

# New Models of Innovation in Life Sciences

As the world begins to gradually recover from the economic downturn, companies of all sizes are refocusing on growth, and innovation has once again become a priority.<sup>i</sup> For the majority of these companies, the approach they employ to generate good ideas and turn them into products and services has not changed for decades. They regard innovation as a proprietary activity conducted largely inside the organization in a series of closely managed steps.

Figure 1a (p.5) illustrates that with this traditional, closed model, a company is responsible for pursuing an idea from inception to market using vertically integrated internal resources, retaining all intellectual property (IP) within the company boundaries.

## Open innovation model spurs growth

Organizations that consistently outperform financially (compared to industry averages), and accordingly are the fastest-growing among their peers, have embraced a different innovation approach. Open innovation, a concept first described by Henry Chesbrough in 2003,<sup>ii</sup> is leveraged by these organizations to bring products and services to market faster and at a lower cost [Figure 1b, p.5]. According to Chesbrough, open innovation “...is a paradigm that assumes that firms can and should use external ideas as well as internal ideas, and internal and external paths to market.” Year after year, Apple, Google and Toyota appear at the top of Bloomberg Businessweek’s annual *Most Innovative Companies* ranking. Each has embraced open innovation to supplement in-house expertise, creating products and services that resonate with consumers and fuel company growth. Toyota, for example, designs world-class vehicles that are made up of hundreds of components, most of which are made by different suppliers who own the IP for the parts. Toyota also actively taps into technology and talent found at start-ups, universities and incubation hubs across the globe. This approach “...inspires companies to find the most appropriate business model to commercialize a new offering—whether that model exists within the firm or must be sought through external licensing, partnering, or venturing.”<sup>iii</sup>

Collaboration is at the core of the open innovation approach. Successful collaboration extends in many different directions. Toyota’s collaboration with suppliers and universities differs drastically from that of the video-streaming company, Netflix. When Netflix sought to better predict a viewer’s enjoyment of a particular movie based on their past preferences, it went to the masses with the Netflix Prize.<sup>iv</sup> The company offered a prize of \$1 million, and the competition attracted thousands of teams from more than 100 nations. The prize winner was a team of statisticians, machine-learning experts and computer engineers from the United States, Austria, Canada and Israel, calling itself BellKor’s Pragmatic Chaos. The group was actually a merger of teams that came together late in the contest.<sup>v</sup>

## Co-creation enablers

Despite the popularity of the open innovation concept across multiple industries, it is still too early to develop standardized frameworks and protocols that enable co-creation. Executives at most companies agree that participating in the open innovation ecosystem is important, but most admit to lacking the necessary skills to manage innovation effectively.<sup>vi</sup> Over the past few years, many organizations have launched open innovation efforts to derive value from the approach [Table 1, p.7], going at it alone or with help from one or more of a plethora of enabling intermediary platforms and resources that have emerged [Table 2, p.8]. Toronto-based Innovation Exchange is an example of an enabling platform; the organization describes itself as “an online open innovation marketplace.” It’s a community that invites its worldwide membership to respond to innovation challenges sponsored by Global 5000 companies and not-for-profit organizations. Currently, Innovation Exchange caters to multiple disciplines, including life sciences and health care.

Perhaps the epitome of open innovation, usually mentioned in any discussion of the topic, is InnoCentive, a Waltham, Massachusetts

company spun out from Eli Lilly in 2001. InnoCentive was created by two Eli Lilly executives, Alpheus Bingham and Aaron Schacht, who sought to connect and leverage the expertise of many individuals in solving challenging research problems.<sup>vii</sup> The company is recognized as an open innovation and crowdsourcing pioneer. It uses a cloud-based technology platform to connect over 200,000 entrepreneurs, inventors and scientists around the world with organizations that wish to solve pressing business and technological problems. InnoCentive has attracted leading commercial, public sector and non-profit organizations such as Eli Lilly, Medtronic, Janssen Pharmaceutica, NASA, nature.com, Procter & Gamble, Roche, Rockefeller Foundation, and *The Economist* and helped them find solutions to their business challenges.

