Agovic. J Regen Med 2014, 3:1
http://dx.doi.org/10.4172/2325-9620.1000111

Journal of Regenerative Medicine

Short Communication

A SCITECHNOL JOURNAL

Patent Knowledge and Stem Cell Scientists

Amina Agovic[1*]

Abstract

The knowledge economy is progressing at a rapid pace and increasingly relying on intangible assets as a form of recoupling its investments. Intangible assets include intellectual capital and intellectual property, with an emphasis on patents here. Due to the unawareness about intellectual property rights, researchers, very often, are flying blind unaware of opportunities and threats posed by patents to their research projects. Although, the business acumen of many (private and public) scientists has markedly increased in recent years, large numbers are still left outside the patent loop of opportunities and knowledge of obstacles to their research. Knowledge about patents carries important implications for all researchers and those responsible for science and technology policy making. The heavy reliance on patent protection required for science to prosper suggests an increasingly vital need for researchers to venture beyond 'normal science' in textbooks and laboratories in order to understand the non-science based factors that have a direct impact on their abilities to engage in, conduct and commercialise on their research projects. Being informed about key factors that can make or break their research, puts scientists in an enviable position to make and reach better decisions that not only would assist in promoting innovation but could even affect legal changes in their field. Global governance, national policies, the knowledge era of which patents are a significant part of, are shaping and moulding the present stem cell technology environment. Therefore, the science education should and must respond accordingly. With the right know-how, scientists can not only nurture their young breakthrough ideas into successful commercial initiatives but such knowledge would allow them to be in full control over the direction of their research and freedom to operate.

Keywords: Patents and patent knowledge; Stem cell technologies; E-learning

Abbreviations: IP: Intellectual Property; IPR(s): Intellectual Property Right(s); EPO: European Patent Office; ETAN: European Technology Assessment Network; hESC(s): human Embryonic Stem Cell(s); iPSC(s): induced Pluripotent Stem Cell(s); SC(s): Stem Cell(s)

Introduction

Stem Cell (SC) science is deemed one of the most significant areas in emerging biomedical research today. Despite being a relatively new field of scientific exploration, many promising research results suggest that SC research is ever closer to the prospect of damaged tissue regeneration in clinical applications [1-3]. Yet, the road to new and emerging technologies is paved with high risks and even higher research costs. As a result, attracting investors not so eager to risk their capital in an innovation, still in its early stages of development is all, but, a challenging task. To counteract the perils and still be able to return profits, SC industry and investors, and increasingly, many researchers, rely heavily on the availability of patent protection. For many, patents can make or break emerging technological breakthroughs. That patents are deemed of crucial importance is evident in numbers of patent applications filed by world's leading SC scientists. For example, Kyoto University and Shinya Yamanaka, the Nobel Prize Winner in Medicine 2012, filed some 220 patent applications alone for his breakthrough technology with induced Pluripotent SCs (iPSCs). Similarly, James Thompson, the founding father of human embryonic SC (hESC) research and the University of Wisconsin Alumni Research Foundation (WARF) quickly filed for a broad hESC patent across the globe in the late 1990s. Though, the WARF patents have proved intensely controversial both in Europe and the US, Geron Corporation, an exclusive licensor to the key WARF patent in the US, was able to seek and obtain the US regulatory approval to begin one of the first hESC trial treatments to repair diseased or damaged tissue, from back and hearts to brains and muscles in October 2010.

