BSDB Newsletter

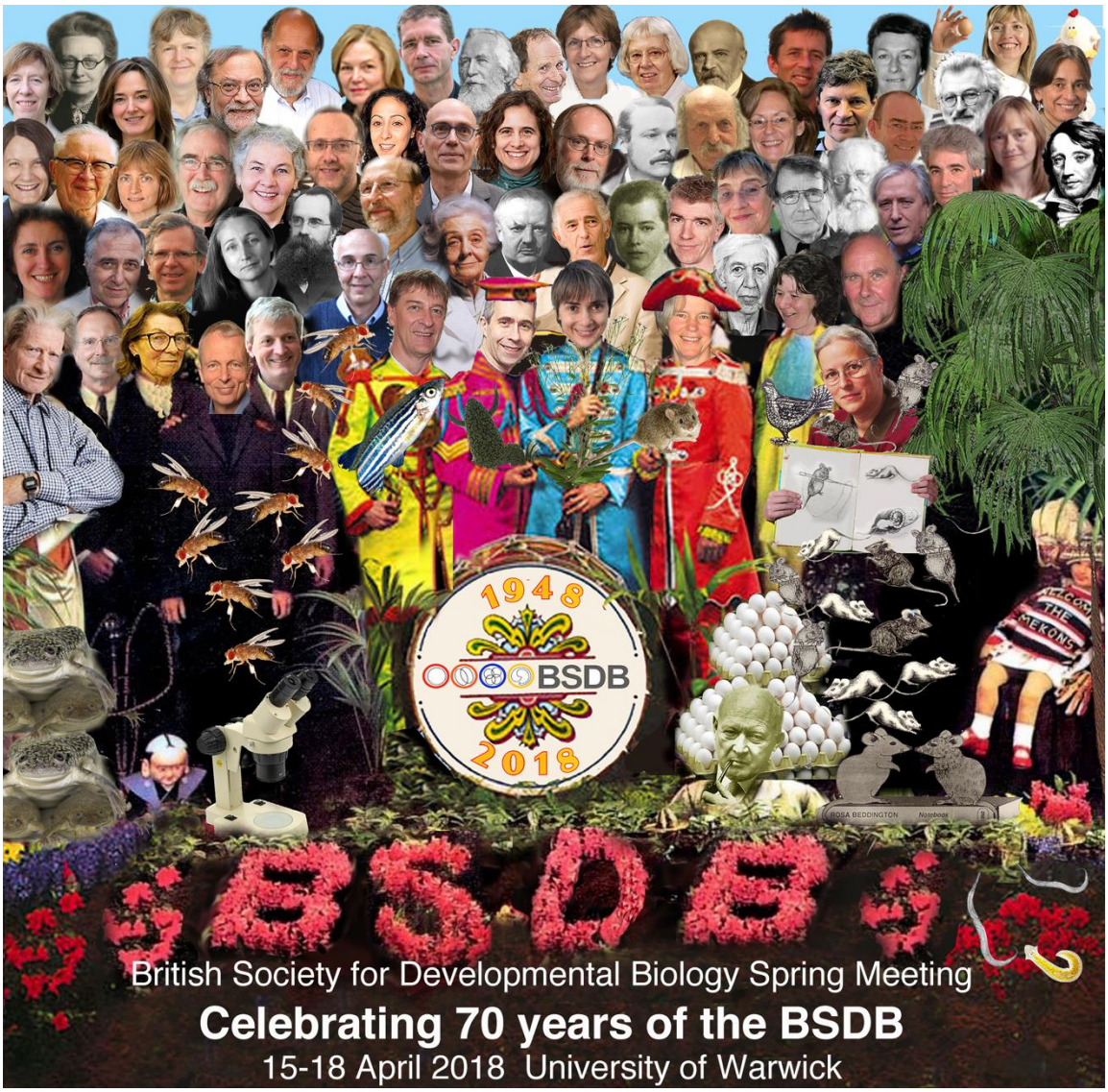
2016 & 2017

Vol. 37 & 38

British Society for Developmental Biology

www.bsdb.org

BSDB Spring Meeting
Warwick
15–18 April 2018



BSDB Autumn Meeting

Edinburgh
10-12 Sept 2018
Embryonic-Extraembryonic Interactions – from genetics to environment

The Company of Biologists

THE NODE

My final newsletter – and some thoughts about communication

"This changes the nature of the newsletter from being a source of primary information, and turns it into a legacy item or even a historical document for future BSDB generations."

This is my final newsletter as communications officer of the BSDB. I must admit that I enormously enjoyed the task, and can only hope that the changes to our website and the ways in which the society has been represented during my time in office are seen positively by our members. It is my pleasure to announce that Ben Steventon (p.6) has agreed to take over as BSDB communication officer from autumn 2018. I am confident that he will do a brilliant job.

Unlike previous editions, this newsletter covers two years of our society's life. But honestly, did you even notice the delay? Extrapolating from the download metrics of former newsletters, the long gap is very likely to have gone widely unnoticed, and I can see two reasons for this. Firstly, on the positive side, all our society news is now being published more promptly on our website or on The Node. This changes the nature of the newsletter from being a source of primary information, and turns it into a legacy item or even a historical document for future BSDB generations. This is reason enough for the BSDB to continue with its newsletter. Secondly, a reason of more concern is that the low viewer numbers likely reflect a tendency of communication fatigue in our community. Let me briefly extend on these thoughts before outlining the content of this newsletter.

<u>The BSDB informs promptly online.</u>
If I have done my job well for the last two years, the contents of this newsletter should no longer be news to you, but rather be a reminder of our active society life during this period. I have made every effort that news was brought to you promptly via our website

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or through **The Node**. Of these, The Node has become an increasingly important medium.

Maintained by The Company of Biologists as a **communication platform for the community of biomedical scientists**, it has taken on the form of a **modern electronic newsletter** that reaches out internationally. As explained in a recent publication, The Node's community manager Aidan Maartens either authors or commissions meeting reports, book reviews, obituaries or interview transcripts, and collates community-relevant information about meetings and workshops. Importantly, we as individuals or societies can use The Node as a communication platform to advertise jobs and events, write about science-related topics, explain our latest publications, or share community-relevant experiences. Once registered, we can publish freely and 'uncensored' as long as we keep within The Node's reasonable rules. In this way, we can capitalise on a very well established communication platform, which is further enhanced by The Node's Twitter and Facebook accounts, each with thousands of followers. Much of the science-related news that would previously have been disseminated via the BSDB newsletter or website, is being covered by The Node, taking an enormous work load off my shoulders - and the same can likely be said for Developmental/Cell Biology societies worldwide. There is true synergy and, naturally, more community members visit The Node's website than the BSDB's. Consequently, I closely collaborate with Aidan and follow a strategy in which many of our news posts are published on The Node - of course always making sure that they are likewise accessible through our own site.

This said, the **BSDB website** still has an important purpose. User metrics indicate that our site has its prime function in BSDB-specific information, such as our conference and travel grants, awards and meetings and committee information. I take great care that these pages are updated as soon as new information is available. Please, let me or Ben know if there is anything that's wrong or missing – we'll act swiftly.

Is our communication failing?

Regardless of whether **newsletters** occur in static journal format or as dynamic websites, they often are **important motors for scientific communities** and their science, as is well explained in an article by C. M. Kelty from 2012. But does this strategy still work effectively? I sometimes feel that we were better informed in pre-internet times when information was less abundant but focussed on the essentials, and when dissemination was easier because the readership was hungry for information. Today, we tend to see quantity over quality: more than a hundred emails rain into our accounts every day, and social media timelines have become so busy that there is hardly time to view even a fraction of the messages. And, even if information is being read, I see little evidence that this leads to impactful social media debates. Furthermore, the sharing of information on social media is short-lived and often ineffective as can be deduced from viewer metrics of shared links. Even the use of social media as a mere source of professional information seems to fail: a survey by The Node showed that most members of our community have no Twitter account. Even more alarmingly, subscription rates to websites are low (~900 for The Node and ~150 for the BSDB), when considering that the BSDB alone has a ~1400 strong membership. In a nutshell, besides not reading the newsletter, many of us are not tapping into the existing online community news channels.

In consequence, important information can no longer be disseminated effectively and reliably, and our community no longer has the means to develop a common voice. This clearly weakens us in times where the need for communicating the importance of

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"Finally, the newsletter concludes with reports about our main awardees of the last two years…"

fundamental science is perhaps greater than ever. In recognition of this challenge, many contributions in this issue are dedicated to the **topic of science communication**: our chair Ottoline Leyser speaks about the importance of communication (p.4); a dedicated article explains the BSDB's advocacy campaign in collaboration with The Node (p.23); an overview of a recent special issue on science communication in the field of biomedical science is being provided (p.27); our student and postdoc representatives announce a writing competition aiming at advocacy (p.31); the example of an advocacy article for Open Access Government is given (p.78).

Further contents of this issue: As usual, the start of this newsletter is made by the chair's and officers' reports. In the **chair's address** (p.4), Ottoline Leyser reflects on the BSDB as an inclusive, co-operative, and outward looking society, and the need to uphold these traits in times of Brexit and worldwide political tendencies of isolationism; Ottoline ends her address with some thoughts on the importance of communication. The **secretary's report** by Kim Dale (p.5) highlights the positive developments of the BSDB in terms of its steadily growing membership. She notes that, in 2018, the committee will see a turn-over of 5 members (see also p.7) - so await a call for nominations before the next Spring Meeting. In the same vein, the three **new members** that have joined the committee in 2017 are being introduced on page 6. The **meetings officer** Joshua Brickman (p.9) looks back at the BSDB's excellent meeting record of the last two years (see also **meeting reports** on pages 11 and 14), and gives an outlook on the exciting meetings planned for the next three years (see also p.10), including the **BSDB's 70th anniversary meeting** taking place 15-18 April 2018 in Warwick (see this issue's cover image). The **treasurer's report** by Chris Thompson (p.19) is an impressive account of the high number of members that were supported to attend meetings or workshops in 2016 and 2017, and sends out the reconfirming message that our financial status remains solid, providing the BSDB with continued capacity to support its members and their science-related activities. Our **student & postdoc representatives**, Alexandra Ashcroft and Michelle Ware (p.30), report about their outstanding efforts to deliver on the requests of junior members expressed during the survey from 2015. In response, Alex and Michelle introduced a very successful career workshop (see the respective reports on p.32) and a new career website (detailed on p.35). Finally, the newsletter concludes with reports about our main awardees of the last two years, in particular the winners of the **Waddington** (p.38), **Cheryll Tickle** (p.41) and **Beddington** medals (p.45), as well as the two **Dennis Summerbell** awardees (p.47), and 14 project reports by students who were supported by the **Gurdon/The Company of Biologists Summer Studentship** scheme. See a complete overview of all awardees, including poster prize winners (p.36) – and remember that most award lectures were documented and are available on our **YouTube channel**.

Andreas Prokop

The BSDB gratefully acknowledges the continuing financial support of The Company of Biologists Ltd (CoB).

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Chair's welcome note by Ottoline Leyser

"It is a sign of the great strength of our community that there are always BSDB members willing to serve on our Committee."

"At its best, science is an inclusive collaborative effort to understand the world around us and thereby to make life better for everyone."

"…the success of the BSDB is based on its inclusive community ethos."

"…for example, half a dozen nationalities/countries are represented on the current Committee alone. We have a long tradition of working with our sister societies across Europe and around the world."

In this bumper issue of the BSDB News Letter, I have many people to thank. It is a sign of the great strength of our community that there are always BSDB members willing to serve on our Committee. The Society is deeply grateful to those who have given their time to the BSDB, in particular our retiring Committee members Anna Philpott, Jo Begbie and Henry Roehl, and our new Committee members Cynthia Andoniadou, Clare Baker and Ben Steventon.

Meanwhile, it has been a turbulent time in the UK and internationally. I remember quite distinctly several conversations in the first half of 2016, including at the BSDB Spring meeting, where we nervously joked about the possibility that by the end of the year, the UK could be on its way out of the EU and Donald Trump could be on his way into the White House. Hardly anyone I know wanted either, and tellingly neither did they expect these things to happen. I am sure people will be analysing the causes and consequences of these momentous events for many years to come.

The scientific community is undoubtedly still in shock. We work in a highly international culture. At its best, science is an inclusive collaborative effort to understand the world around us and thereby to make life better for everyone. The Brexit and Trump votes seem born out of feelings of exclusion and powerlessness, leading to self-interested parochial protectionism. Given this culture clash, it is not surprising that scientists are so traumatised. What should we do about it?

The top priority for me is precisely to affirm and reaffirm to as wide an audience as possible the inclusive, collaborative and problem-solving nature of science. There is a danger of exactly the opposite happening. Scientists are people too, and we are just as prone to self-interested parochial protectionism when we feel excluded and powerless, as we do now. For example, I have heard an awful lot of rhetoric from scientists about the horrors of a post-truth society where expertise is derided and anyone can say anything they like regardless of its factual accuracy or veracity. While there is no doubt that access to accurate information is an important element of democracy, this post-truth narrative is dangerous. It can easily slip into the notion that as scientists, we are superior beings, protected from the weak-minded allure of confirmation bias - all our views are based on a careful analysis of all the evidence and you would not catch a scientist succumbing to a Twitter rumor. This is clearly tosh and is exactly the sort of divisive thinking that got us into this mess in the first place. Most of the scientists I know were against Brexit for ideological reasons - a conviction that nations working together to tackle the world's problems is the way to go and the EU, for all its imperfections, is better than a bunch of individual nation states focused on their own interests. This is, to my mind, a compelling argument. That being in the EU is beneficial for our trade deficit really does not do it for me, and in any case, I am not an economist and I have no idea whether the evidence supporting this assertion is any good or not.

To fight self-interested parochial protectionism, you can't start with a misguided premise of exclusive superiority. Instead we need to celebrate loudly the inclusive nature of science and its transformative potential. Thinking locally, for me the success of the BSDB is based on its inclusive community ethos. This is what brings everyone back to the Spring Meeting every year. Of course, science is global, as the Royal Society's post-referendum twitter campaign sought to highlight (#ScienceIsGlobal). The BSDB, as you would expect, reflects this diversity with, for example, half a dozen nationalities/countries represented on the current Committee alone. We have a long tradition of working with our sister societies across Europe and around the world. For example, in 2019 look out for the first in a new series of 4 yearly European Congresses in Developmental Biology, which we will co-sponsor as our Autumn Meeting.

"Now more than ever we need to welcome people into science, not wall ourselves off."

Meanwhile, we need to work harder to engage wider audiences including policy makers and diverse publics. The committee has discussed what the Society can do to support such efforts. You may have noticed the new and improved outreach section on our website (bsdb.org/public-outreach) for which I would like to thank our communications officer Andreas Prokop. He has also catalysed an advocacy campaign in collaboration with Development and the Node (bsdb.org/advocacy). Any suggestions from members on this and related topics would be most welcome, as well as examples of things you have done that have worked well. Now more than ever we need to welcome people into science, not wall ourselves off.

In this spirit of celebration of our field, I look forward to welcoming you to the 2018 BSDB 70th Birthday Spring Symposium (bsdb.org/meetings).

Ottoline Leyser

Secretary's report by Kim Dale

"Since March 2016, we have had 124 new applications. The current membership stands at 1350."

"Lastly, six committee members, including three officers and two representatives, will finish their term in 2018…"

2017 has been another wonderful year for the Society in terms of membership, medal nominations and indeed medal winners. Since March 2016, we have had 124 new applications. The current **membership** stands at 1350. The nominations for the 2018 **Waddington Medal** (see also p.38) were outstanding again this year. The voting was completed on schedule and I invite you all to come along to the Spring Meeting to hear what will be a spectacular talk by the worthy winner. This year's **BSDB Spring Meeting**, 15-18 April 2018 at Warwick, will be one not-to-miss as we will be celebrating the 70th birthday of the Society. Thus the meeting schedule will be dotted throughout with special birthday-related items to mark this memorable milestone in the history of British Developmental Biology (see also p.9).

The voting for the 2018 **Cheryll Tickle Medal** was completed on schedule, and we proudly announce that the winner of the Cheryll Tickle Award is Christiana Ruhrberg (p.41). Again, I encourage you all to come to the Spring Meeting to listen to Christiana's medal talk.

The third medal of the BSDB, the **Beddington Medal**, is awarded for the best PhD thesis of the year (see also p.45). I encourage you all to send in nominations for the 2018 Beddington Medal for PhD dissertations that were defended during 2017. The closing date for nominations this year is Friday, 26 January 2018.

Following a generous donation, the BSDB has instituted the **Dennis Summerbell Lecture**, to be delivered at its annual Autumn Meeting by a junior researcher at either PhD or Post-doctoral level. The 2017 lecture awardee was **Helen Weavers** (School of Biochemistry, Faculty of Biomedical Sciences, University of Bristol) with her submitted abstract "Understanding the inflammatory response to tissue damage in *Drosophila*: a complex interplay of pro-inflammatory attractant signals, developmental priming and tissue cyto-protection" (see also p.48).

Lastly, six **committee members**, including three officers and two representatives, will finish their term in 2018 (see also p.7), and these positions will need to be replaced at the AGM taking place during the Spring Meeting 2018. I therefore encourage you to consider potential nominations for these important positions in the BSDB committee and will be emailing you all soon to request nominations to be sent in ahead of the Spring Meeting. The committee members leaving in 2018 are myself as Secretary, Joshua Brickman (Meetings Officer), Andreas Prokop (Communications Officer), Sally Lowell, Michelle Ware (Postdoc Rep) and Alexandra Ashcroft (Graduate Rep). I am glad to be able to report that the current committee members **Megan Davey**, **Sally Lowell** and **Ben Steventon** have kindly agreed to take over as secretary, meetings officer and communications officer, respectively (see also p.7).

A Happy New Year, and see you in Warwick in April 2018.

Kim Dale

Introducing the new BSDB committee members

Cynthia Andoniadou

"Her group focuses on the regulation of the stem cell pool and the signalling mechanisms mediating stem cell decisions, with a focus on non-cell autonomous regulation."

Benjamin Steventon

"The lab applies live and quantitative imaging techniques to investigate how cell fate decisions are orchestrated in space and time during axis patterning in zebrafish embryos."

We would like to thank the BSDB committee members who stepped down this year for their excellent services. They are **Anna Philpott** (Cambridge; 2012-17), **Jo Begbie** (Oxford; 2012-17) and **Henry Roehl** (Sheffield; 2012-17). At the 2017 Spring Meeting's AGM in Warwick, three new BSDB committee members, Cynthia Andoniadou, Benjamin Steventon and Clare Baker, were elected to serve until 2020. We would like to welcome them. Please, read here about their careers and research interests. An overview of all committee members is provided here and on page 7.

Cynthia Andoniadou

Cynthia is a tenured Lecturer at the Craniofacial Development and Stem Cell Biology division at King's College London [LINK].

She has a degree in Genetics and Microbiology from Queen Mary University of London, and a PhD in Anatomy from University College London. As an undergraduate she used cytogenetic approaches to investigate the phylogeny of an allotetraploid iris (Andrew Leitch lab). Her PhD in the group of Robin Lovell-Badge (National Institute for Medical Research) focused on the function of Sox2 in maintaining the multipotent identity of neural stem cells.

Her postdoctoral work in Juan Pedro Martinez-Barbera's lab (UCL Institute of Child Health) explored the mechanisms through which the developing anterior forebrain is prevented from acquiring posterior fates and demonstrated that key transcription factors in this tissue mediate this by repressing WNT targets. This sparked her interest in the WNT pathway. It led to studies focusing on its influence during pituitary development and to the generation of mouse models for human developmental pituitary tumours, as well as the finding that these arise due to the paracrine actions of stem cells that activate this pathway. Using mouse genetics she demonstrated the in vivo function of pituitary stem cells during embryonic and postnatal development.

She started her independent research group in 2013 at the Craniofacial Development and Stem Cell Biology division at King's College London, where she is a tenured Lecturer. Her research is supported by an MRC New Investigator Award and a Lister Institute Research Prize Fellowship. Her group focuses on the regulation of the stem cell pool and the signalling mechanisms mediating stem cell decisions, with a focus on non-cell autonomous regulation. She is involved in teaching developmental biology and stem cell biology to undergraduate and postgraduate students and in the dissemination of science through numerous public engagement and educational initiatives.

Benjamin Steventon

Benjamin is a Wellcome Trust/Royal Society Sir Henry Dale fellow at the Department of Genetics, University of Cambridge [LINK].

He has a Biochemistry degree from the University of Bath and a PhD from University College London. His interest in early neural crest development began as a project student working with zebrafish in the lab of Robert Kelsh. This interest continued during his PhD with Roberto Mayor, looking at the timing of neural crest induction in *Xenopus*. He showed that the order of presentation of extracellular signals is essential for the correct induction of the neural plate border and neural crest genes during gastrulation.

After obtaining his PhD in 2008 he moved to KCL to work with Andrea Streit and began working with the chick model. During this time he was interested in the mechanisms that pattern and orchestrate cell fate decisions and movements of the early embryonic ectoderm. Together with the Mayor lab,

Clare Baker

"…her research currently has two main strands. The first is the development of olfactory ensheathing glia cells..."

"Her group's other main focus is the evolution and elaboration of neurogenic placodes and the neural crest…"

"To answer questions relating to the development and evolution of these sensory organs, her lab has worked with the embryos of a wide range of vertebrates…"

he uncovered a novel 'chase and run' mechanism that is important in both driving the directional migration of the cranial neural crest and the organisation of pre-placodal cells into distinct placodes. He also investigated a conserved role for the Gbx2-Otx2 boundary in organising the peripheral structures of the developing nervous system. Subsequently he moved to the lab of Jean-Francois Nicolas and Estelle Hirsinger at the Institut Pasteur, Paris. Here, he went back to working with zebrafish embryos in order to get a complete understanding of the tissue deformations that lead to the elongation of the embryonic body axis. In order to develop imaging and analytical techniques to study this process at the cellular and molecular levels, he was awarded a Marie-Curie fellowship to work with Scott Fraser (University of California, USA) and Alfonso Martinez-Arias (University of Cambridge).

Ben started his independent research group in 2016 within the Department of Genetics, University of Cambridge. He is currently supported by a Wellcome Trust/Royal Society Sir Henry Dale fellowship. The lab applies live and quantitative imaging techniques to investigate how cell fate decisions are orchestrated in space and time during axis patterning in zebrafish embryos. While a zebrafish performs this with little overall growth in embryo size, higher vertebrates like mammals undergo a large degree of growth. His lab is interested in how such fundamental differences in embryo size, cell number and energy supply have influenced the interpretation of conserved regulatory networks and patterning mechanisms by individual cells. What are the limits of adaptability and developmental constraint that are encoded within developmental systems during vertebrate evolution?

Clare Baker

Clare is Reader in Comparative Developmental Neurobiology at the University of Cambridge, in the Department of Physiology, Development & Neuroscience [LINK].

As a PhD student at Cambridge with Janet Heasman and Chris Wylie, Clare described the first molecular marker of migrating lateral line placodes in *Xenopus*. During her postdoctoral training with Nicole Le Douarin (Institut d'Embryologie du CNRS et du Collège de France, Nogent-sur-Marne, France) and Marianne Bronner-Fraser (Caltech, Pasadena, CA, USA), she used the quail-chick chimera technique to show that early- and late-migrating mesencephalic neural crest cells have equivalent potential, and to study the development of the trigeminal placodes.

Clare set up her own lab in Cambridge in 2002, where her research currently has two main strands. The first is the development of olfactory ensheathing glia cells, which are of clinical interest since they can promote nerve repair when transplanted into the damaged spinal cord. Using grafting techniques in chicken embryos and genetic lineage-tracing in mice, Clare's lab discovered that these cells are derived from the neural crest, like all other peripheral glial cells, and not from the olfactory placodes as previously thought. The lab is currently investigating how olfactory ensheathing glia cells develop from the neural crest, and their role during the embryonic development of the olfactory system.

Her group's other main focus is the evolution and elaboration of neurogenic placodes and the neural crest, with an emphasis on sensory systems, including the mechanosensory paratympanic/spiracular organ, the chemosensory carotid body, and the electrosensory division of the lateral line system. To answer questions relating to the development and evolution of these sensory organs, her lab has worked with the embryos of a wide range of vertebrates, including lamprey, shark, skate, paddlefish, sturgeon, catfish, zebrafish, axolotl, *Xenopus*, mouse and chicken.

Current committee members

Current committee members

- **Chair** – **Ottoline Leyser** (Cambridge; 2014-19) - chair@bsdb.org - interest: shoot branching control in *Arabidopsis*
- **Secretary** – **Kim Dale** (Dundee; 2013-18) - secretary@bsdb.org - interest: vertebrate segmentation in chick and mouse **–** *post will be taken over by* ***Megan Davey***
- **Meetings Officer** – **Josh Brickman** (Edinburgh/Copenhagen; 2013-18) - meetings@bsdb.org - interest: early embryonic lineage specification in ES cells **–** *post will be taken over by* ***Sally Lowell***
- **Treasurer** – **Christopher Thompson** (Manchester; 2014-19) - treasurer@bsdb.org - interest: evolutionary & developmental Genetics in *Dictyostelium*
- **Communications Officer** – **Andreas Prokop** (Manchester; 2013-18) - comms@bsdb.org - interest: axon growth & maintenance in *Drosophila* **–** *post will be taken over by* ***Ben Steventon***
- **Graduate Representative** – **Alexandra Ashcroft** (Cambridge; 2015-18) – students@bsdb.org - importance of DLK family gene dosage **–** ***apply*** *for this post before the next Spring Meeting*
- **Postdoc Representative** – **Michelle Ware** (group of Jenny Morton in Cambridge; 2015-18) - postdocs@bsdb.org - interest: circadian rhythms in Huntington's disease **mouse** models **–** ***apply*** *for this post before the next Spring Meeting*

Other committee members

- **Sally Lowell** (Edinburgh; 2013-18; **meetings officer** 2018-23) – early lineage decisions in **ES cells**
- **Andy Oates** (London; 2014-19) – vertebrate segmentation in **zebrafish**
- **Megan Davey** (Edinburgh; 2014-18; **secretary** 2018-23) – cilia during neural tube & limb development in **chick** & **mouse**
- **Alistair McGregor** (Oxford; 2015-20) – evolution of animal development & morphology in **arthropods** incl. ***Drosophila***
- **Berenika Plusa** (Manchester; 2015-20) – early mammalian embryogenesis in **mouse**
- **Tristan Rodriguez** (London; 2015-20) – cell fate & survival in early **mouse** & **ES cells**
- **Rita Sousa-Nunes** (London; 2015-20) – neurogenesis and cancer in ***Drosophila*** & **mammalian cells**
- **Cynthia Andoniadou** (King's College London; 2017-22) – pituitary stem cells in **mouse**
- **Clare Baker** (Cambridge; 2017-22) – neurogenic placodes and the neural crest in a range of vertebrates
- **Ben Steventon** (Cambridge; 2017-18; **communications officer** 2018-23) – neuromesodermal progenitors in **zebrafish**

"*Even more alarmingly, subscription rates to websites are far too low (~900 for The Node and ~150 for the BSDB), when considering that the BSDB alone has a ~1400 strong membership. In a nutshell, besides not reading the newsletter, many of us are not tapping into the existing online community news channels.*" (p.2)

Please, subscribe to **bsdb.org** by entering your email address in the "*Subscribe to new posts by email*" field on the right-hand side and press "*Subscribe*". Similarly, press "Subscribe" on the right-hand side of **thenode.biologists.com** to provide your email and choose your subscription option.

Meeting Officer's report by Joshua Brickman

"…our recent meetings have been a resounding success."

"…the 2018 Spring Meetings stands out because it will be our 70th birthday meeting which will take place in a new venue in Warwick with brand new lecture theatres. We will celebrate 70 years of Developmental Biology in the UK with 10 plenary speakers, including two Nobel Prize winners!."

Ideas for a meeting?

A major task of the BSDB Committee is to host high quality scientific meetings.

We welcome therefore suggestions of future topics for Autumn Meetings. Simply contact: meetings@bsdb.org

I am coming to my last year as meetings secretary and am pleased to announce that Sally Lowell (Centre for Regenerative Medicine, University of Edinburgh) has agreed to take on the role of meetings secretary. She will be taking over serving from fall 2018.

I am very pleased to report that also our recent meetings have been a resounding success. Our **2016 Spring Meeting** was joint with the BSCB and organised by Sally Lowell and Anna Philpott for us, and Buzz Baum and Silke Robatzek for the BSCB. Our **2016 Autumn Meeting** focused on "Chimaeras and their use in studying developmental processes and disease models" and was organised by Jenny Nichols and Tristan Rodriguez. It was supported by the Anne McLaren Memorial Trust Fund and the Company of Biologists. It was an exciting meeting steeped in history as is detailed in our meeting report on page 14.

Unfortunately, 2016 was the first year in about five years that our meetings lost money, largely due to the increasing costs of the venues concerned. While the amounts were not great and they do not have any significant implications for our society, we have decided to increase registration rates to ensure that our meetings are close to revenue neutral or perhaps even above. Any proceeds we make from these meetings we invest back in travel awards.

Our **Spring Meeting in 2017**, joint with the BSCB and Genetics Society, had around 400 attendees and was a fantastic meeting. Thanks to the organizers Andrew Oates and Henry Roehl for us, Julie Welburn and Andrew Cartler for the BSCB, and Rebecca Oakly and Marika Charalamous for the Genetics Society. Our **2017 Autumn Meeting**, organized by Megan Davies, took place in Stockholm and was our first meeting jointly with the Scandanavian Societies for Developmental Biology: from Sweden, Finland, Norway and Denmark. Megan did a fantastic job for the BSDB on the program committee for this meeting.

Future meetings are planned well ahead until autumn 2020, and updated information can be obtained from the BSDB meetings webpage, which also lists meetings of previous years.

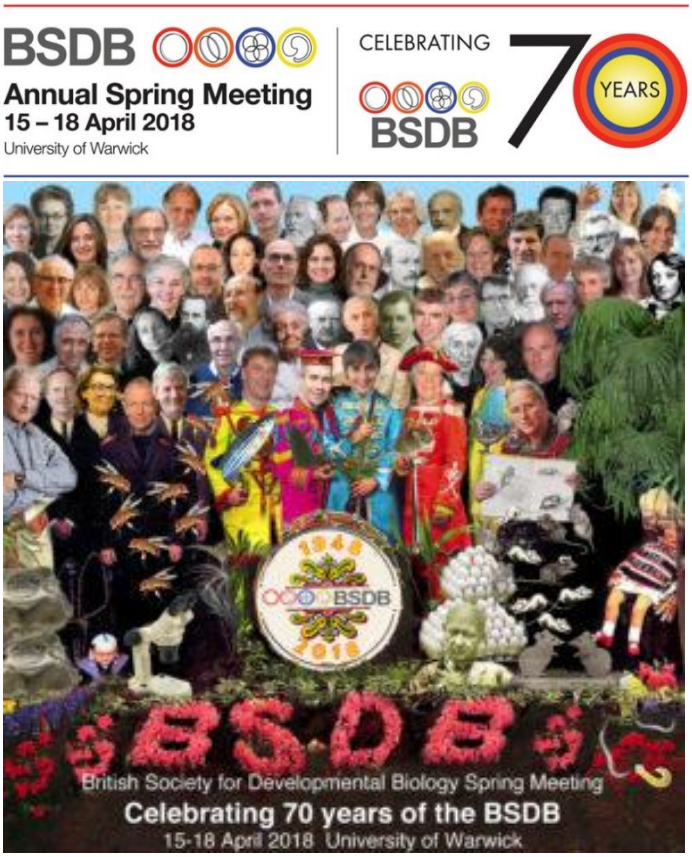
Our **Spring Meetings** have been **agreed for the next three years**, all of which will take place in Warwick: in 2018 (15-18 April) the BSDB will have its own Spring Meeting, in spring 2019 (7-10 April) we will again be joined by the BSCB, and in spring 2020 (29 March - 1 April) we will be joined by the Genetics Society. Of these, the **2018 Spring Meetings** stands out because it will be our **70th birthday meeting** which will take place in a new venue in Warwick with brand new lecture theatres. We will celebrate 70 years of Developmental Biology in the UK with 10 plenary speakers, including two Nobel Prize winners! In addition to great science, the meeting will feature a special session on the history of Developmental Biology. This will be followed by a panel discussion on how our field can move from the past into the future, and then an evening workshop aimed at showing how Developmental Biology can build on its past successes to inspire early career researchers in this field to address future research questions through multidisciplinary approaches. There will also be games, competitions, a picture exhibition of paintings by former and present society members, and of course a party. Make sure you register early to insure to reserve your place.

Autumn Meetings can be organised by all BSDB members so do not hesitate to approach me or Sally if you have any ideas. However, we are booked for meetings through to 2021 at least….so think ahead, think of new ideas and we will help you to organise the meeting. Our 2018 Autumn Meeting will take place in Oxford's Corpus Christi College (10-13 Sept). It is entitled "Embryonic Extra-embryonic interactions: from genetics to environment" and organised by Tristan Rodriguez, Shankar Srinivas (UK), Kristen Panfilio (UK/Germany), Susana Chuva de Sousa Lopes (Netherlands), Kat Hadjantonakis (US). In autumn 2019 (23-26 Oct) we will

be contributing to the first ever European Congress of Developmental Biology in Alicante Spain. In autumn 2020 (date to be announced) Anestis Tsakiridis will organise a meeting on posterior growth in Sheffield.

Joshua Brickman

Upcoming BSDB Meetings



- date: 15-18 April 2018 – REGISTRATION NOW OPEN!
- place: Warwick
- organisers: Berenika Plusa, Sally Lowell, Alistair McGregor, Joshua Brickman
- website: www.bsdb-meetings.co.uk/home
- poster can be downloaded here

Autumn meeting 2018

- Embryonic-Extraembryonic Interactions – from genetics to environment
- date: 10-13 September 2018
- place: Oxford, UK (Corpus Christi College)
- organisers: Tristan Rodriguez (BSDB, UK), Shankar Srinivas (UK), Kat Hadjantonakis (US), Kristen Panfilio (UK/Germany), Susana Chuva de Sousa Lopes (Netherlands)
- Poster: bsdb.org/wp-content/uploads/EEI-2018-preposter.pdf

Spring meeting 2019

- Jointly with BSCB
- date: 7-10 April 2019
- location: Warwick
- organisers: Rita Sousa-Nunes (BSDB), Tristan Rodriguez (BSDB), Victoria Sanz-Moreno (BSCB), Susana Godinho (BSCB)

Autumn meeting 2019

- European Congress for Developmental Biology
- date: 23-26 Oct 2019
- location: Alicante, Spain
- organisers: tba

Spring meeting 2020

- Jointly with Genetics Society
- date: 29 March – 1 April 2020
- location: Warwick

Note that all this information is listed and updated on bsdb.org/meetings. For all these conferences, BSDB members INCLUDING PIs can apply for BSDB Grants to attend.

BSCB/BSDB Joint Spring Meeting Report
by Rachna Narayana

The BSDB had its joint Spring Meeting with the BSCB 10th -13th April 2016. It was my first time at the Meeting, which had been enthusiastically sold to me as “a good one, a fun one – they have a pub quiz!” and although I had been ‘sent to Coventry’, I have to confess, I had a great time. It was a busy 3 days, brimming over with interesting talks and stellar plenary and medal lectures. The concurrent sessions were on topics of interest for both cell and developmental biologists and so I ended up flitting between the talks of the concurrent sessions each day. Unfortunately, due to the impossibility of being in two places at once, there were excellent talks that I did miss and I apologise to these speakers for my non-attendance. I also want to say a big thank you to the speakers who have very kindly given me permission to write about the unpublished work they presented.

The meeting started, for me, with a Career Workshop on the Sunday afternoon. It was organised as a series of roundtable discussions with lecturers, group leaders, and people in industry, science publishing and communication. I got to speak to Paul Conduit, a Henry Dale Fellow at the University of Cambridge, Anne Wiblin from Abcam who provided the perspective of science life in industry, and Catarina Vicente from the Node, with whom I discussed the power of Twitter (and cakes) for communicating science.

Sunday evening’s plenary lectures were given by stalwarts – Mark Kirschner gave the BSDB Plenary Lecture and Ruth Lehmann the BSCB Plenary Lecture.

Mark Kirschner’s lecture sought to give quantitative answers to a fundamental question – “what is the economy of RNA and protein in embryonic development?’ with impressive technology and precision. By examining the dynamics of RNA and proteins on a single cell level, the Kirschner group has been able to show that while the correlation between the mRNA and protein levels is 0, the protein synthesis rate correlates with the mRNA synthesis and decay rates (Peshkin et al. 2015).

Jordan Raff, while introducing Ruth Lehmann, mentioned that he remembered her work, where injecting *nanos* mRNA into the anterior of the embryo caused the formation of an embryo with “essentially 2 bums”. Co-incidentally Ruth Lehmann came back to the “2 bums” embryo in her talk in the context of mitochondrial segregation in primordial germ cells. A second research story she presented was of mitochondrial maturation during germline cyst formation – developmentally regulated folding of the inner mitochondrial membrane into cristae is dependent on ATP-synthase dimer formation (Teixeira et al. 2015).

In a break with tradition, the student and post-doc social did not have a pub quiz, but instead we were put into random pairs and teams to build spaghetti towers and play science Pictionary. It was an excellent way to meet fellow attendees and bond over our total lack of talent at either drawing or building design (or complete mastery of, in a few cases).

