JOHNS HOPKINS TECHNOLOGY VENTURES

FISCAL YEAR 2023 ANNUAL REPORT

BRINGING THE BENEFITS OF ACADEMIC DISCOVERY TO THE WORLD

JOHNS HOPKINS
TECHNOLOGY VENTURES

WELCOME

It may come as a surprise to learn that the most inspirational book of the year for Johns Hopkins Technology Ventures was not about entrepreneurship or artificial intelligence or gene therapy, but rather a reflection on military leadership by retired U.S. Army Gen. Stanley McChrystal. Universities and the military have many points of contrast, but they share traditional notions of mission, structure, consensus and communication. Both organizations pride themselves on being innovative, but are also careful decision-makers and protectors of tradition.

In *Team of Teams*, McChrystal challenges all modern organizations to recognize the increasing pace of society and the impact of technology on traditional work processes. Facing technology-enabled insurgents in the Middle East, even the very process-driven military with centuries of tested SOPs has had to experiment, embracing a more flexible approach to cross-team collaboration, frequent low-friction communication, and efficient, data-driven decision-making.

As a university commercialization hub with the mission to introduce high-impact technologies to the world, it feels especially incumbent on JHTV to be fast-moving and creative to meet the needs of each project. This year, we saw many new "flavors" of invention, intellectual property protection approaches, industry collaboration models and business strategy. Heck, an entire generative AI industry popped up seemingly overnight.

The members of the staff at JHTV are extraordinary and mission oriented, and we are committed to working nimbly to meet the growing pace and complexity of innovation. The quality of our individual team members is rivaled by the quality of our teamwork, and we consider our researchers, our entrepreneurs and our industry partners all part of the team that makes great Johns Hopkins inventions a reality. We truly are — and aspire always to be — a "team of teams."

Cheers to another great year behind us, and with some summer rest and rejuvenation behind us, we're on to another.

Christy Wyskiel
Senior Advisor to the President of Johns Hopkins University for Innovation and Entrepreneurship
Executive Director, Johns Hopkins Technology Ventures

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This year's annual report focuses on five innovation themes that dominated our activity this year. These themes reflect society's unmet needs, the shifting marketplace and policy environment, and the broad institutional capabilities of Johns Hopkins University.

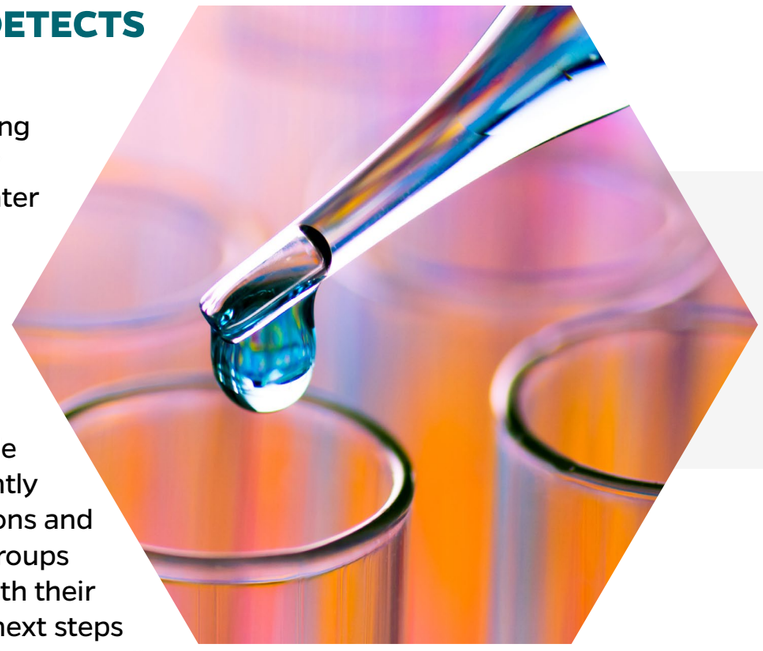
CANCER DIAGNOSTICS

Johns Hopkins is both a best-in-class clinical setting for cancer treatment and a hotbed of discovery that promises to bend the curve of cancer mortality.