Contentious or not, biotechnology has arrived to the today's stage primarily because of patents and no other field is impacted greater by patent related policies than biotechnology. Nevertheless, very often, scientists fail to spot a patentable invention and a possible commercial application of such. Although, the business acumen of many (private and public) scientists has markedly increased in recent years, many are left outside the patent loop of opportunities and/or threats to their research. Knowledge about patents carries important implications for all researchers and those responsible for science and technology policy making. The heavy reliance on patent protection required for science to prosper suggests an increasingly vital need for SC researchers to venture beyond 'normal science' in textbooks and laboratories in order to understand the non-science based factors that have a direct impact on their abilities to engage in, conduct and commercialise on their research projects. Being informed about the key tools that can make or break their research has the power to put scientists in an enviable position to make and reach better decisions that not only would assist in promoting innovation but even affect legal changes in their field. Global governance, national policies, the knowledge era of which patents are a significant part of, are shaping and moulding the present SC technology environment. This has created a situation where universities, SC institutions and decision makers are now required to take a serious look at the patent system as one of the key instruments in the education of SC scientists worldwide. In its recommendations, the European ETAN expert working group highlights the importance of creating an intellectual property (IP) culture throughout Universities and a need to educate and improve the IP rights (IPRs) training in different public and private sectors [4]. In fact, knowledge is generally acknowledged as a foundation of institutional competitiveness [5,6].

It is the purpose of this paper to explore the role that IPRs with emphasis on patents, play in SC innovation and the role that they

*Corresponding author: Amina Agovic, Malmö University, School of Technology and Society, Sweden, E-mail: amina.agovic@mah.se

Received: January 14, 2014 Accepted: August 01, 2014 Published: August 05, 2014

SciTechnol International Publisher of Science, Technology and Medicine

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should subsequently play in SC education. In particular, the paper examines the importance of patents to SC technologies and a necessity for patent education to be considered as an unavoidable educational skill in furthering SC sciences, especially in Europe. The article is not meant to go into depth with respect to potential educational tools that can be used to achieve the goal of redesigning scientists' education. Rather it is an argument for a stronger accent on patent related education at Universities and SC institutions, in particular for those based in Europe. In addition and without going into too many details, the author puts forth a suggestion of creating an e-learning SC tool as one of the possible educational policy tools in achieving this objective.

The Knowledge based Economy and Patents

Patent knowledge pays off

Innovation is:

particularly important for economies as they approach the frontiers of knowledge and the possibility of generating more value by only integrating and adapting exogenous technologies tends to disappear [7].

The rising importance of knowledge is seeing private and public institutions (i.e. Universities and research institutions) extensively rely on the protection of IP for purposes of commercial opportunities or to avoid business or research threats posed by competing patents. In addition, growth of these institutions no longer seems to arise from competing on 'labour costs, raw materials or access to capital', but in fact, their competitive edge now depends on their 'capacity to innovate, especially in the high margin, knowledge intensive businesses which now exist across all sectors [8].'

Ownership of IP created at public institutions is becoming increasingly prominent, especially in view of the potential revenue it can generate and due to public funding for higher education continuously wearing thin. For instance, in the US, total state funding for higher education saw a hefty decline of around US $1.4 billion between 2008 and 2010. For the US public sector, this reduction in funding is turning the US academia toward 'academic capitalism' described as 'the pursuit of market and market-like activities to generate external revenues', of which patents form a large part of it. In 2007, approximately, 161 US institutions earned US $1.9 billion in net royalties from patent holdings [9].

A key factor to SC technologies' market and other advantages lies in the scientists' abilities to patent emerging biotechnologies. By nature, a patent is a negative right. It is an exclusive right to prohibit all others from exploiting (i.e. use, sell, make…) a patent holder's patented product or process for a limited period of time. International treaties on IP law such as the TRIPs Agreement prescribe minimum standards [10,11] for patentability of inventions to be complied with by each of the World Trade Organization (WTO) Member State. Minimum patentability requirements are spelt out in the Article 27.1 of the TRIPs, which states that 'patents shall be available for any inventions, whether products or processes, in all fields of technology, provided that they are new, involve an inventive step and are capable of industrial application'. Similar requirements are found in patent laws of Europe, US and likewise.

