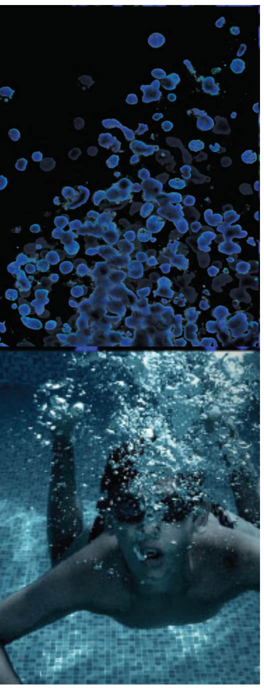
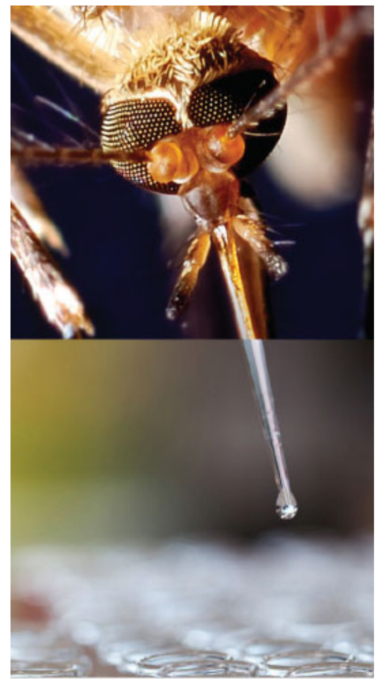
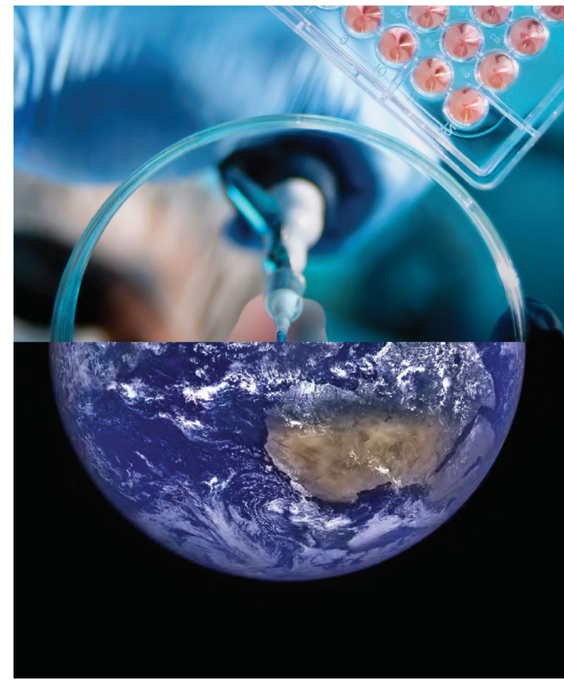


Understanding COVID-19: A Global Pandemic

Britany Tang, BS
Microbiologist, ATCC

Credible Leads to Incredible™

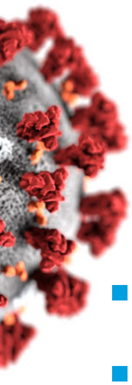


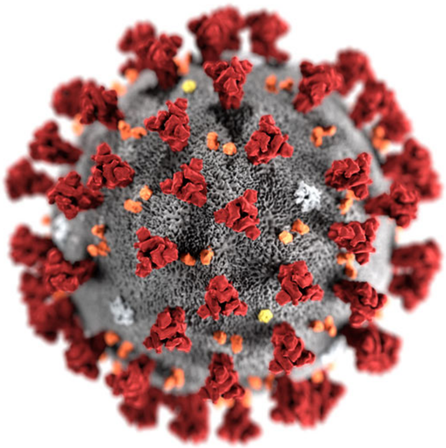


About ATCC

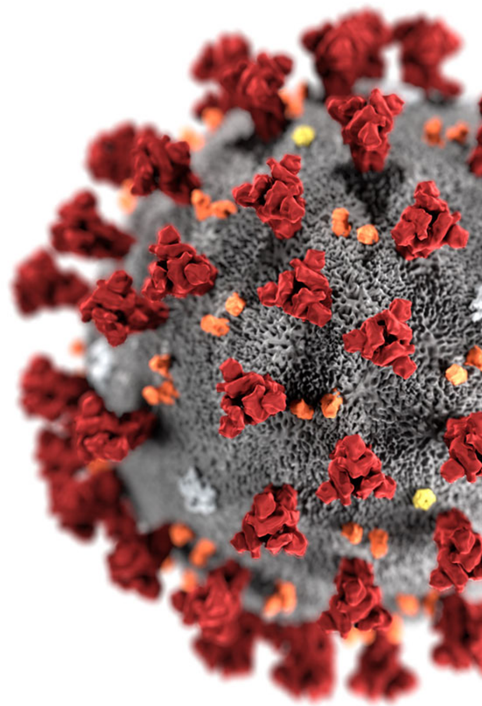
- Founded in 1925, ATCC is a non-profit organization with HQ in Manassas, VA, and an R&D and Services center in Gaithersburg, MD
- World's largest, most diverse biological materials and information resource for microbes – the "*gold standard*"
- Innovative R&D company featuring gene editing, microbiome, 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

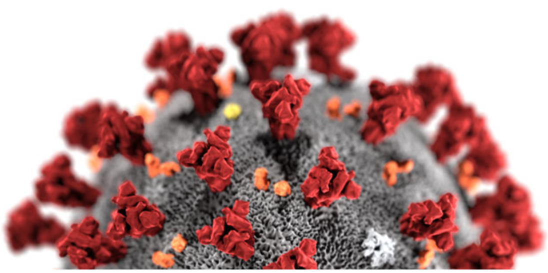
Agenda





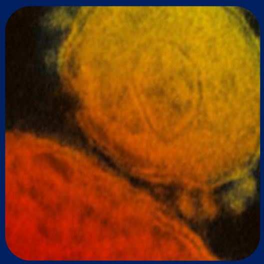
- What is COVID-19 and SARS-CoV-2?
- What are coronaviruses?
- Diagnostics
- Vaccines
- Therapeutics
- ATCC solutions





Major areas in scientific research to combat the pandemic

Understanding the disease (COVID-19)



Understanding the infectious agent (SARS-CoV-2)

