

Gone Tomorrow?

A Call to Promote Medical Innovation,
Create Jobs, and Find Cures in America



Prepared By:
The Battelle Technology Partnership Practice

Prepared For:
The Council for American Medical Innovation

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The Council for American Medical Innovation (CAMI), launched in 2009, has brought together leaders in research, medicine, public health, academia, education, labor, and business, who are working in partnership to encourage public policies that advance medical innovation and the development of lifesaving treatments, enhance job growth, and promote patient access.

CAMI believes leadership in medical innovation is a key part of America's economic recovery, future prosperity and health. For additional information, please visit www.americanmedicalinnovation.org.



This study was undertaken for the Council for American Medical Innovation (CAMI) by the Battelle Technology Partnership Practice. Battelle is the world's largest nonprofit independent research and development organization, conducting \$5.6 billion in global R&D annually through contract research, laboratory management, and technology commercialization. The Technology Partnership Practice is the technology-based economic development consulting organization of Battelle and is a national leader in advancing bioscience strategies around the nation.

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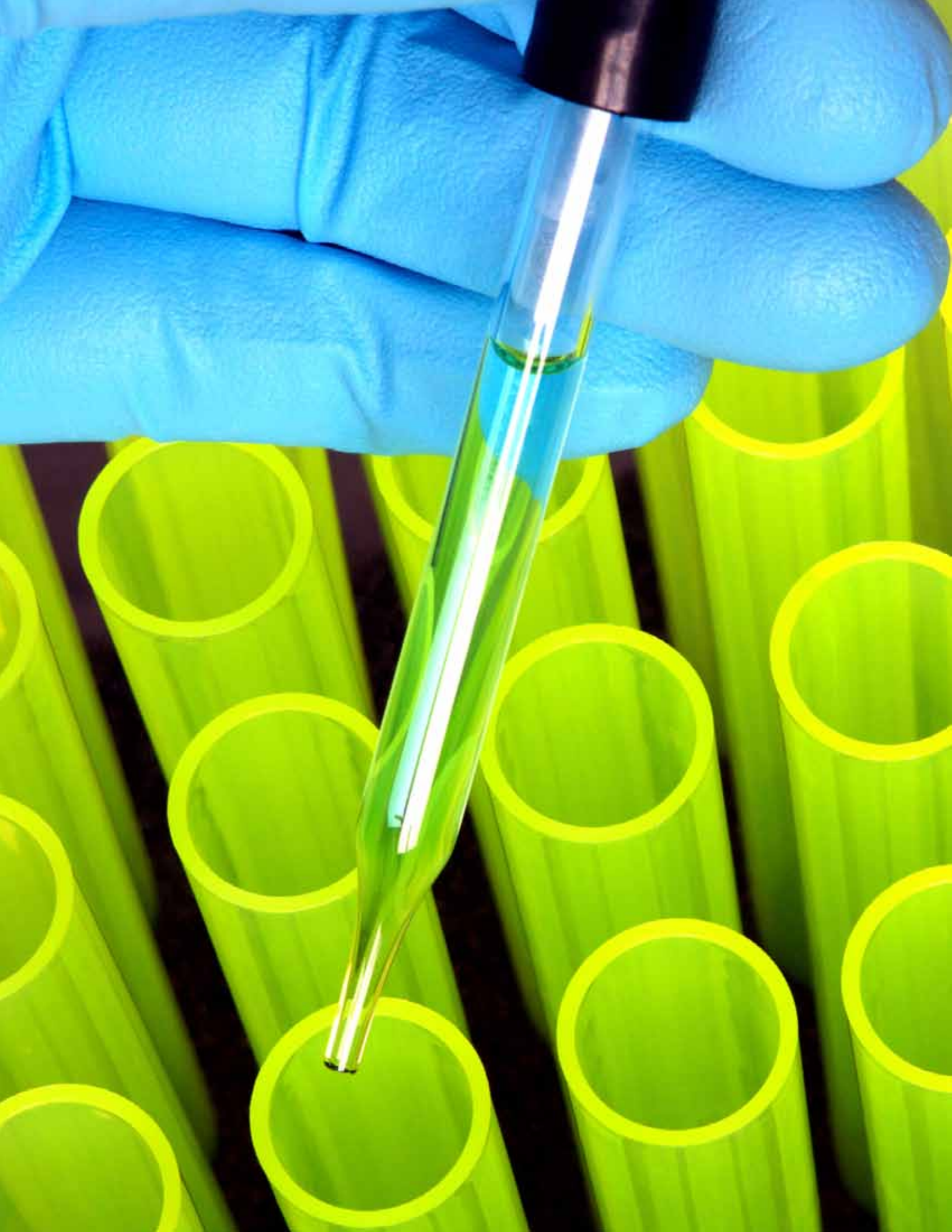
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Medical Innovation—The Key to U.S. Economic and Human Health in the 21st Century

America faces a health and economic crisis that rivals some of the toughest domestic challenges in recent history. While healthcare costs soar, obesity and its serious health consequences continue to rise; Alzheimer's disease is predicted to cost the nation \$1.08 trillion by 2050; and cures for cancer, AIDS, and diabetes continue to elude us. Only through investment in our nation's medical innovation ecosystem will we address these challenges, build health security for all Americans, add high-quality jobs, reverse skyrocketing healthcare costs, and curb budget deficits.

Many sentinels call now for decisive action. While the United States has long been recognized worldwide as the leader in medical innovation, studies show that we are losing our global edge. To respond to this challenge, the Council for American Medical Innovation (CAMI) commissioned the Battelle Technology Partnership Practice to identify the most effective public policy directions for maintaining our nation's global leadership in medical innovation. Over the past 2 months, Battelle has interviewed experts, thought leaders, entrepreneurs, and many other of our brightest minds. This report presents the consensus observations of these recognized leaders on key policy opportunities to drive regulatory reform, build private capital formation and R&D investments, bridge the innovation gap between basic research and human application, and ensure the retention and training of our nation's young people.

Emerging from this review is a single new imperative: it is time to join the forces of the public and private sectors in new ways to sustain and enhance the nation's medical innovation ecosystem. This challenge should rise to the same level of national focus as has distinguished us in the past—whether it be the launch of a system of national labs, placing a man on the moon, or rising to the challenge of building new capacity as the era of the semiconductor emerged.

The jobs that come from investment in biomedical industries are high-paying jobs, exceeding the national average private-sector wage by more than \$24,000. From lab coats to hard hats, the jobs and new enterprises associated with this critical sector create an array of highly desirable positions across academic disciplines, management fields, health services, and skilled trades. Even through the worst economic downturn since the Great Depression, jobs in this sector are being added at a faster pace than the overall private sector and other knowledge-related industries.

Equally important, investment in medical innovation is about health. As the United States implements historic health reform legislation, medical innovation should not be viewed only through the lens of cost containment, but rather be examined as a driver of substantial returns to personal and national economic health. Medical advances lengthen life, reduce disability, and improve productivity.

We invite you to join with us in advancing this important call to action. We look forward to your input and support as the nation takes up this challenge to move discovery into applications to human health, strengthen the economy, and improve quality of life for generations to come.

Sincerely,



Dick Gephardt
Former U.S. House Majority Leader and
Chairman of the Council for American Medical Innovation



Debra Lappin
President of the Council for American Medical Innovation

Introduction

Medical innovation has the proven ability to generate economic growth by sustaining and creating new jobs in the highly desirable, knowledge-based economy and providing significant health advances that benefit individuals and society as a whole. Policy proposals designed to spur innovation, economic development, and job growth must include medical innovation as a cornerstone to succeed fully.

Today, global leadership in medical innovation and resulting biomedical development is “ours to lose.” While other nations have aggressively pursued medical innovation as an economic growth strategy, we have allowed our ecosystem for medical innovation to decline. We need a proactive, collaborative approach engaging public and private efforts to secure our continued leadership, fuel job growth and economic development, and ensure that America fully benefits from advances in health.

Recognizing what is at risk and the opportunities before us, the Council for American Medical Innovation engaged the Battelle Technology Partnership Practice to develop a policy agenda built on the consensus views of diverse and highly informed stakeholders. This agenda is intended to inform the development of a national strategy on innovation, jobs, and economic growth with advancing medical innovation at its core.

Altogether, 72 experts representing the diverse stakeholders involved in advancing medical innovation informed this agenda, including the following:

- 25 industry executives involving all sectors of the biomedical industry—biopharmaceuticals, medical devices, diagnostics, and contract research organizations—as well as well-established, public companies and smaller, start-up companies.
- 14 research institution leaders from academic medical centers, universities, and nonprofit research organizations.
- 8 patient advocate leaders representing specific disease areas.
- 5 private foundation and nonprofit executives, many involved in either supporting the funding of medical innovation or developing policies to advance medical innovation.
- 16 executives with state and regional biomedical organizations and state agencies from all regions of the nation.
- 4 capital investment officials involved in providing venture-related capital.

These experts provided their views regarding the following:

- Key challenges facing medical innovation in the United States today
- Challenges posed by increasing international competition and best practice lessons to be learned
- Specific action steps needed to advance medical innovation in the United States.

The Imperative for Public-Private Collaboration to Sustain Medical Innovation

Over the past 30 years, the unique, complementary investments made and actions taken by the public and private sectors helped the United States become the leader in medical innovation worldwide. Today medical innovation remains a defining feature for the United States in the global economy. But, as this report reflects, many believe that the U.S. leadership position is tenuous. While *'here today'*, it could be *'gone tomorrow.'*

The keys to our past success in medical innovation are that while the public sector made significant, sustained investments in basic life sciences research and in talent generation, the private sector invested in research and development (R&D) of breakthrough medical technologies . . . spurring job creation and economic growth through new medical products and services that have produced to a significant dividend of health gains for society overall. We also made public policy decisions that recognized the importance of intellectual property (IP), facilitated technology transfer, created science-based product review and approval, and maintained and created incentives to attract investments that resulted in the founding and growth of new companies and the development of breakthrough medical technologies.

Key Elements of the U.S. Unique Public-Private Partnership for Advancing Medical Innovation

Public Sector Provides:

Funding for medical research
Funding for developing bio talent

Legal and regulatory framework for:

- Safety and efficacy of products
- Raising private venture capital
- Bayh-Dole framework for licensing of university research
- IP protection

Private Sector Provides:

Development of technologies from private R&D
Hiring and using talent

Undertaking clinical trials
Creating new firms and raising capital
Licensing and/or forming firms from R&D

This highly interrelated, synergistic blend of public-private partnership strength and resources is not found in any other technology sector. Indeed, the dependencies between academia-led basic science largely funded by the public sector and private industry-led product development are quite striking. One study found that 31 percent of new products and 11 percent of new processes in the biomedical field could not have been developed, without substantial delay, in the absence of academic research.^{*1}

American medical innovation now stands at a crossroads. Our leadership in medical innovation and the health benefits and economic growth that accrue because of it are at risk. What has changed is:

- Biomedical science has become more complex and demanding, requiring more involved technology development efforts, including more complex clinical trials.
- Regulatory review and approval processes are not keeping pace with scientific advances and are no longer as predictable or consistent.
- Early-stage financing and private investment for R&D are harder to access because of the changing risks and rewards in advancing medical innovation.
- Talent pipeline supporting medical innovation is at risk.

