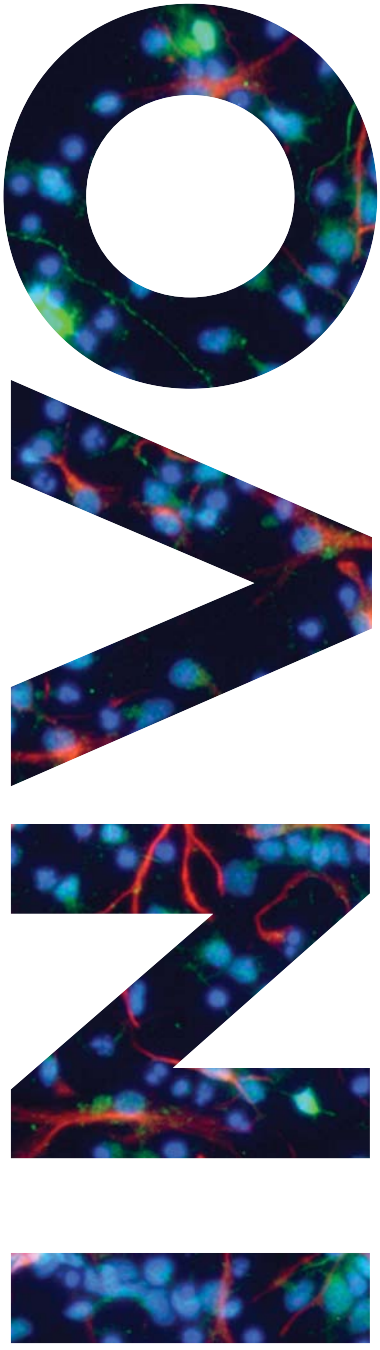


# INVENTIVE ACTIVITY
FY2016

Northwestern | INVO
INNOVATION AND NEW VENTURES

**DEAR MEMBERS OF THE NORTHWESTERN COMMUNITY,**

At Northwestern University, innovation is not a buzzword. Innovation is our reality.

Led by faculty and students and collaborative partnerships determined to solve pressing problems, our diverse and multidimensional innovation ecosystem cuts across our Evanston and Chicago campuses with a creative, vibrant, and persistent energy. INVO helps fuel this world, identifying technology with compelling potential, adding value through resources such as coaching and IP protection, and then capturing value in the marketplace.

This past year, FY16, showed no slowdown in invention disclosures, filed patents, and deals, though the year might best be remembered as a key inflection point in student innovation. As our students—increasingly eager for a taste of entrepreneurial adventure—captured national competitions and landed spots in prestigious accelerator programs, Northwestern and INVO celebrated the debut of The Garage, our hub for student entrepreneurship, as well as the launch of NUseeds, a multi–million dollar VC fund to boost promising early-stage ventures from students. It's a bet on the future—and one placed with strong confidence in our people.

Throughout this report's pages, you will see stories of accelerating areas of inventive strength at Northwestern in fields such as wearables, ALS, and depression; details of new programs designed to drive innovation, such as the Northwestern Women Innovator Initiative (N.Wii) and N.XT, the first building block for the development of faculty-led, science-driven inventions; and the metrics that landed Northwestern another top-10 nod in Reuters' annual rankings of the world's most innovative universities.

To be certain, the past energizes us, but it is the spectacular enthusiasm, surging momentum, and substantial vision of our institution that inspires our excitement for the future. With strategic nurturing, unrelenting drive, and steadfast support, we know that today's discoveries will deliver tomorrow's game-changing results and move more and more Northwestern innovations to market.

*Know our innovative spirit is higher than ever. Know our future is bright. Know there is much, much more to come. Know We Will.*

**Alicia Löffler**
*Executive Director, INVO*
*Associate Provost, Innovation and New Ventures*
*Associate Vice President for Research*

# KNOW OUR INNOVATIVE SPIRIT IS HIGHER THAN EVER. KNOW OUR FUTURE IS BRIGHT.

**203**
DISCLOSURES

**15.7**
MILLION IN LICENSING REVENUES, DOLLARS

**169**
AGREEMENTS

**2.2**
MILLION IN EQUITY SALES, DOLLARS

**11**
STARTUPS

**3.2**
MILLION IN RESEARCH FUNDED BY STARTUPS

**488**
FILED PATENTS

**130**
ISSUED PATENTS

**NORTHWESTERN INVENTIVE ACTIVITY CONTINUED STRONG**

Figure 1 illustrates invention disclosure activity since 2002. In FY16, INVO processed 202 invention disclosures, similar to the FY15 level (212). This minor adjustment might reflect the fact that in FY16, INVO, through The Garage, began providing invention waivers to students before they disclose. This change in process was established to reduce the administrative burden on the INVO office.

Inventorship spans both campuses. Figure 2 represents the distribution of inventive activity per school. The McCormick School of Engineering (McC) and the Feinberg School of Medicine (FSM) have the largest shares, followed by the Weinberg College of Arts and Sciences (WCAS).

Inventions span many disciplines and markets. Figure 3 shows the distribution of inventions by category. Biomedical inventions (therapeutics, medical devices, and diagnostics) continued to be the largest share of the inventive output.

It is important to note that many inventions in the areas of chemistry, computer science, and materials are considered platform technologies with undefined markets. For example, a new software invention might find applications in the future in a variety of markets such as energy, consumer, and biomedical.

*Figure 1.* Invention disclosures, 2002–2016

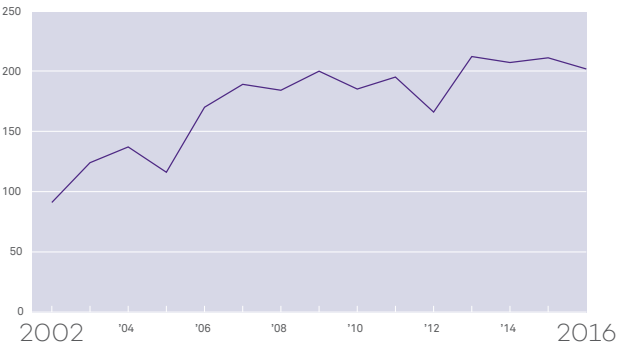





*Figure 2.* Inventions by school

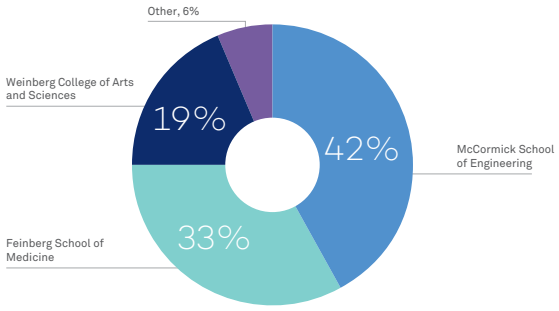
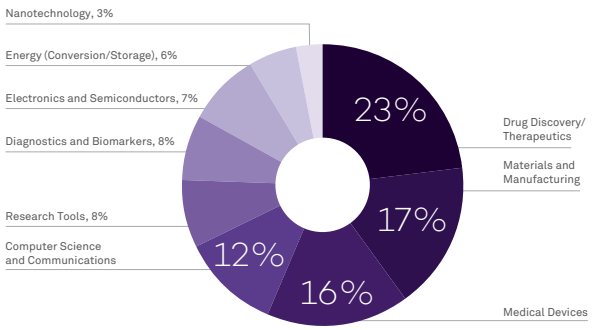



*Figure 3.* Inventions by category



**CHANGING THE SOLAR CELL MARKET** Professor Mercouri G. Kanatzidis (Weinberg) knew there had to be a better way. Though perovskite solar cells had shown compelling promise since 2012, reenergizing the solar field and leading some to call the technology "the next big thing in photovoltaics," the mainstream potential of the technology faced a glaring obstacle: the presence of toxic lead.

A seminal publication in 2012 helped to spark the field of perovskites. This pushed Kanatzidis—an inorganic chemist—and his Northwestern team of researchers, including nanoscientist Robert Chang (McCormick), to develop a lead-free alternative. In 2014, Kanatzidis' group found early success by swapping lead for tin as the harvester of light. Subsequent innovation from the Kanatzidis-directed team has spurred significant interest from both public and private enterprise, particularly given that Kanatzidis' technology requires neither elaborate equipment nor hazardous materials.