InnoCentive has a strong footprint in the life-sciences and health-care sectors. When Prize4Life (a non-profit organization dedicated to accelerating the discovery of treatment and a cure for amyotrophic lateral sclerosis [ALS]) sought a novel way to advance the development of a biomarker that could accurately measure the progression of ALS, it partnered with InnoCentive to launch the \$1M ALS Biomarker Prize. The goal was to speed the discovery of an effective biomarker that would make clinical trials of ALS drugs cheaper, quicker and more efficient. The challenge, announced in 2006, attracted 1,000 participants from more than 20 countries, and culminated with the development of a method called *electrical impedance myography* (EIM), which sensitively measures the flow of a small electrical current through muscle tissue. EIM can accurately measure the progression of the disease by comparing the size and speed of electrical current that travels differently through healthy and diseased tissue. Various remarkable solutions were proposed, including promising technology from a plant biologist and a dermatologist who applied a method used in the cosmetic industry. Ultimately, Dr. Seward Rutkove, a neurologist and scientist at Harvard Medical School in Boston, was announced as the winner in February 2011.

## The case for open innovation in life sciences and health care

Biomedical research and development face substantial challenges in Canada and the rest of the world. Despite unprecedented investment in pharmaceutical and biotechnology research and development (\$46 billion in 2009), the number of new drugs approved by the US Food and Drug Administration remains low, with 1,247 drugs approved since 1950 (as of December 2009)<sup>viii</sup> and thus productivity is stagnant or declining [Figure 2, p.5].

Faced with declining productivity as well as patent expiries, more complex disease targets, a downward trend in drug pricing and an increasingly difficult and expensive regulatory climate, the pharmaceutical industry must rapidly adapt to survive.

Unlike the historic blockbuster drug model (where big bets are

placed on a few molecules in the hope that market revenues will drastically surpass internal research and development [R&D] costs), the current operating model exhibits increased internal innovation costs with little impact on revenues, making it unsustainable in the long term [Figure 3, p.6]. Moreover, the patents on many of the breakthrough medicines launched in the 1990s will expire over the next few years, leaving large pharmaceutical firms exposed. US-based Bernstein Research estimates that generic erosion will eliminate 2% to 40% from the revenues of the top 10 firms between 2008 and 2015 [Table 3, p.8]. And more alarming is that only 4 of the 10 companies have pipelines that contain products sufficiently valuable to offset these losses, assuming the successful commercialization of said products.<sup>ix</sup> On average, of every dollar in revenue lost from established products by the largest pharma companies, new products are only expected to replace 26 cents.<sup>x</sup>

Finally, the cost of bringing these new products to market is increasing. The estimated cost to bring a drug to market is in excess of \$1 billion.<sup>xi</sup> Clearly, there are substantial variations in expenditure depending on the therapeutic area concerned, but massive price tags remain the norm.

Open innovation, in its varied iterations, provides the opportunity for organizations to look beyond their own walls to address the “innovation deficit” at a reduced cost—potentially enhancing product pipelines and increasing overall productivity. So how are life-sciences organizations using open innovation to achieve these objectives?

## Big Pharma on board

Since the beginning of 2008, Merck, GlaxoSmithKline, AstraZeneca and Pfizer have all established multi-million-dollar, multi-year collaborations with academic institutes across a number of therapeutic areas.

As an example, in early 2011, Pfizer announced that it was aligning with seven New York City-based medical centres to discover novel biotherapeutics with up to \$100 million in funding. This announcement marks phase II in an ambitious plan to roll out a series of “Centers for Therapeutic Innovation” across eight cities. The first phase was a five-year, \$85-million alliance with the University of California, San Francisco that will be expanded to other San Francisco-based institutions.

*“The term ‘open innovation’ describes a number of different concepts,” says Mark Lundie, Director, R&D at Pfizer Canada Inc. “At Pfizer Canada, over the last two to five years, open innovation has become a significant platform in our strategy.”*

To Lundie, the definition of open innovation is the free flow of intellectual property (IP). Other iterations of the approach can be open source, in which there’s no IP held. It can also be semi-open with a public-private partnership (which the Centers for

Therapeutic Innovation fall under), where the IP is shared by the participants. Finally, pre-competitive innovation is early-stage research where competitors and partners share resources (money, talent and infrastructure) for the benefit of all, with no IP position until a pre-determined, still “pre-competitive,” stage.

