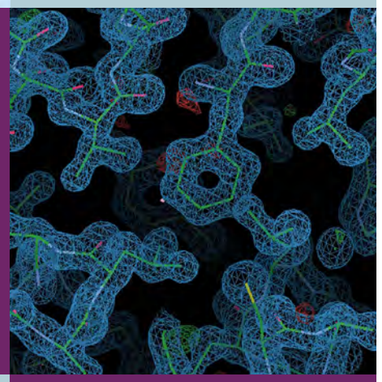
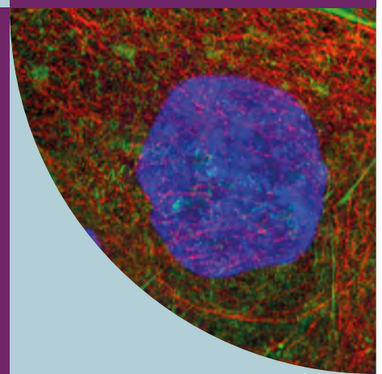

Durham
University
Inspiring the extraordinary
Department
of Biosciences

07
Ecology, Evolution & Environment (EEE)

22
Molecular Plant Sciences (MPS)



36
Biomolecular Interactions (BI)



50
Animal Cells and Systems (ACaS)



# Contents


**Durham University and the Department of Biosciences** 04

**Ecology, Evolution & Environment (EEE)** 07

Prof Robert Baxter 08
Dr John Bothwell 09
Dr Wayne Dawson 10
Dr Jonathan Drury 11
Dr Will Feeney 12
Prof Rus Hoelzel 13
Prof Steve Lindsay 14
Prof Martyn Lucas 15
Dr Rebecca Senior 16
Prof Phil Stephens 17
Dr Sean Twiss 18
Dr Andreanna Welch 19
Prof Stephen Willis 20

**Molecular Plant Sciences (MPS)** 22

Dr Adrian Brennan 24
Dr Steve Chivasa 25
Dr Peter Etchells 26
Dr Elaine Fitches 27
Prof Patrick Hussey 28
Dr Heather Knight 29
Prof Marc Knight 30
Prof Keith Lindsey 31
Dr Junli Liu 32
Dr Miguel de-Lucas 33
Prof Ari Sadanandom 34

**Biomolecular Interactions (BI)** 36

Dr Tim Blower 38
Prof Martin Cann 39
Dr Peter Chivers 40
Prof Paul Denny 41
Dr Karrera Djoko 42
Dr Sushma Grellscheid 43
Prof Ehmke Pohl 44
Prof Nigel Robinson 45
Dr Martin Schröder 46
Dr Gary Sharples 47
Dr Brian Suarez-Mantilla 48
Dr Tessa Young 49

**Animal Cells and Systems (ACaS)** 50

Prof Carrie Ambler 52
Dr Adam Benham 53
Dr Paul Chazot 54
Dr Rebecca Clark 55
Dr Vincent Croset 56
Dr Tim Davies 57
Dr David Doupe 58
Dr Martin Goldberg 59
Prof Colin Jahoda 60
Dr Akis Karakesisoglou 61
Dr Arto Maatta 62
Prof Stefan Przyborski 63
Dr Susan Pyner 64
Dr Olena Riabinina 65
Dr David Weinkove 66

# Departmental Structure & Research Synthesis

**Biosciences has core facilities that are exceptional. These include, for example, next generation sequencing, super-resolution microscopy, proteomics and metabolomics facilities.**

Durham Biosciences has a long history, its current structure having originated from an historical amalgamation of the former departments of Botany (established 1932) and Zoology (established 1946). Biosciences staff and facilities are housed in a purpose-built department, though close research links with other departments, notably Chemistry, mean that we also have lab and office space elsewhere, to facilitate collaboration. Our research builds upon strengths in three subdisciplines, 'Ecology and evolution', 'Biochemistry' and 'Cell and developmental biology'.

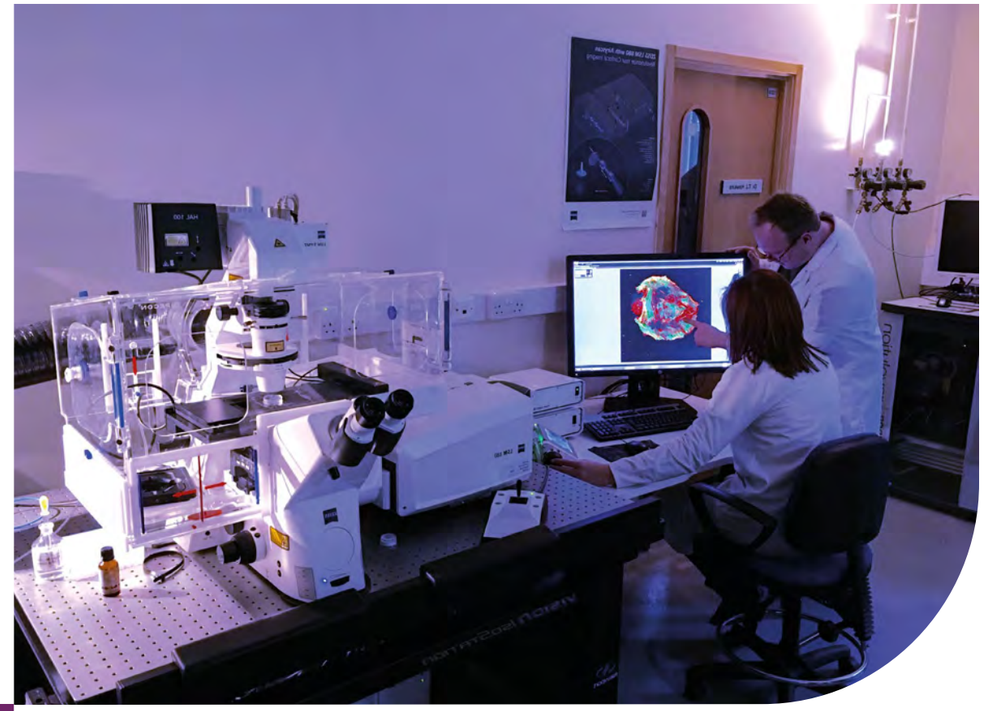
Currently, Durham Biosciences is ranked 9th in the Complete University Guide (2022) and 12th in The Guardian's Best Universities 2021 league table, a measure of the excellence of our research environment and our cross-disciplinary approach to research, and also as a result of our high graduate employability. We were ranked in the top ten bioscience departments in REF 2014 for impact (100% of which was graded internationally excellent or world-leading) and our research environment was similarly 100% internationally excellent or world-leading. More than 95% of our research outputs were internationally recognised, internationally excellent or world-leading. The vision for Biosciences in Durham is to become a world class centre for cross-disciplinary approaches to fundamental biological questions, with impact on the bioeconomy and the environment. The central feature of this renewed vision is an increased collaboration between biologists and other science disciplines (notably physical scientists and mathematicians) to develop new approaches to a range of biological problems that will benefit from the high quality expertise found across Durham's Faculty of Science. These biological problems are focused around four research groupings - Ecology, Environment and Evolution (EEE); Molecular Plant Sciences (MPS); Biomolecular Interactions (BI); and Animal Cells and Systems (ACaS). To assist research management, each member of staff has a primary home in a group focussed on one of these four research areas. These groups organise focused seminar series, run research away-days, manage joint research facilities, oversee mentoring and internal peer review, and serve to nucleate larger research projects.

Biosciences has core facilities that are exceptional given the department's relatively small size. These include, for example, next generation sequencing, super-resolution microscopy, proteomics and metabolomics facilities.

This report briefly summarises the objectives of the department's four research groups, before going on to provide summary descriptions of the research interests of our academic staff.

Research strengths in EEE are well represented at the cutting edge of research in the discipline of ecology. There is also synergy between ecosystem modellers, including computation of landplant-





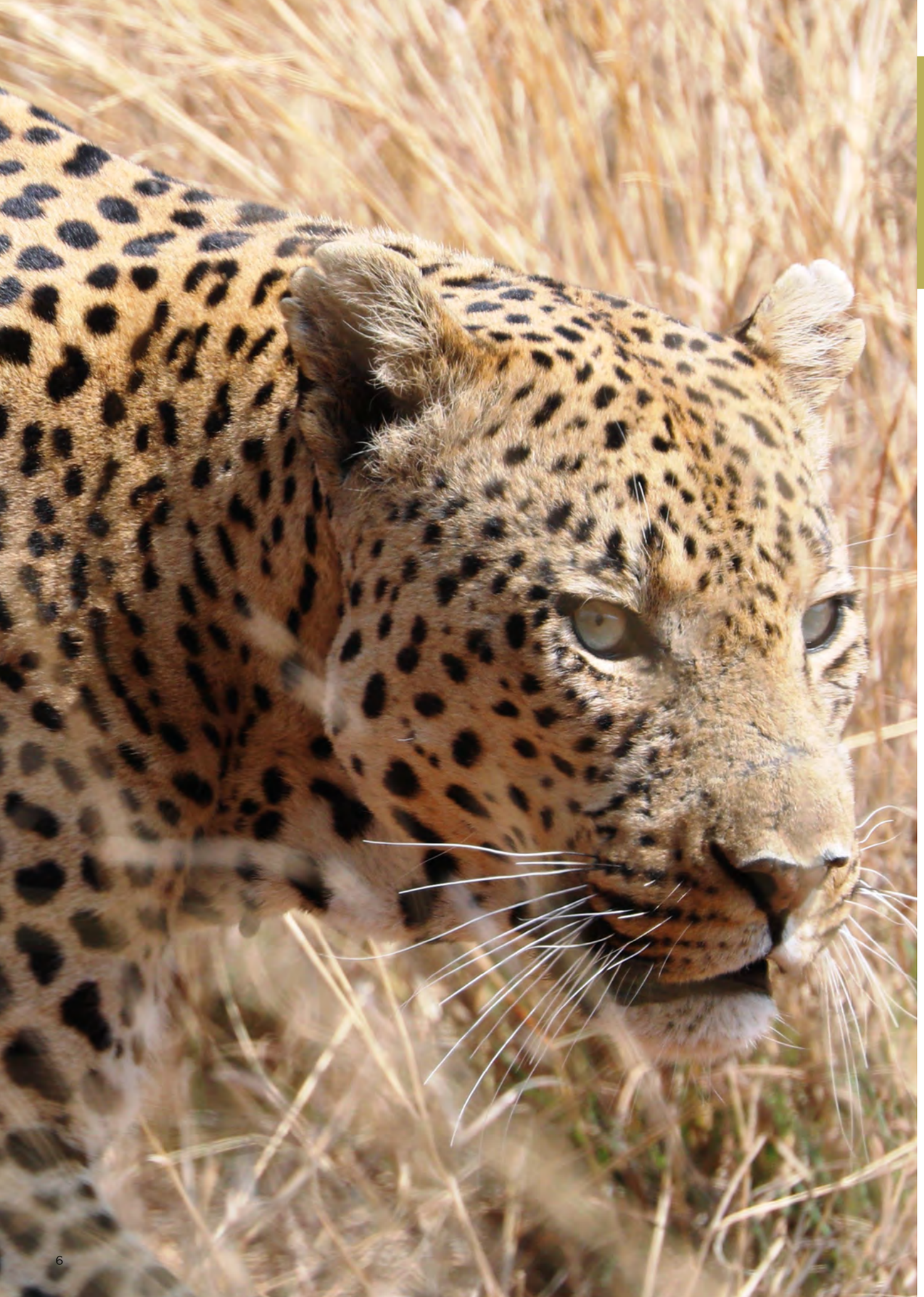
atmosphere interactions, and modelling for agricultural production (with relevance to MPS). MPS, BI and ACaS take advantage of state-of- the-art imaging modalities in the department (e.g. bioimaging using advanced light and electron microscopy techniques), which enable the visualisation of complex, dynamic and 3D protein nanostructures in living cells, tissues and animals. All groups also benefit from access to high processing computing and genomics support for our research, as well as access to supercomputing capabilities.