Monday was a day packed with scientific goodness – 4 sessions of talks, 2 medal lectures and 2 poster sessions! The sessions of the morning were Cell and Tissue Architecture and Evolution. In the Cell and Tissue Architecture session I listened to Val Wilson talk about neuromesodermal progenitors (NMPs) – bi-fated cells at the caudal end of the mouse embryo who contribute either to the spinal cord or paraxial mesoderm, depending on their position in the progenitor region. She talked about NMP behaviour during the formation of the mid-trunk (Wymeersch et al. 2016). Olivier Hamant went on to talk about the role mechanical forces play in providing growth cues –

microtubule dynamics in response to stress give the characteristic shape of sepals in *Arabidopsis* (Hervieux et al. 2016). Yara Sanchez Corrales showed how tube morphogenesis in the embryonic *Drosophila* salivary gland occurs. Cell division does not occur during the process and tube formation is driven entirely by cell shape changes and rearrangements. Their live cell imaging approach allows for the cell shape dynamics to be analysed in 3D.

In the Evolution session, I took in the talks of Marie-Ann Felix, Andrew Gillis and Marty Cohn. Marie-Ann Felix presented work aimed at understanding the effect of random mutation at the phenotypic level. They assayed the sensitivity of the vulval precursor cells of *C. elegans* to fate changes after the accumulation of random mutation and find that the P3.p vulval cell fate is most affected and is sensitive to mutations in many loci. This means that mutational effects can produce altered responsiveness to signalling pathways and, in this view, the P3.p cell fate is evolving the fastest. Andrew Gillis showed that Sonic hedgehog is required for gill arch anteroposterior polarity and for the branchial ray development in the gills of sharks, skates and rays (Chondrichthyans). This finding parallels paired fin development, giving traction to the hypothesis that there is serial homology between paired fins (and tetrapod limbs) and Chondrichthyan gill arches. Marty Cohn talked of the origin of cartilage – while true cartilage is considered to be unique to vertebrates, invertebrates like cuttlefish show cartilage-like tissue that develops via a deeply conserved gene regulatory network (Tarazona et al. 2016).

The afternoon sessions were Hijacking Cell and Developmental Processes and Polarity. In the Hijacking session, Shuchen Zhang presented her work trying to understand the genetic interactions of Sox2 that underpin its dual functions as a regulator of pluripotency in human embryonic stem cells and as a key factor in neural differentiation. Steve Jackson presented work on how cell-based screens in his lab have identified novel drug targets for cancer therapies, focussing on a PARP inhibitor that is now used in chemotherapy to treat hereditary ovarian cancers. In the Polarity session, Takashi Hiiragi showed that the apical domain of cells is instructive for the initial symmetry breaking in early mouse embryonic development by some fantastic live imaging. Nate Goehring showed us how through the use of novel small molecules, his lab has manipulated the activity and localisation of kinase PKC to understand the PAR polarity network in the *C. elegans* embryo. Ray Keller talked of the "mechanome" and the game plans – convergent extension, epithelial to mesenchymal transition and convergent thickening (driven by changes in cell affinity) – that tissues use to generate the forces required to drive morphogenesis in amphibians (Pfister et al. 2016).

The evening was host to BSCB's Hooke Medal and BSDB's Waddington Medal lectures. Tom Surrey was the recipient of this year's Hooke Medal. He presented 3 facets of his lab's research into understanding microtubule dynamics. Through impressive time-lapse fluorescence microscopy movies, we were shown the dynamics of microtubule growth, catastrophe (Duellberg et al. 2016) and nucleation (Roostalu et al. 2015) in *in vitro* reconstitutions. Tom Surrey's medal lecture (and all other medal lectures of the meeting) can be watched here:

The recipient of the Waddington Medal was completely shrouded in secrecy until just minutes before the lecture, Ottoline Leyser (the BSDB president) even engaging the audience in a little guessing game to introduce him. It was Enrico Coen! He started his talk with a series of sketches of bulls by Picasso and posed the question – what is harder, describing something with every detail or capturing its essence? In a very cinematic presentation with beautiful images and movies, videos of collaborations with potter and glass-blower friends set to a lush soundtrack and a live demo of growth conflicts with melting plastic, Enrico Coen gave us the essence of his obsession – the snapdragon flower. The talk strongly resonated with the conference. References were made to it in almost every subsequent session and he might just have convinced everyone to drop everything they are doing and start studying snapdragons and bladderworts. I have it on good authority that he believes a good talk is like the movie High Noon. I know what you'll be doing at your next lab meeting…

On Tuesday morning I attended the Growth and Cell division session. I heard Anja Geitmann talk about the mechanisms the pollen tube uses to grow towards the ovaries in plants and it genuinely seems a bit of a wrecking ball. Using a microfluidic device her group has been able to measure the pressure the pollen tube can exert – it is about 150kPa. That's the pressure in a car tyre! Shane Herbert presented data showing that asymmetric cell divisions and Notch-Delta mediated lateral inhibition establishes the hierarchy of motility in the

endothelial tip cells that allows for the leader-follower mode of cell migration in angiogenesis and Silvia Santos brought the session to a close by shedding some light on the temporal control of the cell cycle. Mitosis time is typically short and constant and insulated from the timing of early cell cycle phases. This seems to be regulated by the positive feedback of Cdk phosphorylation. Breaking the feedback leads to longer, more variable mitosis that is coupled to the interphase time.

The Graduate Student Symposium was held on Tuesday afternoon. Despite being fraught with technical difficulties, it was one of the most enjoyable and engaging sessions of the meeting. Kudos to the speakers for their quick thinking and improvisation in face of the 'your-presentation-won't-play' challenge! We heard about (and saw, when the computers co-operated) *Mycobacterium* infection, cell divisions in motile cells and stretched tissues, centrosome clustering in cancers, neuroretinal self-organising aggregates, neural tube lumen formation, neuromesodermal progenitors, segmentation in spiders and flies, zebrafish cilia formation and calcium signalling in angiogenesis.

Uri Alon provided a brief and unexpected (i.e. not in the schedule) interlude titled the 'The Life Scientific' before the Woman in Science Medal talk. With a flip chart, a guitar, witty and tuneful songs that required back up singing by the audience, Uri Alon highlighted the need to acknowledge and discuss the emotional and subjective nature of the scientific process. Feeling lost, stuck and being in "the cloud" is all part of doing innovative science. Please, please watch his TED talk on YouTube, whether you are lost in "the cloud" or not. It is Game of Thrones-level essential viewing.

The Woman in Science Medal was awarded to Lidia Vasilieva for her work in understanding mechanisms of gene expression. Lidia began by highlighting the progress made in science to help women achieve their goals and then focussed on her work in understanding the regulation of gene expression. Her lab has discovered that exosome mediated RNA degradation, in co-operation with the splicing machinery, can regulate levels of mRNA (Kilchert 2015).

Abigail Tucker was the recipient of the first Cheryll Tickle medal. The Cheryll Tickle medal is being awarded by the BSDB to a mid-career female scientist for outstanding contributions to her field. And Cheryll Tickle herself was present to award the medal to Abigail Tucker. She quipped that she was rather glad that the BSDB went with her full name for the medal as "the Tickle medal" might suggest an award for something else (but the medal does feature a feather (!)). Abigail Tucker's talk was a simultaneous career and life retrospective. She presented a career timeline, talking briefly about her PhD and postdoc work before taking us through the current activities of her lab studying the development of opossums, pit vipers and cobras. I imagine that this is the kind of work Indiana Jones would do, if he were a scientist. She also highlighted personal events of great significance on her career timeline. It is both inspiring and heartening to know that it is possible to have a thriving scientific career alongside a family.

Wednesday morning was a bit of tough start thanks to the late-night/early-morning revelry and dance floor antics that followed the conference dinner. But, I did manage to make it for Wendy Bickmore's opener for the information processing session at 9.30am (!) about enhancer-promoter interactions studied by chromatin conformation capture and single molecule FISH. She was followed by Stefano De Renzis who showed how he can reconstitute invagination in embryonic *Drosophila* tissues that normally wouldn't by optogenetically modulating the local actomyosin contractility.

I then caught the last 2 talks of the ageing and regeneration session. Yves Barral showed us how the bud lineage in budding yeast stays immortal – a diffusion barrier made of phytoceramides separates the mother and daughter preventing exchanging of membrane proteins and allows age to accumulate in the mother cell. Allison Bardin talked about mechanisms causing instability of the genome in adult stem Drosophila intestinal stem cells and how this affects homeostasis. Using an X-linked Gal80 construct she showed that mitotic recombination promotes loss of heterozygosity. She also showed that genomic rearrangements in these cells could lead to the spontaneous development of neoplasias in male flies (Siudeja et al. 2015).

Elena Scarpa, recipient of the Beddington medal for the best PhD thesis, presented her work in Roberto Mayor's lab before Uri Alon brought the conference to a close. Elena showed the role of cadherins and the interplay of intracellular and external forces in contact inhibition of locomotion in migrating neural crest cells (Scarpa et al. 2015). Uri Alon spoke about how quantitative thinking could be brought into discussions of morphology and showed work from his lab where phenotypes had been studied

using Pareto optimality. The approach is based on the logic that no phenotype can be good at all tasks and there is a trade-off with respect to the tasks to ensure maximal fitness, leading to optimal phenotypes. These phenotypes fall into simple shapes such as lines and triangles (Pareto fronts), the vertices representing an archetype – phenotypes that are specialised at a single task (Hart et al. 2015).

To sum up my experience at Warwick – I had spent 3 days being inspired by great talks, fascinated by all the new science I had heard, making new friends, having interesting discussions about my project and science in general. I discovered I am as hopeless at art as I am at origami and have no future at all as an architect. I was also strangely buoyed by the knowledge that most of my experiments are destined to fail. I returned home and fell into the dreamless slumber of a happy and exhausted child and woke up refreshed and ready to get lost in "the cloud".

Rachna Narayanan

Meeting review: BSDB/Anne McLaren Memorial Trust 2016 Autumn Meeting

"Their ideas and work led to remarkable discoveries that have been essential not only for our current knowledge in the area of developmental biology, but also to shed light on key biological concepts such cell fate and plasticity."

"…five sessions saw a wide range of applications of chimaeras discussed in various model systems. Overall, the talks were a mixture of traditional uses of chimaeras, recent innovations within this historical context and a broad range of other ideas and approaches – incorporating both the weird and the wonderful!"

Under the sponsorship of the Anne McLaren Memorial Trust Fund and The Company of Biologists, the BSDB Autumn meeting organised by Jenny Nichols and Tristan Rodriguez took place in the Pollock Halls at the University of Edinburgh. The topic this year was: **'Chimaeras and their use in studying developmental processes and disease models'**. Chimaeras are made of cells from two or more different organisms of the same or different species. Since their first conception, chimaeras have been an essential tool to dissect cellular potential and are used to address a large number of questions in developmental biology using a variety of different model organisms, from plants to vertebrates. Read here the meeting report by **Carla Mulas** and **Juan Miguel Sanchez Nieto**.

The meeting kicked off with plenary talks by Professors **Nicole le Douarin** and **Sir Richard Gardner**, both responsible for key innovations using avian and mouse chimaeric embryos respectively. Their ideas and work led to remarkable discoveries that have been essential not only for our current knowledge in the area of developmental biology, but also to shed light on key biological concepts such cell fate and plasticity. Nicole le Douarin presented her earlier work on the use of chick-quail chimaeras and the realisation that their different nuclear organisation could be used as a marker to distinguish host versus graft cells.

She took the audience through the application of chimaeras to study the neural crest, revealing the large contribution of these cells to the development of anterior structures in vertebrates. This work remains relevant to the present day when mouse-human chimaeras have been used to trace neural crest in mammalian embryos (Cohen et al. 2016). Richard Gardner's development of tools to enable injection of single cells into mouse blastocysts, and the successful development of the embryos thereafter, was essential to decipher clonal behaviour of cells during early mouse development – with important observations spanning the fields of embryology, epigenetics and embryonic stem cell biology.

Through the following two days, five sessions saw a wide range of applications of chimaeras discussed in various model systems. Overall, the talks were a mixture of traditional uses of chimaeras, recent innovations within this historical context and a broad range of other ideas and approaches – incorporating both the weird and the wonderful!

The first and largest session, *LINEAGE TRACING AND POTENCY,* focused on the use of modern labelling and imaging techniques in order to trace the descendants of specific cells, which were either labelled *in situ* or challenged by transplantation. What was particularly interesting in this session was how

"…Claire Baker presented work on cells responsible for sensing hypoxia in vertebrates, trying to resolve, by a combination of lineage tracing and deletion studies, whether homologous cells in different organisms share a common embryonic origin."

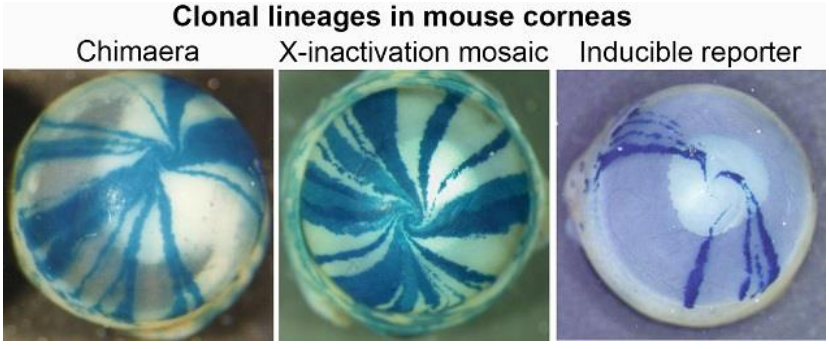
"…Virginia Papaioannou's tour de force on her analysis of T-box genes and their importance as an example of harnessing knowledge from the study of development to understand the human condition."

"In the SIGNALLING MECHANISMS session that followed, the speakers covered the influence and relevance of signalling pathways regulating cell fate choice."

universal the application of chimaeras is in different organisms and at different developmental stages. For example, **Clare Baker** presented work on cells responsible for sensing hypoxia in vertebrates, trying to resolve, by a combination of lineage tracing and deletion studies, whether homologous cells in different organisms share a common embryonic origin. Both **Janet Rossant** and **Berenika Plusa** used chimaeras as tools to assess the changes in cellular potential within the mouse pre-implantation embryo as it undergoes the first two cell fate decisions. Janet explained the correlation between the plasticity of cells from the inner cell mass (ICM) and Hippo signalling pathway combining classic chimaera experiments with single cell sequencing technologies to probe deeper into questions of cell fate and cell potency in the pre-implantation mouse embryo. Berenika discussed the different roles of Sox2 and Klf4 in regulating the fate choice that ICM cells make between epiblast and primitive endoderm. Staying with the early mouse embryo, **Josh Brickman** argued the importance of specific nutrients in the media to support the maintenance of the naïve pluripotent and endodermal states as well as increasing the efficiency of chimaera formation. After this talk came another highlight of the meeting, **Virginia Papaioannou**'s tour de force on her analysis of T-box genes and their importance as an example of harnessing knowledge from the study of development to understand the human condition.

From here we moved back to avian models, where **Mike Clinton**, used mixed-sex chimaeras in chickens to study how the host influences the grafted tissue. He investigated how sex identity is specified, showing that somatic cells possess an identity which is cell autonomous. To round off the session, two speakers illustrated the enormous power of chimaeras and lineage labelling to uncover the boundaries for cell fate determination and cell plasticity, **John West** in the adult mouse cornea and **Filip Wymeersch** for the neuromesodermal progenitors.

In the *SIGNALLING MECHANISMS* session that followed, the speakers covered the influence and relevance of signalling pathways regulating cell fate choice. **Claudio Stern**'s hunt for a new universal organiser's signature opened probably the most diverse session of the conference. **Alexander Bruce** presented his work, in which he identified p38 as a regulator of primitive endoderm differentiation in the early mouse embryo (Thamodaran and Bruce, 2016). **Chris Thompson**, conversely, used *Dictyostelium* as a model system to interrogate how genetically uniform systems can break symmetry and undergo differentiation. In this session there was also exciting insight provided by plant chimaeras. **Nicola Harrison** discussed the implications of the technique of grafting in apple trees and how our understanding of this process may affect the quality of the product and the yield of the crops. **Kim Dale**, the last speaker of this session, presented her work on how Notch amplifies Shh signalling pathway in the neural tube regulating the cell fate of neuro-ectodermal progenitors (Stasiulewicz et al. 2015).



"On day two, the REGENERATIVE MEDICINE AND HUMAN DEVELOPMENT session was started with a talk by Iwo Kucinski. Iwo was awarded the first Dennis Summerbell Lecture Prize, and he presented his work deciphering signalling pathways favouring the elimination of unfit cells in the process of cell competition."

"Throughout the last two sessions, DISEASE MODELS and GENE FUNCTION several speakers discussed the advances in modern techniques and their applications to developmental biology and potential regenerative therapies."

"Throughout the meeting there were many fond tributes to Anne McLaren, who, amongst her many other accomplishments, previously organised a chimaera-themed meeting in the early 90s."

On day two, the *REGENERATIVE MEDICINE & HUMAN DEVELOPMENT* session was started with a talk by **Iwo Kucinski**. Iwo was awarded the first Dennis Summerbell Lecture Prize, and he presented his work deciphering signalling pathways favouring the elimination of unfit cells in the process of cell competition. Interestingly Iwo showed that unfit cells, identified by a variety of means, show a number of common signalling changes that are not detrimental for viability when surrounded by other unfit cells, but that trigger their elimination when in a competitive environment with fitter cells. **Nicholas Tan** presented a novel strategy (DNA Adenine-Methyltransferase Identification sequencing) to identify genome-wide transcription factor binding targets within single embryos or with samples that have only 1000 cells and **Man Zhang** discussed the importance of ESSRb for Nanog function. Unfortunately, Hiro Nakauchi could not attend the meeting but **Hideki Masaki** flew in from Japan to present his own work in collaboration with the Nakauchi lab. Very interestingly, they observed that primed pluripotent stem cells with acquired resistance to apoptosis can contribute to chimaeras when injected into blastocysts, a process that does not occur when attempted with wild-type primed pluripotent cells. These experiments suggest that not only the pluripotency status of the cells is important for efficient chimaera formation but also their apoptotic threshold, thus providing an avenue for efficient chimaera generation with cells with restricted developmental potential.

Throughout the last two sessions, *DISEASE MODELS & GENE FUNCTION* several speakers discussed the advances in modern techniques and their applications to developmental biology and potential regenerative therapies. For instance, **Stephen Pollard** and **Bill Skarnes** outlined CRISPR-based approaches to generate genetically modified adult and embryonic stem cells while **Ben Steventon** and **Kenzo Ivanovich** demonstrated beautiful applications of live imaging to study the development of neuro-mesodermal progenitors during axis elongation and the early stages of mouse heart development, respectively. **Vasso Episkopou** presented her work analysing how Arkadia modulates the levels of TGFb signalling during early mouse development and **Elena Lopez-Jimenez** discussed how Oct4 is not only a pluripotency factor, but can provide positional information by regulating the Hox cluster. To complement these approaches, **Megan Davey** gave a fascinating insight into how chick chimaeras can tell us not only about the signalling inputs that pattern the vertebrate limb, but also shed light into the evolutionary origins of our five digit structure. The grandiose finale of the meeting was **Liz Robertson**, who discussed the importance of Blimp1 in the control of mammary gland development and homeostasis. Interestingly she showed how important Blimp1 is for the organization of this epithelial tissue, providing new insight into the regulation of mammary gland tissue integrity (Ahmed et al. 2016).

Throughout the meeting there were many fond tributes to **Anne McLaren**, who, amongst her many other accomplishments, previously organised a chimaera-themed meeting in the early 90s. A great scientific atmosphere was created during all the poster sessions that ran throughout the breaks and during the evenings, where everybody had the chance to present their work, learn, discuss and network. Reflecting the beauty of developing systems, chimaera and embryo-inspired artwork was on display and available for purchase, designed by **Mia Buehr** [LINK] and **Aurora Lombardo** [LINK].

Overall, it was a brilliant and diverse meeting that took the audience literally through time, from the earlier discoveries and innovations presented by the keynote speakers, towards the current state, where modern techniques are allowing a new generation of developmental biologists to explore deeper into development and disease by using chimaeras.

Acknowledgements
We would like to thank the meeting organisers and sponsors, especially the Anne McLaren Memorial Trust Fund and the Company of Biologists. We apologize to all the speakers and references that are not mentioned directly owing to space limitations.

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Meeting Report Joint BSDB/Nordic Conference on Developmental Biology and Regeneration

Aula Medica, Karolinska Institute, Stockholm, Sweden 25-27th October 2017

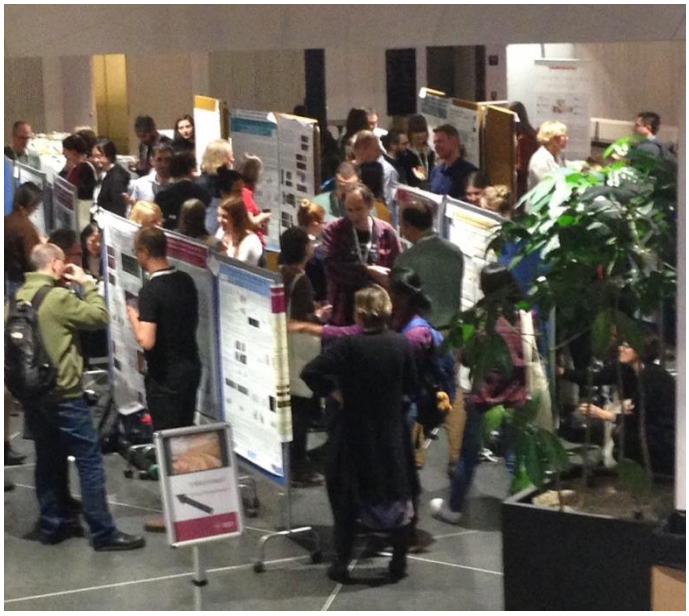
The Joint BSDB/Nordic Conference on Developmental Biology ad Regeneration was first proposed to SWEDBO and FSDB in December 2014, so had been in planning for almost three years. It was organised by Megan Davey (BSDB), Joe Rainger (Univ. Edinburgh), Elke Ober and Palle Serup (Denmark), Satu Kuure (FSDB), Luiza Ghila and Helge Raeder (Norway), Christos Samakovlis, Andras Simon and Sara Wilson (SWEDBO). Particular thanks go to Sara Wilson, Andras Simon and their ground support, Paulina Pettersson, for their hard work and organisation, and to Joe Rainger who drove the sponsorship. Thanks also to the BSDB members who travelled to Sweden for the meeting and Thomas Jessell who could be persuaded to travel all the way from New York for his plenary session. I strongly feel that the meeting was an outstanding success.

Attendance - With volunteers and sponsors attending we had a total of 212 attendants, of which 194 were registered scientific attendees, 15 were invited speakers, and 22 were BSDB members (8 being supported by **travel grants**). Other than UK attendees, Sweden (understandably) had the most attendees (94) but there was also a strong showing from Denmark, Finland and China. We additionally had attendees from Austria, Ireland, Brazil, Norway, Spain, Czech Republic and USA.

Program - We aimed to have a general scientific program covering all aspects of Developmental Biology in plants, invertebrates and vertebrates. With **Tom Jessell** (Columbia University, NY. USA) as our EMBO-sponsored plenary, there was a strong emphasis on **nervous system development** (Session 1 -13 talks), which included development of motor circuits, visual circuits, enteric nervous system, regeneration, neural crest, evolution and single cell transcriptomics. Highlights of this session were Tom's superb talk who explained how they pick apart the identity and function of interneurons, and the presentation by Igor Adameyko (Karolinska Institute, Sweden) about single cell transcriptomics in neural crest development. Session 2 (15 talks) was on **organogenesis & morphogenesis** and covered mathematical modelling of development, mammalian blastocyst, pancreas, heart and kidney development, and vertebrate genetics. A particular highlight was Leif Andersson's (Uppsala University, Sweden) talk who illustrated wonderfully how structural genomic changes contribute to dramatic

phenotypic evolution in birds, with particular emphasis on behaviour and plumages. Session 3 (8 talks) was on **stem cells & regeneration** which included a huge variety of science, including the role of forces in developing stem cell niches, regeneration in salamanders, skeletal muscle, tissue repair and regeneration and organisation in plants. Another highlight was Ari Pekka Mahonen who presented his work identifying a core regulatory network within the cambial stem cell niche in *Arabidopsis*. We also had two 3hr-long poster sessions with drinks and nibbles. The buzz was really fantastic, attendance was superb and, in fact, we had to ask people to leave at the end of both evenings, so security could close the building.

L-R: Poster prize winners Yiqiao Wang, Li Hi, and Arvydas Dapkunas, with organiser Joe Rainger



Prizes - The Swedish society for developmental biology (SWEDBO) gave out three €100 travel grants as poster prizes to Yiqiao Wang (Karolinska Institute, Sweden), Mariane Teradup Pedersen (Univ. Copenhagen, Denmark) and Li Hi (Stockholm University, Sweden). A prize of €200 donated by Scanbur, was awarded to Arvydas Dapnkunas (University of Helsinki, Finland) for his work developing a 3D culture system to explore factors governing the organisation and self-renewal of nephron progenitors. Finally, the BSDB organised the **Dennis Summerbell Award Lecture** which was given by Helen Weavers on the inflammatory response to tissue damage in *Drosophila* (see details **here**).

Venue - What can I say … the Aula Medica at the Karolinska Institute was amazing! Beautiful, beautiful building! Amazing staff! Best AV I've experienced ever! Great areas for posters and sponsors! Super comfy chairs! A green room! With showers (just in case…??)! And the best of it all: we could get it pretty cheap since it was organised internally through the Karolinska Institute.

Sponsorship - Joe Rainger led on the recruitment of sponsors, including designing the different sponsorship rates, contacting sponsors and assisting them on-site, and establishing communication between sponsors, Aula Medica team and conference attendees. The effort the sponsors themselves put in was great. For example, Nikon and Zeiss bought microscopes including a spinning disk confocal from Nikon. Everyone came away really happy, and Aula Medica was very impressed, as were the sponsors.

Megan Davey

Treasurer's report by Christopher Thompson

"The Society awarded 105 travel grants to allow members to attend BSDB meetings (71 to the Spring Meeting 2016 in Warwick, and 34 to the Autumn Meetings in Faro and Edinburgh), at a total cost of £41,757."

"Our expenditure on travel grants was higher than the income the Society received from its membership (£34,075), and reflects the fact our investments have performed well in recent years, thus allowing us to provide increased funding in our core areas."

"As shown in the accompanying provisional accounts for the Society for the period August 2016 - July 2017, the last year has again been a successful one."

Treasurer report for the period July 2015 to July 2016

As shown in the accompanying provisional accounts for the Society for the period August 2015 - July 2016, the last year has again been a successful one. The Society awarded 105 travel grants to allow members to attend BSDB meetings (71 to the Spring Meeting 2016 in Warwick, and 34 to the Autumn Meetings in Faro and Edinburgh), at a total cost of £41,757. This included 25 travel awards for our Autumn Meeting in Portugal, at a total cost of £7,950, which provided an opportunity to strengthen our European ties through this joint meeting with the Spanish and Portuguese Societies of Developmental Biology. Our expenditure on travel grants was higher than the income the Society received from its membership (£34,075), and reflects the fact our investments have performed well in recent years, thus allowing us to provide increased funding in our core areas.

The Society receives a sum from the Company of Biologists, which provides for the running of Society activities (£35,000) including the funding of meetings in spring and autumn, and Gurdon CoB Summer Studentships. We also receive an amount (£35,000) to spend on CoB/BSDB travel awards to help towards the costs of our members' attendance/travel to overseas meetings. In total, a record number of awards 98 CoB/BSDB travel awards were made in 2015-16 (£34,856), reflecting the high demand for the awards, with awards being made to all eligible applicants. We are also very grateful to have been awarded a trial sum of £10,000 to support the attendance of PIs with little other funding at overseas meetings. This money was used to support the ten travel awards (£8778).

Although from the accounts it appears that our income was 9K higher than our expenditure, this is something of an accounting anomaly. Our income was boosted this year by the generous awards of 20K (to support PI travel to conferences) and 5K (to support member attendance at practical courses). These awards were only advertised after our Committee meeting in March 2016, so only 2K has been spent to date. We do, however, fully expect to spend these sums within the next year. If this allocated spending is taken into account, then our overall expenditure was 14K greater than our income. Despite this, our Legal and General and Baillie Gifford funds, the main vehicles for the Society's reserves have performed very well. Thus, overall the Society's actual reserves show a slight increase. Bearing in mind that we have continued our commitment to fund 10 Gurdon CoB Summer Studentships (at a cost of £14,400), and that our investment in the ISD meeting was a one off, this suggests that we can continue to support new expenditure in a sustainable fashion. Our ability to maintain such a healthy balance on current expenditure is largely due to the great efforts of our conference organisers, both to raise income via sponsorship and by keeping costs under control. Most notably, the Autumn Meeting 2015 (Faro) returned income to the Society, with the total (£9,495), reflecting the success of our joint meeting approach.

The financial reserves of the Society are invested in Baillie Gifford and L&G funds and, overall, these did well over the last 12 months. As a result of this, and the balanced budget, the Society continues to have a very healthy reserve to cope with unforeseen events (e.g., cancellation of a meeting) and, indeed, to invest in new activities to promote developmental biology. Our overall solid financial health means that we can do this without any significant threat to the core business of the Society. The other expenditure items (e.g., prizes, administration, ISDB membership) were in line with previous years.

Treasurer report for the period July 2016 to July 2017

As shown in the accompanying provisional accounts for the Society for the period August 2016 - July 2017, the last year has again been a successful one.

"The Society awarded 74 travel grants to allow members to attend the BSDB Spring Meeting 2017 in Warwick. In addition we funded 9 grants to attend the Autumn Meetings in Edinburgh), at a total cost of £38,180."

"…we were also grateful to receive a dedicated award (£5,000) to support travel to practical courses and training courses. These have proven very popular and have allowed us to fund travel at a higher amount than normal, which is necessary given the normally prohibitive cost of these courses."

"…the Society continues to have a very healthy reserve to cope with unforeseen events (e.g., cancellation of a meeting) and, indeed, to invest in new activities to promote Developmental Biology."

The Society awarded 74 travel grants to allow members to attend the BSDB Spring Meeting 2017 in Warwick. In addition we funded 9 grants to attend the Autumn Meetings in Edinburgh), at a total cost of £38,180. Plans are well advanced for another joint meeting in September 2017 (this time with the Scandinavian Developmental Biology Societies). The success of these meeting means that plans are being made to use these as a basis for a new pan European Developmental Biology Meeting to be held every 2 years. This will undoubted provide an opportunity to further strengthen UK-European ties. Our expenditure on travel grants was higher than the income the Society received from its membership (£34,600), and reflects the fact our investments continue to perform well, thus allowing us to provide increased funding in our core areas.

The sum received from the Company of Biologists is essential for the running of the society. The block grant (£35,000) helps us to support the running costs of meetings in spring and autumn, and Gurdon CoB Summer Studentships. In order to remain competitive and to ensure we attract the best students, these studentships were funded at a slightly higher rate than previous years (£15,800 total). We also receive an amount (£37,500) to spend on CoB/BSDB travel awards to help towards the costs of our members' attendance/travel to overseas meetings. In total, 84 CoB/BSDB travel awards were made in 2016-17 (£35,018), reflecting the high demand for the awards, with awards being made to all eligible applicants. Awards were made at a slightly higher amount than previously, partly to match inflation costs of conference travel. We expect the remaining funds will be spent before the end of the calendar year. This was also made possible that most eligible PI applications were funded via the PI travel grants. We are therefore very grateful to have been awarded £20,000 to support the attendance of PIs with little other funding at overseas meetings. So far this year, we have spent £8410 of this money. Uptake was initially slow, largely because new schemes take time to be advertised and then taken up. Finally, we were also grateful to receive a dedicated award (£5,000) to support travel to practical courses and training courses. These have proven very popular and have allowed us to fund travel at a higher amount than normal, which is necessary given the normally prohibitive cost of these courses. So far, we have spent more than the allocated amount in this area, as demand was extremely high (£9,000).

Our ability to maintain such a healthy balance on current expenditure is also due to the great efforts of our conference organisers, both to raise income via sponsorship and by keeping costs under control. Although, the 2016 Autumn meeting ran at a slight loss (-£4,386), we do expect to receive some return from the Spring meeting in 2017 (~8K).

Although from the accounts it appears that our income and expenditure were very similar, the Society reserves have risen. Our Legal and General and Baillie Gifford funds, the main vehicles for the Society's reserves have performed very well. As a result, the Society continues to have a very healthy reserve to cope with unforeseen events (e.g., cancellation of a meeting) and, indeed, to invest in new activities to promote Developmental Biology. Our overall solid financial health means that we can do this without any significant threat to the core business of the Society. The other expenditure items (e.g., prizes, administration, ISDB membership) were in line with previous years.

Christopher Thompson

Breaking news! We re-discovered the BSDB archives dating back to the early 1960s, including a full set of BSDB newsletters from No.1 in 1979 and meeting programs from at least 1964. Digitisation of newsletters is currently taking place and will be made available **here**. More might follow. If you take an interes or have a good idea where to store the archive, please contact comms@bsdb.org.

BRITISH SOCIETY FOR DEVELOPMENTAL BIOLOGY

FINANCIAL STATEMENT YEAR ENDING JULY 31st 2016

Accruals Basis

Balance Sheet

2014/15 £		2015/16 £
	Investments	
65,977	L&G Global 100 Index Trust ®	77,334
271,182	Baillie Gifford Managed Fund	306,590
	Current Assets	
49,002	Barclays Bank High Interest Account	49,025
26,807	Barclays Bank Current Account	35,282
3,056	Barclays Bank: Louie Hamilton Account (1,2)	3,056
921	PayPal	2,045
79,786	**Total Current Assets**	89,408
0	Less: Unpresented cheques	0
0	Debtors – Creditors	0
79,786	Net Current Assets	89,408
416,944	**Total Funds**	**473,332**

Income & Expenditure Account

Income	£	Expenditure	£
Membership (Standing Order & PayPal)	34,075	CoB Grants (BSBD Meetings)	33,806
Block Grant (CoB)	35,000	CoB Travel Grants (Overseas & Courses)	34,856
Travel Grant Fund (CoB)	35,000	CoB Support Grants	8,778
Support Grant (CoB)	10,000	CoB PI Travel Grants	1,000
PI Travel Grant (CoB)	20,000	CoB Practical Courses Grants	1,000
Practical Course Grant (CoB)	5,000	Gurdon Summer Studentships	14,400
Spring Meeting 2016	837	Autumn Meeting 2015 (Faro)	7,951
Autumn Meeting 2015	9495	Spring Meeting 2016	16,040
Refunds in	250	Autumn Meeting 2016	8,000
Unpresented cheques 15-16	0	Prizes	2,688
		Committee & administration	8,598
		ISDB membership	1,778
		RSB membership	670
		Bank Charges	136
		Refunds out	357
Interest and Investment Appreciation:			
Barclays High Interest a/c	23		
Barclays Louie Hamilton a/c	0		
Total Income	**149,680**	Total Expenditure	**140,058**
		Net Surplus for the Year	**9,622**
		Unrealised Gains on L&G	11,357
		Unrealised Gains on Baillie Gifford	35,408
		Fund balance at 31st July 2015	416,944
		Fund balance at 31st July 2016	**473,331**

Notes

These accounts were prepared under the accrual basis convention, in accordance with the applicable accounting standards and Recommended Practice of Accounting by Charities. There have been no major changes to our financial arrangements this year.

1. The Louie Hamilton account valuation is at 14.9.13

2. This is the only restricted account and no call was made on it in the financial year 2015/16

BRITISH SOCIETY FOR DEVELOPMENTAL BIOLOGY

FINANCIAL STATEMENT YEAR ENDING JULY 31st 2017

Accruals Basis

Balance Sheet

2015/16 £		2016/17 £
	Investments	
77,334	L&G Global 100 Index Trust ®	91,514
306,590	Baillie Gifford Managed Fund	360,479
	Current Assets	
49,025	Barclays Bank High Interest Account	49,037
35,282	Barclays Bank Current Account	35,313
3,056	Barclays Bank: Louie Hamilton Account (1,2)	3,056
2,045	PayPal	3,167
89,408	**Total Current Assets**	90,573
0	Less: Unpresented cheques	
0	Debtors – Creditors	
89,408	Net Current Assets	90,573
473,332	**Total Funds**	**542,566**

Income & Expenditure Account

Income	£	Expenditure	£
Membership (Standing Order & PayPal)	34,600	CoB Grants (BSBD Meetings)	34,455
Block Grant (CoB)	35,000	CoB Travel Grants (Overseas & Courses)	35,018
PI travel grants	20,000	CoB Support Grants	0
Travel Award Grant	35,000	CoB PI Travel Grants	8410
Practical grants (CoB)	5,000	CoB Practical Courses Grants	9000
Travel Grant Supplement (CoB)	2,500	Gurdon Summer Studentships	15,800
Spring Meeting 2017	0	Autumn Meeting 2016	4,386
Autumn Meeting 2016	0	Spring Meeting 2017	12,000
Refunds in	1,261	Autumn Meeting 2017	0
Unpresented cheques 16-17	0	Prizes	404
		Committee & administration	10,006
Interest and Investment Appreciation:		ISDB membership	1,807
Barclays High Interest a/c	0	RSB membership	677
Barclays Louie Hamilton a/c	0	Bank Charges	89
		Refunds out	151
Total Income	**133,362**	Total Expenditure	**132,203**
		Net Surplus for the Year	**1,159**
		Unrealised Gains on L&G	14,180
		Unrealised Gains on Baillie Gifford 1	53,889
		Unrealised Gains on Baillie Gifford 2	0
		Fund balance at 31st July 2016	473,332
		Fund balance at 31st July 2017	**542,560**

Notes

These accounts were prepared under the accrual basis convention, in accordance with the applicable accounting standards and Recommended Practice of Accounting by Charities. There have been no major changes to our financial arrangements this year.