*“Obviously the old [innovation] model is broken,” says Lundie. “So is the Centers for Therapeutic Innovation—approach the way to go? We don’t know yet. It’s definitely a change and Pfizer, along with other companies, is changing the way it does business.”*

Pfizer Canada is active with a number of high-profile open innovation partnerships. One of the most successful collaborations taking place involves the Québec Consortium for Drug Discovery (CQDM), AstraZeneca and Merck, with additional monies from provincial and federal funds. Others involve the Ontario Institute of Cancer Research, which keeps the IP as part of their arrangement. Collaborations with the Centres of Excellence in Commercialization and Research (CECR) are already seeing some commercial success. More recently, Pfizer Canada supported Pfizer Inc’s partnership with one of the world’s pre-eminent pre-competitive research initiatives: Toronto-based Structural Genomics Consortium (SGC).

## Pre-competitive research initiatives

Unlike most open innovation approaches between collaborators that share knowledge only among those involved, pre-competitive research collaborations advance knowledge or technology development to benefit the entire health-care community.

*“In most open innovation models, there’s a closed relationship around the IP,” says Aled Edwards, Director and CEO at SGC. “In pre-competitive research, you declare stringently what is pre-competitive—as in the outcome of the project. For us, that’s three-dimensional structures. As soon as they’re generated, they are put in databases for everybody to have.”*

This approach has made the SGC one of the world’s leading pre-competitive consortia, with collaborators across the globe and locations in Toronto, Oxford and Stockholm. The SGC is a public-private partnership that promotes the development of new medicines by carrying out the basic science of relevance to drug discovery. The core mandate of the SGC is to determine 3D structures of proteins of biomedical importance and proteins that represent potential drug targets.

*“Early basic research does not [have] to be competitive. All partners benefit from this when done collaboratively,” says Edwards. “As the economic realities of drug discovery are beginning to hit, it becomes less important for pharma to invest heavily in the basic science to discover that molecule first. Since most molecules end up not working, the value is not there.”* Therefore, establishing areas of pre-competitive research with open standards and protocols, will enable companies to pool their knowledge and resources to fill current technology gaps.

Big Pharma is slowly warming to the idea of collaborating with their competitors. The SGC has attracted attention and investment from Pfizer, Novartis, Eli Lilly and GSK. Life Technologies will soon join the consortium, along with two or three other companies yet to be announced. *“Knowledge creation is so random you never know which partner will come up with answers,”* concludes Edwards.

Michael May, CEO at the Centre for Commercialization of Regenerative Medicine (CCRM), agrees. *“We are clear supporters of the open innovation model,”* says May. *“There will be projects where there will be a number of collaborators working together to address a pre-competitive issue.”* But CCRM does not restrict itself to pre-competitive research; some projects will be driven by CCRM alone, and some will involve a single company which will hold the IP. All of these approaches are diverse forms of open innovation.

CCRM brings together Ontario stem-cell scientists, biologists, bioengineers and biomaterial scientists, and leverages their expertise and its existing infrastructure to drive product development. Along with public researchers, CCRM assembled a consortium of 15 to 20 of the world’s leading regenerative medicine companies. A mix of large and small businesses, national and international, this consortium represents companies that work in pharma, tools and instruments, cell manufacturing, reagents, and support services.

The companies join *“because they get access to expertise they may not have in-house, they have access to facilities and infrastructure, they have access to a valuable network of academia and other companies, and they can leverage funds and mitigate risk by partnering,”* says May.

The success of pre-competitive research has led to the formation of a number of consortia around the globe [Table 4, p.9].

## Standing on the shoulders of giants

Open innovation is not the exclusive domain of large pharmaceutical companies. Smaller biotech and health-care start-ups also leverage the benefits of open innovation to drive their commercialization strategies.

Ontario-based health-care IT start-up, Infonaut Inc., is focused on solving the problem of hospital-acquired infections. The company’s platform uses mapping and geospatial technologies to understand space and time within a hospital and to deliver a solution that traces the contacts, interactions and spread of disease throughout a facility. This enables the facility to better manage and prevent such occurrences.

*“We pursued relationships with large global multinationals, smaller players, and colleges and universities,”* says Niall Wallace, CEO of Infonaut Inc. Instead of building everything from scratch, the company partnered to leverage the expertise and technology of the likes of Microsoft, Dell, Cisco and Zurich. Each partner provides

a specialized capability, and when combined with Infonaut's proprietary software, the end result is a unique solution for the customer.

During product development, Infonaut teamed up with colleges and universities to offer faculty and students a chance to solve a particular challenge. "*We have good relations with Polytechnics Canada, a national alliance of nine leading research-intensive, publicly-funded colleges and institutes of technology,*" says Wallace. The company also works with George Brown College and Durham College, usually collaborating on smaller projects of three to six months in duration.