TECHS AVAILABLE FOR LICENSING

- Early Cancer Detection by Single-molecule Imaging of Nucleocytoplasmic Tumor-specific Proteins in the Peripheral Circulation
- Integrated Proteomic Biomarkers for the Detection of Aggressive Prostate Cancer
- Non-invasive Urinary Biomarker for the Detection of Bladder Urothelial Carcinoma

NOVEL AI BLOOD TEST DETECTS LIVER CANCER



An artificial intelligence blood testing technology developed and used by Johns Hopkins Kimmel Cancer Center detected more than 80% of liver cancers in a recent study. The blood test, called **DELFI**, detects fragmentation changes among DNA from cancer cells shed into the bloodstream. The researchers believe this is the first genome-wide fragmentation analysis independently validated in two high-risk populations and across different racial and ethnic groups with different causes associated with their liver cancers. The researchers say next steps include validating this approach in larger studies for clinical use. The foundational technology referenced in this story is licensed to **Delfi Diagnostics**.

ANCHOR VENTURES HOSTS CANCER DIAGNOSTICS PANEL

Left to right: Helen Montag, JHTV senior director of ecosystem development; Mary Morris, University of Maryland Baltimore, director of Baltimore Fund; Daniel Lunz; Christina DeMur, JHTV director and team lead, technology development; Victor Velculescu; and Daniel Edelstein

Cancer diagnostics and therapies developed here in Baltimore are making enormous strides — and big news. To discuss the development and commercialization efforts with local companies advancing the latest diagnostic innovations in nano-biotechnology, liquid biopsies, artificial intelligence and biomarkers, Anchor Ventures invited Baltimore startup leaders in these fields to JHTV. Panelists included **Daniel Edelstein**, CEO and co-founder of Haystack Oncology, **Daniel Lunz**, CEO and co-founder of Previse (formerly Capsulomics), and **Victor Velculescu**, **M.D., Ph.D.**, founder and CEO of Delfi Diagnostics.

STARTUP HEADLINES

- Delfi Diagnostics Announces $225M Series B Financing
- Haystack Oncology Acquired by Quest Diagnostics for $450M
- Previse Closes $3M Seed to Tackle Early Cancer Detection

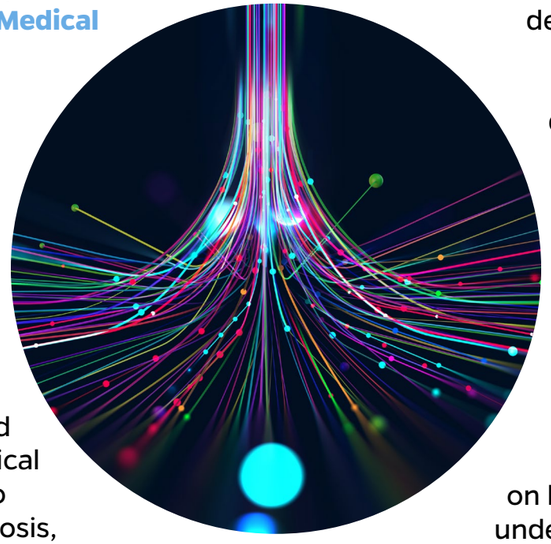
The growing cluster of cancer diagnostics companies raised a cumulative $288 million in private investment capital this year, and Pylarify is changing the standard of care in pancreatic CT/PET scanning, two years after FDA approval.

DIGITAL HEALTH & DEVICES

The teaming up of researchers and clinicians is a powerful formula for high-impact innovation, and there is no richer setting for such collaboration than Johns Hopkins and Baltimore.

COLLABORATIONS

The long-standing relationship between The Johns Hopkins University and **Canon Medical Systems Corporation** has resulted in a new international clinical study investigating the effectiveness of ultra-high-resolution computed tomography to detect coronary artery disease. The study will test the idea that more detailed information from medical imaging translates into a more accurate diagnosis, compared with the assessment facilitated by conventional technology, and will reduce the need for invasive testing procedures such as cardiac catheterization.



Johns Hopkins and **Howard University** have joined forces to develop medical devices to diagnose, treat and manage neurological disorders. Researchers with the NIH-funded **NeuroTech Harbor** technology accelerator will collaborate with global partners to create equitable and accessible technologies and solutions, with a focus on bringing technology to underserved communities. NeuroTech Harbor aspires to launch 45 projects in the coming five years, at least 15 of which will have one woman or under-represented minority on the founding team.