1. The Louie Hamilton account valuation is at xxx

2. This is the only restricted account and no call was made on it in the financial year 2016/17

The BSDB's advocacy strategy by Andreas Prokop

"…there are alarming indications of communication fatigue in our community which weakens our ability to coordinate our activities and promote the importance of our science."

"…current circumstances cry out for communication and we MUST find feasible and effective ways to do so. As I argued, this is possible through the formation of collaborative networks of science communication."

"…hopefully more members of our community will join in and help to develop creative science communication initiatives that carry dialogue proactively into the relevant target groups."

As argued in the editorial and a recent PLoS Blog, there are alarming indications of communication fatigue in our community which weakens our ability to coordinate our activities and promote the importance of our science. But why do we turn off in this way at the worst possible time when conditions for fundamental research are worsening? As my colleague Sam Illingworth and I have argued in a recent special issue about science communication (see p.27), the likely reasons include (1) lack of awareness about the means and power of communication, (2) lack of incentives and external rewards for participation in science communication, and (3) lack of time: as academics we usually have more than 5 professions rolled into one, and the increase in time demand in each of these professional spheres is steadily increasing, suffocating our productivity as scientists, let alone as communicators.

Notwithstanding, I argued in the above mentioned PLoS Blog that current circumstances cry out for communication and we MUST find feasible and effective ways to do so. As I argued, this is possible through the **formation of collaborative networks of science communication**. To achieve this, we need to communicate within our own communities to be able to coordinate our action (see thoughts in the editorial, p.1). We need to make our individual contributions to science communication; if we are prepared to share the fruits of our activities, for example via The Node, this can then lead to the cumulative build-up of high quality and freely available resources and strategies. Finally, we need to make active use of and further improve existing resources and strategies; by reaching out jointly we will have a higher chance of gaining momentum and impact – all with the common goal of promoting dialogue about the science we love.

To lead the way in this direction, the BSDB has started an **advocacy campaign** together with The Node. The first step is simple and consists in putting together the best **arguments for Developmental Biology** and powerful examples illustrating these statements. The first draft of this document has been published on the BSDB site, on The Node and is printed below. This resource can now be capitalised on by us all; but it also requires further community input to refine and complement the arguments - in particular also in the areas of Plant Biology and Evo-Devo which are not well represented thus far. To catalyse this process, the editorial team of Development has complementary plans that will be announced in due term, and the BSDB has initiated a writing competition for PhD students and postdocs focussing on advocacy (p.31).

The gradually improving advocacy resource is intended to provide us with **effective elevator pitches** that can be used in dialogue with the public, students, other scientists, clinicians and politicians – and many of the arguments may fly well also on grant applications or in scientific publications. The overarching goal is to achieve wider recognition of fundamental Developmental Biology research as an important science branch that deserves public funding support.

But we should not stop there, and hopefully more members of our community will join in and help to develop creative science communication initiatives that carry dialogue proactively into the relevant target groups. Ideally, this is done through collaboration and long-term objective setting which has a higher chance of achieving sustainability, momentum and impact. To illustrate this point, a recent special issue on science communication in fundamental biomedical science (p. 27), describes examples of existing initiatives, their origins and gradual developments. To facilitate the task, the BSDB and The Node have collaborated to put together a link collection (originally published on the BSDB site) which provides ideas, advice and resources that can be used and followed. We hope that these actions taken by the BSDB will help to raise the awareness of and participation in science communication and advocacy within our community for the benefit of all.

Resources for Developmental Biology advocacy

"…whenever there is an opportunity to engage with audiences about our discipline – be it with the public, students, fellow scientists or policy makers."

"At first sight, Developmental Biology could be viewed as an academic discipline driven by mere curiosity and, hence, to be of little relevance to the big challenges of population health or sustainability."

"Developmental defects in humans are very abundant. By studying the underlying mechanisms and causes, Developmental Biology addresses the key challenge of population health."

"Sustaining food resources is another major global challenge, and Developmental Biology can provide key strategies to improving crop and plant cultivation."

To promote Developmental Biology and bring across the importance of fundamental research in this field, ***we all should have our elevator pitches ready at all times*** *– whenever there is an opportunity to engage with audiences about our discipline – be it with the public, students, fellow scientists or policy makers. Here we present a first attempt at providing a concise rationale and ideas that can be woven into such conversations. The arguments presented can and must still be improved and complemented. Therefore, we would like to invite you to* ***send in your thoughts and ideas****, potential corrections, suggestions for improvement, additions, new arguments and/or potential links to supporting resources – all with the aim of* ***further strengthening the message*** *that we need to bring across (please, send to Andreas.Prokop@manchester.ac.uk). In particular those working in* ***Evo-Devo or Plant Development****, please come forward and make your contributions by helping us explain the importance of your disciplines and extend this resource* ***for the benefit of all****.*

If you would like to use some of the ideas currently presented, please download PowerPoint slides with the advocacy information here. If you are already active in science communication or plan to do so, please, also have a look at our public engagement outreach collection which can be found on the BSDB site and in revised form on The Node, at a special issue on science communication in "Seminars in Cell & Developmental Biology" (see a summary on page 27) and at a recent PLoS Blog post.

Why should we engage in Developmental Biology?

Developmental Biology enquires about the fundamental processes that underpin the fertilisation of an egg cell and its step-by-step transformation into the fascinating complexity of a whole organism (Box 1).

Box 1: Some definitions of Developmental Biology

Developmental Biology is the study of the processes by which organs grow and develop. Modern developmental biology studies the genetic control of cell growth, differentiation and morphogenesis, which is the process that gives rise to tissues, organs and anatomy, but also regeneration and ageing *(after L. Wolpert)*

Developmental Biology is the study of the process by which animals and plants grow and develop, and is synonymous with ontogeny (*Wikipedia*).

Developmental Biology is the causal analysis of the cellular mechanisms that drive processes of growth, pattern formation and morphogenesis *(A. Martínez Arias)*

At first sight, Developmental Biology could be viewed as an academic discipline driven by mere curiosity and, hence, to be of little relevance to the big challenges of population health or sustainability. On the contrary, Developmental Biology – along with Physiology[1] – is arguably the most important biological discipline we have. Here we will explain and substantiate this statement[2].

(1) Developmental defects in humans are very abundant (Box 2). By studying the underlying mechanisms and causes, Developmental Biology addresses the key challenge of population health. **Sustaining food resources** is another major global challenge, and Developmental Biology can provide key strategies to improving crop and plant cultivation (*see Mathan et al., 2016, Development 143, 3283ff. — LINK; further arguments will follow – please help us by contributing your ideas!*).

Box 2: Statements illustrating the abundance of developmental defects in humans

The frequency at which all classes of developmental defects occur is thought to be ... exceeding half of initial pregnancies.

"Developmental Biology (like Physiology) is asking fundamental questions at the level of whole organisms, organs or tissues (Box 3). Notably, this is the level at which diseases become manifest."

"By asking fundamental questions at the level of organisms, organs and tissues, Developmental Biology-related research is a generator of new ideas and concepts."

"Developmental Biology is exciting and powerful because it reaches across the different levels of biological complexity and explanation…"

"Consequently, Developmental Biology embraces disciplines such as genetics, molecular biology, (stem) cell biology, biochemistry, biophysics as well as evolutionary biology."

Major developmental defects … occur in approximately 3% of live births.

In 1995, major developmental defects accounted for approximately 70% of neonatal deaths (occurring before 1 month of age) and 22% of the 6,500 infant deaths (before 15 months of age) in the US.

Approximately 30% of admissions to pediatric hospitals are for health problems associated with such defects.

source: Scientific Frontiers in Developmental Toxicology and Risk Assessment, 2000, National Academic Press, Washington DC, pp.354; edited by the National Research Council (LINK)

(2) Developmental Biology (*like Physiology*) is **asking fundamental questions at the level of whole organisms, organs or tissues** (Box 3). Notably, this is the **level at which diseases become manifest**. For this reason, Developmental Biology has been, and continues to be, most effective in delivering explanations for diseases or medically relevant processes including infertility, neonatal death, birth defects (*e.g. deformation, body growth abnormalities, developmental brain disorders, blindness, deafness*), cancer, wound healing, tissue regeneration (*regenerative medicine including stem cell biology*), etc.

Box 3: Fundamental questions asked by developmental biologists – and how they translate into biomedical application

What processes lead to fertilisation and the initiation of development? How can we overcome infertility and childlessness?

How do single fertilised egg cells, or later on groups of progenitor cells, generate the enormous cellular diversity of an organism and its organs and tissues? How do stem/progenitor cells generate whole tissues or organs – for example in regeneration or tissue engineering, and how does wound healing work?

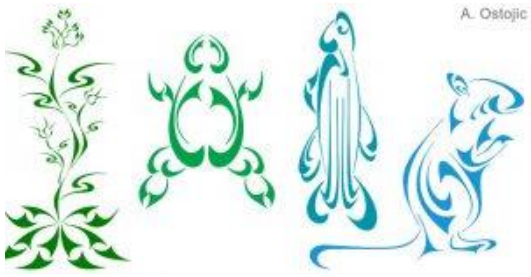
How do cells, which originate from common ancestors and contain the same genetic information, adopt different fates? How do cells change their identities and behaviours – for example in cancer?

How do tissues and their cells know when to stop growing? How can cells evade growth control – for example in tumour growth?

How is the formation of different cells/tissues coordinated in space and time? What are the patho-mechanisms underlying birth disorders?

(3) By asking fundamental questions at the level of organisms, organs and tissues, Developmental Biology-related research is a **generator of new ideas and concepts** (Box 4). These concepts essentially underpin **the modern biomedical sciences** and include cell signalling, tissue and body patterning, growth regulation, cell migration or morphogenesis; they form the basis for contemporary research into stem cells, cancer, wound healing, regeneration or ageing.

(4) Developmental Biology is exciting and powerful because it **reaches across the different levels of biological complexity and explanation**; phenomena at the level of organisms, organs or tissues can ultimately be understood only by tracing them back to events at the level of genes and cells. Consequently, Developmental Biology embraces disciplines such as genetics, molecular biology, (stem) cell biology, biochemistry, biophysics as well as evolutionary biology.



"Developmental Biology capitalises on the principle of evolutionary conservation of genes, mechanisms and concepts by making informed and strategic uses of suitable model organisms, down to experimentally and genetically amenable invertebrates."

"If we want to improve the standing of our discipline, we MUST embrace these ideas with passion, help to complement and further improve them and, most importantly, use them whenever possible and adequate to advocate our discipline with self-confidence and enthusiasm."

"But we need to be realistic and accept that most members of these target audiences will, by default, show little interest to engage with us."

5) Developmental Biology **capitalises on the principle of evolutionary conservation of genes, mechanisms and concepts** by making informed and strategic uses of **suitable model organisms**, down to experimentally and genetically amenable invertebrates. The use of invertebrate model organisms provides an efficient and powerful strategy to generate new ideas, concepts and understanding which can then be tested (and often validated) in higher organisms, eventually leading to medical applications in humans (LINK). This discovery pipeline has been a central driver for the enormous contributions that Developmental Biology has made and continues to make to the biomedical sciences.

Box 4: A metaphor explaining how Developmental Biology works

Understanding a combustion engine requires investigating its single parts, such as the sparking plug, cylinder or crank shaft. However, for a developmental biologist it is not sufficient to find out how each of these parts works, but this new knowledge needs to be linked back into the mechanistic framework that constitutes the entire engine and explains its function. Linking detailed findings back to the bigger question *of understanding the engine* is an important validation and filter step that reveals whether the detailed findings are actually relevant and make deeper sense. Only through such systematic and holistic "reverse enginieering" can the necessary systemic and conceptual understanding be achieved which is required to diagnose and eventually repair a faulty engine.

By executing all research work with the ultimate aim of understanding the bigger question (*e.g. how to make an organ, appendix or entire body*), Developmental Biology has become such an important contributor of concepts and understanding in the field of the biomedical and medical sciences.

As an interesting side note: already in the late 18th century, Johann Wolfgang von Goethe understood that it is not enough to "have the pieces in your hand" but that they need to be connected and "woven" together to "recognise and describe the living".

These are only some thoughts (*still incomplete and in need of further optimisation*) about the importance of Developmental Biology as a discipline. If we want to improve the standing of our discipline, **we MUST embrace these ideas** with passion, help to complement and further improve them and, most importantly, **use them whenever possible** and adequate to advocate our discipline with self-confidence and enthusiasm. To do this with impact, we need to acknowledge that communicating science is a **difficult task** which requires belief, love for our subject, stamina, and efficient strategies that enable us to engage with a **wide spectrum of target audiences**. Such target audiences include the general public and schools, fellow scientists and clinicians, as well as politicians and other decision makers. But we need to be realistic and accept that most members of these target audiences will, by default, show **little interest to engage with us**. Therefore, intelligent and **strategic long-term approaches** –

Goethe: Faust I, part 4, Das Studierzimmer / The study - Mephistopheles:

Der Philosoph, der tritt herein
Und beweist Euch, es müßt so sein:
Das Erst wär so, das Zweite so,
Und drum das Dritt und Vierte so;
Und wenn das Erst und Zweit nicht wär,
Das Dritt und Viert wär nimmermehr.
Das preisen die Schüler allerorten,
Sind aber keine Weber geworden.
Wer will was Lebendigs erkennen und beschreiben,
Sucht erst den Geist heraus zu treiben,
Dann hat er die Teile in seiner Hand,
Fehlt, leider! nur das geistige Band.

The philosopher comes with analysis
And proves it had to be like this:
The first was so, the second so,
And hence the third and fourth was so,
And were not the first and second here,
Then the third and fourth could never appear.
That is what all students believe,
But they have never learned to weave.
Who would study and describe the living, starts
By driving the spirit out of the parts:
In the palm of his hand he holds all the sections,
Lacks nothing except the spirit's connections.

translation: W. Kaufmann (Discovering the Mind: Goethe, Kant, Hegel.ISBN13: 978007033116)

Then the philosopher steps in: he'll show
That it certainly *had* to be so:
The first was - so, the second - so,
And so, the third and fourth were - so:
If first and second had never been,
Third and fourth would not be seen.
All praise the scholars, beyond believing,
But few of *them* ever turn to weaving.
To know and note the living, you'll find it
Best to first dispense with the spirit:
Then with the pieces in your hand,
Ah! You've only lost the spiritual bond.

translation: A.S. Kline (Poetry in Translation, ISBN-10: 1507547269

"For those who take an interest, this special issue provides many ideas of how long-term strategies for the communication of biomedical research can be implemented successfully – and can then even become rewarding for our own science and career."

ideally shared within **networks of scientists** – likely provide the most promising path of engagement – as is explained in greater detail in the editorial of a **special issue on science communication** (*published in Sem Cell Dev Biol; Box 5*). For those who take an interest, this special issue provides many ideas of how long-term strategies for the communication of biomedical research can be implemented successfully – and can then even become **rewarding for our own science and career**. Please, also have a look at our link list of public engagement **outreach resources** which will provide you with further ideas and useful support materials.

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[1] In the sense used here, Physiology comprises disciplines like immunology or functional studies in the field of neurobiology

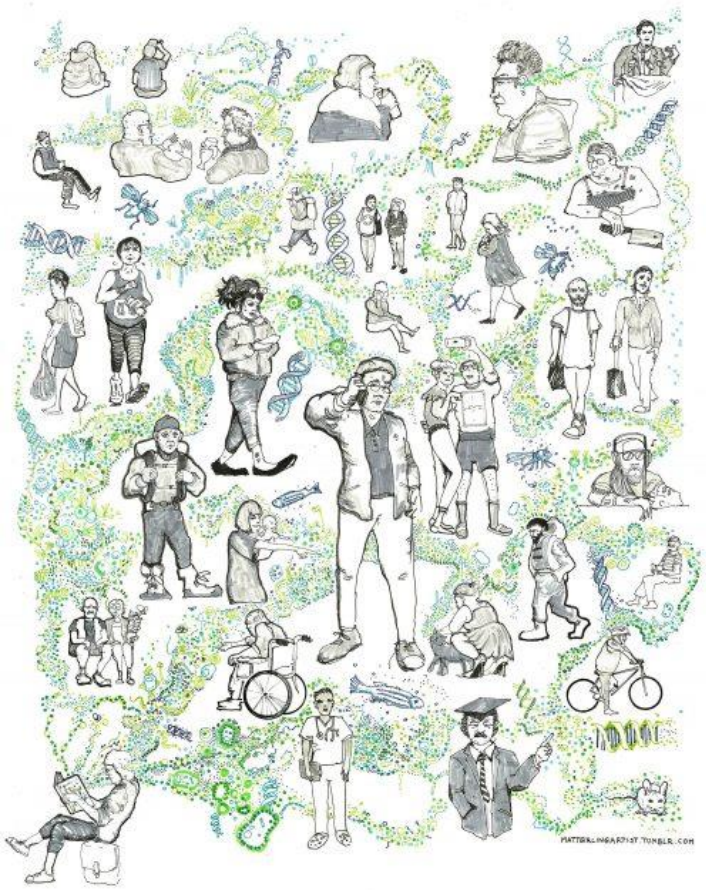
[2] Arguments and examples given so far concern studies of animal development, and those for plant development will follow soon

Science communication in the field of fundamental biomedical research edited by Sam Illingworth and Andreas Prokop

(**Vol. 70; Oct. 2017**, **free access** for one year)

The aim of this special issue is to provide concise and accessible advice on how to engage effectively, as well as share valuable practice gained from successful long-term science communication initiatives – thus providing ideas to all those who want to participate in dialogue with the public, policy makers or other scientists, or are participating already. This issue is primarily written for scientists working in the field of the biomedical sciences (and beyond), but will hopefully also be seen as a helpful resource for academic & professional science communicators. To appeal to both groups and hopefully stimulate impact-enhancing interdisciplinary collaborations, the issue is an unprecedented experiment written at the interface of both disciplines. The enormous opportunities of long-term approaches and the formation of interdisciplinary science communication networks are explained in great detail in our editorial. Further explanations about this issue were given in the recent NCCPE and PLoS|BLOGS posts.

1. EDITORIAL: Science communication in the field of fundamental biomedical research (*Sam Illingworth, Andreas Prokop*) – This article provides a critical assessment of the current state of science communication in the field of fundamental biomedical science, including lists of existing science communication initiatives, as well as a conceptual overview of the articles in the special issue [**PDF**] [**see also**].



Cover art by Matt Girling

(see figure legend in the editorial)

2. Delivering effective science communication: advice from a professional science communicator (*Sam Illingworth*)

From his experience as Senior lecturer in Science communication, Sam Illingworth writes about important considerations for all who want to participate in active science communication. His tips and tricks for science fairs, school visits or many other forms of dialogue are provided in plain language. [**PDF**] [**YouTube**]

3. The nuts and bolts of evaluating science communication activities (*Suzanne Spicer*)

From her experience as specialist for science communication at the Manchester Museum, Suzanne Spicer writes about the importance and practical implementation of project/event evaluation as an important means to improve quality and demonstrate impact. [**PDF**]

4. EuroStemCell: A European infrastructure for communication and engagement with stem cell research (*Jan Barfoot, Kate Doherty, C. Clare Blackburn*)

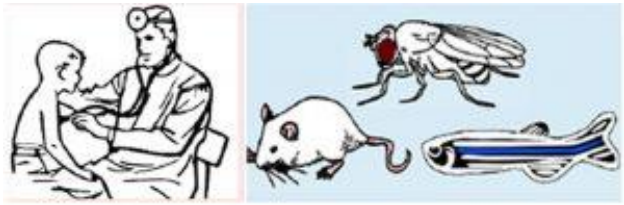
EuroStemCell is the flagship of non-commercial science communication in the area of the biomedical sciences, centred around their website with over a million annual visitors. The initiative was born out of an EU grant consortium and has developed into an interdisciplinary network that promotes responsible dialogue about stem cells, also through developing outreach resource and providing training. [**PDF**]

5. The Manchester Fly Facility: Implementing an objective-driven long-term science communication initiative (*Sanjai Patel, Andreas Prokop*)

The Manchester Fly Facility is an excellent example of an initiative communicating the importance of model organism biology. They promote *Drosophila* research through improved research training, school projects, science fair programs, and the development of publicly shared resources and strategies. Furthermore, they address *Drosophila* researchers to stimulate wider participation in science communication. [**PDF**]

6. Building dialogues between clinical and biomedical research through cross-species collaborations (*Hsiao-Tuan Chao, Lucy Liu, Hugo J. Bellen*)

Clinicians and biologists do not necessarily share a common scientific culture and way of thinking, but they share the common scientific goal of understanding and treating diseases. To this end, they can complement each other in powerful ways. This article by the Bellen lab provides helpful tools and successful strategies towards interdisciplinary collaboration between biologists working on model organisms and clinicians. [**PDF**]



7. Science Communication at Scientific Societies (*Jeanne Braha*)

As former member of the AAAS science communication team, Jeanne Braha explains how societies can help their communities to improve science communication through offering advice, providing resources and training, connecting scientists to audiences, making information available to the public, and awarding prizes for outstanding science communication work. [**PDF**]

8. Engaging with primary schools: supporting the delivery of the new curriculum in evolution and inheritance (*Paula Kover, Emily Hogge*)

The "Teaching Evolution for Primary Children" initiative is an excellent example of successful dialogue with schools. The key strategy explained here is to research curricular and teacher requirements first, to then decide on suitable contents and develop useful resources in close collaboration with schools. This ensures influence of scientists on the correctness and quality of content and the influence of teachers on the way of presentation – in sum an excellent way to engage audiences at young age with science. **[PDF]**

9. The droso4schools project: long-term scientist-teacher collaborations to promote science communication and education in schools (*Sanjai Patel, Sophie DeMaine, Joshua Heafield, Lynne Bianchi, Andreas Prokop*)

Analogous to the previous article, the droso4schools initiative by the Manchester Fly Facility seeks true dialogue with teachers in that students are placed as teaching assistants in schools to learn about teaching strategies and teacher requirements. These experiences are then turned into sample lessons that use *Drosophila* as a teaching tool to explain curriculum-relevant concepts of biology, spiced up with micro experiments that are possible with flies even in classrooms. [**PDF**]

10. DrosAfrica: Establishing a Drosophila community in Africa (*Maria Dolores Martín-Bermudo, Luka Gebel, Isabel M. Palacios, I. M.*)

DrosAfrica is an excellent example of how cost-effective, yet cutting edge research - as it is possible with *Drosophila* - can be used to free resources and promote active science and science education in disadvantaged countries. This article describes the origins of the DrosAfrica initiative and provides detailed insights into how their activities are organised. [**PDF**] [**YouTube**]

11. The Node and beyond – using social media in cell and developmental biology (*Catarina Vicente, Aidan Maartens, Katherine Brown*)

This article describes The Node as a unique communication platform for biomedical researchers, in particular from the fields of Cell and Developmental Biology. The Node does not only collate event and advocacy information, publish job vacancies and report about science-relevant topics, but it is also a blog site with international outreach where members of the science community can share news, thoughts or experiences. As such it acts as a modern electronic newsletter. [**PDF**]

The BSDB gratefully acknowledges the continued financial support from

The Company of Biologists Ltd (CoB).

www.biologists.com

Report from the graduate student and postdoc representatives

Alexandra Ashcroft

Michelle Ware

"During the 2016 ASM, we included new meet-the-speaker science breakfasts and revamped the graduate symposium, the student and postdoc social and the career workshop event - all to great success."

"The students and postdocs had another successful Spring Meeting in Warwick, kicking off the meeting with our annual careers workshop."

2016

In late 2015, Michelle and I conducted a highly successful survey (Results). Some clear trends emerged from the survey; namely a desire for more transferable, professional development at the annual spring meeting (ASM) and beyond.

During the 2016 ASM, we included new meet-the-speaker science breakfasts and revamped the graduate symposium, the student and postdoc social and the career workshop event - all to great success. A more detailed discussion of the introduced changes can be found here, but to briefly summarise:

- The highly attended careers session took a new format with round table discussions from table leaders with a focus on non-academic careers (p.32). We had speakers from Abcam, Accenture, Development to name a few. The node has also published a review of this workshop.
- The graduate student seminar took place during the middle of the meeting to give more prominence. 80.6% of survey respondents rated this new format as excellent or good with comments such as "Graduate symposium was one of the highlights".
- During the social, students and postdocs made spaghetti towers and played science pictionary.

Going forward in 2017 (and beyond), Michelle and I are keen to provide more resources for our student and postdoc members for careers in and outside academia. We are in the process of developing new resources to support young researchers at critical junctions where they may decide to remain in or transition out of academia. We are in the process of creating an online network of developmental biologists that can be used to provide support for each other, wherever their careers take them - watch this space! We are looking to include:

- Career stories from both academics and those who have transitioned out of academia
- List of grants and fellowships available, along with developmental biologist contacts who have successfully applied for and received a fellowship

Finally we are working on the careers workshop for the 2017 ASM - we hope it will be bigger and better than ever. We have selected an even more diverse range of speakers than last year - from last year's feedback we saw how valuable it is for young scientists to talk to other scientists who have trained as cell or developmental biologists and go onto successful 'alternative' careers. The revamped student and postdoc social and graduate symposium and science breakfasts will all be returning for the 2017 ASM. Michelle and I hope to see you there.

If you are interested in giving talks, mentoring or helping with the new careers development initiative in any way please contact Alex at students@bsdb.org or Michelle at postdocs@bsdb.org. Your comments or suggestions on any other matters are also welcomed.

2017

The students and postdocs had another successful Spring Meeting in Warwick, kicking off the meeting with our annual careers workshop.

- The career workshop consisted of roundtable discussions with table leaders from academia, the civil service, Nature communications and Agilent Technologies.
- The student/postdoc social included building shoe towers and we organised a networking event with the plenary speakers and society chairs/presidents.
- We launched a careers website for graduate student and postdoc members of the BSDB.

"We also have a number of career stories from people who have stayed in academia and from those who have left academia…."

"…we are busy preparing for the 70th birthday celebrations at the Spring meeting. The 2018 career workshop will focus on academia, 'building resilience and overcoming obstacles'. Please don't forget to register your interest when registering for the meeting."

Career website

We hope it will help support you with careers both in and outside academia. There are lists of fellowships where successful members of our society have offered themselves up as advisors to the community about a given fellowship/grant. We also have a number of career stories from people who have stayed in academia and from those who have left academia. We also have information about science policy, communication and other 'CV boosters'. Please do check out the site.

Spring meeting 2018

Looking forward, our term on the BSDB committee is nearly at the end and we are busy preparing for the 70th birthday celebrations at the Spring meeting. The 2018 career workshop will focus on academia, **'building resilience and overcoming obstacles'.** Please don't forget to register your interest when registering for the meeting.
We will also be hosting a student/postdoc social - please come along, meet some new people and be ready to get creative. Of course, we are planning on getting you to build something!!

Writing competition

We will also be running a PhD student and Postdoc writing competition (p.31). First prize will be awarded at the meeting and is a free trip to and attendance of the 77th Annual Society of Developmental Biology meeting in Portland, Oregon, USA. See the BSDB website click for more information.

If you are interested in contributing to the career website please contact Alex at students@bsdb.org or Michelle at postdocs@bsdb.org. Your comments or suggestions on any other matters are also welcomed.

We look forward to hearing from you, and don't forget to join us on Facebook: https://www.facebook.com/groups/2204017190

Alexandra Ashcroft & Michelle Ware

Advocacy: Writing competition for students & postdocs

*In preparation of our upcoming 70th anniversary to be celebrated at the special Spring Meeting in Warwick (April 15th-18th 2018), the BSDB announces a **writing competition** for its **graduate student and postdoc members**. We are curious to hear about your thoughts (in not more than **500 words**) on one of the following topics:*

- The future of Developmental Biology
- What Developmental Biology has contributed to society
- The experiment/paper in Developmental Biology that most inspired you

Further details of the competition will be announced shortly, but we thought it might help if we give you some head-start. The deadline will be **Sunday, 4th of March 2018,** and the winner is going to be announced at the Spring Meeting.

The first prize is a free trip to and attendance of the **77th Annual Society of Developmental Biology meeting** in Portland, Oregon, USA.

If you have any questions or would like to submit your essays, please contact Alex at **students@bsdb.org** or Michelle at **postdocs@bsdb.org**.

Reflecting on the student & postdoc events at the BSCB/BSDB Spring Meeting 2016

In 2015, the BSDB carried out a student and postdoc survey (see here), and the results clearly highlighted the need for more dedicated program items for young researchers on BSDB conferences. In response, the BSDB student rep ***Alex Ashcroft****, the BSCB postdoc representative* ***Alexis Barr****, and the BSDB postdoc representative* ***Michelle Ware*** *took initiative and organised a serious of highly successful events at the 2016 BSCB/BSDB joint Spring Meeting. Read below what happened from the perspectives of Michelle and Alex, followed by an independent report by Hamze Beati.*

Survey & workshop report by Alex Ashcroft and Michelle Ware

Career workshop

From the BSDB student/postdoc survey results last year, it was evident that most people wanted to find out more about 'alternative' careers other than those on the traditional route of academia. With more PhDs being awarded and few top level jobs there is a need to provide more information as to what else can you do with your PhD. For this reason, we chose to focus this year's careers session on alternative careers to academia. The highly attended session took the format of roundtable discussions and covered a plethora of topics including but not limited to, consulting, publishing, academic fellowships and engaging with the media. We would like to thank all the table leaders who provided stimulating discussions. This event wouldn't have been possible without you!

Obtaining a lectureship/fellowship

- Claudia Barros (Peninsula School of Medicine, Plymouth University)
- Paul Conduit (Henry Dale Fellow, Department of Zoology, University of Cambridge)
- James Wakefield (University of Exeter)

Careers outside of academia

- Katherine Brown (Editor, Development)
- Anne Wiblin (Research Collaborations Manager, Abcam)
- Caroline Grant (Senior Manager, Accenture)
- Valentina Sasselli (Associate Publisher, Cell Biology)

Science Communication

- Andreas Prokop (University of Manchester)
- Catarina Vicente (Community Manager, The Node)

From the feedback, we realise how valuable it is for young scientists to talk to other scientists who have trained as cell or developmental biologists and go on to have successful 'alternative' careers. For future workshops, we intend to build on this theme and invite an even more diverse selection of speakers.

Some selected comments from the participants:

- 'Open and honest speakers, Enough time to discuss and explore career prerequisites, responsibilities and prospects'
- 'Great organisation and table choices, Thank you! I feel quite optimistic now!'
- 'Table leaders were friendly, easy to talk to and answered all questions'
- 'Learning about career paths, Variety of careers amongst speakers'

See below an in depth summary of the workshop.

Science Breakfasts

This was the first year that we ran science breakfasts, whose goal was to facilitate informal discussions between junior researchers and scientists at the top of their field. A small number of students and postdocs got to participate in this event, discussing everything from research, careers and life in general with Abigail Tucker, Ottoline Leyser, Jordan Raff, Lidia Vasilieva and Thomas Surrey – who we are really grateful for giving up their time.

Student social

This year the reps decided it would be fun to do something more interactive for the student/postdoc social. We randomly attached a name to the back of every guest, where each name was one-half of a famous pair, such as Romeo and Juliet. Each guest could not see their own name but could see the names of other guests. Using yes-no questions, each guest had to work out who they were and then find the other half of their pair. Each pair were given the task to build the tallest possible tower using marshmallows and spaghetti. The pairs were then grouped into teams of ten which competed against each other in a round of science pictionary.

Thank-you to all the sponsors who donated gifts. For the pair that found their pair first won a bound notebook each from Horizon and sweets. Class Learning provided a voucher for two books up to £100, which was awarded to the winners of spaghetti towers (Erik Clark, Gautham Dey and their winning tower pictured here).

Chocolates and sweets from the BSDB committee were awarded to the winning teams after the Pictionary round. Molecular biology of the Cell (Garland Science) was given to the winner of the best image (Rachna Narayanan with a drawing of WALL-E).

Student Symposium

This year the graduate student symposium was moved to the middle of the meeting, resulting in excellent attendance. This was a truly excellent event – the speakers covered a diverse range of topics in an engaging manner. Some talks even got mentioned in the twitterverse!

The format was also altered so that there were six fifteen minute presentations and six five minute presentations. All the speakers did an excellent job – particular mention must be made for everyone who managed to describe their complex research in just five minutes!

We hope to see many of you next year. If you have any comments or ideas please get in touch with Alex (students@bsdb.org), Alexis (Alexis.Barr@icr.ac.uk) or Michelle (postdocs@bsdb.org); especially if you have ideas for games to play in the student social, know someone who would be a great table leader for the careers workshop or if there is someone with whom you would really like to have breakfast.

Alex Ashcroft and Michelle Ware

Workshop report by Hamze Beati

I was kindly asked to shortly summarize my experience at the Career Workshop at the BSDB/BSCB Meeting at the University of Warwick.

My name is Hamze Beati and I am currently a postdoctoral researcher in the laboratory of Arno Müller in the Department of Cell and Developmental Biology in the School of Lifesciences at the University of Dundee. I am about to finish my postdoc after doing my PhD in

the lab of Andreas Wodarz in Göttingen, Germany (now in Cologne). Later this year I will start my own junior research group "Nachwuchsgruppe" at the University of Kassel in Germany, which of course made the Career Workshop an interesting opportunity to learn about individual careers/career paths.

The first session was led by James Wakefield from the University of Exeter. The discussion was very interesting for me as he had chosen an academic career path, establishing his own group following up his own research interests. We have learnt that he changed the places he lived and worked frequently, also including times when he had to commute extensively. It was particularly nice to see that he managed to balance his work/life balance, also having a family with children at home. From our discussion I have learnt that a very important factor for an academic career path is to work together with PIs where one can follow up own ideas and interests to a particular extend. That covers my own experience so far as I was always able to develop my own ideas and thoughts about particular questions in Cell and Developmental contexts.

The second session I have attended was of great interest to me and was hosted by Claudia Barros, as she is working with the same model organism (*Drosophila melanogaster*) as I do. She was trying to establish the most important things for a successful academic career by looking back at her own career path. Similarly to James Wakefield we learnt that she had to change the places she lived and had to go through a hard time working in the US while her partner still lived in Europe. Things she pointed out were that winning awards are important for a successful career, including winning poster prizes, travel grants, etc. These are all factors for a good CV. Both sessions agreed that the publication record is the most important determinant for a successful career, which was not surprising to me. Also, both sessions pointed out that during an academic career work in the laboratory will decrease, while work in the office is increasing drastically (University duties, paper and grant writing, etc.).

The last session I have attended was led by Anne Wiblin from Abcam. This discussion was also of big interest to me as she is working for a company and had left an academic career path. I learned that it was not very easy for her to find a job in industry coming from Lifesciences, something I was aware of before talking to many young researchers who decided to leave academia. Anne had to apply to many companies to finally get a position. We were able to ask her about the kind of work which is done once one decides to leave Lifescience, starting work in a company. She told us that the scientists in her company are quite busy testing new reagents, antibodies, etc. for their specificity, etc., which is quite nice as many people leaving Lifesciences would prefer to continue doing "benchwork".

I really liked the Career Workshop and would highly recommend people to try and attend in the future. It also helped to network with the hosts, which sometimes is not very easy elsewhere at the conference.

Hamze Beati

Grants for conference or workshop attendance

BSDB Conference Grant application deadline for the 70th anniversary Spring Meeting is 26th of January 2018. Note, that only BSDB members paying the correct subscription to the Society will be eligible for a Travel Grant.

Members can apply for BSDB Conference Grants to attend BSDB-sponsored meetings, for The Company of Biologists Travel Grants to attend meetings and courses outside the UK, The Company of Biologists travel and attendance grants for practical courses, The Company of Biologists Travel grants for group leaders and PIs to attend meetings and the Louie Hamilton Fund provides travel support for handicapped members. For an overview visit the **"Grant" tab** on the BSDB.org site.

Subscription information

Full members: **£35** per annum

Students: **£15** per annum (as long as you have student status, max. for 4 years)

Student members that joined the Society in 2015 are reminded to upgrade their subscription to the full member rate of £35.

New BSDB website for junior members, with career advice

"The website was initiated by our postdoc representative Michelle Ware (group of Jenny Morton in Cambridge; 2015-18) and PhD representative Alexandra Ashcroft (group of Anne Ferguson-Smith in Cambridge; 2015-18) on the basis of feedback obtained via the 2015 survey of student and postdoc BSDB members."

"Eminent developmental biologists are sharing their Career stories to elucidate the rationale behind their decision."

"Our Toolkit page (under construction) will highlight the academic skills uniquely gained in Developmental Biology."

If you are a junior BSDB member, please see our separate website providing support for academic and non-academic careers, clearly illustrating why the BSDB is such a great society!

The website was initiated by our postdoc representative Michelle Ware (group of Jenny Morton in Cambridge; 2015-18) and PhD representative Alexandra Ashcroft (group of Anne Ferguson-Smith in Cambridge; 2015-18) on the basis of feedback obtained via the 2015 survey of student and postdoc BSDB members. To make sure that the page continues to serve your needs and expectations, please don't hesitate to send in your ideas, corrections and feedback. Simply write to students@bsdb.org or postdocs@bsdb.org.

