JOHNS HOPKINS
TECHNOLOGY VENTURES

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FY20 ANNUAL REPORT

Bringing the benefits of
academic discovery
to the world

JOHNS HOPKINS
TECHNOLOGY VENTURES

A YEAR TO REMEMBER

... And not just for the reasons we anticipated! The coronavirus pandemic was unexpected and unprecedented. It tested the limits of our flexibility, resilience — and our technology. The Johns Hopkins Technology Ventures (JHTV) team continued its work remotely, and had the unique privilege of supporting researchers and startups in the urgency of the moment. Our university is a dynamic place, always pulsing with innovation and creativity, but it was, in many ways, at its best this spring.

Pandemic aside, our **new website was launched** on the eve of our fifth anniversary and then quickly put to the test as a key tool for helping faculty members and students access resources from afar. This year, we launched our **Women in Innovation initiative,** supporting female entrepreneurs across Johns Hopkins. Our student teams participated in FastForward U's **student accelerator program**, and our student teams continue to earn recognition across the country. We also embraced a swell of innovation activity in software, cell and gene therapy, and precision medicine.

Please read on. We are grateful to serve our students and our faculty, and we love to share and celebrate their breakthroughs.

Onward,

Christy Wyskiel
Executive Director, JHTV
Senior Adviser to the President
for Innovation and Entrepreneurship

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YEAR-IN-REVIEW

RANKING

7 Ranked by the **National Academy of Inventors** and the Intellectual Property Owners Association's report "Top 100 Worldwide Universities Granted U.S. Utility Patents"

10 Named a top 10 university for startups in **IP Watchdog's** 2008–2018 report

LICENSING

464 REPORTS OF INVENTION

$27.3M LICENSING REVENUE

114 LICENSES AND OPTIONS

173 NEW U.S. PATENTS

STARTUPS

$278M RAISED BY

23 LICENSED STARTUPS

11 LICENSED STARTUPS CREATED

$24M RAISED BY

63 STUDENT-LED VENTURES

9 OTHER VENTURES CREATED

$17.3M CORPORATE-SPONSORED RESEARCH COLLABORATIONS MANAGED BY JHTV

27 TEAMS RECEIVED TRANSLATIONAL FUNDING TOTALING **$3.1M**

COVID-19

The pandemic provided the opportunity for **Johns Hopkins startups** to pivot their focus in an effort to help those in need

BURNALONG
CLEARMASK
EMOCHA MOBILE HEALTH

MARKET SUCCESS

Net Health acquired **Tissue Analytics**, founded by Whiting School of Engineering students. This will expand Net Health's leadership position in the wound care market and will accelerate the delivery of next generation wound care technology solutions.

TOP STORIES OF 2020

Our startups and researchers made great strides in their innovations, attracting industry attention, and funding along the way. The coronavirus pandemic altered plans for many but also sparked new research and discovery. The following is a selection of the compelling stories we documented this year.

COVID-19

» Coronavirus Vaccine in Development at Johns Hopkins
» Johns Hopkins Alum's Skin Care Company Now Producing Hand Sanitizer
» Johns Hopkins Engineers Develop 3D-Printed Ventilator Splitters

STARTUPS

» Thrive Earlier Detection Releases Results of First Study on Multicancer Blood Test
» Galen Robotics Makes Itself at Home in Baltimore with New Offices, Internship Program

STUDENTS

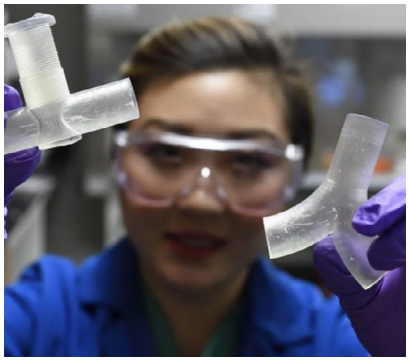
» Student Engineers Design a Solution to Address Common Dialysis Complication
» FastForward U Spark Team Wants to Reinvent the Food App Industry

AWARDS

» Five Johns Hopkins Startups Receive Inaugural Microsoft Acceleration Awards for Artificial Intelligence and Data Science Technologies

COLLABORATIONS

» Johns Hopkins, Toshiba Collaborate on Precision Cardiovascular Medicine Project
» Basic-Science Researcher Shows Path to Corporate Collaboration



