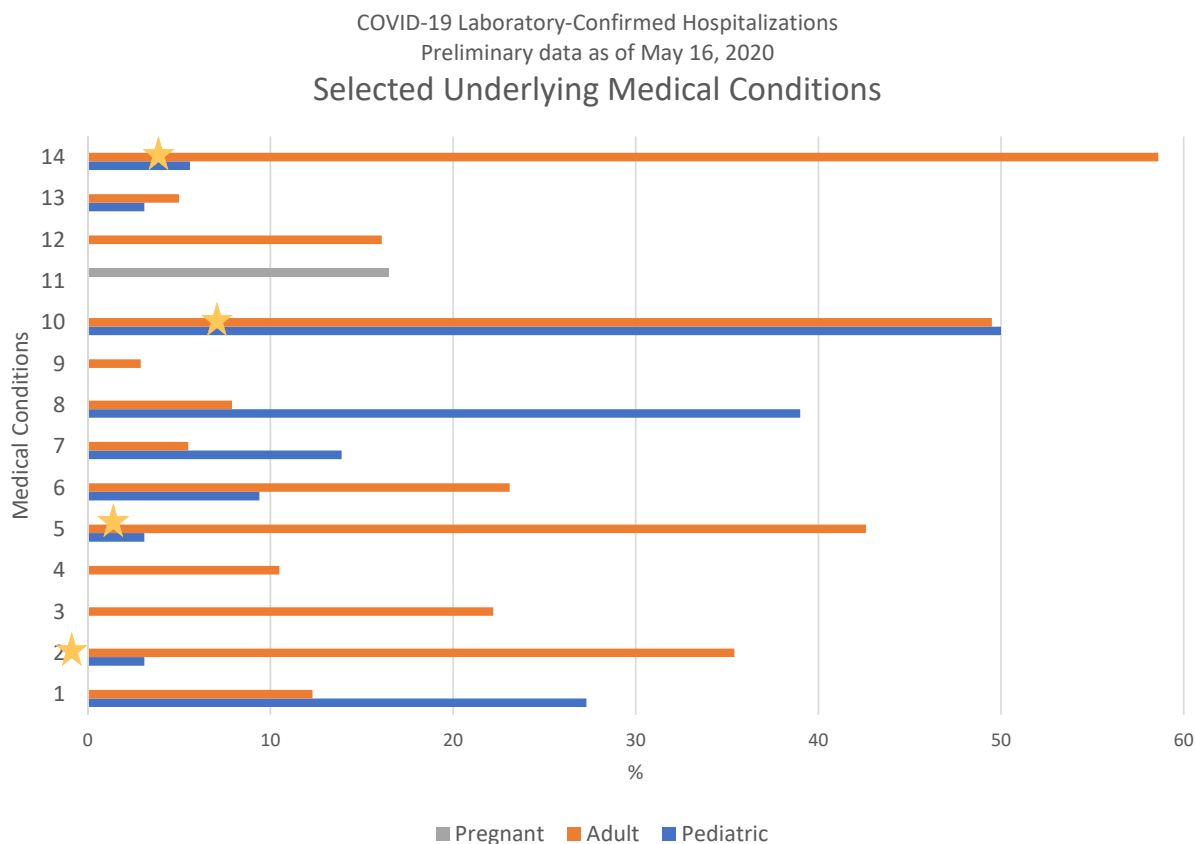
People of any age can be affected by COVID-19; however, **older adults** (65 years +) might be at higher risk for severe illness from COVID-19.

Age	0-4 yr	5-17 yr	18-49 yr	50-64 yr	65+ yr	Total
2020	68	91	5356	6561	9984	22060

The Coronavirus Disease 2019 (COVID-19)-Associated Hospitalization Surveillance Network (COVID-NET) hospitalization data are preliminary and subject to change as more data become available. In particular, case counts and rates for recent hospital admissions are subject to lag. As data are received each week, prior case counts and rates are updated accordingly.

Epidemiology

Risk factors: selected underlying medical conditions



Based on the current information available and clinical expertise, **people of any age who have serious underlying medical conditions** like heart disease, lung disease, or diabetes might be at higher risk for severe illness from COVID-19.

COVID-19

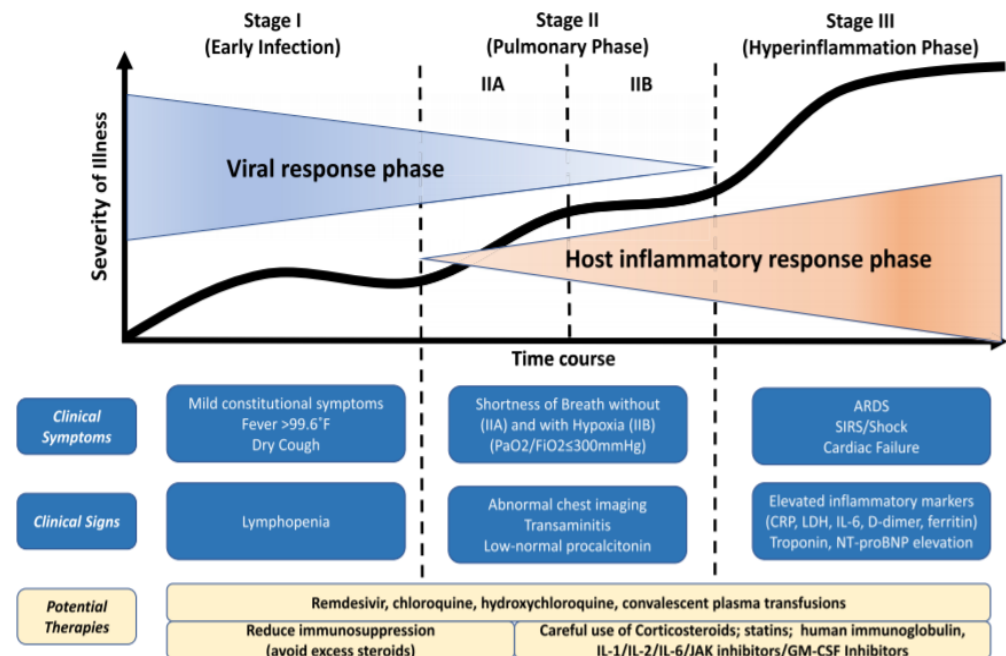
Pathogenesis & clinical manifestations

Symptoms appear 2 to 14 days after exposure

- Range from mild to severe illness with either of the following accompanying symptoms:
 - Flu or fever-like symptoms
 - Muscle pain
 - Shortness of breath or difficulty breathing
 - Temporary loss of taste or smell

Based on various risk factors, symptoms can progress to:

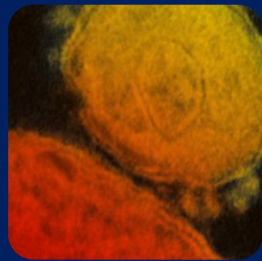
- Developing pneumonia in both lungs
- Extrapulmonary systemic hyperinflammation syndrome
- Acute respiratory distress syndrome (ARDS)



Major areas in scientific research to combat the pandemic



**Understanding the disease
(COVID-19)**



**Understanding the infectious
agent (SARS-CoV-2)**



Diagnostics

Detection & Surveillance



**Development of
Prophylactics**

Vaccines



**Development of
Therapeutics**

Antiviral drugs

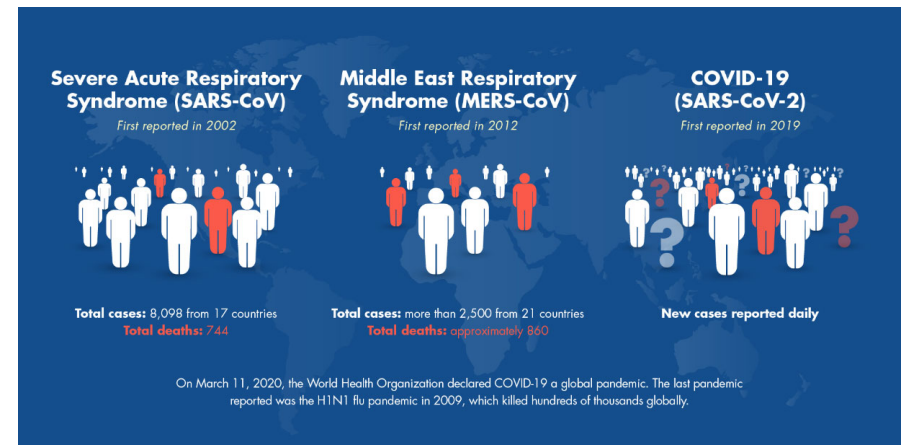
What do we know about Coronaviruses?



