Report of the Committee on the Innovation Ecosystem

May 2014

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I. EXECUTIVE SUMMARY

On August 15, 2013, President Ronald J. Daniels and Dean Paul B. Rothman formed this Committee to consider options for an innovation center to support entrepreneurship in the life sciences. The Committee consulted widely across the university community, considered a wide range of internal and external studies and information, visited innovation hubs around the nation, and solicited feedback from prominent venture capital firms and pharmaceutical and biotech companies. On April 11, 2014, the Committee posted online and made widely available an initial draft of this report available online. From that point, the Committee received hundreds of substantive comments online and in person from more than 100 individuals, encompassing university faculty, students and staff as well as outside private and public stakeholders.

The Committee respectfully submits herein its final set of observations and recommendations.

Our emphatic conclusion is that the university needs to take a broad range of steps to strengthen its innovation ecosystem, in a manner that spans the entire Johns Hopkins community. An investment in innovation and entrepreneurship is an imperative for our university for several reasons. First, our entrepreneurship initiatives will be essential to translating our discoveries into inventions that can improve the human condition and reshape the world. Second, an investment in innovation will be critical in the coming years to our efforts to continue to attract and retain the most talented students, staff and young faculty. Third, in a time of federal research austerity, the revenue from these activities can be reinvested in the groundbreaking research, education and service and clinical activities of tomorrow. Finally, our entrepreneurship activities can have a profound impact in catalyzing economic development in the communities around us.

Our university has made substantial improvements in the realm of entrepreneurship and commercialization in recent years. And yet, there is ample evidence that the university lags behind key peers in this area, and faces significant and enduring challenges. Our view is that the university should make an investment in its innovation ecosystem that consists broadly of three parts.

One is a physical space in East Baltimore, where start-ups can take root and entrepreneurs can interact. The space should be integrated seamlessly into FastForward and other entrepreneurial spaces that now exist across the university, with office, laboratory and design studio space for young companies, open and co-location space for educational opportunities and creative collisions, and room for university administrative offices that facilitate licensing and entrepreneurship activities. The space should be designed in a manner that is conducive to collaboration, and should be open to internal and external companies, to allow a flow of ideas and expertise. It should also offer affordable office and laboratory space for start-ups, flexible options for student and early stage teams, and an operations team to ensure that the hub runs smoothly. Finally, the physical space should be complemented by a virtual, online hub, and an interim space in East Baltimore pending the development of the permanent hub.

The second area of need is the funding of translational activity. The development of a new therapeutic or invention is a challenging and uncertain process in the best of times, but we now see private companies easing away from translational research and development, leading to what is termed a 'valley of death' in the financing of translational research. The generation of urgent and worthy ideas now vastly outpaces available funding. To meet this problem, the university should set itself to developing funding mechanisms, in partnership with a range of other innovation stakeholders. Specifically, the Committee recommends three different mechanisms: An evergreen commercial seed grant to promote advanced early concepts towards proof-of-concept and prototype development; an externally managed investment fund for companies that emerge from Johns Hopkins discoveries and innovation; and a grant program to fuel compelling student and fellow technology development.

The final component is a set of resources and incentives calibrated to provide the needed support for the university's scholar-inventors. The needed set of investments will take a number of forms:

- A network of outside experts and investors, available across the university, who can facilitate fundraising, offer guidance and mentorship to our faculty, student and staff entrepreneurs on licensing their technologies and launching start-ups, and provide access to industry resources.

- A cadre of business analysts and entrepreneurs-in-residence to assist our entrepreneurs with market assessment, business plan drafting, financial modeling, identifying sources of funding, and other needs.

- An integrated and streamlined approach to contracting, commercialization and licensing offices across the university, including concierge service for members of our community and outside investors to navigate the different offices, and geographic co-location of offices.

- A more extensive menu of educational options that are available across the university, including entrepreneurship boot camps, the I-Corps program, and events with subject matter experts.

- A range of additional rerces to stimulate innovation and business development, including accelerators, cores and business plan competitions.

- A review of policies and practices for how they influence our innovation and entrepreneurship ecosystem, including in the areas of promotion and conflict of interest.

- A review of compliance with the recommendations of the 2011 university study group on the dissemination of discoveries.

Finally, we recommend that university leadership convene an appropriate group to consider next steps regarding these recommendations.

II. INTRODUCTION

On August 15, 2013, President Ronald J. Daniels and Dean Paul B. Rothman formed this Committee to consider options for an innovation center to support entrepreneurship in the life sciences.

We were asked to provide our views on the ideal design components of an innovation center; how best to build on and amplify existing resources and investments for entrepreneurship across the university; what we can learn from other universities' experiences; and how best to integrate outside partners into our innovation efforts. The Committee was chaired by Jennifer Elisseeff of the Department of Biomedical Engineering and the Wilmer Eye Institute, and Director of the Translational Tissue Engineering Center, and Drew Pardoll of the School of Medicine and the Sidney Kimmel Comprehensive Cancer Center and Director of the Johns Hopkins Cancer Immunology and Hematopoiesis Program. The full mandate and roster of the Committee can be found in Appendix A.

In the course of its work on this report, the Committee met a number of times in person as a group. We collected information on the approaches to entrepreneurship at more than 30 universities across the nation, and members of the Committee visited innovation centers in Boston/Cambridge, Atlanta, San Diego, Washington D.C. and San Francisco, as well as in Baltimore. Three faculty focus groups were held with university leadership to discuss questions of translational research, innovation and entrepreneurship. All said, members of the Committee and its staff consulted with more than 100 faculty, staff and students in developing the initial draft, and conducted a survey of MD and PhD students regarding their perspectives on innovation at the university.

The Committee also consulted with the Johns Hopkins University Commercial Advisory Group (consisting of representatives from Technology Transfer, FastForward, Business Development and Strategic Alliances, and the Center for Bioengineering Innovation and Design), and the Johns Hopkins Alliance for Sciences and Technology Development (including members from industry and the investment community). We solicited feedback from prominent venture capital firms and pharmaceutical and biotech companies, and reviewed background and supporting materials from a wide range of internal and external sources.

On April 11, 2014, the Committee posted online and made widely available an initial draft of this report. The Committee solicited feedback through a message to the university community. We also convened town halls on the Homewood and East Baltimore campuses and broadcasted one of the town halls simultaneously online. All said, the Committee received hundreds of substantive comments on the interim draft from well over 100 individuals across the university and the outside innovation community. The comments touched each of the major components of the report, and came from faculty, students, staff, alumni and trustees; government agencies and not-for-profits, and pharmaceutical and technology companies and the investment community, from Baltimore and beyond.

The Committee offers this report as its final set of recommendations.

The initial mandate of the Committee was focused principally on the question of a physical center for innovation. However, as our work progressed, it became apparent that while such a space is an important element of a thriving innovation environment, it is far from sufficient on its own. It is the view of the Committee that a true solution to the question of innovation at Johns Hopkins will need to include a number of ingredients, encompassing not only a new location for entrepreneurial activities in East Baltimore, but also an integrated set of funds, services and incentives to support the entrepreneurial impulses of all of our scholar-inventors who seek to translate their research into innovations that reach the broadest available populations.

In short, we believe that the university needs to strengthen its innovation ecosystem, in a manner that spans the entire Johns Hopkins community.

The rest of this report sets out our views on the rationale and ingredients of such an investment.

The Innovation Imperative

There are several reasons why the Committee believes an investment in innovation and entrepreneurship is an imperative for our university.

First, our entrepreneurship initiatives will be essential to translating our discoveries into therapeutics, medical devices and technologies that can improve the human condition and change the world. Our translational research activities will empower us to harness the market to bring our ideas to the world, and in so doing advance the tripartite mission of the university in profound ways. This is an especially exacting concern at a time when pharmaceutical companies and others in the private sector are easing away from investments in basic and translational research, a development that has led a wide range of observers, including most recently the President's Council of Advisors on Science and Technology, to call on universities to more fully embrace their potential as hubs of entrepreneurship.

Second, an investment in innovation will be critical in the coming years to our efforts to continue to attract and retain the most talented students, staff and young faculty. In the course of our consultations, we heard from across the university community a strong call for more robust and readily available support for entrepreneurship support across a range of activities. More than ever, scholars have come to expect resources to empower them to transform the results of their educational, research and service activities, now and into the future, into the products, technologies and companies that can touch every corner of the world.

Third, in this age of financial constraints at every level of government, we are already seeing the dramatic impact of budgetary cuts on the stability of research, investments in laboratories, and our capacity to bring in and support new and young investigators. Our translational research activities can help to add another source of revenue for the university at a moment when it is essential that our university, the most reliant in the nation on federal research funding, identify opportunities to diversify its streams of financial support. The revenue from these activities can be reinvested in the groundbreaking research, education and service and clinical activities of tomorrow.

Fourth, our entrepreneurship activities can have a profound impact on the communities around us. It is no coincidence that so many of the geographic areas within the United States that

are seen as emerging clusters of activity in next-generation economies – Boston, San Diego, San Francisco, Raleigh-Durham, Philadelphia – are also the homes to world class research institutions. A number of recent studies show that the presence of anchor institution like universities that have the capacity and the will to invest in innovation and build connections across diverse stakeholders is one of the key determinants of a thriving urban economy.

For all of these reasons, an investment in our innovation ecosystem holds the potential to advance in profound ways our education, research and service and clinical missions, and contribute to the betterment of the city, the country and the world in which we live.

Investing in Entrepreneurship

As one of the preeminent institutions of higher learning in the world, Johns Hopkins is uniquely positioned to harness such an investment.

The university is a global leader in research, education and service, producing insights that have expanded the frontiers of knowledge. We have been the home to trailblazing discoveries in areas as far ranging as synthetic vitamin D, dialysis, restriction enzymes and the sequencing of the cancer genome. We are the home to schools and programs that are widely regarded as among the best in the world in medicine, public health, nursing, and biomedical engineering, to name only a few, and the home of one of the top rated hospitals in the country. We have been the number one university in the receipt of competitively awarded federal research funding for 34 straight years.

Johns Hopkins is, in point of fact, an incredibly entrepreneurial place.

And yet, when we look at Johns Hopkins' history of activity when it comes to licensing our discoveries, starting new companies, or partnering with existing companies, our record is below that of our aspirational peers.

So, for example, in fiscal year 2012, the income we received from our licensing activities reached an all-time high of $15.9 million. This capped a six year period of steady increase in our revenue figures, representing a remarkable reversal of a previously troubled area for the university. And yet, the yield remains consistently higher for so many of our peers. In the same year, Columbia University received close to $162 million in income from the licensing of intellectual property. The Massachusetts Institute of Technology received $137 million; the University of Massachusetts $52 million; the University of Washington $77 million; and the University of Utah $37 million. This is money that these schools were then able to reinvest in their core academic mission.

Consider the following chart that compares licensing revenue to total research funding for an assortment of the more successful universities in this area:

Institution	License Income	Sponsored Research	License Income x 100 /Sponsored Research
Columbia U.	$161,748,043	$788,727,066	20.51
Northwestern U.	$122,198,183	$681,646,225	17.93
Stanford U.	$76,727,029	$853,917,196	8.99
MIT	$137,070,000	$1,555,965,000	8.81
U. of Washington/Wash. Res. Fdn.	$76,955,819	$995,623,918	7.73
U. of Minnesota	$45,651,548	$849,749,000	5.37
U. of Wisconsin-Madison/WARF	$41,100,000	$1,189,794,000	3.45
Duke U.	$24,590,271	$840,113,651	2.93
U. of Pennsylvania	$17,944,068	$911,088,299	1.97
Johns Hopkins U.	$15,940,401	$1,509,520,000	1.06

Even when one excludes the sponsored research of the Applied Physics Laboratory, as this chart does, Johns Hopkins has a low ratio of licensing income to research, almost one-twentieth that of Columbia University.

We recognize that these income figures are not a perfect metric of our ability to translate our discoveries into inventions in the market by any stretch. Our successes in this area should be measured in terms of ideas catalyzed, inventions disseminated, and lives touched – and we encourage the university in the years to come to develop its own metrics of success that are keyed to these priorities. And yet, income is the benchmark index used across the tech transfer industry and an objective measure that can be compared across institutions. And, these numbers are consistent not only with other objective measures of progress in this area, but with the feedback we have received from across our community, who identify numerous areas where support for the development of our entrepreneurship and translational activities could stand improvement.

In fact, the historic distance between Johns Hopkins and its peers in the maturity of an entrepreneurial ecosystem led a pair of scholars to write a paper surmising that the university has held itself apart from partnerships with the private sector because we found those activities to be in tension with the aspirations that define our academic community.[1] Whatever the precise reason, the Committee believes that the evidence strongly points to our having some ground to travel in developing a truly integrated, streamlined and focused approach to innovation and entrepreneurship across our university.

We underscore that our university has made some important strides in this area in recent years. Over the last decade, with major investments from the School of Medicine and other divisions, the university technology transfer operation has made significant progress. The number of disclosures of inventions has grown from 244 in 2006 to 441 in 2013. The number of license

[1] Maryann Feldman and Pierre Desrochers, *Truth for Its Own Sake: Academic Culture and Technology Transfer at Johns Hopkins University*, available at http://www.cs.jhu.edu/~mfeldman/Minerva102.pdf (Sept. 2001).

agreements and options has grown from 57 to 133 during the same period. We have increased the number of start-ups from four in 2004 and five in 2005 to an average of 12.7 each year across the last three years. Our faculty has expressed their appreciation for a wide range of improvements in these services.