To the biotechnology sector, patents enable many 'to increase their expected profits from investments in research and development while fostering innovation that would not occur but for the existence of the patent [12].' In fact, even if the invention does not end up being offered on the market, the patent holder can block all others from engaging in the same type of innovative activities as herself. In a way, the form of a monopoly afforded by a patent right allows the patent owner to 'establish and shape a marketplace [13].' Unsurprisingly, Universities' appetite in patents has risen ten-fold from 1970s to 1998 where even the most basic research is afforded increased patent attention [14]. The US, for example, is the world's leader in technological advances in SC research and is estimated to comprise a 60% of a global market share with forecasts of worth amounting to around USD $88.6 billion by 2014 [15]. The US patent policy and continuous encouragement to patent at both private and public institutions can be seen as one of the more strategic causal factors for the US market dominance.

All in all, economic consequences appear to be a decisive factor with respect to the choice of research projects. In its 2011 report, the US Federal Trade Commission stated that, 'the patent system plays a critical role in promoting innovation across industries from biotechnology to nanotechnology, and by entities from large corporations to independent inventors [16].'

The rush for stem cell patents

With respect to SC patents, there is a continuous growth of the number of patent applications filed by leading scientists and alike. Yamanaka's revolutionary efforts in 2007 reported making iPSCs by 'introducing four genes that could reprogram cells from an adult to an embryonic-like pluripotent state.' Despite the fact that the genes and the viruses used to introduce the genes can cause malignant tumours, Yamanaka's achievement was hailed as remarkable and akin to the Wright brothers' first flight [17].

In addition, to Yamanaka's outstanding success, Kyoto University and the Nobel Prize Winner timely recognised the importance of patents and filed for protection of their iPSC breakthrough technology in more than 40 countries worldwide. In the US alone, Kyoto University now effectively covers 80% of the global market share in this revolutionary technology. Yamanaka's patent encompasses two basic methods of creating iPSCs - producing pluripotent cells similar to embryonic SCs (ESCs) by injecting three kinds of genes into skin and other somatic cells, and by inserting two kinds of genes and proteins with cellular multiplication properties into somatic cells [18,19]. Patent claims sought have a far broader scope of protected subject matter in the US and even wider scope in Europe than in Japan [18,19]. In total, the iPS Academia Japan, Inc, an affiliate of Kyoto University has a patent portfolio of more than 60 patent families with the total number of patent applications around 220 - all grounded in Yamanaka's breakthrough work [20].

Similarly, the founding father of hESC research, James Thompson, filed for a broad hESC patent across the globe in late 1990s. Whilst, the patents [21] survived the re-examination proceedings in the US to an extent, the WARF patent filed at the European Patent Office [22] became an entirely different story. The WARF application claims 'a purified preparation of pluripotent primate and human embryonic stem cells' with no changes being claimed in the composition of ESCs when compared to the removing the non-coding introns to produce cDNA, as in gene patents. Thomson's major contribution is a method for isolating and culturing the cells and does not claim the development of a new product isolated from its natural environment through human intervention [23]. Notwithstanding that new methods for reaching already known products traditionally have been subject of patent protection, one critic for example exclaims:

doi:http://dx.doi.org/10.4172/2325-9620.1000111

It is a claim that reads very much like a description of the method involved in digging gold, but which then claims the gold itself as an invention. The digging is supposed to have 'purified' the gold, but the cell lines are valuable exactly because they are able to behave as they would ordinarily do in one, or several, of their ordinary roles in the developing embryo or in the mature organism that would ordinarily result from embryonic and foetal development [24].

Nevertheless, an exclusive license to the key WARF patent in the US, allowed Geron Corporation to form a formidable patent portfolio which, despite subsequent trial cancellations of its own accord, led to the regulatory approval to begin the hESC trial treatments to repair diseased or damaged tissue, from back and hearts to brains and muscles in October 2010. This was the first time such a drug was used on humans [25].