Infonaut plans to continue working closely with strategic partners to drive the growth of their business and enhance their product offering.

changing, as the industry discovers the benefits of working collaboratively in an open innovation approach.

Nevertheless, despite the strong arguments in favour of collaboration, many logistical challenges lie ahead. Barriers may include the management of IP, conflicts of interest, administration of rewards, publication policies, insufficient funding and even the overall innovation culture and lack of leadership.

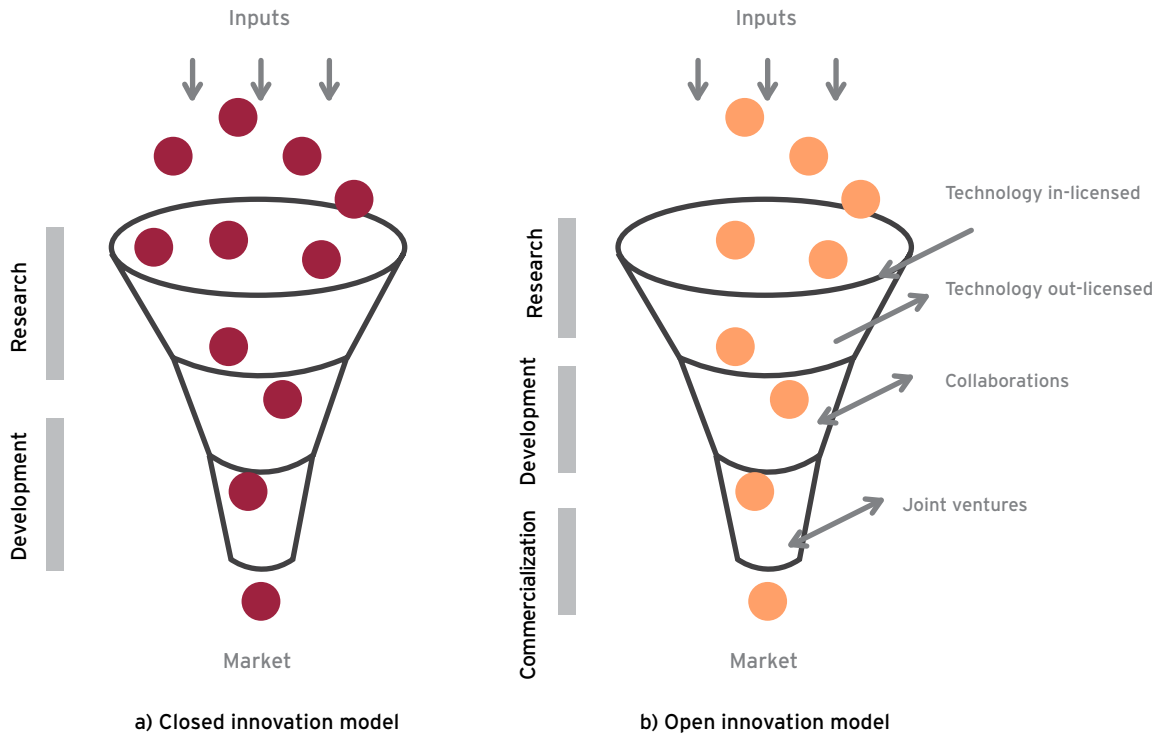
Open innovation has provided tangible benefits in other sectors and promises to do the same in life sciences, though the timelines are much longer. Life-sciences companies and academia agree that while some of the issues raised above remain unanswered, a paradigm shift toward accepting new innovation models is slowly taking shape.