Currently, Kanatzidis' lab is working to raise the efficiency levels of its tin solar cells to 10 percent, specifically seeking ways to extract extra voltage from the post-transition metal. They are also working to prepare a stable device that can be further developed into a panel. Success in those efforts, Kanatzidis says, will help him license the technology or secure a partnership to accelerate the discovery process.

"Solar energy is the only sustainable energy and we hope to translate our discovery to the broad-based distribution of solar energy panels that convert sunlight to electricity for homes and businesses in a more environmentally friendly way and at a lower cost than presently available," says Kanatzidis. He is also working with INVO on two other environmental projects, one that removes radioactive elements from nuclear waste and another that cleans industrial water from toxic metals.

Professors Mercouri Kanatzidis (middle) and Robert Chang (right) discuss solar-cell preparation methods with graduate student Byunghong Lee. *Photo Credit: Mitch Jacoby/C&EN*

# COLLABORATION IS ONE OF THE PILLARS OF HIGH QUALITY INVENTIONS

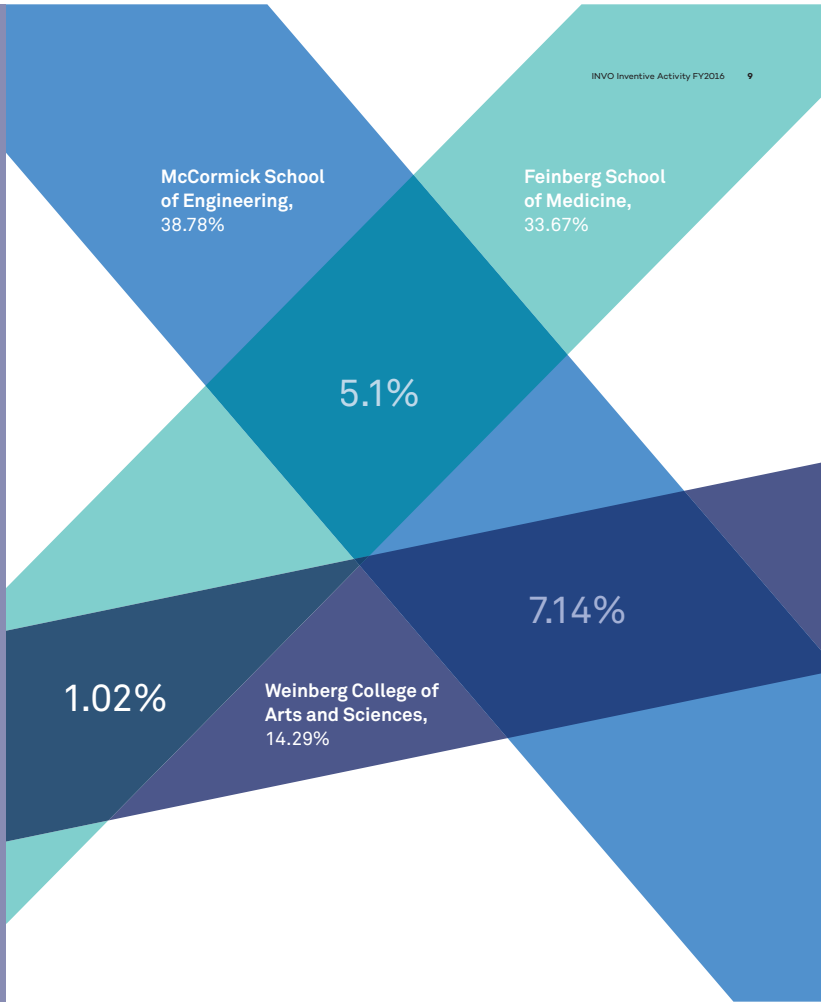



**FIGURE 4.** Boundary crossing ideas produced the most disruptive inventions, which are also most valued in the marketplace. Northwestern's interdisciplinary approach is displayed by the high level of co-inventorship activity among different schools.

# INVENTORSHIP OCCURS IN ALMOST ALL DEPARTMENTS WITHIN THE SCHOOLS

Figures 5, 6 and 7 illustrate inventive activity within each school.

*Figure 5.* McCormick School of Engineering inventions by department

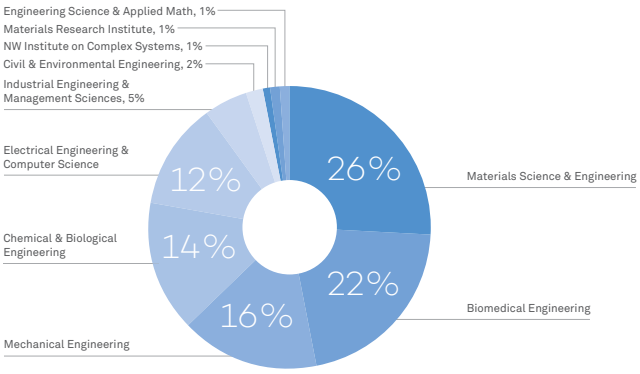





*Figure 6.* Feinberg School of Medicine inventions by department

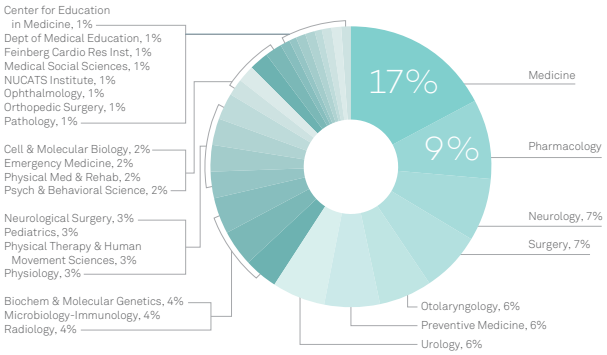
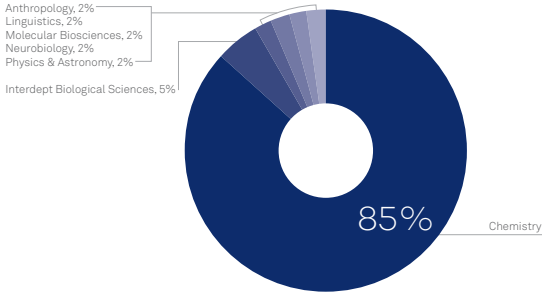



*Figure 7.* Weinberg College of Arts and Sciences inventions by department




**INVESTING IN BILLION-DOLLAR PEOPLE** Student startups at Northwestern have a new champion—and it's one with deep pockets, NUseeds. Earlier this year, the University awarded the first two NUseeds investments, a $4 million venture capital fund providing seed investments to accelerate the launch of the most promising student-founded, early-stage ventures.

Pak'd, the brainchild of Kellogg students Nate Cooper '17 and Rebecca Sholiton '16, received a $75,000 investment, which the startup is devoting to growing its user base and driving expansion outside of the Chicago area. Specifically targeting parents of the school-aged crowd and pledging to eliminate the frustrating work of preparing school lunches, Pak'd delivers fresh, customizable lunches directly to homes.

Another Kellogg student, Blair Pircon '16, received $40,000 for her venture, The Graide Network. The online platform connects teachers with university students studying education—so-called "Graiders"—to provide additional feedback on student work ranging from essays to computer science projects. Pircon has earmarked her NUseeds award for the hiring of personnel tasked to recruit and onboard new Graiders.

In addition to the capital infusion, both Pak'D and The Graide Network receive coaching from a network of external alumni and community experts at The Garage, Northwestern's one-year-old, on-campus innovation hub for students.

Future NUseeds recipients will come from The Garage's collection of student-founded startups and its Wildfire accelerator program, while award candidates will continue to be evaluated and selected by an external investment committee comprised of professional investors.

*"With NUseeds, we're placing a bet on our best and most talented student entrepreneurs and showing that we're engaged in driving the growth of their ventures."*
—**Melissa Kaufman**, Executive Director, The Garage

The Graide Network co-founders, Liz Nell (left) and Kellogg MBA student Blair Pircon (right) tied for first in the Northwestern University Venture Challenge.

**.WII: SUPPORTING WOMEN INNOVATORS** Compared to their male counterparts across the broader entrepreneurial landscape, female innovators remain less likely to disclose inventions, to patent, and to engage in entrepreneurial activity.

With its Northwestern Women Innovator Initiative (N.Wii), INVO looks to challenge that global reality, discarding myths about entrepreneurship, empowering female innovation and inventorship, and increasing the number of Northwestern female faculty in the entrepreneurial ranks by 30 percent over the next three years.