As part of MPS, Agritechnology in Durham was highlighted in the 2013 Witty report. The EEE group was highlighted for impact and BI was highlighted for outputs in feedback from the last government assessment of research quality (REF 2014), with MPS and EEE highlighted in previous assessments (RAE 2008).

We are a partner in the N8-initiative on Agri-Food Resilience, a cross-disciplinary and cross-University programme on agriculture and food production.

We direct a collaborative network Biotechnology and Bioenergy (BBSRC NIBB) titled: 'Metals in Biology: elements of biotechnology and bio energy'. We also lead a BBSRC doctoral training programme (DTP; with Newcastle and Liverpool); a major feature of the successful BBSRC DTP is Durham's expertise in Agriculture and Food Security. Durham also leads a multi-institute NERC DTP, to which Biosciences is a major contributor. These DTPs, along with regular funding from industry, government, NGOs, and via RCUK (BBSRC, NERC, EPSRC, MRC) and EU grants, ensure a healthy recruitment of research fellows, PDRAs and postgraduates to the department. We have also had recent success in the Global Challenges Research Fund, with a multinational team, led by Durham, being awarded £8M to use chemical and biological tools to identify new targets to combat neglected tropical diseases.

The history of Biosciences in Durham has been one of constant growth and innovation, exploiting new technologies to enhance our understanding of the living world, exemplified by our current status as one of the best-equipped universities in the UK for the imaging of plant and animal cell ultrastructure. Throughout, the integration of cutting-edge research and teaching has remained central to our ethos, ensuring that our graduates are fully equipped to make their own contribution to improving human welfare, maintaining the health of the environment, supporting sustainable agriculture and conserving biodiversity for future generations.



# Ecology, Evolution & Environment (EEE)

Research in the Ecology, Evolution & Environment Research Group (EEE) aims to answer fundamental questions about the processes that have shaped the evolution and distribution of biodiversity in space and time and the consequences of human activity on these processes. Staff members in EEE approach these questions from diverse and often interdisciplinary angles, including fieldwork observing the ecology and behaviour of free-living organisms, high-throughput genomic analyses, and the development and implementation of cutting-edge spatially and/or temporally explicit models.

Within the EEE group, the Conservation Ecology Group (www.conservationecology.org) takes diverse approaches to solve biodiversity conservation issues. The Molecular Ecology Group uses state-of-the-art genomic techniques to test hypotheses about the evolutionary processes shaping biodiversity and contribute to more effective conservation management. Other group members study key ecosystem and land-surface processes to improve regional estimates of land-surface-atmosphere fluxes of gases, such as CO2, or to evaluate ecosystem services.

**Selected Recent Papers:**


Titley, M. et al. & **Willis, S.G.** (2021) Global inequalities and political borders challenge nature conservation under climate change. *Proc Natl Acad Sci (USA).*

P.S. Stewart et al. & **Dawson, W.D.** (2021) Impacts of invasive plants on animal behaviour. *Ecology Letters*

Obiol, J.F. et al. & **Welch, A.J.** (2021). Integrating sequence capture and restriction site-associated DNA sequencing to resolve recent radiations of pelagic seabirds. *Systematic Biology.*

Belletti, B., et al. incl. **Lucas, M.** (2020). More than one million barriers fragment Europe's rivers. *Nature.*

Howard, C. Flather, C.H., & **Stephens, P.A.** (2020) A global assessment of the drivers of threatened terrestrial species richness. *Nature Communications.*

**Drury, J.P.** et al. (2020) Competition and hybridization drive interspecific territoriality in birds. *Proc Natl Acad Sci (USA).*

Shuert, C. et al. & **Twiss, S.D.** (2020) Energetic limits: Defining the bounds and trade-offs of successful energy management in a capital breeder. *Journal of Animal Ecology.*

de Jong, M. et al. & **Hoelzel, A.R.** (2020) Demography and adaptation promoting evolutionary transitions in a mammalian genus that diversified during the Pleistocene. *Molecular Ecology.*


**Group Coordinator:** Dr. Jonathan Drury

**Academic Staff:** Prof. Robert Baxter, Dr John Bothwell, Dr Wayne Dawson, Dr Jonathan Drury, Dr Will Feeney. Prof. Rus Hoelzel, Prof. Steve Lindsay, Prof. Martyn Lucas, Dr Rebecca Senior, Prof. Philip Stephens, Dr Sean Twiss, Dr Andreanna Welch, Prof. Stephen Willis.

Prof. Robert Baxter
**Research Group:** EEE
**Area of Research:**
Climate Change Biology

## Abstract of Research Interests:

The overarching theme of my research over the past 30 years is the eco-physiological responses of plants to environmental perturbation.

My work has mainly focussed upon Arctic and alpine environments in northern Europe, Canada and the USA. It is here that ca. 14% of the world's carbon is stored as organic peat soils of the Arctic and alpine tundra. It is here also that the fastest and largest warming of the lower atmosphere is occurring, threatening to alter the soil-plant-atmosphere interaction and cycling of carbon, potentially releasing huge quantities of carbon that has been stored for millennia into the earth's atmosphere, fuelling yet greater warming.

Recent work has been at the forefront of international efforts to address key factors related to the winter season of the Arctic and how this impacts upon the yearly carbon balance.

Current work, including studies on forest fire ecology in a changing world, based in far eastern Russia is highly interdisciplinary in nature, combining expertise in carbon exchange at a variety of spatial scales from single leaf to landscape level, using state-of-the art techniques, including gas exchange, stable isotopes of carbon and nitrogen, earth observation (including satellite) imagery and landscape-scale modelling.

## Selected Research Publications


1. Street L. Garnett MH. Subke J-A. **Baxter R.** Dean JF & Wookey PA. (2020). Plant carbon allocation drives turnover of old soil organic matter in permafrost tundra soils. *Global Change Biology* 26: 4559-4571.
2. Barrett K. **Baxter R.** Kukavskaya E. Baltzer H. Shetsov E. Buryak L. (2020). Post-fire recruitment failure in Scots pine forests of southern Siberia. *Remote Sensing of Environment*. 237: 111539.
3. Sabater AM. Ward HC. Hill TC. Gornall JC. Wade TJ. Evans JG. Prieto-Blanco A. Disney M, Phoenix GK. Williams M. Huntley B. **Baxter R.** Mencuccini M. Poyatos R (2020). Transpiration from subarctic deciduous woodlands: Environmental controls and contribution to ecosystem evapotranspiration. *Ecohydrology early view* https://doi.org/10.1002/eco.2190
4. Dean JF. van der Velde Y. Garnett MH. Dinsmore KJ. **Baxter R.** Lessels J. Street L. Subke J-A. Tetzlaff D. Washborne I. Wookey PA. Billet MF. (2018). Abundant pre-industrial carbon detected in Canadian Arctic headwaters: implications for the permafrost carbon feedback. *Environmental Research Letters* 13: 034024.
5. Street L. Subke J-A. **Baxter R.** Dinsmore KJ. Knoblauch C. Wookey PA (2018). Ecosystem carbon dynamics differ between tundra shrub types in the western Canadian Arctic. *Environmental Research Letters* 13: 084014.




Dr. John Bothwell
**Research Group:** EEE
**Area of Research:**
Algal Evolution
and Physiology

## Abstract of Research Interests:

Work in my group looks at algal evolution and physiology; findings are being applied to develop the biotechnology and bioenergy potential of the UK's marine resources. Our key achievement is the establishment and development of the green seaweed, Ulva mutabilis, as a model system for the study of macroalgae (Wichard et al., 2015). I'm currently leading an international consortium to sequence the genome of this species (MS in prep) that links Durham with groups internationally in Gent, Belgium, and Jena, Germany, as well as nationally with groups in Cambridge and Birmingham. Aspects of this are also being developed through the N8 Bioeconomy theme, to which I am contributing. An important point to note is that the World's seas are connected in a way that allows seaweed species to operate over very large ranges; this makes algal biology a naturally international field. Accordingly, having established links to groups in India (Mumbai and Bhavnagar), the bioinformatic and analytical resources that we are developing through our Ulva genome project have now led to further links with groups in the US (Rutgers), India (Jammu; funded through an International Fellowship), Japan (applications pending) and Mexico (again, Fellowship applications pending).