Meeting these challenges will depend on strengthening and leveraging the public-private collaboration that helped the United States become the world leader in medical innovation. In the past, the public and private sectors, otherwise operating independently, have come together through a new architecture to address a crisis facing the nation. One need only think of defining efforts to bolster national defense, to bring talent and focus to the nation's competencies during the emergence of the semiconductor age, or to advance our impressive national labs to realize the power of this partnership in America. Many of the experts interviewed suggested that nothing less than a discrete new mission-focused enterprise where public and private expertise and investment can come together to spur translation and early development is required today to sustain the nation's vital medical innovation enterprise.

*Please refer to the "Endnotes" section for the references used in this report.

Key Findings

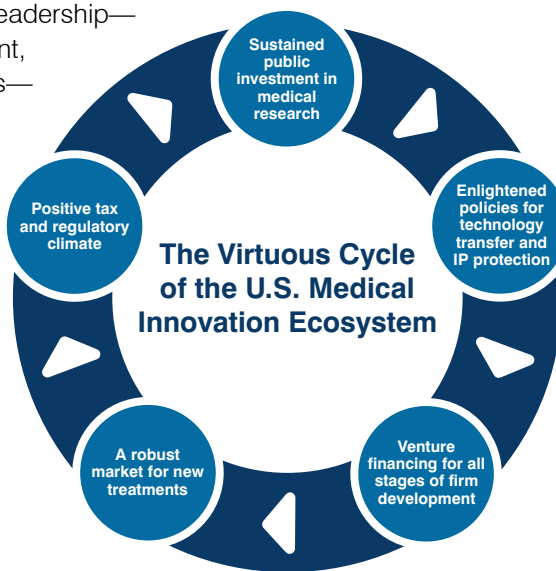


Despite the diversity of stakeholders involved in medical innovation, there is wide agreement among them that we cannot take for granted our success and ongoing competitiveness in medical innovation and we face some considerable challenges.

Over the past 30 years, the United States has become the global leader in biomedical development because of its world-class medical innovation ecosystem. The experts interviewed point out that, in the 1970s, the United States was not yet a world leader in medical innovation. Instead, Europe led in the medical innovation industry, with Germany, Switzerland, and the United Kingdom as the dominant players.

The United States earned its global leadership—as measured by industry development, inventions, and scientific publications—based on a well-balanced approach involving key roles for both the public and private sectors. The hallmarks of our medical innovation ecosystem include the following:

- Sustained public investment in medical research
- Enlightened public policies supporting technology transfer and IP protection
- Advanced venture financing at all stages of firm development
- A robust market for new treatments and technologies
- A tax and regulatory climate that provided a path for private enterprise to advance new product development.



Today, global leadership in medical innovation and resulting biomedical development is “ours to lose.” And we seem to be doing just that. While many other nations are strategically investing to support medical innovation as an economic growth strategy, we have allowed our ecosystem for medical innovation to decline. Though the leadership gap is narrowing, the United States stills leads and, with proactive policy changes, can secure continued leadership and fuel job growth and economic development for the United States.

A critical concern raised by the medical innovation experts interviewed is the “public perception” of medical innovation—there is little public understanding of the benefits from medical innovation and a rising tide of anti-science sentiment within public opinion.

Strengthening medical innovation in the United States cannot be accomplished without addressing why medical innovation matters or should matter to the general public. In particular, the value of medical innovation for improving the lives of patients with acute and chronic conditions is often underrated, and the economic value of medical innovation in creating high-quality jobs is overlooked. Instead, elected officials and

the general media increasingly focus on the risks and costs of medical innovation without giving proper weight to its significant health benefits and the direct and indirect economic gains from job growth and productivity gains from disability reduction.

- As one industry executive explained: “General climate for innovation is a problem. As a nation we have gone from seeing medical innovation as a good thing to being fearful of it and very anti-science. Medical innovation is largely absent from our national discussions on healthcare reform, yet without dramatic improvements from medical innovation for neurodegenerative diseases and chronic diseases the cost of healthcare will not improve. There is a palpable fear of new technology doing harm or costing more.”
- Or as echoed by a foundation executive: “Anti-science tenor in the country. Scientists are as much to blame as anyone else, but as long as it persists problems will be pervasive—an inability, which rests squarely on those of us in science and science policy, to engage the public and policy makers.”

Our success in medical innovation is under threat primarily due to our nation’s neglect and failure to recognize the reasons for our success and build upon our strengths.

The experts interviewed highlighted four critical challenges that require focused attention for the United States to ensure its global leadership in medical innovation. These four challenges represent areas of our medical innovation ecosystem in which, through neglect and failure to build upon our success, we now face significant hurdles.

Challenge: Lack of consistency and predictability in U.S. Food and Drug Administration (FDA) regulatory review and uncertainties in reimbursement and new standards under healthcare reform

One significant challenge of our own doing is the failure to keep up the scientific, objective, and predictable basis of our regulatory review and approval processes. In the midst of the explosion of scientific knowledge and improvements, we have allowed our regulatory system to fall behind in its scientific skills and tools and instead become mired in processes that are unable to predictably balance the need for safety as well as patient benefits.

The cost of this is huge. The lack of certainty and predictability in the review and approval process heightens risks of failure, raises the costs of development, makes the struggle to raise capital more difficult, and ultimately denies patients timely access to innovative treatments. While the FDA is working to address this issue, in part with its proposed Initiative for Advancing Regulatory Science, the resources available are very limited and a broader public-private partnership is needed to bring forward the needed expertise from government, patient advocates, the research community, and industry.

With healthcare reform’s passage, we will begin to shift healthcare delivery to a system that reimburses based on the quality of services and outcomes versus the quantity of services regardless of outcome. This effort poses both opportunities and risks. To limit risks, new standards and structures created must allow for evolution to keep pace with the development and diffusion of new technologies and treatment options and allow for flexibility in addressing diverse patient needs.





Challenge: Shortfalls in private investment for company formation, R&D, and related manufacturing job growth

One of our distinguishing features in medical innovation—that of having robust private investment in innovation—is at risk. The United States is falling behind in its R&D tax credit as well as other tax incentives and policies that incentivize medical innovation and related manufacturing. At the same time, formal venture capital is seeking later-stage investments in medical innovation to shore up its prospects of strong financial returns, leaving start-up and emerging bioscience companies with diminished prospects of success. New threats are emerging to venture capital firms that would eliminate their current preferential tax status. In turn, the growing limitations on capital availability are widening the innovation gap, challenging our universities and medical centers in their technology transfer efforts and small start-ups working to move promising research discoveries further down the development pipeline. On top of these realities, the recent financial crisis has all but shut off the initial public offering (IPO) market. Some experts are concerned that the IPO market issue may not be a transitory trend but a structural issue that could cripple medical innovation significantly.

Challenge: Gaps between research and translation of medical innovation into new treatments

The breadth and depth of U.S. research efforts found across universities and medical centers remain a formidable competitive advantage for our nation. Instead of building on this strength, we face new threats to the basic rules that have facilitated the public-private collaboration that has helped move research discoveries out of the lab and into product development. Stakeholders from across the medical innovation community are concerned about proposals to restrict technology transfer at universities as well as continued litigation efforts to diminish IP protections. These pose fundamental threats to the highly valued rules that have facilitated our nation's successful medical innovation efforts. IP protections, in particular, provide a clear legal framework for all to work, innovate, and compete within, giving participants a sense of predictability and security necessary to ensure continued private R&D investment for tomorrow's medical innovation.

More importantly, these threats divert attention from the real needs to strengthen university-industry partnerships in medical innovation; to consider a more strategic and translational focus to National Institutes of Health (NIH) funding; and to invest in technology transfer capacity at universities in the face of a reawakened set of global players that include the European Union, Japan, and the much-acknowledged developing country newcomers, namely China, Singapore, and India. Only by playing to our strengths in medical innovation—finding new and improved ways to leverage our academic research base even as we continue to invest in its capacities—can we hope to keep our leadership and the high-quality jobs it drives.

Challenge: Limitations in U.S. bioscience talent pool

Perhaps the most serious long-term threat to medical innovation is the well-documented crisis in building the scientific talent pool needed to fuel an innovation-driven economy. Urgent attention is needed to increase the U.S. talent pipeline to keep pace with demand. Attention is needed at all educational levels to build both the interest and skill-sets needed. Opportunities exist beyond K-12 education to include bolstering efforts to retrain incumbent workers for careers in the biosciences through more targeted support at the vocational education and community college level. Our universities and industries engaged in medical innovation also depend on retaining

foreign talent, educated in the United States. Now, restrictive U.S. immigration policies as well as incentives from their home nations are leading foreign-born, U.S.-trained scientific talent to return to their native countries. The return of well-educated scientific talent is raising the level of international competition for desirable sites to locate not only sophisticated manufacturing, but also R&D.

One overarching challenge we face is the lack of ownership over the advancement of medical innovation at the national level. The key challenges identified by the experts involve multiple federal agencies and departments. Only with dedicated leadership at the national level engaging with public and private stakeholders can we overcome the key challenges we face and fully realize the benefits advancing medical innovation offers.



