

Institution: The University of Edinburgh		
Unit of Assessment: UoA5 – Biological Sciences		
Title of case study: Research into stem cell biology leads to an engagement programme that increases patients', educators' and the public's understanding of current and potential applications of stem cells.		
Period when the underpinning research was undertaken: 2000- 2020.		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Prof. Ian Chambers	Head of Institute for Stem Cell Research	1991-present
Prof. Clare Blackburn	Professor of Tissue Stem Cell Biology	1997-present
Prof. Austin Smith	Director – Institute for Stem Cell Research	1990-2006
Prof. Wendy Bickmore	Director – MRC Human Genetics Unit	1986-present
Prof. Josh Brickman	Group Leader and Research Fellow- Institute for Stem Cell Research	2001-2015
Dr Tilo Kunath	Reader in Regenerative Neurobiology	2003-present
Period when the claimed impact occurred: 01/08/2013 – 31/12/2020		
Is this case study continued from a case study submitted in 2014? Y/N Yes		
1. Summary of the impact <p>Attribution: Impact has been achieved through a large-scale programme of public engagement (PE) in stem cell research and regenerative medicine (SCR-RM) - the EuroStemCell project (ESC) - that has arisen from and utilises research carried out at the University of Edinburgh (UoE) led by Professors Smith, Chambers, Blackburn, Bickmore, Brickman and Dr Kunath. The programme is led by Professor Blackburn. Management, content identification and format, editorial input, and evaluation are led at UoE.</p> <p>Impact: Extensive engagement with a broad target audience has increased public understanding of current applications, and the hopes and hypes generated by SCR-RM at UoE and elsewhere. Science communications practitioners and teachers have benefited from resources and training to deliver high-quality (PE) and science education around SCR-RM and related societal issues.</p> <p>Beneficiaries: Patients and people affected by conditions, educators, teacher trainers, science communicators, school students.</p> <p>Significance and Reach: This programme has promoted informed decision-making among non-specialists, and public acceptance of stem cell-based research and future therapies in Europe. The project is focused on Europe, but participation is worldwide.</p>		
2. Underpinning research <p>The impacts reported result from basic research into stem cell biology carried out at the UoE. The initial underpinning research was the discoveries by Smith, Chambers and UoE colleagues of key mechanisms that regulate the two cardinal properties of embryonic stem cells, the ability to 'self-renew' and to differentiate, and the use of this knowledge for growing these cells in culture, using a completely defined culture medium [3.1, 3.2]. Smith and colleagues also demonstrated that cells could change identity as a result of cell fusion [3.3], negating prominent claims that some adult stem cells could generate any cell type in the body upon transplantation.</p> <p>This research led to the award of the first large-scale EC-funded pan-European stem cell research consortium (EuroStemCell, 2004-2008, EUR12,000,000 (02-2004). Blackburn developed and led a substantial programme of training and science communication for this project (budget of EUR800,000, 02-2004), which drew extensively on the UoE research and on the advances and discoveries made subsequently in the field of SCR-RM. The science communication element was subsequently developed as a major project and was funded as a stand-alone coordinating action by the EC, also called EuroStemCell, through two consecutive funding rounds (FP7 2010-2015, EUR830,000 and H2020 2015-2018 EUR600,000, 01-2015).</p> <p>This PE programme has drawn on Kunath's work providing new stem cell-based tools for understanding the mechanisms of Parkinson's disease [3.4], Brickman and Bickmore's work related to development of improved means of generating pancreatic beta cells from pluripotent stem cells and hence potentially to new treatments for patients with Type 1 Diabetes [3.5], and</p>		

Blackburn's work establishing that the key cell type required for T cell production can be generated *in vitro* by reprogramming of unrelated cell types [3.6].

3. References to the research

[3.1] Niwa, H., Miyazaki, J., and Smith, A.G. Quantitative expression of Oct-3/4 defines differentiation, dedifferentiation or renewal of ES cells. *Nat Genet.* 2000 24: 372-6.

