Bio-business in brief: a bit about technology transfer

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What is technology transfer and what does it need to succeed? Various factors concerning the scientist, the academic institution, a fresh entrepreneur or an existing company, government policies and the environment contribute to greater efficiency in transferring technologies from academia to industry. These factors are discussed here with reference to the situation in the US and India.

Keywords: Biotechnology, intellectual property, license, pharma industry, technology transfer.

'THE best tech transfer takes place in a pair of shoes', says Lita Nelsen, for over 20 years the Director of the Technology Licensing Office at the Massachusetts Institute of Technology[1]. Although we never heard the phrase 'tech transfer' when we were students, it has been in the air much more these past few years.

So what is technology transfer, and what does it need to succeed? If one picks up a good biology journal and looks at any of the abstracts, the jargon is enough to make one's head spin. But there are some people, the experts in the area, to whom that abstract makes perfect sense. These experts in frontline areas of biological research are usually found in academia. How can their knowledge be brought to companies whose expertise is principally in developing fundamental research into useful products on the market? This process of transferring scientific knowledge and embryonic technologies from academia to (usually) companies is called technology transfer. Here, I explore briefly the several pieces of the puzzle required for successful technology transfer.

How is technology transferred? There are a few important steps. One, the academic institute usually needs to patent the invention. This protection gives the transferee company an incentive to invest in developing the invention further. Two, the institute must license this patent to a start-up or existing company. And three, the relevant faculty member is often involved in the company's work on the invention, especially if it is a start-up company. In the latter case, a student or post-doc familiar with the invention would often join the company especially if it was set up explicitly to exploit the invention (and this is where the statement about 'a pair of shoes' comes in). The institute's Technology Transfer Office (TTO) therefore has to first assess the commercial importance of the invention in order to invest in a patent. It then has to identify possible licensees and license the patent to one or more of them. There are several types of licenses (exclusive, non-exclusive, time-limited, territory-specific and so on). In the process of outlining the type of license, the TTO has to juggle various interests: (a) the interest of the institute to pursue its primary goals of education and research, (b) the company's interest in pursuing profit, (c) the inventor's wish to receive a reasonable royalty on his or her invention, (d) the interest of other scientists who may have related inventions whose ability to attract corporate or other funding should not be stymied by a pre-existing license, (e) the interests of science which would be better served by free dissemination of knowledge and research reagents for instance, and last but not least (f) broader humanitarian goals of reaching technologies to populations without much purchasing power. The difficulty of reconciling these sometimes conflicting interests has probably put the TTOs in a bit of a spot on various occasions. This has led to a document entitled 'In the public interest: nine points to consider in licensing university technology' which has been endorsed by the TTOs of many American universities, including Cornell, Duke, Harvard, Rockefeller, Stanford and Yale. It lays out the principles that TTOs should keep in mind while licensing their technologies, and is available at the website of The Association of University Technology Managers (http://www.autm.net/AM/Template.cfm?Section=Nine_Points_to_Consider).

The process of technology transfer looks quite do-able on paper, but actually requires several ingredients to succeed, and these ingredients cannot be taken for granted. In a study a few years ago, I showed that only about 10% of bio-pharma start-ups in India are set up by academics[2]. That is a low number. To be noted, also, is that in each case mentioned in that article (Avesthagen, Bangalore Genei, Microtest Innovations and Strand Life Sciences), the founders left academia. In contrast, the American scientific founders of companies mentioned in Table 1 stayed on in

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Table 1. Ingredients that contribute to an efficient technology transfer ecosystem

Actor	Activity
Individual scientist	Willing to engage with companies
Academic institution	Enable scientists to engage with industry
Company	A fresh entrepreneur or pre-existing company willing to take up and develop a technology
Government	Suitable policies and institutions
Other factors	A favourable environment, including appropriate events and networks

Table 2. Some American academic scientists involved in starting companies

Scientist name and affiliation	Company
David Baltimore, California Institute of Technology	Calimmune, Immune Design Corp
Gunter Blobel, Rockefeller University	Chromocell
Walter Gilbert, Harvard University	Biogen (now Biogen, IDEC), Memory Pharmaceuticals, Paratek Pharmaceuticals
Alfred G. Gilman, University of Texas Southwestern Medical Center	Regeneron Pharmaceuticals
Alfred Goldberg, Harvard University	MyoGenetics
Lawrence Goldstein (University of California, San Diego), James Spudich (Stanford University), Ronald Vale (University of California, San Francisco)	Cytokinetics
Eric Kandel, Columbia University	Memory Pharmaceuticals
Eric S. Lander, Whitehead Institute	Infinity Pharmaceuticals, Millennium Pharmaceuticals
Robert Langer, MIT	Acusphere, BIND Biosciences, MicroChips, Mimeon, Momenta, Pervasis Therapeutics, PureTech Ventures
Stanley B. Prusiner, University of California, San Francisco	InPro Biotechnology
Jonathan Sessler, University of Texas	Anionics, Pharmacyclics
Inder Verma, Salk Institute	Signal Pharmaceuticals

academia. So, perhaps the nature of the involvement is different, or the rules have not permitted in-service Indian academics to be involved in companies in the past, or maybe both. Here, we discuss some of the factors that contribute to an enabling environment for technology transfer.

