

Update on COVID-19-Related Research at Berkeley Lab

Jeff Neaton

Associate Laboratory Director for Energy Sciences

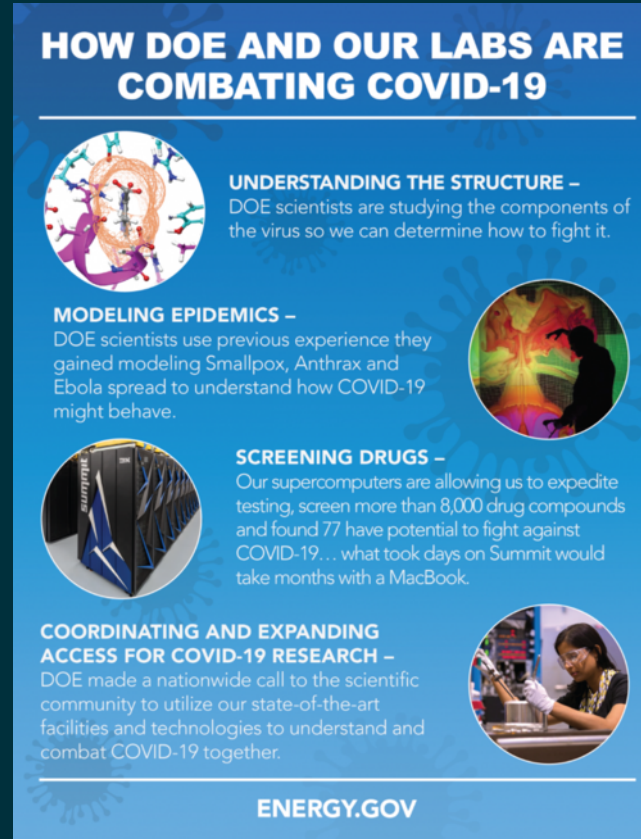
Community Advisory Group Meeting
January 11, 2021

The National Labs' Response Strategy to COVID-19

The 17 U.S. Department of Energy national laboratories have facilities and expertise relevant to fighting COVID-19:

- User facilities, including light and neutron sources, nanoscience centers, computing facilities, and the Joint Genome Institute
- People with deep expertise relevant to:
 - Testing
 - Antiviral drug discovery
 - Vaccine discovery
 - Supply chain bottlenecks
 - Materials
 - Modeling and understanding disease spread
 - Molecular and structural biology

HOW DOE AND OUR LABS ARE COMBATING COVID-19



UNDERSTANDING THE STRUCTURE –
DOE scientists are studying the components of the virus so we can determine how to fight it.

MODELING EPIDEMICS –
DOE scientists use previous experience they gained modeling Smallpox, Anthrax and Ebola spread to understand how COVID-19 might behave.

SCREENING DRUGS –
Our supercomputers are allowing us to expedite testing, screen more than 8,000 drug compounds and found 77 have potential to fight against COVID-19... what took days on Summit would take months with a MacBook.

COORDINATING AND EXPANDING ACCESS FOR COVID-19 RESEARCH –
DOE made a nationwide call to the scientific community to utilize our state-of-the-art facilities and technologies to understand and combat COVID-19 together.

ENERGY.GOV

The National Virtual Biotechnology Laboratory (NVBL) was established in March 2020 to coordinate a COVID-19 research response across the national laboratory system and has been supported by the CARES Act funding provided to the DOE Office of Science

Berkeley Lab's COVID-19 R&D Response

- Continued operations of Berkeley Lab facilities for essential COVID R&D during shelter-in-place
- Stood up 6 LDRD projects, industry projects, and the BLADE testing R&D facility, coordinated with the Innovative Genomics Institute on UCB campus
- Berkeley Lab received \$12M in CARES Act stimulus funds
- Awarded 5 NVBL-funded multi-Laboratory projects
- Carried out a Lab-wide strategic planning process in summer/fall to identify COVID R&D directions for FY21 and beyond



Horst Simon,
CRO



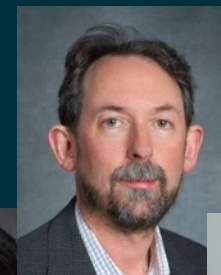
Jeff Neaton,
ALD Energy
Sciences and
NVBL POC