TECHS AVAILABLE FOR LICENSING

- Arrhythmic Sudden Death Survival Prediction Using Deep Learning Analysis of Scarring in the Heart
- Remote Tracking Location System for Patient Ambulation Monitoring
- Quantitative Human Motion Analysis using Video-based Pose Estimation

STARTUP HEADLINES

- Burnalong Acquired by Tivity Health
- Galen Robotics Raised $15M, Working on FDA Approval for Surgical Robots
- StoCastic Acquired by Beckman Coulter

Digital health startup successes abound. Large health care companies are crucial key ingredients in the launch and adoption of health care technology.

SCENE HEALTH RAISES $17.7M TO IMPROVE MEDICATION ADHERENCE FOR MEDICAID, MEDICARE POPULATION

Scene Health team members, left to right: Steven Cutbirth, Morad Elmi, Amanda Allen, Sebastian Seiguer, co-founder and CEO, and Erica Drohan

Baltimore-based startup Scene Health (formerly emocha Health) collects data on medication adherence and engages patients through its platform, providing insight to improve patient health for health care plans. With funding from its latest round, Scene Health plans to identify programs and initiatives that can affect patient outcomes using data such as transportation to and from pharmacies. Scene Health earned a National Institutes of Health/National Heart, Lung, and Blood Institute Small Business Innovation Research award for $1.67 million to support pediatric heart transplant patients through its platform in Florida; this intervention could potentially reduce the frequency of organ rejection over the next two years.

ENERGY

The stars aligned this year, as federal policy and university research priorities alike hone in on society's energy transformation imperative. The Inflation Reduction Act of 2022 drives $400 billion in federal funding toward clean energy, and Johns Hopkins' energy institute, ROSEI, is leveraging expertise in chemical engineering, materials science, chemistry and environmental health — among other disciplines — to meet the challenges of energy transformation.

ROSEI team working the Whiting School of Engineering booth at the ARPA-E Energy Innovation Summit. Photo Credit: Chad Restrick

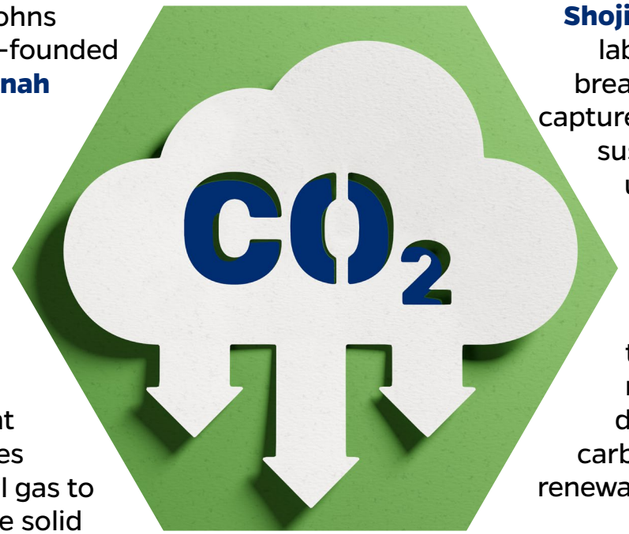
Launched in 2021, the **Ralph O'Connor Sustainable Energy Institute (ROSEI)** is the university's hub for energy-related research and translation, enabling innovations within four broad pillars: carbon, grid, storage and wind. ROSEI's 10 core faculty members span the gamut of engineering, chemistry and policy.

We hit the conference floor in Washington, D.C., at the **2023 ARPA-E Energy Innovation Summit**, one of the nation's largest showcases of energy technology. With the Whiting School of Engineering as the conference's platinum sponsor, Johns Hopkins asserted its commitment and capabilities in addressing the nation's energy transformation needs. To further energy technologies, our researchers are leveraging government funding, private investors and corporate sponsors alike. JHTV marketed over a dozen energy technologies, including negative carbon cement and solar concentrator lenses.


Gov. Wes Moore visiting the Johns Hopkins ARPA-E booth.
Photo Credit: Anthony Depanise/Office of the Governor

DECARBONIZATION STARTUP ETCH INC. CLOSED $7.5M SEED ROUND

This summer, the Johns Hopkins spinout co-founded by **John Fini** and **Jonah Erlebacher, Ph.D.**, announced its first capital raise. ETCH Inc.'s patented technology will accelerate the decarbonization of natural gas via a unique closed-loop reaction system that effectively eliminates carbon from natural gas to produce both usable solid carbon and clean hydrogen in a portable, scalable process.