With a soft launch in late 2015, N.Wii takes aim at those numbers, helping female innovators become inventors and female inventors become entrepreneurs or board members, particularly in the STEM and life science fields.

The initiative confronts two common impediments to female entrepreneurial success: uneven access to resources and the lack of a network. Through the N.Wii program, select female innovators will be pulled into the INVO ecosystem and its vast array of resources, including: connections to targeted role models and mentors; support in the pursuit of scholarly, funding, and promotional awards as well as commercialization grants; training for pitch sessions; access points to partners and investors; and guidance through the startup formation.

While the upstart INVO initiative is currently for targeted female faculty and staff members only, the long-term plan is to cover the entire Northwestern entrepreneurial pipeline from undergraduates to senior faculty and for N.Wii to broaden its reach with targeted programming designed to further drive female entrepreneurship.

*"We know that diversity ensures we get the best innovations and increased chances of success, and N.Wii looks to bring greater diversity into the entrepreneurial ranks."*
—**Dimitra Georganopoulou**, INVO Innovation and Commercialization Officer

McCormick School of Engineering Professor and logistics expert Karen Smilowitz (middle) and her team of engineering students using their dashboard to collaborate with Bank of America Chicago Marathon on data analytics. ***Photo Credit: Bank of America Chicago Marathon***

# INVO LOOKS TO EMPOWER FEMALE INNOVATION AND INVENTORSHIP

Figures 8, 9 and 10 represent the gender distribution of tenured and tenure-eligible faculty and the percentage of whom have disclosed inventions during FY 2016.

Weinberg College of Arts and Sciences percentages represent faculty from the departments of Chemistry, Molecular Biosciences and Neurobiology.

*Figure 8.* Inventions McCormick School of Engineering, gender distribution

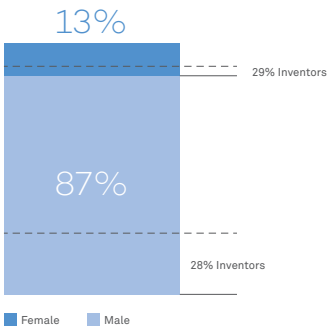



*Figure 9.* Inventions Feinberg School of Medicine, gender distribution

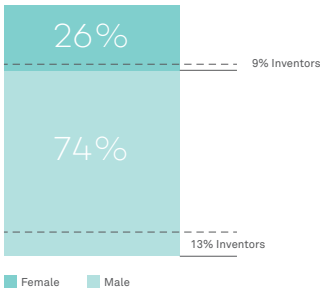
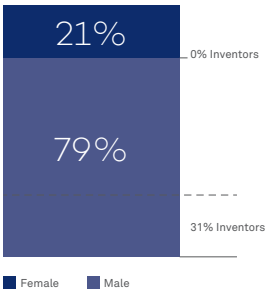
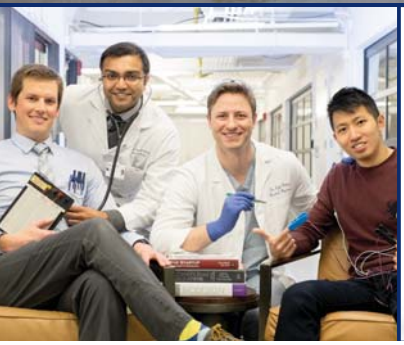



*Figure 10.* Inventions Weinberg College of Arts and Sciences, gender distribution





**MAKING WAVES IN THE WEARABLES MARKET** Being an innovative force in the explosive wearables market is nothing new for Northwestern University. Innovative research from the lab of Professor Tobin Marks (Weinberg) spurred the ascent of Polyera, a materials developer whose ActivInk technology has been applied to a diverse range of products from solar cells and sensors to RFID tags. The research of Professor Mark Hersam's (McCormick) group into premium single- and double-walled carbon nanotubes fueled NanoIntegris, a startup acquired by Raymor Industries in 2012.

In the still-nascent wearables field, Northwestern is now quickening its pace.

This year, Northwestern welcomed John Rogers (McCormick, Feinberg), a world-renowned scientist and pioneer in the field of bio-integrated electronic devices whose research is capable of changing the fields of industrial, consumer, and biocompatible electronics. By making semi-conductor devices look more and more like biology—think more temporary tattoo than wrist watch—Rogers blends the dynamic world of modern consumer electronics with human health, inspiring potential groundbreaking solutions such as implantable medical devices that can harvest energy from organs or automatically treat medical conditions.

Development of such wearable technologies is aided by one of Professor Rogers' frequent collaborators, Professor Yonggang Huang (McCormick), whose work includes establishing mechanics and thermal analysis models for stretchable and flexible electronics, epidermal electronics and transient electronics, as well as 3D fabrication of any materials.

Then, there is Bold Diagnostics, an award-winning venture fueled by the Center for Device Development's (CD2) Innovation Fellowship program. Replacing the traditional bulky arm cuff for blood pressure measurement with Bold Bands, a wearable device that provides continuous blood pressure monitoring, Bold Diagnostics aims to reduce the risk of misdiagnosis from inaccurate readings and to drive more pinpoint treatment of hypertension and other cardiovascular diseases. After a successful run in the 2016 business plan competition circuit, Bold Diagnostics captured a first-place nod in the 2016 Create the Future Design Contest, an annual global event that rewards engineering innovation.

*"The CD2 Fellowship program challenges fellows—two physicians and two engineers—to identify a clinical need and develop a solution within one year. With protected and paid time to develop their solution along with additional instructional support, the goal is to create meaningful medical innovations that can improve treatment and results."* —**Sonia Kim**, Managing Director of Marketing and Commercialization Education, INVO

***Top:*** **"Tattoo electronics", flexible wireless electronics developed by Professors Yonggang Huang (McCormick) and John Rogers (McCormick, Feinberg).** ***Bottom:*** **The 2016 CD2 Fellows (left to right: Sean Connell, Jay Pandit, Kyle Miller and Andrew Wu) won over $128,000 through the business plan competition circuit and received an NSF SBIR grant of $225,000 to advance its technology and build its next phase prototype. They benefited from the guidance of Adjunct Kellogg Lecturer Peter McNerney, INVO's Managing Director Sonia Kim as well as key physicians, professors, and staff at Northwestern University and Northwestern Memorial Hospital and the Chicago medtech community. To their right, the Bold prototype of the Bold Band and its associated app platform.**


**ADDRESSING DEPRESSION FROM ALL ANGLES** Northwestern University is attacking depression, an oft-debilitating condition estimated to affect 6–10 percent of the U.S. population each year, from a trio of angles—therapeutics, diagnosis, and monitoring.

Researcher Joe Moskal (McCormick) led the recent charge with Rapastinel, the signature drug at his Northwestern startup Naurex. Developed to combat major depressive disorder, Rapastinel entered Phase 3 trials this past summer, about one year after global pharmaceutical giant Allergan acquired Naurex in a deal that included a $560 million upfront payment. In previous trials, the drug captured attention as a faster-acting, longer-lasting alternative to current depression therapeutics, while also carrying fewer side effects.

Eva Redei (Feinberg), meanwhile, continues her encouraging research into depression biomarkers, heightening the potential of qualitative analysis for a condition long hampered by the limits of quantitative diagnosis. Redei's biomarkers research has displayed promising potential to identify depression's biological links and accelerate the path to—and perhaps even the acceptance of—helpful interventions.

Spurred by the work of David Mohr (Feinberg), IntelliCare tackles three of the most frequent impediments to treatment of depression and anxiety—access, affordability, and stigma—with a suite of 14 free mobile apps. The patent-pending platform targets the common causes of depression and anxiety, such as sleep problems, lack of activity, and social isolation. During a recently closed eight-week field study, nearly 100 IntelliCare subjects used the apps consistently and showed measurable improvement. IntelliCare is now in the midst of a randomized clinical trial and continues fielding potential partnership opportunities from both private and public healthcare providers.

*"Professor Redei's work with biomarkers capitalizes on already–available clinical and lab tools and helps to destigmatize depression by showing there's a biological reason at play, which hopefully leads more people to seek treatment."*
—**Mike Moore**, INVO Invention Manager

**IntelliCare Hub, a suite of apps developed by Professor David Mohr (Feinberg) to deliver treatment for depression and anxiety.**

**PATENT FILING INCREASED 17% FROM FY15** Figure 11 shows patents filed in FY16 per school. Patent filing is consistent with the invention disclosure activity reported in Figure 2. Figure 12 illustrates the breakout of patents filed in FY16.