The Whiting School of Engineering in particular has been a place of remarkable and laudable activity in this area. Last year, the school launched the FastForward accelerator in the Stieff Silver building near the Homewood campus for Johns Hopkins affiliated companies that have received external funding. The accelerator has received 48 applications for participation from across seven Johns Hopkins divisions. Twenty-nine of the applicants were accepted into the program, seven currently lease space within the building, and nine teams have received external funding, including one technology that received a $2 million seed round. The Whiting School is also the home to innovative centers of translational education and research including the Center for Leadership and Education and (along with the School of Medicine) the Center for Bioengineering Innovation and Design.

Other areas of entrepreneurial and translation activity and funding have emerged across other parts of the university, including the Brain Science Institute, the Institute for Clinical and Translational Research, the Institute for Computational Medicine, the Johns Hopkins University-Coulter Translational Partnership, and the Discovery to Market program and the Innovation Factory at the Carey Business School, to name only a few. This past year, the Applied Physics Laboratory launched an accelerator in partnership with Howard County. Jhpiego has only continued to expand its trailblazing work to harness technology and other innovations to improve the delivery of health care to women and their families around the world.

The university recently partnered with stakeholders from across Baltimore to launch the DreamIt accelerator for health care information technology start-ups. And the university invested in a Social Innovation Lab to support organizations developing innovative solutions to local and global problems. Earlier this year, the university completed a multi-million dollar cross-university research and educational partnership with biologics company MedImmune, and Hopkins has continued to deepen its partnership with Walgreens, a relationship that includes a multi-year strategic collaboration and joint business and research collaborations to advance evidence based care for chronic disease in the community. Our Montgomery County campus is home to dozens of cutting-edge biotech firms and research labs.

These are noteworthy and tangible achievements in the realm of entrepreneurship and innovation, to be sure. At the same time, the Committee believes that the university faces significant and enduring challenges in this arena.

Johns Hopkins does not have a focal space for innovation activities in proximity to our East Baltimore campus, where so many of the scientists and laboratories that will birth the inventions of tomorrow are located. There is no dedicated set of funds – or associated mentorship and management – for in-lab development of nascent technologies, licensing opportunities or affiliated start-ups that approaches the need and demand of our community. Our faculty report that our technology transfer, licensing and related operations across the university are fragmented, and policies that touch on translational activities are crafted and implemented, in ways that can impede entrepreneurship. We lack a comprehensive set of entrepreneurship and translational educational

programs that are freely available to the students of all of our schools, particularly in East Baltimore. And we are missing the sorts of internal resources and connections to outside expertise that can help to meet the entrepreneurial aspirations of our scholar-inventors.

Our peers, for their part, are continuing to make far ranging investments in their innovation ecosystems. The University of Chicago is opening a new innovation center in late 2014 that will provide space for proof-of-concept work, business incubation, collaboration opportunities, programming and financial support for entrepreneurial endeavors, as well as a $20 million innovation fund. Cornell has raised hundreds of millions of dollars to create a sprawling new campus for technology innovation. The University of Utah launched a pre-seed funding and business guidance program and a separate venture philanthropy fund, and is breaking ground this year on a 20,000 square foot 'garage' for student entrepreneurs and innovators. NYU is opening an 'entrepreneurs lab' later this year in the heart of Washington Square for aspiring entrepreneurs. Harvard recently signed a $25 million research agreement with GlaxoSmithKline to study stem cells. Other peer examples abound, a number of which are described in Appendix C.

One Ecosystem

Of course, we need to develop an approach that is emphatically our own, and tailored to our mission, structure and needs.

One enduring principle that guided the work of the Committee is that our work in this area needs to remain true to our commitment to excellence and integrity in scientific research and the values of our community. Ultimately, the Committee believes that our activities in the translational space are – and can continue to be – in full alignment with our tripartite mission. Indeed, as described earlier, our view is that they are integral to the future of that mission. And in truth, the entrepreneurial spirit is in our DNA, and reflected in so much that we do: from our groundbreaking experimentation and research; to our boundless service and clinical work, touching every corner of the globe; to our enterprising students who dare to press up against and even over the boundaries of knowledge. We believe it is time to unleash that same spirit in service of a new range of endeavors and partnerships, including with the innovation community in Baltimore and beyond.

We also emphasize that our solutions should be crafted in a manner to meet the needs of the entirety of our community, from our faculty in East Baltimore to our undergraduates in Homewood; our graduate students at the Carey School of Business to our staff at the Applied Physics Laboratory; and all of our scholar-inventors in between. A successful ecosystem will permit the free movement of people and resources across the many areas of translational activity across the university. And, the ecosystem should be responsive to a variety of categories of translational activity, from therapeutics to medical devices to hardware to mobile applications, and all in between. In particular, we should take care not to neglect the many innovations that are protected by intellectual property other than patents. The Committee notes that there are software products emerging from so many of our divisions, including the School of Medicine, the Whiting School of Engineering, the Bloomberg School of Public Health, the School of Nursing, and others, that could yield remarkable successes in the near future with additional guidance and support.

We emphasize that entrepreneurship, by its nature, is highly speculative and uncertain. It is true not only here but at all institutions that investment funding is often elusive, the market is not

always the answer, and our translational and entrepreneurial endeavors will fail as often as they succeed. And yet, these risks are not foreign to a university such as ours: trailblazing research itself is subject to the same uncertainty. The time has come to improve the conditions for success. We need to answer the call of our faculty, staff and students for a more robust, streamlined and effective set of resources and partnerships to take their discoveries to the world. And in so doing, to answer – and renew – the call of our founding president Daniel Coit Gilman, who asked his university to promote "the encouragement of research . . . and the advancement of individual scholars, who by their excellence will advance the sciences they pursue, and the society where they dwell."

III. DISCUSSION

The remainder of this report sets out in greater detail our recommendations on a path forward.

A. Space: An Entrepreneurial Focal Point

A physical hub is an integral ingredient of an innovation ecosystem. The virtues of space are many: it allows entrepreneurs a foothold from which to grow and develop their business; creates opportunities for creative and felicitous interactions with other entrepreneurs; permits access to equipment on a shared basis for start-ups that cannot yet afford them on their own; provides a one stop solution to services and smarts needed to launch a business; and is a beacon for companies to locate in the surrounding area, creating clusters of start-ups and economic activity. Making available turnkey, affordable lab space for young companies near their scientific partners can increase collaboration and chances of success. Space creates an environment where ideas, guidance, or your next partner are a hallway away.

Throughout our consultations, our faculty, students and staff have conveyed their desire for more affordable and start-up friendly space with shared equipment; flexible terms and areas for meetings; access to other start-ups; proximity to their offices and laboratories; and space that is inviting and designed to promote a co-working experience, with working and casual dining areas that are open outside of normal working hours, and that are complemented by weekend, evening and even neighborhood events. Feedback centered not only on private space for offices and team meetings, but public and open lounge spaces that foster inter-team collaboration.

The new FastForward accelerator in the Stieff Silver building near the Homewood campus provides a window into the demand for services on campus: More than 51 Johns Hopkins affiliated companies have applied for access to FastForward resources since it launched last year, and demand far outstrips the available space in the Stieff Silver building. At the same time, dozens of companies call our Montgomery County campus home, with its proximity to key government agencies and some of the largest biohealth companies in the world. However, the university lacks an integrated center for entrepreneurship in East Baltimore, one that sits in close proximity to the university's world class research and clinical community in that area, while providing a cadre of services and resources and expertise that can flow seamlessly to these and other centers of entrepreneurial activity around the university.

There is demand for such a center not only across Hopkins, but across the city of Baltimore as well, and such a center could present new opportunities to build ties between our Hopkins community and the broader entrepreneurial community. Although there are highly regarded opportunities around the city, including Betamore and the ETC, more collaborative spaces with integrated resources, lab space, and services are needed. In a February 2013 report commissioned by the Abell Foundation, 85 percent of surveyed entrepreneurs said they would take advantage of a new

innovation hub if created, with a meeting space and space for various activities listed as two of the characteristics receiving the strongest support.[2]

For Johns Hopkins in particular, there is one additional salutary benefit of a new physical space: it will allow the opportunity to co-locate multiple offices that support entrepreneurial translational activities. Currently, these are spread throughout the city, creating a real geographic barrier to efficient interactions among them and the individuals across the community they serve. The offices that could benefit from co-location include, but are not limited to, the Office of Technology Transfer, the Business Development and Strategic Alliance Group, the Office of Research Administration, and the Office of Policy Coordination.

Models for space at peer institutions with successful innovation ecosystems vary, but one near constant is a location at or near the university, with flexible options for start-ups and growing companies. These spaces tend to provide easily accessible and open spaces for work, educational and networking opportunities, staff to provide expertise and guidance, and office or lab space for start-ups that are affiliated with the university and others from the surrounding region. This cross-pollination of ideas and expertise is one of the primary drivers of success. The successful centers also tend to be well integrated with the local ecosystem of entrepreneurs and have well-established industry and venture connections.

Two particularly successful models at other universities include the Harvard Innovation Lab, which has developed a 30,000 square foot space that promotes opportunities for student and faculty learning, formal networking, and space for social and commercial start-ups. The facility includes several dozen meeting rooms, a classroom, a workshop to build prototype devices, a stocked kitchen and café, and nine employees on staff. Another example is the QB3 at the University of California, which provides dedicated space in four separate buildings where start-up companies (sometimes as small as one bench) can thrive, co-located with major lab equipment, expertise, and venture capital to ensure essential facilities are available to all.

For all of the above stated reasons, the Committee concludes that a physical focal point for entrepreneurship in East Baltimore is an essential component of a renewed effort to catalyze innovation and translational activities at Johns Hopkins.

Specifically, the Committee recommends the following:

- *A physical space in East Baltimore.* The university should create a hub in East Baltimore for entrepreneurship and translational activities. This space should be easy to access and within walking distance from all Johns Hopkins East Baltimore facilities, including the Bloomberg School of Public Health, the School of Medicine and the School of Nursing, and the Johns Hopkins Hospital. And, in particular, the space should be located in the proximity of the research groups that are creating the technology around which the start-up is built, especially at the early stages of development. We envision the hub sitting in the East Baltimore Development Initiative footprint. As with other peer innovation hubs and the FastForward model, we

[2] "A Canvas for Innovation" Feasibility Study Final Report, Feb. 24, 2013.

envision an application process that will screen for promising technologies likely to contribute to a thriving incubator.

- *For one university.* Although the hub should sit in the East Baltimore complex, it should not only be for the East Baltimore complex. Rather, the hub and its resources should be open to faculty, staff and students from around the university, and its resources should dock seamlessly into sites of innovation activity in other parts of the university, including FastForward and the Montgomery County campus. What is more, there should be an easy movement of experts and other personnel across to these and other existing spaces of translational activity around the university. The hub should serve a broad range of different disciplines and technologies, and the for-profit and non-profit company alike. Finally, in light of the overwhelming existing demand for space and services at Homewood, and the goal of achieving an integrated network of cross-institutional space and resources, the university should look to make certain needed investments in the FastForward facility.

- *A design conducive to entrepreneurship and collaboration.* The center should offer office, laboratory and design studio space, with shared equipment and access to core services. With limited cash, start-ups will need flexible, affordable terms, including the ability to cancel the lease with 30 days notice. The space should be open and inviting, with plentiful and visitor friendly common spaces; conference rooms with state of the art audio-visual capabilities for meetings, workshops and other educational opportunities; wireless internet for all; and a restaurant or coffee shop and a kitchen to encourage presence and socialization. We also recommend that the space offer flexible support to virtual companies in need of an address for grant applications, and short term, so-called 'hotel' work space they would be able to use as needed.

- *Options for students and early stage teams.* The hub should also seek to provide smaller allocations of space to student-run and earlier stage teams, who can find it particularly difficult to find room for their projects. For example, the Center for Bioengineering Innovation & Design (CBID) program has a small space of less than 300 square feet in Traylor Hall in the School of Medicine for projects that have emerged from the CBID program. The space often houses four projects at one time, all of whom are willing to work in the limited space in order to benefit from the proximity to clinicians and labs in East Baltimore. With only a small allocation of space that is conducive to innovation and design, student and early stage teams will be able to launch their projects while benefiting from access to the resources, expertise, and energy of the projects, new ventures, and commercial partners in the innovation hub.

- *Open to entrepreneurs beyond Hopkins.* To promote cross-pollination of ideas and tap into the ideas and expertise from around Baltimore, we would want to encourage promising members of the Baltimore entrepreneurial community with a wide range of experiences to be part of our innovation hub. Accordingly, the Committee feels it is important to open the center to outside companies who will work alongside Hopkins start-ups. To attract non-Hopkins entrepreneurs and investors to the space, the monthly rent will need to be competitive with other accelerators in Baltimore, such as the ETC and Betamore. One model might be a monthly rate of $500 to

$700 per person for wet lab and office access, such that a 3 person company would pay $1,500 to $2,100 per month.[3]

- *Co-located commercialization offices.* The Committee strongly believes that the hub should bring together the multiple functions involved in supporting and managing the university's commercialization activities and relationship with the private sector. Presently, these offices are not located together or coordinated operationally. Placing them alongside one another, and in the same space as the innovation hub, will improve their ability to interact with entrepreneurs across the university, integrate into translational efforts, and help the community to bring products to market. Therefore, we recommend that the innovation hub include space for offices such as Technology Transfer, Offices of Research Administration from all East Baltimore schools, the Offices of Policy Coordination, and the Business Development and Strategic Alliance Group.