Diagnostics

Detection & Surveillance

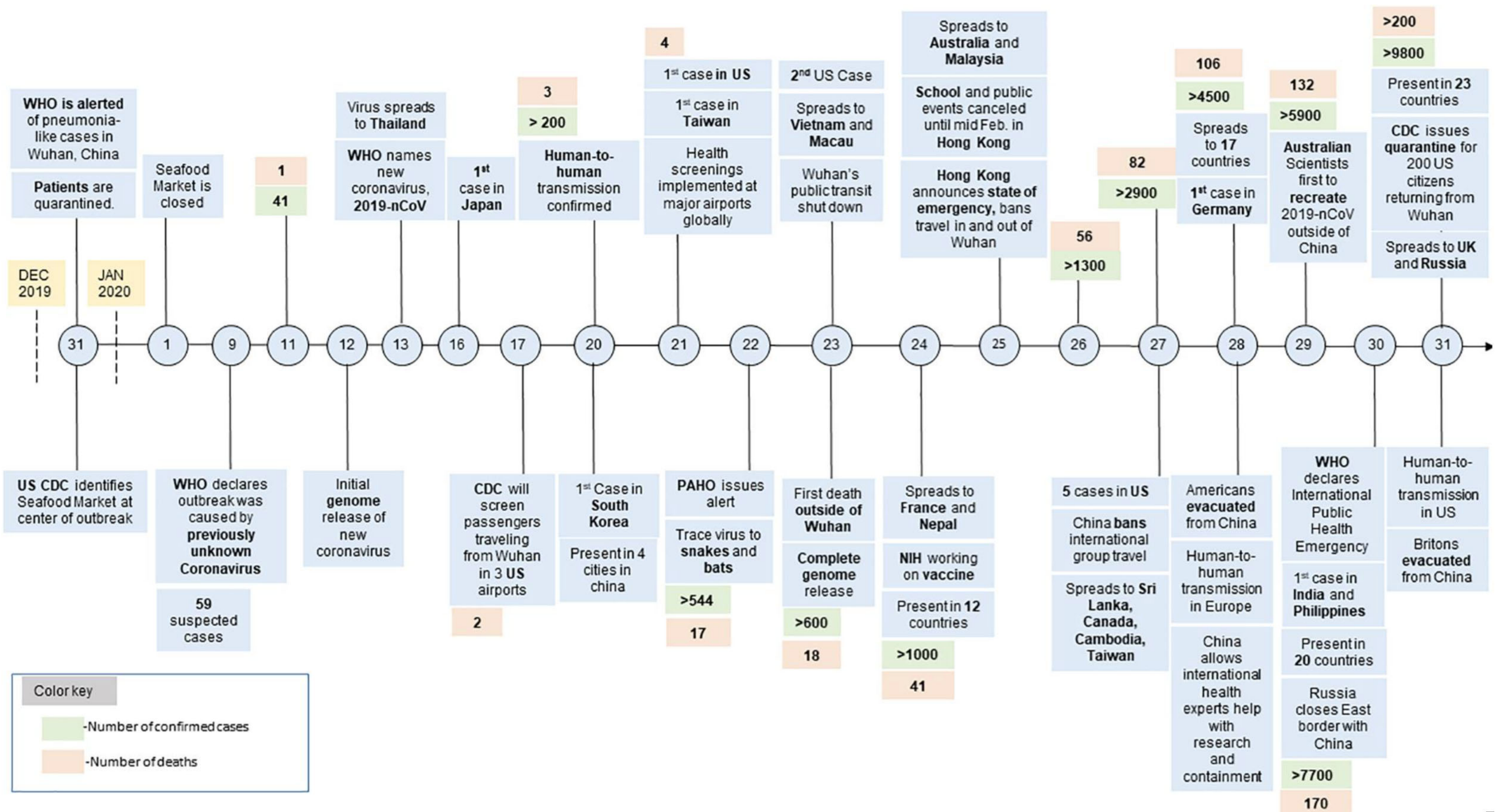
Development of Prophylactics

Vaccines

Development of Therapeutics

Antiviral drugs

COVID-19 timeline



ME El Zowalaty and JD Järhult One Health 9 (2020)

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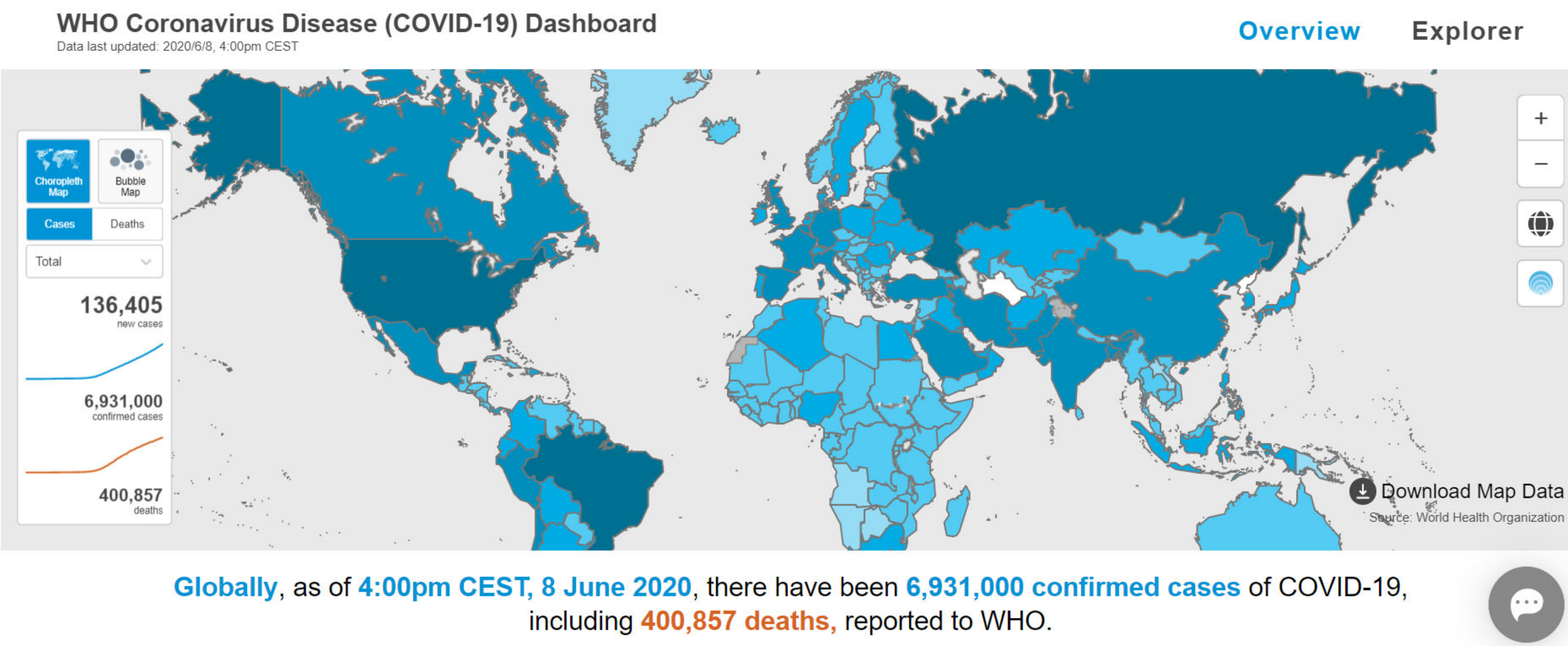
Epidemiology

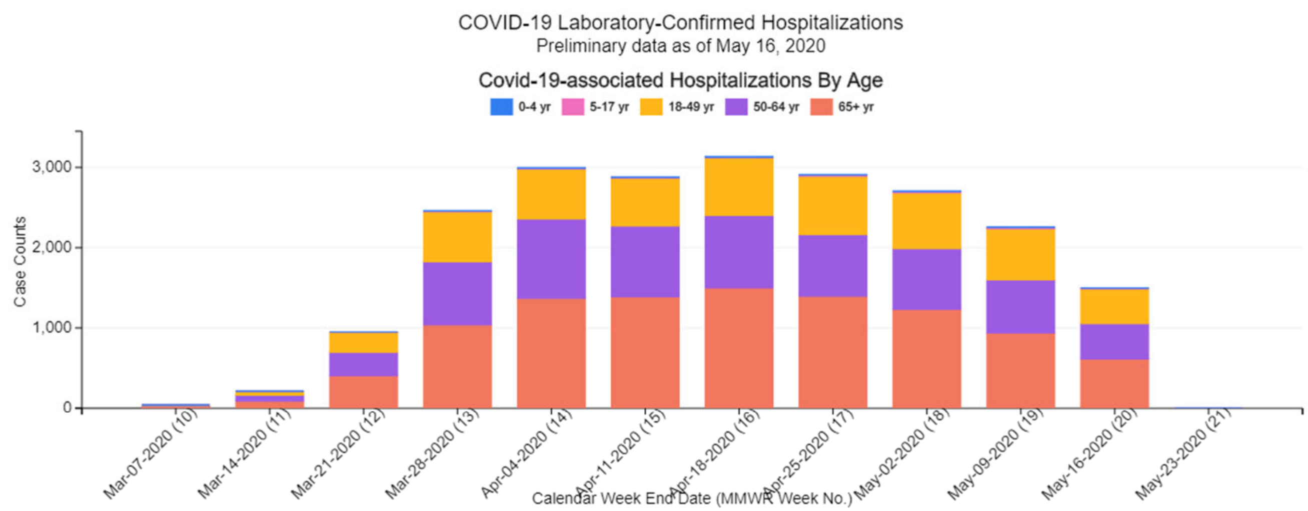
- There are 215 countries, areas, or territories with cases
- More than 6.9 million cases of COVID-19 and 400,000 deaths have been reported to WHO



Data Source: WHO

Epidemiology

Risk factors: age groups



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.

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.