Key Challenge Area	Key Perspectives
Lack of Consistency and Predictability in Review and Approval of New Medical Products and Uncertainties in Reimbursement	<ul style="list-style-type: none"> • Funding limitations and new mandates are preventing the FDA from keeping pace in developing and applying a scientific framework that facilitates science-driven assessment of risks and benefits of new medical innovations. • The FDA approval process lacks consistency and predictability. • The FDA lacks resources, particularly in light of need to keep pace with scientific advances that can impact the tools and approaches for evaluating new medical technologies. • The FDA is facing a workforce crisis. • Increasing efforts to restrict and control reimbursement under health reform may undermine the marketplace for medical innovation.
Shortfalls in Private Investment	<ul style="list-style-type: none"> • R&D incentives for innovation are not keeping pace, particularly important given the changes in capital availability for medical innovation and potential limits on reimbursement. • Foreign tax havens make it difficult for the United States to compete for biomedical manufacturing. • More incentives are needed to ensure R&D-related manufacturing takes place in the United States. • Recent freezing of capital markets poses a major problem for start-up and emerging bioscience companies. • Venture capital is moving toward later stages of investment and away from early-stage investments.
Gaps in Translational Research	<ul style="list-style-type: none"> • Public investment is a key driver for U.S. rise in medical innovation, but concerns exist about funding levels. • Concerns exist that NIH funding is too skewed toward basic research and that greater value could be generated with a more balanced focus on applied research and strategic areas. • Concern exists about attacks on Bayh-Dole. • Most universities and research centers do not treat technology transfer as an institutional capacity that needs support. • Much-needed university-industry collaboration is hindered by conflict of interest concerns. • The United States may be losing competitiveness for clinical trials—with the risk that new medical treatments based on U.S. R&D will benefit patients in other nations before they are introduced in the United States.
Limitations on Availability of Educated and Trained Workforce	<ul style="list-style-type: none"> • Major challenges exist in priming the U.S. talent pipeline in the sciences. • Concerns exist about specific fields of expertise being available in the United States. • The United States needs a more systematic approach to attracting and retaining foreign talent.

Recommended Action Agenda



This national medical innovation policy agenda provides the basis for a renewed focus on the very public-private partnerships that have made us world leaders. The agenda sets out specific actions in which the public and private sectors can work together to address key issues holding back medical innovation today, including pursuing regulatory sciences to balance safety and patient needs, ensuring the incentives and mechanisms for marshalling private investment in medical innovation, improving the translation of basic research discoveries, and generating the talent integral to long-term medical innovation. Together, these actions can address unmet patient needs for new treatments, raise our competitiveness in medical innovation, and generate new high-quality jobs in research, development, and manufacturing.

The agenda will succeed only with committed leadership at the national level that engages public and private leaders collaboratively to advance medical innovation in America. Specifically, we need a designated leader on medical innovation with the mandate and authority to work closely with federal departments and agencies with an impact on medical innovation and public and private partners representing patients, industry, universities and medical centers, governors and mayors, and other key stakeholders.

Within the U.S. Congress, we need an organized Congressional Caucus on Medical Innovation to examine the impact of current laws on medical innovation advancement and enact changes where needed to facilitate medical advances.

Key Challenge—Regulatory Policy:

- **Launch a public-private partnership to establish a comprehensive and meaningfully funded FDA-wide Regulatory Sciences Roadmap, building upon the proposed Advancing Regulatory Science Initiative of the FDA, to implement a science-based benefit/risk framework informed through a collaboration of government, patient advocates, and industry.**
- **Fund FDA sufficiently to address critical short-term needs and commit to a sustained funding growth.** Sustainable funding should reflect the increases in FDA's mandated jurisdiction, the growing complexity of science and related workforce challenges, and other demands.
- **Expand the extensive and highly successful harmonization efforts of the International Conference on Harmonization of Technical Requirements for Registration of Pharmaceuticals for Human Use and the Global Harmonization Task Force** to further identify and advance best practices and research findings in regulatory sciences and procedures for gaining qualified expert input into regulatory approval processes.
- **Adopt policies that account for and encourage the diffusion of new medical technologies as a part of reimbursement policy and new standards and measurements** in the implementation of healthcare reforms. Policies should accommodate evolution in standards of care, allow for consideration of individual patient needs, and avoid penalizing early adopters of new technologies.

Key Challenge—Private Investment for Company Formation, R&D, and Related Manufacturing:

- **Strengthen the federal R&D tax credit** by making it permanent, raising it to levels that make it globally competitive, allowing partial refunds for emerging companies without income, and providing incentives to further public-private partnerships.

- **Adopt tax and economic incentives to boost manufacturing and export-related job growth resulting from medical innovation.** Activities can include incentives for manufacturing resulting from medical innovation in the United States and other export-related manufacturing incentives to encourage U.S.-based production.
- **Encourage venture financing for emerging biomedical ventures from formation through IPO** by creating a federal-level angel investment tax credit, providing federal matching incentives to foster “fund of funds” equity capital pools, maintaining the tax treatment of carried interest for venture capitalists, and promoting alternative stock market mechanisms for IPOs.
- **Provide federal financing support for bioscience R&D infrastructure at university-related research parks.**

Key Challenge—Translational Research:

- **Commit to a 10-year “growth” budget strategy for NIH, which includes an emphasis on translational research that moves discoveries through more applied technology development to bridge the “valley of death.”**
- **Advance more specific university-industry collaboration funding approaches at NIH similar to mechanisms long used by the National Science Foundation (NSF) in its Industry-University Cooperative Research Centers or the new Energy Innovation Hubs approach of the Department of Energy.**
- **Protect and enhance support for university technology transfer set out in the Bayh-Dole Act** by allowing for the reimbursement of cost of patents and a consistent level of overhead support for technology transfer through an indirect overhead charge against federal research grants.
- **Appropriate funding for the Cures Acceleration Network (CAN)** as a means to enhance incentives and support for medical innovation in rare diseases and to address broader systematic breakdowns that hinder medical innovation for major public health issues, such as potential pandemics and bioterrorism threats.
- **Reform the Small Business Innovation Research (SBIR)/Small Business Technology Transfer Research (STTR) programs to better address “valley of death” challenges in the commercialization of medical advances, including venture-capital-backed companies.**
- **Advance national policies and demonstration projects to encourage participation and retention in U.S.-based clinical trials.** Policies could include harmonizing approaches across institutions for institutional review board (IRB) approval standards and patient consent, addressing patient recruitment and retention in clinical trials through increased public awareness, and providing incentives in Medicare and Medicaid to encourage physician participation in clinical research activities.

Key Challenge—Talent:

- **Provide federal support for the biosciences in K-12 science, technology, engineering, and mathematics (STEM) efforts, including bioscience teacher preparation and professional development.**
- **Provide funding to vocational and technical schools and community colleges to establish, in concert with industry consortia, programs to retrain existing workforce for biomedical careers.**
- **Increase the number of U.S. and foreign students pursuing graduate degrees and careers in the biosciences in the United States.** Strategies may include scholarships and loan forgiveness for U.S. students pursuing degrees in biology, chemistry, engineering, and related majors and a streamlined green-card application process for foreign graduates of U.S. universities at the master’s and Ph.D. levels.



Why Medical Innovation Matters



As a source of unparalleled individual and societal benefits from improved health and a proven generator of high-quality jobs, medical innovation is uniquely positioned as a driver of economic growth.

The Benefits of Medical Innovation for Patients and Improved Healthcare

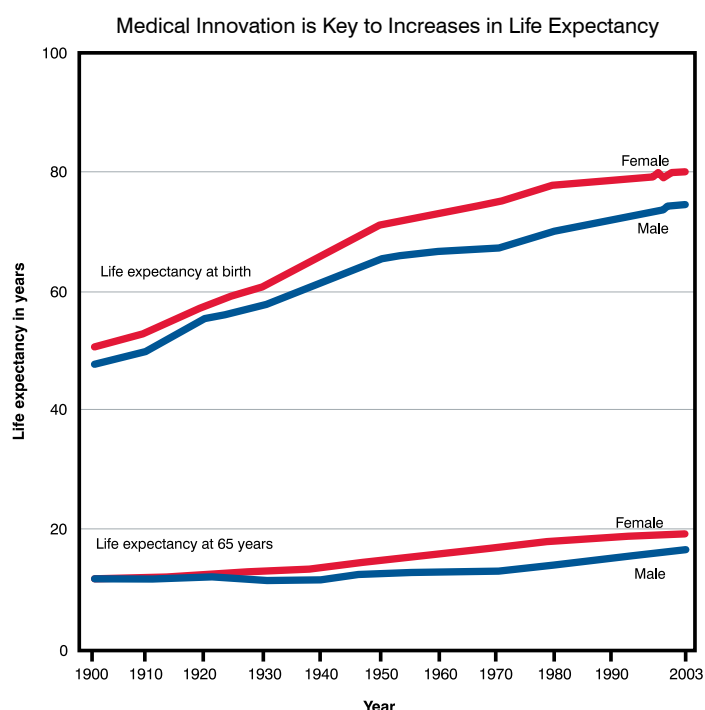
New technologies lead to improved quality of healthcare and better health outcomes to the benefit of individuals and society overall.

New vaccines, diagnostics, medicines, medical devices, and surgical procedures have enhanced the quality of healthcare, led to better health, increased longevity, reduced disability, and improved quality of life. Between 1999 and 2006 alone, medical advances, including new diagnostics, medicines, and devices, have helped cut the death rate from cardiovascular disease by 29 percent.² Survival rates for people with certain cancers have also risen dramatically; in 1975, 5-year survival was just 50 percent; but, by 2002, survival rose to 68 percent.³ For all childhood cancers combined, the number of children surviving 5 years after diagnosis has grown from less than half in 1975 to more than 80 percent today due to new and improved treatments.⁴

In addition to improving individual health, medical advances have contributed to substantial societal health gains such as lengthening life spans, reducing disability, and improving productivity. In fact, the nearly 2.5-year gain in life expectancy achieved between 1991 and 2004 is largely attributed to advances in medical innovation.⁵

Health economists have estimated that the economic gains from declining mortality in the United States from 1970 to 2000 had an economic value to society of more than \$3 trillion a year.⁶ Meeting unmet medical needs promises even greater benefits. For example, a breakthrough that delayed the age of onset of Alzheimer's disease by 5 years would mean 1.6 million fewer Americans would have Alzheimer's and could save \$50 billion a year in medical costs within 5 years of its availability and \$111 billion within 10 years.⁷ Most of the savings would accrue to Medicare and Medicaid.

Though the advances in health improvement are significant, tremendous unmet needs remain and the search for better answers is paramount. Medical innovation holds the promise of not only greater understanding of the causes of disease and disability, but tangible ways to prevent, diagnose, treat, and ultimately eliminate them.