3D Printed Ventilator
PHOTO: Will Kirk/The Johns Hopkins University

From the left: **Flave co-founders Jal Irani, Derek Battle, and James Soldinger**
PHOTO: Beatrice Shim/FastForward U

Galen Robotics' president and CEO Bruce Lichorowic, second from right**,** and **Dave Saunders, chief technology officer and co-founder,** third from right, with former Johns Hopkins interns
PHOTO: Galen Robotics

TECHNOLOGY TRANSFER

JHTV's **Technology Transfer** group is privileged to support the translation of best-in-class science to the marketplace, so that discoveries can be most impactful in addressing unmet needs. Notwithstanding Johns Hopkins' preeminence in life sciences and health care innovation, the **technology portfolio** is broad, and there is no ground we are not breaking – literally this year, we licensed a geothermal well technology! As the university went "remote" this spring in response to COVID-19, our office saw an uptick in faculty interaction — reports of invention in April and May were up 40%. Licensing activity also grew during that period, with a 25% increase in license executions.

TECH TRANSFER SNAPSHOT	2020
REPORTS OF INVENTION	**464**
LICENSING AGREEMENTS	**114**
ACTIVE PATENTS	**3,131**
MATERIAL TRANSFER AGREEMENTS	**4,973**
NONDISCLOSURE AGREEMENTS	**438**

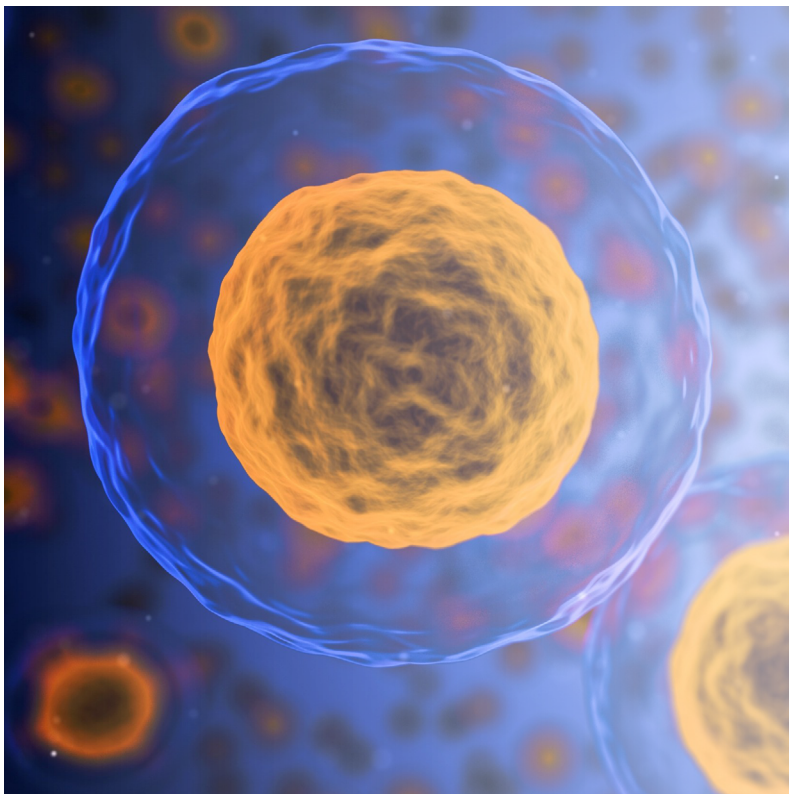
TRANSLATIONAL FUNDING

$3.1M
AWARDED

27
PROJECTS

» BISCIOTTI
» COHEN
» THALHEIMER

A set of philanthropy-enabled **translational funds** help investigators advance their early-stage technologies. Through technology development and prototyping, these technologies become stronger candidates for licensing. From 90 applications, JHTV was able to support researchers' goals of building better batteries, fighting mosquito-borne disease, perfecting cranial drug delivery, and blocking cancer metastasis, among others.



COVID-19 INNOVATION

JHTV collaborated with Chris Heaney, associate professor from the Bloomberg School of Public Health, on the commercial development of an oral diagnostic to measure immune responses (antibody) to SARS-CoV-2 infections.