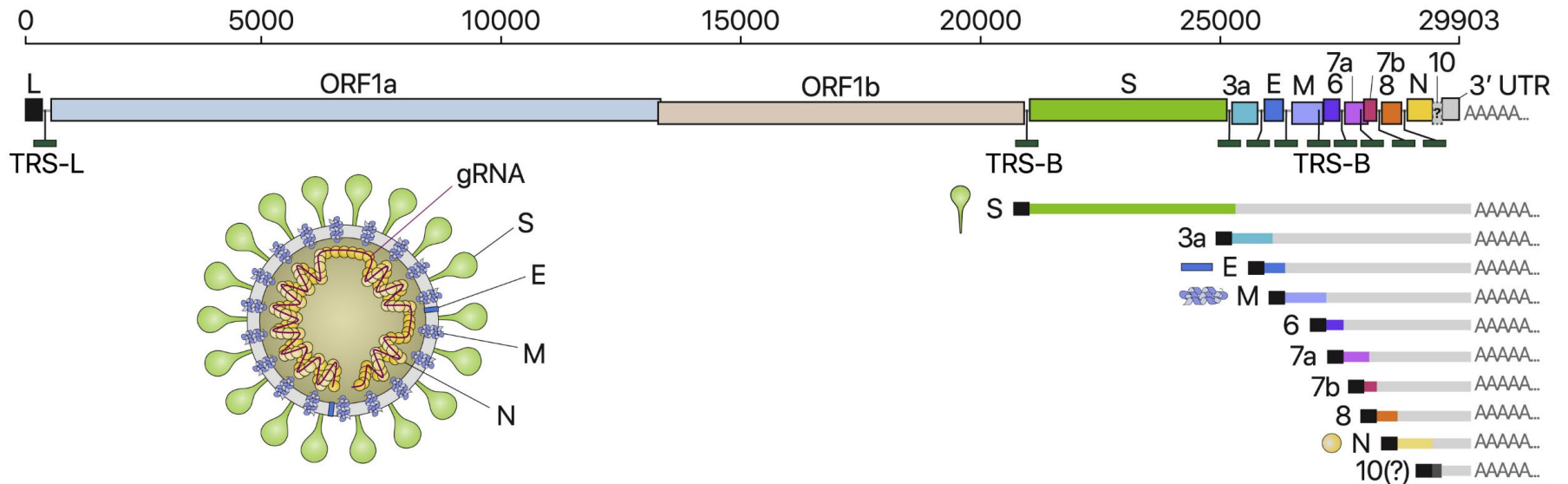
- Coronaviruses (CoVs) are **large, enveloped RNA viruses of both medical and veterinary importance.**
- These viruses cause a variety of diseases, including respiratory disease, enteric disease, neurological illness, and hepatitis.
- Zoonosis:
 - These viruses are described in various wildlife species such as swine, cattle, horses, camels, cats, and dogs. Many coronavirus infections are subclinical.
 - In humans, coronaviruses are included in the spectrum of viruses that cause the common cold.
 - Alphacoronaviruses (229E and NL63)
 - Betacoronaviruses (OC43 and HKU1)

Recent history of Coronavirus epidemics

- During the past two decades, three zoonotic coronaviruses have been identified as the cause of large-scale disease outbreaks:
 - Severe Acute Respiratory Syndrome (SARS)
 - Middle East Respiratory Syndrome (MERS)
 - Swine Acute Diarrhea Syndrome (SADS)
- SARS and MERS emerged in 2003 and 2012, respectively, and caused worldwide pandemics that claimed thousands of human lives while SADS struck the swine industry in 2017.
- Common characteristics of these viruses:
 - Highly pathogenic to humans or livestock
 - They originated in bats
- It is highly likely that future SARS- or MERS-like coronavirus outbreaks will originate in bats.



Coronavirus genome biology



Coronaviruses are enveloped, positive-sense RNA viruses that are characterized by three main features:

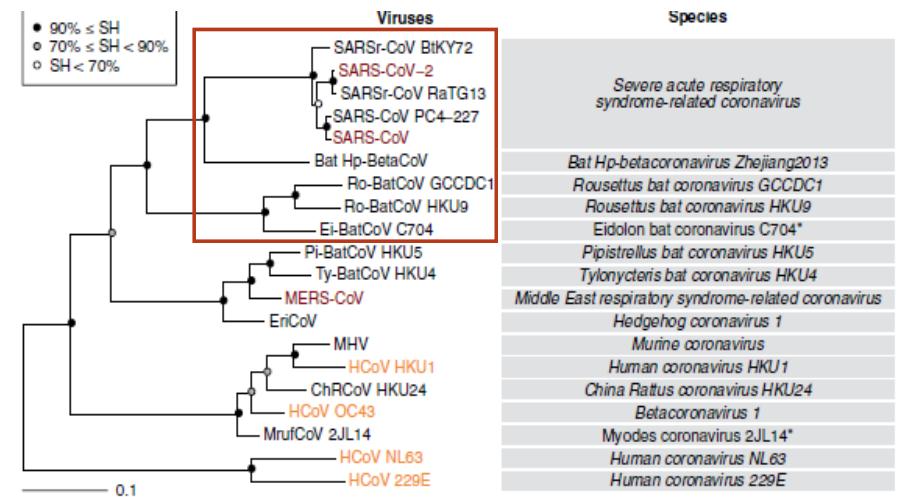
Club-like spikes that project from their surface

An unusually large RNA genome

Unique replication strategy

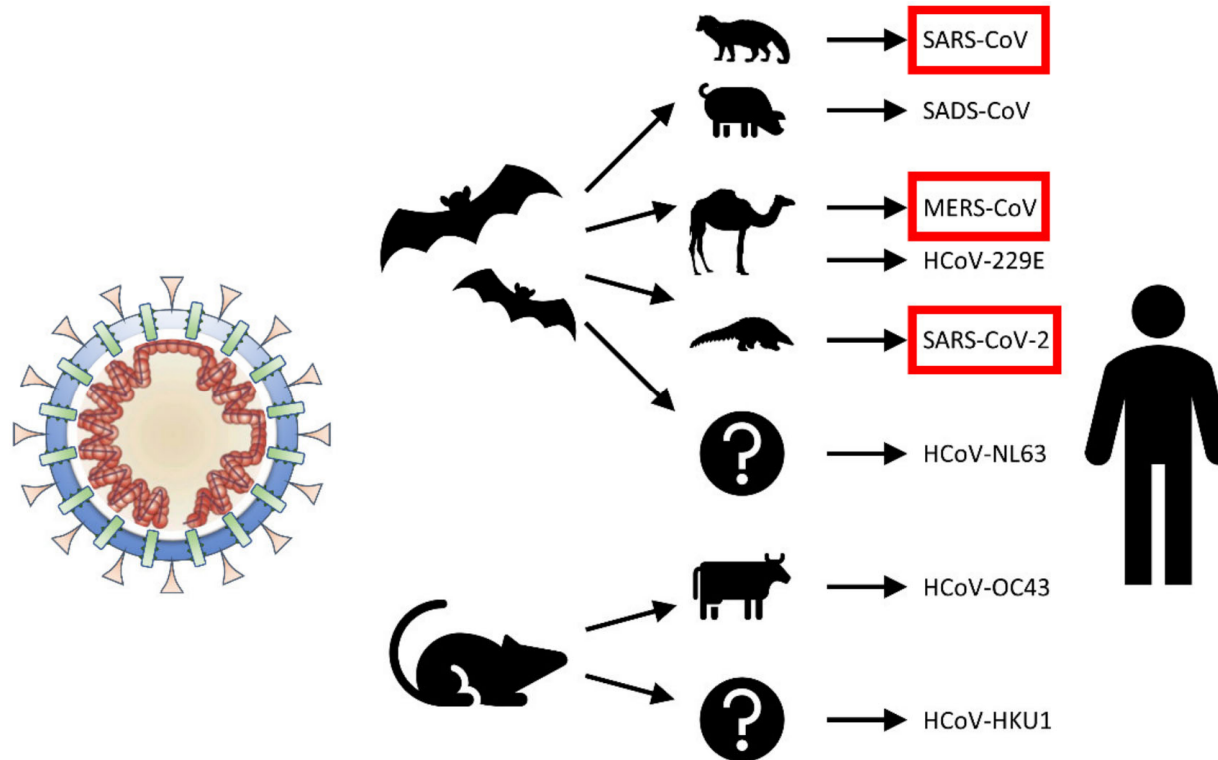
Phylogeny

Category	Coronaviruses	Humans	Divergence
Realm	<i>Riboviria</i>		●
Order	<i>Nidovirales</i>	Primates	●
Suborder	<i>Comidovirineae</i>		●
Family	<i>Coronaviridae</i>	Hominidae	●
Subfamily	<i>Orthocoronavirinae</i>	Homininae	●
Genus	<i>Betacoronavirus</i>	<i>Homo</i>	●
Subgenus	<i>Sarbecovirus</i>		●
Species	<i>Severe acute respiratory syndrome-related coronavirus</i>	<i>Homo sapiens</i>	●
Individuum	SARS-CoV Urbani, SARS-CoV VGZ-02, Bat SARS CoV RH1/2004, Civet SARS CoV SZ3/2003, SARS-CoV PC4-227, SARSr-CoV BtKY72, SARS-CoV-2 Wuhan-Hu-1, SARSr-CoV RatG13, and so on.	Dmitri Ivanovsky, Martinus Beijerinck, Friedrich Loeffler, Barbara McClintock, Marie Curie, Albert Einstein, Rosalind Franklin, Hideki Yukawa, and so on.	●



SARS-CoV-2 is more closely related to bat-related betacoronaviruses of the sub-genus Sarbecovirus.