## Status of open innovation in life sciences

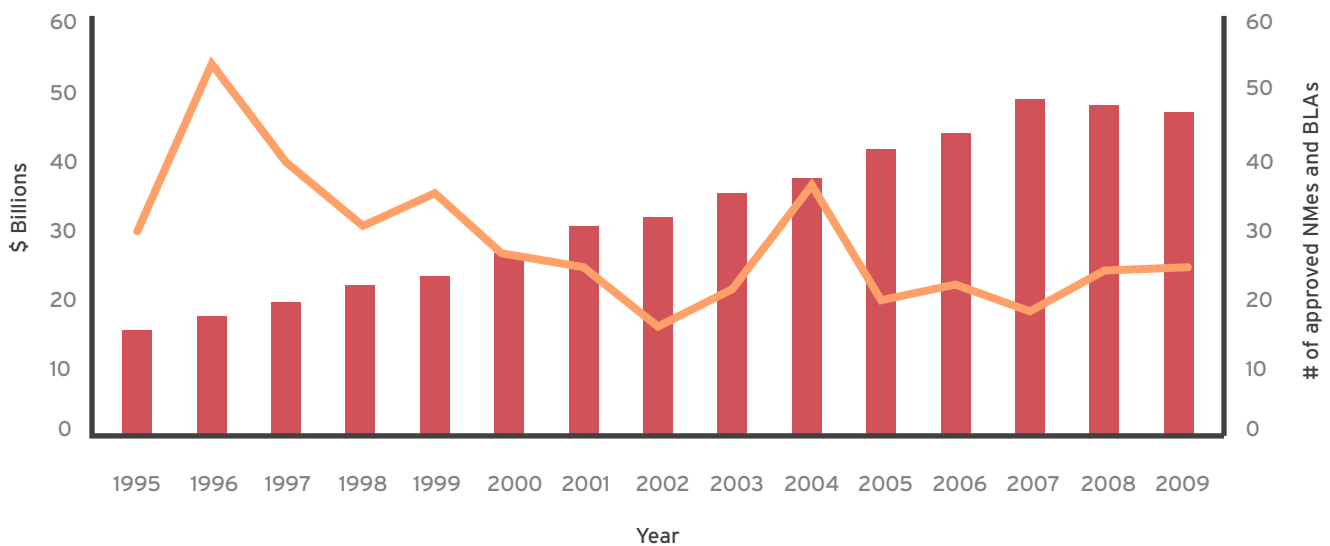
Although open innovation is a hot topic in many industries, the life-sciences and health-care sectors have not yet fully embraced this new way of doing business. Organizations have adhered to a "closed" model for drug discovery for many years, and continue to plough millions of dollars into in-house R&D in a bid to discover the next blockbuster drug, device or service. This trend is slowly