DIGITAL INNOVATION

75

of the 464 reported inventions this year were digital innovations. Johns Hopkins is dedicated to making these available through various means, ranging from traditional licensing to open source licensing. This year, digital innovations were at the core of **51 licenses** and the formation of **five new licensed startup companies**.

MATERIAL TRANSFER AGREEMENTS

4,973

JHTV's seven-person contracts team processed nearly 5,000 Material Transfer Agreements (MTAs) in the first three quarters of the fiscal year, with almost 90% processed within five days of receiving them and nearly all processed within 30 days. Due to the coronavirus, some companies are providing access to proprietary materials they previously kept off limits, and with that allowance comes tighter restrictions about use of their materials and the companies interest in future results.

FEATURED TECHNOLOGIES

PREMISE
Target Validation of Splicing Repression, a Major Function of TDP-43 in the Motor Neuron

PRINCIPAL INVESTIGATOR
Philip Wong, professor of pathology

PROGRESS
The fundamental cause of amyotrophic lateral sclerosis (ALS) is unknown. In the last decade, however, the TDP-43 protein has been shown to abnormal RNA splicing, which causes loss of motor neurons in 97% of ALS cases. Wong and his colleagues have validated a therapeutic strategy designed to restore the normal splicing of TDP-43 in motor neurons of mice and flies that mimics the loss of TDP-43 splicing in ALS. Development of this technology may lead to a gene therapy for the treatment of ALS.

PREMISE
Diffuse-Light-Collecting Microconcentrators for High Efficiency Solar Cells

PRINCIPAL INVESTIGATOR
Susanna Thon, assistant professor of electrical and computer engineering

PROGRESS
Thon and her colleagues at the Whiting School of Engineering have developed and tested concentrators to maximize light absorption in third-generation solar cells in a cost-effective way. The technology dramatically increases power output by creating lenses that can be bonded directly to solar cells and deliver up to 20 times the current of existing third-generation technologies.

PREMISE
SulAnchor Cathodes for High Charge/Discharge Lithium Sulfur Batteries

PRINCIPAL INVESTIGATOR
V. Sara Thoi, assistant professor, Department of Chemistry

PROGRESS
These new Lithium-Sulfur (Li-S) batteries could be used for consumer electronics and large-scale stationary energy storage, as well as in the heavy electric vehicle industry, in which long range and high payload transportation will need high energy, lightweight batteries. Li-S batteries with SulAnchor technology also have remarkable energy storage capabilities at various charge and discharge rates, allowing stable recharging as fast as 15 minutes.

CORPORATE PARTNERSHIPS

Redefining best practice in academic corporate research collaboration

We specialize in facilitating industry collaborations that translate the novel work of Johns Hopkins researchers into real-world applications. This year, we began industry collaboration on Johns Hopkins' precision medicine initiative, **inHealth**, which leverages university-wide assets and analytics infrastructure to develop transformative health care products and services. JHTV also facilitated collaboration regarding cutting-edge **therapeutic modalities**, including cell and gene therapies, and we created a rapid **COVID-19** coordination center to connect industry with institutional experts.

THERAPEUTICS

Corporate partners are critical to our success in developing new treatments — for Johns Hopkins' own patients and populations beyond. Our strengths in **disease biology**, **discovery science**, and **computer science/engineering**, along with our clinical expertise and diverse patient population, complement biopharma's drug discovery, medicinal chemistry, and manufacturing expertise. As corporations scaled back in-house R&D over the past decade, Johns Hopkins and the biopharmaceutical industry have jointly benefited from the symbiosis that exists between us.

DEVICES, DIAGNOSTICS, AND SOFTWARE

Industry collaborations in this area are focused on development of **novel diagnostic** and **data analytics platforms** and advances in **medical image processing** and **medical robotics.** Our precision medicine initiative, inHealth, has provided a particular point of intersection with industry interest in data-driven, hypersegmented approaches to care management and product development.

ENGINEERING

Faculty expertise at the Whiting School of Engineering is deep in a wide array of research areas, and our faculty members collaborate frequently at the intersection of disciplines — a great setup for industry partnerships. This year, we established new industry partnerships in the fields of — among others — **materials science** (low-cost sensing applications; modeling of new materials for **novel battery design**), **predictive health care analytics** (predictive algorithms for intensive care unit clinicians) and **computational biology** (biophysical modeling to design antibodies and antigens).