In comparison, that SC patents are equally as important to European SC scientists suggests the degree to which the European scientists are willing to go to obtain patents. For example, a renowned European SC scientist, Oliver Brüstle fought for the rights to his SC patent (initially granted by the German patent office) all the way to the Bundesgerichtshof (German Federal Supreme Court) which subsequently found its way before the Court of Justice of the European Union (CJEU), the EU's Supreme Court [26]. Unfortunately for Brüstle and European SC researchers, the CJEU decided to bar any procedure that involves hESCs from patentability if the hESCs were derived from the destruction of human embryos [27]. Whilst, the CJEU ruling does not bar the scientists from engaging in hESC research experiments, it does remove 'a key commercial incentive for biotechnology and pharmaceutical companies to back stem-cell research in Europe [28].' What this translates to is that, 'of all the intellectual work being done in Europe, if something is successful it will now be (commercialized) by a company outside Europe where patent protection is available [28].'

Brüstle received doubly disappointing news in Spring 2013, when his European patent, EP 1040185 B1, granted in 2006 for the same invention, was revoked by the EPO Opposition Division [29].

In any case, it is possible that this CJEU decision could trigger calls for amendments to current legislation or even enacting of new one and this is where the European SC scientists' knowledge and voice will prove crucial. Moreover, for the European SC scientist to advocate for any change concerning patenting SC technologies in Europe, they will need to be very knowledgeable and extremely well informed on the issue of patents and SC technologies.

1. The Need for Multi-disciplinary Education

Recent times have witnessed a surge in patenting in academia with many researchers realising the potential of IPRs and utilising on them. In fact, since the passage of the Bayh-Dole Act of 1980 in the US, American research institutions, including universities have been strongly encouraged to patent inventions funded by federal funds and to licence the same to the private sector [30]. With such a policy in force, US Universities and research institutions are indirectly required to adapt to the changing times. Some institutions are increasingly satisfying such needs by establishing patent knowledge offices and/or educational courses that inform the researchers of the patent system and at the same time, urge them to patent their latest innovative research [31].

However, when it comes to patent threats, obliviousness about the IPRs carries a huge risk of infringing on someone else's IP and thereby risking not only litigation but also an entire halt of the research project. Yet, many researchers stand idly by and prefer to ignore the issue entirely [32]. Some even see it as an absolute waste of time:

I'm a scientist. And for me to go off and try to do what business people do or what patent attorneys do is a waste of my time. The more time I spend in the laboratory developing new technologies, the better off everybody is [33].

Such attitude presents a significant risk, especially in today's technological age where any meaningful research very often builds on the already patented technologies. This is particularly relevant in the US where no academic research exemption exists there. There, for example, WARF patents wreaked legal and social havoc by interfering with emerging research and in some instances even preventing researchers from continuing with their SC research [34]. This is unsurprising because when it comes to emerging technological areas such as SC research where innovation is at its nascent stage, patents are usually taken out early and tend to be very broad and even protect building blocks necessary for follow up research. Those circumstances leave follow-on inventors at a mercy of the patent holder who has a right to refuse access of his patented technology to others under reasonable conditions. WARF in the US was a prime example of aggressive patenting protection, which resulted in the Los Angeles based Foundation for Taxpayer and Consumer Rights and New York based Public Patent Foundation seeking re-examination of all three WARF's patent claims in 2006. Both foundations expressed their concern over the breadth of those claims and said that:

by demanding significant financial consideration before allowing research to be performed, the owner of 5,843,780, 6,200,806 and 7,029,913 patents is impeding, and in some cases literally stopping, domestic human embryonic stem cell research in its infancy. This not only harms scientific advance here in the United States it also has a harmful economic impact on Americans by diverting taxpayer dollars meant for research to pay for licensing fees. In the words of one industry insider, this aggressive patent assertion is 'stifling industrial research and investment [35].

In general, just because a researcher has not encountered an issue with patents throughout his previous research, it does not mean that he or she will not face such in the near future. In addition, some inventions might be rather obvious to the researcher, but in the area of patent law, they would definitely fulfil the patenting requirements. Missing out on these opportunities might bring about situations similar to that of a Karaoke machine. Nowadays, the karaoke business is a billion dollar industry, but its inventor, Mr Daisuke Inoue earned nothing from the invention he created. By the time, Mr Inoue thought of patenting his invention, it was already too late. Yet, had he done it at the right time, he would have heavily capitalised on his intellectual endeavours. Being far from an isolated incident, many inventors are still unacquainted with an array of choices that come along with the IPRs [36].