CARBON CAPTURING TECHNOLOGY AWARDED THE THALHEIMER FUND

Shoji Hall, Ph.D., and his lab made a significant breakthrough in carbon capture, achieved through sustainable chemistry using a copper/zinc compound. This highly efficient and cost-effective catalyst enables the electrochemical reduction of carbon dioxide into valuable carbon monoxide using renewable electricity as its energy source.

EDAC LABS SIGNS LICENSING AGREEMENT WITH JOHNS HOPKINS FOR CORE ELECTRO-SYNTHESIZER TECHNOLOGY

Founded by **James Lavin**, **Brian Toll** and **Chao Wang, Ph.D.**, associate professor of engineering at Johns Hopkins, EDAC Labs was awarded a grant through the Department of Commerce's Maryland Energy Innovation Accelerator Pitch Competition to further their research. Wang developed a novel electrochemical system to efficiently capture atmospheric carbon dioxide and produce marketable acids and bases. EDAC was also accepted into a national climate accelerator, and is focused on scaling its solution.

James Lavin, CEO of EDAC Labs (left) and Steve Kousouris, JHTV executive director of technology transfer

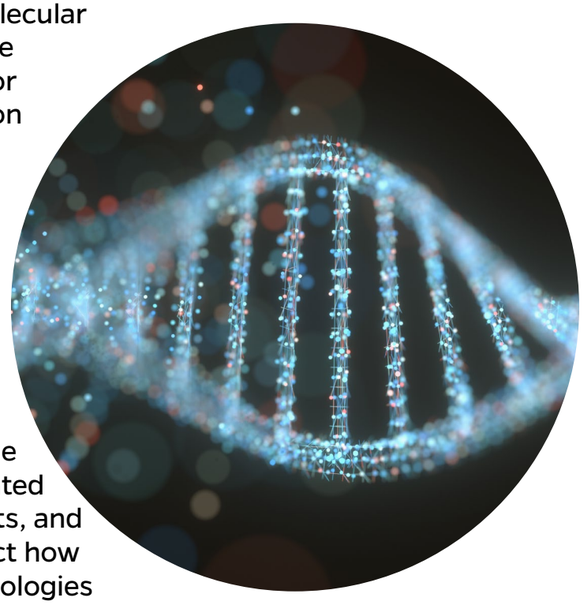
Visit JHTV's technology publisher to search energy technologies available for licensing at jhu.technologypublisher.com

SOFTWARE & AI

Digital innovations represented more than 20% of reported inventions this year, up from only 5% 15 years ago. Beyond the concentration of health care-related applications that befit an institution with rich health care expertise, investigators are also designing solutions for construction, manufacturing, cybersecurity and other industries.

RESEARCHERS BEGIN CREATION OF MATERIALS CONTROLLED BY ARTIFICIAL GENES

A team led by **Rebecca Schulman, Ph.D.**, associate professor of chemical and biomolecular engineering and associate researcher at the Whiting School of Engineering's Institute for NanoBioTechnology, is laying the foundation to create artificial genes. Our bodies are composed of about 25,000 genes, and the chemical interactions that these genes use to regulate cells have many steps and moving parts. Researchers have learned that they don't need to recreate meticulously every one of these natural biological steps to create synthetic gene analogs capable of carrying out the same functions. To improve and better predict the behavior of gene analogs, researchers created a molecular tool kit, which includes genelets, and simplified mathematical models that predict how the genelets will behave. Schulman's technologies are available for licensing through JHTV.