COLLABORATION NEWS

Beginning in 2016, AbbVie and The Johns Hopkins University (JHU) established an oncology research collaboration focused on better mechanistic understanding, validation of novel targets and biomarkers, and discovery/development of medicines for the treatment of cancer. Since its inception, our scientists have embarked on multiple projects together. Many of them are ongoing.

With combined research interests, innovation, and expertise in oncology and immunology, Bristol-Myers Squibb and JHU have collaborated over several years to advance medical treatment options for patients. Our existing collaborations span both early-stage target validation and drug discovery through clinical development of promising new therapies for myriad cancer and rheumatologic indications. One of our largest joint programs is focused on identifying mechanisms of response and resistance to cancer patients treated with checkpoint inhibitor-based immunotherapies.

Since 2015, Bayer and JHU have been collaborating to jointly develop new ophthalmic therapies targeting retinal diseases. Two Bayer projects have achieved major pre-clinical development milestones. The collaboration has been renewed for a second term, and six more projects at the Johns Hopkins Wilmer Eye Institute were approved.

Canon Medical's collaboration with JHU is centered on the company's state-of-the-art MRI and ultra-high resolution CT scanners housed at the university. This collaboration spans several departments including cardiology, radiology, biomedical engineering (BME), and neurological surgery. With four ongoing projects, we anticipate having six additional active projects by the end of 2020 that will investigate the heart, bones, lungs, and brain.

The lab of Andy Pekosz, professor of molecular microbiology and immunology at the Bloomberg School of Public Health, has established a human nasal epithelial cell SARS-CoV-2 infection model. JHTV/Corporate Partnership facilitated a partnership with Takeda to test their proprietary compounds in this JHU model of infection to potentially discover novel treatments for COVID-19.

Emphasizing emerging technologies to solve critical health problems, DH Diagnostics has engaged with research and medical faculty for sponsored research, collaborated on a BME student project and sponsored the 2019 Carey Business School Case Competition, taking advantage of the diverse areas of expertise offered through a strong relationship with JHU.

FASTFORWARD

A coordinated suite of resources designed to efficiently move technologies from startup to marketplace. With innovations in an array of markets from drug development to manufacturing and digital health, FastForward startups are bringing myriad life-changing technologies to market

FY20

160
ACTIVE STARTUPS

$278M
VENTURE FUNDING RAISED BY 23 STARTUPS

1,280
LOCAL JOBS AT STARTUPS

$3.1M
TRANSLATIONAL FUNDING RAISED BY STARTUPS

INNOVATION HUBS

FastForward provides affordable, turn-key spaces for our startups at two locations in Baltimore City. This year, our spaces were home to 41 startup companies, including 13 therapeutics, five diagnostics and 11 health information technology startups. Critical research activities continued this spring during the COVID-19 shutdown, and even as much activity was remote, all companies continued to leverage FastForward membership to access mentorship, fundraising support, pro bono services from sponsors, and other support.

CLICK BELOW TO SEE HOW OUR HUBS WORK

STARTUP PORTFOLIO

2014

PROTENUS

Developing insightful solutions that remove barriers to efficient, safe, and effective delivery of patient care

2015

SONAVEX

Creating novel and automated ultrasound technology that empowers clinicians with actionable data to deliver superior patient care and savings to the health care system

2016

WINDMIL THERAPEUTICS

Translating insights in bone marrow immunology into life-saving cell therapies for cancer patients

2017

LIFESPROUT

Developing revolutionary products for aesthetic and regenerative medicine

2018

DRACEN PHARMACEUTICALS

Leveraging immunometabolism to create a potential new treatment paradigm with broad application for many cancer types

2019

THRIVE

Developing CancerSEEK, a blood-based test designed to be affordable and used as part of routine medical care to detect multiple types of cancer at earlier stages, launched with $110 million in Series A funding

NOTABLE 2020 ACTIVITY

FUNDING

AsclepiX Therapeutics raised $35 million in Series A financing, the proceeds of which will fund phase 1/2a clinical trials for the treatment of macular conditions. AsclepiX uses computational biology to identify potent peptide regulators of vascular homeostasis for the treatment of retinal and other important diseases.