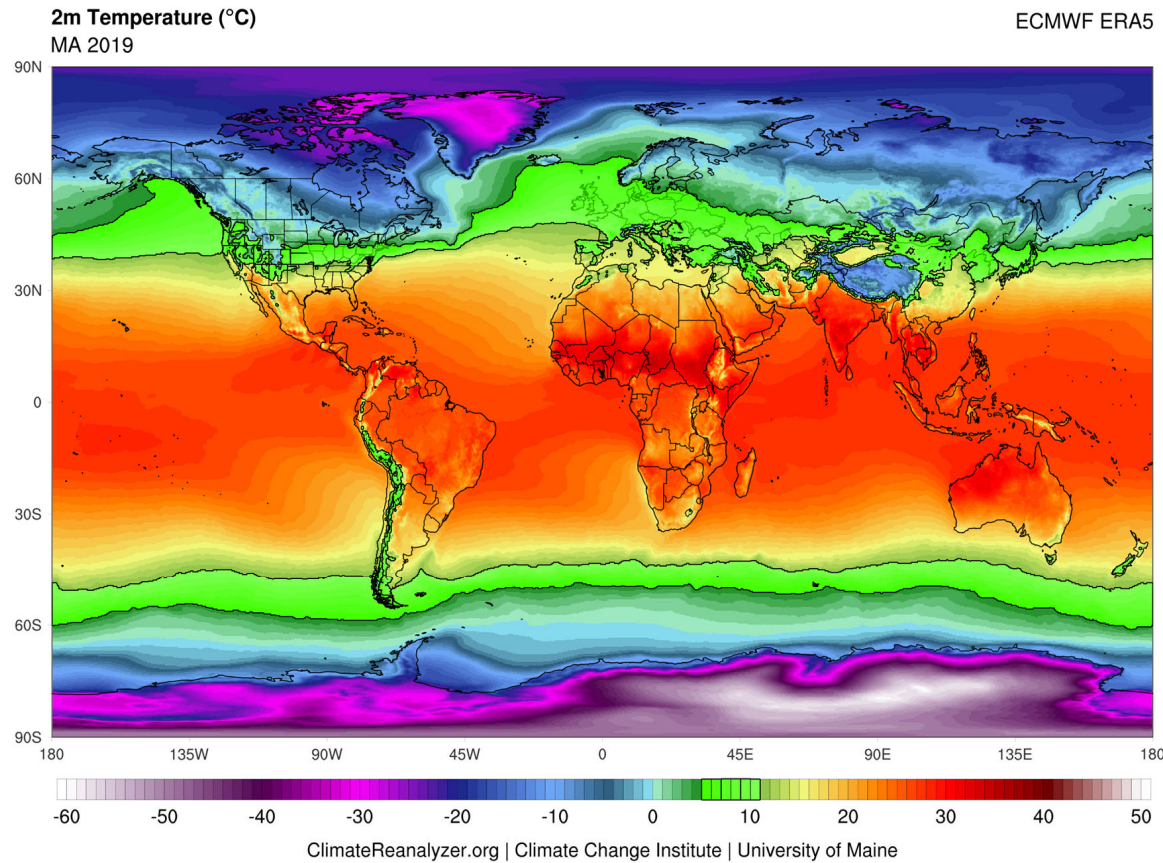
Host range



Proposed host reservoir: bats

Possibilities of intermediate hosts: Bamboo rats, pangolins, snakes, and others?

Seasonality



This map reflects the average temperature data from March-April 2019 and was developed to predict the areas that are at risk for community transmission of COVID-19. Zones at the highest risk are within the green bands.

Given the consistent seasonal variation of the four endemic coronaviruses (229E, HKU1, NL63, and OC43), SARS-CoV-2 may be affected by the following factors:

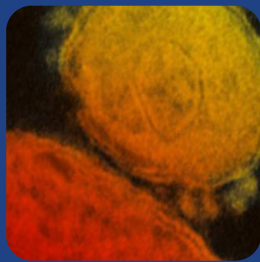
- Climate
- Humidity
- Presence of UV light

Image from Climate Reanalyzer, Climate Change Institute, University of Maine, USA. Image manipulation by Cameron Gutierrez and Glenn Jameson.
Z Sun, et al. *International Journal of Environmental Research and Public Health* 17(5): 1633, 2020
SM Kissler, et al. *Science*, 2020.

Major areas in scientific research to combat the pandemic



**Understanding the disease
(COVID-19)**



**Understanding the infectious
agent (SARS-CoV-2)**



Diagnostics

Detection & Surveillance



**Development of
Prophylactics**

Vaccines



**Development of
Therapeutics**

Antiviral drugs

Current methods for detection & surveillance

Molecular and serological/immunological assays

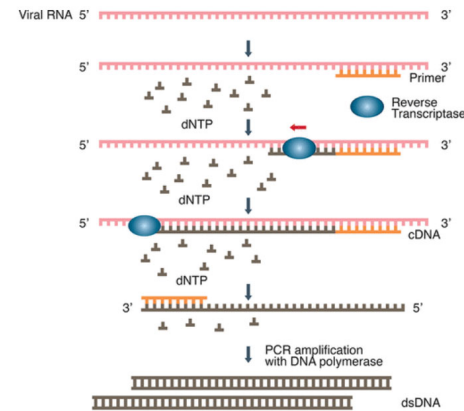
Molecular-based assays

- Reverse transcription-polymerase chain reaction (RT-PCR)
- Isothermal nucleic acid amplification
- Reverse transcription loop-mediated isothermal amplification (RT-LAMP)
- Transcription-mediated amplification (TMA)
- CRISPR/cas9-based assays
- Rolling circle amplification
- Nucleic acid hybridization using microarray
- Amplicon-based metagenomic sequencing

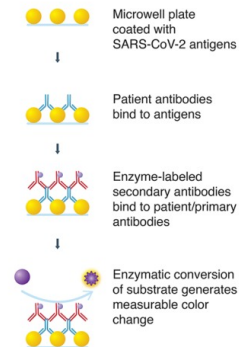


Serological & immunological assays

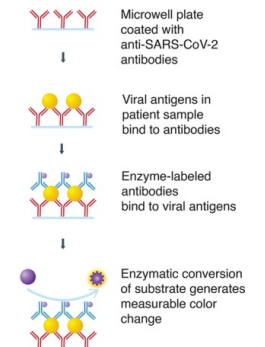
- Enzyme-linked immunosorbent assay (ELISA)
- Lateral flow immunoassays
- Rapid antigen test
- Neutralization assay
- Luminescent immunoassay
- Biosensor test



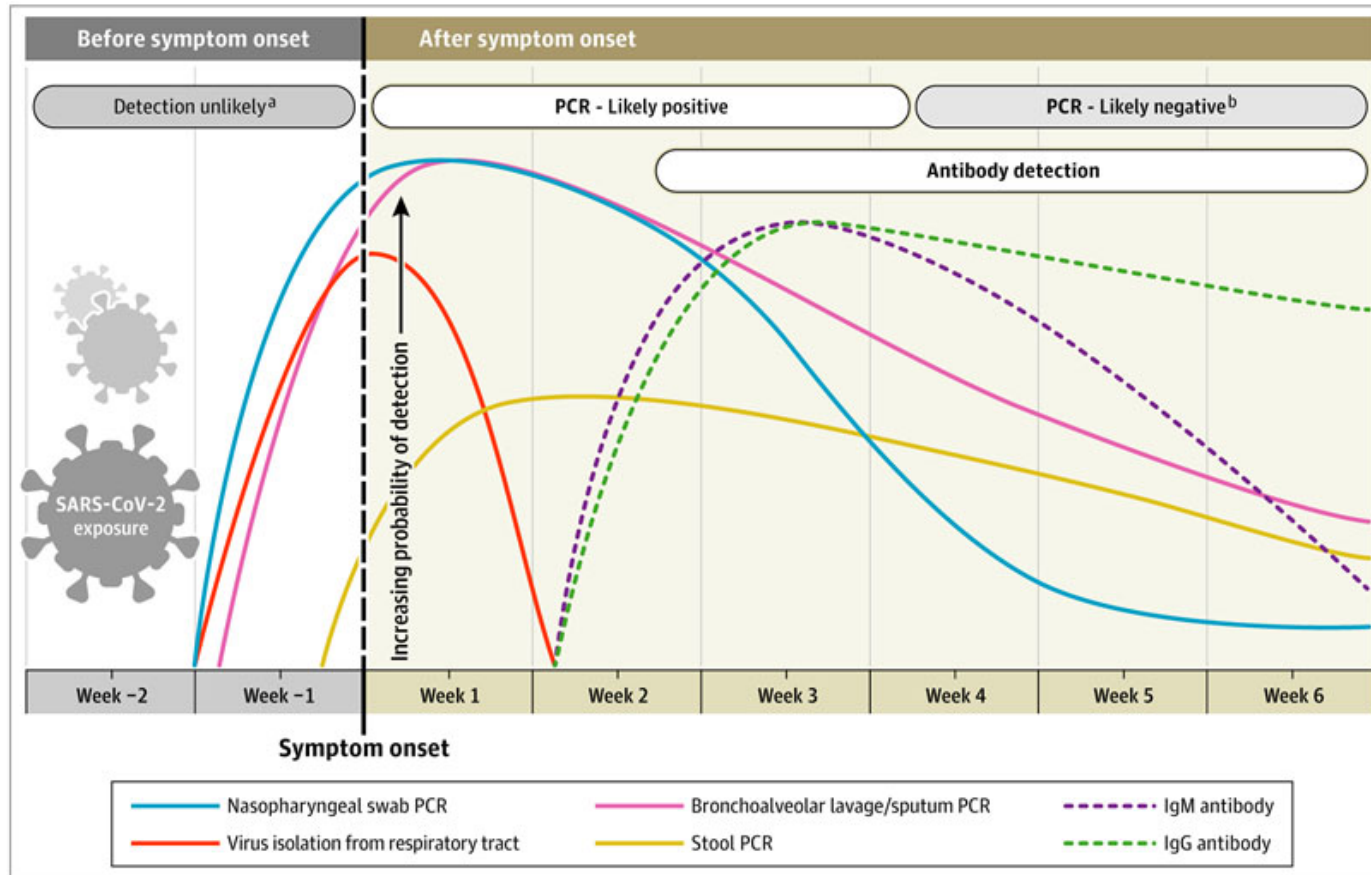
A Indirect ELISA for detecting anti-SARS-CoV-2 antibodies



B Sandwich ELISA for detecting SARS-CoV-2 antigens



Variation in diagnostic tests relative to symptom onset



Diagnostics

Molecular and immunological assays and targets

A majority of PCR-based assays target the ORF1ab, RNA-dependent RNA polymerase (RdRp), E, N, and spike regions. Currently authorized serological tests for SARS-CoV-2 measure IgM and/or IgG antibodies, total antibodies, or the spike protein.