COVID-NET: COVID-19-Associated Hospitalization Surveillance Network, Centers for Disease Control and Prevention

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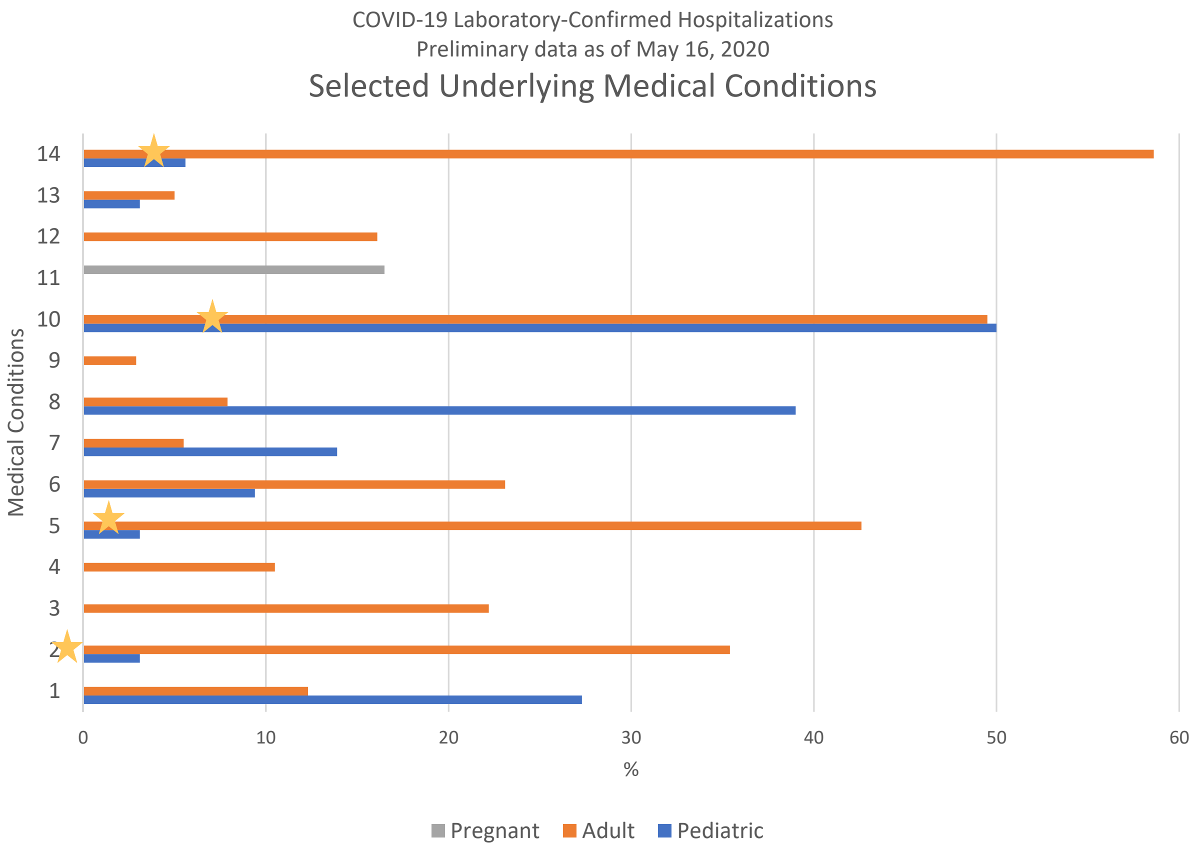
Epidemiology

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-NET: COVID-19-Associated Hospitalization Surveillance Network, Centers for Disease Control and Prevention

COVID-19

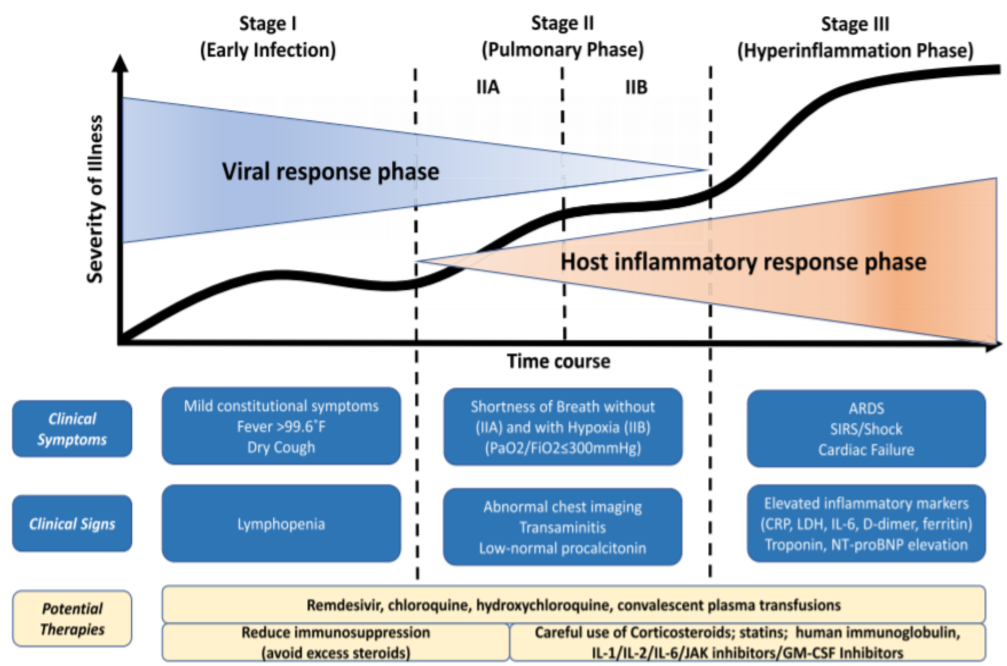
Pathogenesis & clinical manifestations

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:

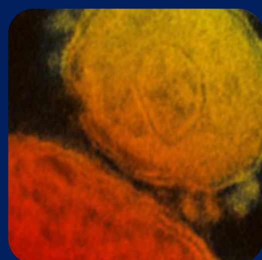
- Developing pneumonia in both lungs
- Extrapulmonary systemic hyperinflammation syndrome
- Acute respiratory distress syndrome (ARDS)



The Journal of Heart and Lung Transplantation 39(5), 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

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)

M Kohanksi, Nat Rev Microbiol. June 8(6): 423–435, 2018

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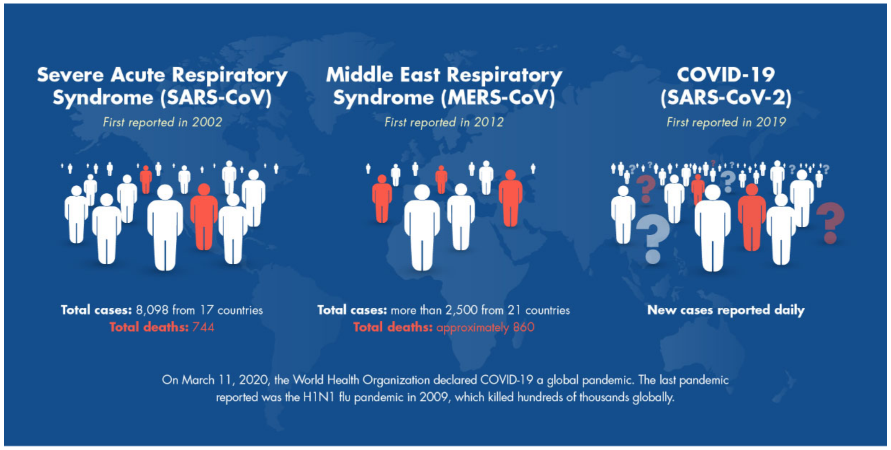
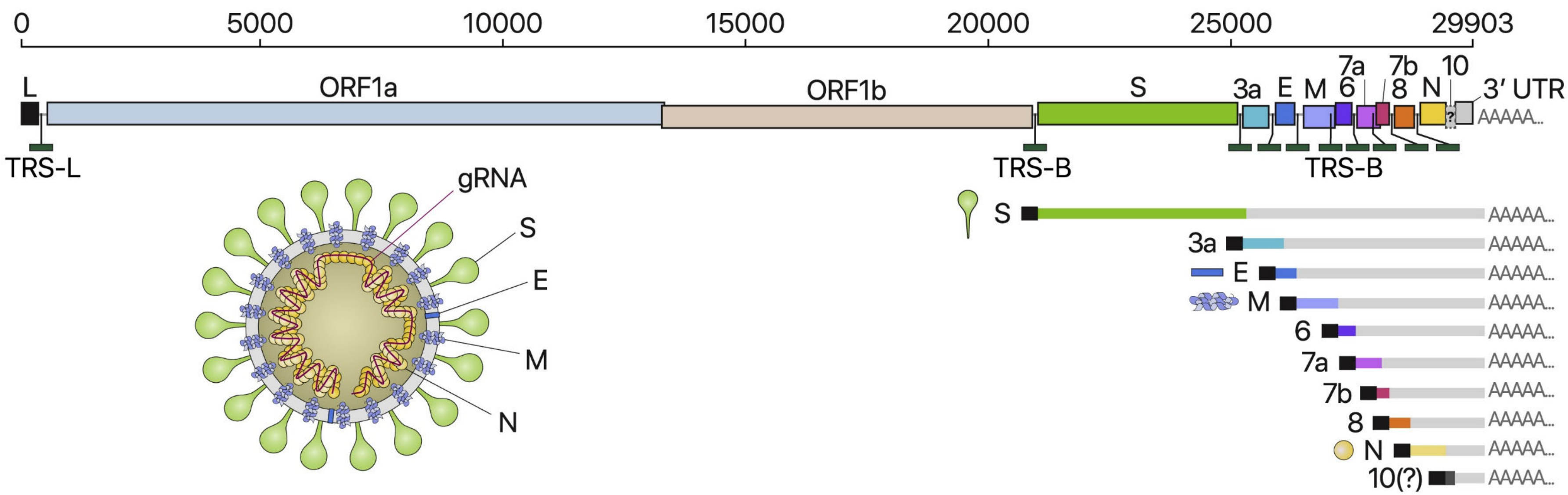
Recent history of Coronavirus epidemics

- 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.