## Selected Research Publications


1. Wylot, Marta, Whittaker, David T.E., Wren, Stephen A.C., **Bothwell, John H**., Hughes, Leslie & Griffin, Julian L. (2021). Monitoring apoptosis in intact cells by high resolution magic angle spinning 1 H *NMR spectroscopy. NMR in Biomedicine*
2. Ramessur, Anusha Devi, **Bothwell, John H**., Maggs, Christine A., Gan, Sook Yee & Phang, Siew Moi (2018). Agrobacterium-mediated gene delivery and transient expression in the red macroalga *Chondrus crispus. Botanica Marina* 61(5): 499-510.
3. De Clerck, et al. & **Bothwell, John H**. (2018). Insights into the Evolution of Multicellularity from the Sea Lettuce Genome. *Current Biology* 28(18): 2921-2933.e5.
4. Reddin, Carl J., **Bothwell, John H**., O'Connor, Nessa E. & Harrod, Chris (2018). The effects of spatial scale and isoscape on consumer isotopic niche width. *Functional Ecology* 32(4): 904-915.
5. Trivedi, N, Baghel, R.S., **Bothwell, J.H**., Gupta, V., Reddy, C.R.K., Lali, A.M. & Jha, B. (2016). An integrated process for the extraction of fuel and chemicals from marine macroalgal biomass. *Scientific Reports*, 6, e30728.
6. Reddin, C.J., **Bothwell, J.H**. & Lennon, J.J. (2015). Between-taxon matching of common and rare species richness patterns. *Global Ecology & Biogeography*, 24, 1476-1486.

Dr. Wayne Dawson
**Research Group:** EEE
**Area of Research:**
Ecology of introduced and invasive species

## Abstract of Research Interests:

My research is mainly focused on understanding the causes and consequences of the introduction, establishment and spread of invasive plants. My work on invasions makes use of manipulative experiments, meta-analysis and global databases to better understand the drivers of invasion at multiple spatial and ecological scales. Using the Global Naturalised Alien Flora database (GloNAF, see https://glonaf.org/), I explore macroecological patterns of introduced plant species, and the processes underlying those patterns. My work on invasive plants also includes monitoring invasive plant management on South Georgia island (with RBG Kew), assessing impacts of white ginger on the Atlantic Forest (Brazil, pictured), predicting invasions under future climate change (Norway), and studying impacts of invasive cacti on wild mammals (Kenya).

## Selected Research Publications


1. Stewart, PS, Hill, RA, Stephens, PA, Whittingham, MJ & **Dawson, W** (2021) Impacts of invasive plants on animal behaviour. *Ecology Letters*, 24, 891-907.
2. van Kleunen, M, Xu, X, Yang, Q, Maurel, N, Zhang, Z, **Dawson, W**, Essl, F, Kreft, H, Pergl, J, Pyšek, P, Weigelt, P, Moser, D, Lenzner, B & Fristoe, TS (2020). Economic use of plants is key to their naturalization success. *Nature Communications*, 11, 3201.
3. Caroline, B, Pouteau, R, **Dawson, W,** Pester, M, Ramirez, KS & van Kleunen M (2020). Towards Unraveling Macroecological Patterns in Rhizosphere Microbiomes. *Trends in Plant Science*, 25, 1017-1029.
4. Haeuser, E, **Dawson, W** & van Kleunen, M (2019). Introduced garden plants are strong competitors of native and alien residents under simulated climate change. *Journal of Ecology*, 107, 1328-1342.
5. Moser, D, Lenzner, B, Weigelt, P, **Dawson, W**, Kreft, H, Pergl, J, Pyšek, P, van Kleunen, M, Winter, M, Capinha, C, Cassey, P, Dullinger, S, Economo, EP, García-Díaz, P, Guénard, B, Hofhansl, F, Mang, T, Seebens, H & Essl, F (2018). Remoteness promotes biological invasions on islands worldwide. *Proceedings of the National Academy of Sciences*, 115, 9270.
6. **Dawson, W**, Moser, D, van Kleunen, M, Kreft, H, Pergl, J, Pysek, P, Weigelt, P, Winter, M, Lenzner, B, Blackburn, TM, Dyer, EE, Cassey, P, Scrivens, SL, Economo, EP, Guenard, B, Capinha, C, Seebens, H, Garcia-Diaz, P, Nentwig, W, Garcia-Berthou, E, Casal, C, Mandrak, NE, Fuller, P, Meyer, C & Essl, F (2017). Global hotspots and correlates of alien species richness across taxonomic groups. *Nature Ecology and Evolution,* 1, 0186.




Dr. Jonathan Drury
**Research Group:** EEE
**Area of Research:**
Species Interactions & Evolution

## Abstract of Research Interests:

Competition between species plays a central role in generating the phenotypic diversity we see in nature. My research aims to identify the impact of interspecific competition on trait evolution and range dynamics at multiple scales using a combination of field research on free-living organisms and development and application of phylogenetic comparative methods. My field research on rubyspot damselflies (Hetaerina spp.), for example, shows how behavioural interference between closely related species has shaped the evolution of traits involved in mediating between-species aggression in males. I have demonstrated, for instance, that variation across sites in levels of reproductive interference (interspecific competition for mating opportunities) predicts the magnitude of interspecific aggression, supporting the hypothesis that interspecific territoriality can be an adaptive response to local mate competition between species. Phylogenetic analyses provide another means by which to assess the impact of competition between species on evolution, yet, relative to approaches for analysing traits that evolve independently in every species, there are fewer methods for testing whether traits are involved in interspecific interactions. Research in my lab group thus combines development of new phylogenetic comparative methods with empirical applications to assess impact of competition on trait evolution at macroevolutionary scales.

## Selected Research Publications


1. **Drury, J**., Cowen, M., & Grether, G. (2020). Competition and hybridization drive interspecific territoriality in birds. *PNAS*, 117, 12923-12930.
2. Grether, G., **Drury, J**., Okamoto, K., McEachin, S, & Anderson, C. (2020). Predicting evolutionary responses to interspecific interference in the wild. *Ecology Letters*, 23, 221-230.
3. **Drury, J**., Anderson, C., Cabezas, M., Fisher, J., McEachin, S., & Grether, G. (2019). A general explanation for the persistence of reproductive interference. *The American Naturalist*, 194, 268-275.
4. **Drury, J**., Burns, K., Mason, N., Tobias, J., Shultz, A., & Morlon, H. (2018). Contrasting impacts of competition on ecological and social trait evolution in songbirds. *PLOS Biology*, 16, e2003563.
5. **Drury, J**., Grether, G., Garland Jr., T. & Morlon, H (2018). An assessment of phylogenetic tools for analyzing the interplay between interspecific interactions & phenotypic evolution. *Systematic Biology.*
6. **Drury, J.**, Clavel, J., Manceau, M. & Morlon, H (2016). Estimating the effect of competition on trait evolution using maximum likelihood inference. *Systematic Biology*, 65, 700-710.


Dr. Will Feeney
**Research Group:** EEE
**Area of Research:**
Behavioural and
Evolutionary Ecology

## Abstract of Research Interests:

My research aims to understand how interactions within and between species operate, how they shape and regulate biodiversity, and how they are impacted by environmental change.

I conduct question-driven research that utilizes marine and terrestrial study systems in locations including: Australia, Belize, China, and French Polynesia. I aim to produce studies that combine multiple techniques to comprehensively examine ecological phenomena; however, my work does tend to stem from natural history observations, targeted field experiments, and the analysis of long-term monitoring data. Ongoing projects include: investigating how the relationships between cuckoos and hosts operate in areas where multiple cuckoos and hosts coexist; exploring how mutualisms, such as those between cleaner wrasses and clients or fishes and anemones impact surrounding biodiversity under changing environmental conditions; and working with citizen-scientists to explore how bird communities are affected by environmental change.

## Selected Research Publications

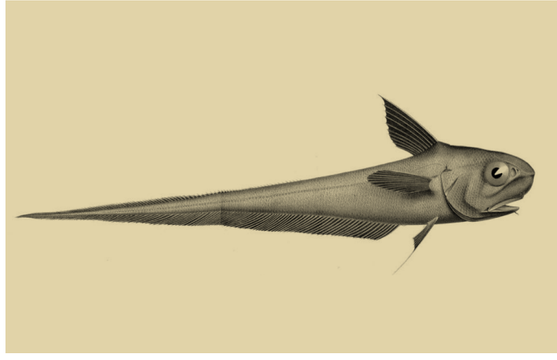

1. Brooker RM, Casey JM, Cowan Z-L, Sih T, Dixson DL, Manica AM, **Feeney WE** (2020) Domestication via the commensal pathway in a fish-invertebrate mutualism. *Nature Communications*. 11: 6253
2. Yang C, Ye P, Huo J, Møller AP, Liang W, **Feeney WE** (2020) Sparrows use a medicinal herb to defend against parasites and increase offspring condition. *Current Biology* 30: R1411-R1412
3. Besson M, **Feeney WE**, Holzer G, Moniz I, François L, Roux N, Brooker RM, Laudet V, Lecchini D (2020) Anthropogenic stressors impact fish sensory development and survival via thyroid disruption. *Nature Communications* 3614
4. **Feeney WE**, Riehl C (2019) Monogamy without parental care? Social and genetic mating systems of avian brood parasites. *Philosophical Transactions of the Royal Society B: Biological Sciences* 374: 20180201
5. **Feeney WE**, Brooker RM, Johnston LN, Gilbert J, Besson M, Lecchini D, Dixson DL, Cowman PF, Manica A (2019) Predation drives recurrent convergence of an interspecies mutualism. *Ecology Letters* 22: 256-264
6. **Feeney WE**, Troscianko J, Langmore NE, Spottiswoode CN (2015) Evidence for aggressive mimicry in an adult brood parasitic bird, and generalised defences in its host. *Proceedings of the Royal Society B: Biological Sciences* 282: 20150795
7. Cortesi F, **Feeney WE**, Ferrari MCO, Waldie PA, Phillips GAC, McClure EC, Sköld HN, Salzburger W, Marshall NJ, Cheney KL (2015) Phenotypic plasticity confers multiple benefits to a mimic. *Current Biology* 25: 949-954
8. **Feeney WE**, Welbergen JA, Langmore NE (2014) Advances in the study of coevolution between avian brood parasites and their hosts. *Annual Review of Ecology, Evolution and Systematics* 45: 227-246
9. **Feeney WE**, Medina I, Somveille M, Heinsohn R, Hall ML, Mulder RA, Stein JA, Kilner RM, Langmore NE (2013) Brood parasitism and the evolution of cooperative breeding in birds. *Science* 342:1506-1508