- *An operations team.* We will need to hire a strong operational team to support the innovation hub. Their function – modeled after best-in-class innovation centers – will include planning entrepreneur-to-entrepreneur events, hosting subject matter experts as guest speakers on relevant topics, and ensuring the environment remains a turn-key, all-in space that allows entrepreneurs to focus on running their company. We envision that other needed personnel and resources in our innovation ecosystem, discussed in greater detail in Part C below, will also be housed in the hub.

- *A virtual counterpart.* Especially in light of the geographic distance among many of the university campuses, it is essential that the university integrate an online experience with its physical space. A virtual hub can provide a list of internal and external resources and information, videos and educational materials, and opportunities to connect with entrepreneurs who inhabit the physical space. Broadly speaking, the web site should seek to provide to our entire community, across all locations, a set of translational and entrepreneurial instructions and services in an easily accessible form.

- *An interim space.* We anticipate that it could take more than three years to build a permanent home for our entrepreneurship and commercialization activities. On an interim basis, until the new hub can be built, we recommend repurposing existing space in East Baltimore to accommodate Johns Hopkins entrepreneurs on a first come, first serve basis. This will give the university an opportunity to position the pieces for the permanent center to come. Here too, proximity to the East Baltimore divisions will be key.

[3] See Appendix E.

B. Funding: Fuel for Translational Activities

One of the central challenges facing the translation of discoveries is the ever greater scarcity of needed funding. This is due to a convergence of factors.

At the outset, the development of a new invention is a difficult and uncertain process. Take the example of drugs: discovery to target validation to clinical development to approval is a process that can take up to 15 years and between $800 million and $1 billion dollars. And even though we live in an age of incredible advancement in research, the translational successes are rare. Every 5,000 to 10,000 compounds that enter the innovation pipeline result in only a single approved drug by the Food and Drug Administration. According to one analysis, the number of new drugs approved per billion US dollars spent on R&D has halved roughly every nine years since 1950, decreasing about 80-fold in inflation-adjusted terms.

At the same time, corporate laboratories are shying away from their previous commitments to translational research and development. Angel and venture funding so far has been unable to fill this void: As one report described it, investors are tending to "devote more of their capital to later-stage companies that already have established a position in the market."[4] As a consequence, "many promising start-ups – especially in capital-intensive sectors, such as bio-medical – struggle to raise the funds needed to survive the perilous period of transition when a developing technology is deemed promising, but too new to validate its commercial potential and thereby attract the capital necessary for its continued development."[5] The result is what has come to be known as the translational "valley of death", or in the words of one commentator, the "chasm . . . between biomedical researchers and the patients who need their discoveries."[6]

The question for institutions of higher education is how to help their scholar-inventors navigate the path to innovation in this new reality. The Committee considered mechanisms for funding at many of our peer institutions. Even at the most successful of universities, the internal sources of funding in this area are small, requiring support from a range of external streams. And so these institutions have joined with a variety of external stakeholders to support translational activities, including state and local governments (often with matching funds), corporate partnerships, venture philanthropy and outside accelerators. For example, the University of Michigan raised money for a pre-seed early commercialization fund and an early stage proof of concept fund through matching resources from the Michigan Economic Development Corporation. Cornell University assembled a "Cornell Angel Network" of investors with an interest in making equity investments in new Cornell-related businesses. And MIT built its Media Lab with the help of dozens of corporate sponsors who participate in a shared intellectual property pool.

There are reasons to believe that a similar strategy – one of mutually advantageous partnerships with a diverse network of interested stakeholders – can take hold here.

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[4] National Research Council, Rising to the Challenge: U.S. Innovation Policy for the Global Economy 97 (2012).
[5] Id.
[6] Declan Butler, Translational Research: Crossing the Valley of Death, Nature (June 11, 2008).

For example, the State of Maryland has been highly attentive to the promotion of innovation. The State, through its Technology Development Corporation, recently launched the Maryland Innovation Initiative, which sets aside five million dollars to support start-ups that emerge from university-based research, with funding in blocks of $100,000 to $270,000. So far, Johns Hopkins faculty have received 33 of these awards, and several of the projects have signed licenses or are in the final stages of negotiations to go into new start-up companies. The State has also allocated a total of $84 million through its InvestMaryland program for investment in technologies in the areas of software, communications, cyber-security and life sciences, with the money split between venture capital firms and a venture fund for emerging companies, and $12 million through the Biotechnology Investment Incentive Tax Credit program. Other examples of commitments to innovation by the State of Maryland can be found in Appendix F.

There are extensive opportunities for collaborations with foundations and not-for-profit organizations across the region and the nation as well. One noteworthy example is the Johns Hopkins-Coulter Translational Partnership in the Department of Biomedical Engineering, which has awarded $2.3 million in grants, helping 22 separate projects move toward commercialization. Johns Hopkins is one of 16 universities nationwide to host a Coulter partnership since 2005. In a recent audited report, the Coulter Foundation found a 7:1 return on investment to universities and university spinouts from Coulter programs. In two years, the JHU-Coulter program as already generated a 1:1 match in external funding for projects.

More recently, the Abell Foundation has provided awards to Hopkins faculty inventors to support the commercialization of their discoveries, and the Harrington Project has given funding to scientists at Hopkins and across the nation to support the development of therapeutic breakthroughs. And, Biohealth Innovation, a public-private nonprofit partnership, has played a key intermediary role in coordinating and supporting translational endeavors throughout the region, including at Johns Hopkins.

Finally, the private sector is of course an essential source of mutually beneficial relationships in this area. Earlier this year, the university entered into a $6 million research partnership with AstraZeneca subsidiary MedImmune. Through the deal, MedImmune and Johns Hopkins will each contribute funding, personnel, and materials to address important scientific questions through joint research efforts, training programs, and access to specialized knowledge, facilities, and equipment. The partnership will focus on cardiovascular and metabolic disease; oncology; respiratory, inflammation and autoimmunity; infectious disease; and neuroscience. Other similar relationships are emerging across the university, with companies such as global health care company Novo Nordisk committing close to $2.7 million for three separate projects.

The initiatives discussed above are highly encouraging, and through them we can see the makings of a multidimensional approach to the financing of translational research at Johns Hopkins, one that depends on textured and enduring relationships among our faculty and a variety of public and private stakeholders. The university needs to take deliberate steps to draw together these threads to raise investments for the next generation of groundbreaking translation. A promising strategy will marry deeper and more integrated collaborations with the State of Maryland and peer institutions of higher education in the region; new partnerships with area and national foundations; deeper

relationships with the private sector around areas of mutual interest and opportunity; and stronger links with the venture capital, angel and other investment communities to fund the promising technologies of tomorrow.

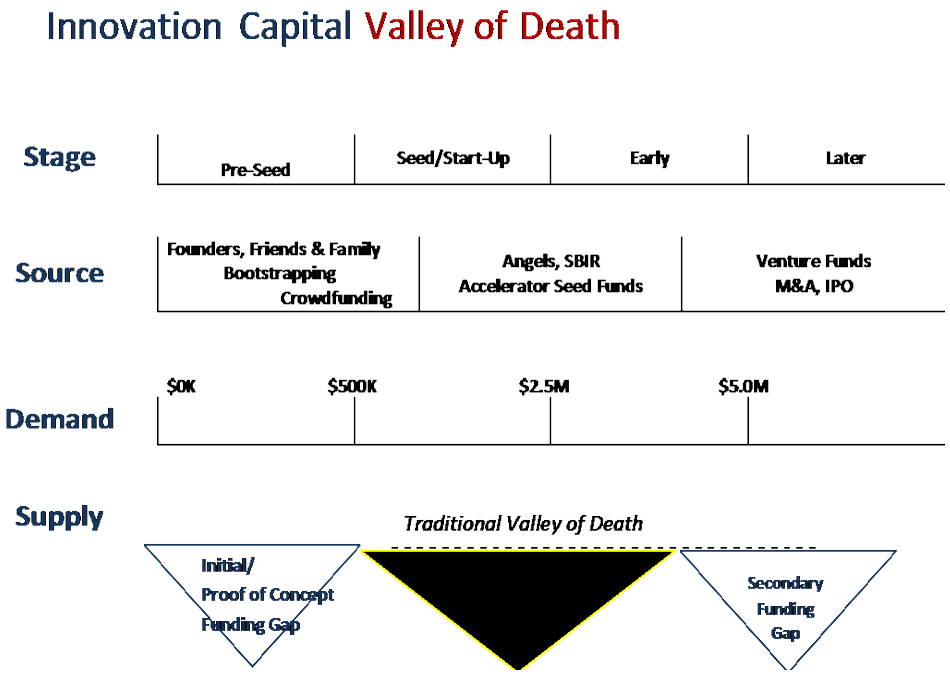
The view of the Committee is that such funding should be deployed in the following manner:

- *Translational seed grant program.* The university should seek to raise money, from the above mentioned and related sources, for a seed funding program for early commercial translational activity. The goal of this grant program will be to promote value creation for nascent technologies, and move early concepts toward proof of concept and prototype development. This program should be "evergreen", meaning that the university's investments would be recouped with a multiplier upon a major financing or liquidity event. The program would ideally issue grants on the order of $2,000 to $100,000. Each grant would be closely monitored with quarterly milestones set by industry and external scientific experts working with the key investigators. The funding would be administered in tranches upon completion of milestones. The program would be available for a wide range of inventions – including but not limited, to therapeutics, devices and information technologies – from across the university community.

- *Investment fund.* Separately, the university should seek to raise an investment fund to support JHU start-up companies with proof of concept data and who have licensed JHU technology. This investment fund should be externally managed by investors and experts with a track record of successful life sciences investing and product development and should be guided by commercial principles. One promising peer example is the Partners (Harvard) Innovation Fund, with a commitment of $35 million from the Brigham and Women's and Massachusetts General Hospitals. That fund employs four partners to capture more value from the Partners HealthCare research portfolio, bridge the capital gap between discovery and clinical trials, attract external capital by demonstrating institutional commitment, and generate a return on investment to refresh capital for additional technology investments.

- *Student support.* Johns Hopkins attracts some of the most innovative and entrepreneurial undergraduate students from around the world. Each year, with little support from the university, teams of students, often self-directed or with faculty mentorship, form to develop solutions to a wide range of societal challenges. The solutions they have developed often have a high potential for societal impact as well as commercial success. In some cases, students work on projects started within a course but continue long after the course is complete. For such teams, small grants can have a major impact. We recommend that the university raise money for an undergraduate grant program to support student-led teams that seek to address important societal challenges with commercially sustainable solutions.

Illustration 1



C. Resources and Policies: Empowering our Scholar-Inventors

Finally, our university will be unable to achieve its true potential in entrepreneurship and innovation unless it provides the necessary combination of investments and incentives to support the entrepreneurial aspirations of our entire university community.

The areas of support in this area will need to take a number of different forms. At the outset, there is the question of how to provide stronger connections to the outside innovation community. One feature of high-caliber universities with a robust innovation function is the capacity to strategically tap networks of advisors with expertise in the relevant industry, the investment world, relevant areas of law, and business development. The Clinical and Translational Science Institute (CTSI) at the University of California San Francisco employs three full-time equivalents solely for the purpose of matching faculty entrepreneurs with external, commercially relevant advice. We know that there is an array of investment and business leaders who are interested in counseling and partnering with Johns Hopkins start ups. Developing and managing a network of experts will require a commitment of focus and resources.

A second imperative involves internal expertise. Today, it is not uncommon for universities with strong innovation functions to hire ten to twenty industry-savvy professionals to guide faculty through the process of applying for grants, finding investors, writing business plans, and working through the various business, strategy, legal, and financial complexities required for starting and running a successful business. Our own tech transfer operation has made tremendous strides in patenting and licensing activities in recent years, but when it comes to the more proactive elements of entrepreneurship, we suffer from an absence of committed resources, at least when compared to our peers: Johns Hopkins Tech Transfer currently has a single employee dedicated to this effort. We need to recruit individuals with real biotech expertise to take residence at Johns Hopkins and share their wealth of knowledge, expertise and experiences with our community.

The next area of acute need is educational resources. Other universities are developing innovative approaches to providing members of their community with educational offerings in entrepreneurship: The Lester Center for Entrepreneurship at the University of California, Berkeley offers 20 core classes in entrepreneurship and commercialization taught by seasoned entrepreneurs, venture capitalists, and business executives. The University of Utah has launched The Foundry, a free twelve-week business accelerator educational program. The University of Pittsburgh offers a Business of Innovation commercialization course aimed at educating student and faculty researchers in innovation development, commercialization and entrepreneurship. The Duke Center for Entrepreneurship and Research Commercialization lists more than a dozen entrepreneurship courses that draw medical, engineering and business students alike.

The Committee believes strongly that we need to build on existing assets and offerings across the university – in divisions ranging from the Carey School of Business to the Whiting School of Engineering to the Krieger School of Arts and Sciences, to name only a few – to make educational offerings more readily available to students, faculty and staff in all of our divisions, and in particular in the East Baltimore curricula. Making an education in entrepreneurship more readily available will not only benefit those who want to bring a discovery or invention to market now, but any number of

individuals across the university who will be able to deploy the business skills they learn in their chosen fields and pursuits later in life.

One highly promising move in the area of educational programs is the launch this summer of a four day Entrepreneurship Bootcamp for biomedical and life-science entrepreneurs to provide faculty, residents, students, post-docs and fellows with the knowledge and skills to turn raw ideas into validated business proposals. We also encourage the university to explore participation in he exemplary National Science Foundation I-Corps program, which includes a three month course that accompanies work on market validation of a given technology.