Mary Maxon,
ALD
Biosciences



Kathy Yelick,
Tiger Team
Co-Lead



LBL's State-of-the-Art Facilities



Genome sequencing,
viral genomics



Protein structure, virus-cell interactions



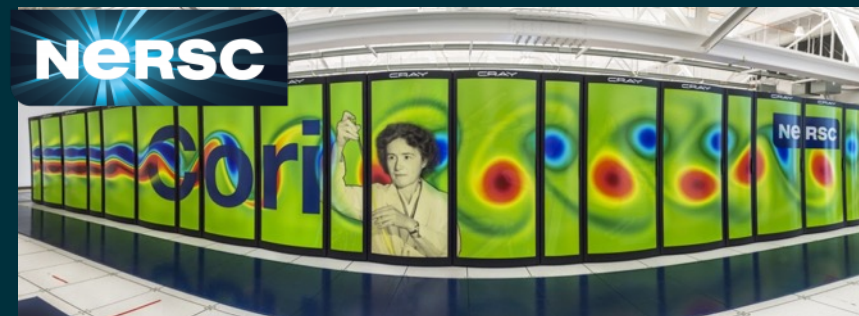
Therapeutic production and scale-up



Advanced droplet imaging



Peptoid synthesis, manufacturing,
virus detection



High-performance computing



Indoor environment simulations



Faster, cheaper diagnostic testing

Team Science in Action

275 science and ops staff
involved since March 2020

Improving the Effectiveness of Personal Protective Equipment

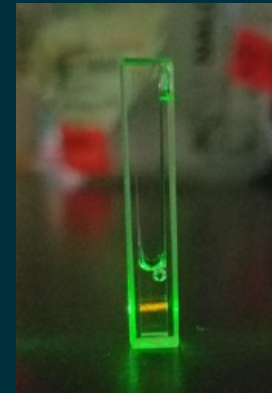
Rechargeable mask



- Berkeley Lab scientists designed a reusable silicone mask with a rechargeable filter that traps and neutralizes virus particles
- The team ultimately hopes to produce a model that can be plugged in to recharge overnight, like a cell phone

Instant visual detection of virus contamination on PPE

- Berkeley Lab scientists developed a simple, instant test that can determine when PPE or other surfaces have been contaminated by SARS-CoV-2
- Newer variants of the test are being developed for increased sensitivity and will be tested against active virus



These projects are supported by the DOE Office of Science through the National Virtual Biotechnology Laboratory, a consortium of DOE national laboratories focused on response to COVID-19, with funding provided by the Coronavirus CARES Act.

Developing More-Efficient COVID Tests and Improved Protocols

- LBNL established the Berkeley Lab Automated Diagnostics Experimental Lab (BLADE), a fully functional and enclosed automated lab for COVID-19 testing R&D
- Current projects include developing simpler, faster, cheaper diagnostic testing and developing sample pooling strategies for surveillance testing
- The Joint Genome Institute provided expertise in setting up UC Berkeley's Innovative Genomics Institute surveillance testing lab



Berkeley
UNIVERSITY OF CALIFORNIA



Innovative
Genomics
Institute

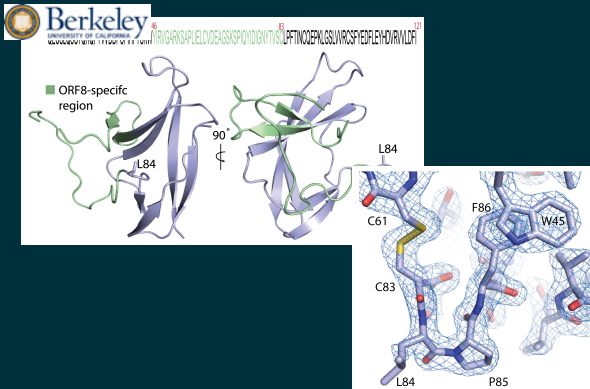
Testing R&D is supported by the U.S. DOE National Virtual Biotechnology Laboratory. CSR and Curci Foundation supported BLADE set-up.

Revealing the Inner Workings of the SARS-CoV-2 Virus

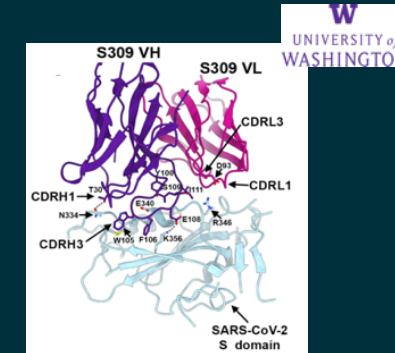


X-rays from the Advanced Light Source are answering such questions as:

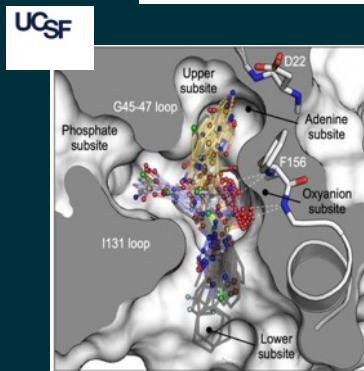
- What is the virus's structure? How does it work, and where are its weak spots?
- Which candidate drug molecules successfully attach to weak spots in the virus structure and inhibit its function?
- How does SARS-CoV-2 infect a human cell?