Prof. Rus Hoelzel
**Research Group:** EEE
**Area of Research:**
Molecular Ecology
& Evolutionary Biology

## Abstract of Research Interests:

Our lab works in the fields of evolutionary biology and population genetics, and especially on the evolution of diversity in natural populations and the relative contributions of natural selection and genetic drift. Research highlights include a series of papers on the intraspecific genetic differentiation of foraging specialists for several dolphin species, suggesting in some cases parapatric population division driven by habitat boundaries, and in another, incipient ecological speciation in sympatry. Other studies have investigated the relationship between historical environmental change and the evolution of population structure and differential population dynamics. These studies often incorporate ancient DNA, and for example included the tracking of the founding and extinction of a population of elephant seals in the Antarctic between 2-10K years ago closely associated with climate change and the gain and loss of suitable breeding habitat. Another highlight has been work on local adaptation based both on the study of immune system genes and on genome scans for loci under selection. For example, we have been studying the adaptation to habitat depth of fish species in the deep sea. In one case, resequencing 60 genomes along a depth gradient together with the generation of an annotated reference genome showed fixed differences in coding genes associated with habitat depth, supported by evidence for strong disruptive selection. Impact from most of these studies has been in the improvement of conservation and management policy.



## Selected Research Publications


1. De Jong, M., Li, Z., Qin, Y., Quemere, E., Baker, K., Wang, W., & **Hoelzel A.R.** (2020) Demography and adaptation promoting evolutionary transitions in a mammalian genus that diversified during the Pleistocene. *Mol. Ecol.* 29, 2777-2792 (From the cover - News & Views: 29, 2765-2767)
2. Moura, A.E., Shreves, K., Pilot, M., Andrews, K.R., Moore, D.M., Kishida, T., Moller, L., Natoli, A., Gaspari, S., McGowen, M., Chen, I., Gray, H., Gore, M., Culloch, R.M., Kiani. M.S.Willson, M.S., Bulushi, A., Collins, T., Baldwin, R., Wilson, A., Minton, G., Ponnampalam L, & **Hoelzel, A.R.** (2020) Phylogenomics of the genus Tursiops and closely related Delphininae reveals extensive reticulation among lineages and provides inference about eco-evolutionary drivers. *Mol. Phylo & Evol.* 146, 106756
3. Gkafas, G.A., de Jong, M., Exadactylos, A., aga, J.A., Aznar, F.J. & **Hoelzel, A.R.** (2020) Sex-specific impact of inbreeding on pathogen load in the striped dolphin. *Proc. Royal Soc. B* 287, 20200195
4. Goncalves da Silva, A., Barendse, B., Kijas, J., England, P.R., & **Hoelzel, A.R.** (2019) Genomic data suggest environmental drivers of fish population structure in the deep sea; a case study for the orange roughy (Hoplostethus atlanticus) *J. Applied Ecol.* 57, 296-306.
5. Gaither, M.R., Gkafas, G.A., de Jong. M., Sarigol, F., Neat, F., Regnier, T., Moore, D., Gröcke, D.R., Hall, N., Liu, X., Kenny, J., Lucaci, A., Hughes, M., Haldenby, S., **Hoelzel, A.R.** (2018) Genomics of habitat choice and adaptive evolution in the deep sea. *Nature Ecology & Evolution* 2, 680–687
6. Gray HWI, Nishida S, Welch AJ, Moura AE, Tanabe S, Kiani, MS, Culloch R, Moller L, Natoli A, Ponnampalam LS, Minton G, Gore M, Collins T, Willson A, Baldwin R. **Hoelzel AR** (2018) Cryptic Lineage Differentiation Among Indo-Pacific Bottlenose Dolphins (Tursiops aduncus) in the Northwest Indian Ocean. *Mol Phylogenet Evol.* 122, 1-14.

Prof. Steve Lindsay
**Research Group:** EEE
**Area of Research:**
Vector-borne diseases

## Abstract of Research Interests:

Steve Lindsay is a public health entomologist with a passion for studying some of the world's most important mosquito-transmitted borne diseases, including malaria and dengue. He has considerable experience in medical entomology, parasitology, ecology and clinical epidemiology. His particular interest is in the design of simple tools for the control of mosquito-transmitted diseases and he has carried out field studies in The Gambia, Burkina Faso, China, Ethiopia, Kenya, Laos PDR, Tanzania, Thailand and Uganda over the last 35 years. He has published over 250 peer-reviewed papers, many in major international journals. He was in one of the leading group of researchers in the 1980s that demonstrated that insecticide-treated bednets protected children against malaria. Since then he has helped develop and carry out field trials of topical repellents, larval source management, combinations of long-lasting insecticidal nets and indoor residual spraying, new combination mosquito nets and house screening. Recently, he has worked with a team from the London School of Hygiene and Tropical Medicine (LSHTM) and the Medical Detection Dog charity to show that trained dogs can identify people infected with malaria by their smell. This team is currently engaged in research to determine whether dogs can detect people with COVID-19 by their smell. He is an advocate for integrated vector management and the improvement of housing as a protection against vector-borne diseases. He has an Honorary Chair in Public Health Entomology at the LSHTM. He has helped write numerous policy documents for the World Health Organisation (WHO) including being one of the two lead writers for WHO's global strategy for vector control, the Global Vector Control Response 2017-30.

## Selected Research Publications


1. **Lindsay, S.W.** et al. (2020). Recommendations for building out mosquito-transmitted diseases in sub-Saharan Africa: the DELIVER mnemonic. *Philosophical Transactions B.* (in press).
2. Tusting, L.S. et al. & **Lindsay, S.W.** (2020). Environmental temperature and growth faltering in African children: a cross-sectional study. *Lancet Planetary Health,* 4, e116-23.
3. Tusting, L.C. et al. **Lindsay, S.W.** & Bhatt, S. Housing and child health in sub-Saharan Africa: a multi-country analysis (2020). *PLoS Medicine*, 17, e1003055.
4. Tusting, L.S. et al. **Lindsay, S.W.**, Gething, P.W. & Bhatt, S. (2019). Mapping changes in housing in sub-Saharan Africa from 2000 to 2015. *Nature.* 568, 391-394.
5. Guest, C., Pinder, M., Doggett, M., Squires, C., Affara, M., Kandeh, B., Dewhirst, S. Morant, S.V., D'Alessandro, U., Logan, J.G. & **Lindsay, S.W.** (2019). Trained dogs identify people with malaria parasites by their odour. *Lancet Infectious Diseases*, 19, 578-580.
6. **Lindsay, S.W.** et al. (2019). Reduced mosquito survival in metal-roof houses may contribute to a decline in malaria transmission in sub-Saharan Africa. *Nature Scientific Reports,* 9, 7770.
7. Tiono, A.B. et al. & **Lindsay. S.W.** (2018). Efficacy of Olyset Duo, a bednet containing both pyriproxyfen and permethrin, versus a permethrin-only net against clinical malaria in an area with highly pyrethroid-resistant vectors in rural Burkina Faso: a cluster-randomized controlled trial. *The Lancet.* 18, 31711-2.




Prof. Martyn Lucas
**Research Group:** EEE
**Area of Research:**
Aquatic Animal Ecology

## Abstract of Research Interests:

My group's research centres around the behaviour, ecology and evolution of aquatic animals, in particular, the impacts of anthropogenic changes on them, and on the measures needed for their conservation or management. We have particular expertise in spatial ecology and the application of telemetry methods to study migration, dispersal, habitat use and activity patterns. Our research has highlighted migration as an important tactic for a much wider range of freshwater fishes than previously considered (when species such as salmon were overemphasized, to the detriment of natural biodiversity). With colleagues, nationally and internationally, this research has stimulated policy measures which take better account of the movement needs of fishes in inland aquatic ecosystems, and is facilitating ecological restoration.

The group's research also includes studies on impacts of invasive species, ecology of threatened species and the role of behavioural and ecological specialisation in evolutionary processes. We collaborate internationally on a wide range of field-based projects and in recent years have worked in Svalbard, West and South Africa, the North American Great Lakes and South and East Asia. A current large project in which Durham is a major partner (Biosciences, together with Business and Geography) is the H2020 funded Adaptive Management of Barriers in European Rivers. AMBER typifies the applied ecology direction and policy relevance of part of our research, both in terms of identifying environmental impacts on aquatic ecosystems, and helping to develop solutions. Regions such as Europe have an industrial legacy of engineered river infrastructure and we are making a major contribution to cost-effective, evidence-based adaptive management and river restoration to support biodiversity needs.