Y Fan, et al. Bat Coronaviruses in China. Viruses, 11(3): 210, 2019

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

AR Fehr & S Perlman Coronaviruses pp 1-23, 2015
D Kim, et al. Cell 181(4): 914-921, 2020

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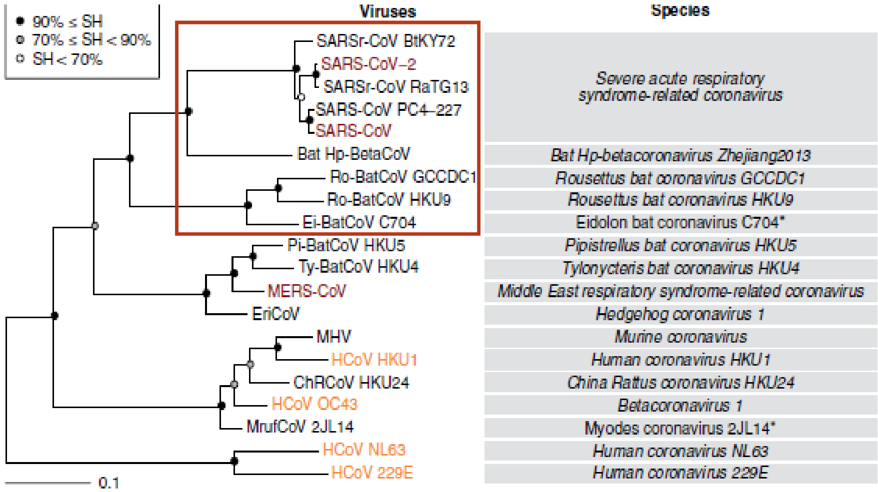
Phylogeny

Category	Coronaviruses	Humans	Divergence
Realm	*Riboviria*		
Order	*Nidovirales*	Primates	
Suborder	*Cornidovirineae*		
Family	*Coronaviridae*	Hominidae	
Subfamily	*Orthocoronavirinae*	Homininae	
Genus	*Betacoronavirus*	*Homo*	
Subgenus	*Sarbecovirus*		
Species	*Severe acute respiratory syndrome-related coronavirus*	*Homo sapiens*	
Individuum	SARS-CoVUrbani, SARS-CoVGZ-02, Bat SARS CoVRf1/2004, Civet SARS CoVSZ3/2003, SARS-CoVPC4-227, SARSr-CoVBtKY72, SARS-CoV-2 Wuhan-Hu-1, SARSr-CoVRatG13, 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.

AE Gorbalenya, et al. Nat Microbiol 5, 536–544 (2020)

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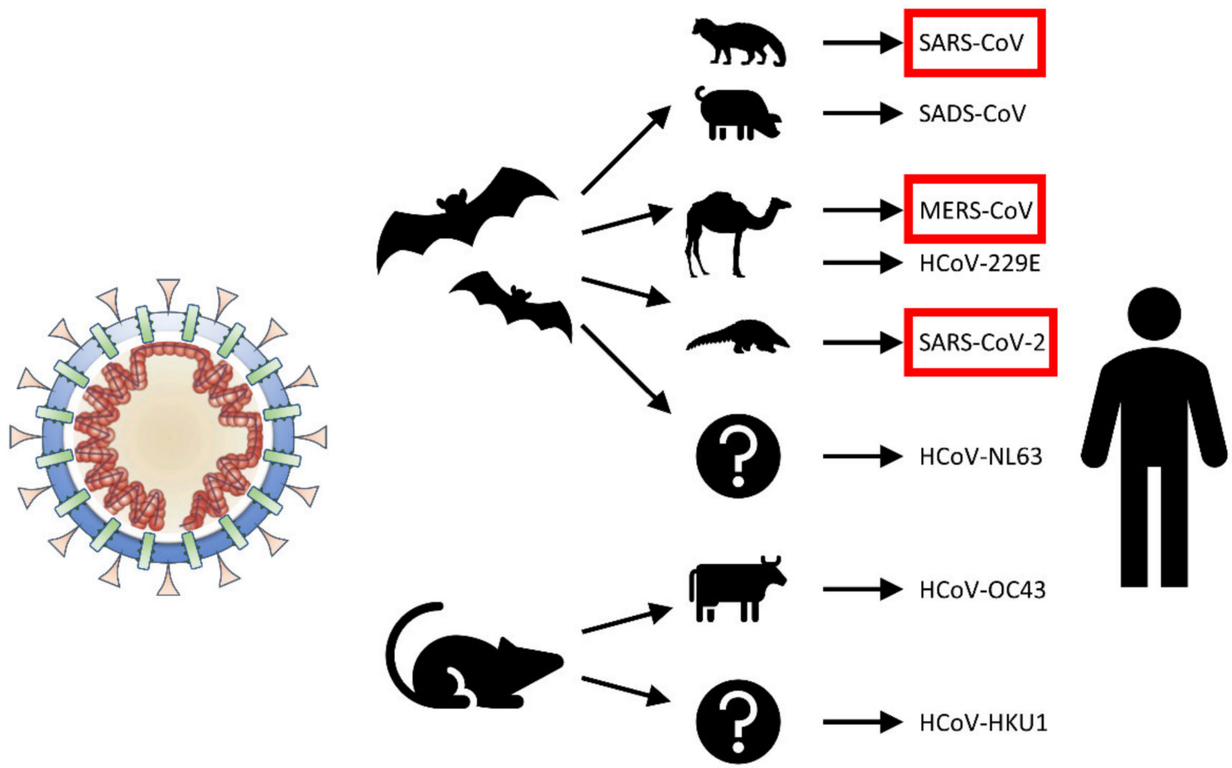
Host range