COVID-19

emocha Mobile Health adapted its technology to remotely monitor health care workers who have been exposed to COVID-19. They are working with Johns Hopkins Medicine and LifeBridge Health affiliated hospitals to identify, track, and manage symptoms of workers through video check-ins.

EXPANSION

Columbus, Ohio-based **Ready Robotics** $23 million to expand its robotic operating system, which allows workers without any robotics background or coding experience to easily program the robots that their plant uses.

SIGNATURE PROGRAMS FOR ENTREPRENEURS

Facilitating startup formation and growth through a range of supportive programs

Since 2014, JHTV has advanced innovation ecosystems and developed tomorrow's solutions for today's biggest challenges. We are committed to supporting all ventures, including community and student startups. **FastForward U (FFU)** is our hub for student entrepreneurship. It is a collaborative, extracurricular environment for any student looking to experiment, innovate or start a business. Our **Social Innovation Lab (SIL)** supports innovative nonprofits, mission-driven companies, and disruptive technologies to create change and opportunity in Baltimore and beyond.

SIL IMPACT FORUM WINNER

Bree Jones of Parity was awarded the Cohort Prize of $25,000 by her peers based on the strength of her progress over a six-month cohort period, plans for future growth, and potential for impact. Parity's mission is to rehabilitate vacant and abandoned properties in distressed neighborhoods to create affordable homeownership opportunities.

FFU DEMO DAY WINNER

Competing against eight FFU Fuel teams, **Relavo** came out on top and won this year's top prize of $15,000 during Demo Day. Relavo is a medical device venture developing the PeritoneX, which prevents infection in peritoneal dialysis and allows patients with kidney failure to receive higher quality care in the comfort of their homes.

BISCIOTTI STUDENT PRIZE WINNER

ForagerOne was awarded $30,000 in nondilutive funding. The team's mission is to build a more efficient way to connect students and faculty members at academic institutions for research collaboration. More than 2,000 students and faculty members, as well as six colleges and universities nationwide, currently use ForagerOne's platform at Johns Hopkins.

STUDENT STATS

108 VENTURES SUPPORTED

1,326 STUDENTS ENGAGED IN PROGRAMMING

$232K GRANTS AWARDED

FFU ACCELERATOR

90+ APPLICATIONS

19 TEAMS PARTICIPATING

8 SPARK AND FUEL WINNERS

$112K FUNDING AWARDED

FASTFORWARD U ACCELERATOR PROGRAM

Johns Hopkins student teams work collaboratively and advance their ventures through **FFU's Accelerator program**. The two tracks in the program provide students support at different stages in the development of their work. Spark is designed for early-stage teams to validate their ideas, while Fuel is best suited for late-stage ventures to prepare them for market.

The accelerator program culminates during FFU's Demo Day, when teams pitch their ventures for the opportunity to win nondilutive funding. This year's Spring Demo Day was held virtually and included eight Fuel teams and 11 Spark teams competing against one another for a prize pool of $30,000.

SIL IMPACT 2011–2020

93 VENTURES SUPPORTED

258 PAID EMPLOYEES AT VENTURES

$67M FUNDING SECURED

SIL 2019–2020 COHORT

50% WOMEN-LED VENTUES

70% BIPOC-LED VENTURES

70% COMMUNITY-MEMBER-LED VENTURES

$421K FUNDING SECURED

THE SOCIAL INNOVATION LAB

The **Social Innovation Lab (SIL)** provides social entrepreneurs the funding, mentorship, office space, and workshops they need to develop into thriving, sustainable ventures that have a measurable impact. Focused on catalyzing the Baltimore-area innovation ecosystem, SIL invites community members to participate in addition to Johns Hopkins students, faculty members, and staff members.

SIL's cohort-based learning model offers a six-month program during which innovators and entrepreneurs support one another on their pathway to scale. Each October, SIL conducts a competitive application process during which Baltimore-area residents and JHU students, faculty members, and staff members can apply for support for their social ventures.

SIL is looking for talented teams and individuals with innovative ideas that have the potential to sustainably deliver social impact. The program culminates with SIL's Impact Forum. This year, the event was held virtually.

For a detailed account of the year, **read the 2019-2020 SIL Impact Report**.