**Provisional patents:** Approximately 60%–70% of all invention disclosures are filed as provisional patents; approximately 50%–60% are converted into non-provisional patents within a year.

Filing a provisional patent application before filing a Utility application presents several advantages:

- Relatively inexpensive, and allows the inventor to spend one year gathering more data resulting in a stronger patent application;
- Allows INVO to conduct a more in depth commercial assessment of the invention and identification of potential licensees; and
- Delays the formal filing date, which results in a later patent expiration date.

**Non-Provisional (Utility) patent applications:** The filing of a Utility patent starts the official examination process with the USPTO to determine if the invention is patentable. The USPTO review of a patent application can take several years.

**PCT applications:** A PCT is an international treaty with more than 145 Contracting States. The PCT makes it possible to seek patent protection for an invention simultaneously in a large number of countries by filing a single "international" patent. A PCT application must be followed up within 18 months by entering into national or regional phases to proceed towards grant of one or more patents. Foreign prosecutions are very expensive. INVO files in specific countries (National Phase) only when there is a licensee for the patent.

**Continuing patent applications (CIP):** These are patent applications that follow and claim priority to an earlier filed patent application.

**EPO Validation:** Granted European patents that are in the process of validation in individual states.

**Divisional patent applications:** Patent applications with claims that were divided out of the original filed application and which have to be resubmitted as a separate application.

Figure 13 illustrates that patent filings span many disciplines and markets.

*Figure 11.* Filed patent applications by school

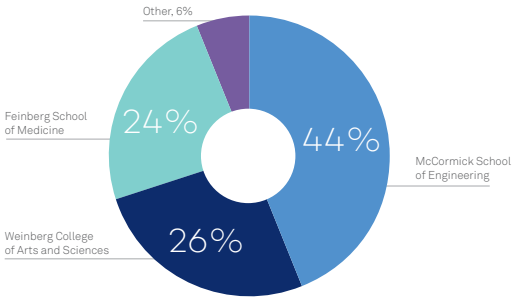





*Figure 12.* Filed patent applications by type

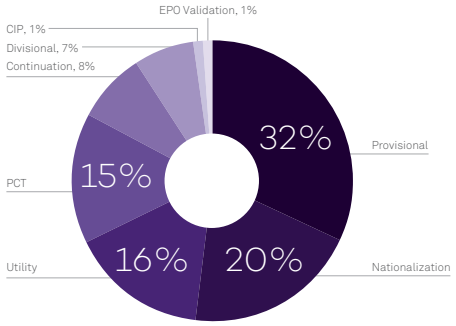
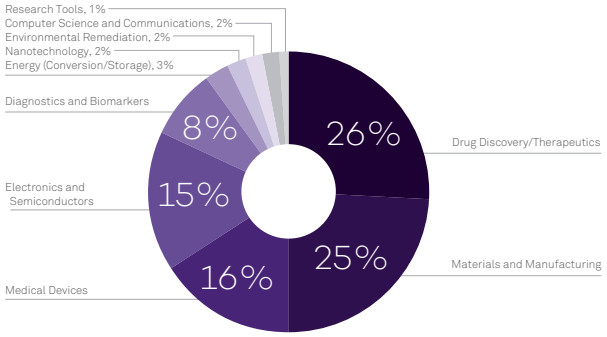



*Figure 13.* Issued patent applications by category



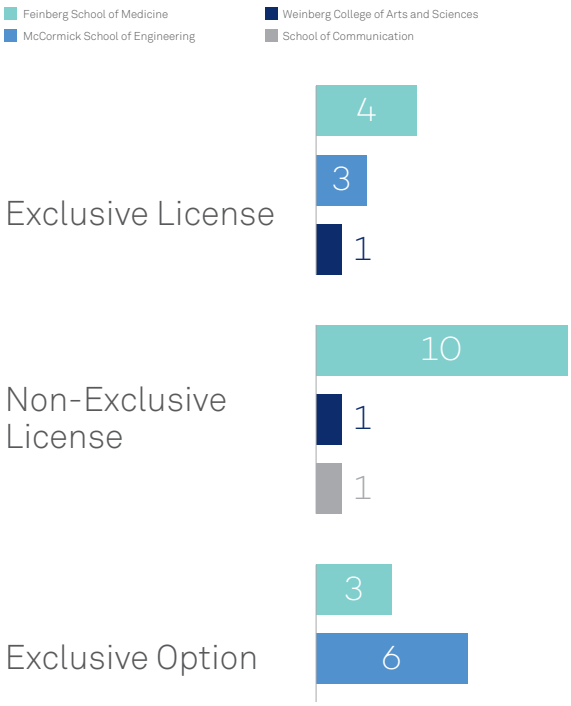
# NUMBER OF AGREEMENTS CONTINUED TO GROW

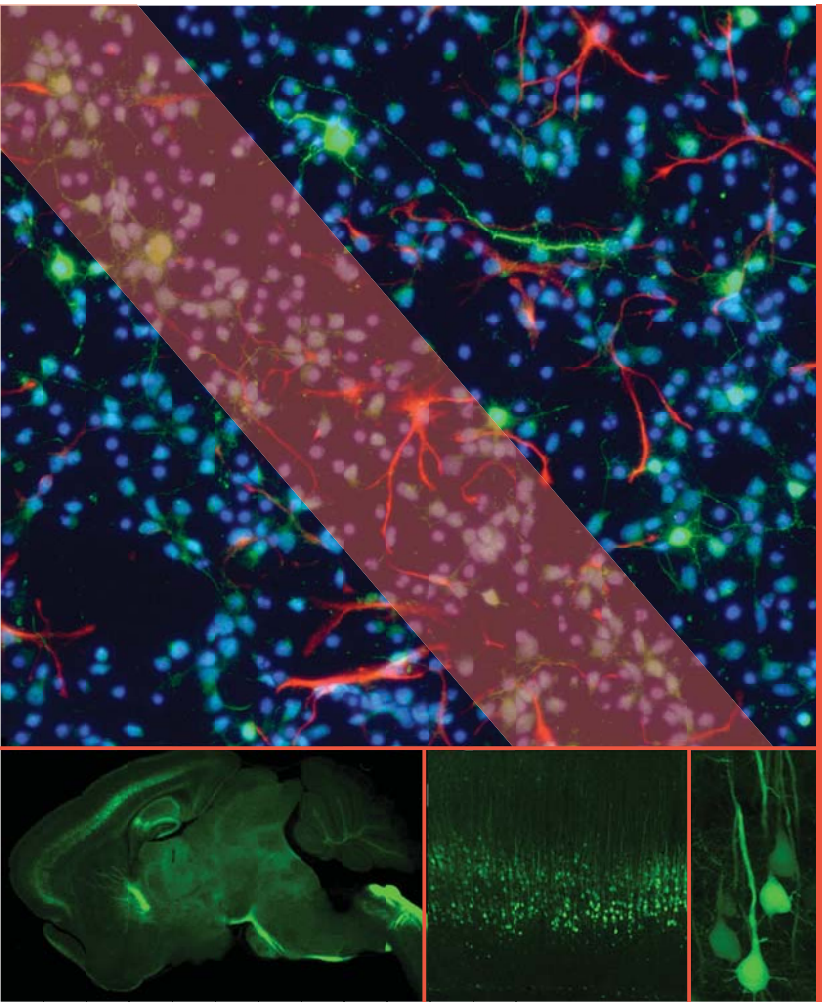
INVO executed 169 agreements during FY16, representing a 36% growth compared to FY15 and 150% increase compared to FY14. Agreements ranged from inter-institutional agreements to material evaluation agreements and licenses. The volume of agreements signals a growing external interest in Northwestern's inventions.

There are two main paths to commercialize academic inventions: license to developers or license to spinouts. Most co-development partnerships will include some type of licensing agreement as well.

Exclusive licenses or options are generally executed for technologies that require significant private investment to reach the marketplace or are so early stage that exclusivity is necessary to induce investment needed to determine utility.