Source: *Chartbook on Trends in the Health of Americans*, Figure 24.
<http://www.ncbi.nlm.nih.gov/bookshelf/br.fcgi?book=healthus06&part=A43>

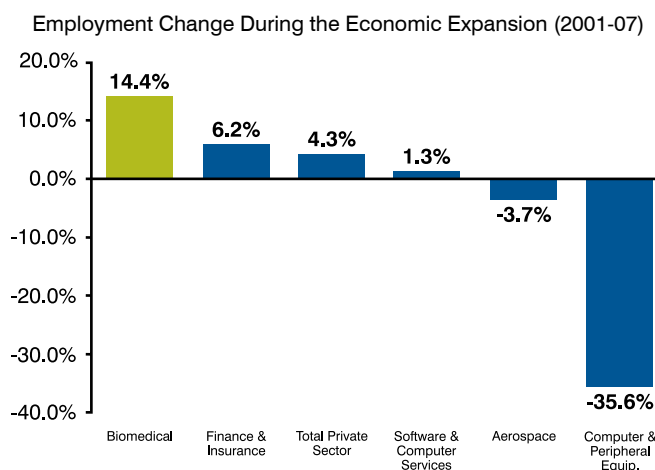
The value of medical innovation in the United States outweighs increased treatment costs. Chronic diseases, such as neurodegenerative diseases, cancer, and diabetes, account for more than 75 percent of what the United States spends on health care.⁸ A study that evaluated seven of the most common chronic diseases in the United States estimated that these conditions cost the nation nearly \$1.3 trillion annually; four-fifths of this burden was related to economic loss as a result of lowered productivity.⁹

Given that the primary outcomes of addressing these conditions are improved health and longevity, it is critical that an assessment of the value derived from treatment advances for these diseases include associated health gains and economic impact beyond medical costs. This analysis is particularly important in the advancement of an agenda designed to spur economic growth.

Medical innovations are often assumed to increase costs. However, improved health outcomes have a significant positive net benefit for patients, the healthcare system, and the economy overall. These health benefits, including lower overall medical costs, reduced disability, and improved productivity and quality of life, often offset increases in spending associated with innovation. For example, every \$1 spent on heart attack care has produced \$7 in gains.¹⁰ Similarly, the introduction of the rotavirus vaccine has saved more than \$1 billion annually in direct and indirect costs associated with physician and emergency department visits and hospitalizations.¹¹

The Jobs and Economic Competitiveness Context of Medical Innovation

The U.S. biomedical sector is a proven economic driver and generator of high-quality jobs. The biomedical industry—from biopharmaceuticals to medical devices and diagnostics to commercial bioscience research, testing, and medical labs—has outpaced overall private sector job growth as well as the job growth in most “knowledge-economy” sectors, in both strong and challenging economic times. More importantly, the biomedical industry offers a source of high-quality, high-wage, and high-skilled jobs across a broad spectrum of occupations, including production workers, technicians, scientists, and engineers. However, while the biomedical industry is a strong job generator, the sector is not immune to the economic downturn and other market pressures.



Source: Battelle analysis of BLS, QCEW data from the Minnesota IMPLAN Group



U.S. Biomedical Industry Is a Key Economic Engine

- **Strong Job Growth Over the Last Business Cycle:** Biomedical industry grew 14.4% in jobs compared with 4.3% for all industries.
- **Continuing to Grow Through the Recession:** Biomedical industry grew 1.5% in jobs from 2007 to 2008, while overall economy declined by -0.7%.
- **High-Quality Jobs:** Average wages in biomedical industry stood at \$66,716 in 2008, well higher than the national average for all industries of \$42,270. Every occupation group in biomedical industry exceeds its comparable national average.

Key Challenge—Regulatory Policy: Providing a predictable, modernized, and science-driven regulatory review and approval process is critical to ensuring new medical product development and associated job creation. Preserve market incentives for adoption of new technologies and evolution of standards of care.

Overview:

The explosion of scientific knowledge, underfunding, and increasing mandates have prevented the FDA from keeping pace in developing and applying the most current scientific knowledge, skills, and tools to the regulatory process. These challenges hamper the FDA’s ability to make science-based, timely regulatory decisions to advance public health while sustaining continued progress on developing and securing access to new medicines, diagnostics, and devices. The lack of certainty and predictability in the review and approval process heightens risks of failure, raises the costs of development, makes the struggle to raise capital more difficult, and ultimately denies patients timely access to innovative treatments. In addition, downward pressure and government intervention in prospective reimbursement of new products have heightened uncertainty for innovators and risk hindering the diffusion of new technologies into patient care.

Insights from Experts:

An overwhelming majority of the experts interviewed viewed the regulatory review and approval process as a critical challenge to medical innovation in the United States.

Comments from Experts:



Funding limitations and new mandates are preventing the FDA from keeping pace in developing and applying a scientific framework that facilitates science-driven assessment of risks and benefits of new medical innovations.

Patient Advocate

From patient community, there cannot be an absolute safety standard. The networks of patients are as much concerned about getting new drugs approved as industry.

Patient Advocate

FDA needs to expedite the process of approvals and be more flexible and responsive to unique aspects of diseases impacting small patient populations.

Industry

We need to be clear that we can’t achieve perfection and can’t achieve zero risk. We need to come to common understanding about what level of risk we are willing to accept in return for more opportunities for treating diseases and improving the lives of patients.

Industry

No longer does FDA bring expert science knowledge to addressing protocol development, rather defers to advisory committees that often lack experts in the particular disease area.

The FDA approval process lacks consistency and predictability—and, in doing so, delays and raises the costs of advancing medical innovation.

Patient Advocate

FDA not able to effectively address what are good endpoints for a clinical trial—tend to be very subjective.

Industry

FDA is falling short in providing timely scientific advice to companies, particularly feedback on novel protocols. Meetings with companies are not being granted on a consistent basis. There is a general lack of communications with industry by FDA. Also, need to improve the consistency of the overall review process. FDA working on improving milestones and best practices for review process, but implementation is slow.

Industry

In the past, FDA set clear endpoints that needed to be met for clinical trials. But that is no longer the case. Now it is hard to design clinical trial protocols because we don't know what the right goals are for the study.

The FDA lacks resources, particularly in light of the need to keep pace with scientific advances that can impact the tools and approaches for evaluating new medical technologies.

Patient Advocate

FDA is facing huge resource issues. It does not have the time or money to develop effective expedited policies.

Private Foundation

There has been a vast underinvestment in FDA since its inception, but particularly dire in the last 10 to 15 years. It has really slowed down their rate of approval. The impact is not just on companies, but on patients. Funding needs to be more stable instead of relying on user fees and assuming that federal investment can fund only a small trickle. Funding needs to be boosted and expanded.

Industry

FDA is long underfunded. Using 30-year-old science. Needs to be more proactive in advancing regulatory science with new tools and standards, which can then guide how industry applies to clinical research. The Critical Path report in 2004 shed light on the situation, but hit barriers due to funding delay and lack of staff. This remains a critical area for speeding innovations to patients—and significant gains can be made with the right attention and resources.

The FDA is facing a workforce crisis.

Industry

Major near-term and critical concern is the brain drain at the FDA. Not clear that the FDA is competitive in hiring qualified workers. Science has become more complex requiring higher levels of skill, but with over a decade of underfunding the FDA's existing talent base is stretched thin and is found to be lacking.

Private Foundation

FDA has recorded a lot of attrition because of poor morale, and add to that coming retirements and lack of trained workforce.

Increasing efforts to restrict and control reimbursement under health reform may undermine the marketplace for medical innovation.

Industry

Changing health reimbursement policies could stifle innovation if we are not careful.

State and Regional Development

We need to figure out how to reward innovation in an appropriate and sustainable way. We run the risk of confronting a discontinuity in that paradigm that would be very disruptive and we need to anticipate that problem and put solution in place.

Key Supporting Facts and Studies:

According to the FDA in its ground-breaking white paper known as the Critical Path Report, “[the year] 2000 marked the start of a slowdown of new drug and biological submissions to regulatory agencies worldwide. The submission of innovative medical device applications has also slowed recently. This means that fewer new products can be approved and made available to patients. At a time when basic biomedical knowledge is increasing exponentially, the gap between bench discovery and bedside applications appears to be expanding. There is great concern about the ability to bring hoped-for outcomes of basic research advances—much-awaited new treatments—to patients. There is concern that hoped-for advances in medicine and new treatments for diseases may never materialize.”¹²

Recent trends reveal the difficulties that FDA has in approving new molecular entities (NMEs) and medical devices:

- FDA approval of new medicines with truly novel chemical compounds is significantly lower in the 2005 to 2008 period, with only an average of 19, compared with the 1990 to 1999 period of 31.¹³ The total elapsed time for PMA reviews grew from 388 days to 446 days FY2003–2007.¹⁴
- The length of time it takes FDA to review and approve new drug applications (NDAs)—which is the period after which clinical trials are completed and data analyzed in support of a new drug—has not improved over the past 5 years, remaining at a median of 6 months for the past 5 years, while 2008 saw a major increase in the median time for standard approvals to 13.1 months. Shortening this period of time for NDA review is essential to providing patients access to new treatments that have gone through required clinical trials.¹⁵

The FDA, to its credit, recognizes the challenges and has expressed concern over the current course.

- In 2007, the Subcommittee on Science and Technology of the FDA Science Board in its report, *FDA Science and Mission at Risk*, concluded that FDA is unable to fulfill its mission, in part because it lacks modern scientific expertise. The Subcommittee noted that drugs entering phase 1 clinical trials today are no more likely to reach the market than those entering phase 1 trials more than 20 years ago. This delay, the Subcommittee suggested, was in part due to the inefficiency and outmoded nature of the evaluation methods used to anticipate product safety and test product efficacy during development. The lack of core scientific capacities for new and emerging technologies has hampered regulatory review at FDA, delayed the development of promising new therapies, and handicapped FDA’s ability to promote and preserve public health.¹⁶
- On March 10, 2010, FDA Commissioner Hamburg testified before Congress and echoed the persistent problems in advancing regulatory sciences:

“Today, FDA is relying on 20th-century regulatory science to evaluate 21st-century medical products. Regulatory science is needed to provide better tools, standards, and pathways to evaluate products under development. It also serves to create efficiencies in the development process, and improve product safety, quality, and manufacturing.”¹⁷

Need to Monitor Upcoming Medical Devices’ Regulatory Reforms

The FDA is currently considering reforming how most medical devices are reviewed and approved. In September 2009, the FDA announced that it had asked the Institute of Medicine to conduct a comprehensive study of how it approves most new medical devices that fall under the 510(k) process for lower-risk medical devices that do not support or sustain human life. The IOM study of the 510(k) process is not expected to conclude until March 2011, but the FDA has convened its own internal working group that has held a public meeting and is expected to make its own recommendations later in 2010. It is important that, as these administrative deliberations on the 510(k) process continue, reforms being advanced improve the transparency and predictability of the process. It is also important that for medical devices involving a higher level of risk, such as for heart valves and intraocular lenses, the approval process undertaken before they may be marketed identify ways to improve the total time to market, while maintaining the track record of approving safe and effective innovative medical devices.

