Institution: University of Dundee

Unit of Assessment: 5: Biological Sciences

Title of case study: Creation of the spin out company Dundee Cell Products (DCP) and impact on commercialisation of life sciences technology and reagents from the University of Dundee.

1. Summary of the impact (indicative maximum 100 words)

As sophisticated proteomics methodologies are increasingly embraced by both academics and industry across the globe, growth in this area is set to explode. The University of Dundee has a leadership position in quantitative proteomics technology, through the expertise of Professor Angus Lamond. Dundee Cell Products Ltd is a University of Dundee spin-out company that was created to commercialise life sciences technology and reagents, and to exploit technology and expertise in proteomics developed at the College of Life Sciences. As of 2013, DCP offers >5,000 research products and six contract research services, centred around quantitative proteomics.

2. Underpinning research (indicative maximum 500 words)

In 1998, a seminal study by **Prof Angus Lamond FRS** at the University of Dundee, in collaboration with Prof Matthias Mann (then based in EMBL, Heidelberg), provided insight into proteins that control the human spliceosome using mass spectrometry (1). This was one of the first studies to reveal the power of mass spectrometry to biologists and highlighted the potential of using this technique to simultaneously identify all or most of the proteins components of human macromolecular complexes, organelles and cells. In 2000-2001, research by **Dr Paul Ajuh**, then a postdoctoral fellow in the laboratory of Prof Lamond, provided further insight into the composition of the spliceosome complex and demonstrated the involvement of the CDC5L protein complex in spliceosome assembly (2,3). In a further subsequent study, Dr Ajuh identified small peptides that could be used as effective RNA splicing inhibitors (4).

In 2002, Prof Lamond published a comprehensive analysis of the composition of the human nucleolus using a range of mass spectrometry techniques. This work represented a significant advance towards defining a comprehensive inventory of nucleolar proteins and revealed that the nucleolus was likely to perform functions beyond its known role at that time of ribosome subunit biogenesis (5). The ability to purchase large amounts of reliably high quality subcellular components and extracts was identified by Dr Ajuh and Prof Lamond as a major rate-limiting step in all these studies, along with access to appropriate proteomics platforms and expert data analysis. Prof Lamond and Dr Ajuh created Dundee Cell Products in 2006 to fill this niche in the market, taking advantage of the expertise in cell biology, proteomics and mass spectrometry developed in the University. The main strengths (and selling point) of the company were to be the *quality* of their products and the high level of expertise of the individuals involved in the company.

The rapid evolution in proteomics over the last decade, creating a new research field whereby the large-scale detection, analysis and quantitation of proteins has become possible, presented a further opportunity for Dundee Cell Products. The laboratory of Prof Lamond was the first in the UK and one of the first worldwide to adopt and develop quantitative mass spectrometry using stable isotope labeling with amino acids in cell culture (SILAC). In 2008, Prof Lamond and colleagues extended the SILAC methods previously reported, and optimised the technology to produce an unbiased procedure to reliably identify specific protein interaction partners (6). It was quickly realised that there was commercial demand for expertise and reagents associated with this powerful and reliable workflow and as a result, provision of this technology was adopted in the portfolio of products and services offered by Dundee Cell Products.

3. References to the research (indicative maximum of six references)

Publications:

1. Neubauer, G., King, A., Rappsilber, J., Calvio, C., Watson, M., **Ajuh, P.**, Sleeman, J., **Lamond, A.I**. and Mann, M. (1998) Mass Spectrometry and EST-database searching allows rapid

characterization of the multi-protein spliceosome complex. Nature Genetics *20*, 46-50. (doi: 10.1038/1700) (Citations 339, Scopus Nov 2013)

2. **Ajuh, P.,** Kuster, B., Panov, K., Zomerdijk, J.C.B.M. and **Lamond, A.I.** (2000) Functional analysis of the human CDC5L complex and identification of its components by mass spectrometry. EMBO J. *19*, 6569-6581. (doi:10.1093/emboj/19.23.6569) (Citations 110, Scopus Nov 2013)

3. **Ajuh, P.**, Sleeman, J.E., Chusainow, J. and **Lamond, A.I**. (2001) A direct Interaction between the Carboxyl-terminal Region of CDC5L and the WD40 Domain of PLRG1 is Essential for Pre-mRNA Splicing. J.Biol. Chem. *276*, 42370-42381. (doi: 10.1074/jbc.M105453200) (Citations 32, Scopus Nov 2013)

