

TOWARD A SUSTAINABLE BIOMEDICAL RESEARCH ENTERPRISE

The American biomedical research enterprise is the world leader in health-related discovery and innovation. This system has trained students and faculty from all over the world and fostered 70 years of unprecedented human health advances. However, today's American biomedical research enterprise is out of balance, placing the United States at risk of losing global leadership status in innovation and failing to protect the health of the U.S. population. Federal research funding has been flat for a decade, now awarding fewer than one in six submitted proposals, and this award rate is continuing to fall. Talented and highly trained investigators are turning away from careers in research, restricting both discovery and development of drugs and therapeutics, and this trend could easily accelerate. Graduate training at our universities focuses primarily on producing academic scientists, whereas in reality, science Ph.D. graduates pursue a range of career paths. Training and experience gaps leave most graduates not well prepared to compete for positions in industry, a key player in a sustainable biomedical research enterprise. Intellectual property, technology licensing and conflict of interest challenges keep academia and industry at arm's length. Government is the largest supporter of basic biomedical research, yet taxpayers are justifiably asking for evidence of returns in a challenging fiscal environment. Sections of the lay public and their government representatives argue that industry should shoulder the costs of basic biomedical research, a view that is incompatible with industry's focused and relatively short-term timelines. Government regulation of both academic and industrial research creates ever-increasing layers of complexity that rob investigator time from productive experimentation and direct precious financial resources away from research. Maintaining this status quo threatens the network of discovery that defines the success of our national biomedical research enterprise.

The American Society for Biochemistry and Molecular Biology concludes that the success of the American biomedical research enterprise is dependent on implementing a plan for sustainable growth. A sustainable biomedical research enterprise will meet national strategic goals by training a scientifically competent workforce, creating new knowledge and technologies, and feeding an ongoing and vibrant innovation stream that will improve health and drive economic growth. We identify three major stakeholders for the SBRE—academia, industry, and government. Although sustainability requires close integration and cooperation among these stakeholders, they are currently separated by cultural differences (*e.g.* independence vs. teamwork approaches), suspicions that obscure common goals (technology licensing and intellectual property), and failure to coordinate and integrate a highly trained workforce (academia vs. "alternative" careers). ASBMB argues that, to achieve the SBRE, the three major stakeholders must each make significant reforms while working together to solve problems in workforce training, technology transfer, education, regulatory burden and product development. ASBMB has identified three components of the biomedical research enterprise that will need significant modification to become sustainable: training and workforce, stakeholder interactions and cultures and funding. Here we discuss the roles of the three major stakeholders, the three components of a SBRE and the primary issues that must be addressed in order to establish a truly sustainable enterprise.

GOALS OF THIS WHITE PAPER

The goal of this white paper is to raise topics and issues intended to catalyze discussions about sustainability among the three stakeholders. This white paper is not intended to be prescriptive, although potential solutions are discussed in some cases. Prior reports have addressed sustainability in biomedical research, and we acknowledge several at the end of this document. The perspective of this white paper reflects ASBMB's academic membership base, while concluding that sustainability requires all stakeholders to be outward- and forward-looking.

MAJOR STAKEHOLDERS

The three major stakeholders comprising the U.S. biomedical research enterprise are academia, encompassing academic and research institutions; industry, representing biotechnology, pharmaceutical, and medical device companies and government, which allocates a portion of the U.S. budget to fund biomedical research while also setting regulatory policies for product safety/efficacy and the appropriate conduct of scientific research. Each stakeholder has distinct attitudes and beliefs (culture) that define their goals and missions.

Academia conducts basic research that generates new knowledge around ideas conceived by individual researchers toward understanding the natural world. New knowledge is generated at a steady but measured pace, with unpredicted and sometimes serendipitous discoveries that have enormous impact. Academic research, as the name implies, is conducted principally in university laboratories where graduate students and postdoctoral fellows are trained to conduct research while also providing the labor to complete the aims of basic science research grants awarded to university researchers. Significant emphasis is placed on training independent investigators in the model of academic mentors, where independence is a criterion for career advancement. Collaboration is common; however, individual investigators in collaboration usually maintain distinct goals differentiating them from their colleagues.