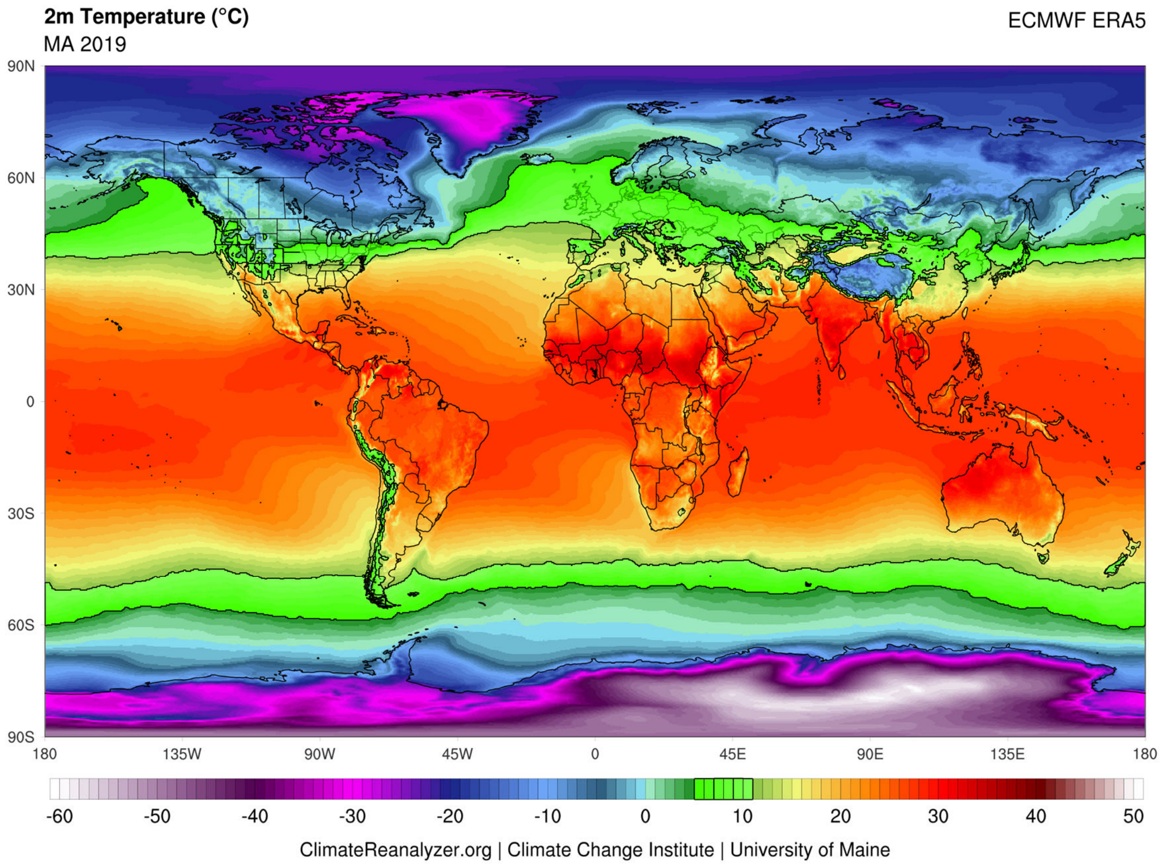


Proposed host reservoir: bats

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

FA Rabi, et al. Pathogens 9(3): 231, 2020

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.

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Discovering the molecular mechanisms of pathogenesis

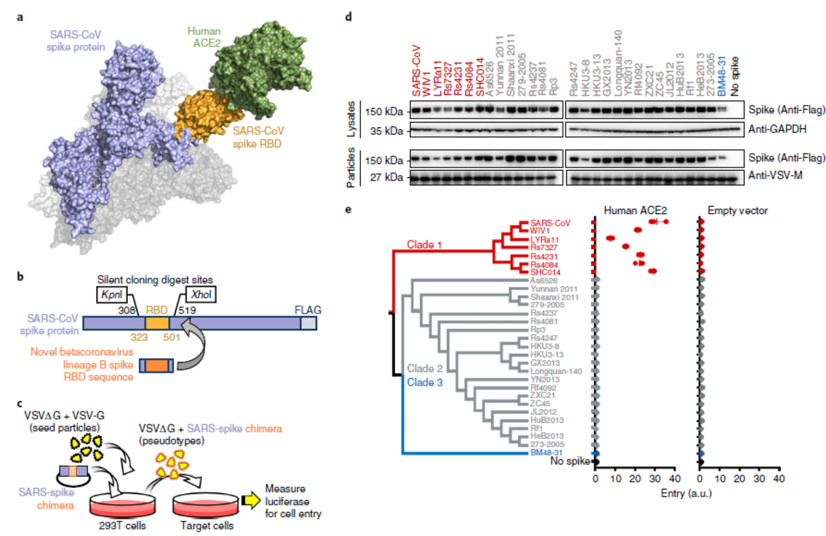
ARTICLES
https://doi.org/10.1038/s41564-020-0688-y
nature microbiology
Check for updates

Functional assessment of cell entry and receptor usage for SARS-CoV-2 and other lineage B betacoronaviruses

Michael Letko, Andrea Marzi and Vincent Munster

Over the past 20 years, several coronaviruses have crossed the species barrier into humans, causing outbreaks of severe, and often fatal, respiratory illness. Since SARS-CoV was first identified in animal markets, global viromics projects have discovered thousands of coronavirus sequences in diverse animals and geographic regions. Unfortunately, there are few tools available to functionally test these viruses for their ability to infect humans, which has severely hampered efforts to predict the next zoonotic viral outbreak. Here, we developed an approach to rapidly screen lineage B betacoronaviruses, such as SARS-CoV and the recent SARS-CoV-2, for receptor usage and their ability to infect cell types from different species. We show that host protease processing during viral entry is a significant barrier for several lineage B viruses and that bypassing this barrier allows several lineage B viruses to enter human cells through an unknown receptor. We also demonstrate how different lineage B viruses can recombine to gain entry into human cells, and confirm that human ACE2 is the receptor for the recently emerging SARS-CoV-2.

NATURE MICROBIOLOGY ARTICLES



Eukaryotic cell lines

Policy information about cell lines

Cell line source(s)	1. A549 - human lung epithelial - ATCC CCL-185 2. Artibeus jamaicensis - primary kidney - obtained from Anthony Schountz, Colorado State University (PMID: 26899616) 3. Artibeus jamaicensis - immortalized cells - AJ-primary cells above were immortalized with SV40 T-antigen as described in our maniscript 4. BHK - hamster kidney - ATCC CCL-10 5. Caco-2 - human colon epithelial cells - ATCC HTB-37

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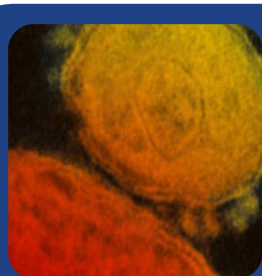
Major areas in scientific research to combat the pandemic

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

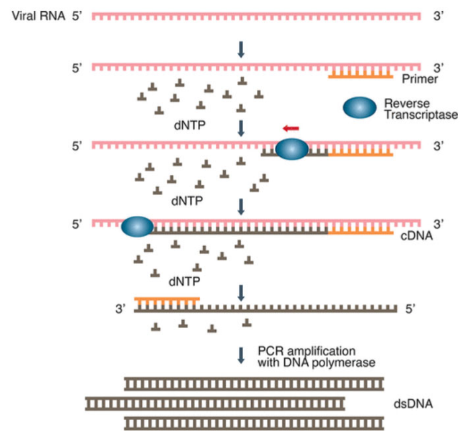
Molecular and serological/immunological assays