■ FDA:

<https://www.fda.gov/medical-devices/emergency-situations-medical-devices/emergency-use-authorizations#covid19ivd>

■ CDC:

<https://www.cdc.gov/coronavirus/2019-ncov/lab/rt-pcr-panel-primer-probes.html>

■ FIND:

<https://www.finddx.org/covid-19/pipeline/>

■ WHO:

<https://www.who.int/who-documents-detail/molecular-assays-to-diagnose-covid-19-summary-table-of-available-protocols>

Institute	Gene targets
China CDC, China	ORF1ab and N
Institut Pasteur, Paris, France	Two targets in RdRP
US CDC, USA	Three targets in N gene
National Institute of Infectious Diseases, Japan	Pancorona and multiple targets, Spike protein
Charité, Germany	RdRP, E, N
HKU, Hong Kong SAR	ORF1b-nsp14, N
National Institute of Health, Thailand	N

Diagnosics

Validation methods & ATCC solutions



Limit of detection/ Analytical sensitivity



Cross-reactivity/Analytical specificity



Clinical evaluation/ Agreement

SARS-CoV-2
Reference Materials

SARS-CoV-2 Synthetic
Molecular Standards

Materials for
Inclusivity Testing

Materials for Exclusivity
[Specificity] Testing

Policy for COVID-2019 tests

Introduction

Contains Nonbinding Recommendations

Policy for Coronavirus Disease-2019 Tests During the Public Health Emergency (Revised)

Immediately in Effect Guidance for Clinical Laboratories, Commercial Manufacturers, and Food and Drug Administration Staff

Document issued on the web on May 11, 2020.

This document supersedes “Policy for Diagnostic Tests for Coronavirus Disease-2019 during the Public Health Emergency: Immediately in Effect Guidance for Clinical Laboratories, Commercial Manufacturers, and Food and Drug Administration Staff” issued May 4, 2020.

- Limit of Detection/Analytical Sensitivity
- Cross-reactivity/Analytical Specificity
- Microbial Interference
- Clinical Agreement Study

Policy for COVID-2019 tests

LOD/analytical sensitivity



Contains Nonbinding Recommendations

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- **Limit of Detection/Analytical Sensitivity**
- Cross-reactivity/Analytical Specificity
- Microbial Interference
- Clinical Agreement Study

(1) Limit of Detection

FDA recommends that developers document the limit of detection (7) of their SARS-CoV-2 assay. FDA generally does not have concerns with spiking RNA or inactivated virus into artificial or real clinical matrix (e.g., Bronchoalveolar lavage [BAL] fluid, sputum, etc.) for LoD determination.

FDA recommends that developers test a dilution series of three replicates per concentration with inactivated virus on actual patient specimen, and then confirm the final concentration with 20 replicates. For this guidance, FDA defines LoD as the lowest concentration at which 19/20 replicates are positive. If multiple clinical matrices are intended for clinical testing, FDA recommends that developers submit in their EUA requests the results from the most challenging clinical matrix to FDA. For example, if testing respiratory specimens (e.g., sputum, BAL, nasopharyngeal (NP) swabs, etc.), laboratories should include only results from sputum in their EUA request.



Policy for COVID-2019 tests

Cross-reactivity/analytical specificity & microbial interference



Contains Nonbinding Recommendations

Policy for Coronavirus Disease-2019 Tests During the Public Health Emergency (Revised)

Immediately in Effect Guidance for Clinical Laboratories, Commercial Manufacturers, and Food and Drug Administration Staff

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- Limit of Detection/Analytical Sensitivity
- Cross-reactivity/Analytical Specificity
- Microbial Interference
- Clinical Agreement Study

(3) Inclusivity

developers should document the results of an *in silico* analysis indicating the percent identity matches against publicly available SARS-CoV-2 sequences that can be detected by the proposed molecular assay. FDA anticipates that 100% of published SARS-CoV-2 sequences will be detectable with the selected primers and probes.

(4) Cross-reactivity

FDA recommends cross-reactivity wet testing on common respiratory flora and other viral pathogens at concentrations of 10^6 CFU/ml or higher for bacteria and 10^5 pfu/ml or higher for viruses, except for SARS-Coronavirus and MERS-Coronavirus, which can be accomplished by *in silico* analysis. As an alternative, FDA believes an *in silico* analysis of the assay primer and probes compared to common respiratory flora and other viral pathogens can be performed. For this guidance, FDA defines *in silico* cross-reactivity as greater than 80% homology between one of the primers/probes and any sequence present in the targeted microorganism. In addition, FDA recommends that developers follow recognized laboratory procedures in the context of the sample types intended for testing for any additional cross-reactivity testing.

Additional information for the validation of molecular diagnostics is included in the manufacturer and developers EUA templates available for download on our website.

Policy for COVID-2019 tests

Clinical agreement



Contains Nonbinding Recommendations

Policy for Coronavirus Disease-2019 Tests During the Public Health Emergency (Revised)

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- Limit of Detection/Analytical Sensitivity
- Cross-reactivity/Analytical Specificity
- Microbial Interference
- **Clinical Agreement Study**

(2) Clinical Evaluation

The availability of positive samples has increased as the pandemic has progressed. As such, FDA now recommends that developers use positive clinical samples for clinical validation. Moreover, due to the increased availability of clinical samples, FDA recommends that developers confirm performance of their assay by testing a minimum of 30 positive specimens and 30 negative specimens as determined by an authorized assay. If you do not have access to clinical samples as determined by an authorized assay, contrived clinical specimens may be considered. Contrived reactive specimens can be created by spiking RNA or inactivated virus into leftover clinical specimens, of which the majority can be leftover upper respiratory specimens such as NP swabs, or lower respiratory tract specimens such as sputum, etc. If contrived samples are used, FDA recommends that twenty of the contrived clinical specimens be spiked at a concentration of 1x-2x LoD, with the remainder of specimens spanning the assay testing range. For this guidance, FDA defines the acceptance criteria for the performance as 95% agreement at 1x-2x LoD, and 100% agreement at all other concentrations and for negative specimens.



ATCC portfolio

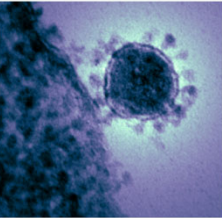


SARS-CoV-2 reference materials for inclusivity testing

ATCC® No.	Product Description	Availability
VR-1986HK™	Heat-inactivated SARS-CoV-2, Washington	Available
VR-1986D™	Genomic SARS-CoV-2 RNA, Washington	Available
VR-1991D™	Genomic SARS-CoV-2 RNA, Hong Kong	Available
VR-1992D™	Genomic SARS-CoV-2 RNA, Italy	Available
VR-1994D™	Genomic SARS-CoV-2 RNA, Germany	June 2020

- Limit of Detection/Analytical Sensitivity
- Cross-reactivity/Analytical Specificity
- Microbial Interference
- Clinical Agreement Study

- Downgraded from BSL-3 to BSL-2 (gRNA) and BSL-1 (heat-inactivated)*
- Applications:
 - Positive controls for RT-PCR or other RNA-based assays
 - Monitoring run-to-run variation within each step of the procedure, such as:
 - Nucleic acid extraction
 - Process verification
 - Amplification

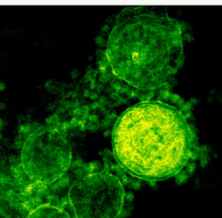


Heat-inactivated SARS-CoV-2

When developing and using a novel detection assay, researchers need access to clinically relevant positive controls to ensure the reliability and accuracy of their results. To meet this need, ATCC has developed a heat-inactivated preparation of the 2019-nCoV/USA-WA1/2020 strain (ATCC® VR-1986HK™).

- Confirmed to be inviable and non-replicative
- Quantitated by ddPCR™
- Useful for assays that include an extraction step

Order your preparation today at www.atcc.org/HKCoronavirus



Genomic RNA for SARS-CoV-2

Clinically relevant reference materials are an essential component of basic research and diagnostic development. That's why ATCC has made it a priority to provide heat-inactivated and genomic RNA preparations from a strain recently sourced from an infected patient in Washington state (2019-nCoV/USA-WA1/2020). This strain serves as the SARS-CoV-2 reference material for the United States.