## Selected Research Publications

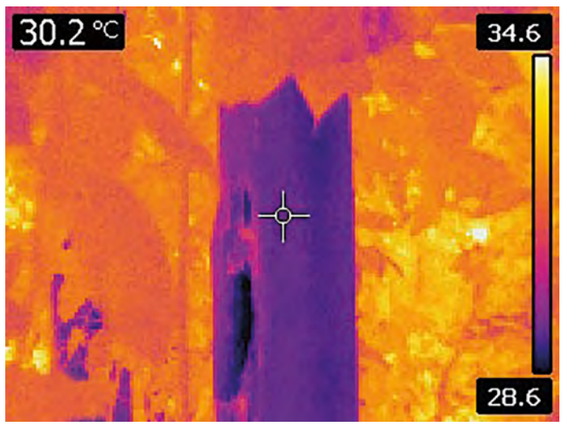

1. Galib, S.M., Findlay, J.D.S. & **Lucas, M.C.** (2021) Strong impacts of signal crayfish invasion on upland stream fish and invertebrate communities. *Freshwater Biology 66*, 223-240
2. Lothian, A.J., Schwinn, M., Anton, A.H., ..... & **Lucas, M.C.** (2020) Are we designing fishways for diversity? Potential selection on alternative phenotypes resulting from differential passage in brown trout. *Journal of Environmental Management,* 262, e110317.
3. Silva, A.T., **Lucas, M.C**. et al. (2018). The future of fish passage science, engineering, and practice. *Fish and Fisheries,* 19, 340-363.
4. Hawley, K.L., Rosten, C.M., Haugen, T.O., Christensen, G. & **Lucas, M.C.** (2017). Freezer on, lights off! Environmental effects on activity rhythms of fish in the Arctic. *Biology Letters,* 13, e20170575.
5. Silva, S., Macaya, C. & **Lucas, M.C.** (2017) Energetically efficient behaviour may be common, but it is not universal in biology: a test of selective tidal stream transport in a poor swimmer. *Marine Ecology Progress Series,* 584, 161-174.
6. Hawley, K.L., Rosten, C.M., Christensen, G. & **Lucas, M.C.** (2016) Fine-scale behavioural differences distinguish resource use by ecomorphs in a closed ecosystem. *Scientific Reports,* 6, e24369.
7. Rosten, C.M., Gozlan, R.E & **Lucas, M.C.** (2016) Allometric scaling of intraspecific space use. *Biology Letters* 12, e20150673.


Dr. Rebecca Senior
**Research Group:** EEE
**Area of Research:**
Conservation & Global Change Ecology

## Abstract of Research Interests:

I am interested in harnessing new technologies and big data to tackle the big issues in conservation and global change. Most of my research to date has focussed on the interactions between land-use change and climate change in tropical rainforests. I am particularly keen to understand the different spatial and temporal scales at which climate change impacts biodiversity. Thus, my work has taken me from the scale of a frog – measuring microclimates in Borneo using dataloggers and thermal imagery – up to the scale of landscapes, modelling the extent to which current forest cover in the tropics can connect species to cooler temperatures.

More recently, my work has begun to explore other major drivers of biodiversity loss, including the role of aesthetic value in driving wildlife trade. Beyond merely outlining problems, I am passionate about solutions and, in particular, informing cost effective and efficient conservation practice. I have collaborators all over the world, for projects with a strong focus on fieldwork, others with an emphasis on modelling and GIS, and everything in between.




## Selected Research Publications


1. Lin, B., Dietrich, M. L., **Senior, R. A.** & Wilcove, D. S. (in press). A better classification of "wet markets" is key to safeguarding human health and biodiversity. *The Lancet Planetary Health*
2. **Senior, R. A.**, Hill, J. K. & Edwards, D. P. (2019a). Global loss of climate connectivity in tropical forests. *Nature Climate Change*, 9(8), 623–626. doi:10.1038/s41558-019-0529-2
3. **Senior, R. A.**, Hill, J. K. & Edwards, D. P. (2019b). ThermStats: An R package for quantifying surface thermal heterogeneity in assessments of microclimates. *Methods in Ecology and Evolution*, 10(9), 1606–1614. doi:10.1111/2041-210X.13257
4. Jucker, T., **Senior, R. A.**, Shenkin, A. F., Svátek, M. & Coomes, D. A. (2019). A research agenda for microclimate ecology in human-modified tropical forests. *Frontiers in Forests and Global Change,* 2. doi:10.3389/ffgc.2019.00092
5. **Senior, R. A.**, Hill, J. K., Benedick, S. & Edwards, D. P. (2018). Tropical forests are thermally buffered despite intensive selective logging. *Global Change Biology,* 24(3), 1267–1278. doi:10.1111/gcb.13914
6. **Senior, R. A.**, Hill, J. K., González del Pliego, P., Goode, L. K. & Edwards, D. P. (2017). A pantropical analysis of the impacts of forest degradation and conversion on local temperature. *Ecology and Evolution,* q7(19), 7897–7908. doi:10.1002/ece3.3262




Prof. Phil Stephens
**Research Group:** EEE
**Area of Research:**
Applied Population Ecology

## Abstract of Research Interests:

I use predictive population ecology to inform biodiversity conservation and wildlife management. In pursuit of a better science of predictive population ecology, my research is focused on four interacting themes.

First, to make predictions, ecologists need a robust understanding of available data. Ecological data are noisy, however, demanding a careful treatment of uncertainty and cautious inference. I am interested in understanding uncertainty and its sources in ecological data, and in methods to make robust inferences from data. Second, baseline data often come from biodiversity monitoring, and I am interested in monitoring techniques and their interpretation. Third, there is no fundamental theory to guide predictions about how populations will respond to change – but there is a fundamental theory to make predictions about how individuals will respond to change: natural selection.

By understanding how natural selection operates and influences individual strategies, we can strengthen the predictions we make about populations, whose fates are the sum of the fates of their constituent individuals. Fourth, populations do not exist in a vacuum, so I am also interested in species interactions – especially predator-prey interactions and their energetic underpinnings. Recent and ongoing work has been funded by NERC, the USDA Forest Service and the European Food Safety Authority. I am a founder and director of MammalWeb (www.mammalweb.org), a citizen science project that enables members of the public to contribute to monitoring mammals across the UK and now also in continental Europe.

## Selected Research Publications


1. Ferretti, F., Lovari, S., Lucherini, M., Hayward, M.W. & **Stephens, P.A**. (2020) Only the largest terrestrial Carnivores increase their dietary breadth with increasing prey richness. *Mammal Review* 50, 291-303
2. Hsing, P.-Y... & **Stephens, P.A**. (2020) Citizen scientists: school students conducting, contributing to and communicating ecological research - experiences of a school-university partnership. *School Science Review* 101, 67-74
3. Howard, C., Flather, C.H. & **Stephens, P.A.** (2020) A global assessment of the drivers of threatened terrestrial species richness. *Nature Communications* 11, 993
4. Howard, C., Flather, C.H. & **Stephens, P.A.** (2019) What drives at-risk species richness? Environmental factors are more influential than anthropogenic factors or biological traits. *Conservation Letters* 12, e12624
5. **Stephens, P.A.**, Vieira, M.V., Willis, S.G. & Carbone, C. (2019) The limits to population density in birds and mammals. *Ecology Letters*, 22, 654-663
6. **Stephens, P.A.** (2018) Ecology: Luck, Scarcity, and the Fate of Populations. *Current Biology* 28, R1384-1386
7. **Stephens, P.A.** et al. (2016) Consistent response of bird populations to climate change on two continents. *Science* 352, 84-87


Dr. Sean Twiss
**Research Group:** EEE
**Area of Research:**
Animal Behaviour:
Individual differences in behaviour and stress reactivity

## Abstract of Research Interests:

My work involves empirical, field-based studies of the causes and consequences of individual variation in behaviour. My primary research centres on long-term studies of breeding grey seals; providing novel insights into intrinsic and extrinsic causes of individual variation in behaviour and success that drive population dynamics, including; fine scale site fidelity and philopatry, spatio-temporal social and kin associations, how local habitat heterogeneity determines pupping site preferences and success, mate choice and the patterns of male behaviour and reproductive success. My research team combines ethological approaches with spatial ecological techniques to examine individual behavioural decisions within their physical, social and genetic contexts, thereby understanding not just the behavioural decisions made by individuals but their behavioural options too.

More recently, my work has been the first to demonstrate the existence of behavioural types ('personalities') in free ranging marine mammals, and fitness consequences of such individual variation, demonstrating a selective mechanism that can maintain a spectrum of behavioural types within wild populations. We are also using heart rate monitors (see image) to investigate the physiological underpinnings of behavioural types in wild seals. This novel research has the potential to reveal how individuals vary in their capacity to cope with stressors, both natural (e.g. conspecific aggression) and anthropogenic (e.g. ecotourism), and the fitness consequences of such differences. Quantitatively assessing how individual animals react to, and cope with, stress is critical in determining 'acceptable' levels of disturbance in situations where human-wildlife interactions are inevitable.

## Selected Research Publications


1. **Twiss, Sean D.**, Shuert, Courtney R., Brannan, Naomi, Bishop, Amanda M. & Pomeroy, Patrick. P. (2020). Reactive stress-coping styles show more variable reproductive expenditure and fitness outcomes. *Scientific Reports* 10(1): 9550.
2. Shuert, CR, Halsey, LG, Pomeroy, PP & **Twiss, SD** (2020). Defining the bounds and trade-offs of successful energy management in a capital breeder. *Journal of Animal Ecology.*
3. Shuert, Courtney R., Pomeroy, Patrick P. & **Twiss, Sean D.** (2020). Coping styles in capital breeders modulate behavioural trade-offs in time allocation: assessing fine-scale activity budgets in lactating grey seals (*Halichoerus grypus*) using accelerometry and heart rate variability. *Behavioral Ecology and Sociobiology* 74(1): 8.
4. Halsey, Lewis G., Green, Jonathan A., **Twiss, Sean D.**, Arnold, Walter, Burthe, Sarah J., Butler, Patrick J., Cooke, Steven J., Grémillet, David, Ruf, Thomas, Hicks, Olivia, Minta, Katarzyna J., Prystay, Tanya S., Wascher, Claudia A. F. & Careau, Vincent (2019). Flexibility, variability and constraint in energy management patterns across vertebrate taxa revealed by long-term heart rate measurements. *Functional Ecology* 33(2): 260-272.
5. Robinson Kelly J., Hazon Neil, **Twiss Sean D.** & Pomeroy Patrick P. (2019). High oxytocin infants gain more mass with no additional maternal energetic costs in wild grey seals (*Halichoerus grypus*). *Psychoneuroendocrinology* 110: 104423.
6. Shuert, Courtney R., Pomeroy, Patrick P. & **Twiss, Sean D.** (2018). Assessing the utility and limitations of accelerometers and machine learning approaches in classifying behaviour during lactation in a phocid seal. *Animal Biotelemetry* 6(1): 14.