As to students, there is much we can do even apart from courses and workshops as well to weave entrepreneurship more intimately into their university experience. There are a wide range of individual students and student groups across our university who are passionate about entrepreneurship and start-ups, and we can do more to lend them support. Other universities are innovating in this area: Washington University in St. Louis runs a program that offers 25 paid internships per summer for students to work in a start-up four days a week, and attend experiential learning workshops one day a week. The University of Wisconsin offers a 100 hour challenge in which students must purchase a product, change it, and create a public web site for outreach.

Another broad area that deserves attention is our policies and procedures. The faculty at our university who are most likely to undertake translational research are also so often the ones who will be juggling grant renewals, teaching responsibilities, and a range of other obligations. Adding to that a gauntlet of processes and paperwork will deter even the most motivated entrepreneur. An investigator who wants to license technology or a start-up must engage staff in many or sometimes all of multiple offices – including, for example, our conflicts office, department chairs, Business Development, and the Office of Research Administration. This is a problem not only for our faculty, but also for outside companies and investors, who describe an absence of clarity as to how to approach our ecosystem and an apparent lack of coordination among the multiple possible points of entry.

This fragmentation cannot help but hamstring our faculty's impulse to engage in translational activities. The faculty that interacted with the Business Development and Strategic Alliances group lauded their support for relationship building with the private sector, but only a small percentage of them had even heard about the office. The Committee also heard concern that the application of many of the policies that touch an entrepreneur at Johns Hopkins was unnecessarily categorical and adversarial, an approach some identified as one of the most severe impediments to entrepreneurship at Johns Hopkins. Finally, the Committee received feedback from many quarters that the university's incentive structure, keyed as it is to papers and grants, does not do enough to recognize translational research.

One final observation in the area of policies and procedures: As the university expands its relationships with outside entities, it is vitally important that we take every precaution to ensure that our activities remain in alignment with the animating values and mission of the university. So, for example, the university must remain attentive to the ways in which partnerships with companies and investors can create a potential for conflicts of interest. We must maintain the highest possible

standards of research integrity, a principle that has been and must continue to remain paramount in all that we do. The university should take all necessary steps to safeguard against the creation of biases that could distort our work, impede our mission and undermine the safety of our subjects or our patients. The Committee is confident that with the appropriate policies and oversight, our work in the translational space will only advance – rather than compromise – our academic, research and clinical missions.

With the above findings in mind, the Committee recommends that the university commit to the following areas of investment and reform:

- *A network of experts.* The university should take steps to cultivate a more extensive and streamlined network of mentors. There are presently a number of different groups that reach out to members of the industry and investor communities. A more institutionalized effort to bring these resources together under one umbrella, and a diverse range of voices from the investment, biotech, pharma, device, information technology and other private sectors will be essential to identifying assistance for the wide range of Johns Hopkins University technologies and know-how, and creating and promoting the most helpful connections between our community and entrepreneurship opportunities. These experts can – as appropriate – play any of a range of mentoring, educational and investment roles.

- *Entrepreneurs-in-residence (EIR) and business analysts.* In addition to its network of outside mentors, the university should bring into the university in a more formal fashion a number of entrepreneurs-in-residence for relevant verticals – including information technologies, medical devices, diagnostics, biotech and pharma, and services – to help our scientists as needed. A number of other universities, including Columbia University, Boston University, University of Michigan, and the University of Washington have run successful EIR programs for several years and have helped to identify best practices in this area. In addition, having full time business analysts on staff to assist with market assessment, business plan drafting, financial modeling, identifying sources of funding, and other needs of start-up businesses will be a key value driver. The staff should be chosen with an eye to be able to assist with SBIR and other grant applications as well. More broadly, we invite the university to consider a co-laboratory model that would allow a stable of experts to help take nascent technology within Johns Hopkins and bring it to an investable stage.

- *Integration of commercialization services.* The university must find a way to streamline and integrate the work of the multiplicity of offices that interact with the commercialization of research and corporate partnerships. There are too many of these offices, and it is too confusing for members of our community to navigate them. Our ecosystem must do more to harmonize and coordinate the administration of our translational innovation efforts, so that we can make strategic investments in the future of innovation in a manner that avoids duplication and redundancy. Along the same lines, the university must take steps to provide a more consumer-oriented set of services in this area to internal and external stakeholders alike. The goal should be a "concierge"-like ease of access, to commercialization functions for members of our university community, and to the Hopkins ecosystem for interested outside investors and companies.

- *Other reforms to tech transfer operation.* The university should consider as well a number of related reforms in the area of translational services, including additional research and writing support for grant opportunities that provide seed funding; standardized licensing contracts and processes, so opportunities can be pursued quickly; more tech transfer personnel embedded in the schools; a directory of external resources available widely to the community; and a greater reliance on surveys and other mechanisms to measure satisfaction with tech transfer services.

- *Educational opportunities.* The university should develop a more extensive cadre of educational offerings on entrepreneurship that are made available across the university. These offerings should not only take the form of classes, but also boot camps, workshops, mini-courses, 'TED' like talks, guest lectures, and so on, with many of them offered at the new innovation hub itself or FastForward. As noted, the university should develop a relationship with the National Science Foundation I-Corps program. A complete and current list of educational offerings should be made available online to the entire university community.

- *Student programs.* The university needs to develop more programs that can match undergraduate and graduate students with translational efforts inside and outside the university. Among the possibilities that the university should explore or expand – some of which are underway in one form or another in parts of the university – are business plan competitions for undergraduate and graduate students, flexible internship and externship programs, or programs to organize teams of students to scan patent libraries, research market demand, and identify promising translational opportunities. Whether a student goes on to start a business, a lab, a school, or a political campaign, they will be able to take pride from these programs that they learned the basic building blocks of starting an entity and were part of starting something that has lasting impact and value.

- *Policy reforms.* The Committee recommends that within a period of six months following the publications of this report, the Provost convene the appropriate individuals to explore changes to tenure and promotion policies across the university to create stronger incentives for translational and commercialization activities. The university also should undertake a searching review of other university policies with which our entrepreneurship activities come into contact – including conflict of interest policies, institutional review boards, use of name policies, intellectual property, and cost recovery from new start-ups – to identify whether there are opportunities to simplify or clarify the intent or application of these policies.

- *Preserving our legacy of promoting access to medicines around the world.* In 2011, the university convened a Study Group to assess the ways in which our technology transfer policies and our partnerships with outside companies can affect access to our discoveries and inventions around the globe. The group produced a series of recommendations for the university, including the adoption of new approaches to improving health-related technology transfer to developing countries, and the inclusion in licensing agreements of provisions that aim to protect the safety and health of patients.[7] To ensure that we preserve our legacy as a pioneer in the dissemination of medicines

[7] *See* Report of Study Group, Dissemination of Discoveries to Advance Global Health at Johns Hopkins University (Oct. 17, 2012) .

and technologies around the world, we recommend that within a period of six months from this report, the Provost and the Office of Technology Transfer should commence a review of our compliance with the recommendations of the Study Group.

- *Protecting the integrity of our research.* As the university expands its partnerships with outside organizations, it is imperative that it maintain vigilance in preserving the values and the ethics that are essential to our groundbreaking research. According to the 2011 Study Group, one of the "most important ways the University can continue to promote health among the citizens of developing countries is to "uphold the highest ethical standards of research conduct, informed consent, and scientific rigor, and to urge its partners to do so as well." Policies relating to the integrity of research are described and administered in each of the schools. The Committee recommends that the Provost use the occasion of the creation of this hub to undertake a review of these policies to ensure that we are adhering to the above mandate, and to identify any areas of needed improvement in the substance or the application of these policies.

- *Cores, transparency and accelerators* . One area of particular interest to the Committee involves the enhancement of existing cores and the definition of new core facilities to provide support for early (and potentially mid-) stages of translational development. The Committee encourages the university to explore the location of new cores in the innovation hub, and the movement of existing cores there where possible. The university should also create an infrastructure with an easy-to-use website that lists the services offered and the pricing. Two other recommendations bear special note. First, we should make efforts to provide information to the university community on research interests and entrepreneurial efforts across the university, to encourage greater collaboration and sharing of best practices. Second, the university should continue to host organizations and initiatives that can stimulate entrepreneurial activity and business creation and impart best practices, such as the DreamIt Health accelerator recently brought to campus.

IV. CONCLUSION

We recognize that many of the above recommendations are not simple. They will require a commitment of focus, will and resources, from across the university. We recommend that university leadership convene an appropriate group to consider next steps regarding these recommendations.

The Committee believes that with the proper combination of investments, partnerships and incentives, we can establish ourselves as a world leader in the translation of discoveries to inventions that can change the world. And, that we can do so in a manner that is true to our legacy and the values and pursuits of our scientists and educators. It is easy sometimes to forget that Johns Hopkins himself was a serial entrepreneur. The 2011 Study Group report described the ways in which relationships with companies such as Sharp and Dohme, E.R. Squibb and Sons and Eli Lilly in the early 20th century helped to fund our early, trailblazing successes in areas such as bacteriology and biochemistry – and how the faculty and staff in this era would use their research to develop products for private companies that are still in wide use today, such as the fluoride toothpaste Crest. It is time to explore these kinds of ties anew, in a manner that honors – indeed, amplifies – our principles and our mission.

The potential exists to catalyze a wave of innovation and translation at Johns Hopkins. Other universities have marshaled the capacity to make this happen. We have no doubt that we can as well.

Appendix A: Mandate of the Committee

August 15, 2013

For more than a century, Johns Hopkins University has been the world leader in research, education and service in the life sciences, producing discoveries that have advanced science and knowledge and healed the world. However, despite making strides in recent years, the university still lags by some measures in the translation of that research, and it has lacked one element that can be key to an innovation ecosystem: an incubation hub that can serve as a font of services, resources, and partnerships for entrepreneurs in the life sciences. Other universities have built innovation hubs to strong effect, catalyzing the entrepreneurial and innovation environment not only at their university, but in the surrounding region.

There has been increasing discussion across the university about the options for developing for an innovation center to support entrepreneurship in the life sciences. A well-designed center that is tailored to the needs of Johns Hopkins and its innovators holds the potential to create an even more dynamic interface and relationship between Johns Hopkins faculty, staff and students and members of the surrounding entrepreneurial community, empower members of the Hopkins community to translate their research into products and services to help patients around the world, forge deeper collaborations across the university in research, education and service, increase revenue to the university from our research and discoveries, and help to transform the university into an epicenter for translational research in the life sciences.

Accordingly, the university is convening a Committee on a Life Sciences Innovation Hub to consider options for a life sciences innovation center at Johns Hopkins University.

The Committee will be charged with providing its views on the needs, objectives and design of such a center, including answers to the following questions:

- What are the areas of greatest need that can be met through an innovation center?

- What should be the key design components of such a center? Examples may include:

    - a physical presence with office space, lab space, and gathering space
    - services for the success of entrepreneurs (e.g., business plan construction, market evaluation, legal/finance assistance)
    - seed funding for companies, either at the incubation or acceleration stage
    - educational components, including courses for students
    - mentoring by seasoned life sciences veterans, including entrepreneurs in residence

- Where does the university already provide certain of the resources and services that one would want in an innovation center, and which of these resources and services should be strengthened, amplified, and integrated or coordinated with a life sciences innovation center?

- What can Johns Hopkins learn from the example of other universities' experiences with innovation centers?

- How can the university best integrate outside entrepreneurs, commercial entities, funders and other innovators into the life sciences innovation ecosystem?

The Committee will be expected to consult widely with appropriate members of the university and external entrepreneurial communities. The Committee will be asked to complete a final set of reports and recommendations in this area by December 2013.

Our first meeting will be on Monday, September 23, from 5-6:30pm in the Mason Hall Alumni Boardroom, and will commence every three weeks thereafter until December. We look forward to seeing you then.

Ronald J. Daniels
President of Johns Hopkins University

Paul B. Rothman
Dean of Johns Hopkins University School of Medicine
Chief Executive Officer of Johns Hopkins Medicine

Appendix B: Membership of the Committee

Drew Pardoll (Co-Chair), Professor of Medicine, Co-Director of Cancer Immunology and Hematopoiesis Program

Jennifer Elisseeff (Co-Chair), Jules Stein Professor at Wilmer Eye Institute, Director of Translational Tissue Engineering Center

Jennifer Calhoun, Assistant Dean for Strategic Initiatives

Dan Ford, Vice Dean for Clinical Investigation

Rich Grossi, Senior Vice President and Chief Financial Officer, Senior Associate Dean for Finance and Administration

Justin Hanes, Lewis J. Ort Professor and Director of the Center for Nanomedicine

Landon King, Executive Vice Dean

Elliot McVeigh, Massey Professor and Director, Department of Biomedical Engineering

Phil Phan, Professor and Executive Vice Dean

Barb Slusher, Professor of Neurology, Psychiatry, Neuroscience, NIMH NeuroAIDS Therapeutic Core Director; Director of Brain Science Institute NeuroTranslational Drug Discovery Program

Jonathan Weiner, Professor of Health Policy & Management and Health Informatics, Director of the Center for Population Health Information Technology

Tyler Brown, MD student, Johns Hopkins School of Medicine

Kelvin Liu, PhD and Post-Doc, Johns Hopkins School of Medicine

Staff:
Christy Wyskiel, Secretary to the Committee
Helen Montag

Advisors to the Committee:
Wes Blakeslee
John Fini
Alan Fish
Andy Frank
Elizabeth Good
Dalal Haldeman
Annastasiah Mhaka

Appendix C: Other University Investments in Innovation

This appendix provides a representative sample of some of the investments other universities have made in their innovation ecosystems.