DOI: <https://doi.org/10.1038/74199>

[3.2] Chambers, I., Colby, D., Robertson, M., Nichols, J., Lee, S., Tweedie, S. and Smith, A.G. Functional expression cloning of Nanog, a pluripotency sustaining factor in mouse embryonic stem cells. *Cell.* 2003 113: 643-655. DOI: [https://doi.org/10.1016/S0092-8674\(03\)00392-1](https://doi.org/10.1016/S0092-8674(03)00392-1)

[3.3] Ying, Q.L., Nichols, J., Evans, E.P. and Smith, A.G. Changing potency by spontaneous fusion. *Nature.* 2002 416: 545-8. DOI: <https://doi.org/10.1038/nature729>

[3.4] Devine, M.J., Ryten, M., Vodicka, P., Thomson, A.J., Burdon, T., Houlden, H., Cavaleri, F., Nagano, M., Drummon, N., Taanman, J-W., Schapira, A.H., Gwinn, K., Hardy, J., Lewis, P.A., Kunath, T. Parkinson's disease induced pluripotent stem cells with triplication of the α -synuclein locus. *Nature Communications* 2011 2: 440 DOI: <https://doi.org/10.1038/ncomms1453>

[3.5] Illingworth RS, Hölzenspies JJ, Roske FV, Bickmore WA, Brickman JM. Polycomb enables primitive endoderm lineage priming in embryonic stem cells. *Elife.* 2016 Oct 10;5. pii: e14926. <https://doi.org/10.7554/eLife.14926.001>

[3.6] Bredenkamp, N., Ulyanchenko, S., O'Neill, K.E., Manley, N.R., Vaidya, H.J. and Blackburn, C.C. (2014) An organized and functional thymus generated from FOXP1-reprogrammed fibroblasts. *Nature Cell Biology*, 16 902-8. DOI: <https://doi.org/10.1038/ncb3023>

4. Details of the impact

A large-scale programme of public engagement (PE) in stem cell research and regenerative medicine (SCR-RM) has arisen from and utilises the above UoE research. This continues from a REF2014 impact case study that outlined how underpinning UoE research led to the establishment of the EuroStemCell project (ESC). The ongoing impacts achieved result from materials developed and regularly updated to support informed decision-making around SCR-RM and to increase **public awareness** and science capital in society through resourcing and supporting education and PE professionals; and from the widespread uptake of and engagement with these by patients, educators, publics and PE practitioners. In 2015, a new EC project began with the objective to further develop the website and resources to encompass new research and associated ethical and societal considerations, with a specific focus on facilitating decision-making with tailored resources for stakeholders, including people affected by conditions. A major redesign of the website was undertaken and launched in 2017 with a new 'Medicine and Stem Cells' section for a patient target audience and a fully catalogued repository of educational resources. Without the UoE research outputs and the links to patient groups and education professionals they foster, the project would not have continued, and the considerable new development of eurostemcell.org and the sustained development of the associated educational resources would not have been possible.

Impact on patients: Patients have benefited from **active participation and access to reliable information**. ESC collaborates with people affected by conditions to develop resources suited to their needs and has established a focus group to discuss the best approaches to patient participation. The impact of Kunath's engagement with the Parkinson's Disease community has been recognised by The Cure Parkinson's Trust with an award for "*a researcher who has had the greatest impact on the lives of people living with Parkinson's (PD) and/or has involved people with Parkinson's in a participatory way in their work*". [5.1]. Kunath was instrumental in the setting up of and ongoing activities of the Edinburgh Research Interest Group (ERIG), which sits in the Edinburgh Branch of Parkinson's UK. ERIG aims to provide opportunities for members with an interest in PD research to meet, communicate, work together and further the cause of research, and to encourage and develop all members' interest in research. ERIG and the UoE's Centre for Regenerative Medicine (CRM) host the annual Edinburgh Parkinson's Lecture. ERIG became a

model for the establishment of other RIGs. Members of the Edinburgh Branch of Parkinson's UK published a paper about their experience of engaging with researchers and the wider public.

"First, catch your researcher! Central to building community and social interest and engagement in research is undoubtedly the involvement of an active and enthusiastic researcher, in our case, Dr Tilo Kunath..."

"All three authors of this article have Parkinson's: for one author promoting Parkinson's research has become a consuming interest which emphasizes the positive side of having the condition; for another, a way of turning anger at the diagnosis into passion to make a difference; and for another, pride in belonging to and contributing to the whole."

(Edinburgh Branch Parkinson's UK) [5.2]

The ESC-led 'Hope Beyond Hype – Scottish Stem Cell Stories' project delivered user-led events to patient organisations and community groups in remote areas of Scotland. All participants who provided feedback described **learning impacts** in three areas – gaining a realistic viewpoint of SCR-RM, learning about the medical research process and timescales, and learning about the applications and opportunities for stem cells in research (eg in drug discovery and development).

"It is important for our members to get a realistic picture of what stem cells can and cannot achieve. They may not like what they hear, but the messages were delivered in such an engaging way that they got their questions answered." (Local patient group organiser) [5.3, page 14].