- Fully sequenced (GenBank: MN985325.1)
- Prepared using methods known to inactivate viruses
- Suitable for RT-PCR or other RNA-based assays

Order yours today at www.atcc.org/CoronavirusRNA.

www.atcc.org/coronavirus



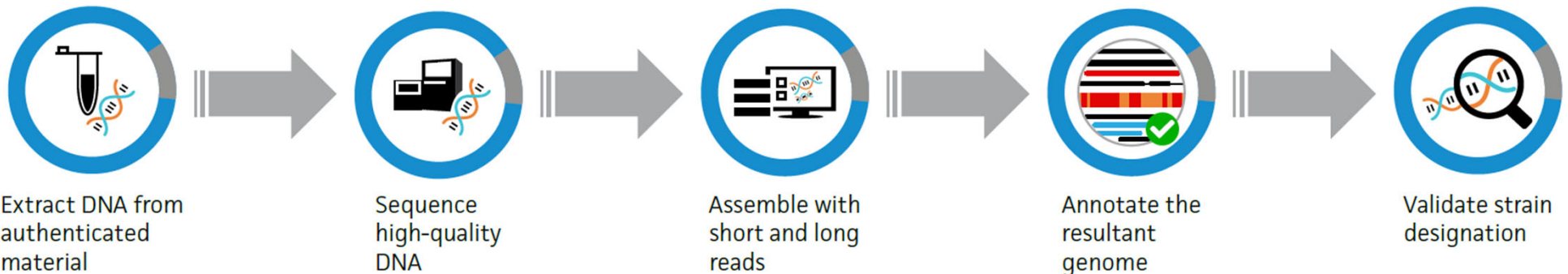
ATCC portfolio



SARS-CoV-2 reference materials for inclusivity testing

ATCC® No.	Product Description	Availability
VR-1986D™	Genomic SARS-CoV-2 RNA, Washington	Available
VR-1991D™	Genomic SARS-CoV-2 RNA, Hong Kong	Available
VR-1992D™	Genomic SARS-CoV-2 RNA, Italy	Available

- The genome of each strain is sequenced and assembled using our standardized workflow
- Genes are annotated and the species identity is confirmed
- Annotated genome sequences are provided on the ATCC Genome Portal.



genomes.atcc.org

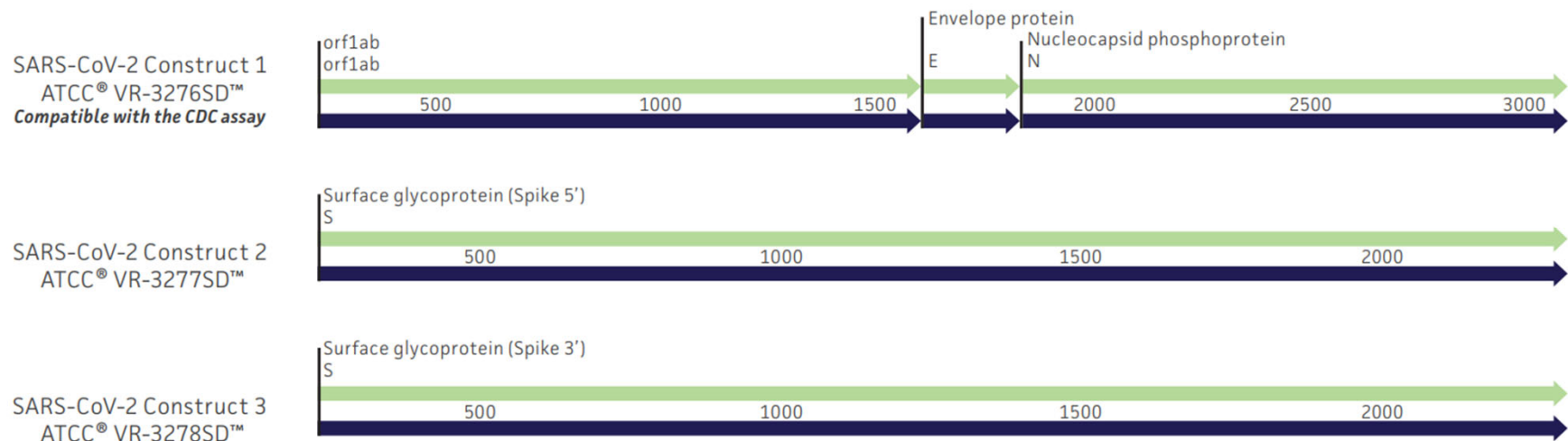
ATCC portfolio



Synthetic molecular standards

ATCC® No.	Product Description	Availability
VR-3276SD™	Quantitative Synthetic SARS-CoV-2 RNA: ORF, E, N	Available
VR-3277SD™	Quantitative Synthetic SARS-CoV-2 RNA: Spike 5'	Available
VR-3278SD™	Quantitative Synthetic SARS-CoV-2 RNA: Spike 3'	Available
VR-3279SD™	Quantitative Synthetic SARS-CoV-2 RNA: nsp9, nsp12 (RdRp)	June 2020

- Limit of Detection/Analytical Sensitivity
- Cross-reactivity/Analytical Specificity
- Microbial Interference
- Clinical Agreement Study



www.atcc.org/coronavirus

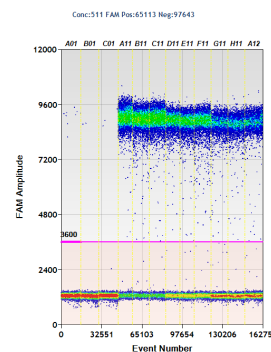
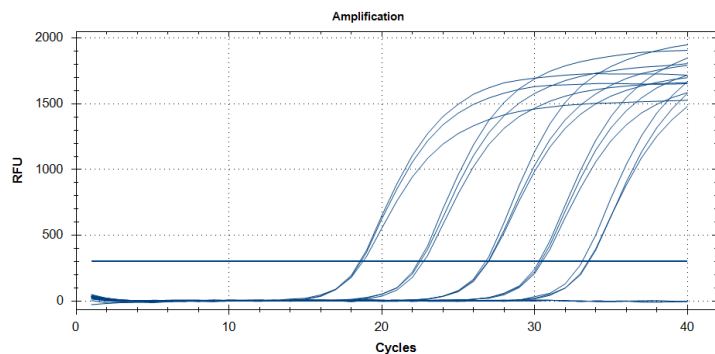




ATCC portfolio

Synthetic molecular standards

ATCC® No.	Product Description	Compatible Assays
VR-3276SD™	Quantitative Synthetic SARS-CoV-2 RNA: ORF, E, N	<ul style="list-style-type: none"> China CDC Primers and probes for detection 2019-nCoV (24 January 2020) Diagnostic detection of Wuhan coronavirus 2019 by real-time RT-PCR – Charité, Berlin Germany (17 January 2020) Detection of 2019 novel coronavirus (2019-nCoV) in suspected human cases by RT-PCR – Hong Kong University (23 January 2020) PCR and sequencing protocol for 2019-nCoV - Department of Medical Sciences, Ministry of Public Health, Thailand (Updated 28 January 2020) US CDC Real-Time RT-PCR Panel for Detection 2019-Novel Coronavirus (28 January 2020) US CDC panel primer and probes– U.S. CDC, USA (28 January 2020)
VR-3277SD™	Quantitative Synthetic SARS-CoV-2 RNA: Spike 5'	<ul style="list-style-type: none"> Detection of WN-Human1 sequence from clinical specimen. – National Institute of Infectious Diseases Japan (17 January 2020)
VR-3278SD™	Quantitative Synthetic SARS-CoV-2 RNA: Spike 3'	<ul style="list-style-type: none"> PCR and sequencing protocols for 2019-nCoV- National Institute of Infectious Diseases Japan (24 January 2020)
VR-3279SD™	Quantitative Synthetic SARS-CoV-2 RNA: nsp9, nsp12 (RdRp)	<ul style="list-style-type: none"> Diagnostic detection of Wuhan coronavirus 2019 by real-time RT-PCR – Charité, Berlin Germany (17 January 2020) Real-time RT-PCR assays for the detection of SARS-CoV-2 - Institut Pasteur, Paris (02 March 2020)



Applications:

- Positive controls for RT-PCR or other RNA-based assays
- Generation of a standard curve for quantitative RT-PCR to determine viral load
- Monitoring run-to-run, assay-to-assay, and lot-to-lot variation within each step of the procedure, such as:
 - Process verification
 - Amplification
- Assay development, verification, and validation
- To assign a genome copy number to secondary calibrators – for example, to establish a ratio of plaque or colony forming units to genome copies
- Can be used in BSL-1

ATCC Portfolio – Synthetic Molecular Standards



FAQs on Testing for SARS-CoV-2

fda.gov/medical-devices/emergency-situations-medical-devices/faqs-testing-sars-cov-2

What If I Do Not Have...?

Q: I am having trouble obtaining viral transport media/universal transport media (VTM/UTM) and a flocced nasopharyngeal swab to collect and transport patient samples. Are there alternatives that I can use? (Updated 5/6)

Q: What happens if I do not have the extraction platform referenced in the authorization of CDC's EUA-authorized test? (Updated 5/26)

Q: What happens if I do not have the instruments referenced in the authorization of the CDC's EUA-authorized test?

Q: **If I do not have assay positive control material, how can I obtain it? (Updated 4/22)**

A: Below is information regarding positive control material. Links provided are for information purposes only and not a recommendation by FDA to use that product. FDA encourages other suppliers of test materials to email COVID19DX@fda.hhs.gov to discuss whether materials they have available may also be appropriate for use.

Control material specific for the CDC EUA is available from the following resources.

