A LETTER FROM THE FOUNDING DIRECTOR

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The Wyss Institute for Biologically Inspired Engineering at Harvard University is not a basic research institute; it’s a translation institute focused on technology innovation and impact. Since our founding in 2009, we have been driven by the belief that breakthrough discoveries cannot change the world if they never leave the laboratory. To achieve our goal of improving human health and the environment by leveraging biological design principles from Nature, we have developed a unique organizational model within academia. Our approach breaks down traditional silos to enable collaborations that cross disciplines and institutions, and removes barriers between academia and industry to produce and commercialize innovative technologies that can have near-term impact in the world.

The projects that have spun out or been licensed from the Wyss Institute over the past eleven years are on their way to revolutionizing an incredible diversity of fields ranging from drug development, cancer treatment, and genetic testing to physical rehabilitation, and many more exciting projects are underway. Several of the startups that have spun out of the Wyss Institute are also redirecting their efforts toward COVID-19, including Sherlock Biosciences and Emulate, Inc. Most impressively, some of the COVID-19-related technologies we developed over the past few months have already been licensed and are now being used both nationally and internationally.

Our first decade was our proving ground in which we transformed from an idea on paper into a world-leading translational institute, demonstrating that our approach to innovation, while unorthodox, produces powerful impact. Having entered our second decade, we are now building on that foundation by exploring new partnerships, new collaboration structures, and new focus areas, pursuing ideas that others may call “risky,” but that we believe will change the world for the better. We collaborate with universities, hospitals, and companies around the world, and have received recognition from numerous organizations for excellence in a variety of fields. And we’re just getting started.
ON DECEMBER 31, 2019, a cluster of what looked like pneumonia cases were reported in Wuhan, China, and it was determined that they were caused by a coronavirus that had not been seen in humans before. Less than two months later, the virus had morphed from a curiosity into a worldwide pandemic, and the Wyss Institute quickly shifted its members to remote work to minimize the risk of infection. But we are a community of problem solvers and, when faced with the problem of fighting COVID-19, our instinct was to lean in.

Since mid-March, more than 70 Wyss researchers have volunteered to put their own work on hold and go back into the lab (wearing appropriate PPE, of course) working full-time to devise ways to combat the novel coronavirus, and support staff have mobilized to ensure access to the materials needed despite shut-downs and shortages.

Wyss Institute members continue to work on more than 18 separate projects with collaborators around the world aimed at bringing the pandemic to an end.
New Problems to Solve

Many of the people working on COVID-19 at the Wyss Institute aren’t infectious disease experts, but they are experts at identifying opportunities to apply their skills to new problems and collaborating across disciplines to solve them. A number of existing research projects already underway have been repurposed to focus on COVID-19 diagnosis, treatment, and prevention. Other teams have taken on challenges beyond the scope of their fields, like designing and manufacturing personal protective equipment (PPE). Importantly, many of these technologies can also be adapted to address future viral pandemics.

Personal Protective Equipment

**Nasal Swabs**

The nasopharyngeal and nasal swabs used to collect clinical samples for diagnosis of COVID-19 and other infections are manufactured from various materials and assembled in multiple steps, adding time, cost, and complexity to their production. A shortage of just one component can completely derail the supply chain, hampering efforts to test and diagnose patients. A multi-institutional group led by Wyss Institute members in collaboration with the Beth Israel Deaconess Medical Center created a new nasal swab design that can be injection-molded in a single step, reducing the time and cost of manufacturing swabs at large volume. This design has been licensed to multiple commercial manufacturers that can produce millions of swabs per week, and the swabs are now available for purchase in the U.S. and internationally.

**Face Shields**

Face shields, which are also in short supply, are made of multiple materials subject to supply chain disruption. Multiple groups within the Wyss Institute used 3D printers and laser cutters to fabricate face shields, which were tested at the Boston Children’s Hospital and then delivered to regional hospitals and clinics. Other Wyss-led designs that protect users in a variety of environments and can be made for a fraction of the cost of a traditional face shield are currently available for purchase from a local manufacturer that can produce up to 100,000 per day for regional and national distribution.
IMPACT IN THE AGE OF COVID-19

Diagnostics

SINGLE-MOLECULE DETECTION

An ultra-sensitive molecular diagnostic assay based on the Simoa® system is being developed to detect SARS-CoV-2-specific RNA and viral proteins in parallel, as well as patient-specific markers. This technology is capable of detecting targets down to the single-molecule level, and can be multiplexed to test thousands of samples at once.

RAPID MULTIPLEXED DETECTION

The eRapid platform, which can detect multiple different biomarkers simultaneously with high sensitivity and specificity at low cost, is being used to develop a diagnostic test for blood or saliva samples that can give readouts of both the SARS-CoV-2 virus and multiple types of anti-CoV-2 antibodies, allowing for rapid detection of patients who are either actively infected or were previously infected in a single test.