University	Description
University of California	• Institutes for Science and Innovation. In 2000, launched four cross-campus Institutes for Science and Innovation designed to open the door to new understanding, new applications and new products through research in biomedicine, bioengineering, nanosystems, telecommunications and information technology. One of the institutes is the California Institute for Quantitative Biosciences (QB3), a joint venture among the three University of California campuses at Berkeley, San Francisco, and Santa Cruz. Four buildings provide research facilities for QB3 faculty and in some cases, the broader community. Incubator network now includes two campus sites, one off-campus QB3-managed site, and two private partners. More than 60 companies currently rent space in the network. Encompasses entrepreneurs-in-residence, 'bridging the gap' awards that provide up to $250,000 in proof-of-concept funding, seminar programs, a 'start up in a box' program to help entrepreneurs launch companies, access to an accelerator, and a multimillion dollar venture fund. Companies in the QB3 network have raised more than $370M in venture financing. • William J. von Liebig Entrepreneurism Center (University of California, San Diego): Operates proof-of-concept program that helps accelerate the transfer of faculty innovations into the private sector and provides entrepreneurial education to graduate students in science and engineering, including access to network of encompasses technology and business advisors and entrepreneurship education programs. • Triton Technology Fund (University of California, San Diego): Will invest in UC San Diego affiliated innovations in the software, communications, electronics, materials, medical devices and instruments sectors. The Fund is externally managed by seasoned venture capitalist. Provides flexible venture capital investment for early-stage innovation, business connections, mentoring, and assistance with raising additional capital. • Lester Center for Entrepreneurship (University of California, Berkeley): Combines over 20 core classes in entrepreneurship and commercialization; local and online training for science and technology startups; startup competitions with local, regional and international partners; Skydeck Accelerator with office space, events, and entrepreneurship community for student and alumni startups; active mentorship of US Berkeley-affiliated startups through the UC Berkeley Startup Accelerator Mentor Network; drop-in mentoring hours and mixers with successful alumni entrepreneurs, angel investors and venture capitals; teaching and promotion of entrepreneurship to faculty and staff; executive education. • Jacobs Institute for Design Innovation (University of California, Berkeley): New design innovation institute to launch, will include educational activities, studio and workshop facility to expand the role of design in engineering education, emphasizing rapid design and prototyping for manufacturability. • The Child Family Institute for Innovation and Entrepreneurship (University of California, Davis): Interdisciplinary institute devoted to education, research and outreach in innovation and entrepreneurship.

California Institute of Technology	• Caltech Innovation Initiative (CI^2) Program focused on providing basic and translational research grants to faculty for concepts that address solutions to significant technological challenges so as to promote the economic, political, and physical well-being of U.S. citizens, the Caltech community, and the world at large. CI^2 awards are intended to provide support for up to two years with up to $250K in total funding (2 x $125K) with the second year of funding based on a competitive renewal at 10 months. • Faculty Select Innovation Development Awards support innovative research and patentable inventions that enable new solutions in fields including materials, photonics, wireless, electronics and software. Awards typically cover one year and funding amounts range from $75,000 to $150,000. • Grubstake: Provides "gap" funding to advance promising projects to the prototype stage.
Case Western Reserve University (and University Hospitals Case Medical Center)	• Think[Box]: Temporarily in a 4500 square foot space, this $25M project will be moving into a 7-story, 50,000 square foot facility, will house collection of initiatives that seek to leverage and enhance Case Western Reserve University's culture of innovation. • Harrington Project for Discovery and Development: Encompasses a range of initiatives for entrepreneurial physician researchers across the country and at UH. For example, the UH Harrington Discovery Institute provides funding, mentorship, and infrastructure for clinical research projects. The Innovation Support Center works closely with institutional technology transfer and business development offices to optimize IP protection and will work collaboratively with university colleagues to evaluate potential for new venture creation and assist in its implementation. A new development company (BioMotiv) will help to commercialize the work of Harrington Scholars and other researchers, issuing grants to scholars anywhere in the nation for up to $100K per year for up to 2 years. Staffing for the Institute includes an 8 person management team at the institute and a 3 person management team within the Innovation Support Center. Funded by the Harrington family's $50 million gift (the largest in UH history), as well as $100 million invested by UH and $100 million of investment being raised by BioMotiv.

University of Chicago	• Chicago Innovation Exchange: New innovation hub to open in late 2014; will provide space for proof-of-concept work, business incubation, collaboration opportunities, and programming for new ventures by UChicago faculty and students, as well as entrepreneurs from outside the University. Includes plans to create an innovation fund of up to $20 million to invest in proof-of-concept and early business development. • Innovation Fund: Has awarded proof-of-concept grants to projects with high potential for societal and commercial impact, helping them to bridge the gap between basic research funding and commercial investment that is often referred to as the "valley of death." Participants receive valuable feedback from a panel of internal and external business development experts to help move their projects forward. Has invested $1.5 million in 23 projects throughout University of Chicago, three of which have each gone on to raise more than $2 million in follow-on funding. • Polsky Center for Entrepreneurship: Supports entrepreneurial learning and collaboration through curricular offerings, innovative hands-on learning experiences, leading faculty research, entrepreneurs-in-residence, conferences, mentorship, and community and global outreach programs.
University of Colorado	• Jake Jabs Center for Entrepreneurship (University of Colorado, Denver): Serves as a new idea laboratory that educates and empowers graduates to act entrepreneurially. Encompasses educational programs, events, business plan competitions, student opportunities, advisory networks and a startup incubator. • Rutt Bridges Venture Capital Fund (University of Colorado, Denver): The fund provides initial startup capital and the possibility of up to one additional round of funding for eligible companies. The typical deal uses a convertible debt structure and the fund participates in the ongoing growth of these young ventures. Managed by a team of student associates and advisors from the Jake Jabs Center Advisory Council.

Columbia	• Eugene Lang Entrepreneurship Center: Offers a comprehensive program of specialized courses, labs, workshops, and funding opportunities, including business plan competitions, entrepreneurship in residence programs, and startup incubators. • IE@Columbia: Program to help entrepreneurial teams to go from concept to launch. Offers educational resources, and where appropriate, will connect participants with potential sources of funding from a network of mentors, angel investors, and venture capitalist. • Columbia Entrepreneurship: New initiative launched to broker collaborations between existing organizations, filling in gaps where much-needed resources are missing and strengthening school-based entrepreneurship programming. • Columbia Catalyst: Special program to assist Columbia inventors who wish to pursue an SBIR or STTR grant. • Columbia Entrepreneurship Coaches Network: Pool of Columbia alumni with domain experience in potential areas of entrepreneurship.
Cornell University	• Cornell Tech and Joan and Irwin Jacobs Technion-Cornell Innovation Institute. New graduate school and institute that seeks to bring a global perspective to research and education with an emphasis on technology transfer, commercialization, and entrepreneurship. Students have the option to team up to found startup companies and create products of their own invention as part of program; with contacts that include domain experts, designers, venture capitalists, and lawyers. New Runway Postdoctoral Program part of an innovative new model for technology entrepreneurs at the PhD level, including a new Intellectual Property (IP) model that positions the Institute as an investor in the companies that spin out of the program. • Cornell Angel Network. Cornell Angel Network brings together new businesses based on licensed Cornell technology or founded by Cornellians[2] ("Cornellian Startups[3]") and accredited investors ("Cornell Angels") with an interest in investing in new businesses related to Cornell. • Entrepreneurship and Innovation Institute: Facilitates hands-on involvement and work with real startups, other businesses, investments and other commercialization initiatives.

Georgia Tech	• Enterprise Innovation Institute (EI^2): Georgia Tech's business outreach organization. Over 100 full-time staff; support funds, ATDC, Georgia Tech Edison Fund, innovation, state and other venture opportunities. • Georgia Tech Edison Fund: Seed funding (equity) for early-stage technology companies that have a close association with Georgia Tech. Invests in companies that may be founded by Georgia Tech faculty, students and graduates; licensing technology from Georgia Tech; sponsoring research at Georgia Tech; or even hiring a large number of alumni. Investments are generally less than $250,000. • Advanced Technology Development Center (ATDC): A startup accelerator at Georgia Tech. Founded in 1980, ATDC has fostered innovation and economic development by graduating more than 150 companies, which together have raised over $2 billion in outside financing. In addition to education programs and event series, companies receive hands on coaching from experienced Entrepreneurs-in-Residence, are eligible for suite space in the incubator, and receive priority in programs such as Industry Connect. Recently named by Forbes as one of the "Top 12 Business Incubators Changing the World". • Flashpoint: Leaner Georgia Tech program to identify consumer demand; includes funding, startup engineering curriculum, shared space, demo day. • VentureLab: Center for technology commercialization offers startup competitions, a four week startup laboratory and mentoring.
Harvard	• Harvard Innovation Lab*:* Serves as a resource for students from across Harvard interested in entrepreneurship and innovation. 30,000 sf; stocked kitchen, café, lobby area, several dozen meeting rooms, a classroom, a workshop to build prototype devices; nine on staff: Managing Director, Director, Manager of Operations, Assistant Director for Health and Sciences, Assistant Director of Social and Cultural Entrepreneurship, Hacker in Residence, 3 Coordinators. Programming and resources include foundational learning, connections to experts, experiential learning, venture incubation program. • Arthur Rock Center for Entrepreneurship: Supports faculty research, fellowships for students, the annual business plan contest, symposia and conferences; 27,782 sf: 30 offices for HBS faculty and for Rock administrative staff. • Technology and Entrepreneurship Center: Helps faculty create and deliver innovation and entrepreneurship project courses, provides students with project support and sponsors and advises student groups working to build the Harvard **innovation community.** • Blavatnik Biomedical Accelerator: $50 million gift to fund a new accelerator to identify early-stage, highly promising technologies, upgrade their value, and prepare them for commercial development, and a fellowship program for life-science entrepreneurship. • New Venture Competition: New venture competition supports students and alumni competing in two tracks: business and social enterprise. The Competition offers more than $300,000 in cash prizes and in-kind support.

Massachusetts Institute of Technology	• Deshpande Center: Mission to increase the impact of MIT technologies on the marketplace. Awards research grants, educates grant recipients about innovation process, coaches grantees on how to commercialize their inventions, provides research teams with mentoring and guidance from investors and entrepreneurs. Five staff members manage the Center. Steering committee of entrepreneurs, investors and MIT leadership provides oversight. Center also incorporates community volunteers to mentor and support ideas. • Martin Trust Center for MIT Entrepreneurship: Provides extensive programming available for MIT students interested in entrepreneurship. 12 on staff: Managing Director, Faculty Director, Founder and Chair, Full-Time Entrepreneur in Residence and Student Evangelist, External Relations Manager, Director, Executive Programs, Regional Entrepreneurship Acceleration Program (REAP), Senior Administrative Assistant, Chief of Staff, Administrative Assistant, Program Coordinator, Receptionist, Liaison to MIT Sloan Office of Communications. • Ignition Grants and Innovation Grants. Seed funding through Deshpande Center for technical innovation at MIT that addresses a market opportunity—emphasis on technology suitable for start-ups. Ignition Grants (up to $50K) to support proof of concept projects; Innovation Grants (up to $250K) to support research project progress to a point of attracting venture funding or commercial investment. • Legatum Center for Development and Entrepreneurship: Runs a highly competitive fellowship program for MIT graduate students who intend to launch enterprises in low-income countries.
University of Michigan	• MTRAC: Translational Research and Commercialization for Life Sciences Program provide translational research funding and resources to identify, nurture and "fast forward" projects with a high potential of commercial success. • Venture Accelerator: Provides laboratory and office space, as well as business services, to startup companies emerging from the pipeline of new ventures at U-M Tech Transfer. • Frankel Commercialization Fund: Pre-seed investment fund established to identify and accelerate the commercialization of ideas generated within the University community and the surrounding area. May invest up to $100,000 per investment (in multiple installments). Student teams are mentored by Tom Porter, the Fund's managing director and executive-in-residence at the Zell Lurie Institute for Entrepreneurial Studies at the Ross School, and guided by an advisory board, consisting of experienced executives in health care and information technologies and early-stage company formation and investing. • Gap Funding: Internal funding with matching external funding resources to speed technology to market.

New York University	• Mark and Debra Leslie Entrepreneurs Lab: New gift will fund a 5,900-square-foot facility in the heart of the Washington Square campus where aspiring NYU entrepreneurs from all of the University's schools and colleges. • Berkley Center for Entpreneurship and Innovation: Equips students, alumni, and researchers from across NYU's campus with the skills, know-how and ability to launch and grow sustainable ventures. • Innovation Venture Fund: Seed stage venture capital fund anticipated to grow to $20 million that invests in technologies and intellectual property developed by NYU students, faculty and researchers. The Fund makes approximately five to six investments per year, from $100,000 - $250,000 each, in partnership with other angel investors and/or venture capital firms. The Fund will recycle investment returns from the successful sale of portfolio companies back into the University to finance further research and spinout ventures. Operated by separate management team with venture capital experience. • Incubators: School of Engineering launched three incubators in last decade, to provide guidance, expertise and resources that organizations need to grow into successful ventures. • Launchpad: An intensive 10-week startup accelerator program for graduating NYU student teams, including boot camp and workshops, mentorship by outside experts, co-working space in one of incubators, and stipend.
University of North Carolina	• Strategic Plan: Announced comprehensive $125 million strategic roadmap to accelerate innovation at the University of North Carolina at Chapel Hill, including through educational programs, enhanced corporate collaborations, and innovation funds.