TRAINING AND EDUCATION

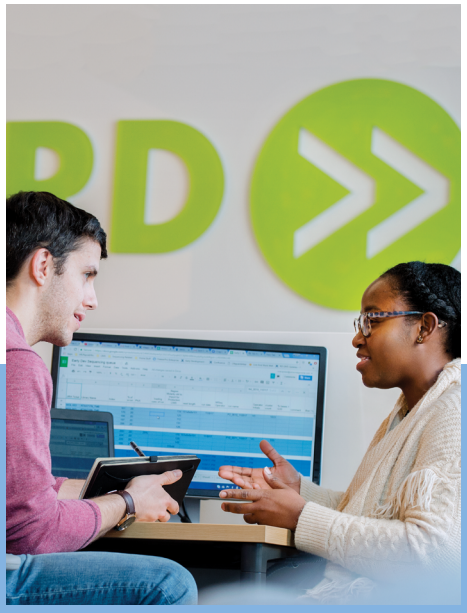
JHTV is committed to the cultivation of a deep, diverse pool of commercialization talent in and around Johns Hopkins. This includes training of students in the 'business of science,' educating and equipping investigators to be translationally-savvy, and ensuring diversity and inclusion in the campus innovation community.

COMMERCIALIZATION ACADEMY

The JHTV **Commercialization Academy** provides exposure to careers in technology transfer and entrepreneurship for full-time JHU students. In this two-year, part-time fellowship program, students are exposed to the day-to-day methods and approaches taken by JHTV professional staff members, corporate licensees and entrepreneurs. This experience adds to participants' contributions in their research labs and in the innovation community, and ultimately to their future as professionals, whether in the field of technology transfer or industry or nonprofit research. In fiscal year 2020, the program expanded to include more than 32 student fellows from across five JHU schools, ranging from undergraduate to postdoc and boosted by the program's first full-time manager and a philanthropic gift from alum Emmett Cunningham. For an exclusive glimpse into the life of a fellow, **read Maya Lapinski's reflection** on the valuable experiences she had while working at JHTV.

WOMEN IN INNOVATION

This was the year of female inventorship at Johns Hopkins! Our community is rich with women pioneers in myriad fields who are striving to impact the world, yet women are underrepresented in commercialization here and across the academic community. Funded by a Small Business Administration grant, JHTV launched the **AccelHERator**, a four-part event series to facilitate learning and community building in the hope that women's contributions to discovery will manifest in proportionate translational activity. We also crowdsourced a celebration of the Johns Hopkins women whose academic ingenuity will change the world. Read about the **initiative** and **meet our rock stars**.



I-CORPS PROGRAM

Since 2015, the National Science Foundation **I-Corps program** has been an integral part of creating a commercialization culture. I-Corps fills the fundamental educational disconnect between invention and market that is not found inside a lab or classroom but only through customer interviews. As an I-Corps Node, JHU's goal has been to advance knowledge and understanding of the commercial potential of life and basic science research, while providing access to JHU's life science expertise in areas including translation, partnering, and entrepreneurship for the greater innovation ecosystem. To date, more than 200 teams have engaged directly with our I-Corps programming, which challenges participants to test their hypothesis on their technology's relevance and viability through customer discovery, which will lead to viable value propositions. Three short course programs are provided per year, and they are open to teams outside of JHU and will be disseminated more broadly to the tech community.

ACKNOWLEDGEMENTS

JHTV is grateful for the **support of many generous stakeholders**, especially its donors, corporate sponsors, mentors, and strategic advisers. Each has a key role in our continued success. Donor and sponsor contributions enable us to fund the innovators, programs, and grants that move ideas from lab to market. Strategic guidance from our Innovation, Development, and Entrepreneurship Advisory (IDEA) Board generates growth to entrepreneurship across The Johns Hopkins University and our region. Our alumni, mentors, and volunteers provide direct guidance to Johns Hopkins innovators and help allocate translational grant funding that catalyzes technology development. This dedicated team is critical to our vision of promoting innovation on a local and global scale.

For more information, contact Maddy Stokes, Director, Innovation Initiatives and Corporate Relations at **mstokes@jhu.edu**

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Chandra Ramanathan

MENTORS

More than 30 individuals provided mentorship to our student, social, and professional ventures. We thank, in particular, our Mentors-in-Residence and those who provided extensive engagement to guide significant projects forward.