AT-HOME DIAGNOSTICS

A suite of bioinspired DNA nanotechnology techniques is being adapted to create a cheap, disposable test that can detect viral RNA or protein from a nasal swab sample and display a colored line on a strip of nitrocellulose paper, much like a home pregnancy test. This handheld test is easy to manufacture at a large scale and does not require special equipment or expertise to use.

WEARABLE DIAGNOSTICS

An ongoing project to embed synthetic biology-based sensors into textiles is being used to create face masks that change color when the wearer has been exposed to CoV-2 viral particles, which can help keep frontline healthcare workers safe when treating COVID-19 patients.
Therapeutics

Drug Repurposing

Wyss computational pipelines that have been successfully used to identify existing FDA-approved drugs for new applications in the past are now being leveraged to identify existing drugs that might inhibit SARS-CoV-2 virus infection or augment the body’s response to COVID-19. Those compounds are then tested to confirm their ability to inhibit infection by SARS-CoV-2 and related coronaviruses both in the Institute’s human lung and intestine Organ Chips and in preclinical cell and animal models in collaborators’ labs at the University of Maryland and Mount Sinai. The team is currently focused on quickly transitioning the first high-potential compounds they have identified into clinical trials.

Broad-Spectrum Therapeutics

The Institute is pursuing two approaches to create new drugs that will inhibit infection by SARS-CoV-2 as well as a broad spectrum of other respiratory viruses that could represent future pandemic threats. One leverages our proprietary computational drug design pipeline to create drugs that target a conserved region within the CoV-2 Spike protein that is shared by many coronaviruses. The other approach focuses on developing RNA therapeutics that augment the body’s response to infection, and has produced compounds that inhibit infection by SARS-CoV-2 and related coronaviruses, and various strains of influenza.

Therapeutic Antibodies

A team of researchers is using computational design to create therapeutic antibodies that target the SARS-CoV-2 Spike protein. These antibodies could be engineered to recognize the most relevant therapeutic targets and be manufactured with high efficiency, and could provide advantages over plasma transfusion therapies or natural antibodies isolated from patient blood samples.

Vaccines

OMNIVAX, a versatile biomaterial-based vaccine platform that can be customized to help the body mount an immune response against of a wide variety of viral and bacterial pathogens, has been coupled with SARS-CoV-2-specific antigens. Initial results from animal testing have shown that the vaccine generates the rapid and robust production of neutralizing antibodies against the virus without requiring a booster dose.

Giving Back

Access for All Patients

The COVID-19 pandemic is a global health crisis that demands rapid and universal solutions for the greater good. As part of the Harvard University Office of Technology Development’s new COVID-19 Technology Access Framework, technologies developed at the Wyss to prevent, diagnose, and treat COVID-19 infection during the pandemic can be commercialized under rapidly executable, non-exclusive, royalty-free licenses. These products will be distributed as widely as possible and at a low cost that allows broad accessibility during the term of the license.
Community Leadership

In early March 2020, hospitals across Massachusetts were bracing for the rising tide of COVID-19 cases despite the absence of any proven COVID-19 treatments, limited diagnostic capabilities, and shortages of PPE for frontline healthcare workers. To help “flatten the curve” while protecting front-line clinical staff, the Mass General Brigham Center for COVID Innovation was created as a research and engineering consortium within the Boston hospital system. Many members of the Wyss community were tapped to lead working groups within the Center that focus on specific COVID-related problems, such as diagnostics, therapeutics, and PPE.

David Walt was appointed to co-lead the Mass General Brigham Center for COVID Innovation. David also serves on the National Academies Committee on Emerging Infectious Diseases & 21st Century Health Threats, and continues to lead research efforts at the Wyss Institute to develop ultrasensitive diagnostics.

Wesley Wong leads the Horizons Technology working group, which supports fundamental researchers who are interested in repurposing some of their discoveries into clinical products, identifies new diagnostic opportunities, and evaluates emerging technologies to help address the pandemic. Within the working group, Jessica McDonough is leading the Engagement subgroup to develop a path for these technologies to clinical testing.

Pawan Jolly leads the Point-of-Service Diagnostics working group, which identified, analyzed, and ranked existing diagnostic tests for use in clinics and hospitals, creating a shortlist of the most effective tests that are being further evaluated by the Center.

Rushdy Ahmad leads the Direct-to-Consumer working group, which performed a similar scan of antigen- and serology-based rapid diagnostics designed for consumers to use at home.

“Wyss faculty and staff have been incredibly effective at leading all aspects of the Mass General Brigham Center for COVID Innovation, bringing their highly innovative and translational perspective to the Center’s activities.”