*Figure 14.* Agreements by school







**THE N.XT FRONTIER OF ALS RESEARCH AT NORTHWESTERN** For more than 30 years, Northwestern University has been working to unlock the puzzle of ALS. The University's unique strength in battling the progressive neurodegenerative disease arrives from a range of dedicated researchers, including Teepu Siddique, MD (Feinberg), who spearheaded the creation of a "research standard" model system for ALS now licensed by researchers around the globe.

Professor Richard Silverman (Weinberg), the world-renowned chemist who developed the pharmaceutical now marketed as Lyrica, and Assistant Professor Hande Ozdinler (Feinberg), an expert on upper motor neuron biology, are now driving the University's latest potential game–changing ALS innovation. The promising early effort combines Ozdinler's novel approach for visualizing motor neurons in the brain with Silverman's compounds designed for the inhibition of protein aggregation, one of the hallmarks of ALS.

Silverman and Ozdinler are now taking their next research steps—more extensive *in vitro* studies and, later, *in vivo* animal studies—as the first recipients of a capital infusion from the University's $10 million N.XT fund, designed to support Northwestern's early–stage innovations and propel commercial development.

While no ALS drug has successfully emerged from clinical trials over the last two decades, Silverman and Ozdinler look to reverse that trend with their novel approach to drug discovery. By focusing on the health of the brain's motor neurons, the researchers' interdisciplinary collaboration represents the start of a paradigm shift in preclinical studies and drug discovery in ALS as well as other motor neuron diseases.

*"Research often reaches a point in which the money runs out and once-promising projects fall into the valley of death. With the N.XT fund, Northwestern is providing a bridge to help innovative projects move on to later-stage development that can lead to additional investment and potential commercialization."* —**Nick Maull**, Assistant Director of New Ventures, INVO

**Professor Hande Ozdinler's visualizations of upper motor neurons in ALS mouse at different scales.**

# NORTHWESTERN STARTUPS RAISED MORE THAN $110 MILLION IN FY16

**FIGURE 17.** Entrepreneurial activity in universities is measured by the number of startups launched every year. Northwestern has consistently ranked high in this metric.

An important metric for startup success is the ability to fundraise. In FY16, Northwestern startups raised more than $110M from the private sector and signed more than $1.5B in co-development agreements. The outstanding success of these NU startups is proven validation of the quality of Northwestern's inventions.

These companies included: Aptinyx (Prof. Moskal), Cour (Prof. Miller), Exicure (Prof. Mirkin), Tanvas (Profs. Colgate and Peshkin), and Transplant Genomics (Prof. Abecassis).

Figure 17 represents the FY16 incoming class to the Northwestern portfolio. These startups cover a variety of markets that include biomedical, food, software solutions, and fab tools.

*Figure 17.* Startups by school

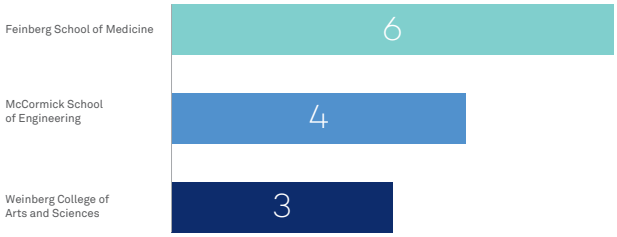
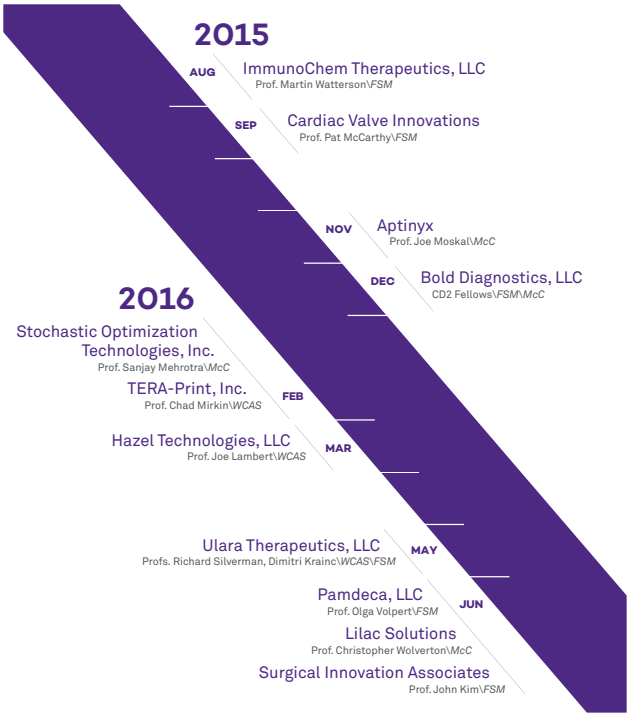





*Figure 18.* FY16 Startups



# APPENDIX



| RESEARCH | RESEARCH VALIDATION | COMMERCIAL VALIDATION | MARKET |
|---|---|---|---|
| | Secure Tool for Medical Data Transfer | OR Supervision Assessment System | **Diagnostic Tools for Language Disorders** |
| | App for Movement Disorders | **Software to Triage ICU Care** | **Depression Apps** |
| | Charging Station Placement Algorithm | **Flexible Electronic Medical Device** | MATLAB to C Translator |
| | | AutoCOG for Android Applications | MINT (Materials Interface) |
| | | Precise Automatic Camera Automation | **Natural Language Generation Software** |
| | | Predictive Optimal Control | **Big Data for Marketing** |
| | | **3D Scanning for Difficult Vision** | **Street-level IP Geolocation** |
| | | **Waveguide Modulators** | **Encryption Technology** |
| | | IChef | **Optimization Software** |
| | | SynthAssist | **3D Vision Systems** |
| | | 6 Degrees of Separation | **Internet Administration Services** |
| | | My Dream Team | **Digital Language Lab** |
| | | Tivo/Cronkite | |

## COMPUTER SCIENCE & COMMUNICATIONS PIPELINE

*Available for License* ***Exclusive License/Option***

## DIAGNOSTICS & BIOMARKERS PIPELINE

*Available for License* ***Non-Exclusive License/Option*** ***Exclusive License/Option***

| CONCEPT & FEASIBILITY | DEVELOPMENT | VALIDATION | MARKET |
|---|---|---|---|
| Analysis of Multiplexed Bead-Based Assays | Electronic Biochip System | UTI Management | **Point of Care Diagnostic Platform** |
| Biomarkers for Malignant Glioma | Nanostructures for CNS Cancers | Optic and Acoustic Imaging | **Neurodegenerative Disease Biomarker** |
| Imaging for Steroid Hormone Diseases | Platform to ID mRNA Signature for Prostate CA | MRE Pasive Driver for imaging | |
| Tracking Reporter Gene Expression for MRI | Screen for Clinical Paeruginosa strains | Atrial Fibrillation Electrogram Analytics | |
| Anthrax Detection | Glucose Biosensor for Diabetes | iSOCT Imaging | |
| At Home Menopause Test | Marker for Chronic Pelvic Pain Syndrome I | Whisker Sensors for Surgery | |
| Microfluidic Detection of Tumor Cells | ER Retinal Skew Diagnostic for Stroke | Nanofabricated Glucose Sensor | |
| Bioscaffolds for Artificial Ovaries | PET Probe for Alzheimers | Genetic Marker for ALS | |
| Antigen Compositions for APS Detection | DOPA Nanoparticles | SERS Sensor for Lactate | |
| | Female Fertility Test | Blood Test for PTSD and Depression | |
| | Biomarker for Female Egg Quality | Heavy Metal Content in Blood | |
| | Biomarker for Colitis | Esophogeal Panometry | |
| | Biomarkers for Prostate Disease | **Virtual EP Test** | |
| | Biomarker for Early Stage Cancers | **MRI Cardiac Stress Test** | |
| | **Marker for Chronic Pelvic Pain Syndrome II** | **Raman Biosensor for Multianalyte Detection** | |
| | | **Partition Layer for Raman Biosensor** | |
| | | **Marker for Neuro-muscular Disorders** | |
| | | **CA Diagnostic via Microscopy** | |
| | | **Endoscopic CA Diagnostic** | |
| | | **Prep-Free Colon CA Screening** | |
| | | **HIV Diagnostic Platform** | |
| | | **Molecular Diagnostic Platform** | |
| | | **Gold NP Templated Nanomaterial** | |