ESC receives and responds to email enquiries from individual members of the public (1,092 in 2019), the majority related to the potential for stem cell-based treatments to cure or alleviate their conditions, including 'unproven' treatments offered by companies in the absence of supporting preclinical data. This demonstrates a need for accurate, evidence-based information to support informed decision-making. Enquirers are advised to consult medical professionals and are directed to materials specific to their condition, and decision-making resources, including questions to ask if they are considering a stem cell treatment. [5.4]

- *"I thank you for that answer which will allow me to understand a little more what happens to me ... I will certainly follow your advice."*
- *"Wow! So grateful for the time and efforts spent on my behalf here... Your precautions are noted and confirmed. Thank you again for the courtesy and oversight provided here. No doubt a far more orderly and measured starting point than I had chosen earlier."*
- *"Thank you so much for your honest reply. I will be sure to take your advice on board before considering any offer of treatment from private clinics. I have appreciated your help and advice very much."*
- *"Thank you for the information. It is really useful for me, clarifying many doubts. Thank you again for your honesty."* (Responses from online enquirers)

To reach citizens at scale, the centrepiece of the project is the website (eurostemcell.org) through which on average 900,000 people each year access evidence-based materials when seeking digital information about stem cells (2019: 927,343 unique visitors, >200 countries). It provides expert-reviewed information on SCR-RM and related societal issues that is accessible for non-specialists, in 6 European languages. The content is significantly underpinned by UoE research, alongside that of other European research institutions via the network of expertise established through the ESC project. >80% of visitors reach the site via a direct Google search for queries related to stem cells and treatments. Due to the importance of Google as a source of public information, ESC conducted a study to measure the project's presence within search results in the UK, US, Canada, and Australia. Data showed that ESC was in the Top 3 of most prominent sources for information about stem cells and stem cell treatments related to Parkinson's Disease (above the NHS and major organisations such as Parkinson's UK). These results reflect the high perceived value of ESC for Google Search users, whose interactions feed back to Google's algorithm [5.5]. Social media channels are widely used (>12,700 Twitter followers; >4,900 Facebook followers; >5,500 YouTube subscribers, >1,200,000 views). A campaign for Stem Cell Awareness Day 2019 produced 32 videos from 8 partner institutions, answering questions submitted by the public (>3,500 unique and complete YouTube views, 34,474 unique Twitter

users). ESC materials are recommended by charities such as Leukaemia and Myeloma Research, Multiple Sclerosis Trust and SCOPE.

“My understanding is that when it comes to stem cells being a possible, safe and reliable treatment for cerebral palsy, things are still very much at the research stage. In my opinion, a good source of impartial advice about stem cell research is the EuroStemCell website....

Personally, I would be confident that if there are any significant, peer-reviewed future breakthroughs with research EuroStemCell will publish about it.”

(SCOPE Specialist Information Officer – Cerebral Palsy, in response to a patient community forum question about whether stem cell treatment is helpful) [5.6].

The films produced in the REF2014 period have been disseminated on DVD, the website and YouTube and screened at events for students (e.g. Stem Cell Australia’s Women in Stem Cell Science 2016) and patients (e.g. Diabetes Clinic, Universitair Ziekenhuis Brussel, World Diabetes Day 2018). A film about cell fate decisions, *Cell Fate: Journeys to Specialisation*, was released in 2014 and was in the official selection of the Goethe Institut Science Film Festival. In 2017, *Diabetes and Stem Cells* was released by ESC and partner project HumEn, featuring research by Bickmore and Brickman. Diabetes UK young volunteers contributed to the film, and one was also on a Q&A panel at the premiere and said that it was good to be involved in something so positive, as often what she sees and hears about diabetes on the news and social media is negative.

“Ever since last year looking round the Edinburgh labs I have decided to seek a career in stem cell research as I believe it has such potential, not just for people with diabetes so hopefully I will be able to contribute even more one day.” (Diabetes UK Volunteer with Type 1 diabetes) [5.7]

Impact on educators: Educators are provided with **resources and training** to support their teaching of stem cell biology. 31 out of 32 reviews of ESC materials on TES Resources 2015-2020 were 4- or 5-star (average >8,500 downloads per year). ESC is endorsed by educational resource providers, including the Scottish Schools Education Resource Centre (SSERC) National STEM Learning Centre and The Guardian’s Teacher Network. During the REF period, ESC contributed to SSERC CPD for 74 teachers in local authorities and held 2 full-day CPD programmes at CRM.