- o ATCC: Order through their website
[https://www.atcc.org/Landing_Pages/Coronavirus_Resources]
 - Product # VR-3276SD: Quantitative Synthetic SARS-CoV-2: ORF, E, N
 - Product # VR-3278SD: Quantitative Synthetic SARS-CoV-2 RNA: Spike 3'

www.atcc.org/coronavirus



ATCC portfolio



Exclusivity [specificity] testing materials

Related Viruses & Nucleic Acids

Human coronavirus 229E
Human coronavirus OC43
Human coronavirus HKU1
Human coronavirus NL63
SARS-CoV
MERS-CoV
Quantitative genomic RNA from human coronavirus 229E
Quantitative synthetic human coronavirus NL63 RNA
Quantitative synthetic human coronavirus HKU1 RNA
Quantitative synthetic MERS-CoV RNA
Quantitative Synthetic SARS-CoV [2003] RNA
RNA from Betacoronavirus 1 OC43
RNA from human coronavirus 229E

Bacteria

Mycobacterium tuberculosis
Streptococcus pyogenes
Bordetella pertussis
Mycoplasma pneumoniae
Candida albicans
Pseudomonas aeruginosa
Staphylococcus epidermis
Chlamydia pneumoniae
Haemophilus influenzae
Legionella pneumophila

Non-related Viruses

Adenovirus (e.g., C1 Ad. 71)
Human metapneumovirus (hMPV)
Parainfluenza virus 1-4
Influenza A & B
Enterovirus (e.g., EV68)
Respiratory syncytial virus
Rhinovirus
Measles
Mumps
Rubella virus
Coxsackie virus
Echovirus

- Limit of Detection/Analytical Sensitivity
 - Cross-reactivity/Analytical Specificity
 - Microbial Interference
 - Clinical Agreement Study
-
- Having access to a variety of coronavirus strains is essential for establishing the inclusivity and exclusivity of a novel assay.
 - To support this need, ATCC provides microbial strains that have a wide spectrum of temporal and geographical diversity.

www.atcc.org/coronavirus

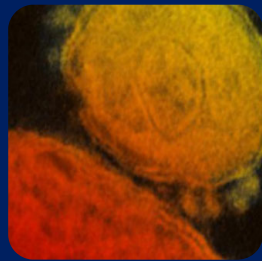


ATCC

Major areas in scientific research to combat the pandemic



**Understanding the disease
(COVID-19)**



**Understanding the infectious
agent (SARS-CoV-2)**



Diagnostics

Detection & Surveillance



**Development of
Prophylactics**

Vaccines

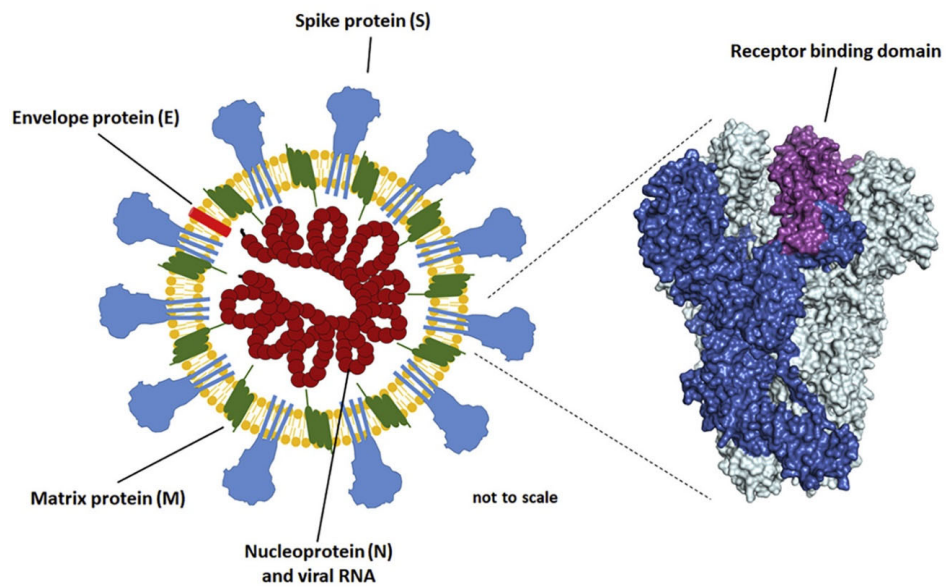


**Development of
Therapeutics**

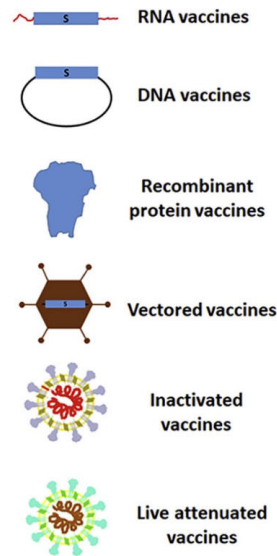
Antiviral drugs

Vaccine development

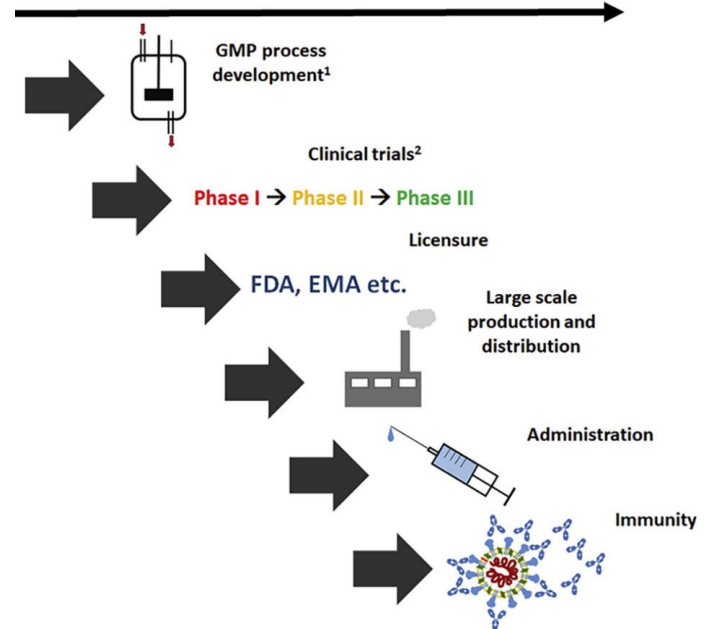
Platforms



Vaccine Candidates



Development and Implementation Phases



Vaccine development

ATCC biological materials – Meeting the need

Cell Lines for SARS-CoV-2 Propagation

- Vero E6 cells (ATCC® CRL-1586™)
- Vero CCL-81 (ATCC® CCL-81™)
- MRC-5 (ATCC® CCL-171™)
- HCT-8 (ATCC® CCL-244™)
- Media and reagents to support cellular growth

Cell Lines for Enhanced Virus Production

- STAT1 knockout cell lines capable of producing high-titer viral stocks:
 - Vero.STAT1 KO (ATCC® CCL-81-VHG™)
 - MDCK.STAT1KO (ATCC® CCL-34-VHG™)
- Additional cell lines can be found on ATCC's website

Volume 26, Number 6—June 2020

Research

Severe Acute Respiratory Syndrome Coronavirus 2 from Patient with Coronavirus Disease, United States

Jennifer Harcourt¹, Azaibi Tamin¹, Xiaoyan Lu, Shifang Kamili, Senthil K. Sakthivel, Janna Murray, Krista Queen, Ying Tao, Clinton R. Paden, Jing Zhang, Yan Li, Anna Uehara, Haibin Wang, Cynthia Goldsmith, Hannah A. Bullock, Lijuan Wang, Brett Whitaker, Brian Lynch, Rashi Gautam, Craig Schindewolf, Kumari G. Lokugamage, Dionna Scharton, Jessica A. Plante, Divya Mirchandani, Steven G. Widen, Krishna Narayanan, Shinji Makino, Thomas G. Ksiazek, Kenneth S. Plante, Scott C. Weaver, Stephen Lindstrom, Suxiang Tong, Vineet D. Menachery², and Natalie J. Thornburg^{3a}

Author affiliations: Centers for Disease Control and Prevention, Atlanta, Georgia, USA (J. Harcourt, A. Tamin, X. Lu, K. Queen, Y. Tao, C.R. Paden, Y. Li, C. Goldsmith, B. Whitaker, R. Gautam, S. Lindstrom, S. Tong, N.J. Thornburg); Eagle Medical Services, Atlanta (S. Kamili, S.K. Sakthivel, J. Murray, B. Lynch); IHRC, Atlanta (J. Zhang, H. Wang); Oak Ridge Institute for Science and Education, Oak Ridge, Tennessee, USA (A. Uehara); Synergy America, Inc., Atlanta (H.A. Bullock, L. Wang); University of Texas Medical Branch, Galveston, Texas, USA (C. Schindewolf, K.G. Lokugamage, D. Mirchandani, S. Widen, K. Narayanan, S. Makino, T.G. Ksiazek, S.C. Weaver, V.D. Menachery); World Reference Center for Emerging Viruses and Arboviruses, Galveston (D. Scharton, J.A. Plante, T.G. Ksiazek, K.S. Plante, S.C. Weaver, V.D. Menachery)

[Cite This Article](#)