STARTUP HEADLINES

- Bullfrog AI Closed $8.4M Initial Public Offering
- Phantom Neuro Secured $6M to Advance Robotic Systems in Real-world Environments

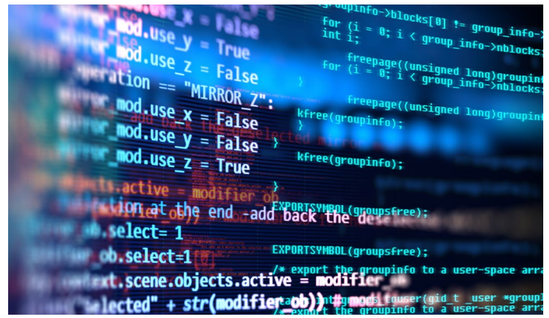
SAFETOWER CREATES SAFETY REPORTING SOFTWARE PLATFORM

With a mission to improve how health care organizations capture, share and analyze patient safety data, a team at the Johns Hopkins Armstrong Institute for Patient Safety and Quality created HERO, an intuitive machine-learning solution for safety reporting and event management. The software, developed by a team led by **Eileen Kasda**, **Alan Kachalia** and **Peter Najjar**, improves upon alternatives on the market. It is used throughout the Johns Hopkins Health System, including six hospitals and over 525 ambulatory clinic locations. A new startup, SafeTower, was formed to bring the product to hospitals nationwide.

CORPORATE COLLABORATIONS

Custom Value Partners (CVP) secured a prime spot to participate in the U.S. Department of Veterans Affairs' Accelerating VA Innovation and Learning contract, with The Johns Hopkins University as the sole academic member in the CVP AVAIL consortium of more than 10 health care technology and innovation organizations. Some core areas that Johns Hopkins experts will contribute to include AI and machine learning, digital care solutions and extended reality solutions. This partnership enables our innovators to translate their research and innovation into the largest integrated health system in the world, while lending their expertise in the clinical, biomedical and health technology spaces. JHTV will continue to facilitate emerging collaborations with CVP and their federal clients, including the National Artificial Intelligence Institute.

The Johns Hopkins University and **Amazon Initiative for Interactive AI (Ai2Ai)** collaboration had a successful year, with eight faculty research projects selected and six Ph.D. students awarded Ai2Ai fellowships. Amazon scientists chose Johns Hopkins faculty projects and fellows that provided innovation solutions to their current research challenges. Joint events were also hosted to encourage the Johns Hopkins research community to engage and learn more about Amazon research.



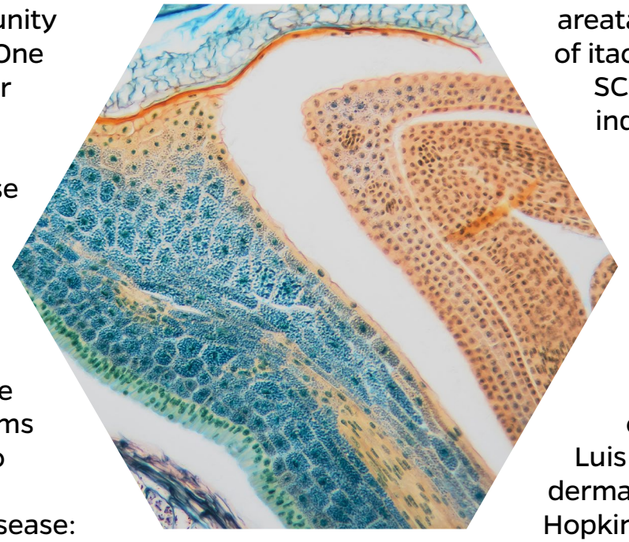
Visit JHTV's technology publisher to search software and AI technologies available for licensing at jhu.technologypublisher.com/

THERAPEUTICS

"There's nothing more gratifying than seeing your research help alleviate suffering," reflects Jan Vilcek, NYU scientific entrepreneur and inventor behind Remicaid, once the second-highest selling pharmaceutical product in the world.

CORPORATE PARTNERSHIPS THERAPEUTICS PROJECTS

The Johns Hopkins University and **Horizon Therapeutics** have entered a multiyear research collaboration to identify new disease targets and advance translational research efforts in autoimmunity and inflammation. One disease of particular interest to Horizon is myositis, a rare autoimmune disease that can result in muscle wasting, significant pain and highly reduced quality of life. The goal is to investigate common mechanisms that may reveal two expressions of the same underlying disease: dermatomyositis, affecting the skin layers, and inclusion-body myositis, affecting the skeletal musculature. The collaboration will also involve research into diseases that cause scarring in the lungs, with a goal of understanding the mechanistic underpinning of connective tissue disorders.