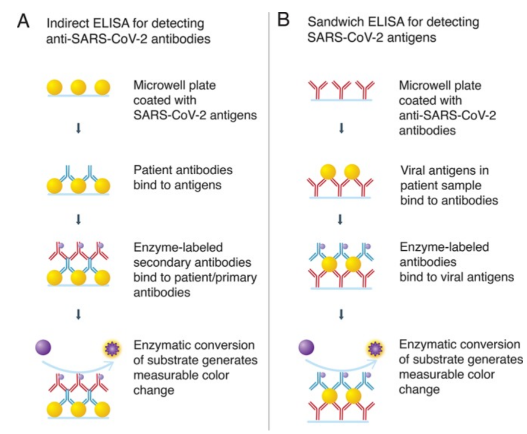
Molecular-based assays

- **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

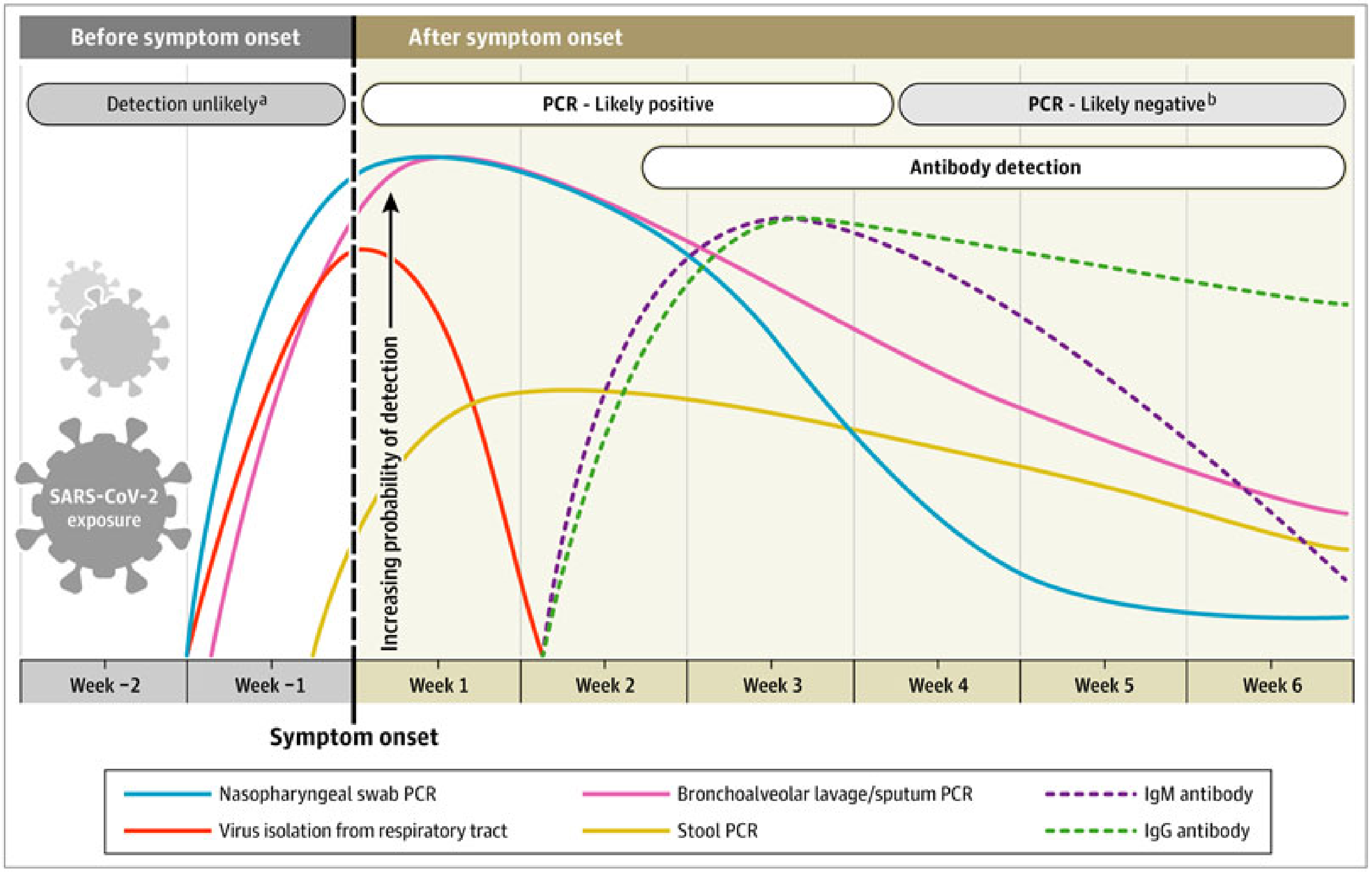
- **Enzyme-linked immunosorbent assay (ELISA)**
- **Lateral flow immunoassays**
- **Rapid antigen test**
- Neutralization assay
- Luminescent immunoassay
- Biosensor test





ACS Cent. Sci. 6: 591–605, 2020

Variation in diagnostic tests relative to symptom onset



JAMA. Published online May 6, 2020. doi:10.1001/jama.2020.8259

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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

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Diagnostics

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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- 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)

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- 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.

ATCC®

Policy for COVID-2019 tests

Clinical agreement

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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- Cross-reactivity/Analytical Specificity
- Microbial Interference
- Clinical Agreement Study

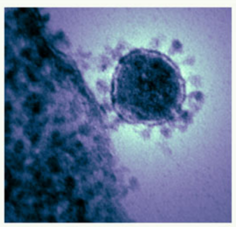
(2) Clinical Evaluation

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

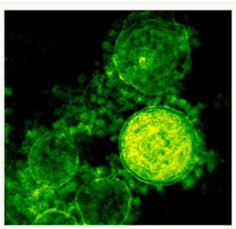


Heat-inactivated SARS-CoV-2

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.

- 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

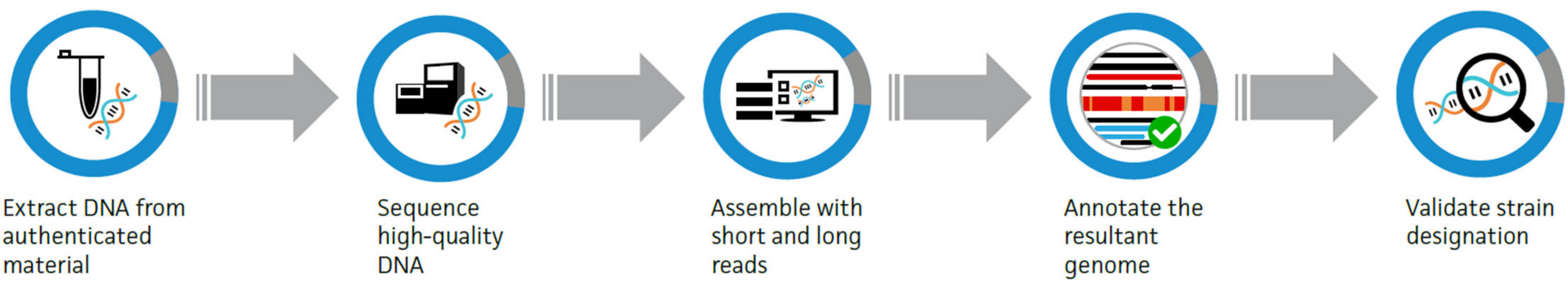
www.atcc.org/coronavirus

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

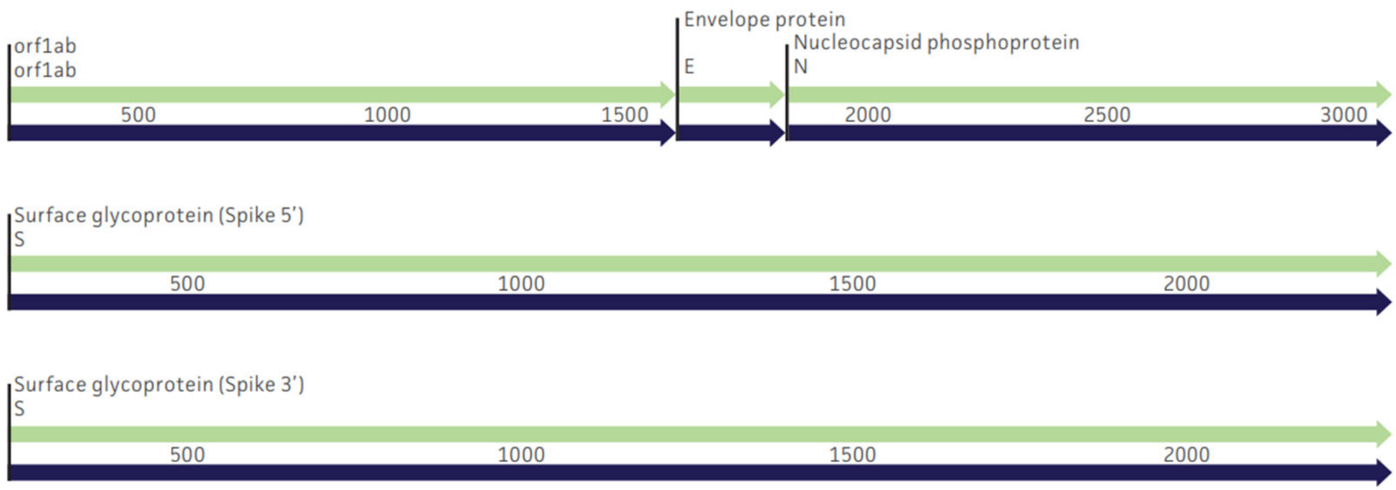
ATCC® No.	Product Description	Availability
VR-3276SD™	Quantitative Synthetic SARS-CoV-2 RNA: ORF, E, N	Available
VR-3277SD™	Quantitative Synthetic SARS-CoV-2 RNA: Spike 5’	Available
VR-3278SD™	Quantitative Synthetic SARS-CoV-2 RNA: Spike 3’	Available
VR-3279SD™	Quantitative Synthetic SARS-CoV-2 RNA: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

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

SARS-CoV-2 Construct 1
ATCC® VR-3276SD™
Compatible with the CDC assay

SARS-CoV-2 Construct 2
ATCC® VR-3277SD™

SARS-CoV-2 Construct 3
ATCC® VR-3278SD™

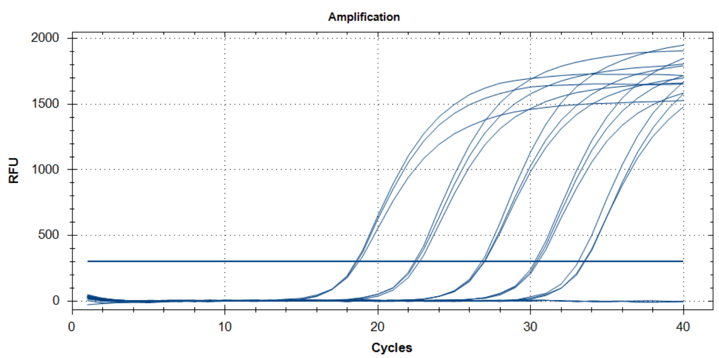


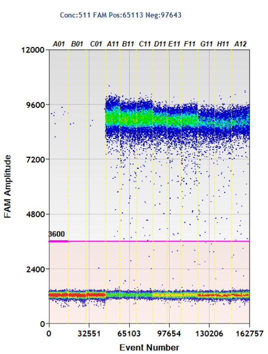
www.atcc.org/coronavirus

ATCC portfolio

Synthetic molecular standards

ATCC® No.	Product Description	Compatible Assays
VR-3276SD™	Quantitative Synthetic SARS-CoV-2 RNA: ORF, E, N	▪ 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'	▪ 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'	▪ 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)	▪ 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

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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 flocked 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.