Brief summary of the BSDB PhD/postdoc site:

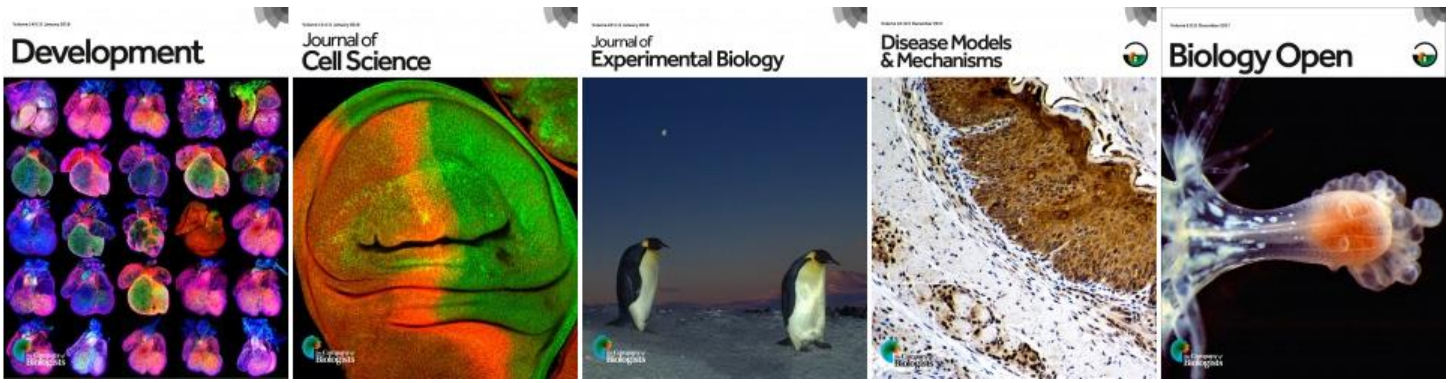
- Advice for a successful academic career
  - Funding lists for postdoctoral research, starting your own group or PhD studentships
  - Eminent developmental biologists are sharing their Career stories to elucidate the rationale behind their decisions
  - Society members provide snapshot Timelines to demonstrate the multitudes of routes to running your own group. These lists are unique in that successful members of our society have offered themselves up as "advisors" to the community. They will answer questions about the process of a given application.
  - Our **Toolkit page** (under construction) will highlight the academic skills uniquely gained in Developmental Biology.

- **Advice** for those looking to **leave academia**
  - Developmental Biologists who left the field share their **Career stories** to show the breadth of what's possible, and how to get there
  - Our **Toolkit page** (under construction) will highlight the transferable skills uniquely gained in Developmental Biology

- **CV Boosters** page (under construction)
  - will offer advice on Consulting, Entrepreneurship, Public Engagement, Science communication and Science Policy

- **Events**
  - alerts to our upcoming career events and looks back at past events we organised

Why not just visit our **PhD/postdoc website** and see for yourself?



Summary of all BSDB awards 2016

Medal Awards

- BSDB Waddington Award winner: **Enrico Coen** CBE FRS (John Innes Centre, Norwich) who gave a talk about his pioneering contributions to understanding patterning and morphogenesis in plants (available on YouTube).
- The BSDB Cheryll Tickle Medal winner: **Abigail S. Tucker** who gave her Cheryll Tickle Award Lecture about the evolution of shape available on YouTube. To read more about Abigail, please download the BSDB Newletter 2015 or go to the post on The Node.
- BSDB Beddington Award winner: **Elena Scarpa** (now Univ. Cambridge in the group of Benedicte Sanson) for her work entitled "Cadherin switch during EMT in neural crest cells leads to contact inhibition of locomotion via repolarisation of forces" which was performed in the laboratory of Roberto Mayor (UCL).

PhD Poster Prizes

- 1st BSDB PhD Poster Prize winner (*visit to 2016 SDB-ISD meeting, Boston*): **Mathew Tata** (University College London, group of Christiana Ruhrberg) – P117 "*Regulation of embryonic neurogenesisi by germinal zone vasculature*" – read an **interview** in The Node.
- 2nd BSDB PhD Poster Prize (*£75 cash prize*): **Laura Martin-Coll** (DanStem, University of Copenhagen) – P87 "*A single-cell analysis of progenitor heterogeneity at the onset of pancreas formation*"
- 3rd BSDB PhD Poster Prize (*£50 cash prize*): **Leila Thuma** (University of Bristol) – P159 "*Modelling immune cell diapedesis from vessels to wounds in the Drosophila pupal wing veins*"

Postdoc Poster Prizes

- Joint 1st BSDB Prize (*£150 cash prize*): **Guilherme Costa** (University of Manchester) – P144 "Cellular localisation of mRNA during angiogenesis"
- Joint 1st BSDB Prize (*£150 cash prize*): **Sophie Gilbert** (University of Oxford) – P29 "*How the worm completes its skin*"
- 2nd BSDB Prize (*£125 cash prize*): **Filip Wymeersch** (MRC Centre for Regenerative Medicine, University of Edinburgh) – P134 "*Transcriptionally dynamic neuromesodermal progenitors coexist alongside a stable niche during axis elongation*"

Summerbell Award

- **Iwo Kucinski** (Gurdon Institute, University of Cambridge) "The molecular signature of the loser cell status reveals key pathways regulating cell competition"

Gurdon Summer Studentship Awardees (see reports p. 50)

Ji Hye Moon (*KCL; host: Richard Wingate, KCL*) • **Iona Imrie** (*Edinburgh University; host: Jamie Davies, Edinburgh*) • **Daniyal Jalil Jafree** (*UCL; host: Pete Scambler, UCL*) • **Paige Paddy** (*UEA; host: Andrea Münsterberg, UEA*) • **Jack Weaver** (*University of Aberdeen; host: Lynda Erskine, Aberdeen*) • **Mireya Vazquez-Prada** (*UCL; host: Stephen Price, UCL*) • **Christopher Taylor** (*Sheffield University; host: Karin Sofefan, Sheffield*) • **Lauren Miller** (*UCL; host: Richard Poole, UCL*) • **Lilli Hahn** (*Cambridge University; host: Brian Hendrich, Cambridge*) • **Jaylee Boer** (*Edinburgh University; host: Mike McGrew, Roslin Institute, Edinburgh*)

Summary of all BSDB awards 2017

Medal Awards

- BSDB Waddington Award: **Bill Harris** – Univ. Cambridge
- The BSDB Cheryll Tickle Medal: **Jenny Nichols** – Univ. Cambridge
- BSDB Beddington Award: **Erik Clark** – Univ. Cambridge

PhD Poster Prizes

- 1st BSDB PhD Poster Prize winner (*Attendance at SDB 76th Annual Meeting, Minneapolis*): **Claire Bromley** (Kings College London) – Poster 25 "*Investigating biomechanical forces in zebrafish brain morphogenesis*"
- 2nd BSDB PhD Poster Prize (*£100 cash prize sponsored by BioMed Central*): **Ariadna Gador Navarro-Aragall** (*UCL Institute of Ophthalmology*) – Poster 86 "*SEMA3E and SEMA3C Cooperate to establish vascular boundaries*"

Postdoc Poster Prizes

- 1st BSDB Prize (*£200 cash prize sponsored by BioMed Central*): **Carla Mulas** (*University of Cambridge*) – Poster 129 "*Functional characterisation of metachronous cell state transitions*"
- 2nd BSDB Prize (*£100 cash prize sponsored by BioMed Central*): **Hadi Boukhatmi** (*University of Cambridge*) – Poster 92 "*Molecular logic behind Satellite cells specification in* Drosophila"

- BSDB Honorary Mention (Certificate): **Eva Higginbotham** (University of Cambridge) -Poster 114 "*Neurotransmitter specification in the ventral nerve cord of* Drosophila melanogaster"

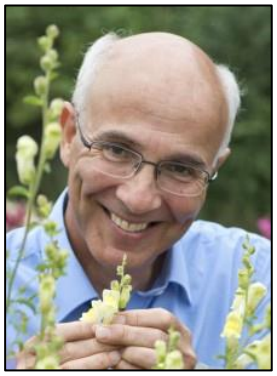
Summerbell Award

- **Helen Weavers** *(Bristol, UK) "*Understanding the inflammatory response to tissue damage in *Drosophila*: a complex interplay of pro-inflammatory attractant signals, developmental priming and tissue cyto-protection"

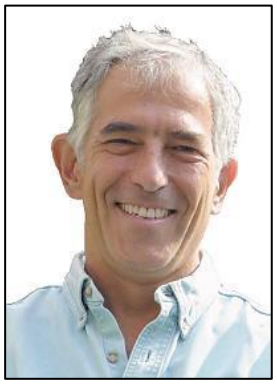
Gurdon Summer Studentship Awardees (see reports p. 50)

Liam Mcmulkin *(University of Dundee; host: Marios Stavridis)* • **Jake Cornwall Scoones** *(University of Cambridge; hosts: Anna Philpott & Roberta Azzarelli)* • **Josie Elliott** *(University of Oxford; host: Prof. Alison Woollard)* • **Jack O'Shea** (*UCL; host: Dr. Richard Poole)* • **Miguel Robles Garcia** *(UEA; host: Andrea Münsterberg)* • **Agata Czap** *(UCL; host: Paola Oliveri)* • **Nicole Serzhantova** *(University of Cambridge; host: Jennifer Nichols)* • **Rachel Adams** *(University of Cambridge; host: Peter Lawrence)* • **Eleanor Sheekey** *(University of Cambridge; host: Dr Peter Rugg-Gunn)* • **Katarina Grobicki** *(University of Oxford; host: Sebastian M Shimeld)*

The Waddington Medal



"The medal talk was a pleasure to watch and is now available on YouTube. It was a scholarly masterpiece of conceptual brilliance, presented with inspiring enthusiasm, enriched with beautiful images, illustrated with enlightening and entertaining movies…"



"Through his passion for science, his leadership and his mentoring of people at all career stages, Bill has made outstanding contributions to Developmental Biology."

The **Waddington Medal**, the only national award in Developmental Biology, is awarded for outstanding research performance as well as services to the subject community. The medal is awarded annually at the BSDB Spring Meeting, where the recipient presents the Waddington Medal Lecture. Here we introduce Enrico Coen and William Harris, as the awardees for 2016 and 2017, respectively.

Enrico Coen: winner of the 2016 Waddington Medal

The BSDB congratulates **Enrico Coen** CBE FRS (John Innes Centre, Norwich) as the 2016 winner of the **Waddington Medal**. Professor Coen was awarded the medal for his pioneering contributions to understanding patterning and morphogenesis in plants, particularly snap dragon flowers. His work elegantly combines molecular genetics, diverse imaging techniques and computational modeling (see the Coen lab site). He is also well known for his popular science books 'The art of genes' (1999) and 'Cells to civilisations' (2012), and his painting, which has appeared on the cover of Cell and the walls of the Royal Society.

The medal talk was a pleasure to watch and is now available on **YouTube.** It was a scholarly masterpiece of conceptual brilliance, presented with inspiring enthusiasm, enriched with beautiful images, illustrated with enlightening and entertaining movies of pottery (!!!) and computer models, and even spiced up with live experiments. It will soon be available on the BSDB's **YouTube channel**. An **interview** performed by Cat Vicente during the Spring meeting is scheduled to be published in **Development**.

Bill Harris: winner of the Waddington Medal 2017

The BSDB congratulates the **2017 winner** of the Waddington Medal: **William Harris** FRS FMedSci, Head of the Department of Physiology Development & Neuroscience at the University of Cambridge. Bill was awarded the medal for his pioneering contributions to the understanding of retinal development.

Bill is Canadian, but underwent his scientific education and early career in the U.S., where he did his B.A. in Biophysics (University of California, Berkeley; 1972), his Ph.D. on "Color vision in *Drosophila*" in the group of Seymour Benzer at the California Institute of Technology (Pasadena; 1972-76), carried out his postdoctoral research in the laboratory of David Hubel and Torsten Wiesel at the Dept. of Neurobiology, Harvard Medical School (1976-80), and joined the faculty of the Dept. of Biology, University of California (San Diego; 1980). He remained in San Diego until 1997, when he moved to the UK to take on a position as Professor of Anatomy at the University of Cambridge and, since 1999, Head of the Department of Anatomy (which became the Department of Physiology, Development and Neuroscience in 2006).

Bills achievements are best summarised in the nomination letter put forward by Sarah Bray, Michael Bate, Nancy Papalopulu, Daniel St Johnston and Steve Wilson:

"Through his passion for science, his leadership and his mentoring of people at all career stages, Bill has made outstanding contributions to Developmental Biology. Working at the interface of Developmental Biology and Neuroscience, he has championed the field within Cambridge, across the UK and throughout the world. His deep interest and scientific enthusiasm have led to major insights in the field of neuronal specification and wiring.

"Bill has made many important contributions to our understanding of visual system development, which has been his focus throughout his career."

"His early discoveries in the USA helped establish basic principles underlying axon guidance in brain wiring and revealed key mechanisms regulating cell differentiation in the retina."

"A pioneer in the field of live imaging in developing systems, he made the very first time-lapse movies of axons growing in the brain. He has harnessed emerging technology to distinguish between different hypotheses."

"…he championed the establishment of the Cambridge Advanced Imaging Centre, whose main focus is on techniques that enable gentle deep imaging of cells in developing animals, and has forged strong links with physicists to develop powerful models."

Bill has made many important contributions to our understanding of visual system development, which has been his focus throughout his career. Time and again, he has pioneered new fields of research. His early discoveries in the USA helped establish basic principles underlying axon guidance in brain wiring and revealed key mechanisms regulating cell differentiation in the retina. Starting with the identification in Drosophila of the sevenless gene (with Seymour Benzer), he went on to discover ways that axons in the brain are guided to the vicinity of their appropriate targets in the absence of neural activity, being one of the first to suggest there might be local chemotactic cues that guide retinal axons from a distance (see Figure 1; Dingwell et al., 2000, J Neurobiol 44, 246ff. – *LINK*). He used the developing Xenopus visual system to find the first vertebrate homologues of genes that influenced fate choice in Drosophila, including Notch, ASH, and ATH, leading to a new and fruitful research direction for Developmental Biologists.

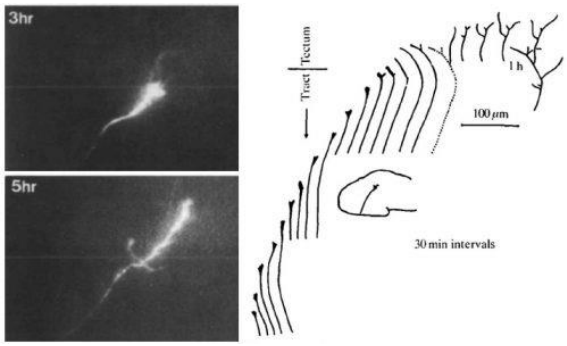


***Figure 1**. Example of an elegant experiment where retinal ganglion cell growth cones that were severed from their axons, were video-images and shown to continue to navigate towards the tectum (thus demonstrating the navigational capacity residing in these structures; taken from Harris et al., 1987, Development 101, 123ff. – LINK).*

After moving to Cambridge in 1997, he built on these earlier observations. He established the retinal ciliary marginal zone as a powerful model to study not only retinal development per se, but also mechanisms controlling stem cells and the pathways regulating differentiation. Perpetually self-renewing and proliferative, this neuroepithelium at the perimeter of the retina in amphibians and fish gives rise to cells that are spatially ordered with respect to cellular development. Combining in vivo lipofection strategies in Xenopus retina with genetic approaches in zebrafish, Bill has uncovered roles for the cell cycle, metabolism and stochasticity in fate determination. A pioneer in the field of live imaging in developing systems, he made the very first time-lapse movies of axons growing in the brain. He has harnessed emerging technology to distinguish between different hypotheses. For example, by watching lineages evolve in vivo he ruled out the idea that their variance was due to random cell death. Through such cutting-edge studies he has shown how cell divisions, cell lineages and cell polarizations contribute to the process of retinal neuron specification (Fig. 2; Agathocleous & Harris, 2009, Annu Rev Cell Dev Biol 25, 45ff. – *LINK*). In doing so, he championed the establishment of the Cambridge Advanced Imaging Centre, whose main focus is on techniques that enable gentle deep imaging of cells in developing animals, and has forged strong links with physicists to develop powerful models.

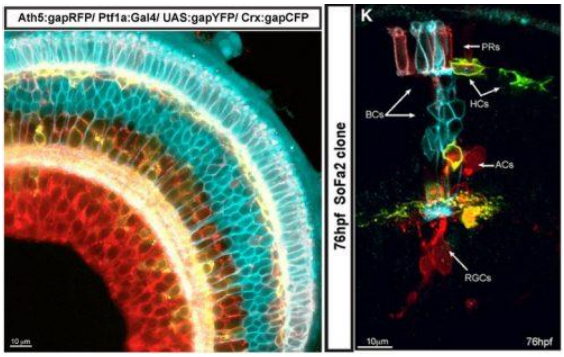


***Figure 2**. The Spectrum of Fates approach can be used to assess various aspects of neural development, such as developmental waves of differentiation, neuropil development, lineage tracing and hierarchies of fates in the developing zebrafish retina (taken from Almeida et al., 2014, Development 141, 1971ff. – LINK)*

Bill has made important contributions to the community. He is an enormous presence in Cambridge, heading one of the major biology departments and taking a lead in the Cambridge Neuroscience initiative. Under his leadership and long-term vision, the Departments of Anatomy and Physiology were merged, establishing "PDN" where the letter D stands for Development. Bill is on the Advisory committee for the Gurdon Institute, and has also been instrumental in the establishment and renewal of the Wellcome Trust 4-year PhD Programme in Developmental Biology. As well as training first-rate researchers in his own lab (23 of whom have PI positions around the world), he has, as Department Head, nurtured many developmental biologists at different stages in their career, housing early researchers (e.g. Fiona Wardle), recruiting talented lecturers (e.g. Clare Baker, Benedicte Sanson, Kristian Franze) and supporting established leaders (e.g. Andrea Brand, Magda Zernicka-Goetz). Despite the burdens of being Department Head, Bill has retained a major teaching role throughout, with lectures and practicals introducing fundamentals of neural development to undergraduates at all stages. As organizer of a number of international conferences, he has included significant themes in Developmental Biology. He is also editor in chief of "Neural Development" and on the editorial boards for "PLoS Biology", "Cell" and "Molecular Neuroscience". Among his many other talents, Bill is an artist who also communicates his scientific vision through his paintings, as illustrated by his impression of a young zebrafish retina (see Figure 3)."

***Figure 3**. A painting by Bill Harris showing his impression of a young zebrafish retina.*

To add to this, the high quality of Bill's work is reflected in his many honours, fellowships and awards which include being a Fellow of the Academy of Medical Sciences (2007), Fellow of the Royal Society (2007) and Member of EMBO (2012). With respect to translational biology, he was founder of the drug discovery company DanioLabs (2002), which was successfully sold to VASTox (now Summit) plc, a leading UK biotechnology company [LINK]. Furthermore, for many of us, Bill has become an inspiring teacher, especially through his textbook ***Development of the Nervous System*** (*Sanes et al., 3rd edition, 2011, Academic Press – LINK*) which was a true eye opener: a highly entertaining read laying essential foundations for conceptual thought about the field and its many facets and directions.

***Figure 4**: The avatar on Bill's lab web page.*

Finally, Bill's passion for ice hockey deserves mentioning (*Fig. 4*). He decided to share it with the Cambridge community by founding the **Cambridge Leisure and Ice Centre** as a community-led initiative in 2001, which he still chairs today. The Cambridge Ice Arena will be the key result of the initiative and is scheduled to open late 2017.

The BSDB would like to congratulate Bill for his life achievements and for being the well-deserved awardee of the 2017 Waddington Medal. The Waddington Medal lecture is available on the BSDB YouTube channel and website, and an **interview with Bill** was published in Development.

The Cheryll Tickle Medal

"In 2016, the BSDB introduced the Cheryll Tickle Medal, which is being awarded annually to a mid-career, female scientist for her outstanding achievements in the field of Developmental Biology."

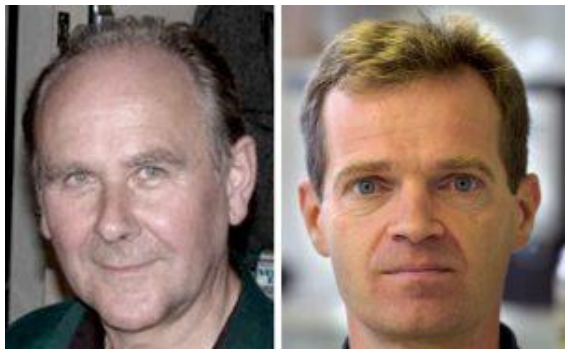
"Jenny's main research interests are the mechanisms that establish and maintain pluri-potency in the early embryo and during the formation of embryonic stem cells in mammals."

In 2016, the BSDB introduced the **Cheryll Tickle Medal**, which is being awarded annually to a mid-career, female scientist for her outstanding achievements in the field of Developmental Biology. The Cheryll Tickle Medal was designed by Andreas Prokop and Megan Davey in discussion with Cheryll Tickle. It shows the famous digit aberrations that occur upon transplantation/manipulation of the zone of polarizing activity (ZPA) or implantation of beads soaked in retinoic acid or sonic hedgehog (*for details see Towers & Tickle, 2009, Int J Dev Biol 53, 805ff.*). Cheryll performed much of this work in chick as illustrated by the feather on the medal's flip side, which also shows the typical tool set required for experimental operations and the BSDB logo depicting *in ovo* development from egg to embryo. Here we introduce Jenny Nichols and Christiana Ruhrberg, the awardees of 2017 and 2018.

Jenny Nichols: winner of the Cheryll Tickle Medal 2017

The BSDB congratulates the 2017 awardee **Jenny Nichols**. The medal was presented at this year's **Spring Meeting** where Jenny gave the Cheryll Tickle Award Lecture (available on **YouTube**). A post-award **interview** with Jenny was published in Development.

Jenny's main research interests are the mechanisms that establish and maintain pluri-potency in the early embryo and during the formation of embryonic stem cells in mammals. She also uses animal models to understand defects which lead to type 1 diabetes. Jenny started her career at Oxford University where she worked as a research assistant to Prof. Richard Gardner (1981-90). In 1990 she moved to the University of Edinburgh to carry out her PhD project in the group of Prof. Austin Smith. She obtained her PhD in 1995 for her thesis entitled '*A Study of the Expression and Function of Differentiation Inhibiting Activity and its Receptor in the Early Mouse Embryo*'. She stayed as a post-doctoral research fellow in the group of Austin Smith in Edinburgh, until she became a group leader at the Wellcome Trust-MRC Stem Cell Institute of the University of Cambridge, where she has stayed since then.



Jenny's mentors: Richard Gardner (left) and Austin Smith (right)

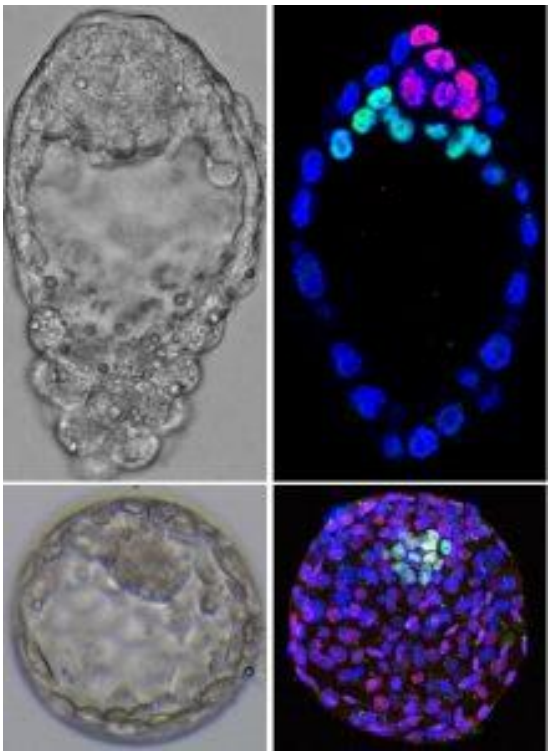
Jenny has an impressive portfolio of current funding with 3 BBSRC, a Wellcome Trust and a Medical Research Council grant, she has published ~70 papers so far, supervised 11 PhD students, and has editorial responsibilities at three scientific journals (PLoS One, Biol Open, Dev Biol), in addition to a number of local administrative tasks. She is active in university teaching and has been the co-/organiser of a number of international stem cell workshops and engages in science communication with the public.

Germline chimaera generated in Jenny's laboratory from ES cells derived in 2i medium

"I was fascinated by the flexibility of the early mammalian embryo and curious as to how the lineages were specified and regulated. This is still my main research theme."

"As someone spanning Developmental Biology and stem cell research I feel very strongly that studying Developmental Biology requires a rigorous and systematic approach that can often be by-passed by the stem cell biologists who work in vitro."

"Go to a good, supportive lab and collaborate broadly."



***Top**: E4.5 mouse embryo stained against Nanog (red) and Gata6 (green); **bottom**: D6 human blastocysts*

Apart from the Cheryll Tickle Medal awarded this year, Jenny won the NC3Rs '3Rs' prize (for research reducing refining or replacing the use of animals in biomedical research; 2009) and the Suffrage Science Award (2013), is an elected Fellow of the Royal Society of Biology (2010) and was an active member of the BSDB committee (2010-15).

The BSDB makes it a tradition to ask the Cheryll Tickle Medal awardees a number of questions concerning our field and its future. Please, read Jenny's answers below.

What were the questions that inspired you to work in the field of Developmental Biology?

I was fascinated by the flexibility of the early mammalian embryo and curious as to how the lineages were specified and regulated. This is still my main research theme. The first questions were 'when do the cells of the inner cell mass lose their ability to become troph-ectoderm?' and 'do they routinely supplement the developing troph-ectoderm?' Most of all I just loved messing about with embryos. We had so few tools in those days and so many questions, but were quite restricted to using observation and grafting.

Why should young researchers continue to engage in Developmental Biology?

As someone spanning Developmental Biology and stem cell research I feel very strongly that studying Developmental Biology requires a rigorous and systematic approach that can often be by-passed by the stem cell biologists who work in vitro. Developmental Biology is necessarily a 3D system, so the questions of cell fate specification can be very tricky and exciting to tackle. One very satisfying thing about experimenting with embryos is that the final readout from any manipulation must measure up to the yardstick of normality.

Which were the key events or experiences in your life that influenced your career decisions and paved your path to success?

Firstly, having been in Richard Gardner's lab surrounded by brilliant embryologists (Richard, Rosa Beddington, John West, Chris Graham) and having had the luxury of my own microscope and microinjection equipment and unlimited access to mice; secondly, joining Austin Smith's lab and having the chance to work on embryonic stem cell derivation when it was such a mysterious process. Austin also gave me the chance to do a PhD and taught me how to think.

What advice do you give young researchers towards a successful career?

Go to a good, supportive lab and collaborate broadly.

"Her postdoctoral research in the laboratories of Robb Krumlauf at the National Institute for Medical Research in London (1997-1999) was funded by a MRC postdoctoral training fellowship and dedicated to studying the role of Hoxa1, Hoxb1 and Hoxb2 during hindbrain development."

"Christiana has an excellent record in obtaining research funding, as illustrated by a Wellcome Trust Junior Investigator Award in 2011 and a Wellcome Trust Investigator Award in 2016 for her research on vascular biology and neurovascular interactions."

Christiana Ruhrberg: winner of the Cheryll Tickle Medal 2018

The BSDB congratulates the 2018 awardee Christiana Ruhrberg. The medal will be presented at the 2018 Spring Meeting where Christiana will give the Cheryll Tickle Award Lecture.

Christiana studied Biology at the Justus Liebig University (Giessen, Germany), and obtained her first class Diploma/MSc degree in 1992. After taking on an MSc/research assistant position at the University of Sussex for two years to elucidate genetic changes in ovarian cancer, she moved to Imperial College London to work for another two years to study the genomic organisation of the gene-rich human 'surfeit' locus. She then carried out her PhD project in the laboratory of Fiona Watt at the Imperial Cancer Research Fund (1994-97) where she identified and described the function of the envoplakin and periplakin genes. Her postdoctoral research in the laboratories of Robb Krumlauf at the National Institute for Medical Research in London (1997-1999) was funded by a MRC postdoctoral training fellowship and dedicated to studying the role of *Hoxa1*, *Hoxb1* and *Hoxb2* during hindbrain development. During her second postdoc with David Shima at the Imperial Cancer Research Fund in London (2000-2002), she was funded by a ICRF fellowship and worked on VEGF-A-mediated blood vessel branching. Having received an MRC Career Development Award in 2003, she became an independent investigator at University College London's Institute of Ophthalmology studying links between vascular and neuronal development, with particular focus on the roles of VEGF and SEMA3A signalling during facial nerve and blood vessel formation. Staying at that same institute, she was appointed Lecturer in 2007, promoted to Reader in 2008 and then full Professor in 2011. Christiana has an excellent record in obtaining research funding, as illustrated by a Wellcome Trust Junior Investigator Award in 2011 and a Wellcome Trust Investigator Award in 2016 for her research on vascular biology and neurovascular interactions.

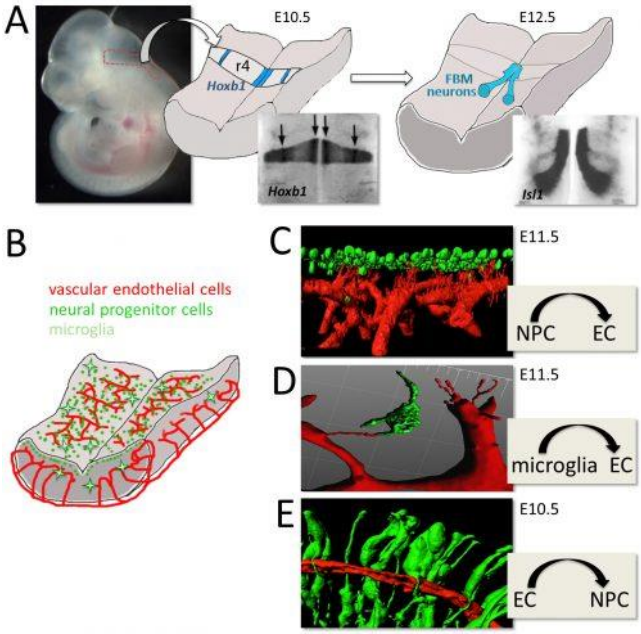


Figure: *Using the mouse embryo hindbrain to elucidate neuronal and vascular development.* (**A**) The hindbrain from an embryonic day (E) 10.5 mouse was dissected to perform visualise the expression of *Hoxb1* in rhombomere 4 (**A**), the origin of the *Isl1*-positive facial branchiomotor (FBM) neurons, which can be observed during their caudal migration by *Isl1* at E12.5 (**B**). (**B-F**) Main cell types (**B**) and cell interactions (**C-F**) in the developing mouse hindbrain. In (**C-F**), dissected hindbrains were stained with the vascular endothelial marker IB4 (red) and markers for mitotic neural progenitors, microglia or neural progenitor processes, shown in green in **C-E**, respectively)**.** Note that neural progenitors attract sprouting blood vessels (**C**), the physical contact between microglial and endothelial processes (**D**) and that neural progenitor processes contact vasculature (**E**).

"Christiana has been a mentor to 11 PhD students and 6 postdocs, 3 of whom have now established themselves as independent investigators. She has published many influential papers in the fields of vascular, neuronal and neural crest cell development, including primary research articles and reviews, methods papers and book chapters."

"Personally, I have always been fascinated by how the vertebrate body develops to enable postnatal life. Developmental studies also yield striking images of a multitude of diverse cellular processes that coordinate organ morphogenesis, making this type of research not only exciting, but also aesthetically pleasing."

"…the developmental biology community is increasingly faced with the challenge of having to convince funding agencies that developmental biology research can underpin research into tissue repair and regeneration!"

Christiana has been a mentor to 11 PhD students and 6 postdocs, 3 of whom have now established themselves as independent investigators. She has published many influential papers in the fields of vascular, neuronal and neural crest cell development, including primary research articles and reviews, methods papers and book chapters. Twelve of her research papers have been listed as recommended reads by the Faculty of 1000, five have been featured with cover images and six have been featured in editorials in influential journals such as JCB, PNAS, Nature, Science, Neuron and JCI.

Christiana received an impressive amount of honours, including the title 'Young Cell Biologist of the Year' (BSCB, 1996), the 'Werner-Risau-Prize' (German Society for Cell Biology, 2003), the MRC's 'Science Heirloom' (Suffrage Science, 2011). She was also named an 'Academic Role Model' (UCL, 2013) and is listed in EMBO's 'Expert Women in Life Sciences' (2013) and 'AcademiaNet' (Robert Bosch Stiftung, Germany, 2014). Besides all these achievements, Christiana takes on regular institutional responsibilities, is a member of various grant committees and a contributing member of the Faculty 1000, editor for PLoS One, and serves on programme committees of a number of scientific meetings.

The BSDB makes it a tradition to ask the Cheryll Tickle Medal awardees a number of questions concerning our field and its future. Please, read Christiana's answers below.

What were the questions that inspired you to work in the field of Developmental Biology?

I was initially attracted to working in the field of developmental biology when the first mouse knockouts became available. Many of them had lethal phenotypes, making embryological studies imperative to determine the physiological functions of the ablated genes. I initially examined mouse knockout models to identify molecules that regulate the migration of facial branchiomotor neurons and subsequently to determine how the growth factor VEGF orchestrates blood vessel morphogenesis. By answering two different biological questions with the mouse embryo hindbrain as a model system, I serendipitously identified VEGF as the elusive migratory cue for facial branchiomotor neurons. This finding inspired me to continue investigating VEGF functions in neuronal and vascular development, with a more recent strive to apply knowledge gained through developmental studies also to further our understanding of disease processes in the adult.

Why should young researchers continue to engage in Developmental Biology?

Personally, I have always been fascinated by how the vertebrate body develops to enable postnatal life. Developmental studies also yield striking images of a multitude of diverse cellular processes that coordinate organ morphogenesis, making this type of research not only exciting, but also aesthetically pleasing. The PhD students, postdocs and technicians who train in my laboratory share these sentiments and have gained much deserved appreciation for their developmental biology research work through journal cover images and when winning presentation prizes at conferences. Developmental biology research also impacts on public health, because understanding how embryonic processes yield functional organs informs regenerative medicine. In particular, knowing how functional tissues are built normally might one day soon provide a gold standard for designing therapeutic strategies to recreate or repair dysfunctional tissues. That said, the developmental biology community is increasingly faced with the challenge of having to convince funding agencies that developmental biology research can underpin research into tissue repair and regeneration!

Which were the key events or experiences in your life that influenced your career decisions and paved your path to success?

"My career path has not been straightforward, but encompassed a series of obstacles and opportunities."

"…it was not careful planning that allowed me to get to my current career stage, but my unwavering enthusiasm for research combined with resilience when faced with adversity and the will to take advice and encouragement from my fabulous mentors Fiona and Robb."

"…I recommend everyone to take advantage of transferable skills training to complement the technical training gained in the research environment."

My career path has not been straightforward, but encompassed a series of obstacles and opportunities. For example, the failure to appoint a successor for our retiring genetics professor at my home university in Germany could have persuaded me to switch subjects from molecular biology and genetics to a different one to avoid a significant delay to graduation, but I took this challenge as an opportunity to study for a year in the UK, being the first student on my course to embark on such an overseas placement. I ended up staying at the University of Sussex for almost 2 years to complete a research project all the way to publication, returning to Germany only to submit my thesis. Incredibly, after all the long hard work, I almost did not graduate, because those in charge at my German University deemed an English-written thesis unacceptable! This experience encouraged me to return to the UK to continue academic research in an English-speaking environment. Unfortunately, I initially chose a PhD supervisor at the Imperial Cancer Research Fund who turned out to be rather unsupportive of my endeavours; yet, I was able to make a 'lateral' move within the same organisation to re-start my PhD with Fiona Watt. She was a most inspirational PhD supervisor and mentor, and later matched me with an ideal postdoc supervisor in Robb Krumlauf at the National Institute of Medical Research. In Robb's lab, I discovered both my love for developmental biology and the inspirational community of scientists working in this area. In a nutshell, it was not careful planning that allowed me to get to my current career stage, but my unwavering enthusiasm for research combined with resilience when faced with adversity and the will to take advice and encouragement from my fabulous mentors Fiona and Robb.

What advice do you give young researchers towards a successful career?

Whether you choose to continue on an academic career or embark on an alternative career, I recommend everyone to take advantage of transferable skills training to complement the technical training gained in the research environment. Strengthening your verbal and written communication skills, learning about project and team management and developing effective networking skills will provide a strong foundation to equip you for success in a diverse range of career options.

The Beddington Medal

The Beddington Medal is the BSDB's major commendation to promising young biologists, awarded for the best PhD thesis in Developmental Biology defended in the year previous to the award. Rosa Beddington was one of the greatest talents and inspirational leaders in the field of developmental biology. Rosa made an enormous contribution to the field in general and to the BSDB in particular, so it seemed entirely appropriate that the Society should establish a lasting memorial to her. The design of the medal, mice on a stylised DNA helix, is from artwork by Rosa herself. Here we present Elena Scarpa and Erik Clark, the medal winners of 2016 and 2017.

Elena Scarpa: the Beddington Medal winner 2016

The BSDB congratulates the 2016 Beddington Medal winner Elena Scarpa. Elena studied in Turin (Italy), went for her Wellcome Trust fellowship-funded PhD

project to the laboratory of **Roberto Mayor** (UCL, London), and works now in the group of Benedicte Sanson (Univ. Cambridge) on the role of mechanical tension in orienting cell divisions in the *Drosophila* embryo. Her **Beddington Medal talk** described the outcome of her successful PhD project (submitted in April 2015) and was entitled **"**Cadherin switch during EMT in neural crest cells leads to contact inhibition of locomotion via repolarisation of forces". Elena introduced her project with the following words: "Contact Inhibition of Locomotion (CIL) was discovered by Abercrombie and colleagues over 60 years ago as the process through which migrating cells move away from each other after cell-cell contact. More recently, it has been shown to play important roles *in vivo* during morphogenesis and cancer invasion, but its molecular mechanisms have not been elucidated. In all systems where it has been investigated, the CIL response seems to rely on cell-cell contact dependent signalling. In particular, Eph-Ephrin signalling has been found to be responsible for CIL in cancer cells and in neurons, while in neural crest Wnt-PCP and N-Cadherin dependent cell-cell adhesion are required for CIL. However, it remained unclear why certain cells display an efficient CIL response while many other cell types do not exhibit CIL and instead remain in contact after cell collision, thus forming a stable cell-cell adhesion. During my PhD, I undertook a comparative approach to pursue this mechanism and ask why some cells exhibit CIL, while others, like epithelial cells, remain in contact and form stable junctions."