Dr. Andreanna Welch
**Research Group:** EEE
**Area of Research:**
Ecological & Evolutionary Genetics

## Abstract of Research Interests:

Research in my lab broadly centers on gaining a better understanding of the amazing biodiversity that we see around us today, how this biodiversity has changed through time, and how we can protect it for the future. We work on multiple scales at the intersection between ecology, evolution, cellular biology, physiology, and conservation.
For example, we investigate questions such as:

1. What are the evolutionary relationships between recognized (and cryptic) species?
2. How does ecology play a role in the divergence of populations and the process of speciation?
3. How do ecological interactions influence competition, coexistence, and ecosystem services?
4. How do species become adapted to their environment?
5. How do species respond to natural and anthropogenic changes through time?
6. What species have been lost, and what mechanisms drive extinction?

To address these questions we employ a variety of genetic techniques, ranging from DNA barcoding, metagenomics, transcriptomics, and targeted sequencing, to full genome sequencing. We incorporate an explicit temporal perspective by sequencing ancient DNA from specimens up to thousands of years old. This integrative approach provides the power necessary to address these complex and critically important questions.

## Selected Research Publications


1. Jarrett C, Powell LL, McDevitt H, Helm B, **Welch AJ**. 2020. Bitter fruits of hard labour: Diet metabarcoding and telemetry reveal that urban songbirds travel further for lower-quality food. *Oecologia* 193:377-388
2. Cassin-Sackett L, **Welch AJ**, Venkatraman M, Callicrate TE, Fleischer RC. 2019. The Contribution of Genomics to Bird Conservation. In: Kraus R (ed): Avian Genomics in Ecology and Evolution: From the lab into the wild. Springer International Publishing (Switzerland).
3. Michael N, Torres R, **Welch AJ**, Adams J, Bonillas-Monge ME, Felis J, López-Márquez LA, Martínez-Flores A, Wiley AE. 2018. Carotenoid ornaments reflect foraging propensity in the brown booby (*Sula leucogaster*): revisiting the rarity hypothesis using stable isotopes and GPS tracking. *Biology Letters* 4:20180398.
4. Ibarra-Laclette E, Lyons E, Hernández-Guzmán G, Pérez-Torres CA, Carretero-Paulet L, Chang T-H, Lan T, **Welch AJ**, et al. (2013) Architecture and evolution of a minute plant genome. *Nature*, 498, 94-98.
5. Miller W, Schuster SC, **Welch AJ**, et al. (2012) Polar and brown bear genomes reveal ancient admixture and demographic footprints of past climate change. *PNAS*, 109, E2382-E2390.
6. **Welch AJ**, Wiley AE, James HF, Ostrom PH, Southon JR, Stafford TW, Fleischer RC. (2012) Ancient DNA reveals genetic stability despite demographic decline: 3,000 years of population history in the endemic Hawaiian petrel. *Molecular Biology and Evolution*, 29, 3729-3740.
7. **Welch AJ**, Yoshida AA, Fleischer RC. (2011) Mitochondrial and nuclear DNA sequences reveal recent divergence in morphologically indistinguishable petrels. *Molecular Ecology*, 20, 1364-1377.

Prof. Stephen Willis
**Research Group:** EEE
**Area of Research:**
Conservation & Climate Change Biology

## Abstract of Research Interests:

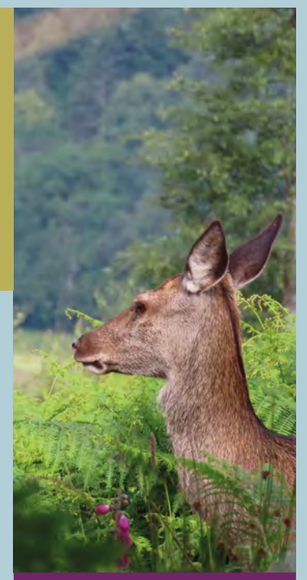
My research explores the impacts of environmental change, particularly global climate change, on ecosystems and the mechanisms by which environmental change acts upon species. Most of my research involves ecological modelling, using both statistical and process-based models and often utilising remote-sensed data.

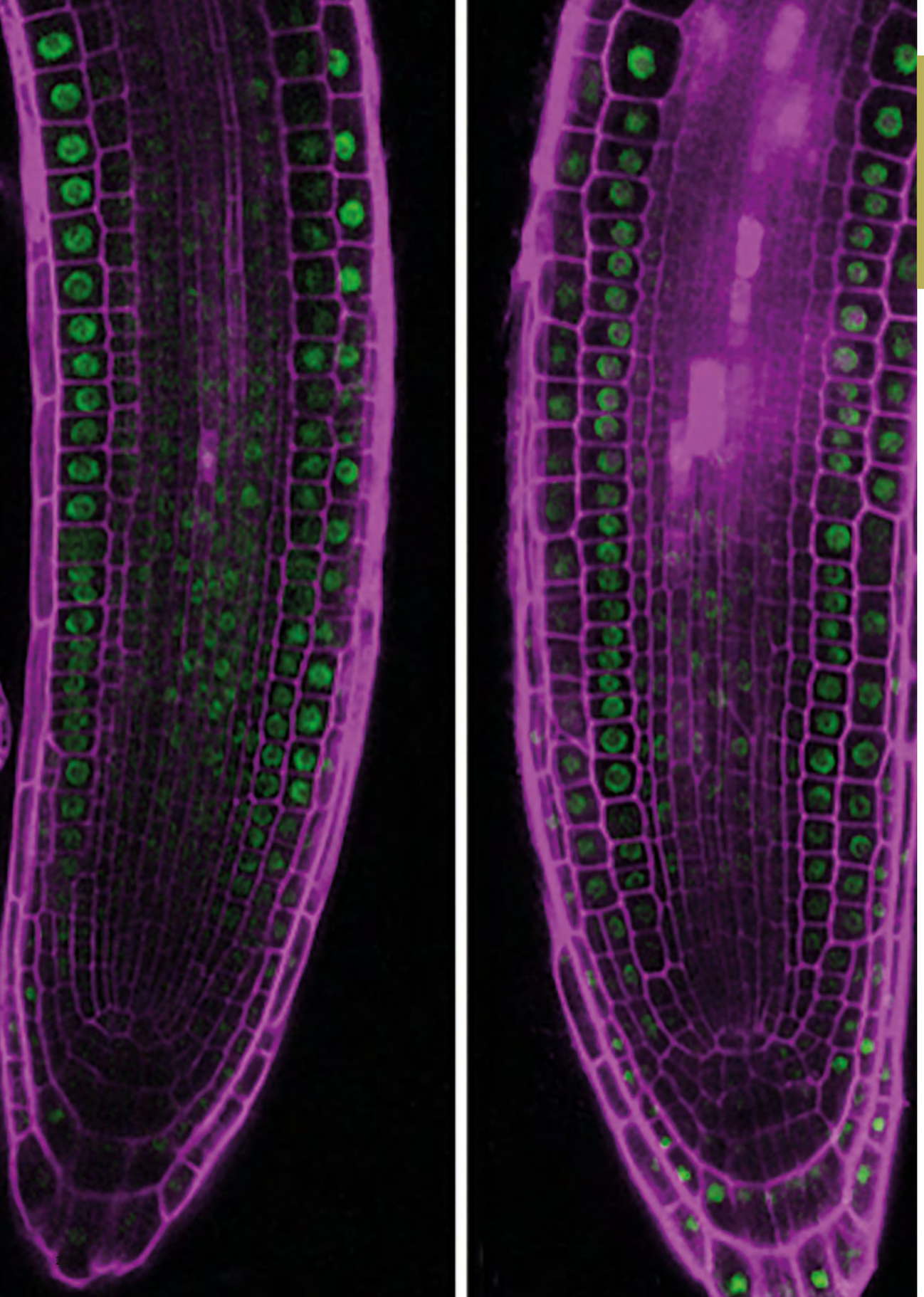
My research group (www.conservationecology.org) typically comprises 1-2 PDRAs and circa 10 postgraduates for whom I act as the primary supervisor. Part of the group's research is developing techniques to incorporate environmental change into realistic models of species range shift and migration. The results of such models are then used to inform the management of networks of conservation sites and in individual species conservation.

Our research has been used on several occasions to direct policy decisions at an international level. My research necessitates collaboration with research institutions worldwide, as well as with non-academic conservation bodies. In additional to modelling work, I also supervise conservation ecology projects with a strong field-based focus. Ongoing current field projects include diverse topics, such as the drivers of global wildlife tourism, the impact of national borders in conservation under climate change and simulating the migration of inter-continental migratory bird species.

## Selected Research Publications


1. Bradfer-Lawrence, Gardner … & **Willis** & Dent (2020) Guidelines for the use of acoustic indices in environmental research. *Methods in Ecology and Evolution*, 10, 1796-1807.
2. Brooker, Stephens, Whittingham & **Willis** (2020) Automated detection and classification of birdsong: An ensemble approach. *Ecological Indicators*, 117, 106609.
3. Bradfer-Lawrence, Bunnefeld, Gardner, **Willis** & Dent (2020) Rapid assessment of avian species richness and abundance using acoustic indices. *Ecological Indicators*, 115, 106400.
4. Howard, Stephens … & **Willis** (2020) Disentangling the relative roles of climate and land cover change in driving the longöterm population trends of European migratory birds, *Diversity and Distributions*
5. Hof, Voskamp, … & **Willis** & Hickler (2019) Bioenergy cropland expansion may offset positive effects of climate change mitigation for global vertebrate diversity. *Proceedings of the National Academy of Science*, USA, 115, 13294-13299.
6. Stephens, Vieira, **Willis** & Carbone (2019) The limits to population density in birds and mammals. *Ecology Letters* 22, 654-663.
7. Howard, Stephens & **Willis** (2018) Flight range, fuel load and the impact of climate change on the journeys of migrant birds. *Proceedings Royal Soc. B: Biological Sciences* 285, 20172329.
8. Burgess, Smith … & **Willis** & Phillimore (2018) Tritrophic phenological match-mismatch in space and time. *Nature Ecology and Evolution,* 2, 970–975.
9. Stephens, Mason … & **Willis** (2016) Consistent biodiversity response to climate change across two continents. *Science*, 352, 84-87.