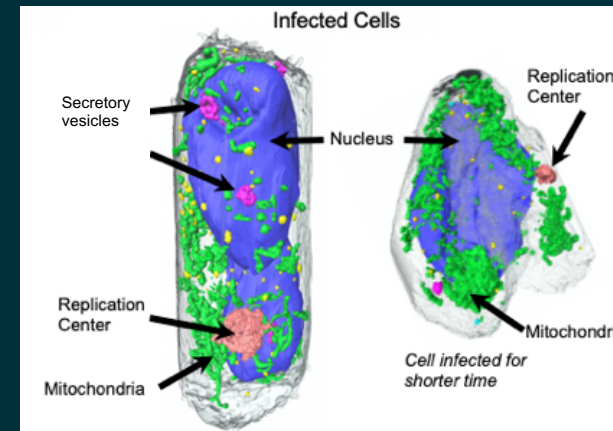
An atomic model of a SARS-CoV-2 protein suspected to help the virus evade the body's immune system



Structures that reveal how an antibody binds to and neutralizes SARS-CoV-2



Candidate treatment agents bound to weak spots in the virus help researchers understand the potential efficacy of treatments



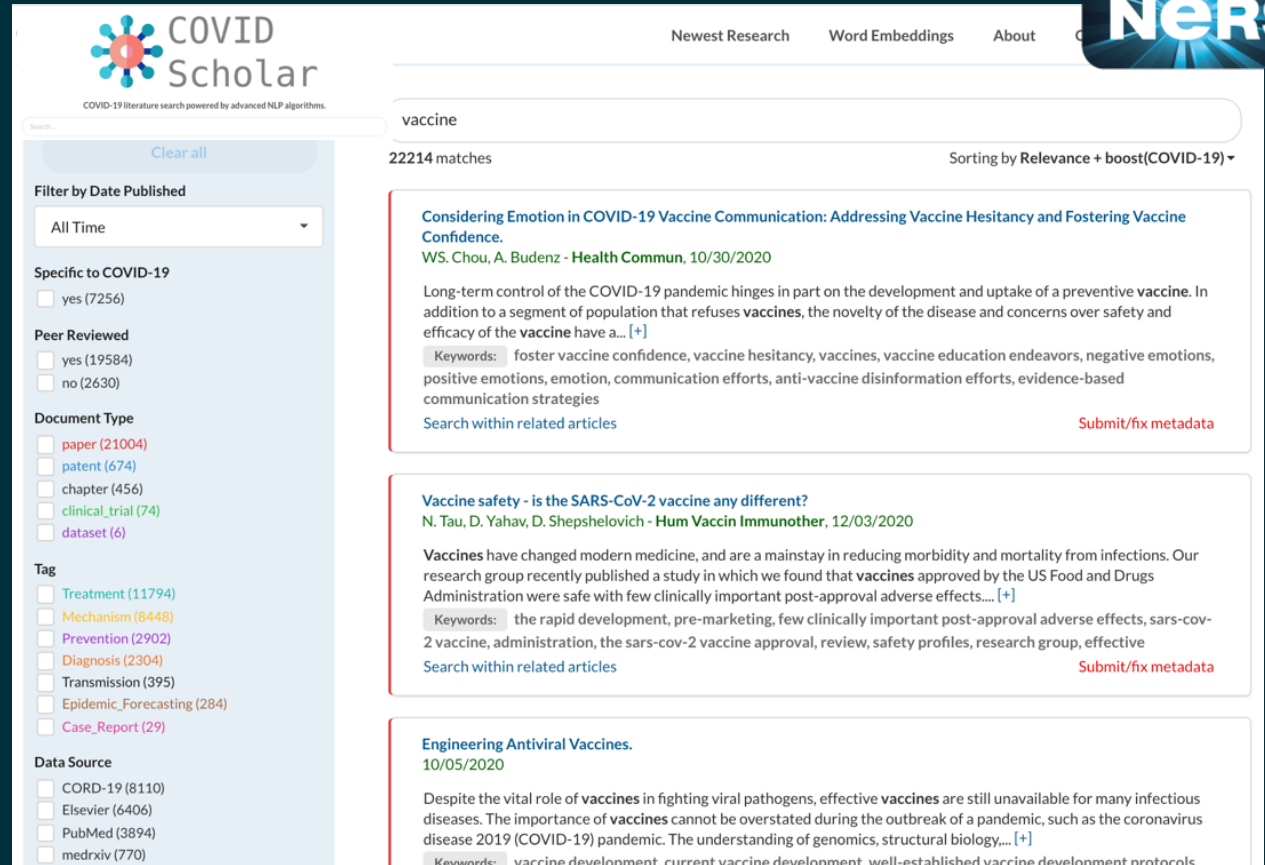
3D views of a cell infected with SARS-CoV-2, revealing how the virus alters cellular function