In addition, many researchers still doubt their ability to comprehend the patent system, that is: the opportunities and threats that patents carry. Publicly funded scientists, whether due to cultural, educational and practical barriers, have a very limited engagement with patent information [37]. Overall, scientists are perplexed and anxious about the world of patents and are equally confused as to the use and usefulness of patents to their research [37].

For example, a recent large-scale survey of some 2000 and so

doi:http://dx.doi.org/10.4172/2325-9620.1000111

students conducted by the National Union of Student, IP Office (UK) and the IP Awareness Network (IPAN) reveals that 'only 40 per cent of respondents thought their IP awareness sufficient for their future needs [38].' According to Ruth Soetendorp who leads the IPAN's Education Group, the lack of understanding the basic nature of IPRs in Further and Higher Education has negative implications for the UK economy. Soetendorp continues by stating that, in order for the UK to be world class in emerging technologies and in a global market, 'proper understanding of IP' must be 'embedded in an educated workforce [39].'

By comparison, some scientists see patent knowledge and subsequent choice to patent equivalent to maintaining some control over their research results. Scientists who understand and have a handle on patents perceive themselves as having a voice in how new technology is subsequently used and by whom. For instance:

If you've patented it then you have some voice, at least, in who uses it and how they use it. This is going to be very important in the area of SCs for example, because there are uses we would rather not see people make of this technology, and I feel a lot more comfortable knowing that [TTO] holds the patents than I would if they were held by a private entity because [private entities] are not accountable to anyone [33].

Furthermore, a scientist who comes up with an invention might opt for an option of promoting her discovery, searching for either a venture capitalist or a firm that could use the invention for product developments. In the absence of patent protection, the scientist is put in a precarious position where the disclosure of the invention can easily be replicated and appropriated by the firm. Such scenario could easily ruin years of one's hard work and destroy any incentive to seek out firms and/or venture capitalists. With patent protection, the scientist finds herself in a much stronger bargaining position with a number of options on the table. This in turn, further motivates scientists to promote their inventions because of the availability of patent protection.

Patent educated researchers are of belief that knowledge about how to take their research outcomes beyond simple discoveries and put them to use, protect and even commercialise via the patent system, leads to a different scientific behaviour. One, which, gives the knowledgeable scientist the necessary competitive edge [33]. Whilst patenting one's results might not be the preferred commercial choice at certain times, 'education and expertise play an important role in fostering a pro-patent environment [40].' Such situations have resulted in the educational 'haves' being better equipped with the necessary knowledge in relation to their research and in turn, have been taking out patents at a 'far greater rate' [40].

Reflecting on the European SC researchers' present position, the question that confronts the SC technologies after Brüstle and the WARF [41] decisions is: what next for SC researchers in Europe. Given the unenviable stance in Europe, an even larger emphasis should be placed on patent education as an essential factor in the innovation process. It is increasingly becoming evident that SC researchers do not simply require learning about the latest techniques concerning SC sciences, but also those concerning patents, ethical and social norms that directly and indirectly affect their ability to do research. To minimise risks and unintended consequences, researchers, SC institutions and policy makers alike need to understand how to make informed choices when it comes to new biotechnologies. For researchers, for example, this requires that they be in tune with societal norms and principles as well as patent related issues that have the potential to seriously affect SC innovation. Patent-trained scientists have an upper hand most are not aware of and it's specifically due to their multi-disciplinary knowledge. Informed and patently skilled SC scientists would be placed in a unique position to alleviate and address public and patent related concerns with respect to their research and thereby, expand and contribute to the public debate on the meaning of patents to the European scientific progress.