Abstract

The etiologic agent of an outbreak of pneumonia in Wuhan, China, was identified as severe acute respiratory syndrome coronavirus 2 in January 2020. A patient in the United States was given a diagnosis of infection with this virus by the state of Washington and the US Centers for Disease Control and Prevention on January 20, 2020. We isolated virus from nasopharyngeal and oropharyngeal specimens from this patient and characterized the viral sequence, replication properties, and cell culture tropism. We found that the virus replicates to high titer in Vero-CCL81 cells and Vero E6 cells in the absence of trypsin. We also deposited the virus into 2 virus repositories, making it broadly available to the public health and research communities. We hope that open access to this reagent will expedite development of medical countermeasures.

virus replicates to high titer in Vero-CCL81 cells and Vero E6 cells in the absence of trypsin

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Podcast

[Listen to audio/Podcast](#)

Downloads

www.atcc.org/coronavirus



Vaccine development

Published research & news

Immunogenicity and protective efficacy in monkeys of purified inactivated Vero-cell SARS vaccine

Ede Qin^{a,*}, Huiying Shi^{b,1}, Lin Tang^{c,1}, Cuie Wang^{a,1}, Guohui Chang^a, Zhifen Ding^b, Kai Zhao^b, Jian Wang^c, Ze Chen^c, Man Yu^a, Bingyin Si^a, Jianyuan Liu^b, Donglai Wu^d, Xiaojie Cheng^c, Baoan Yang^a, Wenming Peng^a, Qingwen Meng^d, Bohua Liu^a, Weiguo Han^a, Xunnan Yin^d, Hongyuan Duan^a, Dawei Zhan^a, Long Tian^b, Shuangli Li^c, Jinsong Wu^a, Gang Tan^a, Yi Li^b, Yuchuan Li^a, Yonggang Liu^d, Hong Liu^a, Fushuang Lv^a, Yu Zhang^a, Xiangang Kong^d, Baochang Fan^a, Tao Jiang^a, Shuli Xu^c, Xiaomei V Xiaohong Wu^a, Yongqiang Deng^a, Min Zhao^b, Qingyu

^a Institute of Microbiology and Epidemiology, Academy of Military Medical Sciences, No. 20 Dongda Street, Feng

^b National Vaccine and Serum Institute, No. 4 Nanli, Sanjianfang, Chaoyang District, Beijing

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^d Harbin Institute of Veterinary Medicine, The Chinese Academy of Agricultural Sciences, No. Nangang District, Harbin 150001, P.R. China

Received 2 September 2004; accepted 12 June 2005

Available online 12 September 2005

Vero cells (ATCC® CCL-81™)

J Virol. 2005 Feb; 79(3): 1635–1644.

doi: [10.1128/JVI.79.3.1635-1644.2005](https://doi.org/10.1128/JVI.79.3.1635-1644.2005)

Molecular and Biological Characterization of Human Monoclonal Antibodies Binding to the Spike and Nucleocapsid Proteins of Severe Acute Respiratory Syndrome Coronavirus

Edward N. van den Brink,¹ Jan ter Meulen,¹ Freek Cox,¹ Mandy A. C. Jongeneelen,¹ Alexandra Thijsse,¹ Mark Throsby,¹ Wilfred E. Marissen,¹ Pauline M. L. Rood,¹ Alexander B. H. Bakker,¹ Hans R. Gelderblom,² Byron E. Martina,³ Albert D. M. E. Osterhaus,³ Wolfgang Preiser,⁴ Hans Wilhelm Doerr,⁴ John de Kruij,¹ and Jaap Goudsmit^{1,*}

Proc Natl Acad Sci U S A. 2007 Jul 17; 104(29): 12123–12128.

Published online 2007 Jul 9. doi: [10.1073/pnas.0701000104](https://doi.org/10.1073/pnas.0701000104)

Medical Sciences

PMCID: PMC1924550

PMID: [17620608](https://pubmed.ncbi.nlm.nih.gov/17620608/)

Potent cross-reactive neutralization of SARS coronavirus isolates by human monoclonal antibodies

le,[‡] Anjeanette Roberts,[§] Tim Sheahan,[¶] Xiaodong Xiao,^{*} kx,[¶] Igor A. Sidorov,[†] Davide Corti,^{**} Leatrice Vogel,[§] Yang Feng,[†] tonio Lanzavecchia,^{**} Kristopher M. Curtis,[¶] Gary J. Nabel,^{††})imitrov^{**§§}

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ABSTRACT

Background: Coronaviruses pose a seriodrome (SARS), Middle East Respiratory Coronavirus (MERS-CoV), and the newly named SARS-CoV-2, are the causative agents of severe acute respiratory syndrome (SARS) and related diseases. Safe vaccines that rapidly induce potent

> *Nat Med.* 2004 Aug;10(8):871-5. doi: [10.1038/nm1080](https://doi.org/10.1038/nm1080). Epub 2004 Jul 11.

An Efficient Method to Make Human Monoclonal Antibodies From Memory B Cells: Potent Neutralization of SARS Coronavirus

Elisabetta Traggiai,¹ Stephan Becker, Kanta Subbarao, Larissa Kolesnikova, Yasushi Uematsu, Maria Rita Gismondo, Brian R Murphy, Rino Rappuoli, Antonio Lanzavecchia

Affiliations + expand

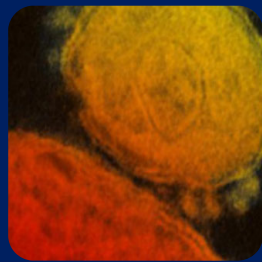
PMID: 15247913 PMCID: PMC7095806 DOI: [10.1038/nm1080](https://doi.org/10.1038/nm1080)



Major areas in scientific research to combat the pandemic



**Understanding the disease
(COVID-19)**



**Understanding the infectious
agent (SARS-CoV-2)**



Diagnostics

Detection & Surveillance



**Development of
Prophylactics**

Vaccines



**Development of
Therapeutics**

Antiviral drugs

Therapeutics

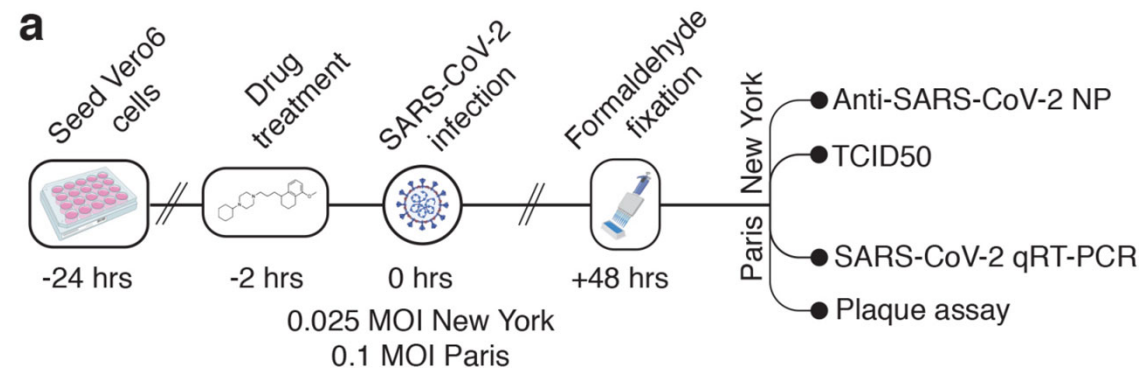
ATCC biological materials – Meeting the need

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 - MDCK.STAT1KO (ATCC® CCL-34-VHG™)



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Therapeutics

Published research & news

Nafamostat Shows High Antiviral Efficacy

Institut Pasteur Korea Finds COVID-19 Treatment Candidate 600 Times More Effective than Remdesivir

By Choi Moon-hee | © May 15, 2020, 11:25

Accelerated Article Preview

A SARS-CoV-2 protein interaction map reveals targets for drug repurposing

Received: 23 March 2020

Accepted: 22 April 2020

Accelerated Article Preview Published online 30 April 2020

David E. Gordon, Gwendolyn M. Jang, Mehdi Bouhaddou, Jiewei Xu, Kirsten Obernier, Kris M. White, Matthew J. O'Meara, Veronica V. Rezeli, Jeffrey Z. Guo, Danielle L. Swaney, Tia A. Tummino, Ruth Huettenhain, Robyn M. Kaake, Alicia L. Richards, Beril Tutuncuoglu, Helene Foussard, Jyoti Batra, Kelsey Haas, Maya Modak, Minkyu Kim, Paige Haas, Benjamin J. Polacco, Hannes Braberg, Jacqueline M. Fabius, Manon Eckhardt, Margaret Soucheray, Michael J. Gorman, Maria J. Gaitanaris, Michael M. Stevens, Alexander J. S. Cook, Matthew S. Baden

Vero E6 cells (ATCC® CCL-1586™)

Cell Research

www.nature.com/cr
www.cell-research.com



LETTER TO THE EDITOR **OPEN**

Remdesivir and chloroquine effectively inhibit the recently emerged novel coronavirus (2019-nCoV) in vitro

Cell Research (2020) 30:269–271; https://doi.org/10.1038/s41422-020-0282-0

Antiviral Research 178 (2020) 104786

Contents lists available at ScienceDirect

Antiviral Research

journal homepage: www.elsevier.com/locate/antiviral



Short Communication

Remdesivir, lopinavir, emetine, and homoharringtonine inhibit SARS-CoV-2 replication in vitro



Ka-Tim Choy^a, Alvina Yin-Lam Wong^a, Prathanporn Kaewpreedee^a, Sin Fun Sia^a, Dongdong Chen^a, Kenrie Pui Yan Hui^a, Daniel Ka Wing Chu^a, Michael Chi Wai Chan^a, Peter Pak-Hang Cheung^b, Xuhui Huang^b, Malik Peiris^a, Hui-Ling Yen^{a,*}




