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From the desert for the world…

BGU COVID-19 Response Effort

Hundreds of BGU scientists, researchers and students are working on some 70 projects to help mitigate and contain COVID-19 and/or its repercussions. Following are highlights from 20 of them:

DEVELOPMENT OF RAPID COVID-19 TESTS

Rapid COVID-19 Detection

Prof. Gabby Sarusi, deputy head of research at BGU's School of Electrical and Computer Engineering, and RAM-Group Global, a sensor design company based in Germany, have developed an electro-optical system that identifies COVID-19 coronavirus carriers in approximately two minutes with greater than 95% accuracy and a significantly lower cost per test than current available methods. The new system can be deployed in hospitals, at ports of entry or large events, and should be available within a few months. The hand-held, point-of-care device records and shares the results to facilitate virus tracking as well as triage and patient treatment.

Test to Identify Asymptomatic Carriers

A team of researchers has developed an algorithm-based test that can speed COVID-19 testing eightfold and help locate asymptomatic carriers. The testing system is based on the method of pooling, taking samples of eight individuals at once. If the results come out negative, everyone in the pool could be declared healthy. If positive, everyone in the pool will need an individual test. The test is currently undergoing clinical trials, while the Health Ministry just approved a pilot project in several centers across Israel. The research team includes Prof. Angel Porgador and Dr. Tomer Hertz from BGU's Shraga Segal Department of Microbiology, Immunology and Genetics and the National Institute of Biotechnology; Prof. Yonat Shemer-Avni, head of Soroka University Medical Center's Virology Lab, and Dr. Noam Shental from the Open University's Department of Computer Science.

A 5-Minute Definitive Home Test for Coronavirus

Dr. Hadar Ben-Yoav is a member of the Department of Biomedical Engineering. He is working on a device that will allow individuals to test themselves for COVID-19 with definitive results within five minutes. A finger-sized diagnostic kit, based on lab-on-chip technology, will enable remote monitoring of coronavirus levels via saliva swab to be conducted at the patient's home. He is collaborating with medical researchers with access to and expertise in naturally produced antibodies.

Detection of COVID-19 Virions in Saliva Enabling Patient Triage

Prof. Robert Marks, of BGU's Department of Biotechnology Engineering, is developing a saliva-based lateral flow one-step test to detect COVID-19, enabling quick triage of patients and allowing for a greater number of screenings. The lower accuracy of the test will be compensated by a greater increase in the number of people tested. Therefore, even with some false negatives, many more positive results will be found, enabling immediate quarantine and containment.

IDENTIFYING ANTIBODIES TO INHIBIT INFECTION

Using Antibodies to Prevent SARS-CoV2 From Entering the Host Cell

Prof. Angel Porgador, Dr. Ran Taube, Dr. Tomer Hertz, and other researchers in BGU's Shraga Segal Department of Microbiology, Immunology and Genetics have formed a consortium to identify neutralizing monoclonal antibodies capable of inhibiting viral entry into target cells. They are also working on developing techniques based on antibody dependent enhancement to predict the severity of COVID-19 and the resultant need for ICU treatment.

Yeast Display of SARS-CoV2 Antigens

Dr. Roi Gazit, of BGU's Center for Evolutionary Genomics and Medicine, is working on determining which individuals have natural immunization, while providing an option for developing mass immunization of the population. Antibodies provide immunity, and quantification of anti-SARS-CoV2 antibodies can identify individuals who have natural immunity following infection and recovery. The type of antibodies may also suggest recent exposure, or earlier exposure that yielded a long-lasting immunity. Utilizing yeast-display, a method by which specific proteins are expressed on the surface of yeast-cells, scientists can develop a platform for the expression of SARS-CoV2 antigens.

NEW DEVICES ENABLING CONTAINMENT

Self-Sterilizing Face Masks Using Anti-Bacterial Graphene

Dr. Chris Arnusch, of BGU's Zuckerberg Institute for Water Research, works on water purification by developing membranes with anti-bacterial and anti-viral properties. For the past five years, he has concurrently been working on air filters with enhanced anti-viral properties. The air filters could then be incorporated into individual face masks that are self-sterilizing. They could also be adapted for ventilation systems in buildings and for use in vehicles. Dr. Arnusch is teaming-up with immunology experts to test the air filters and their anti-viral effectiveness.

Anti-Coronavirus Surface Coating

While COVID-19 is transmitted between people via respiratory droplets, it is known that the virus remains stable on various surfaces for days. Therefore, it is important to be able to sterilize surfaces with high contamination potential, such as doorknobs, elevator buttons or handrails in public areas in general, and in hospitals and clinics in particular.