In addition, for European scientists to remain competitive at both the scientific and technological level with countries like the US, Japan and similar, these very scientists need the patent skills and knowledge necessary to survive and thrive in today's knowledge era. This is especially relevant as most SC patents issue in the US. For every 13 patents that issue in the US, just one patent is granted in Europe [42]. On average, European Universities generate far fewer inventions and patents than their US counterparts [43]. One of the primary causes rests in the lack of 'systematic and professional management of knowledge and IP' by European Universities. A number of factors ranging from, cultural differences between the business and scientific communities to lack of incentives to legal barriers to fragmented markets for knowledge and technology, adversely affect the ability to engage in and conduct research at European research institutions [44].

Yet, the ability to keep the scientists abreast about topical subjects such as that of patent related issues that have a(n) (in)direct impact on their ability to engage in and commercially realize the fruits of their labour is considered a top priority in encouraging and furthering SC innovation. This is ever more applicable, as the research is no longer contingent solely on the scientists' ability to work in a lab. To the contrary, due to the advances in new and emerging technologies, more and more research is intertwined in research driven clusters encompassing a range of disciplines. Thereby, creating a situation where progress in these fields 'often outpaces the relevant ethical, legal and moral discourse, and regulation, which as a result on many occasion creates suspicion and causes backlashes from the public' [45]. Whilst, some scientists are more inclined to commercialise and utilise their research results or 'possess idiosyncratic prior knowledge that makes them better able to recognise entrepreneurial opportunity' [33], many still fail to even recognise the existence of such opportunities.

This in turn, raises a question as to what, if any, factors can contribute to the scientists' understanding and awareness of the threats and opportunities that come along with their scientific innovation. How such factors can be implemented in a standard practice is a further issue to be explored.

Improving Science Education

Europe's pursuit for IP knowledge

The coming of new technologies requires that not only the teaching methods change but that the curriculum adapts to the outside factors that exert a heavy influence on the ability to engage in, conduct and commercialise one's own research. Europe's agenda is to develop into the most competitive and dynamic knowledge based economy in the world. To achieve so, modern and effective research infrastructure 'are critical in achieving science and technology leadership' whereas the term research infrastructure covers also 'knowledge-based resources… [46]' The development of the European society relies heavily on their 'capacity to create, exploit and disseminate knowledge and, from there, to continuously innovate.' Scientific research plays a major role in this regard, and the EU deems it as 'one of the driving

doi:http://dx.doi.org/10.4172/2325-9620.1000111

forces in promoting growth, welfare and sustainable development' [46]. However, to promote innovation, 'a social and cultural environment conducive to successful and exploitable research' needs to be created. As a result, scientists' education and training needs to keep pace with the rapidly changing world thereby enabling the researchers to better develop skills to deal with non-science related issues, such as those presented by patents. This means that a divide as to who has access to relevant knowledge and who does not, as well as those who have the capacity to impact policy-making in research and those who are without such capacity needs to be narrowed if not, eliminated.

In their attempts to educate researchers about IP related matters, many European research institutions have set up knowledge transfer offices with the intention to improve collaboration and exploitation of research results including their potential uptakes by European businesses. Nevertheless, the European Commission has discovered that relatively inexperienced staff is often placed in such positions making the task of knowledge transfer even more difficult [46].

Therefore, in order to fully utilise on the concept of patents and enhance knowledge transfer at public institutions, significant challenges need to be overcome. These barriers include scientists' awareness and knowledge about patents and their implications into their research at every stage of their experimental work [33]. The critical first step being the ability to identify IP in the first place.

Large companies and the industry are backed by substantial resources and can either employ outside help or have their own in-house assistance. On the other hand, researchers with limited resources and time-strapped management are often left to their own demises. In such instances, scientists can only detect and manage their IP by knowing about IP beforehand. Although, there is no substitute for an in depth understanding of the IPRs, developing a basic understanding of patent rules reflects a good start.

It is important to bear in mind that researchers are overwhelmed with their own work and most of the time unable to attend and/or commit to long course sessions on IPRs primarily designed for law and economics students. However, as SC research is being impacted by many factors, among which patents seem to take the lead, it is then crucial for scientists to acquire knowledge about practical applications of patents to their projects. This in turn calls for a development of new type of SC scientists: a sort of multi-disciplinary scientists. Researcher, equipped with the sufficient expertise and knowledge about non-science related disciplines.