## ELECTRONICS & SEMICONDUCTORS PIPELINE

*Available for License* ***Non-Exclusive License/Option*** ***Exclusive License/Option***

| RESEARCH | RESEARCH VALIDATION | COMMERCIAL VALIDATION | MARKET |
|---|---|---|---|
| Bipolar Magnetic Junction | Nanophotonics Directional Coupler | Organic Semiconductors | **High Conductivity Graphene Inks** |
| Organic Ferroelectronics | Efficient Thin Film Synthesis | Low Voltage Organic Electro-optics | **Graphene Ink for Gravure Printing** |
| Emitter-Coupled Transistor Logic | Silver Cathode for Lithium Batteries | Barium Titanate Waveguides | |
| All Carbon Spin Logic | p-Type Transparent Conductors | Thiophene Based Materials for Optoelectronics | |
| Two Qubit Gate | Magnetic Field Sensors | Nanoscale Self-Assembled Dielectrics | |
| Computing Logic Family | Microscopy for Current Flow | Organic Electro-Optic Chromophores | |
| Polymers for Protecting Circuitry | High Energy Density Nanocomposites | Superlattice Dielectrics | |
| Novel Logic Family with Nanowire Transistors | Two Dimensional Nanomaterial Sorting | Hot Pressing Method for Transistors | |
| Iodosalts for Use in Next Generation Solar Cells | Self-Assembled Organic Monolayers on Graphene | Conductive Thin Films Doped with Tin and Zinc | |
| Quantum Interference Molecular Electronic Devices | Generation of Multifunctional Nanocomposites | Self-Assembled Organic Nanodielectrics | |
| Doped Tin Selenium Single Crystals | Lead Free Solar Cell | Transparent Conducting Graphene/ Silica Thin Films | |
| Tin-Based Perovskites for Solar Cells | TEM Nanostructure Characterization Device | Transparent Nanowire Transistors | |
| Ultralow Power Carbon Nantube Logic Circuits | Chalcohalides for X-Ray and g-Ray Semiconductor Detection | Organic Photovoltaics with Nickel Oxide | |
| Integrated On-Chip Thermocouple Array | Low-Cost Semiconducting Single Walled Nanotubes | Nanoscale Doping For Transparent Conducting Oxides | |
| Magnetic Diode Based Programmable Logic | Contactless Probe for Detecting Buried Semiconductors | Printable Dielectrics for Electronic Devices | |
| Transverse Thermoelectrics | Gate Tunable p-n Heterojunction Diode | Organic Transparent Electrodes | |
| Gate Tunable Nanoscale Memristors | Atomic Force Microscopy with Electroluminescence | Metal Oxide Thin Films | |
| Spin Diode Logic Family | Non-Linear Optic Glassy Fibers and Thin Films | **Silole-Containing Polymers** | |
| | Scanning Near Field Thermo-elastic Acoustic Holography | **Acene-Based Organic Semiconductors** | |
| | Broad-Frequency Electric Field Sensor | **Planar Photonic Jet Lens** | |
| | Magnetic Shape-Memory Foams | **Hybrid Thin Film Transistors** | |
| | Anti-Ambipolar Heterojunctions from Semiconductors | | |
| | Magnetic Field Sensors | | |
| | Bridge-Enhanced Nanoscale Impedance Microscopy | | |
| | Tracking Circuit for Hardware Security and Configuration | | |
| | Deducing Charge Density Gradients in Semiconductors | | |

## ENERGY PIPELINE

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| RESEARCH | RESEARCH VALIDATION | COMMERCIAL VALIDATION | MARKET |
|---|---|---|---|
| Doped Tin Selenium Single Crystals | p-type Transparent Conductors | Hole Array Films | |
| | Integrated Solid Oxide Fuel Cell | Novel Organic Self-Assembled Nanodielectrics | |
| | Methane Powered Fuel Cell | Electron-Blocking Layer for Organic Photovoltaics | |
| | Polycrystal Memory Foam for Energy Applications | Organic Photovoltaics with Nickel Oxide | |
| | Solid Oxide Fuel Cells | Improved Power Conversion for Organic Photovoltaics | |
| | Solar Cell Coating | Organic Photovoltaic Cells | |
| | Improved Nanoparticle Processing for Energy Use | **Hybrid Thin-Film Transistors** | |
| | Solid State Solar Cell | Controlling Charge Injection in OLEDs | |
| | Water Processable Graphene Oxide | Crosslinkable Polymer Dielectrics | |
| | All-Carbon Counter Electrode | Superlattice Dielectrics | |
| | Lead-Free Solar Cells | **Rechargeable Lithium Battery** | |
| | High Energy Density Nanocomposites | **Si Nanoparticles for Batteries** | |
| | Novel Batteries for Medical Devices | **MOF for Energy Storage** | |
| | Improved Lead-based Eutectic Composite | | |
| | SMOFC Battery Cathode | | |
| | Graphitized Li Ion Batteries | | |
| | Nanocomposites for Energy Storage | | |
| | Crumpled Graphene Coated Si Nanoparticles | | |
| | Carbon Nanoparticle for Energy Storage | | |
| | Novel Separator for Storage Devices | | |
| | Silver Containing Cathode for Li Ion Batteries | | |

## MATERIALS AND MANUFACTURING PIPELINE

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| RESEARCH | RESEARCH VALIDATION | COMMERCIAL VALIDATION | MARKET |
|---|---|---|---|
| Production of Substituted Imidazole Molecules | p-Type Transparent Conductors | Organic Electro-Optic Chromophore | **Advanced Materials** |
| Synthesis of Priviledged 7-Membered Ring Molecules | Self-Assembly of Oligoamphiphiles | Novel Nickel Based Alloys | **Graphene Ink for Gravure Printing** |
| Synthesis of 2-Aryl Indoles | High Energy Density Nanocomposite | Graphene/Titania Nanocomposite Photocatalysts | **Graphene Ink for Screen Printing** |
| DOPA-Melanin Films | Magnetic Shape Memory Foam | Tunneling Proximity Sensor/Probe | **High Conductivity Graphene Inks** |
| Ductile Magnesium Alloys | Graphene Silica Films | Ceramic Composite | |
| Self Assembled Bioadhesives | Novel Organic Photovoltaic Composition | Micro-Textured Surfaces | |
| Extracellular Matrix with Anticoagulant Properties | Atomic Force Photovoltaic Microscopy | Micro-Surface Texturing System | |
| 3D Printing of Endovascular Stents | Soy Based Biomaterials | Liquid Cast Biodegradable Arterial Stent | |
| High Temperature Soft Ferromagnetic Materials | Fabrication of Complex Metallic Structures | Transparent Nanowire Transistors | |
| Lead Selenophosphate Compound for X-Ray Detection | Soft Materials for Bioprinting | Novel Material for Polymer Light Emittting Diodes | |
| Tin Selenium Single Crystals | Substrate Independent Coatings | Mesoscale Metallic Pyramids with Nanoscale Tips | |
| Tin-Based "Perovskites" for Solar Cell Production | Water Processable Graphene Oxide | Hole Array Films | |
| New Class of Molecular Iodosalts for Next Generation Solar Cells | Synthesis of Layered Metal Sulfide Ion Exchangers | Removal of Metal Pollutants from Water | |
| Semiconductor Material for Detection of Hard Radiation | Adhesive Hydrogels | Electron Blocking Layer for Organic Photovoltaics | |
| Production of Pinhole-Free Perovskite Thin Films | Nanocomposites for Energy Storage | Organic Semiconductors | |
| Polysulfide Compounds for Environmental Remediation | Gas Phase Deposition in Metal Organic Frameworks | Organic Photovoltaic Cells | |
| High Particle Content 3D Printing Inks | Route to Diazeperopyrenium Dication | Controlling Charge Injection in OLEDs | |
| Bioscaffolds for Replacement Ovaries | Arrays for X-Ray Optics Lamination | Crosslinkable Polymer Dielectrics | |
| Carbon Nanotube Logic Circuits | Gate Tunable Carbon Nanotube Diode | Unconventional Electro-Optic Chromophores | |
| Photocatalytic Composite | Nanoscale Subsurface Imaging | Improved Power Conversion for Organic Photovoltaics | |
| Photocatalyst | High Accuracy Double-Sided Incremental Forming | Carbon Nanotube Reinforced Cement | |
| Polysulfide Compounds for Environmental Remediation | Laser Induced Plasma Micromachining (LIPMM) | Superlattice Dielectrics | |
| | Tri-Pyramid Robot | Conductive Tin and Zinc-Doped Thin Films | |
| | Extra-Strength Magnesium Alloys | Novel Organic Self-Assembled Nanodielectrics | |
| | Thermoresponsive Cell-Adhesive Bioresorbable Dressing | Radioactive Water Decontamination | |
| | Nanoscale Self-Assembling Organic Dielectrics | Heavy Metal Removal & Gas Separation | |
| | Thickness Sorting of 2D Nanomaterials | **Multifunctional Coatings** | |
| | Organic-Silicate Matrices for Remediation | **Silole-Containing Polymers** | |
| | Epoxidation of Unsaturated Hydrocarbons | **Separation of Olefin/Paraffin** | |
| | Graphene-Titania Nanocomposite Photocatalysts | **Metal Organic Frameworks** | |
| | Water Detoxification Method | **Graphite Nanoplatelet Dispersion** | |
| | 2D Nanomaterial Sorting | **Graphene Oxide Paper** | |
| | Nickel-Titanium Foams | **Gold Isolation Method** | |
| | Nanoscale Doping for Transparent Conducting Oxides | **Gold Recovery from Halide Etchants** | |
| | Flash Reduction of Graphic Oxide to Graphene | **Polymeric Blends Formed by Solid-State Shear Pulverization** | |
| | Thin Film Monolayers of Graphite Oxide | **Nanoporous Materials** | |
| | Self-Assembled Organic Monolayers on Graphene | **Hybrid Thin Film Transistors** | |
| | Multifunctional Nanocomposites | **Nanocomposite Film and Paper Production** | |
| | Florescent Imaging of Graphene-Based Materials | **Novel Solid Organic Host Silicon Matrix Polymer** | |
| | Sealants for Fetal Membrane Repair | **Fabrication of Metal Composite Thin Films** | |
| | Polymeric Organic Frameworks | **Acene-Based Semiconductor Materials** | |
| | Materials for X-Ray and Gamma Ray Detection-II | **Enhanced Diode Performance** | |
| | Isolation of Single Walled Nanotubes | **Method for Epitaxial Growth of MgO** | |
| | Graphene Concentration Method | **Solid State Shear Pulverization Process** | |
| | Enhanced Strength Cement Composites | | |
| | Low-Cost Semiconducting Single Walled Nanotubes | | |
| | Crumpled Graphene Ball Synthesis | | |
| | Majority Graphene 3D Printed Composites | | |
| | Novel MOF Based On Azolium Salts | | |
| | Lead-Free Solar Cells | | |
| | Stess Manipulated Coating For Figure Reshape of Optics Mirrors | | |
| | Hydrogel Wound Dressing with Controlled Ion Release Properties | | |
| | Nitogen Free Plant Polyphenol Derived Coatings | | |
| | DOPA-Melanin Films | | |
| | Mesoscale Metallic Pyramids with Nanoscale Tips | | |
| | PAH Scavenger System (ExBox) | | |
| | Metal Oxide Thin Film Electronics | | |
| | **Adhesive Polymer Coating** | | |
| | **Electro-Optic Modulator** | | |
| | **Single Photon Detectors and Imagers** | | |
| | **Nano Fountain Pen** | | |