Ethan Agarwal
Sam Ball Brau
Sidd Chhabra
Arthur (Skip) Colvin
Graham Dodge
AJ Donelson
Yair Flicker
Chris Ganan
Richard (Ric) Hughen
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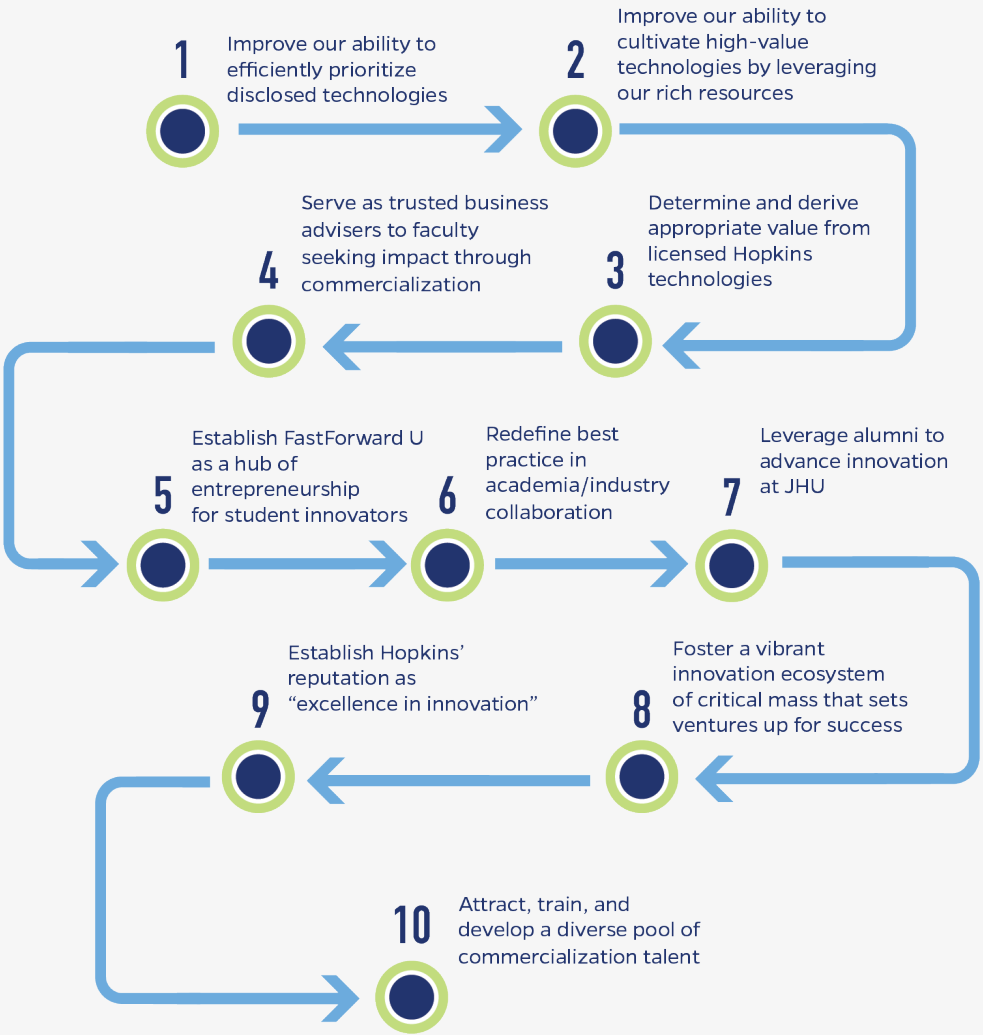
WHAT'S NEXT?

Fiscal year 2020 will go down in JHTV history as a year that challenged our team and our business in both pragmatic and profound ways. We learned how to use Zoom virtual backgrounds and breakout rooms, how to hold virtual events, and a lot about coronaviruses. We considered how to act responsibly in the face of an economic crisis and how to respond to a national reckoning with systemic racism.

Despite the obstacles and new opportunities presented along our journey, we are committed to our FY19–FY23 road map that will enable us to deepen our contributions to the academic pursuit of impact on the world. Some themes you'll see us tackle in fiscal year 2021 include faculty education, the commercialization of new therapeutic modalities, the talent pipeline (and its diverse composition) and the strength of our ecosystem.

JHTV STRATEGIC PRIORITIES FY19–23



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