4. **Ajuh, P.M.** and **Lamond, A.I**. (2003) Identification of peptide inhibitors of pre-mRNA splicing derived from the essential interaction domains of CDC5L and PLRG1. Nucl. Acids Res. **31**, 6104-6116 (doi: 10.1093/nar/gkg817) (Citations 9, Scopus Nov 2013)

5. Andersen, J.S., Lyon, C.E., Fox, A.H., Leung, A.K.L., Lam, Y.W., Steen, H., Mann, M. and **Lamond, A.I.** (2002) Directed Proteomic Analysis of the Human Nucleolus. Curr. Biol. *12*, 1-11. (doi 10.1016/S0960-9822(01)00650-9) (Citations 559, Scopus Nov 2013)

6. Trinkle-Mulcahy, L., Boulon, S., Lam, Y.W., Urcia, R., Boisvert, F-M., Vandermoere, F. Morrice, N.A., Rothbauer, U., Leonhardt, H., and **Lamond, A.I.** (2008) Identifying specific protein interaction partners using quantitative mass spectrometry and bead proteomes. Journal of Cell Biology. **1***83*, 223-239. (doi: 10.1083/jcb.200805092) (Citations 151, Scopus Nov 2013)

Key research grants relevant to this case study:

1. Human Frontiers Science Programme (2001) Functional Organization of the Cell Nucleus Investigated Through Proteomics and Molecular Dynamics. Value: £137,652. Grant Ref. rgp0031/2001-m. Principal Grant Holder: A I Lamond
2. MRC grant (2004) Proteomic Analysis of the Function of Nuclear SUMO Modification. Value: £424,220. Grant Ref. G0301131. Principal Grant Holder: A I Lamond
3. Wellcome Trust Programme Grant (2005) Structure and function of the mammalian cell nucleus. Value: £3,121,320. Grant Ref. 073980/Z/03/B. Principal Grant Holder: A I Lamond
4. Wellcome Trust Strategic Award (2007): Centre for Gene Regulation and Expression. Value: £4,997,609 Grant Ref. 083524/Z/07/Z. Principal Grant Holder: A I Lamond.
5. EU FP7 Prospects network grant (2008) PROteomics SPECification in Time and Space (PROSPECTS). Value: 1,046,019 Euros Grant Ref. HEALTH-F4-2008-201648. Principal Grant Holder: A I Lamond
6. Wellcome Trust Principal Research Fellowship (2009) Structure and function of the mammalian cell nucleus. Value: £3,113,288 Grant Ref. 073980/Z/03/B. Principal Grant Holder: A I Lamond.

4. Details of the impact (indicative maximum 750 words)

Beneficiaries

(a) UK and local Dundee Biotech (by introducing new cutting-edge technology services into the sector).
(b) Pharma and Biotech companies (such as Pfizer) using mass spectrometry and other services provided by DCP.
(c) Academic translational programs using mass spectrometry and other services provided by DCP.

Dundee Cell Products (DCP) is an innovative SME commercialising high quality research tools for life sciences research (http://www.dundeecellproducts.com). Moreover, it provides services to pharmaceutical and biotechnology companies as well as to academic researchers.

DCP was formed in 2006 by Prof Lamond and Dr Ajuh (who became Chief Scientific Officer and Chief Executive Officer respectively) with co-investment and assistance from the University of Dundee. In 2007, the company secured equity investment funding from a syndicate of angel investors to finance and expand its activities, followed in 2009 by a six-figure investment from angel investors and the Scottish Co-investment Fund (SCF). This helped DCP establish manufacturing and research facilities, and recruit expert technical and sales staff to expand its product portfolio. In 2011, Dundee Cell Products was awarded a £70,000 SMART:Scotland award from Scottish Enterprise (1). This award supported the development of proteomic-based methods in predictive toxicology. This was also accompanied by a £20,000 BioKT R&D grant by the Innovation Portal Dundee to develop new human growth factor products and related services (1).

Since its launch in 2006, DCP's turnover has increased ~10 fold and the company broke even in 2010. As of 2013, the company employed 10 people (eight with PhDs) with plans to increase headcount to 15-20 by 2015 with the development of novel high technology products and services. During the assessment period, turnover on the company's core products and services has been growing at ~30% year on year (2). Since 2008, the company has greatly expanded its products and services catalogue and as of 2013 offers >5,000 products and six contract research services. Moreover, the company has built SILAC-based quantitative proteomics, SILAQ^{TM}, as one of its innovative contract research services as a direct result of expertise at the University of Dundee.