- 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'

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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

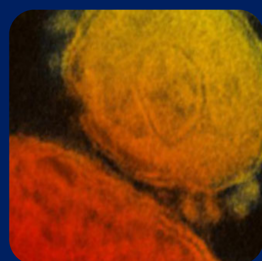
- Having access to a variety of coronavirus strains is essential for establishing the inclusivity and exclusivity of a novel assay.
- To support this need, ATCC provides microbial strains that have a wide spectrum of temporal and geographical diversity.

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

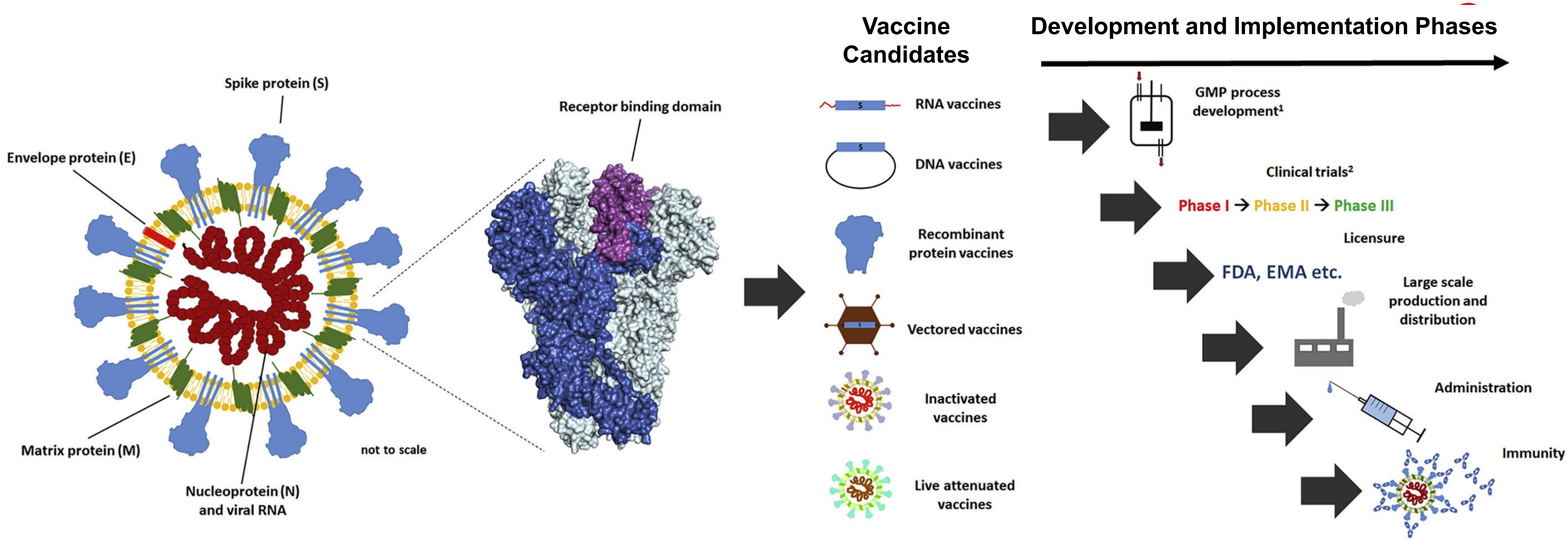
Vaccines

Development of Therapeutics

Antiviral drugs

Vaccine development

Platforms



F Amanat & F Krammer. Immunity, 52(4): 583–589, 2020

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 Harcourt[1], Azaibi Tamin[1], Xiaoyan Lu, Shifaq 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. Menachery[2], and Natalie J. Thornburg[2]

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

On This Page

Methods
Results
Discussion
Cite This Article

Figures

Figure 1
Figure 2
Figure 3
Figure 4

Podcast

Listen to audio/Podcast

Downloads

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

www.atcc.org/coronavirus

ATCC

Vaccine development

Published research & news

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

Ede Qin[a,*,1], 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 W 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*
[c] *Beijing Genomics Institute (BGI), Chinese Academy of Sciences, I-Zone, Shunyi, Beijing 1*
[d] *Harbin Institute of Veterinary Medicine, The Chinese Academy of Agricultural Sciences, No. Nangang District, Harbin 150001, PR China*

Received 2 September 2004; accepted 12 June 2005
Available online 12 September 2005

Vero cells (ATCC® CCL-81™)

Research paper

Microneedle array delivered recombinant coronavirus vaccines: Immunogenicity and rapid translational development

Eun Kim[a], Geza Erdos[b], Shaohua Huang[a], Thomas W. Kenniston[a], Stephen C. Balmert[b], Cara Donahue Carey[b], V. Stalin Raj[e,1], Michael W. Epperly[c], William B. Klimstra[d], Bart L. Haagmans[e], Emrullah Korkmaz[b,f], Louis D. Falo Jr.[b,f,g,h,*], Andrea Gambotto[a,**]

[a] *Department of Surgery, University of Pittsburgh School of Medicine, Pittsburgh, W1148 Biomedical Science Tower, 200 Lothrop St., Pennsylvania, PA 15213, USA*
[b] *Department of Dermatology, University of Pittsburgh School of Medicine, W1150 Biomedical Science Tower, 200 Lothrop St., Pittsburgh, PA 15213, USA*
[c] *Department of Radiation Oncology, University of Pittsburgh, Pittsburgh, PA 15213, USA*
[d] *Center for Vaccine Research, Department of Immunology, University of Pittsburgh, Pittsburgh, PA 15213, USA*
[e] *Department of Viroscience, Erasmus Medical Center Rotterdam, Rotterdam, the Netherlands*
[f] *Department of Bioengineering, Swanson School of Engineering, University of Pittsburgh, Pittsburgh, PA 15231, USA*
[g] *Clinical and Translational Science Institute, University of Pittsburgh, Pittsburgh, PA 15213, USA*
[h] *The McGowan Institute for Regenerative Medicine, University of Pittsburgh, Pittsburgh, PA 15219, USA*

A R T I C L E I N F O

Article History:
Received 16 March 2020
Revised 18 March 2020
Accepted 18 March 2020
Available online xxx

A B S T R A C T

Background: Coronaviruses pose a serio
drome (SARS), Middle East Respiratory
Coronavirus (MERS-CoV), and the n
named SARS-CoV-2, are the causative a
Safe vaccines that rapidly induce potent

Proc Natl Acad Sci U S A. 2007 Jul 17; 104(29): 12123–12128.
Published online 2007 Jul 9. doi: 10.1073/pnas.0701000104
Medical Sciences
PMCID: PMC1924550
PMID: 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,[††]
Dimitrov[*§§]

J Virol. 2005 Feb; 79(3): 1635–1644.
doi: 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 Kruif,[1] and Jaap Goudsmit[1,*]

› Nat Med. 2004 Aug;10(8):871-5. doi: 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

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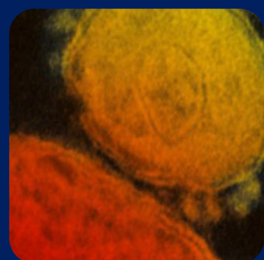
Major areas in scientific research to combat the pandemic

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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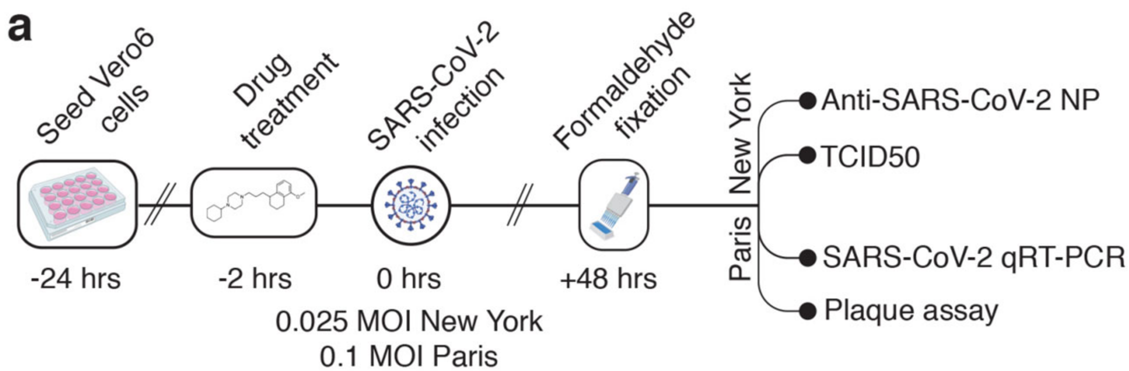


www.atcc.org/coronavirus

DE Gordon, et al. Nature https://doi.org/10.1038/s41586-020-2286-9 (2020)

