Why Science Is Important for Innovation

BY GORDON CONWAY AND JEFF WAAGE, WITH SARA DELANEY

WHY IS SCIENCE IMPORTANT? Science underpins improvements in human welfare, through technologies which it develops for health, food production, engineering and communication. Science is also important in solving problems created by human activity, such as environmental degradation and climate change. Science allows us to move forward through incremental improvements in technology, adapted for particular needs and situations. But it also sometimes allows us to leap forward, through fundamental scientific discoveries that entirely change our sets of tools for human improvement and create new platforms for technology, such as the genetic revolution and the consequent development of biotechnologies for improving health and agriculture.

How does scientific innovation work?

SCIENTIFIC INNOVATION involves the successful exploitation of new ideas to generate new techniques, products and processes. Traditionally, scientific innovation has been viewed as a process starting with curiosity-driven, basic research which generates new understanding. This then leads to translational research, which relates this fundamental understanding to systems we want to improve, and then to applied research, which produces the products which we can use. Private enterprise plays a key role in successful innovation —without business investment and marketing, inventions such as penicillin, computers and mobile phones would not exist today.

WHAT DO WE MEAN BY SCIENCE, TECHNOLOGY AND INNOVATION?

SCIENCE is the process of generating knowledge based on evidence.[1] While it implicitly includes both natural sciences (biology, chemistry, physics, mathematics and related disciplines) and social sciences (economics, sociology, anthropology, politics, law), our focus will be largely on natural science disciplines.

TECHNOLOGY is the application of scientific knowledge, and frequently involves invention; i.e., the creation of a novel object, process or technique.

INNOVATION is the process by which inventions are produced, which may involve the bringing together of new ideas and technology, or finding novel applications of existing technologies. Generally, innovation means developing new ways of doing things in a place where they have not been used before. Modern innovation is usually stimulated by *innovation systems and pathways.*

THE PHRASE "SCIENCE AND INNOVATION" in our book implicitly includes science, engineering, technology, and the production systems which deliver them.

People who live in developed countries sometimes forget how scientific innovations have transformed their lives. They live much longer than their predecessors, they have access to a dependable supply and a great variety of foods and other goods, they can travel easily and quickly around the world and they have a myriad of electronic gadgets designed for work and pleasure. Much of this success is due to sound economic policies and to forms of governance that promote equality, justice and freedom of choice, but much is also due to advances in scientific innovation.

INVENTORS PAST AND PRESENT

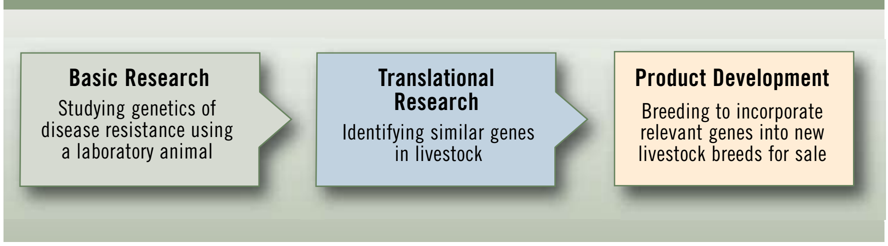
The 20th century witnessed dramatic medical inventions—a vaccine against yellow fever, Fleming's discovery of penicillin, Salk's development of the oral polio vaccine, Barnard's first heart transplant. These and other discoveries have had widespread benefits unimaginable a century before and the pace of discovery shows no signs of abating. In 2005, the average UK life expectancy for men was 78 years, compared to 66 in 1950 and 48 in 1900.[2] The next wave of discoveries is likely to be treatments and cures for cancers and for the diseases of ageing, such as Alzheimer's.