Traditionally, however, Universities (i.e. European in particular) have not been as eager to incorporate IP education into scientists' training because the concept of prohibiting all others from the use of ideas (i.e. patented technology) is not natural to academia [14]. However, for many, knowledge about patents can translate into a source of prestige and a potential source of extra funding. Exposing researchers to basic methods of conducting patent searches, keeping an eye on 'competitors' and how to utilise the latest technological advances disclosed first in patent applications can prove of immense value to one's work. In addition, such approach to patents instils in scientists an invaluable attitude of observing, critically spotting patentable inventions in their work and/or ability to identify potential threats to their research via filed or issued patents. For example, a basic patent search for 'stem cells' on the EPO search engine reveals close to 16 000 patents and patent applications [47]. For the unaware scientist, 16 000 patents in SC field can seriously jeopardise one's own research. On the other hand, for those in the know, it can lead to successful manoeuvring around this 'legal minefield' and thereby avoiding expensive mistakes and even exploiting the patent system to one's advantage.

In addition, although a researcher might not be interested in pursuing a worthless patent, it's a good idea to bear in mind that a worthless patent today might form the foundation for ground-breaking technology tomorrow. Laws and industries change and a slight variation of a patented technology could see the researcher and its Institute recoup sizeable royalties for their originally 'worthless' patent. Furthermore, the original patent idea might 'sprout a tree with many patented branches. The original seed might not have ultimate value, but it is the genealogy of a concept that does [13].'

Having the relevant patent know how affords researchers with an ability to monitor what their rivals and other institutions are up to. After all, today's newest technological advances are almost always found in patent applications first. In order to stay abreast of the advances in emerging biotechnologies, it is next to critical to be familiar with patent law and its policies. It is almost as a game of chess, where the researcher is trying to figure out what she is doing, what the other experts in the area are working on, how to get around their research (if patented) and, ultimately, figure out whether the research result is of certain worth to the researcher and the Institute [13]. Mere ability to search for patents and use them as case studies for cutting edge developments in SC sciences, grants the knowledgeable and the informed SC scientist a competitive edge over the non-informed fellow researcher. Furthermore, being able to invent around patents 'is the stuff of which competition is made and is supposed to benefit the consumer [48].' Patent knowledge also opens a window to the researchers into 'real-world issues in collaboration with their students [14]', thus providing additional advantages to the University and its academic practices.

E-learning tool

IP educated researchers are automatically in a stronger position professionally which takes them from followers to leaders, to those in the know. Albeit, this might not be an easy transition, it is certainly one worth investing in. Institutions and Departments that understand the importance of patent knowledge to researchers and act to fulfil their needs end up creating larger revenue than their counterparts [49,50]. Innovating on one's own is difficult and a path riddled with obstacles, however a little support to researchers can translate into a world of difference. And yet, when it comes to IP information, the support is almost non-existent. Focusing on the needs of SC researchers and then satisfying the same is not an easy task. In order to provide the scientists with the necessary knowledge and skills that would boost their research strategies and better their decision making processes, it is necessary to provide the scientists with the relevant tools that would allow them to quickly access relevant and strategic information. A tool that, would anticipate and manage SC researchers' expectations pro-actively. One such tool could come in form of e-learning. An e-learning tool available to SC researchers could help them in taking the right action at the right time versus taking action improperly or not taking any action thereby resulting in loss of an IPR entirely.