International Example:

European Medicines Initiative

What It Is and Why It's Important

Funded under the European Commission's current, seventh-generation program to support R&D (known as Framework Program 7 spanning 2007–2013), the Innovative Medicines Initiative is a 2-billion-Euro (nearly \$2.5 billion U.S.) precompetitive R&D collaboration whose costs are shared equally by the Commission and the European Federation of Pharmaceutical Companies. The IMI aims to boost the dynamism of the European biopharmaceutical sector. Its agenda was shaped in a multiyear stakeholder consultation not only by academic and industrial participants (including small and medium-sized innovators) but also by patient advocates and regulators at the European and national levels. FP7 designates the IMI as a "Joint Technology Initiative," meaning that it is a first-of-a-kind, major, pan-European public-private partnership. Essentially a full-scale initiative in patient-oriented regulatory science, the IMI may be contrasted with much smaller analogous initiatives in the United States, such as the recently announced Joint NIH-FDA Leadership Council, which issued a request for proposals offering a mere \$6.75 million over 3 years, and which involves no industrial or patient participation. Operating through a series of calls for proposals coordinated by relevant entities in the stakeholder group, the IMI will fund public-private partnerships Europe-wide that address specific bottlenecks or causes of attrition in the new-drug pipeline.

Proposed Policies and Actions in Regulatory Policy:

- **Launch a public-private partnership to establish a comprehensive and meaningfully funded FDA-wide Regulatory Sciences Roadmap**, building upon the proposed Advancing Regulatory Science Initiative of the FDA, to implement a science-based benefit/risk framework informed through a collaboration of government, patient advocates, and industry.
- **Fund FDA sufficiently to address critical short-term needs and commit to a sustained funding growth.** Sustainable funding should reflect the increases in FDA's mandated jurisdiction, the growing complexity of science and related workforce challenges, and the demands added by the rise of global markets.
- **Expand the extensive and highly successful harmonization efforts of the International Conference on Harmonization for Registration of Pharmaceuticals for Human Use and the Global Harmonization Task Force** to further identify and advance best practices and research findings in regulatory sciences and procedures for gaining qualified expert input into regulatory approval processes.
- **Adopt policies that account for and encourage the diffusion of new medical technologies as a part of reimbursement policy and and new standards and measurements in the implementation of healthcare reforms.** Policies should accommodate evolution in standards of care, allow for consideration of individual patient needs, and avoid penalizing early adopters of new technologies.

Key Challenge—Private Investment for Company Formation, R&D, and Related Manufacturing Job Growth: Our competitive advantage of having capital investment in innovation is at risk, and our tax structure is no longer globally competitive.

Overview:

Biomedical start-ups and emerging companies with a potential for high growth face severely limited access to much-needed capital for reasons beyond the recent financial crisis. Over time, formal venture capital has sought later-stage investments in medical innovation to improve prospects of strong financial returns. This shift, in turn, creates a strong need for more early-stage venture financing. The decline in the IPO market, which preceded the recent economic downturn, also has undermined prospects for venture capital investments. Similarly, tax, IP protections, and other policies can have a significant impact on decisions relating to where to make R&D and other investments. Though the United States was one of the first nations to offer an R&D tax credit, we have not kept pace with other nations. The new Therapeutics Discovery Tax Credit, recently enacted under healthcare reform legislation, is a step in the right direction. Recognizing similar challenges in their markets, other countries—and some U.S. states—are making public investments to attract private capital, creating new mechanisms to facilitate IPOs, enhancing IP protections and enforcement, and using tax policies to encourage local investment in R&D and related job growth.

Insights from Experts:

An overwhelming majority of the experts viewed the availability of capital as a critical or important challenge to medical innovation in the United States, and a majority point to the importance of R&D incentives and addressing tax policies to increase investment in R&D and domestic manufacturing.

Comments from Experts:



R&D incentives for innovation are not keeping pace, particularly important given the changes in capital availability for medical innovation and likely limits on reimbursement.

Patient Advocate

Incentives for medical innovation are a good-sized challenge. Given the current structure, it is difficult to generate returns for diseases with a lower number of patients.

Industry

There are not sufficient incentives that are meaningful to emerging bioscience companies. When coupled with early-stage financing gaps, it creates major problems for emerging bioscience companies. R&D tax credit at the federal level is not of value to emerging bioscience companies engaged in R&D and having no profits.

State and Regional Development

At the state level, incentives for product development have been critical for promoting research and development and industry collaborations.

Foreign tax havens make it difficult for the United States to compete for biomedical manufacturing.

Industry

On manufacturing, if the U.S. wants to be competitive it needs to keep pace with those nations that are taking “tax-advantaged” approaches to attracting drug manufacturing.

Industry

Tax issues are as or more important than operating cost issues due to the high capital intensiveness and R&D intensiveness of the biomedical industry.

Recent freezing of capital markets poses a major problem for start-up and emerging bioscience companies.

Patient Advocate

Capital market drying up is a big issue. Need to see from small biotech company perspective.

Industry

Difficulty of raising early-stage funding—investor willingness to stay the course and continue funding is waning. Major factor is IPO market has dried up and so the investor has lost a key exit.

Industry

Key for small companies, running out of funds on hand. Biotechnology companies, in response, are declining in numbers. Some argue that the good ones will still get funding, but it's hard to tell at the early stages who will rise to the top.

State and Regional Development

The closing of the U.S. IPO market is causing real concerns. Some positive movements recently, but the overall market is still not favorable.

Venture capital is moving toward later stages of investment and away from early-stage investors.

Research

The commercialization funding gap between basic science and the first round of venture capital has grown . . . known as the “valley of death.” In the past, venture capital picked it up at the 20 or 30 yard line, but now not getting involved until past the 50 yard line. Basically, the time horizons and risk profiles that venture capitalists are willing to take have changed significantly.

Investment Capital

Valley of death is not being addressed in our nation.

Industry

So the greatest issue we face is that inventions out there cannot make their way into human clinical trials without some source of funding. While venture capitalists used to pick that up, now, because of the inability to exit from their companies before they have an approved product, we are seeing them focus on later-stage companies.

Key Supporting Facts and Studies:

The United States is lagging behind in its treatment of R&D taxation and is missing an opportunity to spur economic growth. According to the Organization for Economic Cooperation and Development (OECD) Science, Technology and Industry Scoreboard of 2007, the United States ranks 17th out of 21 OECD countries in the value of its R&D tax credit. The Information Technology & Innovation Foundation (ITIF) reports that the United States has not only fallen behind the more developed nations in OECD, but also trails a number of developing countries, such as China, India, Brazil, and Singapore, in the generosity of its tax treatment of R&D expenditures.¹⁸

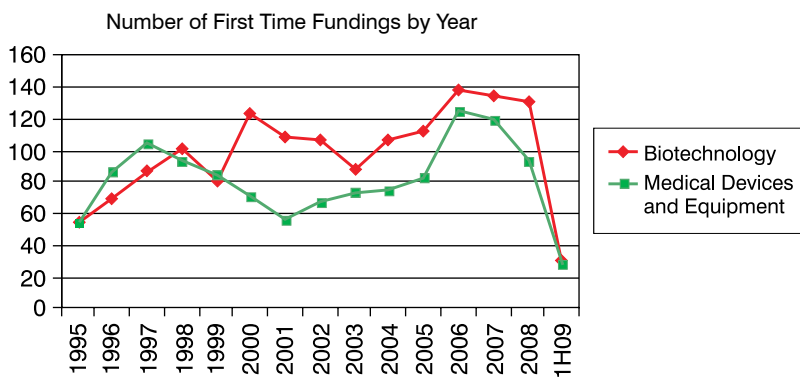
ITIF has recently estimated that expanding the R&D tax credit from 14 percent to 20 percent—which would move us to 10th place among OECD nations—would spur the creation of 162,000 jobs. The estimated increases of \$90 billion in economic output and \$17 billion in federal tax revenues significantly offset the \$6 billion in additional tax credits.¹⁹

According to a 2010 analysis by the Milken Institute, a 25 percent increase over the current level in the R&D tax credit would not only result in increased R&D spending, but also would generate a gain of 316,000 manufacturing jobs by 2019 and reduce the federal deficit by \$22.7 billion, net of the cost of the enhanced R&D tax credit.²⁰

But spurring R&D activity, by itself, is not sufficient to capture all of the jobs related to medical innovation. We also need to be a competitive location for manufacturing of medical innovation. A joint study prepared for the Manufacturers Alliance and The Manufacturing Institute found that high corporate tax rates are the “single most significant drag on manufacturing cost competitiveness.” Since the 1986 corporate rate reductions, the United States has fallen behind its major trading partners by not reducing corporate tax rates. The study found that the United States has a combined 40 percent corporate-tax rate between federal-state rates, compared with an average of 31.5 percent for our nine largest trading partners, including China, South Korea, Taiwan, France, Canada, Germany, and the United Kingdom. Among its nine largest trading partners, the United States stands an average of 7.8 percentage points higher when differences in tax bases are considered, and this differential actually grows to an effective tax-rate spread of more than 9 percentage points.²¹

Venture capital funding for emerging biomedical companies with a potential for high growth has declined sharply. Venture capital for the biosciences fell a dramatic 28.8 percent between 2008 and 2009,

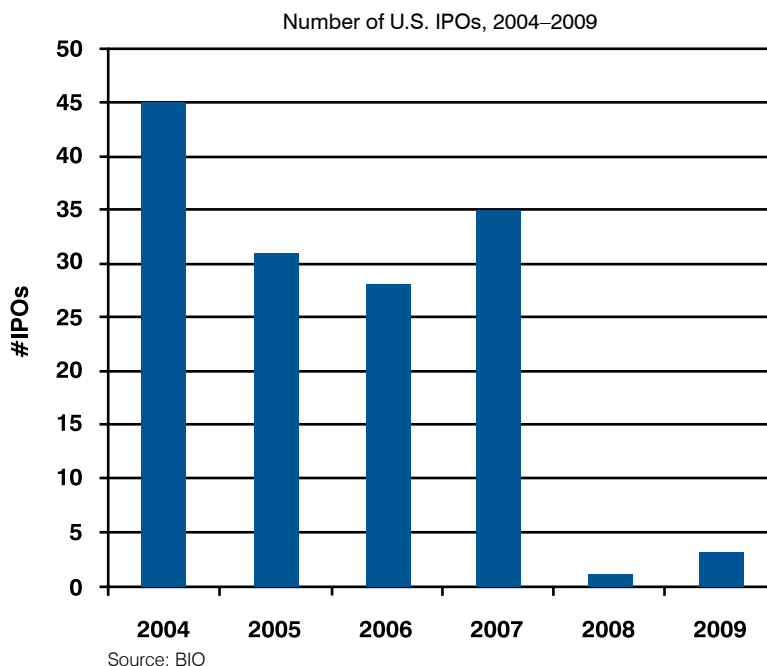
from \$10.799 billion to \$7.695 billion. In 2009, bioscience venture capital stood below levels recorded back in 2005.²² The number of first-time fundings for bioscience ventures—a key measure of early-stage funding—has fallen sharply from a peak of 330 new biomedical companies funded in 2007 to 208 new biomedical companies funded in 2009.