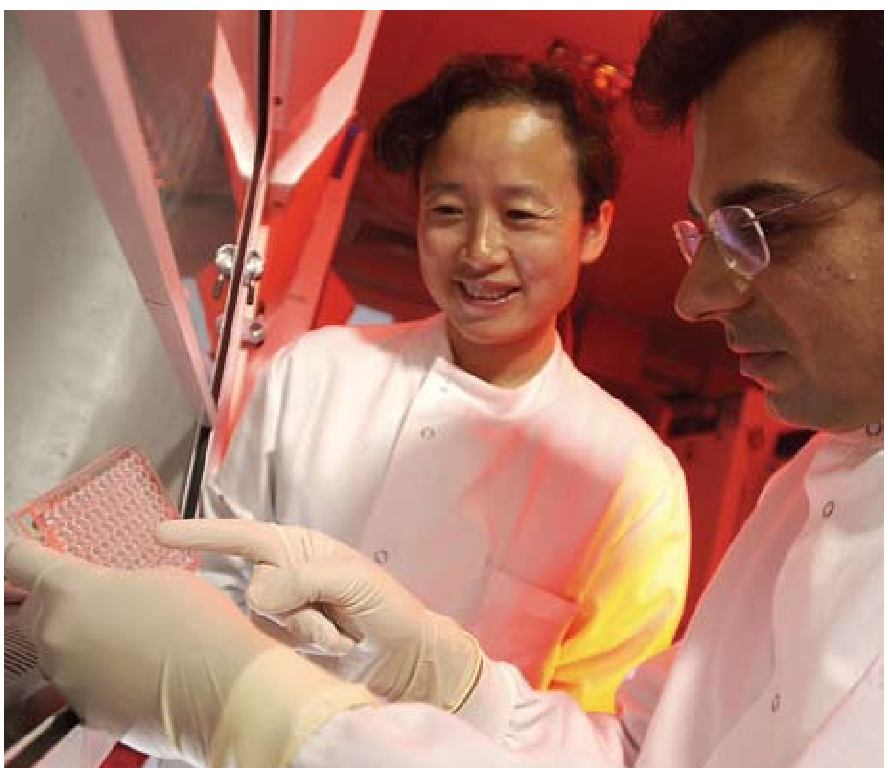
But today it is inventions in electronics and communications that catch the imagination—Jobs' and Wozniak's development of the Apple computer, Berners-Lee's invention of the World Wide Web and its exploitation by Page and Brin in the form of Google, and by Omidyar's eBay.

Arguably the biggest recent impact has come from the mobile phone, but here it is difficult to identify a single inventor. The nature of invention has significantly changed: modern inventions are largely the result of team work.

Alexander Fleming in his laboratory in 1909 at St Mary's Hospital, London.

FIGURE 1: A LINEAR PROCESS OF SCIENTIFIC INNOVATION





Scientists from around the world collaborate to access best expertise.

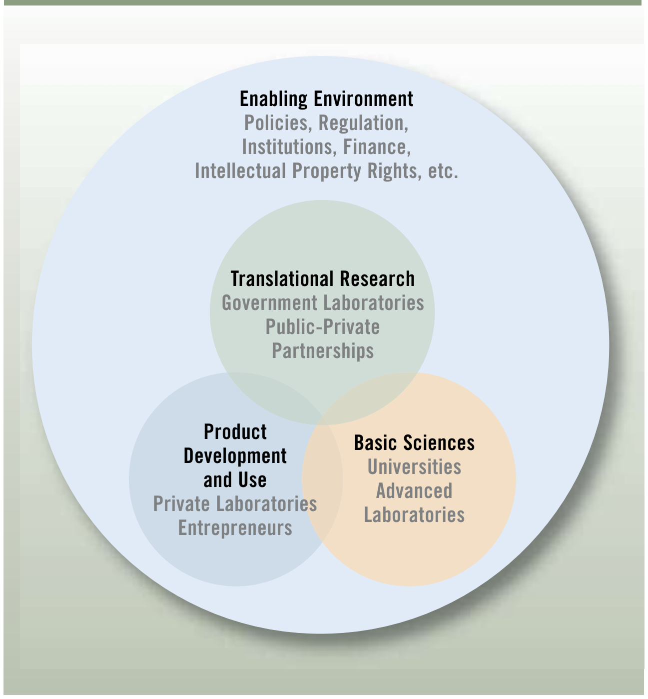
As an example of innovation, consider how new knowledge of the genetics of disease resistance, gained from basic research on a laboratory animal, may lead to translational research on livestock to determine whether similar genes exist that convey useful resistance. If this research is successful, industry may use it to develop products, in this case using livestock breeding methods to incorporate genes conferring resistance into specific commercial breeds for sale to farmers (see Figure 1).