Industry applies current knowledge to develop drugs, therapeutics and devices, often at significant financial risk over a relatively short time period. Research in the industrial sector tends to be very focused toward solving specific problems. In contrast to the independence of academic investigators, research in industry tends to be highly collaborative and conducted in teams where all investigators share common goals. The industrial sector is highly skilled in defining the safety, toxicology and efficacy of candidate drug or devices, using approaches or technology that are generally outside the capabilities or purview of the individual academic investigator.

Government allocates a portion of the U.S. federal budget to fund scientific biomedical research and education, principally through the National Institutes of Health. NIH funding levels are not defined as a percentage of GDP; therefore, research funding is subject to political pressures and tends to cycle through peaks (*e.g.* the "doubling" of the NIH budget from 1998 to 2003) and valleys (*e.g.* flat research funding for the past decade and the significant drop due to sequestration). Government is an essential and irreplaceable source of basic science research funding because it is the only entity with significant

resources and a long-term perspective. Government also sets regulatory policies for safe and appropriate research conduct as well as defining regulatory policies to promote drug and device efficacy and safety.

STAKEHOLDER INTERACTIONS AND CULTURES

Position: ASBMB's position is that a SBRE requires a new era of meaningful and substantive working relationships among the major stakeholders.

Issues: Imagining the biomedical research enterprise as a network, each of the stakeholders controls or influences sections of the network, generally without explicit knowledge of, or consideration for, what lies in other network arms. Each of the stakeholders holds views and approaches that benefit his or her respective mission, although it often appears foreign and difficult to understand by other stakeholders. The result is that stakeholders do not acknowledge the interrelatedness of their missions, and communications among the stakeholders are complicated by their respective cultures. Many opportunities for mutual benefit are thereby missed.

Goal: Engage the major stakeholders in discussions that consider the interrelatedness of their respective missions and the potential for individual and group benefits that arise from addressing problems that currently constrict the biomedical research enterprise network. Sustainability requires that the network be free of clogs that not only prevent output but also cause leaks of ideas and people that are needed to achieve excellence with sustainability. Initial challenges to achieving a SBRE are likely to center on engaging the major stakeholders regarding the facts that (1) their respective goals and potential for success are closely related, (2) maintaining the status quo is untenable and (3) cross-training in all of the stakeholders' cultures and approaches will improve communication, benefit young investigators who are developing their career paths and help remove constrictions from innovation paths.

Action: ASBMB, in partnership with other scientific societies and groups that share our perspectives, should initiate discussions among the major stakeholders to reveal the interrelatedness of their respective goals, an essential first step toward creating a SBRE. The focus should be on defining common goals and demonstrating how each of the major stakeholders must think outside of their traditional domains to gain perspective on the portfolio of work and workers that will keep new ideas flowing into the network, balanced by products and economic benefits that will help ensure continued basic research funding.

Sample Questions for Discussion:

1. What are possible mechanisms to bring the major stakeholders together to address the SBRE?
2. What/where are the major blocks in the biomedical research network?
3. What are examples of how stakeholder culture contributes to these blocks?
4. What are examples of blocks/clogs in one stakeholder's network that could be opened with assistance from another stakeholder?
5. How do we achieve buy-in? What mechanisms would be effective in illustrating to the broad stakeholder communities how enhanced interaction and communication benefit all?

TRAINING AND WORKFORCE

Position: ASBMB's position is that a SBRE requires a highly skilled scientific workforce that is balanced in expertise and numbers across the biomedical research network, from knowledge creation and discovery to products and economic benefit.

Issues: Among stakeholders, academia has the largest role in the training that prepares the scientific workforce for academic, industrial, and government careers. Academic laboratories train students and postdoctoral fellows in research principles and techniques and conduct research that creates new knowledge. Nearly 98 percent of biomedical Ph.D. graduates find employment (including continued training as postdoctoral fellows), but fewer than 25 percent end up in faculty positions. Many students go on to long (more than five years) postdoctoral training periods although it is not clear that these long periods benefit their future research productivity. This places these young scientists at both career and financial disadvantage. Many in academia continue to refer to jobs outside of academia as "alternative careers," suggesting a step down in value. U.S. population demographics are not reflected in Ph.D. graduates and even less so in university faculty, suggesting that science career opportunities are not balanced. "Soft money" research positions have yielded outstanding research output accompanied by relatively little career support from the institution.