David Walt, Wyss Faculty

Jennifer Lewis and James Weaver co-lead the Face Shields working group, which has designed, optimized, and delivered thousands of easy-to-manufacture face shields for frontline healthcare workers.

Richard Novak is a leader of the Nasal Swabs working group, which has designed a new nasal swab for COVID-19 test kits that can be mass-manufactured without the need for traditional supply chains.
Disruptive Innovation
Inspired by Nature

- Licenses: 66
- Startups: 35
- Funding raised by startups: $875M+
- Harvard patent applications enabled by Wyss Research: ~24%
- Patents issued: 704
- Publications: 2,320
As an industry executive who reentered the academic world by joining the Wyss Institute in February 2019, it has been incredibly exciting to gain access to a wide range of new and innovative technologies focusing on unmet needs in therapeutics, diagnostics, and medical devices, and important questions in sustainability, which our society urgently needs to address. Equally invigorating is being able to work with the tremendously talented people at the Wyss, helping them formulate the end user case for their technologies, establishing target product profiles, and defining de-risking pathways so that these technologies can exit the Wyss sooner rather than later, and then grow into impactful products.

Collaboration is front-and-center for us. Embedded within our multiple scientific focus areas are members of our Advanced Technology Team (ATT), who have extensive industrial product development experience earned from previous work at a broad range of companies including AstraZeneca, Dow Chemical, Proctor & Gamble, Sonos, and more. Our ATT members help our scientists identify ideas that have commercial potential and design the experiments needed to validate them, drawing on their deep knowledge of what the biotech and pharma industries are looking for in new products.

The most promising ideas are given additional support from our in-house business development team, which works with project leaders to determine the best path toward commercialization, make connections with potential investors, licensees, and funders, and craft market strategies.

Through our entrepreneur-in-residence program, we bring the right person on board to help guide each project towards the right user application and business model, and to build a strong team to get it to the market. These collaborative efforts have paid off - we have licensed 66 technologies and spun out 35 startup companies to date.

Our commercialization collaborations also extend beyond the walls of the Wyss Institute. We are always interested in refining our use case or business plans for a product through invaluable input from the business community, both locally and, increasingly in the COVID-19 era, remotely. We also work closely with the hospitals around us to understand how our technologies could help patients and physicians, and are devising new ways to combine forces in order to drive the creation of solutions that are useful and valuable in clinical settings.

We understand that the problems that exist in the world today are varied and complex, and solving them requires bringing together people with diverse skill sets and backgrounds who would not otherwise interact within traditional institutional structures. By integrating the best scientists and engineers in the world with experts in product development and business strategy, we create dynamic teams that coalesce around a good idea, take it as far as possible in the lab, and then release it into the world.

The Wyss Institute’s core mission is to translate innovative discoveries into technologies that can be commercialized via the formation of startups or successful licensing. To enable our teams to achieve that goal, we have initiated an annual Validation and Institute Project program that allocates resources to promising projects across the Institute’s platforms, based on their potential for impact and commercialization. Funded projects adhere to a rigorous timeline with specific milestones throughout the year, and, upon successful completion, are supported through further research, licensing, or startup formation.

In the spring of 2020, 28 projects were submitted for this year’s review process (the largest number of submissions to date), and 11 received funding. Our review team consisted of 16 industry professionals who have worked in life science, pharmaceutical, biotechnology, healthcare, and technology companies, with expertise in business development, product development, marketing, startups, technology transfer, and commercialization.
Startup Spotlights

The Wyss Institute’s impact extends far beyond our lab walls and into the real world, where our technologies are commercialized by startups and licensing partners to improve the lives of people worldwide. Sherlock Biosciences and Emulate, Inc. are just two examples of our successful commercialization efforts that are working with groups in academia, biopharma, and government to apply their technology to fight COVID-19.

SHERLOCK BIOSCIENCES

Cambridge-based startup Sherlock Biosciences licensed technology developed by the Wyss Institute in March 2019 to bring affordable molecular diagnostics to the market. When the COVID-19 pandemic hit just a year later, Sherlock quickly focused their R&D efforts on creating diagnostics for the disease. In early May, Sherlock received Emergency Use Authorization from the U.S. Food and Drug Administration for laboratory use of their SHERLOCK platform to test for SARS-CoV-2, launching the Sherlock™ CRISPR SARS-CoV-2 kit through a strategic collaboration with Integrated DNA Technologies (IDT). Developed by the Broad Institute at Harvard and MIT, SHERLOCK enables the detection of nucleic acid targets down to single-molecule levels, and was the first CRISPR-based technology ever approved for emergency use.

Open Philanthropy also advanced Sherlock Biosciences $7.5 million from an initial $17.5 million non-dilutive grant to accelerate the development of INSPECTR™ as an at-home COVID-19 diagnostic.

EMULATE, INC.