DCP has successfully completed commercial contracts with both biotech and major pharma companies. In 2013, ~30% of its income came from international sales to countries including: Italy, Spain, France, Germany, Switzerland, Sweden, Belgium, Hong Kong, Japan, the USA and Malaysia. Two examples of commercial partnerships are:

- In 2009, DCP signed a major contract research agreement with Pfizer to develop new SILAQ applications to facilitate the discovery and development of new and safer drugs, potentially saving millions of dollars of clinical trial costs (3). This agreement was renewed in 2010.
- In 2008, DCP announced a major partnership deal with the biotechnology company Molecular Targeting Technologies, Inc (MTTI) (http://www.mtarget.com) (4). Under this agreement, DCP has the rights to distribute a portfolio of MTTI products in Europe primarily based upon fluorescence research applications.

DCP also provides services to academic clients. As of 2013, the company had contracts with >70 Universities worldwide (2). For example, DCP has been involved in projects with the University of Leeds to investigate the effects of virus infections on cellular proteomes (5) and with the Paul Ehrlich Institute, Germany to study molecular mechanisms of transmissible spongiform encephalopathies (6).

The company maintains a close working relationship with the University of Dundee and other UK Universities. For example DCP has been involved in five CASE studentships over the assessment period: 4 MRC-CASE PhD studentships together with academics at the Universities of Aberdeen, Dundee, Imperial College London and St Andrews and a BBSRC-CASE PhD studentship with the Roslin Institute, Edinburgh. For these studentships DCP provides training in research technologies and in their commercialisation. The company also benefits from continued links with the Lamond laboratory and when appropriate can utilise specialist equipment at the University. From 2010-2013 DCP was engaged in a DTI / Scottish Executive sponsored Knowledge Transfer Partnership with other mass spectrometry researchers in the College of Life Sciences (Dr Dougie Lamont and Prof Julian Blow) (7). DCP has been able to recruit highly skilled staff from the College of Life Sciences, providing jobs for postgraduate and postdoctoral researchers from the University. This highlights the economic opportunity provided by the College of Life Sciences creating a highly trained local pool of life scientists with skills that are of direct benefit to biotechnology companies. Moreover, DCP has provided an outlet for the commercialisation of new products and services in cutting edge proteomics initially derived at the University.

5. Sources to corroborate the impact (indicative maximum of 10 references)

1. Press release regarding SMART Scotland award from Scottish Enterprise for the development of a quantitative proteomics screening assay for predictive toxicology and BioKT R&D award from the Innovation Portal http://www.innovationportal.co.uk/news/news/2011/11/25/282.html
2. Confidential corroboration of the size/revenue of the company can be obtained from the Executive Director of Dundee Cell Products, Dundee Technopole, Dundee, DD1 5JJ. Other data can be found at www.dundeecellproducts.com/
3. Announcement of contract research partnership with Pfizer http://www.dundeecellproteomics.com/latest-news
4. Announcement of partnership with Molecular Targeting Technologies, Inc. http://www.mtarget.com/mtti/whatsnew/DundeeMTTI08Aug22.pdf
5. Collaboration with the Institute of Molecular and Cellular Biology, Faculty of Biological Sciences, University of Leeds: Emmott, E., Rodgers, M.A., and Macdonald, A., McCrory, S., Ajuh, P. and Hiscox, J.A. (2010) Quantitative proteomics using stable isotope labeling with amino acids in cell culture reveals changes in the cytoplasmic, nuclear, and nucleolar proteomes in Vero cells infected with the coronavirus infectious bronchitis virus. Mol Cell Proteomics. *9*, 1920-1936. (doi: 10.1074/mcp.M900345-MCP200)
6. Collaboration with the Paul Ehrlich Institute, Germany: Wagner, W., Ajuh, P., Löwer, J and Wessler, S. (2010) Quantitative phosphoproteomic analysis of prion-infected neuronal cells. Cell Comm and Signaling. *8*, 28. (doi: 10.1186/1478-811X-8-28)
7. Details of the Knowledge Transfer Partnership are available at http://info.ktponline.org.uk/action/details/partnership.aspx?id=7902