“Today was the best CPD I’ve experienced. Information was exciting and useful and gave me so many ideas for learning and teaching. It also helped boost my confidence in new science.” (Participant, 2014 Teacher CPD) [5.8]

A programme of visits to Scottish secondary schools provided pupil workshops and teacher CPD and resource kits for surrounding schools (327 teachers from 138 schools + 69 PGDE students). Evaluation showed that teachers’ practice was positively influenced by the CPD, with reportedly more engaging lessons for pupils, more enthusiastic teaching and feeling more confident with the subject matter. This was attributed to better knowledge, interest and quality resources. 92% of teachers had shared their learning and resources with others. Teachers reported cases of students discussing the themes with their families.

“When they introduced the new National Qualification, my first thought was, ‘I can’t do this topic’ [stem cells]. Hope Beyond Hype was a great watershed moment in my confidence and knowledge. It was one of the most important CPDs we’ve done for a long time.”

(Teacher) [5.9]

In 2015, Education Scotland invited ESC to present the CPD work, as an example of exceptional practice, at a day for government, industry and education on ‘Engaging with Scottish schools to promote STEM’.

Impact on PE Practitioners: PE practitioners in the SCR-RM community benefit from **resourcing and support**, and these practitioners in turn reach a wider geographic spread of public beneficiaries. During the Horizon 2020 funding period (1/1/2015-31/3/18), the ESC partnership collectively delivered >815 stem cell PE events/initiatives reaching in excess of 3,000,000 European citizens. Partner organisations have reported impacts including patients reporting better understanding of the scientific processes involved in therapy development, and why they might take a long time to be ready for use in the clinic; students being inspired to study biology or pursue science careers; and follow-up communications about stem cell treatments with event attendees.

ESC promotes networking of professionals in PE/communication roles and has facilitated 6 annual workshops (2015-2020) on sharing best practice in engaging people with SCR-RM. Participants have taken knowledge back to their home countries and used it to help develop their local PE infrastructure. Feedback showed the workshops deepened participants' understanding about how to engage specific audience groups, and inspired and gave them confidence to undertake forms of PE that they previously thought were unattainable. The workshops also helped identify opportunities to work collaboratively across Europe. An example is the increased participation of ESC partner institutions in UniStem Day, on which high school students are invited into European SCR-RM institutions (2019: 99 research institutions, 351 high schools, 15 countries). ESC was instrumental in the growth of this initiative, through its dissemination and coordination functions, and the ESC toolkit is part of the recommended programme [5.10]. The development of the toolkit was referenced in the REF2014 ICS, extensively featuring the research of Smith and UoE colleagues, with Chambers and Blackburn directly involved in resource development and scientific review. During this REF period, toolkits were distributed in partnership with EC stem cell research consortia and European national stem cell networks. Physical kits are used by 73 research institutes in 15 countries. Individual components can now be downloaded, including a comic now available digitally in 19 languages.

5. Sources to corroborate the impact

[5.1] Tom Isaacs award to Tilo Kunath from Cure Parkinsons charity:

<https://web.archive.org/web/20201218090013/https://www.cureparkinsons.org.uk/ti-award-tk-2019>

[5.2] Adventures with Parkinson's: empowering Parkinson's patients to become active partners in research and treatment. Alison Williams, Ken Bowler, and Bill Wright. *Regenerative Medicine* 2017 12:7, 737-742. <https://doi.org/10.2217/rme-2017-0030>

[5.3] Evaluation of 'Hope Beyond Hype – Scottish Stem Cell Stories'

[5.4] EuroStemCell's response to enquiries submitted by members of the public via the contact form on the website. Original emails- in French, English and Spanish.

[5.5] Data tables reflecting the high perceived value of ESC for Google Search users (5.5i & 5.5ii). <https://www.eurostemcell.org/datadonation>

[5.6] Charities and organisations that recommend EuroStemCell for information:

i) <https://lmruk.org/resources/>;

ii) <https://www.mstrust.org.uk/a-z/stem-cell-therapy>;

iii) <https://community.scope.org.uk/discussion/46977/stem-cell-treatment-for-my-son>

[5.7] Short Film on Diabetes and Stem Cells: <https://www.ed.ac.uk/igmm/news-and-events/news-2017/diabetes-stem-cells-short-film-premiere> and

<https://www.youtube.com/watch?v=v5x0X8-o0bo>

[5.8] Letter of support from Scottish Secondary Education Resource Centre (SSERC).

[5.9] "Regenerate" Project, End of Grant Report (5.9i) and Audience Evaluation (5.9ii).

[5.10] Testimonial from Project Manager, UniStem Centre