"Her Beddington Medal talk described the outcome of her successful PhD project (submitted in April 2015) and was entitled "Cadherin switch during EMT in neural crest cells leads to contact inhibition of locomotion via repolarisation of forces"."

"During my PhD, I undertook a comparative approach to pursue this mechanism and ask why some cells exhibit CIL, while others, like epithelial cells, remain in contact and form stable junctions.""

The details of this research are described in her 2015 publication entitled "*Cadherin Switch during EMT in Neural Crest Cells Leads to Contact Inhibition of Locomotion via Repolarization of Forces*" (Dev Cell **34**, 421-34), and an **interview** with Elena has been published here on The Node.

Erik Clark: The Beddington Medal Winner 2017

The BSDB congratulates the 2017 Beddington Medal winner Erik Clark. Erik did his BA in Biological Sciences at the University of Oxford (1st in his year group) and his MSc in Bioinformatics & Theoretical Systems Biology at Imperial College London where he worked on the project entitled "Evolution of Mutation Rate in Fluctuating Environments". He then moved on to do his PhD within the BBSRC Genes to Organisms Program supervised by **Michael Akam** at the Department of Zoology, University of Cambridge, where he worked on his project entitled "The *Drosophila* Pair-Rule System" and where he continues to work now. Erik won an impressive number of prizes, fellowships and grant awards, including the Gibbs Prize in Animal Biology (Univ. Oxford, 2011), an Isaac Newton Trust Research Grant (2016-17), a Junior Research Fellowship (Trinity College, Cambridge) and he is co-investigator on a BBSRC research grant (2017-20).

His **Beddington Medal talk** described the outcome of his most successful PhD project. About the background Erik explained: "*The Drosophila segmentation cascade is a paradigmatic example of a developmental gene regulatory network, used to gain insight into transcriptional regulation in all animals… Using spatial information from graded domains of "gap" gene expression, seven "pair-rule" genes are expressed in periodic patterns of seven stripes each [which] then work in combination to specify precisely-phased 14 stripe patterns of "segment polarity" genes. These output patterns form the template for the segmental organisation of the insect body…[Although] the pair-rule genes have been studied in Drosophila for over 30 years, there is still no good systems-level understanding of their regulatory interactions*".

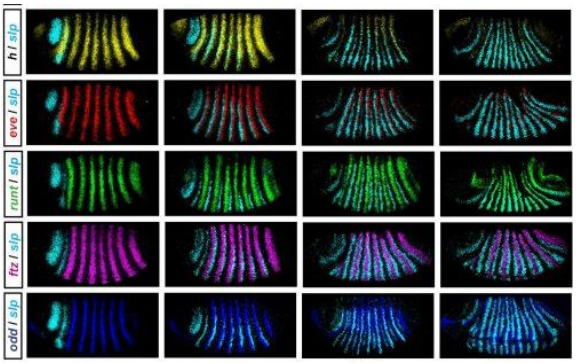
In his thesis, Erik used a combination of modelling and experiment to reverse-engineer the structure of the *Drosophila* pair-rule network and understand how it generates expression dynamics that lead to the patterning of segmental boundaries. He set out to collect a complete time-resolved dataset of

"In his thesis, Erik used a combination of modelling and experiment to reverse-engineer the structure of the Drosophila pair-rule network and understand how it generates expression dynamics that lead to the patterning of segmental boundaries."

"As an outcome of his work, Erik proposes that that spatial resolution emerges from temporal dynamics, rather than static positional information."

"Michael concludes his support letter with the words: "Erik's work is strikingly original, and represents a major innovation in thinking about Drosophila segmentation.""

relative expression for all pairwise combinations of the 7 pair-rule genes in wild type embryos (*see Figure*), and a partial dataset for a number of mutant genotypes. Using these data he defined how the regulatory interactions of pair-rule genes change at the mid-cellularisation stage, and identified *odd-paired* as a temporally regulated factor responsible for these network changes. As an outcome of his work, Erik proposes that that spatial resolution emerges from temporal dynamics, rather than static positional information.



A further part of his thesis proposes that the standard model for how parasegment boundaries are specified, by the interpretation of local gradients of Even-skipped protein, may not be correct. He suggests instead that the shifting of *even-skipped* stripes across the field of cells in the blastoderm, driven by dynamic gap gene expression, coupled with the temporal control of network interactions, may generate the key offsets in downstream gene expression, and this is an entirely novel idea.

To illustrate Erik's path to success, Michael Akam writes: "*Unlike any other student I have had, Erik spent pretty much the whole of his first year reading. He worked through the entire literature on Drosophila segmentation (spanning 30 years and hundreds of papers), assessing the claims made on the basis of the data presented, and with the advantage of hindsight that the original authors lacked. I suspect he has a more detailed and critical knowledge of this literature than any other researcher.*" Michael concludes his support letter with the words: "*Erik's work is strikingly original, and represents a major innovation in thinking about Drosophila segmentation.*"

Erik's publications so far:

Clark, E. (2017) 'Dynamic patterning by the *Drosophila* pair-rule network reconciles long-germ and short-germ segmentation'. *bioRxiv*: 1101/099671

Clark E & Akam M (2016). Odd-paired controls frequency doubling in *Drosophila* segmentation by altering the pair-rule gene regulatory network. *eLife*: 7554/eLife.18215

Clark E. & Akam M. Drosophila pair-rule gene double FISH Data (data from Clark & Akam 2016). *org:*10.5061/dryad.cg35k 2016

Berta Verd, Erik Clark, Karl R. Wotton, Hilde Janssens, Eva Jimenez-Guri, Anton Crombach, Johannes Jaeger (2017). A damped oscillator imposes temporal order on posterior gap gene expression in *Drosophila*. *bioRxiv*: 10.1101/068072

Dennis Summerbell Lecture Awards

Following a generous donation, the BSDB has instituted the **Dennis Summerbell Lecture**, to be delivered at its annual Autumn Meeting by a junior researcher at either PhD or Post-doctoral level. The awardee's costs for attending the meeting will be met in full.

Dennis Summerbell made seminal contributions to our understanding of limb bud patterning by combining detailed quantitative analysis with elegant models, bringing insightful conceptual advances to the field. In addition to his research, Dennis made major contributions to Developmental Biology through his mentoring of junior researchers. An account of his work can be found on page 10 0f the BSDB Summer Newsletter from 2005 [LINK]. Here the BSDB presents the Awardees of 2016 and 2017, Iwo Kucinski and Helen Weavers.

"The lecture was entitled "The molecular signature of the loser cell status reveals key pathways regulating cell competition"."

"Despite its discovery four decades ago and increasing examples of mutations inducing the loser status, the molecular properties that earmark cells as losers have not been identified."

"Altogether these findings provide important new mechanistic insight on how cell competition occurs."

Summerbell Awardee 2016

The inaugural Dennis Summerbell Lecture was given by **Iwo Kucinski** at the 2016 BSDB Autumn Meeting. His work was carried out in Eugenia Piddin's laboratory at the Gurdon Institute, University of Cambridge. The lecture was entitled "The molecular signature of the loser cell status reveals key pathways regulating cell competition".

Abstract:
Cell competition is a process conceptually similar to natural selection at the cellular level. In this process a population of less fit cells (losers) is sacrificed and eliminated by a population of fitter cells (winners), with the ultimate goal of maximising tissue and organism fitness. This mechanism has been proposed to play a role in tissue health and turnover and in disease states such as cancer. Despite its discovery four decades ago and increasing examples of mutations inducing the loser status, the molecular properties that earmark cells as losers have not been identified. We identified molecular differences between winner and loser cells through comparative transcriptomics of two seemingly functionally unrelated mutations, which share the loser phenotype: Minute heterozygous mutations (ribosomal defect) and a mutation in mahj (involved in cell polarity and protein degradation). This revealed a molecular signature composed of a core set of genes that are differentially expressed specifically in loser cells.Through subsequent functional analysis we found that three components of this signature play an important role in controlling proliferation and cell death during cell competition. First, loser cells chronically activate JNK signaling, which restricts their intrinsic growth rate. Secondly, the constitutive activation of JAK/STAT pathway promotes proliferation of loser cells but also nonautonomously fuels the expansion of competing wild-type cells, boosting cell competition. Thirdly, we find that chronic activation of Nrf2 induces the oxidative stress response and that this serves a dual purpose: it promotes survival of loser cells on their own, but it is also sufficient to trigger their elimination when they are confronted by wild-type cells. Altogether these findings provide important new mechanistic insight on how cell competition occurs.

Summerbell Awardee 2017

The lecture awardee of 2017 was **Helen Weavers** (School of Biochemistry, Faculty of Biomedical Sciences, University of Bristol) with her submitted abstract "Understanding the inflammatory response to tissue damage in *Drosophila*: a complex interplay of pro-inflammatory attractant signals, developmental priming and tissue cyto-protection". Her award lecture was presented at the Autumn Meeting 2017, jointly organised by the BSDB together with the Swedish, Finish, Norwegian and Danish Societies of Developmental Biology, 25-27 October 2017 in Stockholm.

Helen's work so far
After completing her PhD studies investigating *Drosophila* nephrogenesis in Helen Skaer's lab in Cambridge, Helen moved to Bristol in 2013 to take up a 5 year, MRC-funded post-doc position between Paul Martin's and Will Wood's labs. Her first publication from this work (Weavers et al., 2016, Cell 165, 1658ff.), showed that *Drosophila* macrophages (haemocytes), must first be "primed" by engulfing at least one dead cell, before they are responsive to wound attractants. These findings are important because the majority of human pathologies are a consequence of too little or too much inflammation. What really excited the judges of the Denis Summberbell Lecture award was the work which had led to her most recent paper entitled "Systems Analysis of the Dynamic Inflammatory Response to Tissue Damage Reveals Spatiotemporal Properties of the Wound Attractant Gradient" (Weavers et al., 2016, Curr Biol 26, 1974ff.). This was a true multidisciplinary study, using a combined approach of mathematics and biology to analyse macrophage behaviours in response to tissue damage. Although the identity of the

"…her submitted abstract "Understanding the inflammatory response to tissue damage in Drosophila: a complex interplay of pro-inflammatory attractant signals, developmental priming and tissue cyto-protection"."

"Building on this strong platform of work, Helen is currently developing her own research towards understanding tissue protection/resilience in Drosophila and man, and this was an exciting novel element of her award lecture."

"We show that the wound attractant is released by wound edge cells and spreads slowly through the tissue, at rates far slower than small molecule DAMPs such as ATP and H2O2."

"Successful tissue repair, therefore, not only relies on the host's ability to mount an effective inflammatory response, but also its ability to finely tune it and limit associated immunopathology."

wound attractant signal/s are still not clear, this study was able to determine several of the characteristics of the attractant(s). Building on this strong platform of work, Helen is currently developing her own research towards understanding tissue protection/resilience in *Drosophila* and man, and this was an exciting novel element of her award lecture. In her talk, she described in a stunningly visual and understandable way how successful tissue repair relies not only on the host's ability to mount an effective inflammatory response, but also on its ability to limit it. Her talk was a fabulous highlight and a shining example of high quality research by members of the BSDB.

Abstract

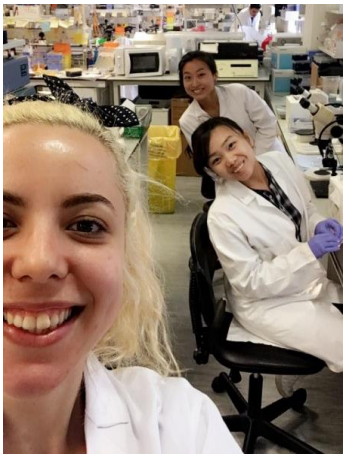
Understanding the inflammatory response to tissue damage in *Drosophila*: a complex interplay of pro-inflammatory attractant signals, developmental priming and tissue cyto-protection

An effective inflammatory response is pivotal to fight infection, clear debris and orchestrate the repair of injured tissues; however, inflammation must be tightly regulated since many human disease pathologies are a consequence of inflammation gone awry. Using a genetically tractable *Drosophila* model, I use precise genetic manipulation, live imaging and computational modelling to dissect the mechanisms that activate the inflammatory response to tissue damage and those that simultaneously protect the regenerating tissue from immunopathology. Upon tissue damage, immune cells (particularly neutrophils and macrophages) are recruited into the damaged area by damage signals (danger-associated molecular patterns, DAMPs) released from the injured tissue. In collaboration with computational biologists, we employ a sophisticated Bayesian statistical approach to uncover novel details of the pro-inflammatory wound attractants, by analysing the spatio-temporal behaviour of *Drosophila* immune cells as they respond to wounds. We show that the wound attractant is released by wound edge cells and spreads slowly through the tissue, at rates far slower than small molecule DAMPs such as ATP and H2O2. Strikingly, we also find that immune cells must be developmentally 'primed' by uptake of apoptotic corpses before they can respond to these damage attractant signals. Such corpse-induced priming is an example of "innate immune memory" and may serve to amplify the inflammatory response in situations involving excessive cell death - and otherwise limit an overzealous and damaging immune response. Indeed, whilst inflammation is clearly beneficial, toxic molecules (e.g. reactive oxygen species, ROS) generated by immune cells to fight infection, can also cause significant bystander damage to host tissue and delay repair – and may underpin chronic wound-healing pathologies in the clinic. To counter this, I find that wounded *Drosophila* tissue employs a complex network of cyto-protective pathways that promote tissue 'resilience', which both protect against ROS-induced damage and stimulate damage repair. Successful tissue repair, therefore, not only relies on the host's ability to mount an effective inflammatory response, but also its ability to finely tune it and limit associated immunopathology.

Established by the British Society for Developmental Biology (BSDB) in 2014, the Gurdon/The Company of Biologists Summer Studentship scheme provides financial support to allow highly motivated undergraduate students an opportunity to engage in practical research during their summer vacation. Each year, ten successful applicants spend eight weeks in the research laboratories of their choices, and the feedback we receive is outstanding. Here we present four reports from the 2016 and 10 reports from the 2017 cohort of students.You can read all the previous reports here.

BSDB Gurdon Summer Studentship Report (8)

*Our first report of the 2016 cohort is by **Ji Hye** Moon, who undertook a project in **Richard Wingate's lab** in King's College, London.*



Me (Ji Hye Moon) at the far back with my colleagues from the Wingate Lab

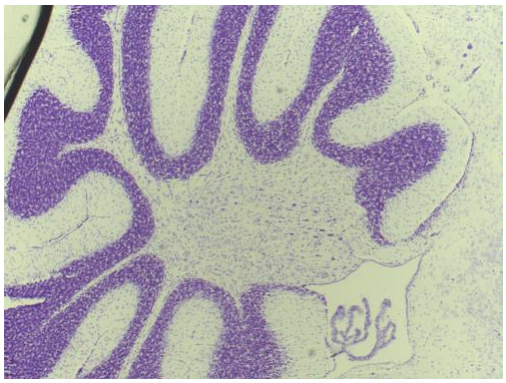
The effects of transient gestational hypothyroidism on the development of foetal cerebellar nuclei

As a graduate medical student with a previous degree in Middle Eastern Studies and Politics, I had not previously been exposed to scientific laboratory work. Progressing through the two years of pre-clinical studies, I surprised myself on just how much I enjoyed learning the science that underpins medicine and I became very aware of my lack of experience in research. I felt that I would benefit enormously from gaining exposure to this field, both in terms of my future competency as a clinician, as well as on my ability to pursue research further down in my career. As such, I felt very privileged to be able to start building up my skills and experience in lab-based research through the summer studentship this year.

The BSDB Gurdon Summer Studentship gave me the opportunity to spend 8 weeks this summer in the lab of Dr Richard Wingate in the Department of Developmental Neurobiology at King's College London. I joined a project which aimed to examine the effects of transient gestational hypothyroidism on the development of the deep cerebellar nuclei in the foetal brain using mouse and chick models. I found this project particularly interesting as the effects of gestational hypothyroidism in the earlier stages of pregnancies are currently quite poorly understood, yet have been linked to postnatal cognitive deficits in the absence of gross malformations of the foetal brain.

The project used the drug methimazole, which is used to treat hyperthyroidism, in order to induce a transient hypothyroidism in pregnant mouse mothers to study its effect on the development of the foetal cerebellum at various embryonic and postnatal ages. All the brain samples were harvested before I started my studentship, so there were a lot of brain samples ready to be studied using immunohistochemistry (IHC) and in-situ hybridization (ISH) methods.

For the first part of the studentship I helped produce the wax and cryosections of the harvested brains necessary for IHC and ISH experiments. For this part of the work, I learned and honed the basic histology skills hands-on, through wax embedding, wax sectioning and cryosectioning of the mouse brain samples. Although this was quite repetitive



A section through the mouse cerebellum (Nissl stained) at postnatal age P23. The cerebellum is an exquisite structure with its distinct layers folded into folia.

Finally, the last few weeks of my studentship were spent producing nissl stains of the control and the experimental juvenile mice brains, which I then carefully studied to look for any subtle structural differences. I noted a potential decrease in the density of the Purkinje Cell Layer in the cerebella of the experimental group, but unfortunately was unable to complete a systematic comparison as my studentship came to an end.

I enjoyed the 8 weeks at the Wingate Lab and have benefited enormously from it. From an academic point of view, my science literacy level has improved immensely. Being exposed for the first time to the fields of mice and chick embryology and neuroanatomy as well as learning and practicing a wide range of experimental methods such as IHC and in-ovo electroporation, provided a steep learning curve that kept me focused and busy for the entire length of the studentship.

After spending two years almost exclusively in the lecture theatre, I really appreciated the hands-on learning experience and the stimulating environment. I learned a huge amount from attending the weekly lab meetings, talks and seminars from leading experts as well as interacting with my colleagues at the lab. Most of all, nothing could beat the depth of learning I gained from carrying out the experiments myself. It was fantastic to see the science come alive in front of my eyes and I found it a powerful way to learn and understand complex concepts. I was very lucky in that Dr Wingate encouraged me to tryout a variety of experimental techniques and always made time in his busy schedule for my questions.

The summer studentship was a rewarding experience on a personal level as well. It gave me a taste of what a career in research is like and an insight into the delights and the difficulties of research work. Ultimately, I've come to have a greater appreciation and admiration for research scientists and the enormous contribution they make to modern medicine and to the innovations that I will put into practice throughout my medical career.

I am very grateful to Dr Wingate, Dr Wilson, Margarita, Deviana, Tristan & Flo for being great hosts and teachers to me. A huge thank you in particular to Richard and the BSDB for making this opportunity possible for me!

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Ji Hye Moon

BSDB Gurdon Summer Studentship Report (9)

*Our second report from the 2016 class comes from **Lauren Miller**, who undertook her project with **Richard Poole** in UCL.*

The *C. elegans* dilemma: should I stay or should I go?

After being awarded the BSDB Gurdon Summer Studentship, I entered the lab with the enthusiasm that only an undergrad who has never spent 12 hours looking down a microscope can possess, and the surety that I was going to discover something. I then spent the next month failing to get my assay to work, which I feel gave me a much healthier perspective of the kind of dedication this whole "discovering" thing was going to require. Happily though, after another couple of months, I did manage to produce some interesting data!

Nervous systems are incredibly interesting, complicated networks, and trying to elucidate what they are doing through behavioural studies is even more challenging. Animal nervous systems are largely left-right bilaterally symmetric, yet they are often functionally lateralised. This is well shown in the human brain where specific functions, such as language, are assigned specifically to only one of the two bilaterally symmetric hemispheres. Congenital defects that disrupt underlying asymmetry have been associated with a wide variety of human neurological disorders, yet the

development of left-right asymmetry in the nervous system is poorly understood. The main aim of my project was to see if specific neuroanatomical asymmetry observed in the nervous system of *C. elegans* corresponded to a functional behavioural asymmetry.

And to do this I had to pick worms, lots and lots of worms. In fact, the first time I tried to pick enough to do a complete assay it took me over 8 hours, and I had barely collected half of them. I then had to beg one of the labs PhD students to help me pick the rest, and I watched in horror as he finished the other half in about 15 minutes. The secret, I learned, was to not pick them up one at a time, but to pick up about 15 or 20 before transferring them to the other agar plate. Fortunately, I can now collect them all in an hour, not that it wasn't character building doing it the hard way, but I can get an awful lot more done now.

C. elegans are naturally attracted to several tastes and odorants, however they can learn to associate them with aversive stimuli and switch their behaviour to being repelled. The assay I was carrying out conditioned males to associate benzaldehyde, which they are attracted to, with different stimuli. When they are conditioned to associate the smell with starvation they are repelled, however this response in males can be trumped if they are also conditioned with mates at the same time. This is sexual conditioning, which has recently been attributed to two newly discovered male specific neurons called MCM's (M. Sammut, 2015).

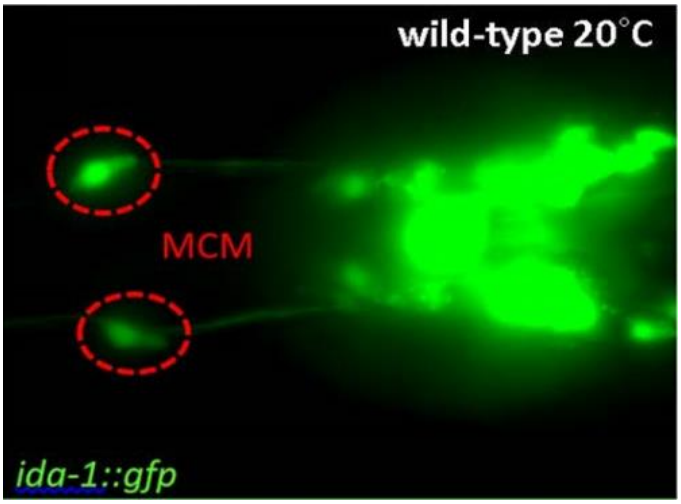

Figure 1: Micrograph with a dorsal view of male C. elegans oriented anterior to the left. MCM's are green (ida-1::gfp) (L. Lin, 2015).

Normal males behave like this after being conditioned to associate benzaldehyde with different stimuli:

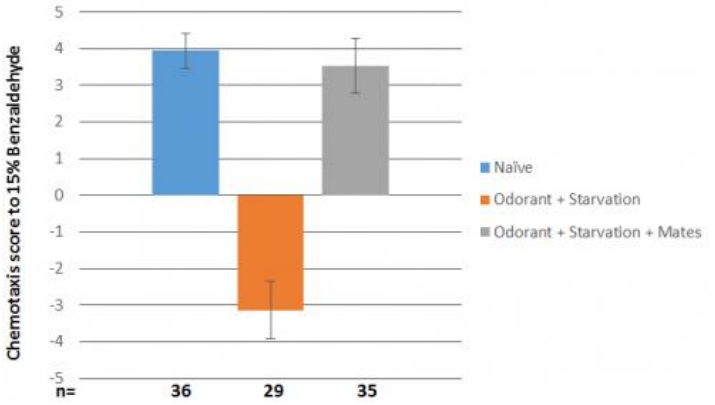

Figure 2: Behavioural responses to odorant after conditioning of unablated males.

Since this was a perfect example of a pair of left-right bilaterally symmetric neurons, the interesting question was now were they indeed functionally lateralised, as was suspected from their connectivity's. If I ablated either the left or the right MCM what would happen? Would there be an asymmetry in the circuit? Would the worms behave differently if I ablated the right MCM versus the left MCM?

As it turns out they did, but not the way we expected; from the connectivity's it was hypothesised that the right MCM may be more important for sexual conditioning than the left. This did turn out to be the case, but what also happened was that it disrupted the worms' ability to aversively condition to benzaldehyde, which is usually very robust. The results that were obtained are as follows:

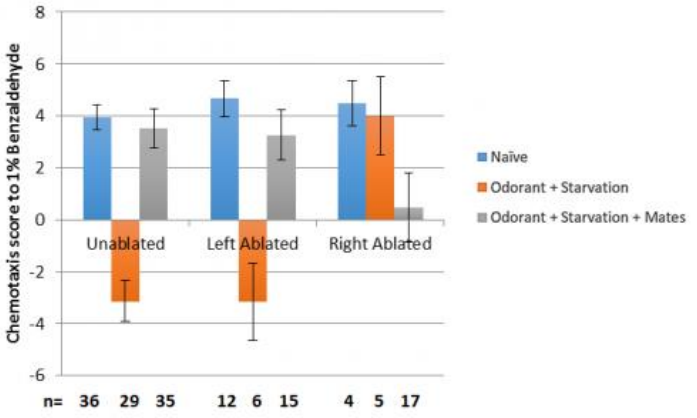

Figure 3: Results of unablated, left and right ablated C. elegans.

The “n” for aversive conditioning with left and right ablated animals is low as in the first few assay’s most of the ablated worms were put in the sexual conditioning plate to try and generate data for this condition; aversive conditioning was not expected to be effected as in mutants with neither MCM, males behave the same as the wild type.

Firstly, this shows clearly that there is an asymmetry in the function of the MCM’s; ablating the left MCM does not affect behaviour at all, which is very exciting! Secondly the worms with the right MCM ablated on the sexual conditioning plate were either very strongly attracted to benzaldehyde or repulsed in an almost 50/50 ratio; hence the bar is very small, and the error is huge. Thirdly there are other interactions going on with the sensing of benzaldehyde, which is sensed by the AWC neurons, as right ablated worms do not appear to aversively condition.

This is the connectivity of the AWC’s with the MCM’s:

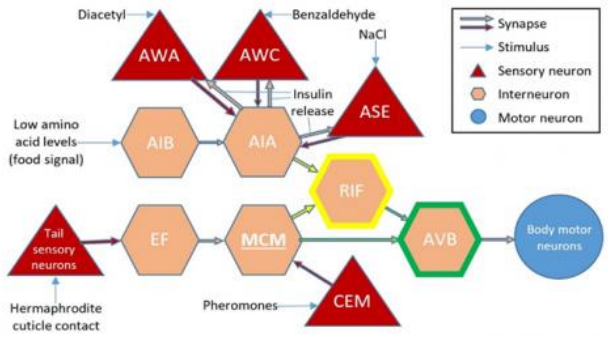

Figure 4: Connectivity of the MCM’s with respect to certain sensory and interneurons (L. Lin, 2015).

Both AWC’s sense benzaldehyde, but they are asymmetric in the sense that during development STR-2, a G-protein coupled receptor, is expressed randomly in one of them, turning it on, whilst the other stays off (P. Wes, 2001). The CEM’s could also be involved, as they are responsible for sensing pheromones given off by the hermaphrodites. There are several theories on what might be happening so far, but further experiments, such as ablating both the MCM’s, will be needed to really explain the source of this behavioural asymmetry.

I loved my time in this lab, and if I didn’t have a degree to finish I’d probably still be there trying to figure out this very interesting behaviour!

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Lauren Miller

BSDB Gurdon Summer Studentship Report (10)

Our third report from the 2016 class comes from Iona Imrie, who undertook her studentship with ***Jamie Davies*** *in Edinburgh.*

Development of the vascular system in the mouse mesonephros

During the summer of 2016, I was fortunate enough to be awarded a BSDB Gurdon Studentship. The funding enabled me to undertake a research project in the lab of Jamie Davies at the University of Edinburgh. Under the supervision of a PhD student in the lab, David Munro, I studied the vascularization of a primitive and transient murine kidney- the mesonephros.

During mammalian embryogenesis, 3 paired renal organs develop sequentially in a cranio-caudal direction. The most primitive kidney is the pronephros, followed by the mesonephros and then the permanent kidney, the metanephros. Both the pronephros and mesonephros are temporary, with the pronephros being nonfunctional and the mesonephros being functional in some species. The mouse mesonephros comprises 18-26 pairs of tubules. The most cranial tubules connect to the nephric duct, while the caudal tubules do not. The mesonephros first appears at embryonic day 9 (E9), before regressing completely in females. In males, the cranial tubules do not degenerate, instead forming the epididymis. Given that, (a) the fate of the mesonephros is sexually dimorphic and (b) the mesonephric tubules are not uniformly

connected to the nephric duct, there could be differences in vascular development that run in parallel with these differences in morphology. During my project, I observed vascular development in order to identify where blood vessels came from and if there were differences in vascular development between sexes and cranial/caudal tubules of the mesonephros.

My project began with dissecting embryos at E11.5. The mesonephroi obtained by dissection were stained with antibodies against CD31, Laminin and Pan-cytokeratin. These antibodies stained endothelia, basement membrane and nephric duct/tubules respectively.

I set out to create a timeline of mesonephric development starting at E10.5 through to E15.5 (Figures 1-4). Dissecting at E10.5 proved difficult due to the small size of the embryo. The gonad develops adjacent to the mesonephros, and I left itattached to the mesonephros in order to observe interactions of vasculature between the two.

Having dissected and stained mesonephroi from various ages, I made the following observations:

E10.5– Aorta branches into mesonephros (Figure 1).

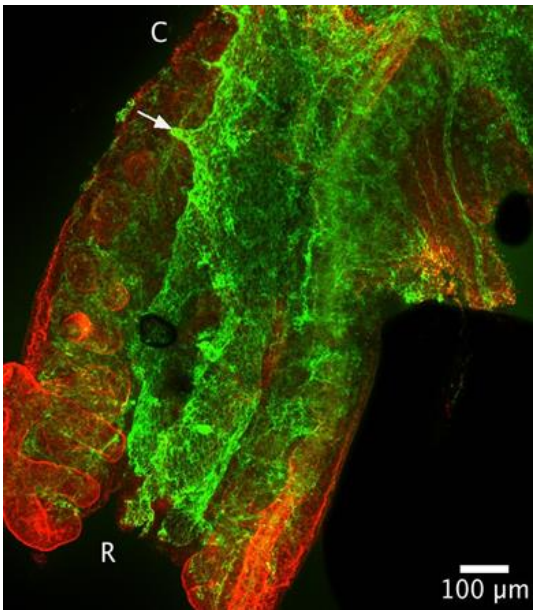


Figure 1: Green=CD31, Red=Laminin. The aorta is shown centrally, between the two mesonephroi. Branches of the aorta going toward the mesonephros can be seen (white arrow). C indicates the caudal end of the mesonephros, and R is the rostral end.

E11.5– Tubules elongate and the mesonephros vascular plexus (mvp) begins to form (Figure 2).

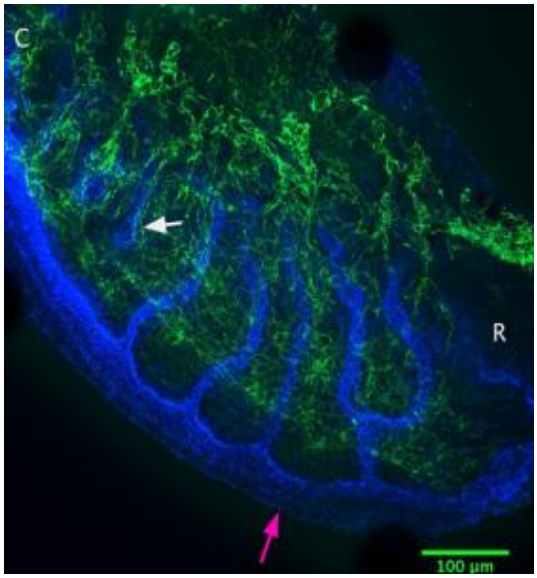


Figure 2: Blue= Pan Cytokeratin, Green= CD31. Compared to E10.5, the tubules look longer. The pink arrow shows the nephric duct, and the white arrow shows the first tubule that is disconnected from the nephric duct. There is a collection of vasculature at the distal end of the tubules where the aorta would be. There are branches into the mesonephros from here.

E13.5– In females, branching of mvp into mesonephros and gonad occurs. In males, branching into the mesonephros occurs but branching into the gonad is not as visible as in females.

E14.5– Formation of the coelomic vessel on male gonad. Continued branching of mvp into mesonephros/gonad in females (Figure 3).

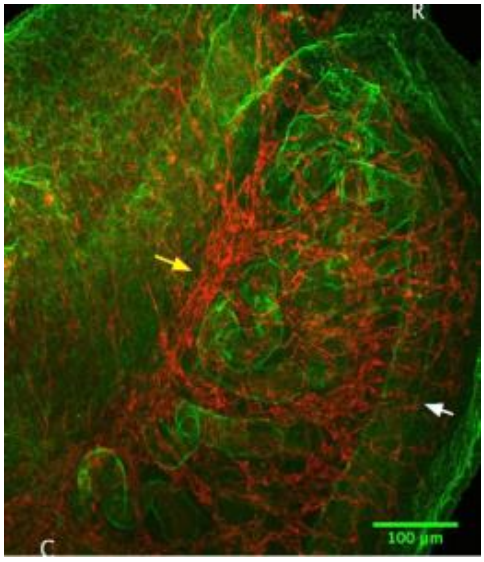


Figure 3: Immunostaining of an E14.5 female mesonephros (right) with gonad attached (left). Green= Laminin, Red= CD31. The white arrow points to the nephric duct and the yellow arrow points to the mvp. Blood vessels seem to branch from the mvp into the mesonephros and into the gonad.

E15.5– Branching of coelomic vessel into gonad, and joining of the gonadal artery to this vessel (Figure 4).

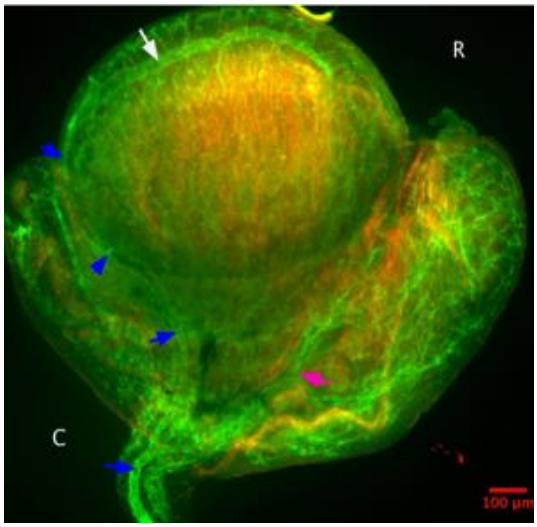


Figure 4: Green=CD31, Red=Laminin. It seems that there is more CD31 staining in this E15.5 male than at earlier ages. The coelomic vessel (white arrow) which first appeared at E14.5 now joins to the gonadal artery (blue arrows). This vessel branches into the mesonephros and bifurcates (pink arrow).

Overall, the vasculature of the mesonephros seems to branch from the mvp and form a network of vessels around the nephric duct. The vessels around the tubules do not look particularly organized. However, confocal slices at 40x objective show vessels wrapping around the tubules. I did not observe glomeruli in the tubules at any age- these structures are rarely found in mouse mesonephroi.

As an adjunct to the main project of vascularization, I tested the functionality of the mesonephric tubules using an assay developed by one of Prof. Davies post doctoral researchers, Dr. Melanie Lawrence. The assay tested the functionality of the tubules to uptake fluorescent anions and cations. The ability of cells in these tubules to transport organic anions and cations would suggest the tubules are functioning as a primitive kidney. It has been assumed that the murine mesonephros has this role, but this has never been proven. Melanie had been using her assay to answer this question, using mesonephroi from different gestational ages. The unpublished data that Melanie has collected shows that these tubules do have the ability to transport organic anions and cations. I was able to help with assaying at some of the gestational time points.

I cultured mesonephroi using the Sebinger culture method, and then assayed the uptake of 6-carboxyfluorescin (anion) through organic anion transporters (OAT) in the basolateral membrane of tubule cells, and uptake of the DAPI (cation) through organic cation transporters (OCT), also in the basolateral membrane. As a control, inhibitors of OAT (Probenecid) and OCT (cimetidine and metformin) were added to mesonephric cultures to show that any fluorescence seen in the tubules was due to uptake via these transporters and not by another process.

The Gurdon Studentship has been an invaluable opportunity. I cannot stress enough how important it is for medical sciences students like myself to spend time in a research lab. As a second year, I didn't really know what being a scientist would be like. From spending time in the Davies Lab, I have been able to understand and practice techniques that were briefly introduced in lectures, while developing a scientific mind, improving my time management skills and working alongside scientists who are extremely dedicated to their research. I would especially like to thank Jamie Davies for giving me this opportunity, and David Munro and Chris Mills for their guidance throughout my time in the lab.

Iona Imrie

BSDB Gurdon Summer Studentship Report (11)

*Our final report from the 2016 class comes from Christopher Taylor, who undertook his studentship with **Karim Sorefan** in Sheffield.*

A dual hormone response in *Arabidopsis thaliana*

The population problem

Human population growth is not a new issue. For much of mankind's history, the species has existed in small, dispersed populations. It is only in the last 100 years where the population has truly boomed with over a fourfold increase in the number of mouths to feed (Fig 1). Demand for food is predicted to increase by 50% by 2050 and already 1 in 7 people are starving, a figure only predicted to increase.

The problems of this unsustainable growth are exacerbated by two issues:

1. Climate change – in certain areas agricultural productivity is severely reduced by rising temperatures and an increase in extreme events.
2. Geography – areas with greatest population growth coincide with areas most likely to be impacted by climate change. These include

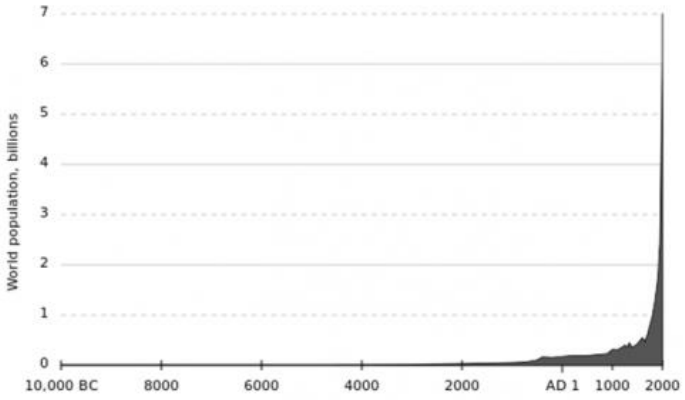


Fig 1: The post-industrial 'population spike' highlights just how rapidly the human population has boomed in such a short space of time.