Goals: A combination of initiatives is needed to enhance the attractive features of biomedical research training paths. The culture of the U.S. biomedical research enterprise must be modified to not only accept, but embrace, responsibility for training individuals to work in the wide range of different careers that depend on rigorous research training. The major stakeholders must collaborate to define and describe the workforce needed to keep new ideas flowing into the research network, spanning both basic research and more applied research that is necessary to continue to grow the fundamental knowledge base that underpins all biomedical investigative efforts and more applied research that translates this knowledge in outputs that have both health and economic benefits.

Action: Rigorous academic scientific training must be retained as a first principle. However, discussions among the major stakeholders are needed to define the training requirements, expertise, and experience that characterize a vigorous biomedical research enterprise. Such discussions may also address how the system can be adjusted to produce a number of trainees that are aligned with career opportunities. Any training enhancements should not extend time-to-degree significantly or provide in-depth education in any discipline. Rather, the training focus should remain on rigorous scientific training and ancillary skills such as oral and written communication. The training enhancements should improve the attractiveness of biomedical research paths for a diverse student population, leading to a more inclusive workforce.

Sample Questions for Discussion

1. Are there approaches that could estimate how many Ph.D., M.S.- and B.S.-level scientists are needed for the American biomedical research enterprise?

2. How should academia modify graduate training to prepare scientists for a wide range of careers in biomedical research?
3. How can academia provide greater career stability without removing the incentives to maintain high level productivity and the leveraging of resources associated with raising substantial salary support from extramural sources?
4. Where/what are the best career development areas in non-academic areas?

ACADEMIC RESEARCH FUNDING

Position: ASBMB's position is that stable federal support for basic biomedical research is irreplaceable and essential for a SBRE. The major stakeholders must coordinate efforts to explore new collaborative research funding mechanisms at their interfaces to balance the workforce and repair and restructure the research network. A positive feedback loop is required wherein stable basic research funding creates knowledge that is translated into economic success by industry, thereby feeding back to government to fund additional science.

Issues: When considering funding, academia looks to government, which is indeed an irreplaceable source of U.S. basic research support. Government is facing significant fiscal issues in an era of a deadlocked Congress. Academia's focus, understandably, tends to be on how to increase the size of the bucket it dips into the government well, without a strong sense of responsibility for their role in keeping the well full. Shifting the focus toward sustainability may be a more productive and active approach to generate returns that translate to increased biomedical research funding and national economic benefit.

Goals and Actions: Sustainability requires balancing the biomedical research enterprise. Although the current biomedical research enterprise network has leaks and constrictions, investment in biomedical research must continue while short-term and long-term solutions are designed and implemented. Academic scientists must share their research success stories with the public and with Congress while advocating for budget increases that present balanced views of the current economic environment and the critical value of innovation for economic growth. The major stakeholders must define a prioritized plan that directs resources toward resolving defects in the network that are leading to the lack of sustainability.

Sample Questions for Discussion:

1. How do we convince Congress that a stably funded SBRE is vital to the long-term economic well-being of our country and the health of its citizens?
2. How can the NIH promote both investigator-initiated research and team-oriented research within academia and between academia and industry?
3. How can we promote productive interactions between academia and industry, with the mutual interchange of ideas and technology?

CONCLUSION

The American biomedical research enterprise has generated many life-saving therapies and cures that have improved or saved the lives of countless people. However, a combination of factors from stagnant funding to dwindling job prospects and skyrocketing research costs have exposed the flaws inherent to the enterprise. These cannot be fixed solely with an influx of money. Rather, each stakeholder must take rapid action to make major changes to ensure the U.S. remains the leader in global biomedical research and generates the knowledge, therapies and cures needed to improve human health. The ASBMB is committed to working with academia, industry and government to move the entire biomedical research enterprise in the direction of sustainability with regard to workforce, funding, and stakeholder interactions.

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