^aSchool of Public Health, LKS Faculty of Medicine, The University of Hong Kong, Hong Kong SAR, China

^bDepartment of Chemistry, Hong Kong University of Science and Technology, Hong Kong SAR, China

Vero E6 cells (ATCC® CCL-1586™)

Correspondence | [Open Access](#) | [Published: 18 March 2020](#)

Hydroxychloroquine, a less toxic derivative of chloroquine, is effective in inhibiting SARS-CoV-2 infection in vitro

Jia Liu, Ruiyuan Cao, Mingyue Xu, Xi Wang, Huanyu Zhang, Hengrui Hu, Yufeng Li, Zhihong Hu , Wu Zhong  & Manli Wang 

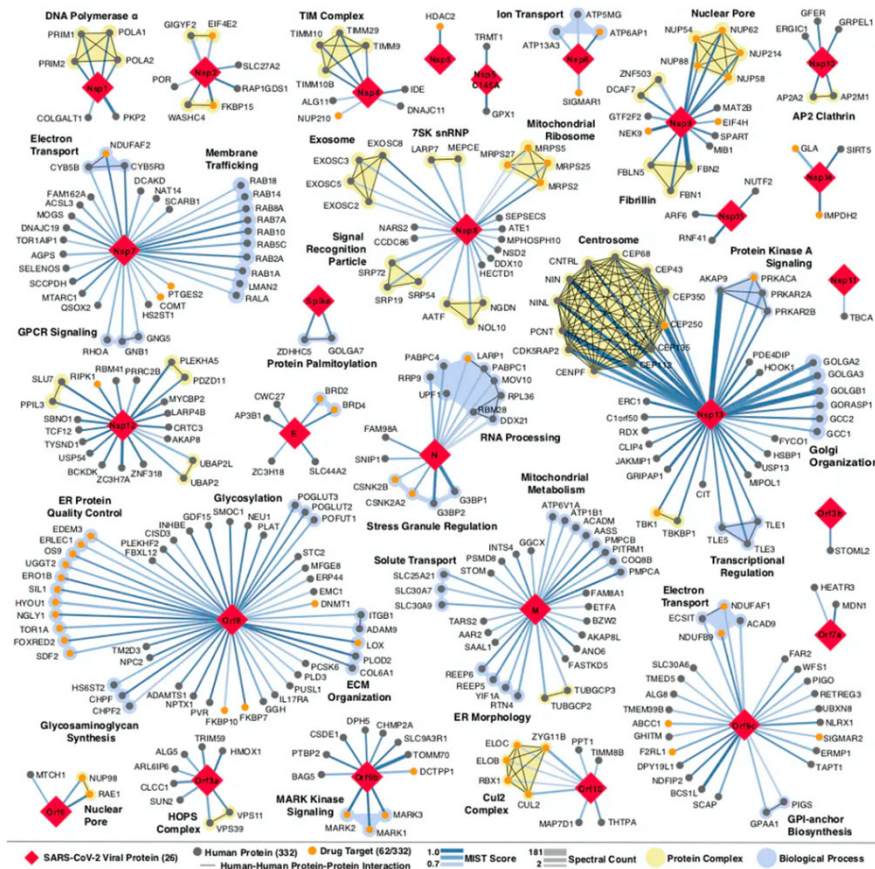
Cell Discovery 6, Article number: 16 (2020) | [Cite this article](#)

Vero E6 cells (ATCC® CCL-1586™)



Therapeutics

Antiviral drug targets



A SARS-CoV-2 protein interaction map reveals targets for drug repurposing

Two groups of drugs that affect the virus and the two different ways that it happens were identified from screening old drugs:

- **Disrupting translation of the virus**
 - Ternatin-4
 - Zotatfin
 - Plitidepsin
- **Sigma receptors**
 - Two antipsychotics: haloperidol and melperone
 - Two potent antihistamines:
 - Clemastine
 - Cloperastine
 - Compound PB28
 - Female hormone progesterone

Eukaryotic cell lines

Policy information about [cell lines](#)

Cell line source(s)



HEK-293T/17 cells were procured from the UCSF Cell Culture Facility, now available through UCSF's Cell and Genome Engineering Core (<https://cgec.ucsf.edu/cell-culture-and-banking-services>); cell line collection listed here: <https://ucsf.app.box.com/s/6xydeqhr8a2xe0mbo2333k1ndqv> (CCLZR076). Vero E6 cells used at Mount Sinai and Institut Pasteur were purchased from ATCC (VERO C1008 [Vero 76, clone E6, Vero E6] (ATCC® CRL-1586™))

Authentication

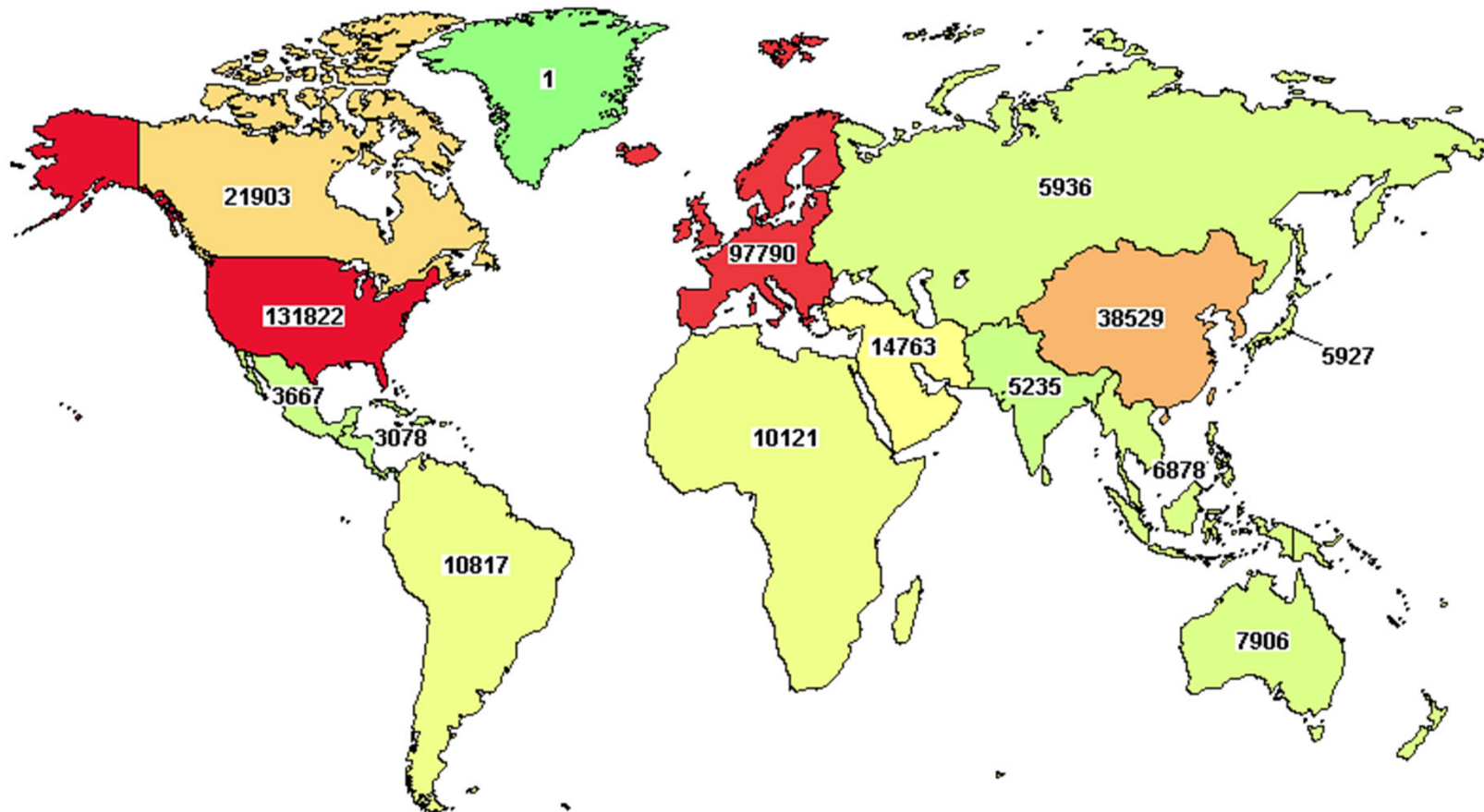


STR analysis by the Berkeley Cell Culture Facility on August 8, 2017 authenticates our HEK-293T/17 cells with 94% probability. The African green monkey kidney epithelial Vero E6 (ATCC CRL-1586) is derived from ATCC, and thus is already authenticated.



Ongoing COVID-19 clinical trials

341,642 studies for COVID-19



Summary

- COVID-19 is a high global and public health threat.
- The development of safe and effective diagnostic methods, prophylactics, and therapeutics will depend on solid scientific research.
- ATCC has expedited scientific research by quickly providing a variety of research materials for the development of diagnostic assays, vaccines, and therapeutics.
- We must proactively protect ourselves and our community from COVID-19 infection.
- Everyone is a part of the solution.



**Infection
prevention and
control**



**Tracking
and data**



**Vaccines,
therapeutics, and
diagnostics**

www.atcc.org/coronavirus

From Our Lab To Yours

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