In 2014, Boston-based Emulate became the first startup to spin out of the Wyss Institute, with the goal of continuing the development of human Organs-on-Chips technology and commercializing it for use across drug development, academia, and government agencies. Organs-on-Chips, developed by an interdisciplinary team led by Donald Ingber, are microengineered cell culture systems about the size of USB memory sticks that contain hollow channels lined with multiple living human tissues interfaced together and exposed to physical cues that they experience in our bodies, such as fluid flow and breathing motions. These chips mimic human organ-level physiology and disease states, as well as responses to drugs that is beyond that obtained with conventional cell culture systems. Organs-on-Chips technology enables researchers to study molecular- and cellular-scale activities, gain new insights into biological functions in both healthy and diseased states, identify or validate new therapeutic targets, and recapitulate patient responses to clinically relevant drug exposures in vitro.

Six years after launching, Emulate has achieved 150 installations of its Zoe® Culture Module, including at 10 of the top 25 global biopharmaceutical companies, the U.S. Food and Drug Administration, and the U.S. Army. Multiple labs, both at the Wyss Institute and elsewhere, are now using Emulate’s Organ-Chips platform to model the SARS-CoV-2 infection in the race to identify existing drugs that can be repurposed to treat COVID-19, understand the viral pathogenesis, and develop new therapeutics.
ANGELIKA: How has the COVID-19 pandemic impacted your ability to continuously engage with important VC [venture capital] firms?

JESSICA: Part of my responsibilities at the Wyss is to support projects that are interested in raising funds for a future startup company. The shift to remote work was a significant transition from our typical in-person meetings, but we immediately switched to utilizing online meeting and collaboration tools. The venture capital community continues to be very interested and engaged in the projects at the Wyss and they want to meet the entrepreneurial teams behind our innovative technologies and emerging business plans. We transitioned very quickly to allow these important interactions to happen, often very effectively with multiple teams in a short window of time.

ANGELIKA: You were able to organize some virtual roundtables with 5AM Ventures – how did that come about?

JESSICA: We were already engaged with 5AM about specific projects, and they expressed interest in learning more about other ongoing projects at the Wyss. We initially met with them to figure out a meeting format and which projects would be a good fit. Then, the Wyss project leads presented their work, with the opportunity to receive feedback on their projects from 5AM Ventures and ask targeted questions to support their strategy.

ANGELIKA: What were the challenges and surprises of working in a virtual roundtable?

“\nThe main challenge, which I think we accomplished very well, is to get across the tremendous talent, energy, and excitement of our teams when they talk about their technologies and commercial vision.

JESSICA MCDONOUGH

JESSICA: At first, we were not sure if a virtual meeting would allow us to achieve this important goal, but we were surprised to see these interactions be so efficient, informative, and fun.

ANGELIKA: Do you think the roundtable was successful? If so, how, and do you think the changes due to COVID-19 will impact the business development process long-term?

JESSICA: I believe that the roundtable provided a great opportunity for our teams to connect with venture capitalist and other teams. COVID-19 will change the way we connect and collaborate in the long term, and continued utilization of new online tools to support our projects will be key. Sometimes the virtual format actually lowers the logistical hurdle to get these larger roundtables organized. The Wyss culture is collaborative, creative, and adaptive, so we look forward to new ways of doing business.
Future Impact

We are developing tests, treatments, and technologies that have the potential to make a significant impact in the world in the near future. We are constantly looking for partners and collaborators who want to help bring these projects to fruition. Learn more about some of our emerging projects below.

HEALTHCARE

OMNIVAX
A modular, injectable vaccine platform that can induce immune memory against a wide variety of viral and bacterial pathogens.

eRapid
Multiplexed electrochemical sensors for fast, accurate, portable detection of nearly any biomarker in whole blood, saliva, or serum in hospitals or at the point-of-care.

CogniXense
Powerful computational drug discovery algorithms coupled with an organism-level modeling platform that allow for rapid, multiplexed analysis of motor and cognitive function to identify potential treatments for human neurological diseases.

3D Organ Engineering
Innovative 3D-printing and other regenerative medicine technologies that enable the creation of large, vascularized tissues that can survive in vivo and could lead to implantable organs.

MyoExo
A comfortable and unobtrusive wearable device for tracking hand and muscle movement to help diagnose and monitor Parkinson’s Disease.

SUSTAINABILITY

Circe
Biodegradable plastics manufactured by engineered microbes that convert greenhouse gases into plastic polymers at a fraction of energy, cost, and land use of plant-derived bioplastics.

DNA Data Storage
Integrated information storage technology for writing large amounts of digital information into DNA using an enzyme-driven, sustainable, low-cost approach.

COLLABORATE WITH US
Email Angelika Fretzen at a.fretzen@wyss.harvard.edu to learn how you can get involved.
Breakthrough discoveries cannot change the world if they do not leave the lab