## MEDICAL DEVICES PIPELINE

*Available for License* ***Non-Exclusive License/Option*** ***Exclusive License/Option***

| CONCEPT | LABORATORY PROTOTYPE | COMMERCIAL PROTOTYPE | HUMAN TESTING | APPROVAL AND MARKETING |
|---|---|---|---|---|
| Fetal Membrane Repair Sealant | IVC Filter Removal | Substrate-Independent Adhesive Coating | Rehabilitation Robotics | **Cement Mixer** |
| Left Atrial Appendage Occluder | Low Power Cochlear Implant | Amputee Prosthetic Pump | AF Peak Detection | **Rehabilitation Devices** |
| Cathether for Gene Therapy | Chamber for in situ Wound Healing | Nanodiamonds for Imaging & Drug Delivery | AF Electrogram Analytics Software | **Northwestern Assessment of Verbs & Sentences (NAVS)** |
| Imaging & Therapeutic Nanoconjugates | Stroke Rehabilitation System | Liquid Cast Biodegradable Drug Delivering Stent | **Atrial Fibrillation Diagnostic** | **Northwestern Anagram Test (NAT)** |
| Scar-Free Tissue Regeneration | 3D-Printed Soy Scaffolds | Gas Sensor for Smart Chest Tube Drainage | **Bedside Wound Pulse Lavage** | **Northwestern Naming Battery (NNB)** |
| Cartilage Coupled Peptide Polymers | Flexible Prosthetic Foot | Bioscaffolds for Replacement Ovaries | **Medical Adhesives** | **Treatment of Underlying Forms (TUF)** |
| Self Assembled Bioadhesives | Adaptable Ankle-Foot Prosthesis | Neonatal Abdominal Surgery Trainer | **Polmers for Vascular Disease** | |
| | Bi-Modal Prosthetic Foot | Brain Wave Processing to Enhance Sleep | **Hearing Aid Interface** | |
| | Structured Ilumination Microscopy | **SNR Improvements for Multi-Slice MRI** | **HIV Diagnostics** | |
| | Novel Chalco-Halides for Imaging | **Quantification of Cerebral Perfusion** | **CA Diagnostic via Microscopy** | |
| | Whisker Sensors for Shape Dectection | **Automated fMRI for Clinic** | **Endoscopic CA Diagnostic** | |
| | Inverse Scattering OCT | **MRI-Perfusion and Diffusion Missmatch** | **Prep-Free Colon CA Screening** | |
| | MRE Passive Driver | **Hearing Test** | | |
| | Triple Balloon Catheter | **Point of Care Diagnostics** | | |
| | Ex Vivo Female Reproductive System | **Vocal Cord Medialization** | | |
| | Parylene Membranes for Drug Delivery | **Central Line Insertion Training Curriculum** | | |
| | Hydrogel for Improved Tissue Graft Survival | **Flexible Electonic Medical Device** | | |
| | Anti-Microbial Hydrogel Coatings | **Implantable Biomedical Sensors** | | |
| | Nanostructures for CNS Cancers | **3D Suture** | | |
| | Drug Releasing Tubes for Tissue Engineering | **Motorized Software: Controlled Calibrator** | | |
| | Anticoagulant Coatings | **Photodetector for Infared Imaging** | | |
| | Extra-Strength Hydrogel Adhesives | **Ankle Prosthesis** | | |
| | Liquid Biodegradable Drug Eluting Stent | **Cell Therapy for Diabetes** | | |
| | Heavy Metal Detection in Dry Blood | **Mammary Prosthesis** | | |
| | Left Ventricular Apex Surgical Technology | **RF Ablation Probe** | | |
| | Biocompatible Hydrogels | **Silica Polymer Pen Lithography** | | |
| | Cardiac Tissue Ablation | | | |
| | Novel Micro Drug Delivery Device | | | |
| | Artificial Blood Capillary Beds | | | |
| | SWCNT Glucose Monitor | | | |
| | Peptide Conjugated MRI Contrast Agent | | | |
| | Protein-Based MRI Contrast Agents | | | |
| | Multimodal T1-T2 MRI Contrast Agents | | | |
| | Macromolecular MRI Contrast Agents | | | |
| | Materials for X-Ray & Gamma Ray Detection | | | |
| | Zinc Sensor for MRI | | | |
| | Shock Absorber for Prosthetic Legs | | | |
| | pH Sensitive Drug Delivery Polymers | | | |
| | pH Responsive Self-Healing Hydrogels | | | |
| | pH Responsive Polymer Caged Liposomes | | | |
| | Adhesive Hydrogels for Surgery | | | |
| | Materials that Promote Bone Regeneration | | | |
| | Diabetes Matrices | | | |
| | **Wearable for Ambulatory Blood Pressure Monitoring** | | | |
| | **Intracardiac Electrogram** | | | |

## NANOTECHNOLOGY PIPELINE

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| RESEARCH | RESEARCH VALIDATION | COMMERCIAL VALIDATION | MARKET |
|---|---|---|---|
| Duplex DNA Detection Reagent | Imaging & Therapeutic Nanocomposites | Proximity Sensor Based on Cantilever | **Gold Nanoparticles** |
| | Maskless Nanopatterning | Polymerization onto Metal Oxide Particles | **Point of Care Diagnostics** |
| | Nanoparticle Sorting Method | Transparent Conducting Oxides | |
| | Nanoparticles for Diagnosis & Therapy | Carbon Nanotubes for Photocatalysis | |
| | Nanostructure Toolbox | **Carbon Nanocomposites** | |
| | Nanoparticle Electrides | **Semiconducting Nanotubes** | |
| | Carbon Nanoparticle for Energy Storage | **Si Nanoparticles for Batteries** | |
| | Multifunctional Nanocomposites | | |
| | Isolation of Single Walled Nanotubes | | |
| | Laser-Assisted Nanpatterning | | |
| | Nanodiamonds for Imaging and Drug | | |