Researchers at Johns Hopkins and **Sun Pharma Advanced Research Company (SPARC)** have identified a potential, promising topical treatment for alopecia areata. A topical prodrug of itaconate (4-MI) called SCD-153 was found to induce significant hair growth in the lab. Results indicated that SCD-153 inhibits the immune response that attacks hair cells and limits hair regrowth. In a collaborative effort, Luis Garza, professor of dermatology at the Johns Hopkins University School of Medicine, is working with Johns Hopkins Drug Discovery scientists Barbara Slusher and Rana Rais, and Czech Academy of Sciences Institute of Organic Chemistry and Biochemistry chemists, led by Pavel Majer. After finding the optimal cell-penetrable prodrug to dampen excessive immune responses, SPARC colleagues repeated the researchers' work to confirm the promising results and are preparing an application to the FDA for human trials.

THERAPEUTICS PIPELINE

Netz Arroyo, Ph.D., recently joined JHTV to speak about his research focus on developing electrochemical sensors to be used in metabolism-responsive dosing in patients.

Jeff Gray, Ph.D., received the Microsoft Innovation Acceleration Award for his lab's work on algorithms that can predict antibody structure from amino acid sequences. The technology is the basis for startup company Ably Bio.

Max Konig, M.D., received the Bisciotti Foundation Award for his work on CAR-T cell therapies for treating and preventing autoimmune diseases.

Mandeep Singh, M.B.B.S., M.D., Ph.D., was recognized with the Young Investigator Award by the Macula Society. His lab is working on stem cell therapies for retinal diseases.

Arroyo holding a 3D-printed prototype that contains four electrochemical sensors. By using a completely 3D-printed device, Arroyo's lab can run numerous clinical samples with a single device.

Our therapeutic-oriented startups raised $261 million in FY23, and the pre-licensed therapeutic pipeline is rich as investigators employ new delivery modalities to cure a range of high-burden diseases.

STARTUP HEADLINES

- Ashvattha Therapeutics First Patient Enrolled in Phase 1/2 Study of Hydroxyl
- Escient Pharmaceuticals Raises $120M Series C Financing
- Glyscend Therapeutics Announces Positive Topline Phase 2a Clinical Results
- Vita Therapeutics Closes $31M Series B Financing

Visit JHTV's technology publisher to search therapeutics technologies available for licensing at jhu.technologypublisher.com

FACULTY AWARD RECIPIENTS

$2.2 million was awarded to develop technologies with translational potential.

BISCIOTTI FOUNDATION TRANSLATIONAL FUND

CLICK FOR MORE INFO

Jeff Coller, Ph.D.
Professor, Molecular Biology and Genetics

Max Konig, M.D.
Assistant Professor, Rheumatology

Maxim Rosario, Ph.D., M.Sc.
Assistant Professor, Pathology

COHEN TRANSLATIONAL ENGINEERING FUND

Nicholas Durr, Ph.D.
Assistant Professor, Biomedical Engineering

Taylor Bobrow, Ph.D. candidate
Gradutate Fellow, Durr Lab

Jordan Green, Ph.D.
Professor, Biomedical Engineering

Stephany Tzeng, Ph.D.
Assistant Research Professor, Biomedical Engineering

THALHEIMER TRANSLATIONAL FUND

Shoji Hall, Ph.D.
Assistant Professor, Materials Science and Engineering

Hai-Quan Mao, Ph.D.
Professor, Materials Science and Engineering and Biomedical Engineering

Jonathan Schneck, M.D., Ph.D.
Professor, Pathology

An additional nine Johns Hopkins faculty members received a total of $1.5 million from the State of Maryland's **Maryland Innovation Initiative (MII)**.

STUDENT & ALUMNI ENTREPRENEURS

FastForward U supports Johns Hopkins student ventures with mentorship, accelerator programs, access to networks and nondilutive funding. As students graduate and scale their ventures, we celebrate their success and continued engagement in the FastForward U — and Baltimore — communities.