Evidently there is an urgent need for a greener revolution.

A solution?

Plants are nature's biochemical engineers, producing everything they need to grow, survive and reproduce from practically thin air (and a little help from the soil). Plants provide the food we eat, the food our food eats and the food that supports the very ecosystems we depend on. 'Improving nature's inefficiencies' by exploiting plants' existing biochemical pathways is one way of increasing food production in the finite space we have.

The production, transportation and signalling of plant hormones (phytohormones) allows plants to orchestrate growth and development and importantly for a changing climate, facilitate a response to environmental cues. The classic example of auxin's role in phototropism may spring to mind. Here auxin exhibits a negatively phototropic response, moving away from the prevailing light direction. This leads to an accumulation of auxin molecules in the side furthest from the light causing acidification of the cell walls and allowing for cell elongation and plant growth. Ultimately this produces a plant (or stem) whose curvature is maximised for intercepting incoming light.

Exploiting these pathways already has agricultural applications. Think of taking a plant cutting, dabbing the base in auxin and growing a whole new plant.

My work in the Sorefan lab in the University of Sheffield's department of molecular biology and biotechnology (MBB), was to investigate the role of a novel hormonal response produced by auxin and cytokinin. Previous microarray data by the lab revealed an interesting occurrence when *Arabidopsis thaliana* seedlings were grown under conditions of elevated auxin (IAA) and cytokinin (BAP) concurrently. When grown under a dual hormone combination, the seedlings showed a significant change in the number and types of genes that were either significantly up or downregulated in the microarray. This response was larger than either responses of auxin or cytokinin alone and has been termed the 'dual hormone response' (Fig 2).

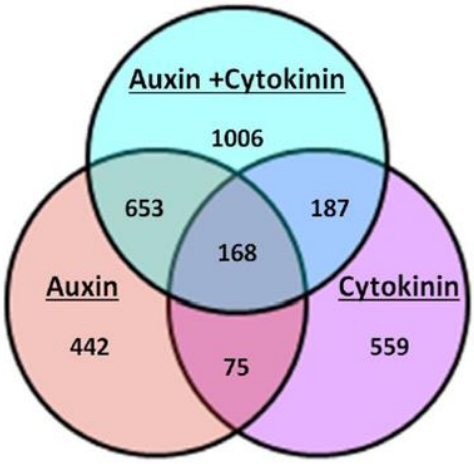


Fig 2: A Venn diagram illustrating the number of genes regulated by auxin alone, cytokinin alone, a combination of auxin and cytokinin and their overlaps. Nearly twice as many genes have significantly altered expression levels when auxin and cytokinin are combined compared to either hormone alone. (Image credit: James Thackery, Sorefan lab)

Functions of the dual hormone response

Prior to environmental stresses we tested if there were any general positive growth responses of the dual hormone response (DHR). We investigated the effects of differing ratios of auxin to cytokinin on cotyledon weight. Cotyledons are embryonic leaves that are among the first structures to emerge following germination and their weight is an accurate proxy of seedling health. We found significantly greater cotyledon mass under DHR conditions particularly with ratios showing high concentrations of auxin (Fig 3). Interestingly, this was significantly higher than the effects of just

auxin alone, implying that the exogenous application of even a small amount of cytokinin may produce positive benefits.

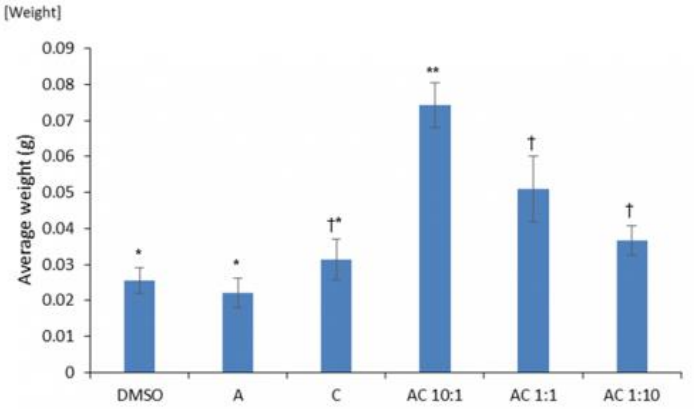


Fig 3: The effects auxin alone (A), cytokinin alone (C) and combinations of auxin and cytokinin (AC various ratios) on cotyledon weight compared to a DMSO control. Means that share a symbol (, ** or †) do not statistically differ from one another.*

Comparing our lab's dual hormone microarray data with that of other labs highlighted approximately 11.2% of our identified genes may show some response to heat stress conditions. I produced cDNA from seedlings grown under different combinations of hormone treatments and designed primers for the heat stress responsive genes identified by these microarrays. Using multiple quantitative real-time polymerase chain reactions (qRT-PCR), I confirmed that a number of these heat-responsive genes were also significantly affected by the dual hormone response.

I then conducted an experiment to investigate the phenotypic effects of heat shock on seedlings grown under DHR conditions (Fig 4).

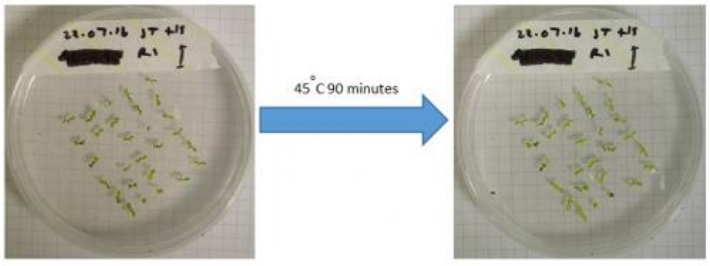


Fig 4: Heat shock experiment before (left image) and after (right image) showing bleaching of the cotyledons as the chlorophyll degrades.

Preliminary data from this experiment suggests that the dual hormone response may convey some resistance to heat stress, as combinations of the two hormones results in significantly fewer damaged / unhealthy leaves than the control or either single hormone alone (Fig 5).

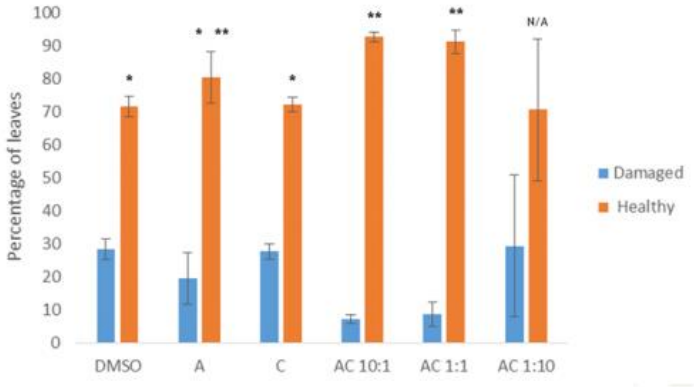


Fig 5: Percentage of leaves that were either damaged or healthy following heat stress under varying hormonal conditions.

Future work aims to quantify chlorophyll more effectively as our own analyses were confounded by the production of purple anthocyanin pigments, which are often produced as a response to stress.

These data may therefore allow us to apply dual hormone responses to agriculture. The dual hormone treated plants were larger and appear to be somewhat de-sensitized to heat stress, which may allow us to manipulate crop plants to convey some heat resistance to them. Knowing the optimal hormone ratios is important for applying this information. Manipulating plants in this way is a promising route for producing 'climate ready' crop species and ensuring that we can continue to feed a world of 7 or 10 billion in a vastly deteriorating climate.

Christopher Taylor

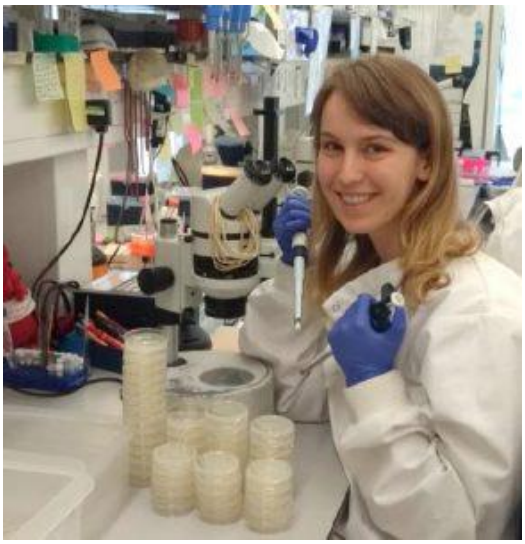
BDSB Gurdon Summer Studentship Report (12)

*Our first report from the 2017 group of student awardees comes from **Josie Elliott** (student at University of Oxford), who undertook her studentship with **Alison Woollard** at the Dept. of Biochemistry in Oxford.*

What is the role of *wrt-2* and *wrt-4* in left-right asymmetry in *C.elegans*?

Once upon a time a genetic screen identified a signalling pathway that caused *Drosophila melanogaster* embryos to develop a 'lawn' of denticles rather than forming them only at parasegment boundaries. Thus the so-called Hedgehog signaling pathway was born (Nusslein-Volhard & Wieschaus, 1980). This pathway has

revealed itself to be one of the core signal transduction pathways in regulating animal development. Through gene duplication and diversification events, different types of hedgehog proteins have been found across vertebrates. The brilliantly named Sonic Hedgehog ligand is the best studied ligand present in mammals. Loss of expression of Sonic Hedgehog in mice causes defects in left right asymmetry (Levin et al., 1995).



The story was expanded into *C.elegans* by bioinformatics (Burglin, 1996). A search of the *C.elegans* genome for homologues of the carboxyl terminal 'hog' domain revealed a family of proteins which did not contain the amino terminal 'Hedge' domain but instead a novel domain dubbed 'Wart'. Thus the warthog (wrt) genes were named. Further genome analysis revealed genes which contained the amino wart domain but lacked the carboxy hog domain. Together this made a family of ten *warthog* genes.

Previous research in my lab (the Woollard lab in the Biochemistry department at the University of Oxford) had linked the *wrt-2* branch of the warthog family (figure 2) to defects in left right asymmetry, with *wrt-2* and *wrt-4* giving the highest penetrance phenotypes. However it was found that the GFP marker used in the previous strains to help quantify another phenotype (related to vulval development) caused defects of its own. This is where I come in. My project was to cross and create strains of worms without this GFP background and then requantify the left right asymmetry defects. I studied the single mutants *wrt-2*, *wrt-4*, *wrt-8*, as well as the double mutants *wrt-4;wrt-2*, *wrt-8;wrt-2*, *wrt-8;wrt-4* and the triple mutant *wrt-8;wrt-4;wrt-2*. The double and triple mutant strains I created myself. The combined mutations allow investigation into redundancy between the genes, giving a glimpse into their evolutionary history. The *wrt-7* gene has been shown to have no expression pattern and is likely a pseudogene, so due to my limited time in the lab I didn't quantify the *wrt-7* mutations.

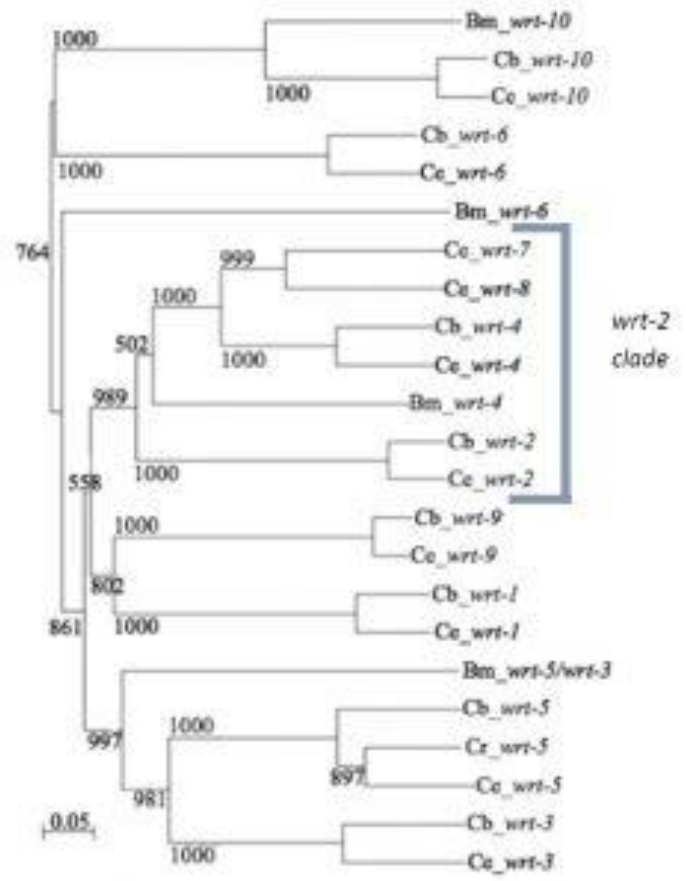


Fig. 1 *The tree presents the origin of the 'Wart' domain in C. elegans' most distant relative in the Rhabditiada order, Brugia malayi, as well as its two closet relatives in the Caenorhabditis genus, C. briggsae and C. remanei. A multiple sequence alignment of Wart domains was used to generate this unrooted Neighbour Joining tree (default setting Clustal_X). Results of 1000 bootstrap trials are shown. Figure from Emily Baker's dissertation.*

On a side note: the *C.elegans* species is great. They're heamaphrodites so you can just leave them on an agar plate to reproduce by themselves. Males do exist – enabling you to perform genetic crosses. They're transparent, so no need to dissect anything. You can even freeze them and they'll be alright in liquid nitrogen until someone needs them!

At first glance *C.elegans* may not seem very asymmetric. However one source of left right asymmetry is the relative positioning of the gonads and intestine either side of the vulva in the worm. This is best shown through pictures. In the wildtype worm (figure 3d) the picture in the lefthand plane shows that in the anterior part of the worm one can see intestinal cells and the intestinal lumen going down the centre. In the posterior part of the worm one can see the U shaped gonad that migrates away from the vulva (just visible in the bottom left

hand corner of that picture) along the body, turns twice then travels back along the body (schematic figure 3c). The top picture of a whole worm (figure 3d) shows the opposite situation (the worm is laying on its other side) where the gonad can be seen at the anterior part of the body and the intestine at the posterior.

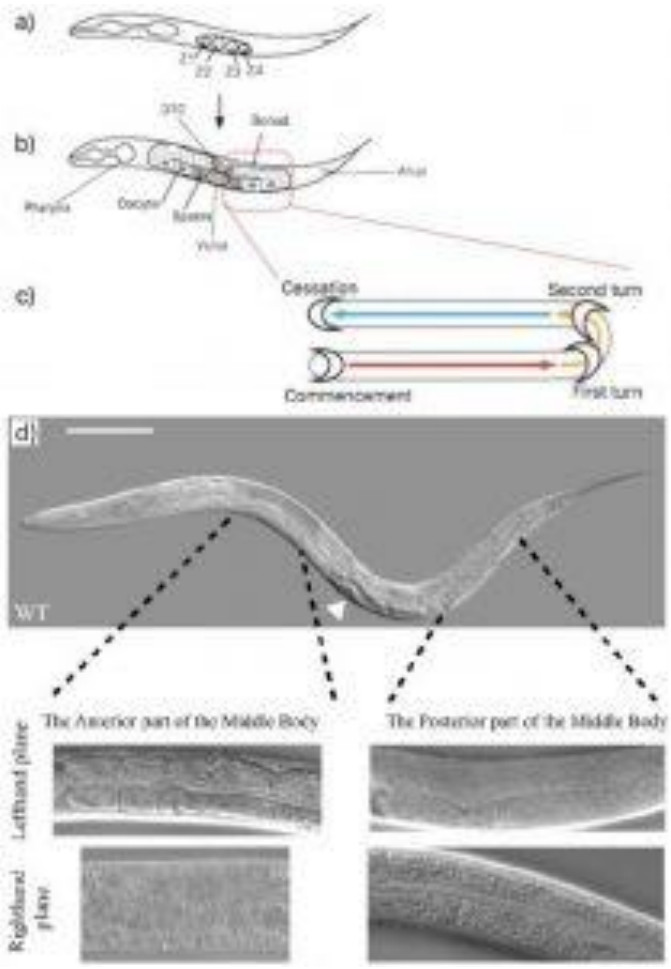


Fig. 2 a) *L1 stage animal.* ***b)*** *L4 stage animal. The gonad turns twice due to the migration of the distal tip cell (DTC).* ***c)*** *Commencement sees the gonad arms depart from the ventral midpoint and travel along the ventral sides of the worm (red arrow); firstly turning to the dorsal side of the animal and secondly along the anteroposterior axis (yellow arrow) until they meet again, this time at the dorsal midpoint (blue arrow). The gonad migration at the anterior end of the worm is the mirror-image. Furthermore, the anterior gonad is located on the right-hand lateral side of the worm (shown as the bottom plane), whereas the posterior gonad lies along the left-hand lateral side (top plane); however, this is not shown in the image. d) Arrowhead points to vulva. The right-hand lateral side is shown and therefore the anterior, but not the posterior, gonad arm is visible. The alternate scenario in which the posterior gonad is visible in the top plane of view is hypothetically depicted; in which instance, the anterior gonad would be hidden from view by the intestine. Scale bar = 25µm. Figure taken from Emily Baker's dissertation.*

Thus the anterior/posterior distribution of gonad and intestine gives us a tool to study and quantify left right asymmetry in worms. After discussions with Emily (a recent biology graduate who had been working on the project before me) we decided to only quantify worms in which the posterior gonad was visible down the microscope. Thus, worms which I counted looked like those in the two lefthand plane pictures in figure 3d. This decision, although arbitrary in itself, allows our results when published to be more understandable and easier to replicate.

The pictures shown in figure 4 demonstrate some of the mutant phenotypes scored in this project. Basically I was looking for gonad tissue poking through anterior intestine tissue and intestine tissue poking through posterior gonad tissue. Worms with this phenotype were scored as mutant and were also further divided into anterior or posterior defects.

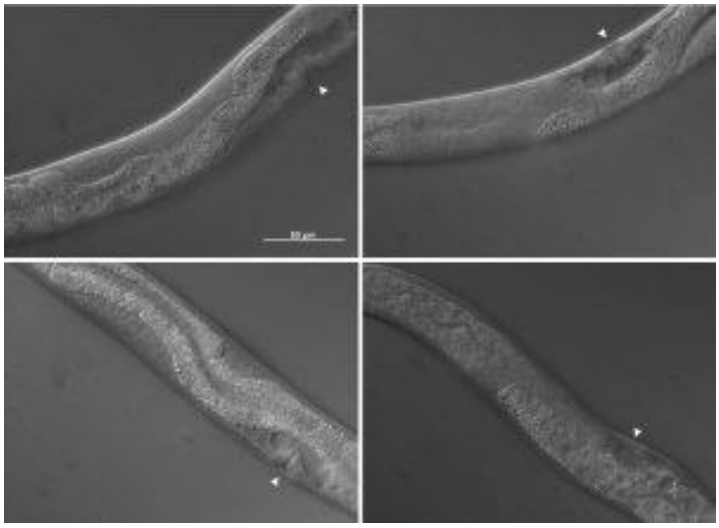


Fig. 4 Top left *shows the anterior gonad of a wrt-2;wrt-4 worm in which gonad tissue can be seen as well as intestine.* ***Bottom left*** *shows the anterior gonad of a wrt-8 worm in which gonad can be seen above and below the intestine cells.* ***Top right*** *shows the posterior gonad of a wrt-2;wrt-4 worm in which the gonad has migrated unsuually thus intestine tissue can be seen.* ***Bottom right*** *shows the posterior gonad of a wrt-2;wrt-4 worm in which half the gonad has disappeared to the other side of the worm. Photos taken by me on a Zeiss microscope.*

One of the most enjoyable parts of this project has been pipetting alongside Emily, who worked on this project before me and is continuing to develop it. In my 8 weeks I have seen first hand a small portion of the amount of research that has gone into studying the *warthog* genes. However chatting with Emily I have seen how my short project may in

future count towards producing a scientific paper. At the moment Emily is taking the story of *warthog* genes in *C.elegans* back to its bioinformatics heart, producing a phylogenetic tree of all the *warthog* genes across the nematode family – trying to link evolution with phenotype. She is also expanding from the *wrt-2* branch of the gene family into as many other members as she can get her hands on.

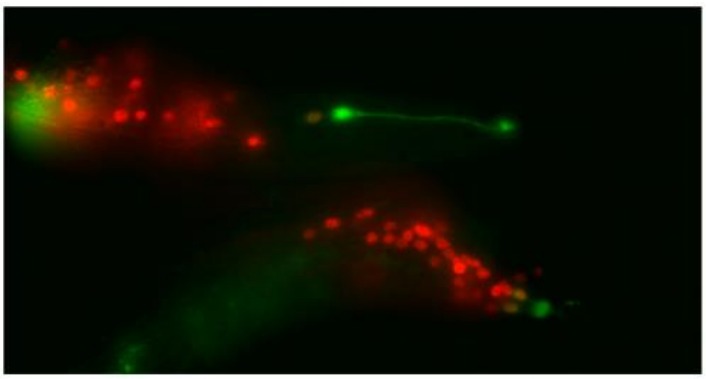
The highlight of my time in the project has been having so much independence in the lab, deciding day to day, week to week how I wanted to spend my time. This has been a fantastic insight into the life of a researcher and totally different to undergraduate labs. The lowlight would have to be the Saturday when I broke a pipette and in the process spilled a box of pipette tips all over my desk…

Thank you so much to everyone in the Woollard lab for being more friendly and welcoming than I could have hoped for.

Josie Elliott

BDSB Gurdon Summer Studentship Report (13)

*Our second report from the 2017 group of student awardees comes from **Jack O'Shea** (student at University College London), who undertook his studentship with **Richard Poole** at the Division of Biosciences in UCL.*



Glia to neuron transitions occurring simultaneously in the MCM (top)and PHDs (bottom) of a single animal

When I tell my friends that I spent my summer looking down a microscope at worms they often give a snigger. My enthusiasm on the subject quickly earned me the affectionate (I hope) nickname, 'Wormboy'. Yet the Wormboys and girls of Richard Poole's lab instilled in me a great thirst for scientific study over the 8 weeks I spent with them, which I will certainly carry forward in my career. The lab studies the nematode worm *C. elegans*, and my job was to help characterise a glia-to-neuron transition they discovered in the male tail that occurs during sexual maturation. During my time, I learned how to handle worms, keep them healthy, perform crosses, use a fluorescent microscope and present my data to an audience. All of this as part of my first lab experience was not only invaluable, but very enjoyable, and I came away wanting more.

Worm death was a regular part of lab life. Saving them from starvation and disease was a constant uphill battle, one that at first I found insurmountable. Along with those natural causes of death, they also had to contend me, often crushing them clumsily under my pick and purging potentially contaminative stragglers on said pick in the Bunsen. Happily for the worms, such fates became less and less frequent, and I was eventually able to sustain healthy populations from which I selected young males to dunk in the intensely toxic chemical sodium azide, all the better to view them under fluorescent microscopy. A necessary sacrifice.

This microscopy work was the first step in characterising the glia-to-neuron transition of phasmid socket 1 (PhSo1) into the neuron PHD, which occurs in the male tail during sexual maturation. The lab had previously identified a similar transition of the amphid socket to MCM neuron in the head of the male (Sammut et al., 2015), though the PHD transition differs in how the neuron is formed. Where the amphid socket divides asymmetrically to generate the MCM, the PHD derives from PHso1 by direct trans-differentiation, without a division, while its sister- PHso2- remains glial. This new neuron's activity was found to be linked to initiation of a novel behaviour employed by males during mating thought to improve their chance of spicule insertion. To track the changing identity of PHso1, I compared its expression of glial and neuronal markers linked to GFP and RFP respectively with that of PHso2. The two glial markers I used were *grl-2* (socket specific protein) and *mir-228* (pan-glial microRNA), and the neuronal marker a nuclear synaptic fusion protein, *rab-3*.

The glia-to-neuron transition appears to start in males of larval instar 4 (L4), while the gonad is taking shape. Through picking many, many worms, I showed a clear gradient of change of marker expression in PhSo1 compared with PhSo2:

- In late L3/early L4 GFP brightness is equal in the two sockets
- By mid/late L4, GFP is dimmer in PHso1
- The PHso1 of day 1 adults is beginning to express neuronal marker, displaying coexpression of GFP and RFP
- By day 2, all GFP has dissipated from the newly formed PHD
- Both glial markers displayed the same trend (fig.1 and 2)
- Some animals classified mid/late L4 displayed coexpression of markers, but these were all on the cusp of adulthood, undergoing moult at the at the time of imaging (fig. 3)

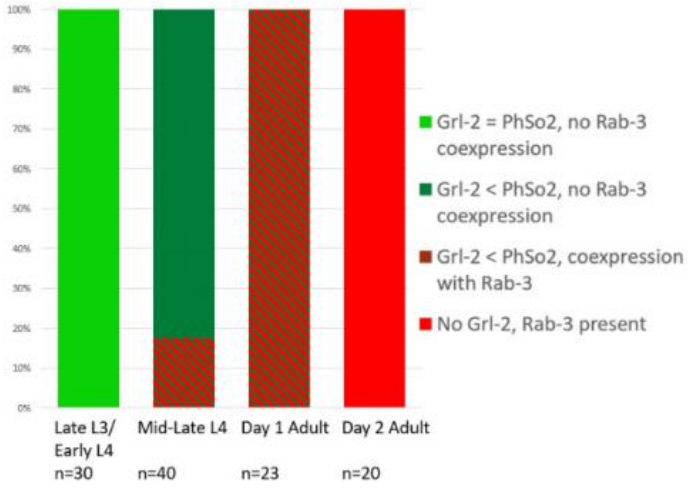


Fig 1.1 – Percentages of observed expression patterns of grl-2 and rab-3 in PHD neurons.

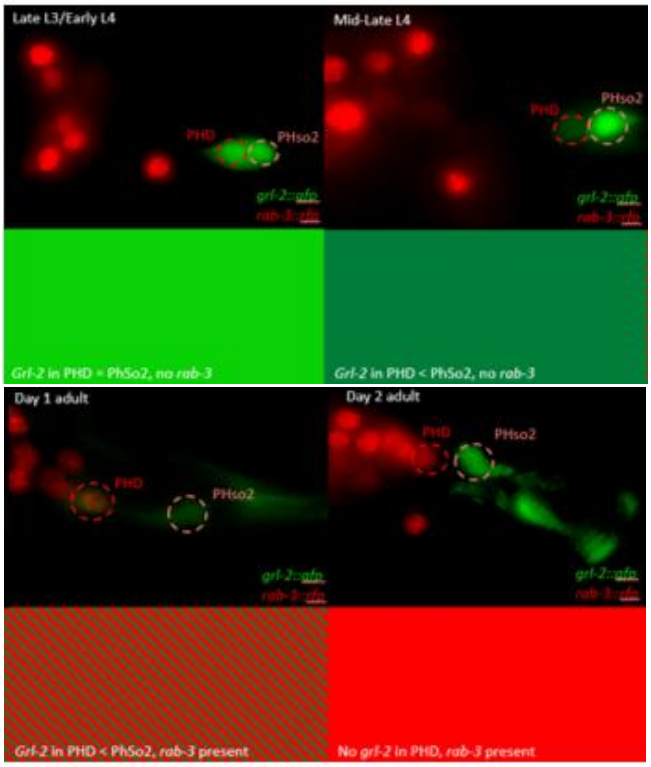


Fig. 1.2 – progression of grl-2 and rab-3 expression in the PHD and PHso2.

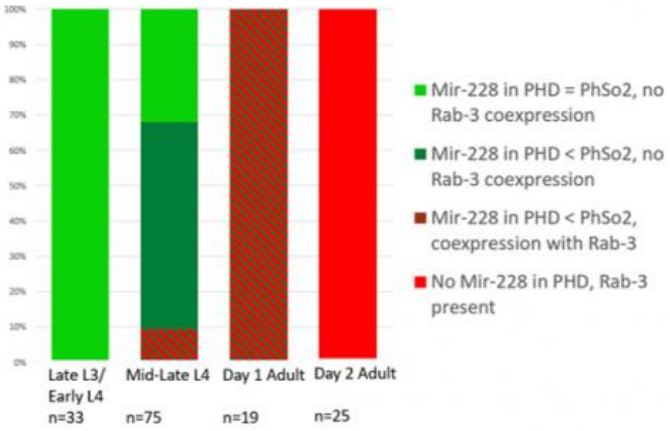


Fig 2.1 – Percentages of observed expression patterns of mir-228 and rab-3 in PHD neurons

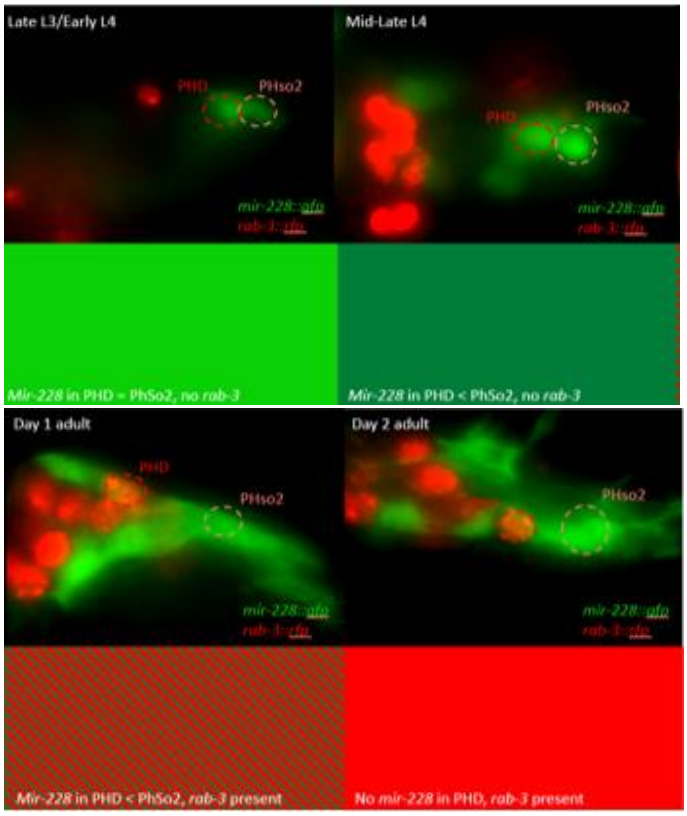


Fig. 2.2 – progression of mir-228 and rab-3 expression in the PHD and PHso2

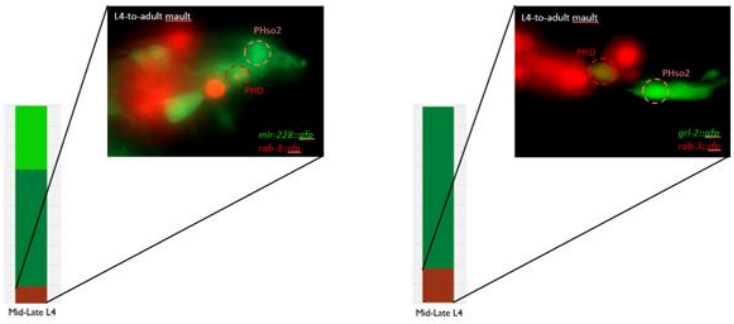


Fig. 3 – examples of maulting animals with glial and neuronal marker coexpression.

Of course, fluorescent proteins do not perfectly match levels of the markers they represent, rather they give a general overview of the transformation. At the very least, this result shows PhSo1 *might* partially dedifferentiate before it eventually acquires neuronal characteristics when the worm becomes an adult. Understanding trans-differentiation events such as this is key to understanding how nature itself reassigns cell fate. And if you're trying to do something yourself in cell biology, it often pays to learn how nature beat you to it. To determine the mechanics of this trans-differentiation would require a more quantitative technique: single molecule fluorescent in situ hybridisation (smFISH).

SmFISH employs fluorescently tagged RNA oligomers, antisense to an mRNA (or miRNA) of interest. Combined, these oligos fluoresce strongly enough that individual RNAs can be resolved and counted within PHso1. Tracking change in RNA quantity rather than GFP fluorescence would tell you whether or not glial expression stops before neuronal expression begins. Does the cell become completely naive? Perhaps only partially? Or maybe there's no dedifferentiation at all, and the cell passes through a totally novel identity- part glia, part neuron. Though I didn't have time to perform these experiments, I did create the necessary strains. By crossing a markerless strain with my GFP/RFP animals, and then selecting against RFP over a couple of generations I rendered worms expressing only one of the two GFP markers so that the RFP reporter used in smFISH would be visible.

Though the work I was doing represented a project in its early stages and was at times very laborious, I quickly got an appetite for it. There was a thrill to it, knowing that no one had ever done what I was doing. I felt that buzz again when I arranged the prettiest pictures I could muster into figures to show to the lab, and then again when they ceremoniously scoured my findings with the same level of scrutiny I had seen them exact on each other. Alongside my data, I showed off a *particularly* pretty picture of both the worm's glia-to-neuron transitions occurring at once in the same animal, which I think will remain my crowning achievement in science for a long time (Richard even kindly offered to steal it for his presentations). The BSDB's grant has allowed me a taste of what a career in academia can offer. Straightforward experiments fraught with unforeseen difficulties. Working on weekends when, infuriatingly, age-specific experiments simply weren't possible on Friday. Enough money to live off (just). But above all, the enormous reward in discovering something new. And getting to work with some really, really great people. Thanks guys.

References

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Jack O'Shea

BDSB Gurdon Summer Studentship Report (14)

Our third report from the 2017 group of student awardees comes from ***Rachael Adams*** *(student at University of Cambridge), who undertook her studentship with* ***Peter Lawrence*** *at the Dept. of Zoology in Cambridge.*

This summer, thanks to the Gurdon/The Company of Biologists Summer Studentship, I was fortunate to spend 8 weeks working in Dr Peter Lawrence's lab in the Department of Zoology.

The group studies PCP, a pathway which coordinates cell polarity and helps to align epidermal patterns in the Drosophila abdomen. Drosophila larvae are covered with a cuticle decorated by denticles which help the larvae to grip substrate in order to move. These denticles form a specific pattern and changes in the pattern can be used to investigate the properties of the PCP pathway. PCP genes are highly conserved and have been identified as being involved in processes such as vertebrate gastrulation, demonstrating their fundamental importance in animal development and patterning.

My project aimed to investigate the importance of Rab GTPases to PCP. Much research has been carried out on the Rab family of proteins, as they act as master regulators of intracellular membrane trafficking. The accurate delivery of cargo between organelles is crucial for normal eukaryotic cell function. Rabs facilitate this by coordinating vesicle formation, transport and fusion.

In order to test the role of as many Drosophila Rabs as possible I carried out a UAS RNAi knockdown screen of 34 different Rab and Rab-related genes, see figure 1. This screen took 7 weeks to carry out as I had to cross a collection of 103 different UAS-RNAi lines with ptc.Gal4 virgin females. This

involved maintaining a population of ptc.Gal4 flies in several bottles. I crossed the virgins with males obtained from each UAS-RNAi stock and incubated the flies at 29℃, the optimal temperature to see the effect of the RNAi. Once each cross was made it was approximately 5 days before third instar larvae could be collected. To identify any change in the phenotype, I mounted several third instar larval progeny of each Gal4-UAS- RNAi cross and examined the denticle pattern produced under the microscope.

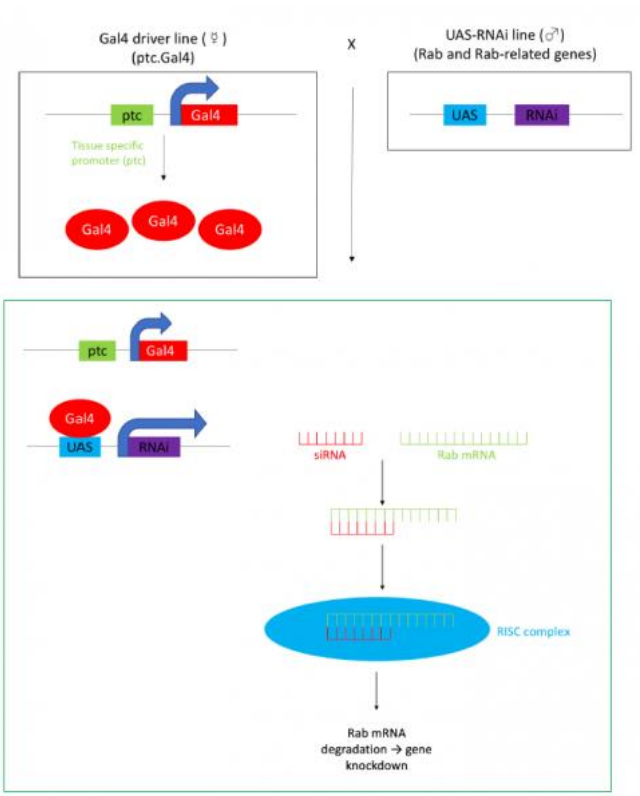


Figure 1- The w;ptc.Gal4 line of flies have the yeast Gal4 gene under the control of the patched(ptc) gene promoter, Gal4 binds to UAS sites to promote transcription. This means that when the driver line is crossed to the UAS-RNAi line the resultant progeny (in green box) express RNAi in the same location as the patched gene. This RNAi is complementary to a specific Rab mRNA, the resultant double stranded RNA is targeted for degradation by the RISC silencing complex, this results in gene knockdown.