# Molecular Plant Sciences (MPS)

Durham has a long-standing record of research in the plant sciences, and is currently supported by significant levels of external grant income from UKRI and industry, with world-leading publications.

Areas of particular research strength are: plant responses to environmental (biotic and abiotic) stresses; developmental biology, with a focus on genetic and epigenetic control of gene expression linked to the development of tissues and organ systems; and cell biology with an emphasis on membrane-cytoskeleton interactions and plant cell signalling, including understanding the architecture and regulation of gene-hormone and second messenger signalling systems. An important feature of our research is its cross-disciplinary nature, fostered through the **Durham Centre for Crop Improvement Technology**; with industry; and with a range of UK and overseas academic institutions.

**Selected Recent Papers:**


Srivastava, M., et al. & **Sadanandom, A**. (2020). SUMO Conjugation to BZR1 Enables Brassinosteroid Signaling to Integrate Environmental Cues to Shape Plant Growth. *Current Biology* 30: 1410-1423.e3.

Wang, M. et al. & **Lindsey, K**., Zhang, X. (2019). Reference genome sequences of two cultivated allotetraploid cottons, Gossypium hirsutum and Gossypium barbadense. *Nature Genetics* 51: 224-229.

Wang, P. et al. & **Hussey, P.J.** (2019). Plant AtEH/Pan1 proteins drive autophagosome formation at ER-PM contact sites with actin and endocytic machinery. *Nature Communications* 10: 5132.

Smit, M. et al. & **Etchells, J. P.** (2020). A PXY-mediated transcriptional network integrates signaling mechanisms to control vascular development in Arabidopsis. *The Plant Cell* 32: 319-335.

**Liu, J.**, Lenzoni, G. & **Knight, M.R.** (2020). Design principles for decoding calcium signals to generate specific gene expression via transcription. *Plant Physiology* 182(4): 1743-1761.

Panter, P.E. et al & **Knight, H.** (2019). MUR1-mediated cell-wall fucosylation is required for freezing tolerance in Arabidopsis thaliana. *New Phytologist* 224: 1518-1531.


**Group Coordinator:** Professor Keith Lindsey

**Academic Staff:** Dr Adrian Brennan, Dr Stephen Chivasa, Dr Peter Etchells, Dr Elaine Fitches, Professor Patrick Hussey, Dr Heather Knight, Professor Marc Knight, Professor Keith Lindsey, Dr Junli Liu, Dr Miguel de Lucas, Professor Ari Sadanandom.

Dr. Adrian Brennan
**Research Group:** MPS
**Area of Research:**
Ecological Genetics

## Abstract of Research Interests:

I am interested in the evolution of genomes and quantitative trait architecture in response to a range of selection pressures. I have experience studying this question in a range of contexts including; hybridization, speciation, invasiveness, and breeding systems in several plant species as part of various research projects.

My current research focuses on Linum bienne (pale flax), the wild crop relative of Linum usitatissimum (flax/linseed) investigating how genomes change as a result of domestication and cultivation. Together with collaborators, we have built a wild and cultivated sample collection spanning the European range of the species. We are examining quantitative genetic variation of traits of adaptive and agronomic interest such as flowering time and stem fibres using a combination of glasshouse and field experiments and we are investigating molecular genetic variation through high-throughput DNA and RNA sequencing. We are preparing a de novo genome assembly of pale flax against which to compare the published cultivated flax genome. The public can view this research in action in the Biosciences demonstration plots at the Botanic Garden.

These flax species are part of a larger genus of around 180 species with a centre of diversity in Europe. Another area of research involving Linum, is based upon the distylous breeding system shown by many species in the genus. Distyly is a floral polymorphism that promotes disassortative mating through the complementary placement of male and female floral organs in each floral form. We have investigated the development and expression of distyly traits in Linum tenue (slender flax).

My other recent collaborations have been to investigate the rapid evolution of traits and reproductive isolation in invasive Centaurea solstitialis (yellow starthistle) across different continents and to investigate genetic variation of wild crop relatives and landraces of wheat and chickpea and their hybrid compatibility with cultivars.

I supervise graduate students as part of these projects and my research feeds into my undergraduate teaching in L2 Evolution, L3 Genomics, and L3/4 Genes and Diversity Workshop.

### Selected Research Publications


1. Gu X., **Brennan A.C.**, Wei W., Guo G., Lindsey K. (2020). Vesicle transport in plants: A revised phylogeny of SNARE proteins. *Evolutionary Bioinformatics* doi: 10.1177/1176934320956575/
2. Landoni B., Viruel J., Gomez R., Allaby R.G., **Brennan A.C.**, Pico F.X. & Perez-Barrales R. (2020). Microsatellite marker development in the crop wild relative Linum bienne using genome skimming. *Applications in Plant Sciences* 8(5): e11349.
3. Walter G.M., Abbott R.J., **Brennan A.C.**, Bridle J.R., Chapman M., Clark J., Filatov D., Nevado B., Ortiz-Barrientos D., & Hiscock S.J. (2020). Senecio as a model system for integrating studies of genotype, phenotype and fitness. *New Phytologist* 226, 326-344.
4. **Brennan A.C.**, Hiscock S.J & Abbott R.J (2019). Completing the hybridization triangle: the inheritance of genetic incompatibilities during homoploid hybrid speciation in ragworts (Senecio). *AoB PLANTS* 11: ply078.


Image legend: Map showing recorded Linum bienne locations. © GBIF. Inset shows flower



Dr. Steve Chivasa
**Research Group:** MPS
**Area of Research:**
Plant Molecular Biology
& Algal Biology

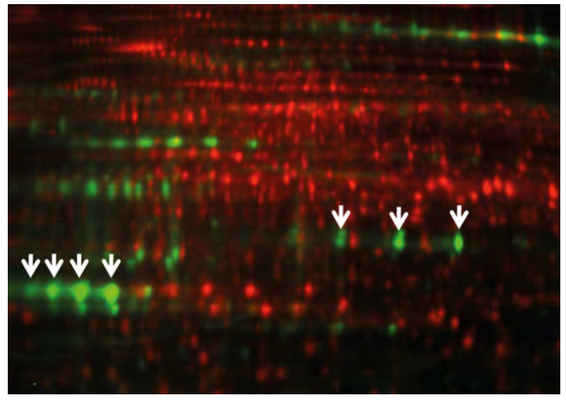
## Abstract of Research Interests:

Fundamental research in the group focuses on understanding cell-cell communications initiated at the cell surface during plant adaptive responses to stress. Current projects include programmed cell death and pathogen defence systems. We use proteomics (2D-DiGE, iTRAQ, MuDPIT) and metabolomics to identify extracellular signals and signal-regulatory proteins intercepted during exposure to stress. A large number of metabolites and proteins have been identified, with selected targets being studied in detail using molecular techniques. The underpinning hypothesis tested across the research themes is that plant cells use extracellular signalling as a mechanism for collective decision-making akin to a democratic quorum-sensing strategy. This has led to translational research projects in the drought stress and herbicide resistance areas. In the drought area, we are using two model plant systems: the drought-sensitive Arabidopsis thaliana and drought-tolerant sorghum, which is an important cereal crop. Research on sorghum is in collaboration with colleagues in South Africa.

In the herbicide area, we are focusing on glyphosate resistance, using several species of Conyza to understand modes of resistance and designing new ways to overcome the resistance. Novel metabolites critical in cell death signalling have been identified and their utility as compositions of a Herbicide Booster Technology is being explored. Partnerships with industry for exploitation of the applied research and protection of IP are being pursued as a strategic pathway to impact. Finally, microalgal and cyanobacterial systems are also being used as simple experimental systems to understand how these processes are regulated in higher plants. We are working with various species of Synechosystis and Chlamydomonas reinhardtii. The work has been supported by grants from the BBSRC, The Royal Society, Gatsby Foundation, Research England, and Innovate UK.

### Selected Research Publications


1. **Chivasa S**, Goodman HL (2020). Stress-adaptive gene discovery by exploiting collective decision-making of decentralised plant response systems. *New Phytologist* doi.org/10.1111/nph.16273
2. González-Torralva, F., Brown, A.P. & **Chivasa, S**. (2017). Comparative proteomic analysis of horseweed (Conyza canadensis) biotypes identifies candidate proteins for glyphosate resistance. *Scientific Reports* 7, 42565.
3. Smith, S.J., Kroon, J.T.M., Simon, W.J., Slabas, A.R. & **Chivasa, S.** (2015). A novel function for Arabidopsis CYCLASE1 in programmed cell death revealed by iTRAQ analysis of extracellular matrix proteins. *Molecular & Cellular Proteomics,* 14, 1556-1568.
4. **Chivasa, S.**, Tome, D.F.A., Hamilton, J.M., Slabas, A.R. (2011). Proteomic analysis of extracellular ATP-regulated proteins identifies ATP synthase ß-subunit as a novel plant cell death regulator. *Molecular & Cellular Proteomics*, 10, M110.003905.
5. **Chivasa, S.**, Simon, J.W., Murphy, A.M., Lindsey, K., Carr, J.P., Slabas, A.R. (2010). The effects of extracellular ATP on the tobacco proteome. *Proteomics*, 10, 235-244.
6. **Chivasa, S.**, Murphy, A.M., Hamilton, J.M., Lindsey, K., Carr, J.P., Slabas, A.R. (2009). Extracellular ATP is a negative regulator of defence gene expression and disease resistance in plants. *Plant Journal*, 60, 436-448.