However, current disinfectants are mainly based on chemicals such as poisonous sodium hypochlorite (bleach) or alcohol, both of which provide only a temporary measure until the next exposure to the virus. Prof. Angel Porgador, from the Department of Microbiology, Immunology and Genetics and the National Institute of Biotechnology in the Negev (NIBN), and Dr. Mark Schvartzman, Department of Materials Engineering, are developing novel surface coatings that will have a long-term effect that contain nanoparticles of safe metal ions and polymers with anti-viral and anti-microbial activity. The researchers are developing anti-viral coatings that can be painted or sprayed on surfaces. The technology has received financial support from the Israel Innovation Authority.

Automatic Sanitizer for Public Objects

Graduate students in BGU's Department of Mechanical Engineering are building a device that can be attached near any door knob/handle, elevator buttons and other high-access objects that will automatically sanitize them (using alcohol or other substance) after the object is touched. This device can be relatively inexpensive and can be easily integrated into public institutions, hospitals and malls to help minimize the spread of viruses. The project is a collaboration with Prof. Ilana Nisky and Dr. David Zarrouk.

Mucus Removal for the Respiratory System

Dr. David Katoshevsky, of BGU's Environmental Engineering Unit, is developing a system that will automatically help patients clear blockage from their respiratory system. The blockage, formed by and containing the virus, will be cleared during the respiratory process. This is a joint project with Dr. Yuval Kavari of Soroka University Medical Center and Dr. Shimon Lerman.

Using Robots to Communicate With Patients and Automating Lab Tests

Dr. Amir Shapiro, director of BGU's Robotics Laboratory, is collaborating with Soroka University Medical Center and RoboTiCan (a BGU alumni-founded robotics company) to build a robot that could visit patients in the hospital and communicate with them by telepresence. A prototype has been built and is now being tested at Soroka. In another project, they are working on the automation of a virology laboratory. The goal is to develop an automatic production line to increase test production and shorten the time needed for each test.

MORE PROJECTS

Analyzing COVID-19 in Wastewater

Prof. Ariel Kushmaro, of the Avram and Stella Goldstein-Goren Department of Biotechnology Engineering, is leading a team that is studying the general distribution of COVID-19 abundance and diversity in the urban sewage system and water cycle. Sewage surveillance can provide better estimates of how widespread the virus is and help determine the extent of those who are infected but have not been tested and are asymptomatic or have only mild symptoms. If the virus is identified in wastewater, using the population size, the researchers can calculate the amount of virus shed in feces and then extrapolate the number of infected people in a population from these samples. The

research team also includes Dr. Yakir Berchenko of BGU's Department of Industrial Engineering and Management; Dr. Oded Nir, of the Department of Desalination and Water Treatment at BGU's Zuckerberg Institute for Water Research; Dr. Itay Bar-Or, a virologist from Sheba Medical Center; and Prof. Eran Freedler at the Technion Israel Institute of Technology.

Examining the Antiviral Components of Microalgae

Microalgae is a potent and renewable resource of antiviral compounds. Prof. Inna Khozin-Goldberg, French Associates Institute for Agriculture and Biotechnology of Drylands, and Dr. Rivka Ofir, of BGU's Center for Regenerative Medicine, Cellular Therapy and Stem Cell Research, will lead a team of researchers to identify potent antiviral agents. Engineering these materials could potentially slow down virus reproduction and would enable patients in early phases of the virus to take alga medication in tablet form or apply plant-based ethereal oil.

Drug Repurposing Using Machine Learning

Applying existing drugs to target COVID-19 could dramatically shorten the time and reduce the cost compared to new drug discovery. Prof. Lior Rokach, Department of Software and Information Systems Engineering, is overseeing a team to develop supervised antiviral drug repurposing and combinations using a multimodal machine learning model. The model will input various known aspects of drugs, such as molecular structure, drug targets, related human proteins, known indications, side effects, and more. Potential drugs and drug combinations that might be useful in treating the virus will be ranked. For example, using a machine learning model for predicting drug safety during pregnancy, Dr. Rokach has found that the drug hydroxychloroquine (plaquenil), a drug of unknown safety for use during pregnancy and a potential treatment for COVID-19, is safe for usage during pregnancy with a probability of 98%.