Source: PricewaterhouseCoopers/National Venture Capital Association MoneyTree™ Report Data: Thomson Reuters

The number of public biotechnology companies is diminishing, and many have limited cash on hand for operations. The number of active public biotech companies fell by 25 percent from January 2008 to January 2010—a decline from 394 firms to 295. About 48 percent of the companies that are no longer “active” have been acquired; 52 percent have gone out of business, filed bankruptcy, or are no longer filing with the Securities and Exchange Commission (SEC). Of the remaining public biotech companies, 38 percent had less than a year of cash on hand needed to maintain their operations.²³ If capital markets do not turn around soon, another large wave of public biotechnology companies may be lost.

Bioscience IPOs are in decline. From 2004 to 2007, the United States had an average of 34 IPOs in biotechnology each year. During all of 2008 to the first quarter of 2010, we had a grand total of eight IPOs in biotechnology.



Source: BIO

International Examples:

European Investment Fund

What It Is and Why It's Important

The European Investment Bank—a traditional development bank that mainly provides loans, credit enhancement, and technical assistance to public- and private-sector borrowers continent-wide—also manages the **European Investment Fund (EIF)**, a venture-capital fund of funds with a mandate to build equity risk capital across Europe, and thereby stimulate financing for innovative small and medium-sized enterprises (SMEs). Each investee partnership, in turn, secures other limited partner investors in the conventional manner, allowing public investment to attract and leverage private capital. While some American states have created analogous funds of funds, there is no equivalent at the national level in the United States.

London Alternative Investment Market

What It Is and Why It's Important

Founded in 1995, the **Alternative Investment Market (AIM)** subsidiary of the London Stock Exchange (LSE) was intended as a low-cost, low-disclosure market that would facilitate public offerings of stock by early-stage, high-risk companies. As of a report issued before the financial crisis of 2008, the AIM had admitted 2,800 companies (including 400 from outside the UK) and helped them raise 49 billion pounds in equity.

Under the AIM model, a company seeking to list and/or offer shares provides only an admission document that is exempt from the pan-European prospectus requirements administered in the UK by the Financial Services Authority (the analogue to our SEC). Throughout the process, a listing company must retain an LSE-affiliated “Nominated Advisor” (so-called Nomad) from the financial industry who provides advice on the admission requirements, manages the offering (if also serving as broker-dealer), and offers continued guidance on compliance and best practices in governance of a public company. The exchange imposes no minimum requirement for the number of shares that must be in public hands, no requirement of prior public trading (although cross-listings from larger markets are easy), no pre-vetting of the admission document by the exchange itself, and no minimum market capitalization. Participants in the AIM markets include sophisticated institutional investors, venture capital partnerships with holdings in the listed companies, and also Venture Capital Trusts—a rough analogue to the American publicly traded, closed-end business development company.

Proposed Policies and Actions in Private Investment:

- **Strengthen the federal R&D tax credit** by making it permanent, raising it to levels that make it globally competitive, allowing partial refunds for emerging companies without income, and providing incentives to further public-private partnerships.
- **Adopt tax and economic incentives to boost manufacturing and export-related job growth resulting from medical innovation.** Activities can include incentives for manufacturing resulting from medical innovation in the United States and other export-related manufacturing incentives to encourage U.S.-based production.
- **Encourage venture financing for emerging biomedical ventures from formation through IPO by creating a federal-level angel investment tax credit, providing federal matching incentives to foster “fund of funds” equity capital pools, maintaining the tax treatment of carried interest for venture capitalists, and promoting alternative stock market mechanisms for IPOs.**
- **Provide federal financing support for bioscience R&D infrastructure at university-related research parks.**



Key Challenge—Translational Research and the “Valley of Death”: Improving the consistency and predictability of federal funding of bioscience research and addressing the “valley of death” are needed to maximize returns on federal investment and facilitate the translation of research from bench to bedside.

Overview:

Federal biomedical funding needs to grow predictably and reliably. While funding basic research will always be at the core of federal research investments, more federal funding should go toward advancing translational and applications development that supports technology transfer and helps to bridge the “valley of death.” These efforts will create higher innovation returns from our public investment in research. We also need to address obstacles to conducting clinical trials in the United States to facilitate patients’ access to clinical trials and generate domestic job growth in a highly job-intensive R&D activity. Finally, we must ensure that appropriate IP protections, the foundation for incentives to pursue biomedical advances, continue.

Insights from Experts:

The majority of experts rated issues related to government support for research, technology transfer, and IP protection as critical or important challenges.

Comments from Experts:



Public investment is a key driver for U.S. rise in medical innovation, but concerns exist about funding levels.

State and Regional Development

A prerequisite that is essential for long-term medical innovation.

Research

Only a few states have funding available today. The U.S. public university systems are in difficult shape that threatens medical innovation. There is a lack of infrastructure and general support. Research costs money even with NIH funding.

Industry

To address the remaining, more complex diseases, there is an even higher need for research. Industry cannot do this alone . . . it is in the universities that the best ideas for disease research sit. But universities are not drivers of medical innovation . . . so a new paradigm of university-industry collaborations is critical to the future of medical innovation for complex diseases.

Concerns exist that NIH funding is too skewed toward basic research and greater value could be generated with a more balanced focus on applied research and strategic areas.

Patient Advocate

Low funding for translation and development pipeline where the hand-off is taking place. Lack of consistency in NIH funding and what we are trying to accomplish.

State and Regional Development

Trying to get the Rs and Ds to get together. The government needs to get more research out to the general public.

Research

Would be great to expand everything, but can’t so need to seriously think about applied research.

Capital Investment

Need more for proof of relevance. Need to think about improving quality of life for patients as well as providing for basic research.

Comments from Experts:



Concern exists about attacks on Bayh-Dole.

Industry

Critical to have in place. The flexible system that has been created through the Bayh-Dole Act is strongly supported and needs to be protected. Many studies underway to “reform” Bayh-Dole, such as emphasizing more government control, restricting the ability of universities to patent and changing the ownership from the university to the inventor. All of these are misinformed and would set technology transfer back. The current system is working well.

Industry

The Bayh-Dole Act, as *The Economist* noted in articles a few years back, has worked very well. Concerned that it is under attack.

Most universities and research centers do not treat technology transfer as an institutional capacity that needs support.

Industry

Weakness in technology transfer is lack of funding—gets treated as a cost/profit center by many institutions and so resources vary widely across institutions.

State and Regional Development

Universities, in particular, have come to view technology transfer as a profit center, and it should not be that. If you view as a profit center, it drives participants in the process to overvalue the IP that they are trying to bring to market and cause a misalignment between perceived value and actual value.

Research

Do not have adequate funds, mentoring, and other support to move results from academic research labs into next phase.

Much-needed university-industry collaboration is hindered by conflict-of-interest concerns—reflecting the public mood of suspicion that surrounds medical innovation.

Research

Lack of support and infrastructure that promote public/private collaborations. Government and industry need to collaborate on niche-focused efforts such as vaccines. Academia and industry need national support to promote partnerships to bring medical innovation forward.

Industry

Academic-industry collaborations and interactions are too low. Runs into the whole issue of conflict of interest across innovation. If one starts with the perception that every dollar from industry is corrupting, one will never get necessary interactions.

State and Regional Development

It is essential to have in place mechanisms for university-industry collaboration and connections.

The United States may be losing competitiveness for clinical trials—with the risk that new medical treatments based on U.S. R&D will benefit patients in other nations before they are introduced in the United States.

Patient Advocate

Sees other nations as having an edge today. We are victim of our past successes in clinical trials, and have not gotten beyond organizing them as a fragmented cottage industry.

Industry

There is a presumption as people look at clinical trials that it is cheaper to do outside of the U.S. Initially true, but when you factor in regulatory costs, time delays outside of the U.S., the cost advantages disappear quickly. Cost not the driver for off-shoring of clinical trials. More driven by ability to accrue patients on clinical trials more quickly and at less expense than in the U.S.

Research

Amount of regulation to get a patient onto clinical trials is too burdensome in the U.S.

Warning Signs on the Horizon for IP Protection for Medical Innovation

Strong IP protection has been a cornerstone of American medical innovation as it provides a significant incentive to innovate. New legal challenges pending in the courts, however, threaten to undermine key U.S. IP protections. Two recent legal decisions, in particular, raise concerns on the ability to patent genomic and proteomic innovations that are at the cutting edge of medical innovation.

- In March of this year, a federal district court ruled that the patents held by Myriad Genetics, a biotechnology firm that advanced diagnostic tests on the genes related to increased risk of breast cancer, are invalid as a matter of law. The case is currently under appeal. If upheld, it may limit rights to patenting genetic discoveries, which could become a major disincentive for innovators to invest the significant resources needed to advance innovative medical products needed by patients for conditions with genetic linkages.
- In *Bilski vs. Kappos*, meanwhile, the appellate court addressed the ability to patent a method in which every step does not include a physical process. The case is pending before the Supreme Court, which could decide it soon. Depending on the outcome, the case could raise questions about patent claims that involve gene-disease associations and relationships.

These and other pending court cases, along with some views in the ongoing deliberations around more broad-based patent reform legislation, could undermine the foundational element of strong IP protection to advancing medical innovation.