Northwestern University	• Farley Center for Entrepreneurship and Innovation aims to move engineering beyond the application of the sciences to the creation of businesses that capitalize on innovations. Brings together faculty from a range of disciplines to develop a curriculum in which students experience the entire innovation life cycle. 3 employees with corporate and engineering project management experience. • Northwestern University Incubator: A friendly office co-working space for tenants to develop startup companies, network with fellow entrepreneurs from the Northwestern community, and gain additional business knowledge through mentorship. • NUvention. Series of classes draw students from all over the university to develop and launch businesses, often working with the tech transfer office. Specialized entrepreneurship crash courses are broken up into the fields of nanotechnology, medicine, energy, the Internet, and social enterprise. • Combe Family Impact Scholars Program at Kellogg: Offers academic and experiential learning opportunities to enable scholars to create and engage in high-impact social entrepreneurial ventures for developing sustainable solutions to global societal and environmental challenges.
University of Rochester	• Center for Entrepreneurship: Creates new partnerships with students, alumni, local businesses, and non-profit organizations; coordinates and publicizes school-based experiences, including courses and signature programming; informs faculty of grant and bridging fellowship opportunities; and encourages collaboration among the schools engaged in entrepreneurship education at the University of Rochester. • Technology Development Fund: Pre-seed grants that support the transfer and translation of UR research into commercial applications. Awards will typically be in the range of $40,000 to $100,000, with the objective to reach a significant valuation milestone within a year's timeframe. • Student Incubator: Provides access to conference rooms, the multi-media center, shared copiers, printers, etc., as well as access to High Tech Rochester's Director of New Ventures and Entrepreneurs-in-Residence, who can provide additional coaching, mentoring, and connections.

Stanford	• Startx: Accelerator founded out of Stanford to provide venture funding and support. Stanford intends to fund about ten percent of each investment round. • Stanford-Startx Fund: Created a new Stanford-StartX fund to invest in current and alumni StartX companies. To receive the investment from Stanford, StartX companies must raise at least $500,000 of their own funding from outside investors. • Institute for Innovation in Developing Economies. Conducts research, coordinate courses in social entrepreneurship and design, and oversee projects worldwide to alleviate poverty.
University of Texas	• UT Horizon Fund: Strategic, evergreen venture fund with ddual mission to improve commercialization of technologies out of research at UT System institutions (strategic goal) and provide a positive return on investment (financial goal). Was capitalized by the UT System Board of Regents with $22.5 million in 2011. Managed by a professional team within the University system. Applicants coordinate through TTO at various UT System Schools. • IC2 (University of Texas at Austin): Interdisciplinary research unit of UT Austin that works to advance the theory and practice of entrepreneurial wealth creation. Employs 31 people. Funding includes city of Austin, multiple private funders, Texas Capital Network. • Austin Technology Incubator (University of Texas at Austin): Startup incubator provide strategic counsel, operational guidance, and infrastructure support to its member companies to help them transition into successful, high growth technology businesses. • Jon Brumley Texas Venture Labs (University of Texas at Austin): Accelerator providing mentoring, team-building, market and business plan validation, technology commercialization and domain knowledge. Since 2010, has worked with 63 start-ups in a wide range of industries, companies have raised over $187 million.
University of Washington	• New Ventures Facility: New incubator to be completed in 2014 will provide dedicated space, facilities and programming for translational research and early-stage business development of technologies en route to commercialization. Completed space will offer 11,500 square feet of new wet lab suites and 11,500 square feet of office space. • The W Fund: An early-stage venture fund that aims to invest approximately $20 million over the next four years in promising start-ups spinning out of the University of Washington and other research institutions across the state. • Jones + Foster Accelerator: Offers mentoring from a committee of entrepreneurs and investors, seed funding, and work space in innovation lab.

University of Utah	• Lassonde Studios: To be completed in fall 2016, will be a 20,000 square foot 'garage' for student entrepreneurs and innovators. • The Engine: An integrated commercialization pre-seed grant funding program focused on early-stage vetting, de- risking and development of ideas and technologies. This commercialization engine is a milestone-driven process that provides faculty inventors with business guidance and incremental funding to move discoveries through stages toward commercialization. • The Foundry: A business accelerator educational program funded and supported by the University of Utah, David Eccles School of Business. • Gateway Crimson Innovation Fund: A "venture philanthropy fund" seeded by the University out of proceeds of a successful exit from a spin-out. • Lassonde Entrepreneur Institute: Hub for student entrepreneurship and innovation across the University of Utah

Appendix D: Core Facilities at Johns Hopkins University

RESEARCH CORE FACILITIES: SCHOOL OF MEDICINE
500/600 NMR Facility
Bayview Flow Cytometry
Bayview Genetic Research Facility
Biostatistics, Epedemiology and Data Management Core (BEAD)
Center for Brain Imaging Science
Center for Extracellular RNA and Vesicels
Center for Inherited Disease Research (CIDR)
Center for Metabolism and Obesity Research (CMOR), Insitute for Basic Biomedical Sciences (IBBS)
Chem Core
Ci3R
ES Cell Targeting Core Facility
Genetic Resources Core Facility (GRCF)
GRCF Biorepository & Cell Center
GRCF Core Store
GRCF Core Store 24/7
GRCF DNA Analysis Facility
GRCF Fragment Analysis Facility
GRCF High Throughput Sequencing Facility
GRCF SNP Center
High Throughput Center
IGM Computing Core, [paradIGM]
JHMI Deep Sequencing & Microarray Core
Johns Hopkins Bayview Medical Campus (JHBMC) Lowe Family Genomic Center
Mass Spectometry and Proteomics Core
Microscope Facility
Microscopy/Confocal Imaging Core
MRB Behavior Core

MRB Molecular Imaging Service Center and Cancer Functional Imaging Core
MRI Service Center
NMR Service Center
Pathology Photography & Graphics
PET Service Center
Phenotyping (and Pathology) Core (Phenocore)
Pulmonary Histology Core
Radiology Research Laboratory
Research Animal Resources
Research Ethics Consulting Service
Ross Flow Cytometry
Sidney Kimmel Cancer Center (SKCCC)- Research Core Facilities
SKCCC Animal Resources
SKCCC Bioinformatics
SKCCC Cell Imaging
SKCCC Clinical Research Office
SKCCC Common Equipment
SKCCC Cytogenetics
SKCCC Experimental Irradiator
SKCCC Flow Cytometry/Human Immunology Core
SKCCC Cancer Functional Imaging Core
SKCCC Glassware Washing
SKCCC Mass Spectrometry Core
SKCCC Microarray
SKCCC Next Generation Sequencing
SKCCC Oncology Tissue Services
Small Animal Imaging
Stem Cell Core Facility
Survival - Asthma and Allergy Center
Survival – Blalock

Survival – Ross
Survival – Traylor
Survival – Woods
Synthetic Core
The Synthesis & Sequencing Facility (SSF)
Transgenic Mouse Core
Wilmer Microscopy and Imaging Core Facility (MICF)
Zebrafish - FINZ Center
ICTR/Translational Sciences Core Facilities
Drug, Device, and Vaccine Development Core
Drug and Device Resource Service (DDRS)
DDRS Consutation Service
Drug and Device Resources
Genetics Translational Technology Core
Proteomics Translational Technology Core
Imaging Translational Technology Core

ICTR Clinical Cores
Bayview Clinical Research
Broadway Adult Inpatient Unit
Broadway Adult Outpatient Unit
Pediatric Clinical Research
Neurobehavioral Research
Johns Hopkins Clinical Research Network (JHCRN)
Exercise Physiology and Body Composition
Cardiovascular Imaging Laboratory
Center For Interdisciplinary Sleep, Research and Education (CISRE)
Clinical Research Informatics Core
Research Nutrition
Pathology Clinical Cores
Blood Disorders & Special Coagulation
Cytokine
HIV Specialty Services
Immunology
Medical Microbiology
Molecular Pathology & Cytogenetics
Neoplastic Hematopathology & Flow Cytometry
SKCC CLINICAL CORE FACILITES
SKCCC Analytic Pharmacology
SKCCC Biostatistics
SKCCC Cell Processing & Gene Therapy
SKCCC Cell Therapy Core
SKCCC Clinical Research Office
SKCCC IRAT Core (Image Response Assessment Team)
SKCCC Research Information Systems

SKCCC Research Pharmacy
SKCCC Specimen Accessioning
Research Participant and Community Partnerships Core
Community Engagement Program
Office of Recruitment and Retention
Research Ethics Achievement Program
Research Participant Advocacy

BSPH CORE FACILITIES
Comstock Center and CLUE Cancer Studies in Washington County
Environmental Microbiology Core
Environmental Surveillance Core
Flow Cytometry and Cell Sorting Laboratory
Gene Array Core
High Perfomance Scientific Computing Core
Imaging and Microscopy Core
Insectary
Johns Hopkins Biological Repository Core Laboratory(JHBR)
Johns Hopkins Biostatistics Center
NIEHS Core Facility
Parasitology Core
Secondhand Smoke Exposure Assessment Lab
Smoke Core Facility
Center for AIDS Research (CFAR)
Clinical Core
Development Core
Prevention Core
Clinical Laboratory and Biomarkers Core
Biostatistics, Epidemiology and Methods Core

HOMEWOOD CORE FACILITIES
Animal Facilities
Biomolecular NMR Center
Center for Educational Resources
Center for Molecular Biophysics
Centralized Characterization Equipment Core
Homewood High Performance Computing Cluster
Homewood Photography
Integrated Imaging Center
Mock Operating Room
The Chemistry Department Mass Spectrometry Facility
Whitaker Microfabrication Lab
WSE Machine Shop
X-ray Crystallography Facility

Appendix E: Real Estate Options for Start-Ups in Maryland

INCUBATORS as of November 3, 2013

Baltimore Region:

BALTIMORE CITY				
Incubator	**Facility**	**Companies**	**Services**	**Notes**
Betamore	8,000 sq. ft. Office space	Technology (15 current companies)	Business collaboration, career-focused education led by current industry experts	10-week courses: Mobile Development, Front-end and Back-end Web Development, Digital Marketing and Sales
Emerging Technology Center at Canton/Johns Hopkins Eastern (Baltimore Development Corporation)	2 Separate Facilities offering a wide range of facilities, from industrial space to fully wired offices 1) Canton=48,909 sq. ft. 2) JH Eastern=45,000 sq. ft. Non-wet lab	Alternative Energy, Engineering and Product Development, Information Technology, Life Sciences, Technology Services (68 current companies) Over 120 graduated companies	Networking contacts, management advice, customized business and technical assistance (business plan review, market research, product planning, investor/corporate coaching, licensing and financing assistance), monthly clinics, seminars and workshops, business library	ETC Review Panel: Establish benchmarks that will be used to regularly gauge growth (product development, marketing/sales, management and staff growth, funding/financing)
Bio Innovation Center (UM BioPark)	Office space, conference rooms Wet lab	Life Sciences	Business and legal services, access to UM faculty scientists, core labs, labs and facilities, legal counseling coordinated by UMD's School of Law's Intellectual Property Legal Resource Center	Emerging Technology Center: "Go-to-market" Affiliate Program provides business advisory services
Fast Forward (JHU School of Engineering)	13,000 sq. ft. (Stieff building) office space and state of the art lab facilities for up to two years, conference rooms	JHU Engineering: robotics, materials, biotechnology, nanotechnology, biomedical engineering (Currently 3 companies ready for investment)	(Education Center and Innovation System) financial means and business expertise needed to get early tech to the marketplace (commercialization-licensing agreements, IPOs, out-right sales, market potential)	Fast Forward Lecture Series on Entrepreneurship (ex. Startups: A Successful Exit Strategy)

BALTIMORE COUNTY				
Incubator	**Facility**	**Companies**	**Services**	**Notes**
Bwtech (UMBC)	350,000 sq. ft. 5 buildings of lab and office space for 55 organizations, shared scientific equipment Wet Lab	High-tech business start-ups (Cyber/Clean Energy)	Facilitates access to capital, provides business support services, and promotes strategic alliances among tenants and connections between tenants, faculty, regional companies and advisory services (market assessment, business planning, networking, a part-time Entrepreneur-in-Residence and an advisory board composed of experienced researchers and executives in the field)	Cyber Incubator: Cyber security-related products and services. MD Clean Energy Technology Incubator: joint venture with the Maryland Clean Energy Center, housed in 18,000 square feet of office and wet lab space
TowsonGlobal (Towson University)	5,100 sq. ft. Office space, conference rooms, copy room Non-wet lab	Bridge for enterprises to find success in the global economy: companies with plans to expand product sales nationally /internationally or are foreign companies interested in penetrating the U.S. market	Education advancement (brownbag lunches and seminars), business counseling in the form of one-on-one mentoring (business plan guidance, sources of capital, foreign marketing/sales research, legal services offered by a local law firm, banking services, accounting services, human resources), networking	Center for Geographic Information Systems, Economic and fiscal impact analysis, IT and technological support and applied economics from RESI, Business planning and advice from the Small Business Development Center

HARFORD COUNTY				
Incubator	**Facility**	**Companies**	**Services**	**Notes**
Harford Business Innovation Center (Harford County Economic Development)	Fully-wired office space and conference rooms	Technology companies or growth-oriented defense contractors	Tailored business services available on flexible terms include business planning, mentoring, business networking, strategic teaming, marketing and sales assistance, technical assistance, product development, legal services and federal contract accounting.	Ground Floor Incubator: Workspace and collaboration center for independent cyber and technology application development entrepreneurs; operated in conjunction with the Chesapeake Science and Security Corridor consortium of 50 regional government agencies
Chesapeake Innovation Center (Anne Arundel Economic Development Corporation)	Office space, conference rooms, common shared office equipment and services, receptionist Non-wet lab	National security and other vital industry sectors (biodefense, security services, computer defense, surveillance, IT consulting, data mining, digital forensics (6 current members) (Has served over 50 member companies)	Serves as direct connection between major users of technology and early-stage companies, offers CEO roundtables and synergy meetings (members gather to discuss business topics)	TechBridge Showcase Program: Allows companies from across the nation to showcase technology with CIC corporate partners Anne Arundel Economic Development Corp VOLT Fund: ($100,000-250,000) Provides loans to qualified small and minority/women-owned business

