Researchers tracing how COVID-19 spreads, mutates in the environment

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Viral ecologist Forest Rohwer with SDSU samples an uncleaned surface on an ATM machine in San Diego. Credit: Willow Rohwer for SDSU

A multi-disciplinary team of experts in virology and computer modeling has quickly assembled at San Diego State University to learn more about

how the new coronavirus (COVID-19) spreads in the environment and how its trajectory can be better predicted.

It is well-known that COVID-19 does not survive on surfaces that are frequently cleaned and sanitized, but what about surfaces in high traffic areas that are not routinely cleaned, such as gas station pumps, park benches and ATMs?

Recognizing the urgency and need for this research, the National Science Foundation has awarded SDSU's viral ecologist Forest Rohwer and his SDSU collaborator, Naveen Vaidya, a mathematician with simulation modeling expertise, a Rapid Response Research grant of $200,000. That is the maximum amount awarded under this program, and is designated to fast-track COVID-19 research.

The exploratory research Rohwer is leading serves two goals: It would help inform the California Department of Public Health and other public agencies about how the virus is spreading, and it could enable Rohwer's team to determine if there are environmental reservoirs where the virus thrives, which is now a big question.

"If there are reservoirs in the city that are unknown, we have to be careful," Rohwer said. "If we say the pandemic is over, and there are reservoirs we don't know about, there could be outbreaks in the future. How do you rule that out? We have to do the best we can with our sampling."

Public can help with sampling

A couple of weeks before the world woke up to the seriousness of COVID-19, virologists across the country met at "The Global Virome in Health and Disease" Keystone Symposia in Lake Tahoe, California where Rohwer delivered the keynote address on phage therapy.

One common belief prevailed during the meeting: We were simply not prepared for the global pandemic.

Even before he returned home, Rohwer, who previously discovered how to sequence the somewhat similar SARS virus, placed orders for the reagents needed to study the coronavirus' DNA. Reagents are compounds required to enable polymerase chain reaction (PCR) assay testing, when biologists make millions of copies of a specific DNA sample rapidly, so they can extract and study short strands of that DNA in more detail.

Back in the lab, Rohwer and his Ph.D. students began setting up the assays.

Their goal: While clinical researchers test and study the virus in humans, Rohwer and his students would leverage their expertise as environmental experts to study how the novel coronavirus was spreading in the community.

Since March, Rohwer's doctoral students, Mark Little and Jason Baer, have been preparing test kits and collecting environmental samples using simple swabs in common public areas. To extend the areas of sampling, Rohwer's team has now opened it up to the public.

Anyone interested in citizen science can apply and, depending on where they live in San Diego County, may be selected to receive a test kit. The researchers are seeking about 1,000 people in different parts of the County to conduct sampling.

Each kit contains 20 vials filled with the reagent and a mild detergent that will inactivate the virus but stabilize and preserve its genetic material, and 20 swabs, as well as disposable gloves and two types of masks (N95, and the Montana Mask which is a 3-D printable, reusable

plastic mask), and instructions on how to proceed.

To help with tracking, citizen scientists will be asked to upload information about where they conducted the sampling, the GPS coordinates and photos of the sampling surface. The kits will be picked up when sampling is completed. Rohwer's team is keeping the timeline open ended to ensure volunteers don't rush the process or limit themselves to one area.

Extraction and analysis

Once the samples arrive in the lab, they're stored in an -80 degree Celsius freezer.

Maria-Isabel Rojas, a microbiologist and Ph.D. candidate in Rohwer's lab who leads the lab testing, isolates and extracts the RNA, which she then converts into DNA via reverse transcription, so it can be amplified through the polymerase chain reaction (PCR) process.

She is looking for a very specific DNA fragment of the coronavirus, using the PCR process.

"Picture the DNA as a length of rope made with building blocks: each block is a letter, and the blocks are organized in a certain order dictated by the genetic code," Rojas said.

To identify SARS-CoV-2, the U.S. Centers for Disease Control and Prevention has found a very specific combination of these building blocks present at certain points of the DNA strand.

"The sequencing of RNA and DNA will tell us if the coronavirus has stayed the same, or if it has mutated," Rojas said. "If it has, we hope to be able to see how the virus is mutating, possibly so it can adapt better

and last in the environment in certain reservoirs."

Building models to predict risk and trends

The data she gathers will then be fed into models that will predict the risk of transmission from the environment, and what the trajectory of this disease would look like.

To do this, Rohwer will loop in mathematical and computational modeling expert Vaidya, who has expertise in building simulation models for various infectious diseases including the flu virus, to predict trends for how the SARS-CoV-2 virus behaves as it spreads.

"With a few weeks' worth of data we can estimate the risk of infection from the environmental virus and try to mimic what's happening with simulation models that predict transmission trends," Vaidya said. "This will also help us see how to ramp up cleaning surfaces, for example."

Vaidya is also using transmission parameters from the outbreaks in Wuhan, China, Italy and elsewhere, and will adapt it for San Diego County's population.

These include parameters such as the latent period when people are infected, but not yet infectious. The predictions from his modeling will help inform public health officials on where to focus their efforts next.

As this research evolves, Rohwer will also bring in additional SDSU researchers, computational biologist Rob Edwards and marine microbiologist Elizabeth Dinsdale, to harness their expertise in further analyzing the virus.

The researchers involved in this COVID-19 study are part of SDSU's Viral Information Institute, a cross-disciplinary coalition of

scientists—drawn from biology, math, computer science, chemistry and physics—exploring viruses from different angles.

"In addition to improving our current knowledge of SARS-CoV-19, this research will be important for the continuing response to CoVID-19 and future pandemics," Rohwer said. "This study will help us understand the ecology of viral-human interactions on surfaces, as well as train the next-generation of field virologists and modelers."

Provided by San Diego State University