AI Analysis of Verbal Characteristics to Aid in Early Diagnosis

Vocal characteristics of speech are affected by emotional and physical states. Prof. Julie Cwikel, of BGU's Center for Women's Health Studies and Promotion, and Dr. Tal Sobol-Shikler, a researcher in artificial intelligence (AI) and machine-learning, are using AI to identify in real time changes in vocal patterns that can be used as an early warning system for detecting emotional or physical distress that requires rapid intervention. The system will monitor both medical personnel who are working at or over capacity and persons in isolation who may be developing symptoms.

Prediction, Tracking and Real-time Monitoring of Infection in Large Populations

The unprecedented speed of the coronavirus pandemic outbreak emphasizes how critically important it is to have accurate tools for predicting the rate of the disease progress, analyzing likely scenarios, and better preparing the health systems and general public. Project leaders Prof. Gonen Ashkenasy and Dr. Nathaniel Wagner of BGU's Department of Chemistry are developing a versatile generic simulation that would enable prediction of the number of people infected at various points in time. This will

allow them to model multiple future scenarios affected by environmental changes and the growing number of infected people in the studied population. This analysis will provide workable predictions for the progress of the disease in the absence of imposed social distancing measures. As more information becomes available on results of social distancing practiced in several countries, this data will be used for machine learning analysis, to indicate which activities would be most effective and optimize the timing and local (i.e., within certain cities) implementation of these measures.

ADDRESSING THE NEEDS OF THE COMMUNITY

Distress, Compliance and COVID-19

A team of researchers spearheaded by Prof. Golan Shahar from the Department of Psychology is studying the behavioral unfolding of COVID-19 in Israel. The team has contacted a representative sample of Jewish Israeli adults prior to the entry of COVID-19 to Israel, and is assessing them every week, focusing on their anxiety, perception of the crisis, attitudes toward the Ministry of Health, and compliance with the ministry's instructions. Several assessments have already been conducted, and many more are planned during this unparalleled, sophisticated study. Results will inform policy makers on emotional responses of the Israeli public in the face of the ongoing medical crisis.

Medical Emergency Drones

Dr. Jessica Cauchard is a member of the Department of Industrial Engineering and Management. Dr. Stav Shapira is a member of the School of Public Health. They are currently conducting research that focuses on integrating drones in emergency healthcare and delivering relief supplies such as food, water and medications to vulnerable populations during large-scale public health emergencies, such as the current COVID-19 eruption. The study is exploring the socially sensitive acceptance of medical relief drones among older persons and ethnic minorities. Their ultimate goal is to develop effective strategies for minimizing exposure among at-risk populations, as well as to prevent the potential deterioration of patients with chronic illness during acute events such as a viral pandemic.

Responding to the Elderly

With a deep concern for the elderly who are especially vulnerable, this project team of geriatric physicians and specialists, emergency medical response personnel, and public health experts (Prof. Mark Clarfield, M.D., Dr. Stav Shapira, Prof. Limor Aharonson-Daniel, and Dr. Paula Feder-Bubis) have already begun to establish a system to identify, map and assist elderly people in need of care in the event of a natural disaster. This initiative is being repurposed for the current corona crisis, and is incorporating innovative technological applications to customize an effective care system for the elderly.

The team is also working to enhance the online communication skills among older people. Online communication via social networking sites can offer solutions for social interaction in times of epidemic. However, since older people have lower rates of

technological literacy this may cause them to encounter barriers to internet use, thus leading to further social exclusion.

This project will conduct a training process for increasing online communication skills among older persons in the community. In the study, to take place in collaboration with social services of the Beer-Sheva municipality and Lehavim local council, BGU students will serve as personal instructors for older persons, conducting telephone and online sessions to teach tools for audio and visual communication – WhatsApp, Zoom and conference phone call.

Skills acquired in this project can be applied in routine daily life following the pandemic. In addition, older persons with knowledge to independently communicate online with others will be able to better adhere to protective guidelines of physical distancing and will thus minimize their exposure to the virus. The project can also increase community resilience by strengthening social connectedness through intergenerational ties.

New Media and Healthcare Professionals' Experience

Dr. Odeya Cohen is a member of Department of Nursing and serves as the head of the master's program in emergency medicine. She is collaborating with communication experts and researchers from the Department of Software and Information Systems Engineering to crosscheck formal publications and conversations in social media on a timeline related to coronavirus crisis phases. This study will investigate the efficiency of these efforts within Israeli society and throughout its sub-populations.

In another project she is leading a team to understand the experience and difficulties of professional health teams by analyzing the narrative that is reflected in social media. This study will explore and help to understand the experiences of healthcare workers in the face of the COVID-19 outbreak as they cope with new techniques of isolation, new needs of high emotional load, and dealing with the unique health system – needs that until now were unknown.

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