However, today we recognize that scientific innovation is not always a linear process, and that it often involves interplay back-and-forth between basic, translational and applied research stages. It is possible, for example, for applied research to identify a need for more basic research in a new area. Going back to the example above, if new breeds exhibit only patchy resistance to the disease in question, farmers may choose not to buy the product. This may stimulate applied research into the causes of breakdown of resistance, which in turn may stimulate more basic research into resistance mechanisms, so as to generate new solutions.

This research interaction involves a diverse system of players and institutions that influence its progress and success. Together, these are often called a science innovation system. The players may come from companies, universities, government and civil society. Scientists play a key role, of course, but so do other stakeholders, such as policy makers, banks and investors. Involving policy makers allows for a conducive policy and regulatory environment for the development and use of new technologies, while banks and investors provide security and capital for product development (see Figure 2).

A striking feature of science innovation systems today is that they are becoming increasingly international, with groups from different countries bringing specific expertise to the innovation process. Science no longer functions in isolation at a national level as it did with the large-scale emergence of nationally funded science during the 20th century, when it was seen as a way of

FIGURE 2: A SCIENCE INNOVATION SYSTEM



ensuring national security and productivity. Scientists from around the world now collaborate with each other for a variety of reasons, but particularly to access the best expertise, resources and partnerships, and funding and institutions have adapted accordingly.[3] Importantly, certain scientists, institutes and countries participate much more actively in the system than others, thus influencing the direction and benefits of research and outputs. ❧

Gordon Conway is Professor of International Development at Imperial College.
Jeff Waage is the Director of the London International Development Centre (LIDC), a Professor at the School of Oriental and African Studies (SOAS), University of London and a Visiting Professor at Imperial College London, the London School of Hygiene and Tropical Medicine (LSHTM) and the Royal Veterinary College (RVC).

This is an excerpt from the new book, *Science and Innovation for Development*, by Gordon Conway and Jeff Waage. UK Collaborative on Development Sciences (UKCDS), London, 2010.

Notes

1 Vermeulen, S. & Bass, S., (2005) *Science and Development.* [Internal Scoping Paper]. IIED, London.

2 Office of Health Economics. (2007) *Life Expectancy in England and Wales.* Available at: www.ohe.org/page/knowledge/schools/appendix/life_expectancy.cfm [Accessed 08 Oct 2009].

3 Wagner, C., (2008) *The New Invisible College*, Science for Development. Brookings Institution Press, Washington DC.

Innovation Policy

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Within broader development strategies

A KEY SUCCESS FACTOR is to integrate a vision for innovation in long-term development strategies. For example China decided to become "the world's factory." Malaysia aimed at becoming an "information society world leader." This vision allows a country to define priorities and implement them across ministries and throughout its territory with properly aligned policies and investments.

This requires an explicit "government-wide approach." Malaysia has such a mechanism for its ICT policy with a powerful monitoring body attached to the Prime Minister. Tunisia is another role model in the Arab World, using a wide consultation process to develop its Five-Year plan in which becoming an innovation and knowledge society is a major goal. In the developed world, Finland was a model pioneer, with its very influential Science & Technology Policy Council, chaired by the prime minister, and involving all the key ministers, including finance, as well as representatives from the business and labor communities.

Although a number of developing (and developed) countries have tried these kinds of coordinating bodies, in most cases they failed because they did not have sufficient authority. So they became, at best, a locus for reaching soft consensus and for information sharing. Making such bodies work takes strong political leadership, collective will, and clear commitments.

In sum, innovation policy can be a key component of 21st century development strategies, even in poor countries with constraining economic environments. But to succeed, innovators must be supported by high-level central and local government policy makers who have the vision, pragmatism, and the ability to work creatively in institutional contexts. ❧

Jean-Eric Aubert, retired Lead Specialist in WBI (Paris Office), Knowledge for Development Program. Prior to joining the World Bank in 2000, Mr. Aubert worked at the Organization for Economic Cooperation and Development (OECD), leading notably S&T country reviews and flagship publications. He has also acted as consultant for international organizations including the European Commission and UN bodies. He has been responsible as author and editor of more than 30 books and published a number of articles in science, technology policy, social sciences and cultural issues.

Note

1 These lessons are based on *Innovation Policy: A Guide for Developing Countries,* Washington, D.C.: World Bank, 2010.