FORBES 30 UNDER 30 LIST

Pava LaPere
EcoMap Technologies, Inc., Co-founder and CEO

HUBLY DRILL FDA APPROVED

Casey Qadir (Grage)
Hubly Surgical, Founder and CEO

PRESIDENT'S VENTURE FELLOWSHIP WINNERS

Taylor Cottle, Ph.D. candidate
Aptabridge Therapeutics, Co-founder and CSO

CurveAssure Team
Evan Haas, Antony Fuleihan, Ariel Slepyan, and Graham Zolkowski

PITCH IT ON! COMPETITION WINNER

Danielle Nicklas, Ph.D. candidate
NovvaCup, Founder and CEO

TIME MAGAZINE'S BEST INVENTIONS OF 2022

Tastee Tape Team
Marie Eric, Tyler Guarino, Rachel Nie, and Erin Walsh

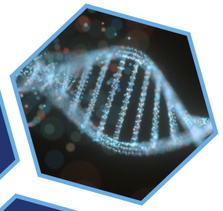
BY THE NUMBERS

TECHNOLOGY TRANSFER

$44.4M Licensing Revenue

3,848 Active Patents

409 Reports of Invention

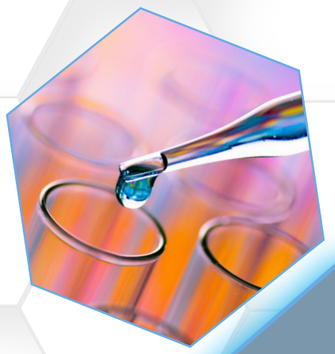


132 Licensing Agreements

121 New U.S. Patents

284 Non-Disclosure Agreements

4,572 Material Transfer Agreements

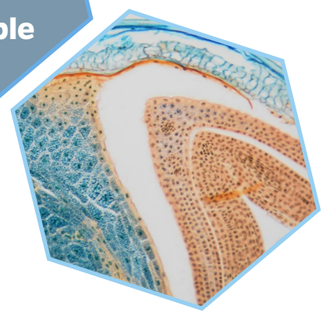


PORTFOLIO SNAPSHOT

277 Technologies on the Market

442 Products In Development

1,934 Techs Available



CORPORATE PARTNERSHIPS

$207.5M Sponsored Research FY14-23

39 Current Partners

STUDENTS

$800K Grants Awarded

250+ Student Ventures Supported

100+ Teams in Accelerators

$3.7M Venture Funding Raised

STARTUPS

$552M Venture Funding Raised by 20 Startups

149 Active Startups

13 New Startups

$2.2M Translational Funding Awarded

$198M Public Equity Offerings

$349M Venture Funding that Stayed in Baltimore

INVESTING IN BALTIMORE

Our innovation ecosystem can only thrive if our community thrives. JHTV works to empower local entrepreneurs and create broad economic opportunities for Baltimoreans through our own programming, the Social Innovation Lab (SIL), and in partnership with peers.

THE SOCIAL INNOVATION LAB

The SIL Showcase is the culmination of a six-month, rigorous, customer-discovery curriculum for emerging ventures. This year's top prize was awarded to student-run **Baltimore City College Writing Center**. The center supports high school students to become effective writers, and hopes to become a citywide workforce development program. Audience Choice Award winners were **R.I.S.E. Arts Center of Baltimore** and **Seedling Hydroponics**.

Lena Tashjian, Baltimore City College Writing Center leader with Anthony Watters, SIL Director

123	$104M	$12.4M
Supported Ventures Since 2011	Funding Raised Since 2011	Funding Raised in FY23

JOHNS HOPKINS HOSTED UPSURGE BALTIMORE'S EQUITECH TUESDAY

Among Baltimore's defining characteristics is the diversity of its entrepreneurial community, a major competitive advantage for the region. Our partners at **UpSurge Baltimore** are nurturing the local startup community to make our city the next great tech hub. In March, 200 members of the ecosystem gathered at the **Johns Hopkins Carey Business School** for happy hour overlooking our city skyline.

SIL ALUMNA SECURES $3M IN FEDERAL FUNDING FOR STARTUP B-360

Brittany Young (pictured right) founded B-360 to end the cycle of poverty, disrupt the prison pipeline and build bridges in communities. B-360 teaches skills necessary for educational and career opportunities in STEM fields, while changing perceptions of dirt bike culture, riders and engineers. The $3 million in funding came with the backing of Maryland U.S. Sens. Chris Van Hollen (pictured left) and Ben Cardin.

ACKNOWLEDGMENTS

JHTV is grateful for the support of many generous stakeholders, including its donors, corporate sponsors, mentors, and strategic advisers.

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