Thanks to advances in new technologies and connectivity, Universities can utilise on this and develop online courses and/or e-learning tools that would cater to each and every researcher's individual need. A more flexible and individually available approach that would accommodate to the scientists' requirements could prove into the most promising solution to building multi-disciplinary and

doi:http://dx.doi.org/10.4172/2325-9620.1000111

IP savvy researchers. In fact, Universities worldwide are increasingly realising the power of e-learning and adopting the same as a solution to offering 'learning-on-demand' to many. Such e-learning tactic, not only reduces time and costs required for training but it also assists the students unable for professional or geographical reasons to engage in courses that would further their studies or research [51]. By comparison, companies view e-learning as the competitive edge in these turbulent economic times. For them, keeping the employees updated with the latest know-how is rendered of paramount importance and large companies have already taken the lead by adopting the use of e-learning tools for their corporate training [51,52].

In contrast to a traditional course, an e-learning course grants the researcher freedom to choose which information she wishes to access and at which time interval. In such instance, the researcher is not strained by geographical, physical or financial limitations. An e-learning tool could provide a sustainable, cost effective and flexible system for both the researcher and her Institution. Such system would allow the researcher to explore and exploit the patent rules, evaluate the information provided by patent applications and granted patents and create follow up inventions. An e-learning tool would take the researcher from a stressful and at times intense environment of a conventional course filled with assignments and exams to an environment of immediate applicability and flexibility tailoring to the individual researcher's needs. Naturally, creating an e-learning tool will require patent experts (i.e. faculty staff) largely familiar with the researchers' IPR related needs and sensitivity to their hectic schedules. As this paper seeks only to put forth a potential suggestion that could address the learning IPR strategies for SC and other scientists, the author hopes that this work will provide a foundation for further discussion concerning the outlook of a suggested e-learning educational tool.

Moreover, given that Universities are strategic contributors to the 'knowledge economy' and to national competitiveness [53], how the Universities proceed to educate their researchers about the cutting edge technologies and all that impacts their research could carry large repercussions for the researchers', Universities' and technologies' current and futures successes.

Concluding remarks

Researchers constantly produce innovation worthy of patent protection, but coping with the demands of patent law presents significant challenges to SC and like scientists. Understanding the basic ins and outs of patents is becoming increasingly crucial in ensuring scientific freedom to operate and being able to commercialise research outcomes. If SC researchers are expected to succeed in their research and potential commercial ventures, they should, at the very least, have some understanding of the basic IPRs (emphasis on patents) in order to make the correct decisions concerning their work and research results. However, to date, most of the SC researchers have learnt about the rules of the patent game, the hard way: by not being aware of opportunities (i.e. how to follow patent procedure and what patents can do for their research) or threats (i.e. other SC patents such as WARF in the US, problems with patenting hESC related inventions in Europe, etc…). Integrating basic patent knowledge into the standard science education (whether offered as an e-learning or a customary course) would prevent the worst of patent related mistakes (i.e. missing out on the opportunity to patent or not inventing around a competitor's invention) that might affect a researcher's project.

In fact, IP savvy scientists that possess the relevant know-how and skilled ways of thinking, behave in a way that takes them from followers to leaders. By recognising patterns with respect to patents and science, IP skilled scientists can apply these throughout their research work. On the other hand, researchers educated in one direction only cannot be expected to be aware of other directions that might interfere with or benefit their research plans.

When it comes to research, the patent system can serve both as an opportunity by providing incentives and as an obstacle to research. The emerging biotechnologies depend heavily on the patent technologies and whilst, the patent system serves the industry rather well, it also preserves for future advances of technology. Knowing how to apply patent rules and protect their fruits of labour can give any particular researcher a competitive edge over a fellow colleague, universities and the overall industry. With the right know-how, scientists can not only nurture their young breakthrough ideas into successful commercial initiatives but will allow them to be in full control over the direction of their research and the freedom to operate.

There is no government that wants to be left behind when it comes to innovation and newest technologies. Similarly, no government wishes to deprive its citizens of a better living standard, which includes the best possible health care system. This in turn requires that researchers working on developing future cures and treatments for diseases and ailments be afforded the best possible training and freedom to do so. In order to achieve so in line with the twenty-first century and contemporary society, the knowledge about patents should and must play a more active role in the professional life of a SC researcher.

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Author Affiliations

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[1]*Malmö University, School of Technology and Society, Sweden*

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