Key Supporting Facts and Studies:

In academic biosciences R&D, the United States has a significant leadership position that is widely shared among universities across the nation. According to the Science and Engineering Indicators, U.S. academic R&D expenditures stood at more than \$50 billion in 2007, nearly three times the next highest nation, Japan, who stood at \$18 billion. Of U.S. academic research spending, 32.9 percent is focused on medical sciences, the highest percentage of any nation reported.²⁴ There are 59 U.S. universities in 29 states and the District of Columbia that recorded in excess of \$100 million in medical sciences for 2008, including 19 universities with more than \$250 million in medical sciences.²⁵ According to the latest Shanghai Jiao Tong University's ranking of the world's universities, based mainly on scientific research papers, 8 of the top 10 universities in the world are found in the United States and 37 of the top 50.²⁶

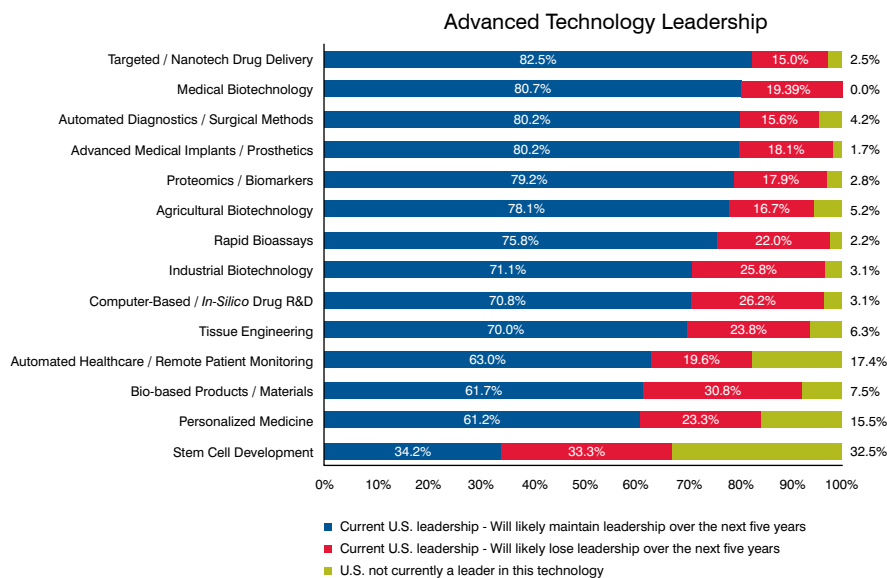
More broadly, the U.S. leadership in medical innovation is widely acknowledged. In patents granted by the U.S. Patent and Trademark Office, the United States comprises the majority of patents in pharmaceuticals, biotechnology, medical equipment, and medical electronics:

Technology Field	U.S. Share of Patents Issued by Patent and Trademark Office, 2008
Pharmaceuticals	56%
Biotechnology	58%
Medical Equipment	70%
Medical Electronics	62%

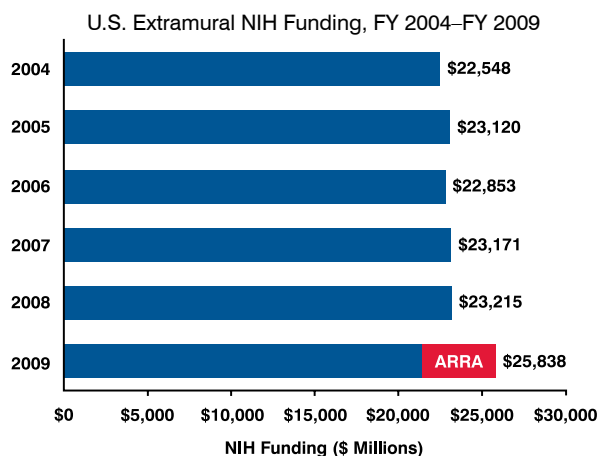
R&D Magazine/Battelle survey of corporate and academic research leaders among their readers found that current U.S. leadership in almost all health/bioscience technologies is unquestioned. One area worth watching, from both performance and policy perspectives, is stem cell development and related technologies.²⁷

But NIH funding—which is the largest source of funding for biomedical research among academic institutions—is not keeping pace. NIH

extramural research funding has been flat or declining in recent years. If not for stimulus funding, it would have declined by more than 7 percent in fiscal year 2009.



Source: 2010 Global R&D Funding Forecast, Battelle and *R&D Magazine*, December 2009.



Source: *Battelle/BIO State Bioscience Initiatives 2010*, prepared for BIO by Battelle Technology Partnership Practice, Figure 7, May 2010.

With passage of the Bayh-Dole Act, the technology transfer activities of U.S. universities have been quite significant. The Association of University Technology Managers (AUTM) reports that in 2007:²⁸

- 17,415 invention disclosures from U.S. university researchers were received.
- 10,468 new patent applications were filed by U.S. universities.
- 3,256 patents were issued to U.S. universities.
- 4,316 new licenses and options were executed with industry by U.S. universities.
- 25,109 total active licenses and options were in place with industry by U.S. universities, generating annual fees of \$2 billion to U.S. universities.
- 502 start-ups were launched by U.S. university technology-transfer offices.

An assessment of the economic impact of licensed commercialized inventions originating in university research over 1996 to 2007 was prepared for the Biotechnology Industry Organization (BIO) based on AUTM survey data regarding licensing income from all U.S. universities. Applying a 5 percent royalty rate, which is a moderately conservative estimate, the BIO study found:²⁹

- A total contribution to economic output over 1996 to 2007 from university licensing of technology at \$196 billion.
- A total jobs impact over the 12-year period of 279,000 jobs.

Clinical trials are advancing internationally, partially due to cost factors and increasingly as a result of the advantages of being able to recruit large pools of patients in a timelier manner.

A 2008 *Science* article on international clinical trials, reporting data from CenterWatch, a Boston-based company that gathers data on clinical trials, found significant growth in investigators working on clinical trials for the U.S. market in other countries. From 2001 to 2007, FDA-registered clinical trials grew as follows in key countries: Russia, from 189 to 674; India, from 46 to 493; Brazil, from 96 to 281; and China, from 16 to 97. The *Science* article reports that costs can be as much as 50 to 60 percent less in India than the United States, but as it quotes a vice president for medical and regulatory affairs for Pfizer: “The cost of running a trial is a factor to some degree, but not to the degree that people think . . . Target patient numbers can be gathered more quickly if trials include sites in developing countries . . . If you speed up development by 1 year, you get an extra year of patent exclusivity; that’s the most important driver.”³⁰

“The [Bayh-Dole] act enables universities to patent any innovation that springs from government-funded research, license it, and share the spoils with the inventor. The idea was not to enrich universities, but to give them a reason to propagate the fruits of research which had been mouldering unexploited. And it has worked. In the past 25 years, more than 4,500 firms have been spun out from nonprofit research institutes, based on patents generated as a consequence of this law.

Scores of medical advances and technical innovations have resulted, including MRI body scanning, the vaccine for hepatitis B, the atomic-force microscope, and even the technique behind Google’s search engine . . . Impressed with this apparent success, other countries, including Japan and Germany, have adopted similar policies. Indeed, just this month, dons at the University of Cambridge, in England, voted to change their institution’s handling of intellectual property so that it resembles the way Messrs Bayh and Dole have organised things for America. In 2002 The Economist trumpeted the law as ‘possibly the most inspired piece of legislation to be enacted in America over the past half-century.’”

The Economist, December 20, 2005.

International Examples:

Israel's Office of the Chief Scientist

What It Is and Why It's Important

With a somewhat misleading name, the Office of the Chief Scientist (OCS) has nothing to do with the Israeli Ministry of Science and Technology, which funds academic research. Rather, it is a unit of the Ministry of Industry, Trade and Labor budgeted at about \$430 million per year and charged with promoting industrial R&D, as a vehicle for economic and job development. Its activities help explain why Israel has so many biotechnology companies per capita and so rapidly achieved and then surpassed its societal goal of having R&D account for 3 percent of GDP. In the last available surveys, Israeli R&D was at 4.68 percent of GDP, the single highest ratio of any industrialized nation. Much of that progress has been made in the area of *business* R&D, leveraged by flexible and generous subsidies provided by the OCS to large international companies, and targeted assistance provided to domestic start-ups.

In contrast to the United States, where small innovative companies struggle through the “valley of death” with sporadic and minimal support from the public sector, Israel has provided a set of programs at the national level that provide support at all stages of the start-up life cycle. Biomedical innovation has been a particular interest of the OCS, which also has co-invested with the Ministry of Finance as limited partners in a privately managed \$63 million biotech venture-capital fund and has announced its intentions to subsidize inward investment by international companies in a wide range of services of Good Laboratory Practices and Good Manufacturing Practices necessary for commercialization of basic biotechnology discoveries into actual medical products. The net effect is that an innovative company in biomedicine or any other field is virtually surrounded by offers of assistance that leverage private capital and multinational partnerships, and far from being fearful of inward financial investment by other nations, Israel actively encourages it.

Singapore's Biomedical Science Initiative

What It Is and Why It's Important

Beginning a decade ago, Singapore added a biomedical science initiative (BMS) as the fourth pillar of the city-state's overall industrial development strategy. Like the other three national sector-based development projects, the BMS relies on parallel tracks: On the one hand, the Singapore Economic Development Board (EDB) wields discretionary grants, tax incentives, and even equity investment funds to encourage large and late-stage firms to invest in manufacturing facilities at the publicly owned 914-acre Tuas Biomedical Park. Manufacturing output has climbed steadily over the decade, and as of 2008, some 45 companies were producing pharmaceuticals (both bulk and secondary formulations) or assembling engineered biomedical devices in Tuas.

At the same time, R&D operations of overseas firms are lured to the 2-million-square-foot Biopolis research park. There, they are collocated side-by-side with the 10 or so “public research institutes” and academic/ industrial consortia in biomedical science that are funded by the Biomedical Research Council of A*STAR (the former National Science and Technology Council). These research institutes are funded to conduct high-quality but relatively targeted research, if possible in partnership with their multinational neighbors. Companies up to certain sizes can share the institutes' core facilities at no cost (provided they are not doing actual production) or have publicly paid scientific staff seconded to their own operations, and companies of all sizes can apply for subsidies of joint R&D. As of 2008, 30 companies with significant biomedical research interests were at Biopolis, many well-known multinational names.

Unlike in Israel, in Singapore, the primary emphasis to date has been on established multinational companies and *late-stage* innovators ready to move into full-scale manufacturing. However, Singapore has created a comprehensive, all-embracing environment for research and commercialization that likely will ultimately generate indigenous entrepreneurs. It has explicitly targeted the next generation of biologics with manufacturing capacity, facilities for clinical-translational research, and partnerships with hospitals operated by the Ministry of Health. Finally, the state appears to be ramping up its capability to invest in earlier-stage enterprises.



Proposed Policies and Actions in Translational Research:

- **Commit to a 10-year “growth” budget strategy for NIH**, which includes an emphasis on translational research that moves discoveries through more applied technology development to bridge the “valley of death.”
- **Advance more specific university-industry collaboration funding approaches at NIH similar to mechanisms long used by NSF in its Industry-University Cooperative Research Centers or the new Energy Innovation Hubs approach of the Department of Energy.** Funding should encourage the growth and formation of commercialization-oriented centers such as experimental therapeutics centers, advanced medical-device development centers, and specific disease-focused centers.
- **Protect and enhance support for university technology transfer set out in the Bayh-Dole Act** by allowing for the reimbursement of cost of patents and a consistent level of overhead support for technology transfer through an indirect overhead charge against federal research grants.
- **Appropriate funding for the CAN** as a means to enhance incentives and support for medical innovation in rare diseases and to address broader systematic breakdowns that hinder medical innovation for major public health issues, such as potential pandemics and bioterrorism threats.
- **Reform the SBIR/STTR programs to better address “valley of death” challenges in the commercialization of medical advances**, including addressing support for venture-capital-backed companies.
- **Advance national policies and demonstration projects to encourage participation and retention in clinical trials In the United States.** Policies could include harmonizing approaches across institutions for institutional review board (IRB) approval standards and patient consent, addressing patient recruitment and retention in clinical trials through increased public awareness, and providing incentives in Medicare and Medicaid to encourage physician participation in clinical research activities.