## RESEARCH TOOLS PIPELINE

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### NUCLEIC ACIDS

- RNA-Directed Gene Editing
- Lung Gene Transfer
- Nuclear Lamins Expression Vector
- Clock Gene cDNA
- Timeless gene cDNA
- pAN1: ElectroTfm of Clostridium
- Luciferase Reporter with hsp70.1
- C. acetobutylicum gene expression plasmids
- Hollow Nanoflares

### ANTIBODIES

- CD31, CD87 and CD15 mAbs
- Tubulointerstitial Nephritis Antibody
- Myeloid Restricted CD13 mAb
- HSP70, HSC70 and HSP72 mAbs
- mAb Murine Hybrima: Vascular Endothelial Ag
- Influenza Virus M2 mAb
- Mutant HSP70/BiP/grp78 mAbs
- Importin b1 mAb
- PGSL-1 mAb
- mAb for Tau Truncated at Residue 412
- Human g2 Laminin C-Terminal mAb
- Human and Rat a3 Laminin mAbs
- Hemidesmosome BP230 mAb
- Hemidesmosome BP180 mAb
- Rat Laminin-332 a3 subunit mAb
- a4 Laminin mAb
- Tau Nitrosylated Tyr18 mAb
- Tau Nitrosylated Tyr29 mAb
- Tau PAD Region mAb (TNT-1)
- **HSF1 and HSF2 mAbs**
- **Lamin A and C mAbs**

*Mouse*
***Rat***
***Rabbit***

### CELL LINES

- Cholinergic Neurons From Stem Cells
- Retinal Muller Cell Line
- MM.1 Myeloma Cell Lines
- **E. coli Isolated from Human Prostate**
- **S. cerevisiae H4S47C**

*Mammalian*
***Bacterial***
***Yeast***

### MOUSE MODELS

- Tg Mouse for Amyloid Pathogenesis
- Superoxide Dismutase Tg Mice
- Mt clock gene Tg Mice: Circadian Rhythm
- Per2-Luciferase Tg Mice: Circadian Rhythm
- BMP4 Tg Mice: FOP Clock Tg Mice: Diabetes
- Uch1-eGFP Tg Mice: Motor Neurons in ALS
- Spinal Motor Neutron Degeneration Tg Mice
- Human Trace Amine Associated Receptor
- **Dyrk-1 Conditional KO**
- **MLCK210 KO Mice: Acute Lung Injury**
- **Synapse Dysgenesis**
- **KO Mice**

***Transgenic***
***Knock-out***

### MISCELLANEOUS

- Reverse Transfection Technique
- Ex Vivo Female Reproductive System
- Non-toxic Probe for Cell Staining
- Cell Sorting Method Based on Motility
- High Throughput 3D Transfected Cell Arrays
- Biomarker for Replicative Senescence
- Fluorescent Sensors For Zinc
- Cell-Free Yeast Protein Synthesis
- Methods for Ribosome Production
- Exosome Targeting
- Tethered Ribosome Production
- Enhanced Gene Silencing by RNAi
- Scaffolds for Artificial Ovary
- Detergent-Free Membrane Solubilization
- Raman Spectroscopy for Anthrax Detection
- Raman Biosensor for Multianalyte Detection
- Partition Layer for Raman Nanobiosensor

## THERAPEUTICS PIPELINE

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### NEW TARGETS

- Chromatin Therapy to Sensitize CA Cells
- Kinase Inhibitors for Cancer
- MAPK Compounds for CNS Disorders
- Bacterial NOS inhibitors as Antibiotics
- 3D Printing of Endovascular Stents
- FGF23 Normalizing Methods
- Exosomes for Cholesterol Modulation
- Female Fertility Treatment
- Sirtuin Inhibitors
- MLCK Inhibitors
- Anti-Inflammatory Antibodies
- Pro-Drugs for Streptococcus
- Immunotherapy for Macular Degeneration
- Screen for Covalent Drugs
- Antibiotic-Coated Nanoparticles
- HLD-Like NPs for Inflammation
- CXCR4 Modulators
- Scar-Free Tissue Regeneration
- Thermoresponsive Adhesive Dressing
- Hydrogel Wound Dressing with Cu Ions
- Gene Therapy for Anti-Depression

### HIT TO LEAD

- Megakaryocytic Leukemia
- Compounds Against Nodal Pathway (CA)
- p53 Reactivator: Cancer
- Peptides for CA Treatment
- Peptides for PEDF
- Small Molecule Against ALS
- Ion Channel Manipulation: Parkinsons'
- Compounds for Neurologic Disorders
- Epstein-Barr Virus Inhibitors
- Urinary Tract Infection Vaccine
- HIV Therapeutics
- **Small Molecule Antiviral Therapy**
- Plaque Digestion: Cardiovascular
- G Protein Inhibitors: Cardiovascular
- CD154 Trimer Stabilization: Immunity
- AMPA Receptor Antagonists
- TGFb Inhibitor Transgene
- FFAR2 Agonists for Type 2 Diabetes
- Therapeutic Exosomes
- Maspin for Bone Disorders
- Megamolecule Synthetic Antibodies
- Soft Materials for Bioprinting

### LEAD OPTIMIZATION

- Kinase Inhibitors
- GLUT Antagonists: Cancer 1
- GLUT Antagonists: Cancer 2
- Maspin Protein Mimics for Cancer Treatment
- Triggered Release Arsenic Drugs for CA
- Inhibitors for Triple Negative Breast CA
- Inhibitors for Leukemia
- Peptides for Neurodegeneration
- Small Molecules for Parkinson's Disease
- **Neuroprotective Therapy**
- **Neurodegenerative Disease Therapy**
- Gene Therapy for Atrial Fibrillation
- Inflammation Modulator
- β Lactamase Inhibitors: Antibiotics I
- Malaria Prophylaxis
- Nanoparticulate Arsenic Platinum Drugs
- Herpes Virus Vaccine and Oncolytic Vectors
- Gene Silencing Enhancers
- Bladder Regeneration
- Glucocerebrosidase Modulators

### PRE-CLINICAL DEVELOPMENT

- Small Molecule CA Therapy
- Flavanones & Chromanones for CA
- Small Molecule for Hepatocellular CA
- Human Melanoma
- **Numonafide: Cancer Therapy**
- Glycosides for Cancer Treatment
- GABA Analogues for Hepatocellular CA
- **Small Molecules for CNS**
- GABA Aminotransferase Inhibitors
- Nitric Oxide Synthase Inhibitors
- NOS Targeting: Neurodegeneration
- **Alzheimer Immunotherapy**
- **Neurodegenerative Compounds (GCase)**
- NOS Portfolio: Inhibitors
- Scaffolds for NOS Inhibitors
- **Anti-Tau Monoclonal Antibodies**
- Sensitization to Steroids
- **Peptides for Immune Tolerance**
- **Preventing Allograft Rejection**
- Bladder Regeneration
- E. coli From Human Prostate
- **Chronic Pelvic Pain Vaccine**
- Peptide Vaccine Against Lupus
- UTI Symptom Prevention
- Medical Food For GI Diseases
- Statin for Hearing Loss Prevention & Therapy
- Preventing Scar Formation
- **Topical Wound Treatment**
- **Spherical Nucleic Acids**
- Nanodiamonds: Imaging and Drug Delivery

### CLINICAL TRIALS

- **Metallophile Technology for Cancer**
- Small Molecules for Liver Cancer
- Dopaminergic Neuron Pacemaking
- Treatments for Traumatic Brain Injury
- **Small Molecules for Tourette's Syndrome**
- **GLYX-13 Depression and Pain Therapy**
- **NMDAR Modulators**
- **Metallophile Technology for ID**
- **Wound Healing with Antisense Molecules**
- **Gene Regulation with NP-Nucleic Acid**

### APPROVAL

- **Lyrica: Fibromyalgia**

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