Most larvae exhibited a wild type pattern, this may be because most of the Rabs I examined don't have a function in PCP or redundancy of Rab proteins may mask certain phenotypes. The low efficacy of some of the RNAi constructs may have also affected the proportion of successful knockdowns. However, I found that several of the Rab23 crosses produced an unusual phenotype where the tendon cell gaps appeared larger than normal, see figure 2. In order to test whether this result is repeatable, I have crossed the UAS-RNAi Rab23 stocks to different driver lines (sr.Gal4 and en.Gal4). As Gal4 expression is under the control of a different promoter in each driver line, this results in a different expression pattern of the RNAi, see figure 3. Whilst different drivers will not produce the same phenotype, if the denticle pattern is disrupted it may help in the investigation of the role of Rab23 in PCP.

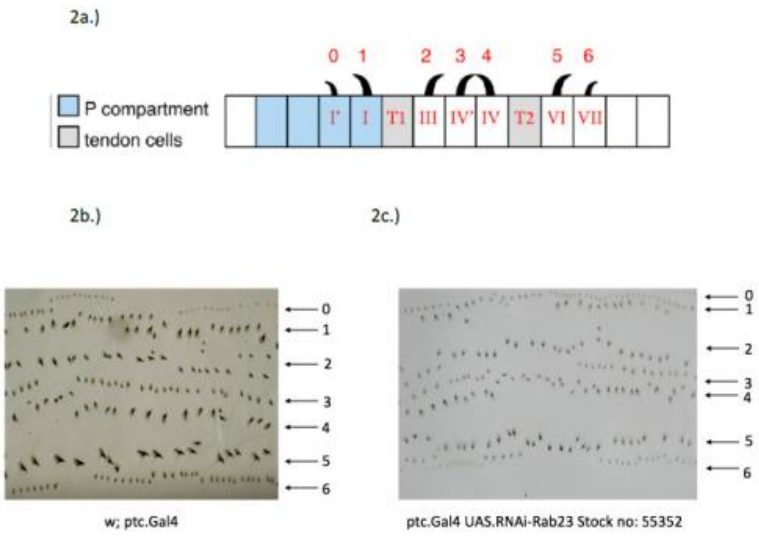


Figure 2- 2a.) A schematic of the wild type denticle pattern (Saavedra, Brittle, Palacios, Strutt, Casal and Lawrence. (2016)) 2b.) The patched driver line denticle pattern. As in the wild type, rows 0,1 and 4 face anteriorly whilst rows 2,3,5 and 6 face posteriorly. The tendon cell gaps are relatively small. 2c.) The Rab 23 knockdown denticle pattern, the tendon cell gaps are enlarged.

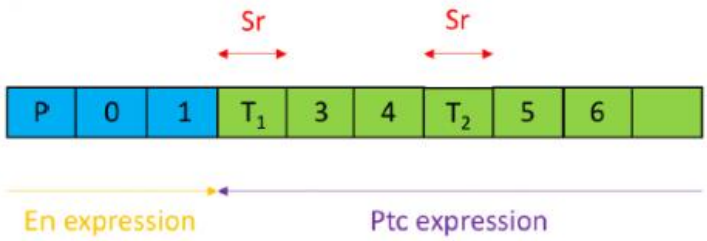


Figure 3- An illustration of where patched (ptc), stripe (sr) and engrailed (en) are expressed relative to the position of denticles and tendon cells. En is expressed in the posterior compartment (illustrated in blue). Ptc is expressed in the anterior compartment (illustrated in green) outside of the domain of en where it acts as a receptor for Hedgehog (Hh). Sr expression is limited to the tendon cells.

The results from the ptc.Gal4- UAS-RNAi Rab 23 crosses raised the question of why the tendon cell gap appeared larger. Possibilities include: that the tendon cells were enlarged, divided more frequently or the surrounding cells were smaller. To investigate this phenotype, I set up a series of crosses and aim to ultimately generate larvae carrying the Rab23 knockdown and expressing spaghetti squash protein (sqh) labelled with the fluorescent marker mCherry. Sqh encodes the regulatory light chain of non-muscle myosin so is expressed throughout cells. The sqh.mCherry construct therefore allows individual cells to be visualised with a confocal microscope and could help identify why the tendon cell gap is expanded.

To further investigate the phenotype I set up crosses to produce marked clones in adult flies where Rab23 is knocked down, the resultant mosaic animal allows comparison with wild type cells. This is achieved by using the Flp-FRT system to bring about site-specific recombination, see figure 4.

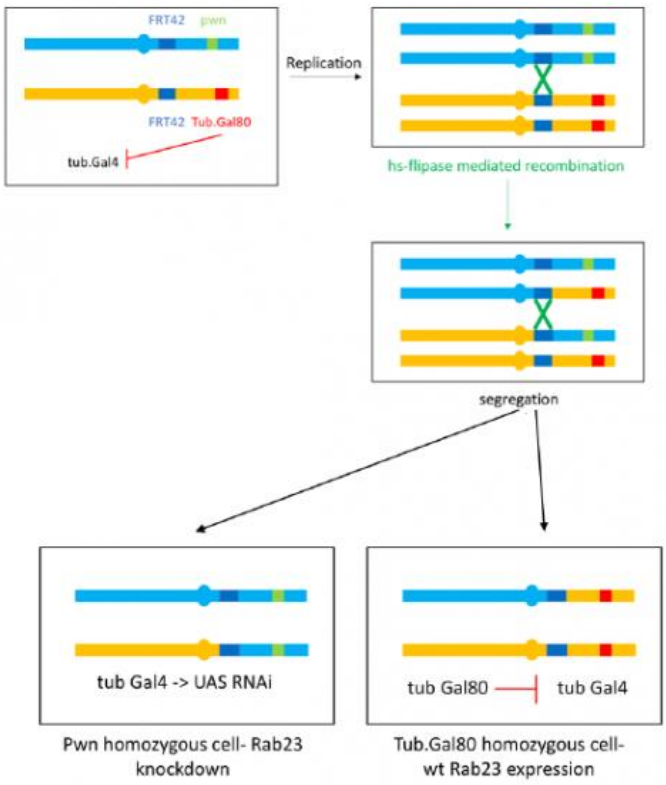


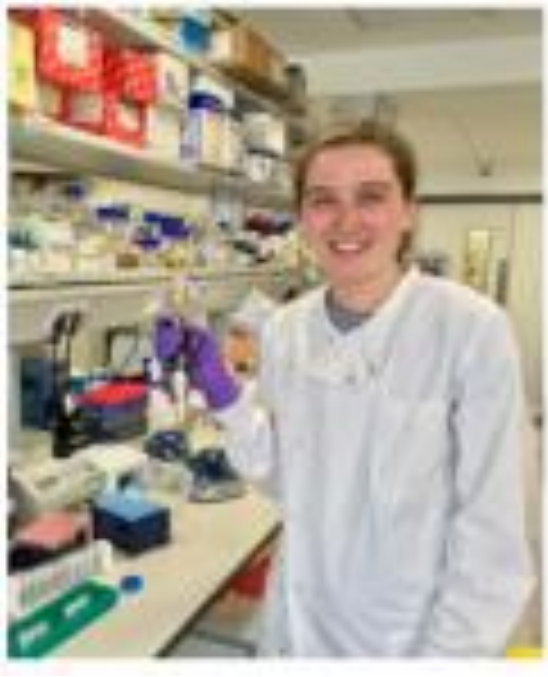
Figure 4- I aim to create flies with the above genotype by a series of crosses. When flipase (Flp) expression is activated by heat shock, recombination between FRT42 sites on the second chromosome occurs. This produces a mixture of clones with the knockdown and pawn (pwn) truncated bristle marker and wild type clones where Gal80 inhibits Gal4 activity and Rab 23 is expressed. Figure inspired by Prudêncio and Guligur, 2015, FLP/FRT induction of mitotic recombination in Drosophila germline.

I have really enjoyed my time in the lab and have learned a great deal. I am looking forward to continuing to investigate the Rab23 phenotype and seeing the results of my crosses as part of my Part II Zoology project this term. My special thanks to José Casal for supervising and to everyone in the lab for providing a great deal of help and advice.

Rachael Adams

BDSB Gurdon Summer Studentship Report (15)

Our fourth report from the 2017 group of student awardees comes from **Eleanor Sheekey** (student at University of Cambridge), who undertook her studentship with **Peter Rugg-Gunn** at the Babraham Institute in Cambridge.



Named after the mythical “Land of the young (Tír na nÓg)”, Nanog is a homeobox transcription factor expressed in embryonic stem cells (ESCs) aiding continual cellular proliferation alongside the other main pluripotency factors, Oct4 and Sox2. However, despite its contribution to pluripotency, much is still unknown of the mechanistic roles that Nanog plays within stem cells, since cells kept in culture deficient in Nanog retain the ability to self-renew [(1)]. Interestingly, it was recently found that Nanog provides a link between pluripotency and chromatin organisation suggesting important functions beyond transcriptional regulation [(3)]. With the BSDB Gurdon Studentship, I was privileged to spend my 8 weeks at the Babraham Institute alongside Dr Clara Novo to continue to explore this link.

Centromeres and chromatin

A key hallmark of stem cells is their ability to divide. However, this division must be executed precisely to avoid aneuploidy, an abnormal chromosomal number in a cell, and prevent unregulated division and cancer formation. Centromeres play a crucial role in chromosome separation, composing centric heterochromatin (CH) for kinetochore formation and pericentromeric heterochromatin (PCH) to hold chromatids together [(2)]. Although centromeres are thought to be defined epigenetically, the centro- and pericentromere contain minor and major satellite DNA repeats, respectively. Nanog binds the major satellite DNA repeats within the pericentromere, maintaining the PCH in a 'more' open state with increased transcription of major satellites and lower levels of H3K9me3[(3)], bridging the gap between pluripotency and chromatin organisation. It also promotes the formation of chromocenters, which are clusters of major satellite repeats from several chromosomes. Deletion of Nanog leads to chromatin compaction including the PCH. Since PCH is essential for genetic stability and Nanog levels are known to fluctuate in stem cell cultures, the consequences of an altered PCH organisation will need to be understood before successfully developing more stably reprogrammed stem cells for future medical treatments [(4)].

Meet E14 and BT12

Throughout my project, I was working with mouse ESCs (mESCs). Much like in a vending machine, each of the different genetically modified mESCs are assigned a systematic name. E14 is like salted crisps, a male, wild type mESC cell line, originally isolated from the inner cell mass of a developing embryo. BT12, on the other hand is spiced up, no longer containing Nanog, but instead expressing a GFP transgene [(1)]. Maintaining these two cell lines in culture was essential for conducting my experiments to study the effect of Nanog$^{-/-}$.

FISH, IF and ChIPs

As Nanog was shown to affect heterochromatin at pericentromeres, we wondered if this effect extended to the centromere. To tease apart any differences in protein levels and localisation at the centromeres between E14 and BT12, we used a combination of techniques. Immunofluorescence (IF) provides a clear single cell insight and is beautiful to visualise under the microscope. Fluorophores had to be carefully chosen to avoid the wavelength clashing with that of GFP (already being expressed in BT12) and to differ from each other. Fluorescence in situ hybridisation (FISH) visualises specific locations of DNA using single-stranded probes and thus in combination with IF provides a good indication of whether proteins localise to a particular DNA region.

We were able to take some stunning images (Figure1) which could be used to quantify the levels of centromeric proteins assayed in wild-type and Nanog knockout cells. We then used the Imaris software [(5)] to quantify signals obtained from multiple 3D stacks, allowing for easy identification of fluorescent foci (Figure 2). Once the quantification of protein intensity was gathered I analysed it on R-studio to test for significant differences between both cell types (Figure 3).

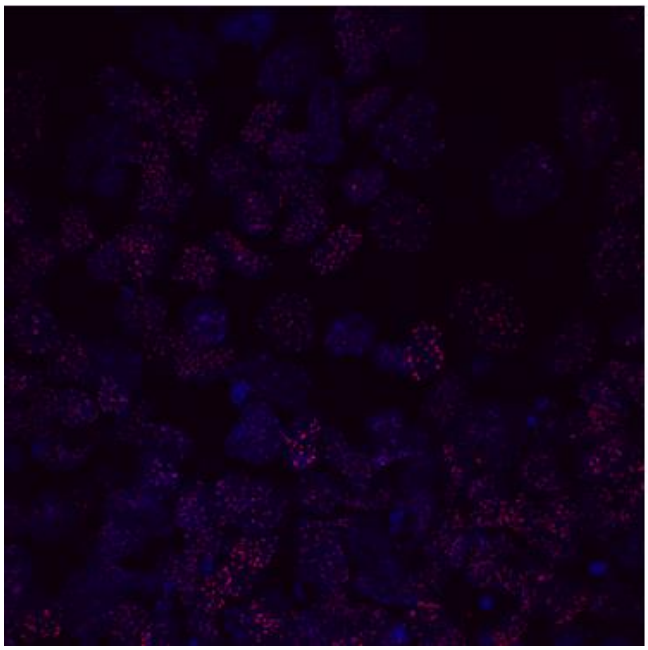


Figure 1 IF images of BT12

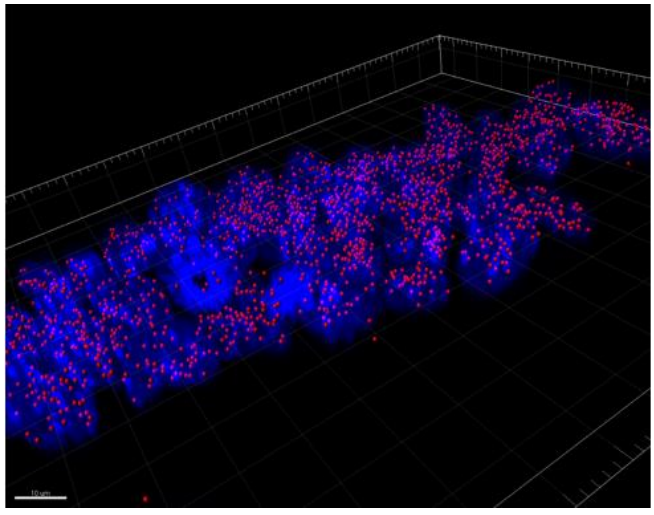


Figure 2 Using the 3D Imaris interphase to quantify my images

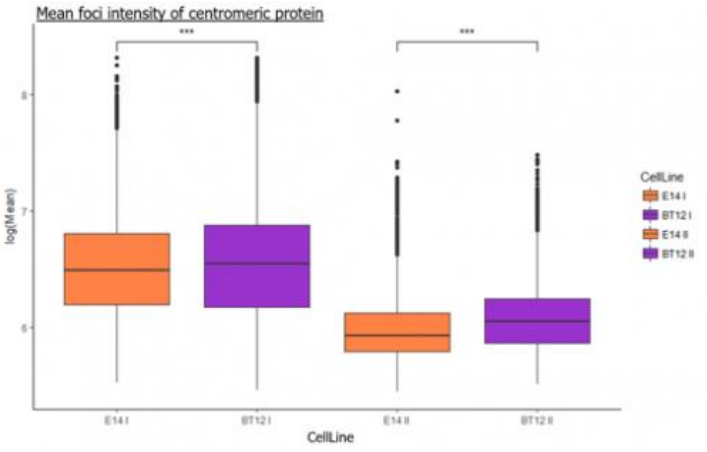


Figure 3 R-studio analysis

To further this analysis, we used Chromatin immunoprecipitation (ChIP) that can answer many biological questions associated with DNA-protein interactions by fixing proteins to chromatin. In brief, by using antibodies specific to the protein of interest and magnetic beads that bind to these antibodies, a 'pull-down' of captured DNA can be isolated. The eluted DNA can then be analysed using ChIP-quantitative polymerase chain reaction (ChIP-qPCR) to quantify protein intensity at specific DNA regions. In our case, by using primers complementary to the major and minor satellites, we could assess if the binding of our proteins of interest differed between the cell lines.

Epilogue

Much like predicting the murderer in an Agatha Christie novel, one of my favourite aspects of the project was piecing together the experimental evidence to suggest hypotheses to explain our results. It is quite feasible for the absence of Nanog to have a diverse range of effects on the mESCs due to its interactions with DNA and other pluripotency factors, which could result in mislocalisation and/or altered post-translational modifications of its partners. Nevertheless, my preliminary results will require further validation and follow up before any conclusions can be made. However, in the manner of Shakespeare's comedy, it has definitely been a fun experience, one from which I have gained much more lab confidence and exposure from, of which I am grateful both to the Rugg-Gunn lab at the Babraham Institute and the BSDB studentship that helped fund it.

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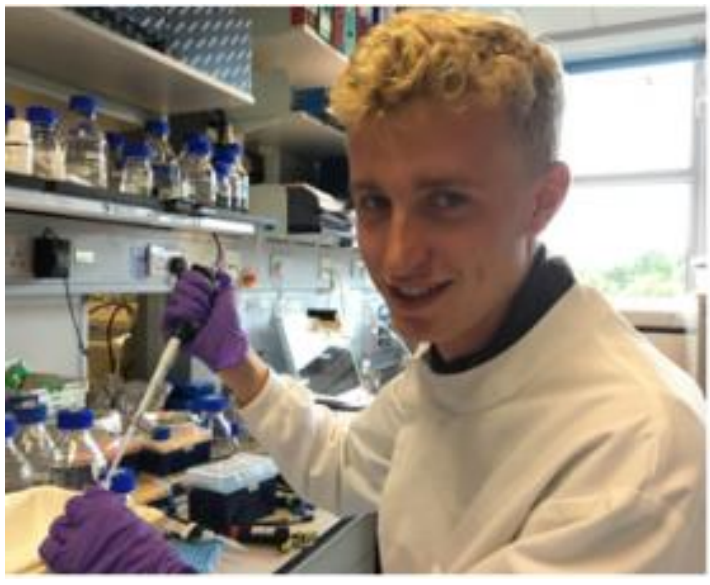
http://www.bitplane.com/imaris/imaris

Eleanor Sheekey

BDSB Gurdon Summer Studentship Report (16)

*Our fifth report from the 2017 group of student awardees comes from **Jake Cornwall Scoones** (student at University of Cambridge), who undertook his studentship with **Anna Philpott** at the Dept. of Oncology in Cambridge.*



Transdifferentiation of pancreatic organoids

This summer, I had the amazing opportunity of undertaking a Gurdon Summer Studentship, working in Prof. Anna Philpott's lab, under the guidance of Dr. Roberta Azzarelli at the Cambridge Oncology Department. Having completed first-year Natural Sciences, I was intrigued to learn more about the molecular mechanisms that underpin development. Focused on a potential transdifferentiation pathway in pancreatic cells, the project has been both fascinating and informative, teaching me many invaluable skills, from tissue culture, to growing organoids, to having the patience required for many of the complex procedures involved.

In recent years, many have championed regenerative medicine as a solution to diseases associated with cell loss like diabetes mellitus. This technique, where cells are grown and differentiated to replace dead or diseased cells, has the potential to overcome many of the pitfalls of transplantation, most notably immune rejection. To minimise rejection, inserted cells must display high genomic identity with the recipient. These cells can be derived by one of two methods:[1, 2] through a differentiation programme, transitioning embryonic(-like)[3] stem cells into the fate desired; or via transdifferentiation, through introducing factors that tweak the cell's genome and epigenome.

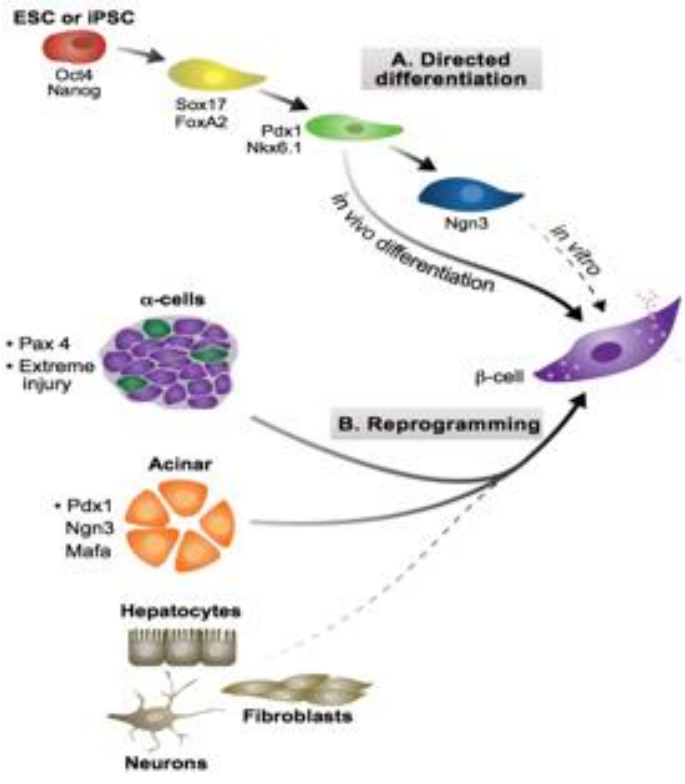


Figure 1: Two possible pathways for generating β-cells. Adapted from Pagliuca and Melton, 2013

During development, cell-lineages sequentially accrue epigenetic modifications that consign them to their fate, transforming from a totipotent zygote to terminally differentiated cells. Waddington's visual metaphor, envisaging this sequential differentiation as a ball rolling down a terrain of bifurcating valleys, helps to frame questions in developmental biology.[4] Upon transplanting the nucleus of somatic Xenopus cells into enucleated eggs, Gurdon found that the resultant cell was pluripotent, capable of differentiating into all cell types.[5] In so doing, Gurdon demonstrated that factors within an egg have the capacity to modify the epigenetic state of a nucleus, implying that the ball can roll back up the valley. In the case of pancreatic transdifferentiation, with sufficient knowledge of this terrain and with the correct molecular intervention, we should able to push the ball into our chosen valley.

Pancreatic development proceeds through two stages: the primary transition (embryonic day 9 (E9) to E12.5); and the secondary transition (E12 to birth).[6] The primary transition sees endodermal thickening, followed by the pancreatic progenitor proliferation leading to pancreatic bud formation. Through a process of epithelial stratification and micro-lumen formation, the initial tubular morphology that will later characterise the pancreas begins to emerge. This initial expansion phase is followed by rounds of specification and patterning, forming a bipotent trunk and a multipotent tip. Adult pancreata are comprised of three different cell types, namely acinar, duct and endocrine cells, the former derived from tip progenitors and the latter two from trunk cells.

Endocrine development, part of the secondary transition, is triggered by the transient expression *Neurogenin 3 (Ngn3)* above a threshold level, and proceeds through delamination from the epithelium and aggregation into *Islets of Langerhans. Ngn3*$^{+}$ cells are specified to one of five fates in a temporally regulated manner:[7] α-cells produced upon earliest *Ngn3*-activation synthesising glucagon; followed by β-cells producing insulin; then δ-cells producing somatostatin; then PP-cells producing pancreatic polypeptide; and finally ε-cells producing ghrelin. Previous work from the lab by Azzarelli et al.[8] demonstrated *Ngn3* is phosphoregulated by proline-directed kinases (e.g. *CDKs*), regulating the balance between proliferation, (*Ngn3* hyper-phosphorylation), and differentiation, (*Ngn3* under-phosphorylation). β-cell maturation is promoted by the transcriptional regulator *Pdx1,* among others, whose expression remains confined to β-cells in the adult pancreas.

Working in tandem with *Pdx1, MafA* transcriptionally regulates genes involved in insulin secretion and biosynthesis and it is thus considered a marker of mature β-cell identity.

Ngn3, crucial in assigning endocrine fate initially, and *MafA* and *Pdx1,* important in β-cell maturation, have been previously over-expressed in combination to induce transdifferentiation of acinar cells to β-fate in an *in vivo* model. These factors were used in our experiment to see if such transdifferentiation is possible in an *in vitro* model, specifically pancreatic organoids, a form of 3D cell culture grown in matrigel. Upon over-expression of these three factors, it is possible to test for changes in cell fate, by looking at symptomatic traits of β-cells, namely the production of insulin.

Over-expression can be achieved through the infection of organoids with lentiviral vectors carrying genetic loci that upon infection will be inserted into the cells' nuclear genomes. The activation of these imported genes should be controllable so a transactivator is used which, when bound to the antibiotic doxycycline *(Dox)*, becomes active, binding the promoter of our genes of interest, inducing their transcription. The three factors are necessarily expressed together through their transcription within a single ORF, containing *MafA, Pdx, Ngn3* and *GFP (*a fluorescent marker) sequences, separated by loci encoding the cleavage peptide *2A*, meaning upon translation, cleavage ensues resulting in four functional proteins. Hence a GFP signal is sufficient to determine the expression of all three factors, leaving other wavelengths free to test for pancreatic hormones through immunohistochemistry.

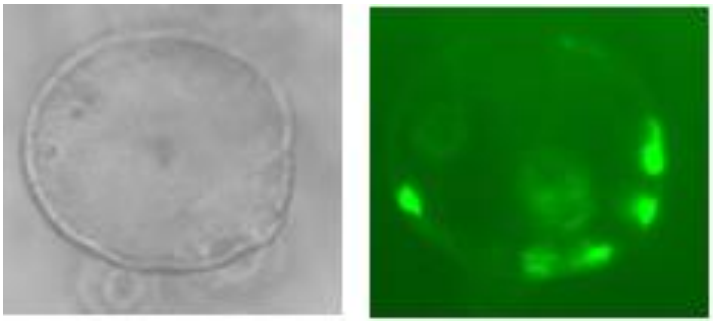


Figure 2: Pancreatic orgnaoids infected with a virus encoding GFP

Two lentiviral vectors were used to infect organoids, one carrying the transactivator gene *Tet3G,* and the other carrying the locus of interest, *Pdx-MafA-Ngn3-GFP* (*PMN),* or *GFP* as our control. Viruses were produced by the transfection of HEK cells with several plasmids, each containing genes encoding different viral proteins plus the locus of interest, followed by incubation, viral purification and titration. Organoids were incubated with viruses for a week with *Dox* and then fixed with PFA. Immunohistochemistry was performed, staining organoids for insulin. Preliminary results are very encouraging and I look forward to seeing how my contribution fits into the larger project as a whole.

This studentship has been an invaluable experience, allowing me to gain an understanding of real-world lab science, a practice venturing into the unknown, far from the rushed experiments for which answers were already known performed as a part of my course. I have developed lab-skills, most notably having the rare opportunity to work with organoids, a relatively novel technology. I urge other students to consider applying for this fantastic opportunity in future years.

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Jake Cornwall Scoones

BDSB Gurdon Summer Studentship Report (17)

Our sixth report from the 2017 group of student awardees comes from ***Katarina Grobicki*** *(student at University of Cambridge), who undertook her studentship with* ***Seb Shimeld*** *at the Dept. of Zoology in Oxford.*

Hedgehogs & Sea Squirts

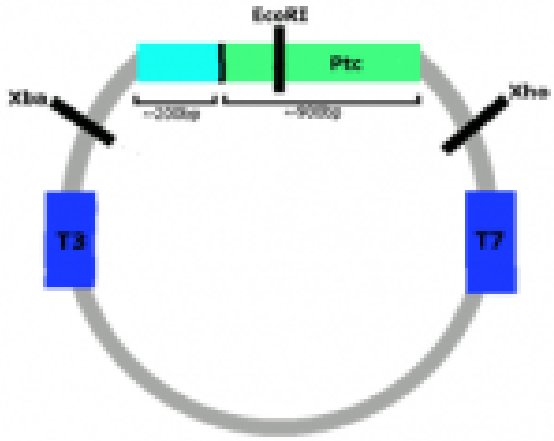
Receiving a Gurdon studentship allowed me to join Seb Shimeld's lab in for a brilliant summer in Oxford and has given me my first taste of independent research. My project focused on the hedgehog signalling pathway in *Ciona intestinalis*. Hedgehog signalling regulates many areas of development, including the nervous system and limb patterning, and also regulates the behaviour of adult stem cells so misregulation can lead to a variety of cancers.

In vertebrates, Hh binds to the cell surface receptor Patched, lifting the repression of Patched on Smoothened and allowing signal transduction. In cells not receiving Hh signal, Gli transcription factors are processed to a repressor form (GliR); when Hh signalling is received, this cleavage is inhibited allowing the longer activator form of Gli to persist (GliA). The balance of GliR:GliA is what determines the expression levels of target genes. In addition to this protein level regulation, signalling also feeds back to regulate the expression of the Gli genes themselves. *Ciona* are of interest because they are urochordates, so are part of the invertebrate lineage most closely related to vertebrates, which split off before the 2R genome duplication. Vertebrates have 3 Gli genes and their expression is differentially regulated by Hh signalling, whereas *Ciona* only have 1 Gli gene. I wanted to investigate whether the *Ciona* Gli gene was also regulated by Hh signalling, or whether this was a novel innovation in vertebrates, made possible by the the 2R duplication.

Making riboprobes

The first step of my project was to synthesise riboprobes for genes involved in the hedgehog pathway (Hh, Ptc, Gli) and a suitable control (FoxIc). Initially I attempted to do this by using PCR with M13F&R primers to amplify the target cDNA from a mini-prepped plasmid, then in vitro transcription to synthesise RNA from this. However after 6 separate PCR and transcription attempts I was still encountering problems. Every PCR of the Gli plasmid produced two DNA fragments (seen by running the products on an agarose gel), even when the primers were swapped (for T7 and T3 primers), a gradient of different temperatures were tried, new PCR reagents were used, and a fresh dilution of the plasmid mini-prep was used. This meant that the Gli PCR product couldn't be used for probe synthesis. I had successfully amplified the other cDNAs (Ptc, Hh, FoxIc) by PCR however not enough RNA was being produced by the transcription reactions so I decided to restart the probe synthesis from scratch using a different method.

I used restriction enzymes to linearise the plasmids and then transcribed from this linear DNA to successfully produce riboprobes. However the probes were still produced in very small amounts, so I transformed competent cells with my plasmids and grew a mini-prep in order to try again with a much larger initial concentration of DNA. Using the mini-preps I produced large enough concentrations of both positive and negative sense probes for Gli and FoxIc (negative sense probes were used as controls in in situs), and positive sense probe for



It was not possible to produce as negative sense probe for Ptc due to the Ptc plasmid also containing around 200bp of cDNA encoding part of an RNA-binding protein (this is due to the way the plasmid library has been constructed and this has been missed in previous studies of *Ciona* Ptc expression). Any riboprobe synthesised using T3 RNA polymerase would also bind to mRNA encoding the widely expressed RNA-binding protein, rendering the probe useless. To produce the positive sense Ptc probe, EcoRI had to be used instead of Xba, so that the DNA encoding the RNA-binding protein was not included.

Once I had produced my probes it was time to collect some *Ciona* and begin in situ hybridisations.

Ciona work

We drove to a harbour on the south coast to collect gravid adult *Ciona* which I used to set up in vitro fertilisations. Dissecting *Ciona* for the fertilisations was tricky and required very steady hands in order to collect eggs without cutting the sperm duct

(essential to avoid self-fertilisation). I set up multiple separate fertilisations in the evenings and then incubated these at 17°C overnight, which meant embryos reached early-mid tailbud by the next morning. I then fixed the embryos in paraformaldehyde (PFA) at different ages, ready to use for in situ hybridisations. For earlier stages which had not hatched I had to dechlorionate the embryos before fixing; this must be carried out very rapidly to avoid damaging the embryos.

In situ hybridisations

After fixation, embryos were washed in ethanol then prehybridised, before adding 3ul of probe to each eppendorf. The probe was thoroughly washed away and embryos were incubated with blocking solution, then with antibody, then washed many times again before adding the staining solution.Larvae treated with the positive sense Gli probe clearly showed real staining in the head, and tailbud embryos seemed to show staining in neural tissue along their dorsal side, but this was less clear due to background in some of the embryos. In addition, unfertilised eggs were evenly stained all over with the positive sense probe but not stained when treated with the control probe.Embryos treated with the FoxIc probe showed the predicted expression pattern, reassuring me that my protocol was working.My Ptc probe required multiple in situs to optimise the pre hybridisation procedure and find the ideal amount of probe to add. Eventually I was able to see staining towards the back of the head on dorsal side (possibly in ectoderm), but there is still quite a lot of background.

Figure 1: *Ciona* embryos treated with positive sense Gli probe

Figure 2: *Ciona* embryos treated with negative sense Gli probe (control)

Figure 3: *Ciona* embryo treated with positive sense FoxIc probe

Figure 4: *Ciona* embryo treated with positive sense Ptc probe

I carried out another set of fertilisations and treated the embryos with cyclopamine (or DMSO as a control) once they reached early tailbud stage; the embryos were fixed in PFA after hatching then used for in situ hybridisations. Cyclopamine inhibits the hedgehog pathway by directly binding to Smo (*Chen, J; Taipale, J; Cooper, M; Beachy, P; 2002. Inhibition of Hedgehog signaling by direct binding of cyclopamine to Smoothened. Genes Dev, Nov 1; 16(21): 2743–2748*). I wanted to test how cyclopamine would affect Gli and Ptc expression in *Ciona* because they only have one Gli gene, which may not be transcriptionally regulated by Hh as it is in vertebrates with their 3 Gli genes. We predicted that Gli expression would not be altered by inhibiting the hedgehog signalling, but Ptc expression would be altered. Unfortunately my embryos stained far too darkly due to me failing to fully remove their outer tunic during prehybridisation, and I ran out of time to repeat this experiment, so I wasn't able to observe how Ptc and Gli expression patterns were affected.

A few of the cyclopamine-treated embryos with the Gli probe didn't stain too darkly so expression patterns could still be seen, and these showed the wild-type expression pattern of Gli, which suggests that Gli is not regulated by Hh signalling. However as my Gli controls and all of my Ptc embryos were stained too darkly to see any expression patterns, I can't conclude anything from these results, as it may have been that the cyclopamine treatment didn't work. This experiment will hopefully be repeated in the lab soon.

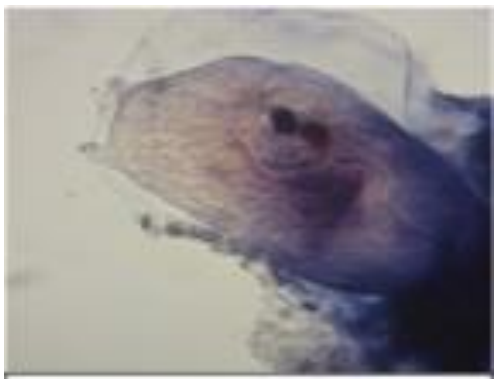


Figure 5: Cyclopamine-treated *Ciona* embryo treated with positive sense Gli probe

I also briefly investigated whether *Ciona* Gli might be alternatively spliced, as in Amphioxus. To do this I extracted RNA from *Ciona* larvae then reverse transcribed from this using oligo(dT) primers to produce cDNA. I carried out a PCR using primers which had been designed to amplify around exons which had been identified as potentially not being included in all transcripts (using the different

transcript models available on ANISEED, a very useful integrated database of ascdian genome and expression data). I then ligated my PCR product into a T vector and transformed this into competent cells, which I grew up and then sent for sequencing. My sequence data suggested that Gli isn't alternatively spliced. My sequence data also suggests that neither the KH2012 transcript model nor the JGIv1.0 transcript model are quite correct in their predictions of exons in Gli, as my cDNA contains 2 exons not predicted by the KH2012 transcript model and doesn't contain an extra exon predicted by the JGIv1.0 transcript model.

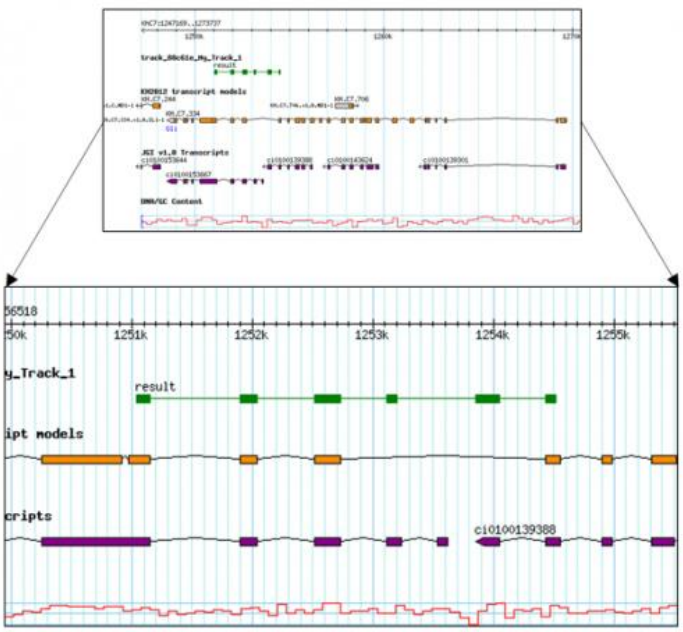


Figure 6: BLAST from ANISEED showing comparison of my segment of sequenced cDNA from Gli mRNA (green) with two different transcript models of the Gli gene (orange and purple). My sequenced cDNA shows positions of exons in different combinations to those predicted by either of the transcript models.

Thank you so much to Seb for hosting me, and to the whole lab for being so welcoming and teaching me so much. Thank you to the BSDB for making it all possible. I really feel like I've learned a lot over the summer and I'm now certain I want to pursue a PhD and hopefully a career in research.

Katarina Grobicki

BSDB Gurdon Summer Studentship Report (18)

*Our seventh report from the 2017 group of student awardees comes from **Agata Czap** (student at University College London), who undertook her studentship with **Paola Oliveri** at University College London.*

How to knockout a gene in sea urchin?

I am Agata Czap, an undergraduate student of MSci Human Genetics at UCL. The BDSB Gurdon Summer Studentship has given me an incredible opportunity to undertake research for 8 weeks at Oliveri lab in UCL. I applied to work with Dr. Oliveri to learn about the challenges of applying the CRISPRcas9 technology to new model systems.