Are academic scientists interested?

Worldwide, although there are several scientists who have been involved in starting companies (Table 2), the name of Robert Langer (also of Massachusetts Institute of Technology (MIT)) stands out. He has licensed products to about 80 companies and been involved in numerous 'start-ups'. He is perhaps as well known for this as for his science where he has made pioneering contributions in both controlled drug delivery and tissue engineering (http://www.redherring.com/Home/10288). This tendency of academic scientists to be involved in company formation is particularly strong in the United States, and it is reported that in the 10-year period from 1998 to 2007, 224 companies were formed based on licenses from MIT alone[3]. This is aside from the thousands of other companies set up by the institute's alumni. Another example is that of the University of California, where scientists from five of its campuses have been involved in founding several hundred companies[4].

Scientists must have an interest in seeing their technologies reach the market. Apart from interest, however, they must also understand the concept of a good market – either a big market with small margins or a small market with high margins. All science will not work well as a basis for business. This is illustrated by the following anecdote. Amongst venture capitalists, there was a time when the phrase 'It ain't dog food' was heard quite frequently. And what they meant by that was that an inventor can claim to have invented better dog food, but if the dog does not eat it, it is not dog food. Lita Nelsen has also commented on how it is difficult to tell a Nobel Laureate that his idea – no matter excellent science – is not a good basis to start a company[5].

So at the level of the individual scientist there has to be an interest in technology transfer and the science also has to make sense in a business context. Of course one can also think of transferring technologies to a non-profit organization, where the size of the market may not matter.

Government policies

Facilitating scientists' involvement with companies

Aside from the individual scientist, the involvement of the institute is also crucial. And since our research institutions are primarily funded by the government, government rules often determine what an institute can or cannot do. In India, there were rules that did not permit

serving academic scientists to be involved in companies. One has heard the story of how in the late 1990s – in order to permit Dr K. S. N. Prasad of the Centre for Cellular and Molecular Biology (CCMB) to work for Shanta Biotechnics, the Council of Scientific and Industrial Research (CSIR) had to break its own rules. Obviously if rules need to be broken each time an academic scientist wants to be involved in a company, then the chance of this involvement is low. Things have changed significantly the past few years, both in terms of rules that permit an academic to be involved and in funding from government that R&D companies can access, which can be significant support to a new venture (http://dbtindia.nic.in/oldwebsite/SBIRI/SIBRI_main-F.html).

Establishing TTOs

An important way that an institute can help technology transfer is to establish a TTO. Most research universities in the US[6], and many outside the US too, have such offices. In addition to MIT's Technology Licensing Office mentioned above, other examples include National Institutes of Health (NIH)'s Office of Technology Transfer, Salk Institute's Office of Technology Management, Stanford's Office of Technology Licensing and the University of Oxford's ISIS Innovation. Some of them, including ISIS Innovation actually list technologies available for licensing on their websites.

Although several Indian institutions have TTOs, I do not know whether their success rates are measured by the revenue they generate. If so, perhaps we should not have very high expectations at the moment. The reasons for this thought are as follows: first, an office needs to serve a large enough body of scientists to make it worthwhile to invest in the right manpower. The number of high quality scientific institutions in India – and their faculty strength – is low: Vale and Dell have estimated that the number of scientists in such institutions in all of India is less than the number who receive grants from the NIH at the University of California's San Francisco campus alone[7]. Second, the scientist who has the invention must help the technology transfer office by identifying companies with possible interest in a license. Lita Nelsen has remarked '… if the inventor has no interest in seeing the technology developed, and will not help in marketing of the patent, the task is often hopeless.'[8] This is easier to do in an environment where academic and corporate scientists attend the same meetings and can get to know each others' work. That does not happen too often in India yet. Third, experience in the US has shown that the best technology transfer officials are those who have worked in companies before and therefore have some feel for what companies look for. In India, we have not had too much mobility between academia and industry, and so there are not yet enough people who would qualify on this count.