# Figures

**Figure 1** The contrast between the traditional closed innovation model and the new open innovation model

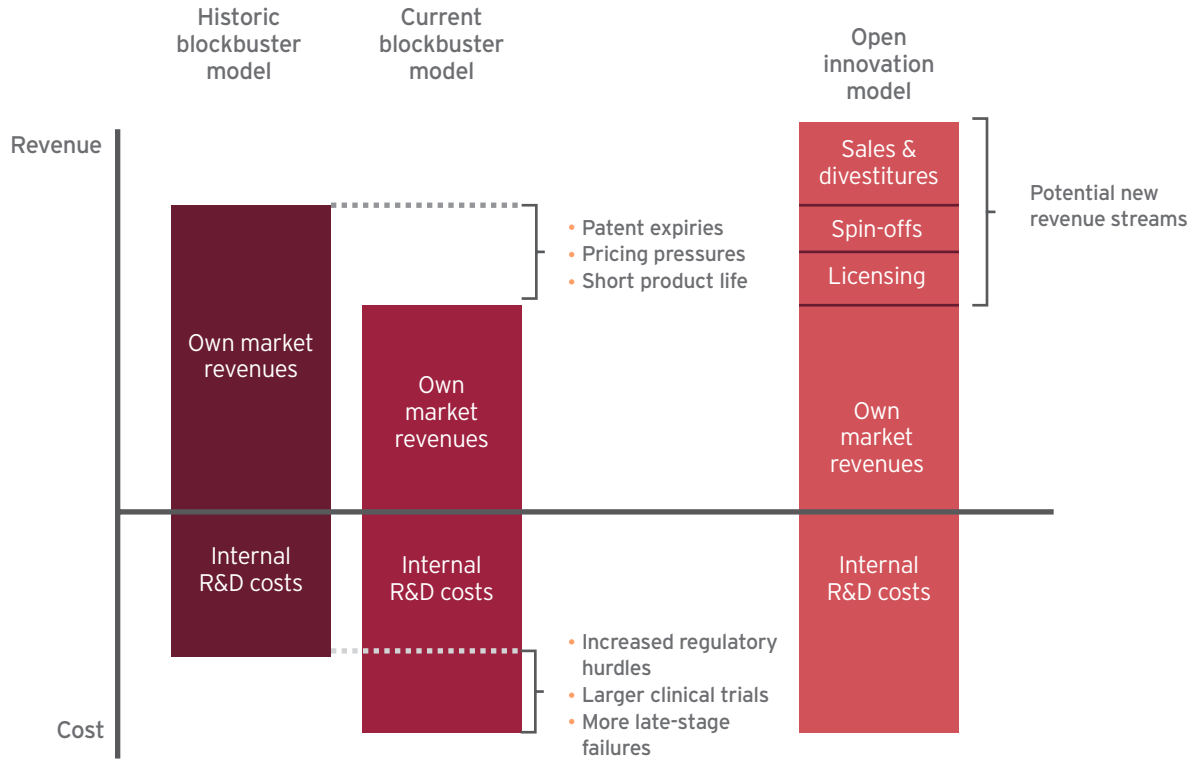


**Figure 2** Increased R&D spending by pharma does not translate into more drug approvals



NME: New Molecular Entities BLA: Biologics License Applications Sources: FDA CDER and PhRMA Annual Reports

**Figure 3** Unlike the historic blockbuster model, the current blockbuster model is economically unsustainable. The open innovation model offers an attractive alternative



Source: Modified from Melese et al. (2009). *Nature Medicine*, 15:502.

## Tables

**Table 1** Examples of open innovation and crowdsourcing for major global companies

<b>Company</b>	<b>Link</b>
<b>BMW Virtual Innovation Agency</b>	<a href="http://www.bmwgroup.com/via/">www.bmwgroup.com/via/</a>
<b>Boots Centre for Innovation</b>	<a href="http://www.bootsinnovation.com">www.bootsinnovation.com</a>
<b>Campbell's Ideas for Innovation</b>	<a href="http://www.campbellsoupcompany.com/ideas/">www.campbellsoupcompany.com/ideas/</a>
<b>Cisco I-Prize</b>	<a href="http://www.cisco.com/web/solutions/iprize/">www.cisco.com/web/solutions/iprize/</a>
<b>Clorox Connects</b>	<a href="http://www.cloroxconnects.com/">www.cloroxconnects.com/</a>
<b>Colgate-Palmolive</b>	<a href="http://www.colgate.com/app/Colgate/US/Corp/Innovation.srv">www.colgate.com/app/Colgate/US/Corp/Innovation.srv</a>
<b>Dell IdeaStorm</b>	<a href="http://www.ideastorm.com">www.ideastorm.com</a>
<b>DSM Licensing</b>	<a href="http://www.dsm.com/en_US/html/dlc/home_dlc.htm">www.dsm.com/en_US/html/dlc/home_dlc.htm</a>
<b>Ericsson</b>	<a href="http://labs.ericsson.com">labs.ericsson.com</a>
<b>Ford Story</b>	<a href="http://www.thefordstory.com/your-ideas/">www.thefordstory.com/your-ideas/</a>
<b>GE Ecomagination</b>	<a href="http://challenge.ecomagination.com/">challenge.ecomagination.com/</a>
<b>General Mills G-WIN</b>	<a href="http://openinnovation.generalmills.com">openinnovation.generalmills.com</a>
<b>GlaxoSmithKline</b>	<a href="http://innovation.gsk.com">innovation.gsk.com</a>
<b>Hershey's Ideaworks</b>	<a href="http://sites.hersheys.com/contactus/ideas/">sites.hersheys.com/contactus/ideas/</a>
<b>HP Labs Open Innovation Office</b>	<a href="http://www.hpl.hp.com/open_innovation/">www.hpl.hp.com/open_innovation/</a>
<b>IBM Collaboration Jam</b>	<a href="http://www.collaborationjam.com">www.collaborationjam.com</a>
<b>Huawei</b>	<a href="http://www.huawei.com/partners/seeking_partners.do">www.huawei.com/partners/seeking_partners.do</a>
<b>Intuit Collaboratory</b>	<a href="http://www.intuitcollaboratory.com">www.intuitcollaboratory.com</a>
<b>Kraft - InnovateWithKraft</b>	<a href="http://brands.kraftfoods.com/innovatewithkraft/default.aspx">brands.kraftfoods.com/innovatewithkraft/default.aspx</a>
<b>LG</b>	<a href="http://www.collaborateandinnovate.com">www.collaborateandinnovate.com</a>
<b>Medtronic</b>	<a href="http://www.medtronic.com/innovation">www.medtronic.com/innovation</a>
<b>Nestlé</b>	<a href="http://www.research.nestle.com/OpenInnovations">www.research.nestle.com/OpenInnovations</a>
<b>Nokia</b>	<a href="http://research.nokia.com/open_innovation">research.nokia.com/open_innovation</a>
<b>P&amp;G Connect+Develop</b>	<a href="http://secure3.verticali.net/pg-connection-portal/ctx/noauth/PortalHome.do">secure3.verticali.net/pg-connection-portal/ctx/noauth/PortalHome.do</a>
<b>Psion</b>	<a href="http://community.psion.com/">community.psion.com/</a>
<b>Reckitt Benckiser</b>	<a href="http://www.rb.biz">www.rb.biz</a>
<b>SAP</b>	<a href="http://www.sdn.sap.com/irj/scn">www.sdn.sap.com/irj/scn</a>
<b>Sara Lee</b>	<a href="http://www.openinnovationsaralee.com">www.openinnovationsaralee.com</a>
<b>Shell GameChanger</b>	<a href="http://www.shell.com/home/content/innovation/innovative_thinking/game_changer">www.shell.com/home/content/innovation/innovative_thinking/game_changer</a>
<b>Siemens</b>	<a href="http://siemens-enterprise.force.com/openideas">siemens-enterprise.force.com/openideas</a>
<b>Starbucks - My Starbucks Idea</b>	<a href="http://mystarbucksidea.force.com/ideaHome">mystarbucksidea.force.com/ideaHome</a>
<b>Unilever</b>	<a href="http://www.unilever.com/innovation/collaborating/">www.unilever.com/innovation/collaborating/</a>
<b>Weyerhaeuser</b>	<a href="http://www.growingideas.com/#/innovation/">www.growingideas.com/#/innovation/</a>
<b>YTL Communications</b>	<a href="http://developer.ytlcomms.my/about.aspx">developer.ytlcomms.my/about.aspx</a>
<b>Xerox</b>	<a href="http://open.xerox.com/">open.xerox.com/</a>