Therapeutics

Published research & news

Nafamostat Shows High Antiviral Efficacy

Institut Pasteur Korea Finds COVID-19 Treatment Candidate 600 Time 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. Rezelj, 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,

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
ELSEVIER
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,*]

[a] School of Public Health, LKS Faculty of Medicine, The University of Hong Kong, Hong Kong SAR, China
[b] Department 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™)

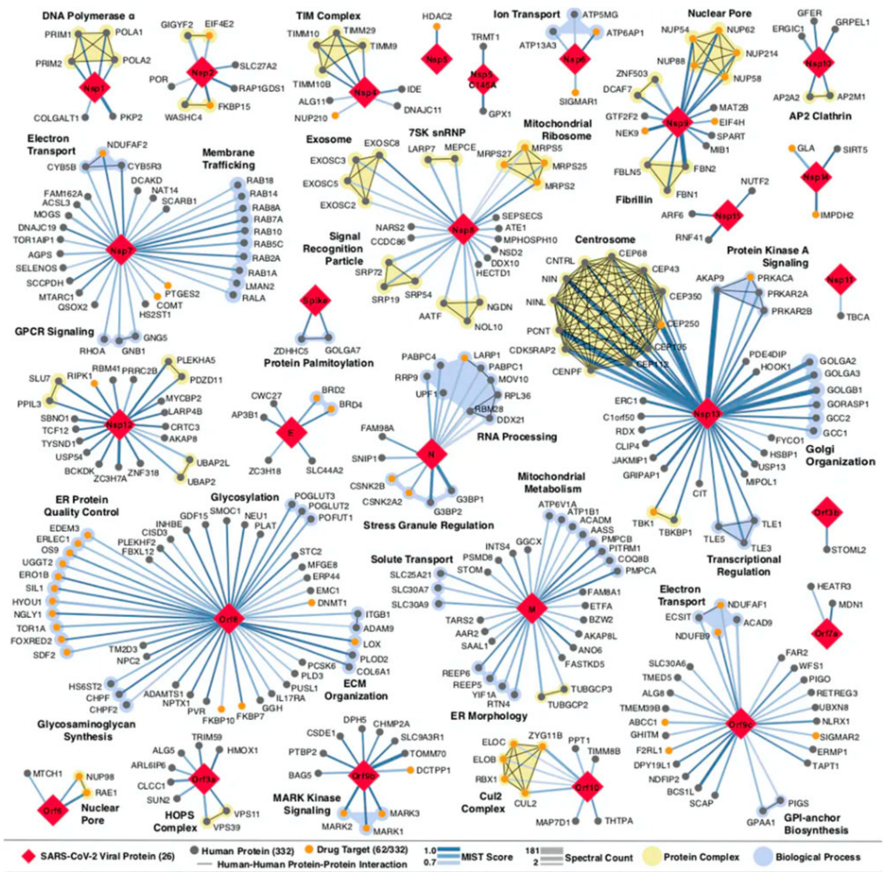
ATCC

nature https://doi.org/10.1038/s41586-020-2286-9
Accelerated Article Preview

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

Therapeutics

Antiviral drug targets



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
  - Zotatifin
  - 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

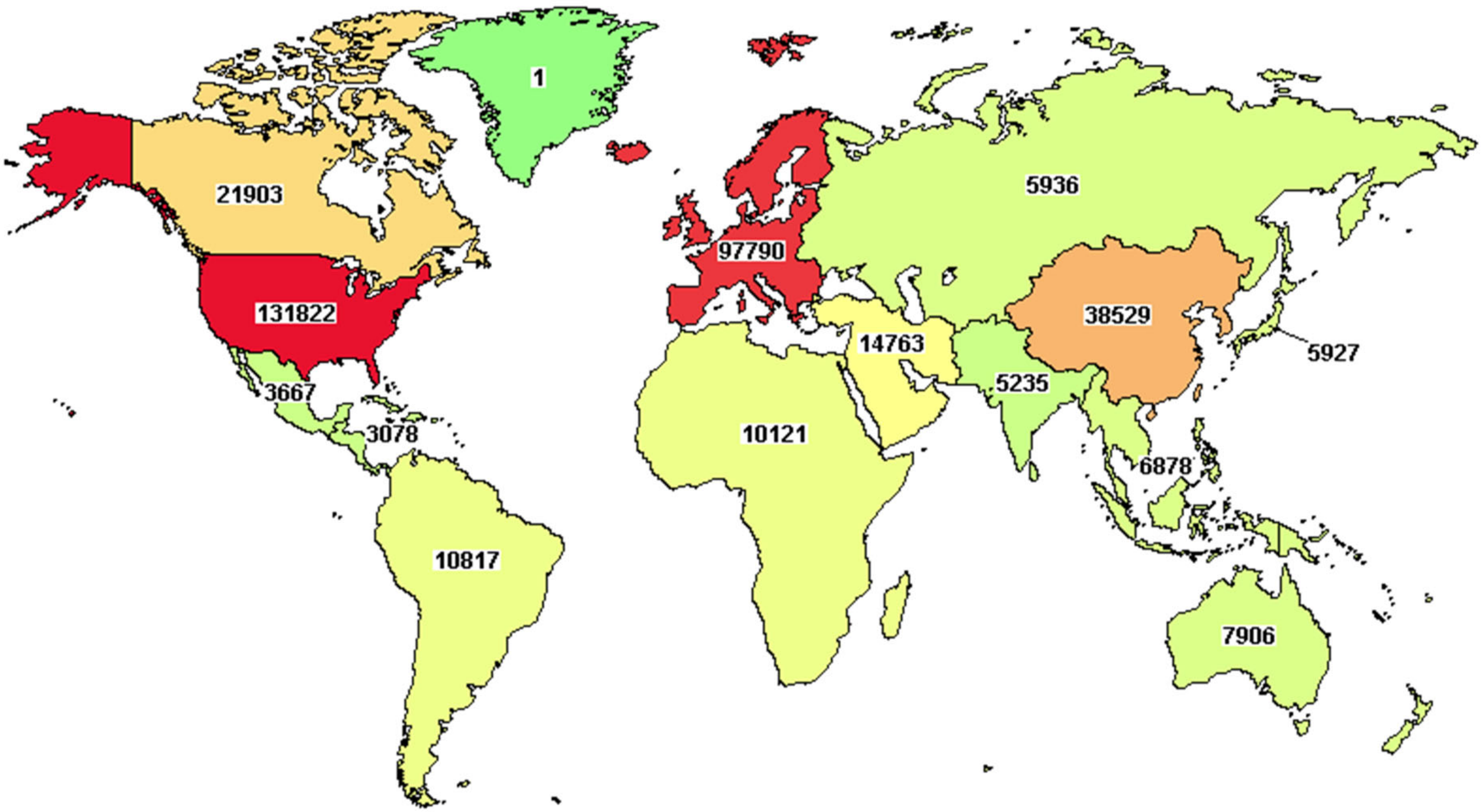
Cell line source(s)	HEK-293T/17 cells were procured from the UCSF Cell Culture Facility, now available through UCSF's Cell and Genome Engineering Core (https://cgec.ucsf.edu/cell-culture-and-banking-services); cell line collection listed here: https://ucsf.app.box.com/s/6xkydeqhr8a2xes0mbo2333i3k1lndqv (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.

N Krogan. The Conversation April 30, 2020.

Ongoing COVID-19 clinical trials

341,642 studies for COVID-19

NIH U.S. National Library of Medicine
ClinicalTrials.gov



NIH. ClinicalTrials.gov, Accessed June 08, 2020.

ATCC

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

Coming soon!

Viral Metagenomics and the Use of Standards: From Biology to Clinical Applications

Presented by Tasha M. Santiago-Rodriguez, Ph.D.

12 ET, June 25, 2020

ATCC