My project focused on knocking out the transcription factor *Pmar1* in sea urchin *S. purpuratus* using the CRISPRcas9 system. *Pmar1* is a part of a characterized gene regulatory network (GRN) and its role has been dissected using ectopic and dominant negative approaches (1). Specifically, *pmar1* represses *HesC* during early development, as part of a double negative gate (DNG) of skeletogenesis. *HesC* is another transcription factor, which represses the downstream skeletogenesis genes (2). This DNG enables specification of micromere cell fate in the correct cells (1), from which primary mesenchyme cells (PMCs) will arise and eventually form the larval skeleton. Furthermore, the DNG enables micromeres to release two signals. Early Signal (3), which is responsible for inducing archenteron invagination, and Delta, which activates the Notch receptor in secondary mesenchyme cells for endomesoderm patterning (4) (figure 1).

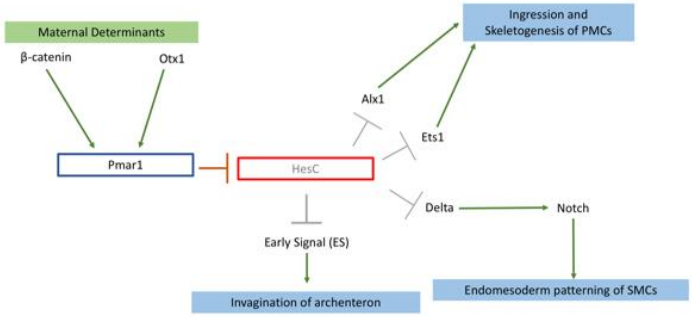


Figure 1: Pmar1 is a part of double negative gate (DNG) in the skeletogenesis pathway. This gene requires β-catenin, and another transcription factor Otx, both maternally expressed. These two determinants bind to promoter of Pmar1 for activation of its expression. Pmar1 represses transcription factor HesC in micromeres. This repression enables expression of skeletogenesis genes and release of two signalling proteins to induce endomesoderm patterning in secondary mesenchyme cells (SMCs) and archenteron invagination.

So far, there have been no functional knockouts of *Pmar1,* as the gene has duplicated 4 times in the *S. purpuratus* genome. Previous experiments deduced possible function with a series of downregulation and rescue indirect strategies (1,4). Micromeres are located on the vegetal plate of the

urchin embryo. One of early experiments carried by Dr. Oliveri, involved removing and transplanting micromeres into animal pole of another healthy embryo (2). This has induced a secondary, ectopic gut (2). Additionally, an embryo from which micromeres have been removed had shown no development of skeleton nor gut (3). *Pmar1* expression requires maternal determinant called β-*catenin,* and imparing its nuclerization results in an embryo similar to micromereless embryo (3). Thus, I have hypothesized that upon successful knockout, the embryo would lack skeleton as well as other endomesoderm derivatives (e.g archenteron). Other ectodermal tissues should be unaffected.

To tackle the issue of *pmar1* duplication, I have collected all 4 (*Pmar1a-d*) FASTA sequences from the Echinobase transcriptome. I have used Jalview to identify conserved regions between duplicates within exon 1 and 2, and generated phylogram to visualize diversification of the sequences. My results agreed with that of Cavaleri's team (4); *Pmar1b* has diverged to become a monophyletic group. The sequences are still highly conserved, the first 810 bp of each transcript show 86% similarity. I used this fragment of the *Pmar1b* sequence, as it had the best consensus when compared to cDNA. I have inserted this sequence into 4 algorithms including CHOPCHOP to generate gRNAs. Unfortunately, the algorithms used different criteria to rate gRNAs. To filter through all 98 gRNAs, I tested each against BLAST in Echinobase for off-targets. This allowed me to obtain top 5 gRNAs, which target every *Pmar1* gene.

A more wet lab-based part of my project then followed. During the first two weeks, I have learned how to culture sea urchin embryos, spawn adults to obtain gametes and assess fertilisation rate. *S. purpuratus* has turned out to be a rewarding model system, embryos can be produced in large quantities and are transparent, allowing clear observation of tissues. Natalie, a PhD student who also worked on applying CRISPRCas9 technology to knockout neuropeptides, has taught me how to synthesize selected gRNAs using PCR and T7 in vitro translation. Once gRNAs were ready, we injected a pair of gRNAs and Cas9 mRNA into oocyte after fertilisation to induce a deletion mutation. The efficiency of knockout was tested with DNA extraction and agarose gels, which measured molecular weight of the target region. I carried out in situ hybridisation and antibody staining on genes acting downstream of *Pmar1* to characterise mutants.

My results were promising. In each knockout, I have used *PKS1* knockout in pigment cells as positive control, which proved Cas9 enzyme is non-toxic for embryos. *PKS1* allows quick visual check that Cas9 works, as albino mutants are easily identified. Furthermore, it has high knockout efficiency of ~90% (5). My knockout attempt had lower *PKS1* efficiency with 50% albino incidence at 45hpf. I have used additional positive control, knockout of *Jun,* a gene downstream of *Pmar1,* which caused delayed invagination in 42% at 45hpf. *Pmar1* gRNA 1 and 5 have been very efficient; at both 45hpf and 70hpf, 100% of embryos were mutants. The embryos did have a blastopore and syncytial rods were present, but the gut nor skeleton were not developed (figure 2).

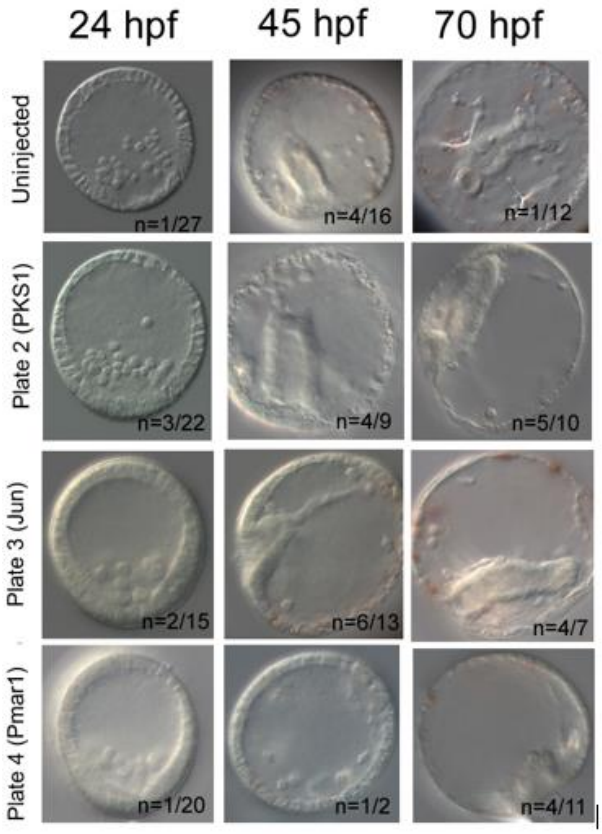


Figure 2: My attempt to knockout Pmar1. Jun and PKS1 knockouts act as positive controls. PKS1 knockout generated albino mutants. Jun knockout has resulted in delayed invagination characterised by undeveloped shorter gut. Pmar1 knockout caused lack of proper skeleton and gut, and round morphology of the embryos.

In conclusion, a successful knockout requires a lot of preparation, resilience and knowledge of molecular tools. The procedure gives you greater understanding of how Cas9 enzyme works and of gene function. My gRNAs will be further used by Oliveri lab to test efficiency of *Pmar1* knockouts using different combinations of gRNA pairs and Cas9 concentrations.

I would like to thank Dr. Oliveri for giving me a chance to work in her lab. Also to PhD student Natalie Wood for being patient when teaching me all the techniques used. I greatly enjoyed being part of a research team and wish to pursue scientific career further. I would recommend Gurdon studentship to any student applying for a laboratory-based internship.

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Agata Czap

BDSB Gurdon Summer Studentship Report (19)

Our eighth report from the 2017 group of student awardees comes from **Nicole Serzhantova** *(student at The University of Edinburgh), who undertook her studentship with* ***Jennifer Nichols*** *at The University of Cambridge.*

Understanding the first step in the formation of organismal complexity in the mouse embryo

As biologists, we are very used to poking and prodding very complex systems, be it *drosophila* or *homo sapiens*. Rarely is it a prerogative to take a step back and really understand how such complexity arises seemingly out of nowhere. How is that we start off from a single cell and over a period as short as 48 hours (in the mouse at least) we already start seeing complexity arising?

In mice, a single-cell zygote undergoes a series of cleavage cell divisions and morphogenetic changes to form a unipotent epithelial vesicle termed the trophectoderm (TE) enclosing a compact group of pluripotent stem cells known as the inner cell mass (ICM) (Fig.1F).

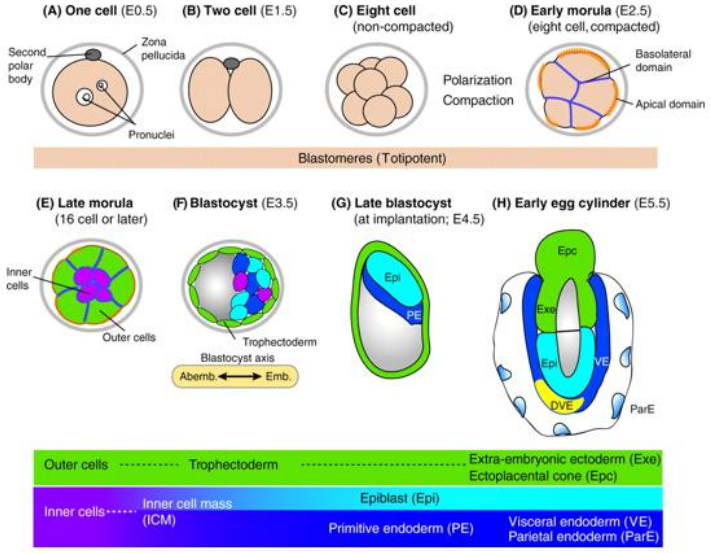


Figure 1. Development of the mouse embryo from one cell pre-implantation stage to a post-implantation stage embryo. (Rossant & Patrick, Development, 2009)

Restriction of cell fate takes place over an extended time period of 48 hours from the 8-cell (morula) stage (Fig.1C), when all cells are indistinguishable from one another and are capable of forming all three germ layers. This feature of cells is termed totipotency and is a transient characteristic of embryonic stem cells before they commit to become either TE or ICM.

At this 8-cell stage compaction of the embryo begins, in which the embryo surface smoothens because of an increase in intercellular adhesion. Cells epithelialise, forming tight junctions (which acts as a seal) between cells, limiting diffusion and what you are left with is fluid-filled epithelial vesicle enclosing a small number of cells (Fig. 1D-F).

It is at point that the first commitment of cells occurs, whereby the outer epithelium (Fig.1E) becomes committed to form the trophectoderm (TE), which subsequently gives rise to the trophoblast layers of the placenta and the trophoblast giant cells. Whilst the small population of enclosed cells commit to becoming the ICM, which is the pluripotent stem cell lineage of the embryo, giving rise to all of the primary germ layers of the foetus and its extraembryonic tissue.

At this stage of development, protein synthesis from maternal mRNA becomes more transient as the embryo's own gene programs begin to switch on. Once commitment occurs, as the morulae becomes a blastocyst, differential gene expression is seen between the ICM and TE. At day 2 ½ post-fertilisation, all cells within the morula uniformly express most genes, including the pluripotency factor Oct4 and the TE marker Cdx2. Interestingly, at day 3 ½ the first real differential gene expression is observed, where the ICM begins to express Oct4 whilst loosing its ability to express Cdx2 and conversely the trophectoderm begins to express Cdx2 whilst loosing all Oct4 activity. There is a mutual repression by Oct4 and Cdx2 which further consolidates the TE and ICM segregation.

Elucidating the mechanism governing a cell's ability to become either a unipotent TE cell or a pluripotent stem cell of the ICM can open up new avenues for generating and maintaining pluripotency *in vitro*. In an attempt to understand this initial lineage segregation, a stem cell line was cultured which removes the Oct4 gene upon treatment with tamoxifen. This cell line also had a florescent tdTomato reporter under the control of a constitutive promoter, meaning that these cells fluoresce red when exposed to light in the blue to green range.

The following cells were cultured in serum-LIF (a differentiation permissive medium) and different portions of the cells were treated with tamoxifen for either 24, 48 or 92 hours to allow for the excision of the Oct4 gene. Once these time points of treatment were reached, cells were microinjected into live mouse morulae and blastocysts. Approximately 5 morulae and blastocysts were microinjected with 8-10 stem cells deficient in Oct4 from each time point as well as un-induced cells form the same batch as a control. These morulae were left for two days to allow for compaction and the first lineage segregation to occur. These were then promptly fixed and immunostained to examine what effect the deletion of Oct4 had on the cell fate choices that the injected stem cells made.

Following what we already know about what happens during development, it can be hypothesized that stem cells that do not have the capacity to make Oct4 will commit to the trophectoderm lineage as they are missing a key pluripotency factor and therefore cannot become pluripotent cells competent of forming all 3 germ layers.

Unfortunately due to rising temperatures in the laboratory during summer (the air conditioning was of course broken on the days the microinjections were performed), upon imaging it was clear that in most cases only 1 stem cell, out of the 8-10 injected, integrated into the embryo. This was prevalent in the un-induced cells also, suggesting that it was not the tamoxifen treatment that caused toxicity to the cells but rather the experimental conditions. Integration rates were higher in morulae than in blastocysts as expected, since by the blastocyst stage cell commitment has already occurred making it harder for integration to ensue.

Out of the cells that did integrate, only 1 appeared to express Cdx2 markers showing that it has adopted a trophectodermal cell fate, whilst the others exhibited a mixture of pluripotency markers. The conclusion from this being that although Oct4 is necessary for cell commitment to the ICM lineage, additional molecular events must underpin this initial commitment in the mouse model. Inferring this from the data is difficult considering how the number of integrated stem cells was so low and future experiments with more tightly controlled conditions are advised.

These results however are concordant with other studies, with Wu and Schöler (2014) reporting that the "establishment of totipotency in maternal Oct4–depleted embryos was not affected, and that these embryos could complete full-term development without any obvious defect." In addition to this, Wu and Schöler were able to form Oct4 expressing inner cell masses in embryos with complete inactivation of both maternal and zygotic Oct4 expression as well as reprogramming of fibroblasts into fully pluripotent cells by Oct4-deficient oocytes.

This, in conjunction with the results I obtained, tends to indicate that Oct4 is not essential for the initiation of pluripotency but in contrast to its role is critical for the maintenance of pluripotency.

I would like to thank Professor Jennifer Nichols, Ayaka Yanagida, Peter Baillie-Johnson, Thorsten Boroviak, Ken Jones, Tim Lohoff and everyone else at the Cambridge Stem Cell Institute for their invaluable guidance and support throughout my internship. I would also like to thank the British Society for Developmental Biology for granting me the Gurdon Studentship Award without which none of this would have been possible.

Nicole Serzhantova

BDSB Gurdon Summer Studentship Report (20)

Our ninth report from the 2017 group of student awardees comes from ***Miguel Robles Garcia*** *(student at The University of East Anglia), who undertook his studentship with* ***Andrea Münsterberg*** *at The University of East Anglia.*

This summer I had the opportunity to undertake an internship at Andrea Münsterberg's Laboratory at the University of East Anglia, where I am currently studying for a Bachelor's Degree in Biological Sciences. Under the supervision of a PhD student, Johannes Wittig, and a postdoctoral researcher, Dr Estefanía Lozano-Velasco, I was able to spend seven weeks learning the ins and outs of everyday research. During this internship, my role was to focus on the early stages of heart development in chicks.

During vertebrate development, the heart is one of the first organs to develop. It is known that during this process many malformations can occur, which are capable of affecting correct heart function leading to potential defects or death. The developmental stages between mammals and birds are similar starting with cardiac looping and resulting in chamber formation. Due to the importance of the heart, its development is tightly regulated by different transcriptional and post transcriptional signalling pathways driven by transcription factors and microRNAs (miRs) respectively. miRs are regulators of gene expression that inhibit the translation of mRNA. During this project, my focus was to aid the postdoctoral researcher with her investigation of miR-133 function, which is thought to regulate BAF60b chromatin during heart development.

I started my time in the lab by dissecting wild type (WT) embryos from stages HH18-19 and HH23-25. The staging of the chick development follows the one described by Hamburger and Hamilton from 1951. Throughout my time in the laboratory, I became familiar with the dissection technique in which the different membranes that cover the embryo need to be removed. This is needed so that in future analyses (such as those that are mentioned) the membranes would not infer in the procedure and to make the tissue more available.

My project then shifted towards the injection of embryos at stages HH 14-16 with the antagomir-133 (AM133). An antagomir is a modified oligonucleotide that binds to its specific micro RNA and inhibits its action. Therefore, this technique can be used to investigate potential effects in hearts which are deprived of a specific micro RNA. I used AM133 which is designed to inhibit miR-133. I also used scrambeled antagomiR (SCR) as a control for the procedure to see that the actual way of injecting the oligonucleotide wasn't the one affecting the development of the heart. Both of these oligonucleotides have 5' fluorescent label that allows the injection to be seen at first with the naked eye, but later after further incubation, with the aid of a GFP microscope (Figure 1). These antagomiRs were injected into a hollow cavity close to the heart walls while the heart is still beating without killing the embryo. After the injection, the embryos were sealed with tape and returned to an incubator at 37°C for 24/48h depending on the intended analysis.

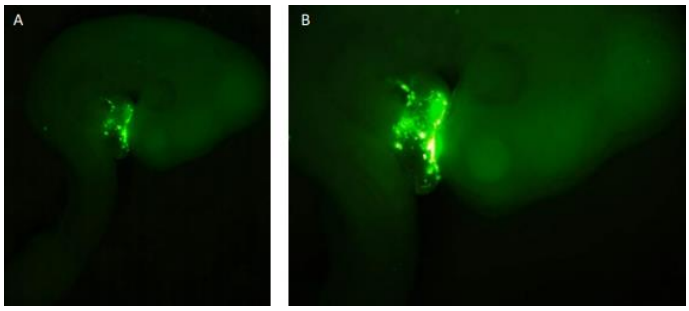


Figure 1. Fluorescence seen in embryos injected with the SCR probe. As depicted the fluorescence is seen only in certain parts of the heart and nowhere else. This shows that only in these places the inhibitor has bound to its target. Figure A shows the whole embryo while B is a close up of the same embryo. The fluorescence signal is stronger on the right-hand side of the heart.

While some of the embryos were used for imaging and making sure the inhibitor bound in the correct place as shown in Figure 1, other embryos were embedded for sectioning. This involved placing the embryos in a gelatine medium that would then solidify at room temperature. Two different approaches were used for this in which one meant leaving the embedded embryos at room temperature for the gelatine to solidify slowly while the other was performed using dry ice for a rapid solidification. This allowed me to section the embryos for a closer examination of the heart. SCR embryos were compared to AM133 injected embryos to see if there is any difference in morphology. However, in order to image the slides containing the embryo section I had to stain them. For this we used an Alcian blue staining procedure (Figure 2). In this case the medium surrounding the tissues of the embryos would be discarded and only the glycosaminoglycans within the actual tissue were stained blue. This was also performed for embryos that had a double knock out of miR133 and miR1.

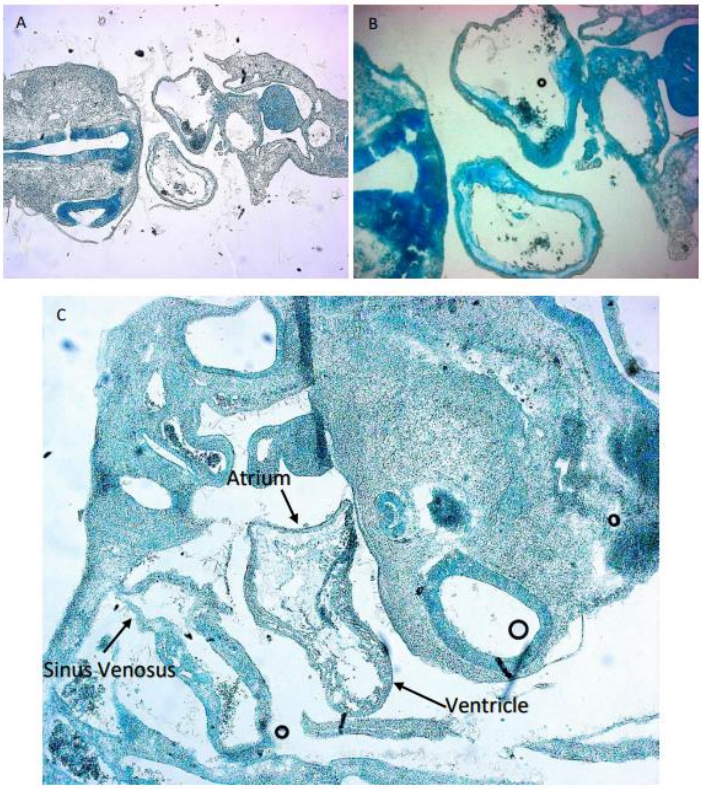


Figure 2. Image shows Alcian Blue staining of cryosections of embryos injected with antagomir-133 and SCR. A) Cross section of SCR injected embryo. The two hollow forms in the middle are the atria (down) and Truncus arteriosus (up) which can be seen connecting to the sinus venosus. B) Cross section of another SCR embryo showing a closer look at the heart. C) shows a sagital section. The top structure of the image is the head while the structure along the bottom is the back and tail of the embryo. The heart can be seen again in the middle of the embryo. Two different chambers are observable the top right one being the atria and ventricle while the bottom left one is the sinus venosus.

I want to thank the BSDB Gurdon Studentship for granting me the opportunity to have what I can just describe as an incredible experience. It has allowed me to develop my skills and scientific mind which I will be able to apply in my future studies and career. This opportunity is of great importance as, as a third-year student, I wasn't sure of how daily lab teamwork alongside other scientists that are dedicated to their research felt like. I would also like to thank the Münsterberg lab for hosting me and Estefanía and Johannes for their guidance through these weeks.

Miguel Robles Garcia

BDSB Gurdon Summer Studentship Report (21)

Our tenth report from the 2017 group of student awardees comes from **Liam McMulkin** *(student at The University of Dundee), who undertook his studentship with* ***Dr. Marios Stavridis*** *and* ***Dr. David Martin*** *at The University of Dundee.*

My project's aim was to expand British Sign Language (BSL) glossary for biology, more specifically areas relating to Developmental Biology.

British Sign Language (BSL) is a form of sign language which involves in the use of hand movements, gestures, body language and facial expressions to communicate. BSL is mainly used by deaf people. Unfortunately, BSL usually does not have signs for technical words that are not normally used in daily conversations, in biology for example, adenosine triphosphate, centriole, ectotherm, and many more which consequently lead to deaf people not having an equal access to biology compared with hearing people e.g. Interpreters don't have signs for biological terms, which results in the use of fingerspelling. However, fingerspelling can be a lengthy process as every letter has to be spelt and is therefore not appropriate for a biology lecture, and also it is unpleasant to watch. Could you imagine a lecturer speaking out individual letter to spell out a word, more than twenty times in an hour lecture? E.g. electrophoresis and electroporation. Sometimes it can be difficult to distinguish between two words in a same lecture e.g. pluripotent, totipotent etc. especially when they are spelt out one letter at a time.

Scottish Sensory Centre has National 4 Biology BSL glossary. Unfortunately, they cannot source more funding to expand their BSL glossary for biology. Therefore, I decided to do something. I want to change this, I want deaf people to have a better access to biology with a better standard of BSL. This is a good timing to change this, as now it is an exciting time to study biology as new technologies open up novel areas of discovery e.g. genetic engineering and stem cells. Deaf people deserve to learn in their first language.

Dr. Marios Stavridis and Dr. David Martin agreed to support me to change this. They persuaded me to apply for this fantastic BSDB Gurdon Summer Studentship. After a month of waiting, I was very pleased to find out my application turned out

successful. Straight away, I was given an unrestricted access to the staff in the Division of Cell and Developmental Biology at the University of Dundee, also space in the building to use as my base and meet with staff and postgraduate students to develop this glossary. In the process, I gained a first-hand experience of topics in Developmental Biology spanning the areas from Evo-Devo, live imaging of gastrulation, stem cells, neural and mesoderm development. This allowed me to get a feel for the terms beyond a dictionary definition. BSL is a very visual language and imagery is important in making good terminology. I spent a month doing this, before I ran the workshops.

The workshops were held on 8th and 10th August at University of Dundee. I sent out invitations using BSL via a video on Facebook with closed captions. The video had many shares, and I think it has shocked some people as they never knew that BSL has a limited glossary. University of Dundee also released a video about my workshops, which has reached to many people. Other news agencies such as Times Higher Education also released a news piece about my project. I am pleased that my project was well informed to the public because it raises awareness about BSL and its glossary.

Over 15 BSL users (aged from 20 and 70) attended and took part in the process of developing signs. Dr. Marios Stavridis briefly introduced what Developmental Biology is. Then, a Ph.D student provided a talk about her research work – two BSL interpreters struggled translating the talk due to lack of complex signs. Before we started developing new signs, a BSL linguistic, Gary Quinn introduced how to develop signs, and ensure they follow BSL grammar. I prepared a PowerPoint with terms we lack signs in with definitions and other helpful resources. All the participants worked together really well and developed over 70 new signs! At the end of the last workshop, the Ph.D student repeated her talk, and the participants were extremely shocked how improved the translations were from the same interpreters.

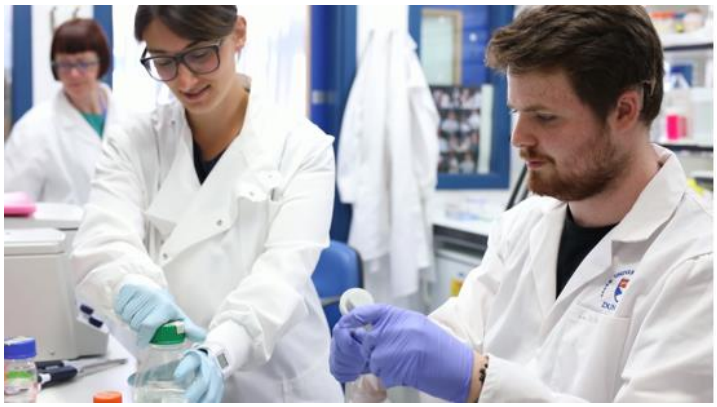
After the workshops, I spent roughly three days signing the newly developed signs. I then shared the signs online via Facebook for review. The feedbacks I received were really positive.

Now, I am at the last stage before finishing the project. The developed signs are required to be reviewed by Scottish Sensory Centre Glossary Manager, Dr. Audrey Cameron and a BSL linguistic, Gary Quinn before they are uploaded online at Scottish Sensory Centre website.

I can't express how much I appreciated everyone's support in this project. I millions of times thank to BSDB for selecting me to part of their studentship programme. Also, millions of times thank to The Robertson Trust for covering the costs for running the 2-day workshops at University of Dundee. I thank all the participants for all their efforts in developing signs for complex terms. Thank you to Dr. Marios Stavridis for being my supervisor. Also, for arranging an unrestricted access to the College of Life Sciences which gave me unique experience meeting world-leading scientists and observed their real work. Many thanks to Dr. David Martin for co-supervising me, and allow me to borrow his high-quality filming devices. My filming skills have improved! Finally, many thanks to Francesca Carrieri for her time observing her work and her time to come along to my workshop to deliver a talk on her research work.

In conclusion, I am very pleased I took this opportunity to improve BSL vocabulary for biology, which will improve deaf people's access to education and science-related workplaces. Also, general science conversations using BSL. From this project, I hope more funding bodies have recognised the work of Scottish Sensory Centre and support them expanding BSL vocabulary to help deaf students in education. Finally, I really hope this project encourages Scottish Sensory Centre to add more of university-level vocabulary rather than just school-level vocabulary for help deaf higher-education students like myself.

Liam McMulkin



Gaining a first-hand experience of topics in Developmental Biology at College of Life Sciences, University of Dundee. Left to Right: Anne Whittaker (communication support worker), Francesca Carrieri and myself.

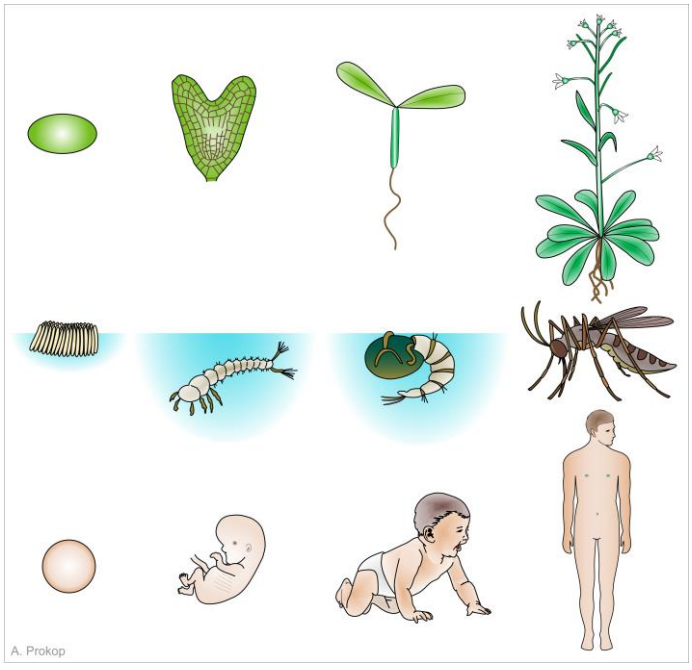
Explaining Developmental Biology to non-specialists

The BSDB recently initiated an advocacy campaign, starting with (1) the gradual development of the best arguments that can be used as elevator pitches in discussions, presentations, applications or publications, and (2) the collation of support resources which were first published on the BSDB website and are now present in improved version on The Node. To take this initiative a step further, I recently took an invitation by the journal Open Access Government as an incentive to write a short text that would explain the nature as well as the societal importance and impact of DB in terms that are understandable to lay audiences. Please, read the outcome of that effort below (or read the original publication here). This is only a first attempt, but I hope that it will serve as a template that can be used and further developed by members of the DB community.

What is Developmental Biology – and why is it important?

Developmental Biology addresses questions of societal importance

The life science discipline Developmental Biology (DB) aims to understand the processes that lead from the fertilisation of an egg cell (or equivalent) to the formation of a well-structured and functional multicellular organism (Fig.1). At first sight, this may appear a mere curiosity-driven academic goal, not necessarily worth tax payers' money. Here I argue that the opposite is true: DB is a key discipline in the life sciences, a motor for research into human disease and fertility, food sustainability and biological responses to environmental pollution and global warming.



According to the US' *National Research Council*, over half of initial pregnancies are affected by developmental defects, ~3% of live births suffer from major developmental aberrations, ~70% of neonatal deaths and 22% of infant deaths have developmental causes, and ~30% of admissions to paediatric hospitals are due to developmental defects. The causes can be random errors, inherited or acquired gene mutations or toxins – as illustrated by severe limb malformations of thousands of new-borns during the thalidomide/Contergan drug scandal in the 1950s, or the stark increase in birth defects after the Bhopal gas catastrophe in 1984.

These numbers and examples clearly cry out for scientific investigations into the developmental processes affected - not only to understand or even treat human disorders, but also to deliver profound arguments that convince policy makers, for example to reduce toxic wastes, fumes and plastics which pose threats to our healthy genes and development. DB is a scientific discipline at the centre of such investigations, and it has two important strategic strengths, as will be explained in the following.

DB asks profound questions at the level of whole organisms or organs

DB investigates questions such as "how does the kidney or brain develop?" or "how do limbs or leaves achieve their characteristic shapes and positions?" To address such questions, a typical DB research strategy may start by identifying the genes or gene networks regulating the respective developmental processes in a chosen animal or plant. These genes can then be functionally manipulated or eliminated in order to study the resulting developmental aberrations. The findings often allow deductions about how the involved genes and processes function in health; they may

also reveal parallels to clinical cases of human developmental disorders, thus directing informed biomedical research into such conditions.

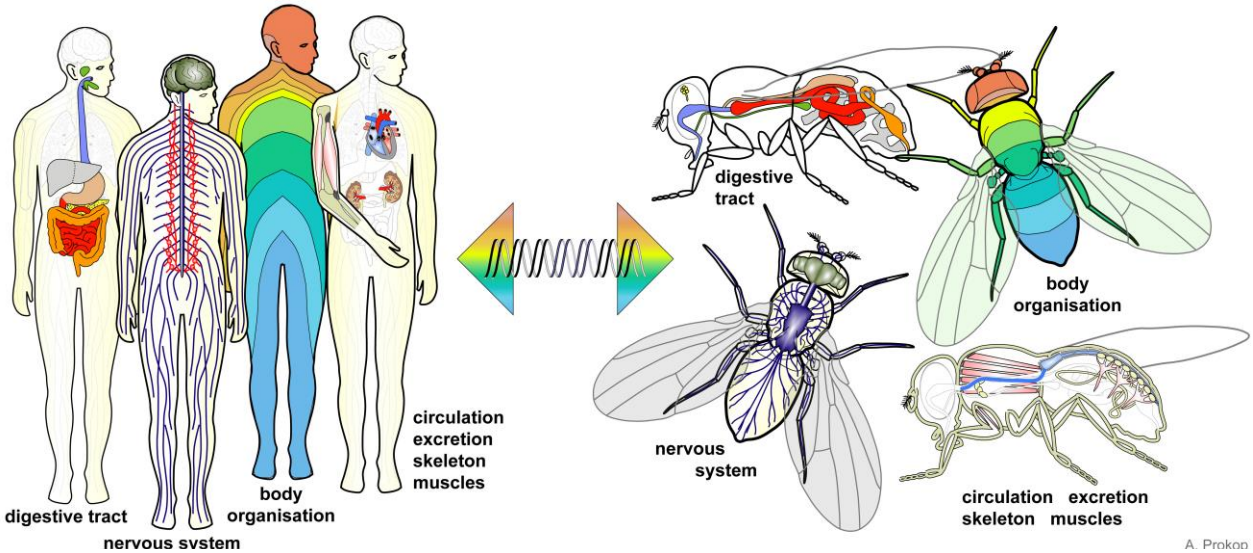
To investigate processes from the genetic level all the way up to the organism/organ level, DB has to be highly inclusive and interdisciplinary, making active use not only of genetics, but also biophysics, biochemistry, cell biology, physiology and anatomy. In this way, it drives discoveries at the various levels of complexity, acts as an umbrella discipline that can provide a common focus towards essential biological questions, and builds bridges to clinicians or plant/animal breeders who tend to think at the organism/organ level.

DB makes strategic uses of model organisms

Most DB research does not use human embryos, but covers the breadth of the animal and plant kingdoms. This ambition might seem to bear the risk of over-stretching our research capacities, but it is in fact a great strength of DB and gold mine for discovery. It turned out that many genes and functional gene networks that steer fundamental biological processes have ancient evolutionary origins and are still being used by very different species for similar purposes (Fig. 2); ~75% of human disease genes have a counterpart in fruit flies, and ~50% of yeast genes can be functionally replaced with human genes. Capitalising on this principle of 'deep homology', highly efficient and cost-effective, hence economically responsible research can be done in smaller organisms, such as worms, flies or even yeast. The genes and concepts learned can then be tested in mammals (most frequently mice) and eventually used for clinical trials. This discovery pipeline has led to significant understanding of human biology and disease, as evidenced by an impressive number of Nobel Prizes in Physiology and Medicine awarded to scientists working with these “model systems”.

What DB has done for us (so far)

DB research starts with the fertilisation of egg cells; studying the underlying processes has provided the foundations for much of what fertility clinics can do these days. DB investigates how fertilised egg cells divide in regulated manners to grow into full-size bodies, how the cells formed in this process communicate in meaningful ways to become different from each other, migrate, change shape and attach to each other, thus assembling into tissues and complex organs. Many of these processes are needed again during wound repair, and DB research helps to speed up wound healing, prevent scars and overcome chronic wounds. Also ‘tissue engineering’, which aims to grow replacement tissues in a plastic dish, is essentially guided by DB research. In cancer, cells lose their identity, divide excessively, detach from their local environments and migrate to form metastases. Much of this understanding that can instruct cures to contain these aberrant cells, comes from DB research. Tissues keep so-called stem cells which can be re-activated in orderly manners to divide and grow replacement tissues. There are high hopes from stem cell research, for example



to replace cartilage in arthritis or damaged discs, or brain cells in dementia, much of which is guided by the vast knowledge gained through DB.

The applications of DB go far beyond biomedical research. For example, understanding plant development provides a means to speed up breeding processes, such as optimising root systems, plant size or flowering time, thus contributing to the efforts of achieving sustainable food security in times of over-population. Furthermore understanding environmental influences on development, such as temperature-dependent sex determination in turtles, has enormous importance for conservation biology, especially in times of increasing pollution and global warming.

In conclusion, DB may appear as a mere academic discipline, but its value for society is enormous. This should make us think about a carefully balanced system of science funding. Current trends seem to favour clinical or industrial research performed to translate biological knowledge into economic or societal benefit. But we must not overlook that fundamental research, such as in the field of DB, lays the long-term foundations for such developments.

Andreas Prokop is Professor of Cellular and Developmental Neurobiology at the Faculty of Biology, Medicine & Health (The University of Manchester) and communication officer of the British Society for Developmental Biology. *The author would like to thank Ottoline Leyser and Aidan Maartens for helpful comments on this manuscript.*

Other articles advocating Developmental Biology

- Duronio, R. J., O'Farrell, P. H., Sluder, G., Su, T. T. (2017). Sophisticated lessons from simple organisms: appreciating the value of curiosity-driven research. Disease Models & Mechanisms 10, 1381-1389 — [LINK] – comment by A Martínez Arias [LINK2]
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