HOWARD COUNTY				
Incubator	**Facility**	**Companies**	**Services**	**Notes**
MD Center for Entrepreneurship (Howard County Economic Development Authority)	25,000 sq. ft. Office space of different sizes to accommodate growth, 6 conference rooms, café, break room	Technology: Computer hardware and software, telecommunications hardware, internet and web development.	Howard Tech Council: Works to provide values to all members of the tech community including firms that support technology companies Startup MD: State-wide initiative for entrepreneurs by entrepreneurs Business Resource Center: Individual counseling and referrals, business education seminars, government contracting assistance, Small Business Awards Program	Race for Innovation Program: Brings entrepreneurs, mentors, and investors together to turn ideas into business concepts in an afternoon Innovation Catalyst EnCorps Program: Brings together successful entrepreneurs and mentors with MCE clients to leverage their experience and connections to help them drive better outcomes (Build partnerships/connect into the ecosystem)

Capital Region:

FREDERICK COUNTY				
Incubator	**Facility**	**Companies**	**Services**	**Notes**
Frederick Innovative Technology Center at Hood and Monocracy (Frederick Entrepreneur Support Network)	Office space, conference rooms Wet lab (Labs range from approx. 300-650 sq. ft.)	Informative Technology, Biotechnology and Renewable Energy (19 current companies)	Entrepreneurs in Residence, coaching and mentoring, entrepreneur education, preferred services providers, identifying potential funding FESN: Wealth of support services and resources including expert business counseling, advocacy, information and exclusive funding programs	Teams with the local SCORE office to present seminars through the year that are of particular interest to entrepreneurs

MONTGOMERY COUNTY				
Incubator	**Facility**	**Companies**	**Services**	**Notes**
Germantown Innovation Center (Montgomery County Dept. of Economic Development) Co-located with the Montgomery College's Goldenrod Academic Center	32,000 sq. ft. 45 offices, 2 conference rooms - accommodates 20-30 companies Wet labs (11)	Life Sciences and Advanced technology	Resource and support services (legal, intellectual property, accounting, and broad technical assistance), access to educational seminars and training through the incubator network, mentoring from the incubator staff, business plan review, referrals to professional services, access to sources of capital	Access to MD Intellectual Property Legal Resource Center, 1 year membership to MD Tech Council, 1 year membership to the World Trade Center Institute VIP: Virtual Incubator Program: Virtual tenant program intended to provide support to businesses that are not physically located in one of the Country's incubator facilities (small monthly fee for benefit of full access to the program)

Rockville Innovation Center (Montgomery County Dept. of Economic Development)	23,000 sq. ft. 45 offices and office suites, 2 conference rooms – accommodates 20-30 companies Non-wet lab	International, professional service and advanced technology companies	“”	“”
William E. Hannah Jr. Innovation Center at Shady Grove (formerly Shady Grove Innovation Center) (Montgomery County Dept. of Economic Development)	60,000 sq. ft. to accommodate 40-50 companies (60 offices, 3 conference rooms) Wet labs (24)	Advanced technology and life sciences companies	“”	“”
Silver Spring Innovation Center (Montgomery County Dept. of Economic Development)	20,000 sq. ft. to 36 offices, 3 conference rooms, accommodate 20-25 companies Non-wet lab	Advanced technology and professional service businesses	“”	
Wheaton Business Innovation Center (Montgomery County Dept. of Economic Development)	12,000 sq. ft. 30 fully-secured offices in a variety of sizes and configurations), shared facility office amenities Non-wet lab	Current, locally-based business service, government contracting and professional trade businesses	“”	Generated over $280 million in private investment One of the county’s Enterprise Zones (offering special tax incentives to eligible businesses

Association for Entrepreneurial Science (Biomedical Research Institute)	Private incubator with office space, environmental rooms and clean room facilities Wet lab	Biomedical (6 current companies)	Access to outside professional services (legal, financial and accounting) and administrative services (secretarial support and purchasing)	
Bethesda Green (Montgomery County Dept. of Economic Development)		Promotes the creation and expansion of green businesses that develop and supply environmentally sustainable technologies, products and services.	""	""

PG COUNTY				
Incubator	**Facility**	**Companies**	**Services**	**Notes**
Technology Advancement Program (UMD MTech)	Office space, conference rooms, receptionist Wet lab	Biotechnology (10 current companies)	Product planning, market intelligence, customer acquisition, financial analysis, fundraising, executive recruiting, legal and intellectual property issues, marketing and PR, networking	Access to UMD resources (library system, industrial partnerships R&D funding, student and alumni recruiting, Biotech Research and Education Program, MD NanoCenter, Micro and Nano Fabrication Lab, UMD Energy Research Center)
Technical Assistance Center (Prince George's County Economic Development Corporation)		(5 current companies)	Business forums, networking opportunities, quarterly meetings for senior business executives in target industry sectors, capital, contract opportunities, joint ventures and alliances, proposal writing and bidding process, resource library	EDI Fund: Assistance with Enterprise Zone Tax Credits and other state/local incentives ($50 million incentive fund that will be used to attract and retain businesses and create more job opportunities)

Maryland International Incubator (UMD, College Park, and MD Dept. of Business and Economic Development)	Connect Maryland with international companies for successful joint ventures, business services, state-of-the-art facilities, and world-class resources	Healthcare, environment, agriculture, energy, and fire protection.	MI2 provides companies with: direct access to faculty, students and research facilities, hands-on mentoring and training, networking with potential partners with complementary interests and potential investors.	
Bowie Business Innovation Center (City of Bowie and BSU)	40,000 sq. ft. Office space, receptionists, conference rooms, shared office equipment (TV/VCR, LCD projector), kitchen	Information technology, Financial services, Telecommunication firms, Government contractors, Construction-related companies	Business plan evaluation, financial forecasting, market research, competitive analysis, press and promotion support, product definition, partnership development, presentation coaching	
Business and Technology Growth Center (University Town Center)	15,669 sq. ft. Office space (Office sizes range from a single office of 170-5,000 sq. ft. suites), conference rooms.	High-tech	Business guidance, workforce development, grants, loans, venture capital search, also houses support companies that work with the incubator tenants at reduced rates to further assist incubator tenants	Partnership with TAP, extension of UMD's campus environment: access to university facilities

Southern Maryland:

CHARLES COUNTY				
Incubator	**Facility**	**Companies**	**Services**	**Notes**
Charles County Innovation Center (Southern Maryland Innovation Network)		Energetics Technology Center: supporting the Naval Surface Warfare Center at Indian Head, ETC has expanded its portfolio to include Modeling and Simulation efforts associated with advanced energetic materials, autonomous unmanned vehicle operations and Traumatic Brain Injury mitigation.		
TechFire (Energetics Technology Center)	2 conference rooms, multi-media spaces, common business equipment and common kitchen area	Technology businesses with a focus on support for women, minority and veteran entrepreneurs (4 current companies)	Members linked to two entrepreneurs in residence, mentors, advisors, and have access to service packages, some discounted, in areas such as finance, legal, human resources, marketing and back office business services	

Western Maryland:

ALLEGANY COUNTY				
Incubator	**Facility**	**Companies**	**Services**	**Notes**
Allegany/Tawes Science/Tech-nology Business Incubator (FSU)	10,000 sq. ft. Converted the former science building, Tawes Hall to an incubator facility Non-wet lab		Offers the benefit of being on FSU's campus (Access to educational collaboration with academic departments and faculty/students)	

GARRETT COUNTY				
Incubator	**Facility**	**Companies**	**Services**	**Notes**
Garrett Information Enterprise Center (Garret College)	Office suites (17 office areas that range from approximately 305 sq. ft. to 4050 sq. ft.), campus library, computer labs, classrooms Non-wet lab	Technology (11 companies currently)	Free business counseling and a network of technical and financial resources, strategic planning and marketing, workforce development, grant programs, regulatory and permitting assistance	Garrett County is a designated HUBZone, Federal government awards contracting preferences to companies located here

WASHINGTON COUNTY+				
Incubator	**Facility**	**Companies**	**Services**	**Notes**
Technical Innovation Center (Hagerstown Community College)	30,000 sq. ft. Large open, flexible area for light manufacturing, twenty -nine 450 sq. ft. office suites Wet lab	Technology	Bookkeeping set-up and clerical support, cash-flow planning and financial analysis, HR planning and policy consultation, market evaluations, manufacturing assistance, presentation/proposal /SBIR/STTR development assistance	

PARKS:

UM BioPark (Baltimore City)	UMD, Baltimore and UMD Medical Center	1.2 million sq. ft. separated into 3 buildings, multi-tenant lab and office spaces
Montgomery County Science and Technology Park (Germantown, Montgomery County)	UMD College Park and JHU Partnership	I-270 Corridor
Riverside Research Park (Frederick, MD)		I-270 Corridor; National Cancer Institute
Science and Technology Park at Johns Hopkins (Baltimore City)	JHU - RANGOS	2 million sq. ft/80 acre mixed use development project (first of five buildings completed in '08) Wet lab
UMD M Square Research Park (College Park, Prince George's County)	UMD	130 acres adjacent to UMD

Appendix F: Sources of Funding for Maryland Based University Start-Ups

SOURCE	FUNDING	DESCRIPTION	AMOUNT	TIMING
TEDCO[8]	Technology Validation[9]	1) Technical Validation (Proof of Principle Study, 6–9 mos.) 2) Market Assessment (Market Analysis, 2–3 mos.)	$40,000 $10,000	Rolling
TEDCO	MII: MD Innovation Initiative	Product development in preparation for launch/advancement of a technology towards a commercial milestone	$100,000 ($215,000)	Licensed last 12 mos.
DBED[10]	InvestMD Challenge	Business Plan Competition (Life Sciences, High Tech, Open industry)	$100,000	Annual
Bio Maryland	Biotech Development Program	1) Biotechnology Commercialization Award 2) Translational Research Award.	$200,000 (1 year)	Annual
NIH[11]	Phase 1 SBIR[12]	Encourages domestic small businesses to engage in Federal Research/Research and Development that has the potential for commercialization	$150,000	Quarterly
NIH	Phase 1 STTR[13]	Facilitates cooperative R&D between small business concerns and U.S. research institutions with potential for commercialization.	$150,000	Quarterly
DBED	MD Venture Fund	Direct investments in technology/life sciences companies and indirect investments in private venture capital funds.	$100,000-$1,000,000	NA
NIH	Phase 2 SBIR	Only Phase 1 winners may apply for a Phase 2 Phase 3 must seek external funding → private sources	$1,000,000	Quarterly
NIH	Phase 2 STTR		$1,000,000	Quarterly
DBED	MD Tax Credit	Provides income tax credits equal to 50% for investors in qualified MD biotech companies. **(**Promotes angel investments)	$250,000	Annual (July)
TEDCO	Technology Commercial. Fund	Support projects that advance a technology toward commercialization.	$100,000	Monthly (Pre-Rev)
DBED	EPIP[14]	Invest in business entities with a proven technological product/ service. An agreement must be developed for the probable method of exit.	$1,000,000 (7 years)	NA

[8] Technology Development Corporation
[9] Note: JHU does not qualify for TEDCO's technology validation programs because JHU is an MII participating institution
[10] Department of Business and Economic Development
[11] National Institute of Health
[12] Small Business Innovation Research
[13] Small Business Technology Transfer
[14] Equity Participation Investment Programs

Background

I. Maryland Department of Business and Economic Development

A. Maryland Venture Fund: The Maryland Venture Fund is a state-funded seed and early-stage evergreen fund making high impact direct investments in technology companies and indirect investments in private venture capital funds. Typically invests at the first round of institutional financing and works with emerging companies to move them into their next stage of development as a viable business. Investment ranges from $100,000 to $1,000,000. (Investments are generally in the form of equity or convertible debt, either as lead investor or following the terms of a lead investor.)

1. Two investment vehicles.

   a. The Challenge Investment Program: The *InvestMaryland Challenge* is a national seed and early-stage business competition hosted by the State of Maryland. The Challenge will award $100,000 in grants to three companies and a host of business services to companies in the life sciences and high tech industries.

   b. Enterprise Investment Fund: *InvestMaryland* is a funding source for early, mid and late stage growth companies. (Through a premium insurance tax credit auction sale, the State of Maryland raised $84M to invest in early stage technologies in the areas of software, communications, cyber-security and life sciences). 60% invested in technology companies (software, communications, and IT security)/ 40% invested in life sciences companies (therapeutics, medical devices, and diagnostics)

2. Key Investment Criteria

   a. Companies must be in a technology industry. (Life sciences–therapeutics, medical devices and diagnostics, information technology–software, communications and IT security)

   b. The applicant must agree to maintain its principal place of business in Maryland for five years.