Identifying Promising Research Directions using Machine Learning

COVIDScholar is a knowledge portal that uses natural language processing to aid researchers in synthesizing the information spread across thousands of emergent research articles, patents, and clinical trials into actionable insights and new knowledge

- ~150,000 papers, clinical trials, patents...
- 2,000 unique users weekly

covid scholar.org



The screenshot displays the COVIDScholar web interface. At the top, there's a navigation bar with links for 'Newest Research', 'Word Embeddings', and 'About'. A search bar contains the term 'vaccine', and below it, it indicates '22214 matches'. The left sidebar offers various filters: 'Filter by Date Published' (set to 'All Time'), 'Specific to COVID-19' (checkboxes for 'yes' and 'no'), 'Peer Reviewed' (checkboxes for 'yes' and 'no'), 'Document Type' (checkboxes for 'paper', 'patent', 'chapter', 'clinical_trial', 'dataset'), 'Tag' (checkboxes for 'Treatment', 'Mechanism', 'Prevention', 'Diagnosis', 'Transmission', 'Epidemic_Forecasting', 'Case_Report'), and 'Data Source' (checkboxes for 'CORD-19', 'Elsevier', 'PubMed', 'medrxiv'). The main content area shows three search results. The first result is titled 'Considering Emotion in COVID-19 Vaccine Communication: Addressing Vaccine Hesitancy and Fostering Vaccine Confidence' by WS. Chou and A. Budenz, published in Health Commun on 10/30/2020. The second result is 'Vaccine safety - is the SARS-CoV-2 vaccine any different?' by N. Tau, D. Yahav, D. Shepshelovich, and Hum Vaccin Immunother, published on 12/03/2020. The third result is 'Engineering Antiviral Vaccines' dated 10/05/2020. Each result includes a brief abstract and a list of keywords.

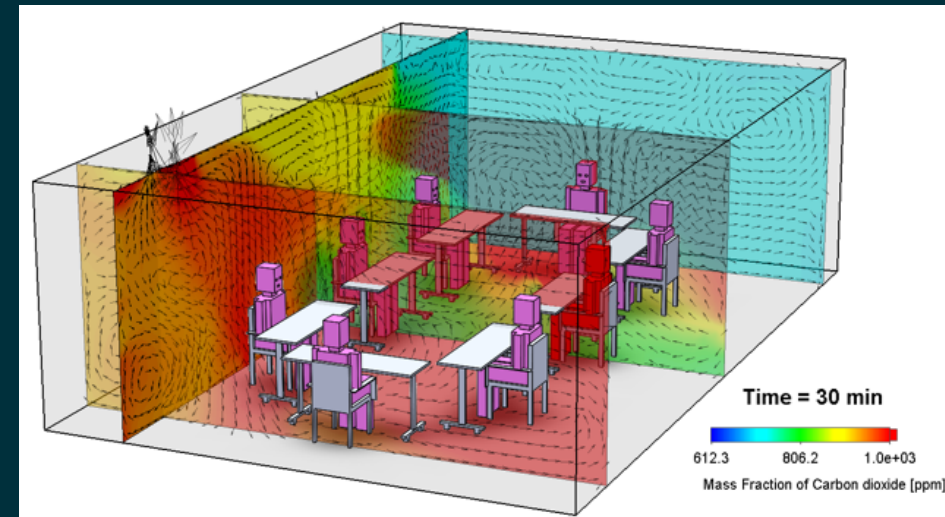
LDRD funding supported content acquisition/management and the creation of the web search portal. U.S. DOE National Virtual Biotechnology Laboratory funding supported the text corpus analysis and the development of machine learning algorithms.

Understanding the Drivers of Airborne Virus Transmission in Indoor Spaces

Berkeley Lab scientists are collaborating with colleagues at seven other national laboratories to study the airborne transport of the virus and how to reduce transmission in indoor spaces like classrooms and conference rooms.



Berkeley Lab is performing experiments in FLEXLAB that release carbon dioxide and particles in a manner that mimics the human exhalation of gas and fluids into the air



Sandia National Laboratories is using models to simulate and extrapolate from Berkeley Lab's experiments

COVID-based Research Visioning and Strategy: FY21 and Beyond



In anticipation of possible additional DOE funding for SARS-CoV-2 / COVID-19 research efforts, Berkeley Lab developed a strategic plan aimed at establishing or expanding capabilities across scientific Areas for future DOE mission research.

- Lays out a vision for multidisciplinary research across Berkeley Lab
- Identifies 7 strategies for new platform technologies and new research
- Each strategy has 2-year and 10-year goals, along with metrics and milestones to assess progress