Key Challenge—Talent: Perhaps the most serious long-term threat to medical innovation is the well-documented, looming crisis in accessing scientific and engineering talent that requires serious and sustained attention.

Overview:

Our universities, community colleges, and K-12 public school systems are critical parts of the talent pipeline that enables us to compete in a knowledge-based, global economy. But, the U.S. talent pipeline is not keeping pace. The reality is well documented by the National Academies' report, *Rising Above the Gathering Storm*, and reflected in Congressional action to enact the America COMPETES Act in 2007 and to pursue reauthorization in 2010. At the same time, our ability to attract and retain foreign scientific and engineering talent is a sign of our innovation strength and must be supported. More immediately, specific skill needs in the biomedical sector are going unaddressed that, with training, incumbent workers could meet.

Insights from Experts:

A large majority of the experts interviewed viewed the generation and retention of talent and workforce development as an important challenge to medical innovation in the United States, but most viewed it as a long-term one.

Comments from Experts:



Major challenges exist in priming the U.S. talent pipeline in the life sciences.

Patient Advocate

Big issue. We need to support funding of students in the early stage in pipeline.

State and Regional Development

On the domestic front, there is a clear lack of passion among U.S. students for science . . . a real disconnect.

Industry

Need to engage bright U.S. kids. Not a crisis today, but with barriers to immigration, it can easily become one.

Research

Cultivating the next generation of innovators is critical and something needs to be done now. The system turns students off to science. Will require a cultural shift, better support to teachers, alternative ways to get teachers into science. Statistics show our high school students are at the bottom of test scores.

Concerns exist about specific fields of expertise being available in the United States.

Research

Lack of skilled workers in certain areas slows down ongoing research and development of innovations.

Research

Workforce development is an issue in certain segments. Biomanufacturing is facing a shortage of people who are trained and can enter industry.

Research

Lack of computational bioscientists at the Ph.D. and master's levels is becoming a bottleneck.

State and Regional Development

Not just scientists, but technicians.

Industry

Looking for nurses and physicians to go into clinical research. It would benefit medical innovation if medical training included a strong research component.

The United States needs a more systematic approach to attracting and retaining foreign talent.

State and Regional Development

Attracting foreign talent is critical—see it as a sign of the state's quality of life.

Industry

Chinese and Indian scientists educated and working in medical innovation in the U.S. are returning home for opportunities.

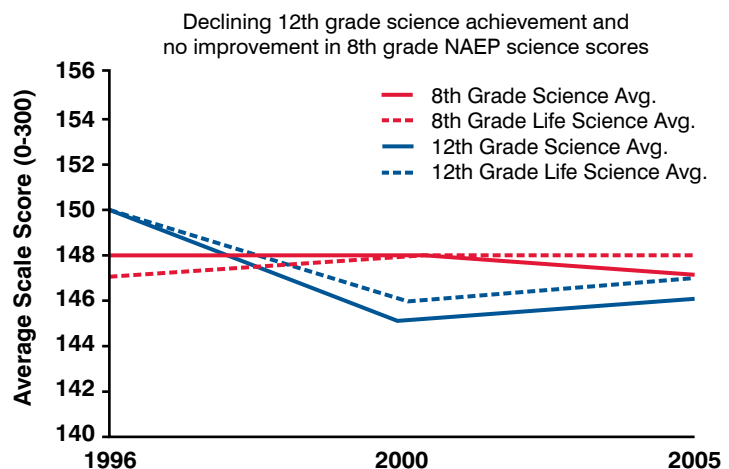
Industry

Difficulties in accessing H1B visas is leading companies to focus on partnerships in China and India to overcome inability to bring those workers to the U.S.

Key Supporting Facts and Studies:

According to the most recent results from the National Assessment of Educational Progress (NAEP), 8th and 12th grade students are performing poorly in science achievement and have shown no improvement over time. NAEP is the only nationally representative state-by-state assessment of achievement. The most recent NAEP science results were completed in 2005. The life sciences field is a major portion of the overall NAEP science test and is broken out for 8th and 12th graders.³¹

- Only 52 percent of 12th graders and 57 percent of 8th graders are at or above a basic level of achievement in the sciences.
- Average scores for 12th graders in the sciences and the life sciences have actually declined from 1996 to 2005 and for 8th graders have shown no improvement both on overall science and the life sciences component.



Source: NAEP, U.S. Department of Education, National Center for Education Statistics.

Even in states with the highest scores, fewer than half of 8th graders are “proficient” in science. The percentage of 8th graders in each state that tested as proficient in science on the NAEP test ranged from a high of 43 percent to a low of only 14 percent in 2005.³²

Warning Signs for Educational Attainment in the United States

A report from the National Academies, *Rising Above the Gathering Storm*, warns: “Having reviewed trends in the United States and abroad, the committee is deeply concerned that the scientific and technological building blocks critical to our economic leadership are eroding at a time when many other nations are gathering strength.”*

Similarly, the Council on Competitiveness in its Competitive Index report explains: “Simply being an American does not guarantee a high-wage job anymore as companies allocate more of their activities across locations based on productivity relative to wages . . . we see rising levels of inequality as the most educated prosper while those who lack education or skills struggle to keep pace.”†

The warning signs for the United States are clear: While the United States still ranks among the top performers in the percentage of older adults (35 to 64) with an associate’s degree or higher, it has slipped to seventh in the educational attainment of younger adults aged 25 to 34. The percentage of younger adults in the United States with at least an associate’s degree falls well below that of Japan and Korea and is marginally ahead of Spain, Ireland, and France.

Unlike many other key competitor nations from both the developed and developing worlds, the educational attainment of the younger generation in the United States is at risk of falling behind that of the older generation it is replacing in the workforce.

On international education comparisons, the United States is falling behind other nations as well. In the most recent testing of science and math literacy for the Program for International Student Assessment (PISA), the United States stood below the average for Organization for Economic Cooperation and Development (OECD) nations in both science and math literacy. U.S. 15-year-olds scored lower than 16 of the other 29 OECD nations on science literacy and lower than 23 of the other 29 OECD nations on math literacy.§

* *Rising Above the Gathering Storm*, National Academies Committee on Science, Engineering, and Public Policy, 2005, page 3.

† *Competitiveness Index: Where America Stands*, Council on Competitiveness, 2007, pages 8 and 9.

§ *Highlights From PISA 2006: Performance of U.S. 15-Year-Old Students in Science and Mathematics Literacy in an International Context*, National Center for Education Statistics, 2007, pages iii and iv.

High schools are not preparing students to pursue college-level science. The American College Test (ACT) is a national standardized test for college admission that is designed to draw subject-specific conclusions on the preparedness of high school exam takers for college-level coursework in a variety of subjects, including biology. The ACT has determined that those students who achieve a score of 24 in the science section have a 50 percent chance of obtaining a B or higher in college-level biology. On average, only 28 percent of the high school students taking the ACT reached a score indicating college readiness for biology, and no state reached even 50 percent.³³

Not surprisingly, given this weak showing in our educational pipeline, non-U.S. citizens make up a high percentage of medical scientists generated and employed in the United States. One-third of the earned Ph.D.’s in medical sciences in 2007 were awarded by U.S. universities to non-U.S. citizens, and 52 percent of the postdocs at U.S. universities are non-U.S. citizens.³⁴

Beyond the importance of immigrant scientists being trained and working in industry and academia in the United States is the fact that they comprise a high percentage of entrepreneurs starting technology companies with a potential for high growth in the United States. A study utilizing the Thomson Financial database to examine the nativity of the founders of all U.S. venture-backed, publicly traded companies, found that, over the past 15 years, immigrants have started 25 percent of U.S. public companies that were venture backed. The current market capitalization of publicly traded, immigrant-founded, venture-backed companies in the United States exceeds \$500 billion; and they employ an estimated 220,000 people in the United States. In the life sciences, immigrant entrepreneurs started 30 venture-backed, publicly traded companies, or 21 percent of the total, and employed 18,660 workers in the United States.³⁵

International Example:

Programs for Returnees

What It Is and Why It's Important

Considerable attention has been paid to very senior academic recruitments in overseas jurisdictions like Singapore. An equally serious challenge comes from more routine programs countries use to attract large numbers of early and mid-career scientists who have earned doctoral degrees in the United States but have not become U.S. citizens or settled here permanently. These scientists are increasingly provided incentives to return to their native countries where they may head up R&D units for innovative companies or conduct clinical research. In time, their presence will draw companies inexorably up the value chain overseas.

Probably the most widely known program is that of the People's Republic of China, whose name poetically evokes the global migration habits of "Sea Turtles." However, the Chinese program is not highly transparent. More easily understood are the programs of the Government of India. Unlike in the United States, where a postgraduate research fellowship is usually tightly linked to a given university laboratory and its lead faculty member's source of research support, Indian programs emphasize *portable* fellowships that travel with the scientist. In this regard, they resemble the NSF Graduate Research Fellowships whose expansion and integration with industrial support is a recommendation of the ITIF.

The competitive threat posed by India may be particularly dramatic, since there is a strong heritage of complete English fluency among working physicians and scientists. Those who train in the United States do not require any extended period of linguistic adjustment and, upon return to India, can easily serve as liaison to U.S. companies that desire to outsource. For example, the 12-hour time difference has already led to some healthcare outsourcing, such as reading of digitized X-rays by board-certified radiologists during the hours American specialists are off-shift.

Proposed Policies and Actions in Talent Development:

- **Provide federal support for the biosciences in K-12 STEM efforts, including bioscience teacher preparation and professional development.** Tactics should include more extensive recruitment of biology majors to enter teaching, alternative certification of biomedical professionals, and summer stipends to universities for professional development for existing teachers.
- **Provide funding to vocational and technical schools and community colleges to establish, in concert with industry consortia, programs to retrain existing workforce for biomedical careers.**
- **Increase the number of U.S. and foreign students pursuing graduate degrees and careers in the biosciences in the United States.** Strategies may include scholarships and loan forgiveness for U.S. students pursuing degrees in biology, chemistry, engineering, and related majors and a streamlined green-card application process for foreign graduates of U.S. universities at the master's and Ph.D. levels.

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