B. Equity Participation Investment Program's (EPIP): Provides financial assistance through loans, loan guaranties and equity investments to enhance business ownership of socially or economically disadvantaged entrepreneurs. To be used for purchasing a franchise, acquiring an existing profitable business or developing a technology based business. (Administered by Meridian Management Company: MD Small Business Development Financing Authority (MSBDFA))

Equity investments may take the form of the purchase of qualified securities, certificate of interest, interest in a limited partnership and other debt and equity investments. All equity investments must be disposed of by the end of the seventh year. → A general agreement regarding the probable method of exit must be developed prior to financing. The most common form is for the owner to buy back

its interest at a predetermined pricing formula between the fourth and seventh year.

1. *Franchising Investments* are limited to forty-five percent (45%) of the total project cost or a maximum of $1,000,000. The applicant is required to make an equity investment of no less than ten percent (10%) of the total project costs. An independent appraisal of the business entity may be required to determine the value at the retirement of the debt or investment. (Project costs can range from $50,000 to $5,000,000.)

2. *Business Acquisitions* are limited to twenty five percent (25%) of the initial investment or a maximum of $1,000,000. The applicant is required to make an equity investment of five percent (5%) of the total project costs. An independent appraisal of the business entity may be required to determine the value at the retirement of the debt or investment. (Project costs can range from $100,000 to $5,000,000.)

3. *Technology Investments* are limited to a maximum of $1,000,000 in a business entity with a proven technological product or service. An independent appraisal of the business entity may be required to determine the value at the retirement of the debt or investment. (Project cost can range from $50,000 to $5,000,000.)

C. Biotechnology Investment Incentive Tax Credit: Provides income tax credits equal to 50% of an eligible investment for investors in Qualified Maryland Biotechnology Companies (QMBCs). This tax credit program offers incentives for investment in seed and early stage, biotech companies, up to $250,000.

II. BioMaryland Center

A. Biotechnology Development Program: Awards provide funding to advance biotechnology research and development in Maryland along the path to commercialization.

1. 2 Biotechnology Development Awards Programs (The primary difference in the types of projects funded by these two programs is the stage of commercialization of the technology associated with the proposed project)

   a. Biotechnology Commercialization Award

   b. Translational Research Award.

2. These awards for commercialization and translational research will be granted on a competitive basis in amounts ranging from $50,000 to $200,000. Both are for projects of one year or less.

3. Projects typically require more than $200,000 for completion. Funds are released in phases tied to successful completion of identified milestones (50% initially, 40% with the midterm report, and 10% with the final report).

4. Companies must apply costs financed by the award to expenses for tasks associated with the milestones. Funding can be used for equipment, salaries

and other business expenses, such as rent, IP expenses, or professional services.

III. **Technology Development Corporation (TEDCO):** Maryland's leading source of funding for seed capital and entrepreneurial business assistance for the development, transfer and commercialization of technology)

A. Start-up Programs: Provide startups and early stage ventures knowledge, funding and resources necessary to launch a new business.

B. Incubator Business Assistance Fund: The Incubator Business Assistance Fund provides technology based incubator facilities funding to obtain consulting and/or training resources to assist incubator companies

1. TEDCO provides funding to qualified incubators to help them implement best practices for their tenant/affiliate companies. The incubators utilize this funding to enhance their current service offerings.

a. Business Assistance Examples: hiring an independent consultant, developing a business model or marketing strategy, retaining legal services, creating marketing collateral, updating a business plan, engaging a temporary CFO, attending business training seminars and purchasing software that helps tenant or affiliate companies in marketing or business development.

2. Eligible Recipients

a. The facility must be located in Maryland and house start-up/early-stage companies.

b. The mission of the incubator must be to assist start-up or early-stage companies to move to self-sufficiency and graduate from the incubator.

c. The facility must offer tenant companies office space with shared common areas and shared resources (e.g. conference rooms, laboratory space, equipment, phone/internet services, a receptionist, etc.).

d. There must be an onsite incubator manager/staff that provides mentoring, business assistance services and training programs to their incubator companies.

e. The majority of companies in the incubator are technology-enabled companies.

f. The incubator is receiving operations funding from public sources, or supports a public entity (e.g. a higher education institution), or is a 501 (c)(3).

g. The incubator is a member in good standing with the Maryland

Business Incubation Association.

C. Maryland Innovation Initiative (MII): Created as a partnership between the State of Maryland and five Maryland academic research institutions (JHU, Morgan State, UMD - College Park, Baltimore and Baltimore County). Program is designed to promote commercialization of technologies discovered by the partnership universities' research and to leverage each institution's strengths through technology validation, market assessment, and the creation of start-up companies in Maryland.

1. Eligible Recipients (Sole Application: A single qualifying university, Joint Application: at least two of the qualifying universities)

   a. Phase I: All Qualifying Universities are eligible to apply

      i. Maximum of $100,000 for a Sole Application and $125,000 for a Joint Application
      ii. Should be completed within 9 months

   b. Phase II: Faculty from Qualifying Universities, and other entrepreneurs, interested in creating a University Start-up

      i. Maximum of $15,000 for a Sole Application and $20,000 for a Joint Application
      ii. Should be completed within 3 months

   c. Phase III: University Start-ups: (i) that have licensed technologies from a Qualifying University within twelve (12) months of applying for a Program award; and (ii) that are located in Maryland

      i. Maximum of $215,000 for projects spanning all three phases of the program at a single Qualifying University (a "Sole Application") and up to $270,000 for a Joint Application.

D. Rural Business Innovation Initiative: RBI² assists start-up and small technology-based businesses in the rural areas of Maryland to advance the company to a higher level of success. The program offers professional ongoing mentoring and targeted projects to help companies succeed at no cost to the company.

1. Assistance to companies is provided by a regional RBI² mentor. Each region has a local RBI² business mentor, whose job is to evaluate potential

clients, provide resources, consulting services and technical management assistance. Mentors work closely with company clients at their business.

2. Examples of Company Assistance: Business model or strategy, market strategy/analysis and competitive analysis, funding opportunities and introductions, financial analysis, business plan or grant review, intellectual property, prototype development and manufacturing problem solving.

3. Eligible Recipients

   a. Must be involved in developing new technologies/products or utilizing technology to create new business or expand their business
   b. Must have fewer than 16 employees
   c. Annual revenues of $1 million or less
   d. Good standing with MD Dept. of Taxation & Assessments

E. Technology Commercialization Fund: Exists (i) to help develop and commercialize new products based on technology created in Maryland's universities, federal laboratories having a partnership agreement with TEDCO, and other non-profit research organizations Maryland, (ii) to support the commercialization of technology by companies affiliated with Maryland's qualified incubator programs, or (iii) to support companies receiving mentorship through TEDCO-supported entrepreneurial development programs (Including ACTiVATE, INNoVATE, and RBI^2)

1. TCF provides up to $100,000 to enable companies to reach a critical milestone in their product (or service) development efforts that will move technologies further along the commercialization pathway, increase the company's valuation, and lead to follow-on investment for further growth.

2. Eligible Recipients:

   a. The company must be a for-profit entity located in Maryland with fewer than 16 employees

   b. The company must meet one of the following conditions:

      i. The company has an active license or research agreement in place with a Maryland university, a federal laboratory that has a partnership agreement with TEDCO, or another non-profit research organization in the State, to advance a technology toward commercialization

      ii. The company is affiliated with one of Maryland's qualified incubator programs and has been receiving business advice or mentoring for at least three months

      iii. The company has received mentorship from one of the TEDCO-supported, entrepreneurial development programs including ACTiVATE or INNoVATE (the applicant must be a graduate), or (RBI2); and the company

is pre-revenue OR has received less than an aggregate of $500,000 in equity investments from sophisticated investors (Angels or institutional investors other than company founders)

3. Investment Conditions

a. TCM is a convertible note bearing 8% interest. In the event that the company receives an aggregate outside investment of $500,000 or more, or in the event that the company sells substantial assets or equity, TEDCO may, at its sole option, convert the principal and interest due on the note at the time of the investment or sale to an equity investment in the company on the same terms and conditions received by the most recent investors.

F. Technology Validation: Provides funding to validate a technology for a specific application and/or to validate the market opportunity for a technology. The goal is to foster the creation of more start-up companies based on technologies developed at Maryland's universities, not-for-profit research institutions, and federal laboratories.

1. Technology Validation Program: 2 Phases

a. The Technical Validation Phase.

1. Consists of awards of up to $40,000 for proof-of-principle studies at a Maryland university.

2. Awards are made for projects that can be completed in 6–9 months.

b. The Market Assessment Phase

1. The Market Assessment Phase consists of awards of up to $10,000 for a market analysis for a technology and for the development of a commercialization plan. Awards are made for projects that can be completed in 2–3 months.

2. University applicants apply for both phases of funding at the same time and TEDCO will determine which phase should be funded first. Upon successful completion of the first phase project, the second phase will be funded.

3. Note: JHU does not qualify for TEDCO's technology validation programs because JHU is an MII participating institution

G. Orange Knocks Cyber Fund: $20 million investment fund will invest in companies with economically compelling, technology-enabled solutions to critical problems in cyber security, including services, products and niche technology companies. The Fund is a multi-stage investor in companies across 2 themes.

1. Start-up companies developing micro-market Cyber product features and point technology solutions with one-to-two year technology maturity horizons; and

2. Established and growing solution providers delivering unique technologies combined with services with three-to-seven-year exit strategies.

H. Maryland Stem Cell Research Fund: Provides a variety of grant programs for human stem cell research in the state of Maryland. All Maryland based organizations of all types are eligible for the Grants. Such organizations include public and private, for profit and nonprofit, universities, colleges, research institutes, companies, medical centers and others. Private companies that are not located in Maryland may apply for Grants with the obligation to locate to Maryland before receiving an award.

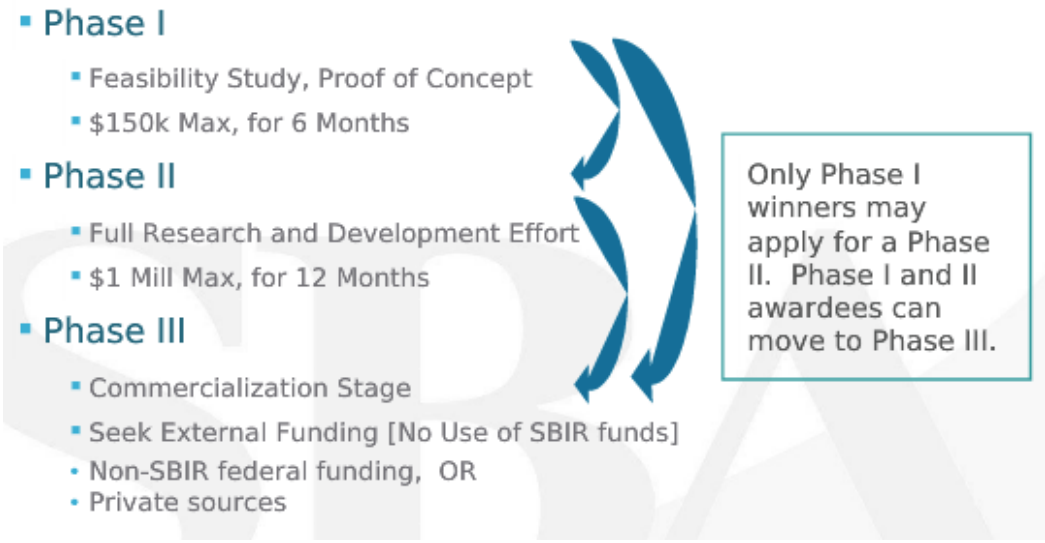
1. Pre-Clinical & Clinical Grants: A single Pre-Clinical Application may request up to $500,000 of direct costs, and a Clinical Application may request up to $750,000 of direct costs both cases for up to three years project.

2. Investigator-Initiated Grants: Designed for investigators with preliminary data supporting the grant application. A single Application for an Investigator-Initiated Research Grant may request up to $600,000 of direct costs, for up to three years project.

3. Exploratory Research Grants: Designed for investigators who are new to the stem cell field and for exploratory projects without preliminary data. A single Application for Exploratory Research Grant may request up to $100,000 of direct costs in any single year, for up to two years.

4. Post-Doctoral Fellowship Grants: For pre-doctoral students and post-doctoral fellows who wish to conduct research on human stem cells in the State of Maryland. Each Fellowship will be up to $55,000 per year, for up to two years.

IV. SBIR/STTR



A. Small Business Innovation Research (SBIR): Highly competitive program that encourages domestic small businesses to engage in Federal Research/Research and Development that has the potential for commercialization. Through a competitive awards-based program, SBIR enables small businesses to explore their technological potential and provides the incentive to profit from its commercialization. (Administered by US Small Business Administration (SBA) Office of Technology)

1. 2.5% of the extramural research budget for all agencies with a budget greater than $100MM per year

2. Program Eligibility Criteria

   a. Organized as a for-profit business based in the U.S.
   b. 500 employees or less, including affiliates
   c. PI's primary employment must be with the small business
   d. At least 51% U.S.- owned by individuals and independently operated; OR, at least 51% owned and controlled by another (one) for-profit business concern that is at least 51% owned and controlled by individuals.

B. Small Business Technology Transfer (STTR): Set-aside program to facilitate cooperative R&D between small business concerns and U.S. research institutions with potential for commercialization)

1. 0.3% of the extramural research budget for all agencies with a budget greater than $1B per year

2. Program Eligibility Criteria

   a. Organized as for-profit small business based in the U.S.
   b. Formal cooperative research and development effort
   c. Minimum 40% by small business and 30% by U.S. research institution, U.S. research institution, college or university, other non-profit research organization, federal research and development

center

d. Intellectual Property Agreement (Allocation of rights in intellectual property and rights to carry out)

e. Follow-on R&D and commercialization effort