**Table 2** Example of open innovation enabling platforms

<b>Innovation enabler</b>	<b>Description</b>
<b>InnoCentive</b>	Open innovation problem solving
<b>Innovation Exchange</b>	Open innovation problem solving
<b>IdeaConnection</b>	Idea marketplace and problem solving
<b>Yet2.com</b>	IP marketplace
<b>PRESANS (beta)</b>	Connect and solve R&D problems
<b>Hypios</b>	Online problem solving
<b>Innoget</b>	Research intermediary platform
<b>One Billion Minds</b>	Online (social) challenges
<b>NineSigma</b>	Technology problem solving

**Table 3** Impact of low productivity and innovation deficit on Big Pharma's revenues. These figures show each company's "base revenues" from products already on the market. They exclude any future pipeline contributions

<b>Base Revenue Estimate (\$ Million)</b>			
<b>Company</b>	<b>2008</b>	<b>2015</b>	<b>% change</b>
<b>Novartis</b>	\$40,529	\$45,714	13%
<b>Schering-Plough</b>	\$20,595	\$20,216	-2%
<b>Wyeth</b>	\$22,367	\$20,537	-8%
<b>GlaxoSmithKline</b>	\$22,858	\$20,294	-11%
<b>sanofi-aventis</b>	\$43,177	\$36,186	-16%
<b>Merck &amp; Co.</b>	\$29,724	\$24,428	-18%
<b>Bristol-Myers Squibb</b>	\$21,603	\$16,364	-24%
<b>Eli Lilly</b>	\$20,275	\$15,286	-25%
<b>Pfizer</b>	\$48,639	\$34,075	-30%
<b>AstraZeneca</b>	\$31,522	\$18,878	-40%

Source: Bernstein Research and PricewaterhouseCoopers

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**Table 4** Examples of pre-competitive initiatives around the world

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<b>Pre-competitive initiative</b>	<b>Location</b>	<b>Mandate</b>
<b>Structural Genomics Consortium</b>	Canada, UK, Sweden	Determine 3D structures of proteins of biomedical importance and proteins that represent potential drug targets
<b>Critical Path Institute</b>	US	Identifying predictive pre-clinical and clinical biomarkers for drug-induced organ toxicities
<b>Innovative Medicines Initiative</b>	Europe	Supports collaborative research projects and builds networks of industrial and academic experts in Europe that will boost innovation in health care
<b>European Bioinformatics Institute</b>	Europe	Hosts pre-competitive quarterly meetings with 16 member companies working in the field of pharmaceutical and biotechnology R&D informatics

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