The Technology Licensing Office of MIT – one of the oldest and most successful in the US – broke even only after 30 years[1] and most TTOs barely break even[6]. One should note that even in the US no more than one-third of university patents (or patent applications) are ever licensed (www.wvu.edu/~research/techtransfer/.../myths_of_tech_transfer.pdf) and those that are usually bring in revenues of less than US$ 10,000 a year[9]. It is only the occasional patent that brings in blockbuster revenues of millions of dollars. Amongst the 'blockbuster' examples are Columbia University's Axel patents for gene splicing and Stanford University and the University of California at San Francisco's Cohen–Bayer patent[9]. Furthermore, Columbia's attempts at ever-greening the Axel patents became controversial[9]. If a TTO's job is defined as much in terms of moving technologies to companies in order that they ultimately are of benefit to society as bringing in revenue, such controversies can be preempted.

So, how does one work around the constraints of an Indian TTO? One possibility is to visualize a national TTO with proper investment, staffed by highly qualified lawyers, former business executives and so on. However experiments in the US have shown that a national TTO does not work: it is important that the office be local, with regular interactions between its staff and the scientists whose work they wish to commercialize[1]. Given the constraints of Indian TTOs, it therefore appeared a perfect solution when the company Intellectual Ventures (IV) came to India. Nathan Myhrvold, Founder and CEO, was earlier the Chief Technology Officer of Microsoft. IV's strategy is to scour academic campuses for unexploited intellectual property. If it is patented, the company licenses the patents. If it is not yet patented, the company undertakes the expense of patenting. It then shares a percentage of its revenues with the patent assignee. IV's business strategy is two-pronged: (i) to build a large basket of patents and then approach companies that may wish to license some of them; (ii) to be a 'patent troll', waiting for someone to infringe its patents, whereupon it can claim damages. Apparently 70% of the company's revenues come from the latter strategy (Anon., pers. commun.), and as a consequence IV has become somewhat controversial (http://www.business-standard.com/india/storypage.php?autono=337388). This is a pity since its expertise and commercial reach is something academic institutions in India would find impossible to match on their own.

Are the companies able and interested?

We shall now discuss the recipients of the embryonic technologies. In past decades, Indian bio- or pharma-companies usually either traded or manufactured. This has changed, and more are providing research services or beginning the long and tedious process of drug discovery.

For a company wishing to take up science from an academic scientist, an important point, therefore, concerns its internal capabilities to understand the science and develop it further. Economists call this the company's 'absorptive capacity'. I once had the opportunity to talk to a scientist from Cuba who had been involved in transferring technology to a couple of Indian companies. He mentioned that one had much better absorptive capacity than the other, making the transfer much easier in the former case.

So, the capabilities of the company matter. How about interest? Is a company willing to make the investments needed to develop the science further? That, too, cannot be taken for granted, but increasingly Indian companies are indeed so inclined. And the government is also facilitating this by funding research partnerships between academic and company scientists (dbtindia.nic.in/docs/Template%20for%20Loan%20only.doc).

The environment

Other than the scientist, the institute, the government and companies big or small, there are other factors that contribute to creating an ecosystem that facilitates the involvement of scientists in new companies and/or entrepreneurship in general. An example is a programme organized by the industry association BIO (Biotechnology Industries Organization) in the US called the 'Chief Scientific Officer boot camp'. This introduces scientists to various business concepts including the ingredients for success as an entrepreneur (http://www.bio2007.org/Attendees/educational_sessions/EntrepreneurshipBootCamp1.htm). Another example is that of the right sorts of social networks that connect diverse professionals such as scientists, business executives, lawyers and venture capitalists since it is a diverse team that must put together a company. Yet another example is the need for risk-taking to be cushioned by safety nets. Although there is much discussion of the 'risk taking' attitude of Americans, this happens in a particular social context. Let us forget the ongoing economic recession for a minute: if an entrepreneur in the US fails in his or her venture, there is always a job to go back to. In the past this was not the case in India where, in every area, there were too many applicants for too few jobs. Today, amongst experienced IT professionals, for instance, one hears of many entrepreneurs, at least partly because in this area too there is always a job to go back to if the venture fails.

Amongst the 'other factors', finally, there's the issue of what's in the air. I would like to believe that this article, and its ilk, contribute to creating awareness about, and interest in, issues related to company formation, including technology transfer.

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ACKNOWLEDGEMENTS. This work is supported by a generous grant from the Wadhwani Foundation. I also thank Teena E. Sebastian and Sajna Soby for assistance.

Received 18 August 2009; revised accepted 21 June 2010