Dr. Peter Etchells
**Research Group:** MPS
**Area of Research:**
Plant Developmental Biology

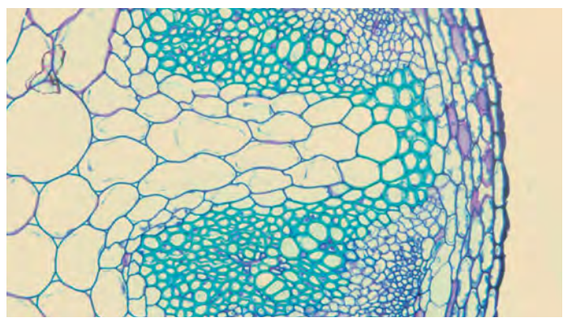
## Abstract of Research Interests:

Work in our lab is characterised by the integration of classical genetics, plant anatomy, and transcriptomic approaches to study gene function during plant development. We aim to understand how plant vascular tissues are specified in space and time, and how once established, the vascular tissue expands via a series of coordinated cell divisions to generate the majority of plant biomass.

These are primarily questions of fundamental developmental biology for which we use the model organism, Arabidopsis thaliana. However, we also look to exploit development to increase plant productivity. Wood is constituted of xylem cells which are specialised vascular cells that transport water. We have shown that manipulating cell divisions in vascular tissue can lead to increases in wood formation in hybrid aspen.

Both Arabidopsis and aspen are dicotyledonous plants, but the most important food crops are monocots, a grouping in which vascular development is poorly understood. Strikingly, vascular tissue is formed differently in monocots and dicots, and recently we have begun to address how developmental mechanisms may differ between these two groups. To do this we have developed genomic resources for studying vascular development in Sorghum biocolor.

Our ongoing research aims to understand how a complex network of factors interact to orchestrate vascular development, initially in Arabidopsis, with a view to expanding this understanding to monocots and forest trees.



## Selected Research Publications


1. Smit, M.E., McGregor, S.R., Sun, H., Gough, C., Bågman, A.-M., Soyars, C.L., Kroon, J.T., Gaudinier, A., Williams, C.J., Yang, X., Nimchuk, Z.L. Weijers, D., Turner, S.R., Brady, S.M.†, and **Etchells, J.P**.† (2020). A PXY-mediated transcriptional network integrates signaling mechanisms to control vascular development in Arabidopsis. *The Plant Cell* 32: 319-335. †co corresponding authors.
2. Wang, N., Bagdassarian, K.S., Doherty, R.E., Kroon, J.T., Connor, K.A., Wang, X.Y., Wang, W., Jermyn, I.H., Turner, S.R., and **Etchells, J. P.** (2019). Organ-specific genetic interactions between paralogues of the PXY and ER receptor kinases enforce radial patterning in Arabidopsis vascular tissue. *Development* 146: dev177105
3. Turco, G.M., Kajala, K., Kunde-Ramamoorthy, G., Ngan, C-Y., Olson, A., Deshphande, S., Tolkunov, D., Waring, B., Stelpflug, S., Klein, P., Schmutz, J., Kaeppler, S., Ware, D., Wei, C-L., **Etchells, J.P.**†, Brady, S.M.† (2017). DNA methylation and gene expression regulation associated with vascularization in Sorghum bicolor. *New Phytologist* 214: 1213-1229. †co corresponding authors.
4. Guo, X., Wang, J., Gardner, M., Fukuda, H., Kondo, Y., **Etchells, J.P.**, Wang, X. & Goellner-Mitchum, M. (2017). Identification of cyst nematode B-type CLE peptides and modulation of the vascular stem cell pathway for feeding cell formation. *PLoS Pathogens*, 13, e1006142.
5. **Etchells, J.P.***, Mishra, L.S.*, Kumar, M., Campbell, L., Turner, S.R. (2015). Wood Formation in Trees is Increased by Manipulating PXY-Regulated Cell Division. *Current Biology* 25:1050. *co first authors.




Dr. Elaine Fitches
**Research Group:** MPS
**Area of Research:**
Insect Biotechnology

## Abstract of Research Interests:

The first of two areas of interest in applied entomology is the development of novel approaches for the control of invertebrate pests. Co-inventor of patented "Fusion Protein technology", a platform approach that enables the oral delivery of invertebrate specific peptide toxins to the CNS of target pests. Many naturally occurring small protein toxins, such as those present in spider venoms, are highly toxic to invertebrates when injected but typically ineffective when delivered orally, as their targets for action are ion channels in the CNS. Our technology enables delivery of such peptides to the CNS through exploitation of a "carrier" protein that, following ingestion, binds to and crosses the invertebrate gut epithelium, and moves into the circulatory system. Recombinant fusion proteins are produced in yeast by bench-top fermentation, purified, allowing efficacy bioassays to be conducted against invertebrate pests. Our group is working with industry to develop novel fusion protein based biopesticides as exogenous sprays and baits but we are also investigating potential for the targeted control of insect pests using transgenic plants.

My second area of interest is exploring the use of insects reared at scale as bioconvertors of food and agricultural "wastes" to yield high quality products for animal feed and reductions in waste volumes in line with a circular economy approach. Scientific co-ordinator of "PROteINSECT", a EU funded programme (2013-2016) that investigated the potential of insects as a source of protein for animal feed that provided scientific evidence that contributed towards the revision of legislation to allow insect protein to be used as a feed in aquaculture in 2017. Currently a partner of a large multidisciplinary Innovate funded project "The Insectrial Revolution" that will see the first commercial scale Black soldier fly production site built in the UK; Durham's role in this project is to elucidate the value of rearing residues for crop and soil health.

## Selected Research Publications


1. Powell, M.E., Bradish, H.M., Cao, M., Mackinson, R., Brown, A.P., Gatehouse, J.A., **Fitches, E.C.** (2019) Demonstrating the potential of a novel spider venom based biopesticide for target-specific control of the small hive beetle, a serious pest of the European honey bee. J. *Pest Science* https://doi.org/10.1007/s10340-019-01143-3
2. **Fitches, E.C.**, Dickinson, M., De Marzo, D., Wakefield, M. E., Charlton, A.C.,Hall, H. (2019) Alternative protein production for animal feed: Musca domestica productivity on poultry manures and nutritional quality of processed larval meals. *Journal of Insects for Food & Feed*. DOI 10.3920/JIFF2017.0061
3. Kumar, A., Orosa, B.m, Singh, P., Cummins, I.m Walsh, C., Zhang, C., Grant, M., Roberts, M.R., Anand, G.S., **Fitches, E.**, Sadanandom, A. (2018) Small Ubiquitin-like Modifier protein, SUMO regulates Jasmonic acid signalling 1 by suppressing the activity of the Jasmonic acid receptor, CORONATINE 2 INSENSITIVE 1, COI1. *The Plant Cell*, DOI: https://doi.org/10.1105/tpc.18.00036
4. Cao, M., Gatehouse, JA, **Fitches, EC** (2018) A systematic study of RNAi effects and dsRNA stability in Tribolium castaneum and Acyrthosiphon pisum, following injection and ingestion of analogous dsRNAs. Int. J. *Molecular Sciences* 19, 1079; doi:10.3390/ijms19041079


# Prof. Patrick J. Hussey

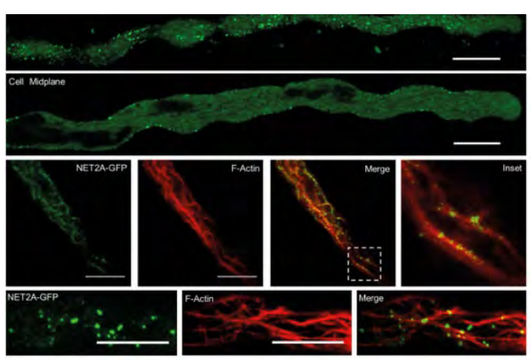
**Research Group:** MPS

**Area of Research:**
The Plant Cytoskeleton

## Abstract of Research Interests:

Patrick joined Durham University in 2000 as Chair of Plant Molecular Cell Biology and served as Head of the School of Biological and Biomedical Sciences between 2010 and 2013, and as a member of the University Executive Committee as Pro-Vice-Chancellor (Science) between 2014 and 2019. Previously, after postdoctoral work at the University of Minnesota and the John Innes Centre, he took up a lectureship in Royal Holloway University of London, where he was awarded a Personal Chair in 1999. Also while at Royal Holloway, he served as Warden of Founder's Hall. Patrick is a former President of the Society of Experimental Biology (2015-17) and has previously served as a Group Convenor for the Cell Section, Head of the Cell Section and Vice-President of the Society (2013-15). In 2016, he was elected to the Council of the Royal Society of Biology by the Member Organisations. Patrick is a former Trustee of the Centre for Life in Newcastle, where he served on the Board and as Chair of the Audit Committee (2014-19). Patrick has served on several Editorial boards including Current Biology, and has served on several research panels including for Agence Nationale de la Recherche (ANR, France) and the Biotechnology and Biological Sciences Research Council (BBSRC). He is a visiting Professor at the University of Lisbon (Prof Catedictics Canidado, FCUL), Huazhong Agricultural University, Wuhan and Charles University, Prague.

Patrick established the Durham Centre for Bioimaging Technology with Dr. Tim J Hawkins and bioimaging is a main feature of his research methodology. His research focuses on the structure, function and regulation of the plant cytoskeleton with a current emphasis on cytoskeleton and membrane interactions.




## Selected Research Publications


1. Delgadillo MO, Ruano G, Zouhar J, Sauer M, Shen J, Lazarova A, Sanmartín M, Lai LTF, Deng C, Wang P, **Hussey PJ**, Sánchez-Serrano JJ, Jiang L, Rojo E. (2020) MTV proteins unveil ER- and microtubule-associated compartments in the plant vacuolar trafficking pathway. *Proc Natl Acad Sci* 117(18):9884-9895.
2. Wang P, Pleskot R, Zang J, Winkler J, Wang J, Yperman K, Zhang T, Wang K, Gong J, Guan Y, Richardson C, Duckney P, Vandorpe M, Mylle E, Fiserova J, Van Damme D, **Hussey PJ.** (2019) Plant AtEH/Pan1 proteins drive autophagosome formation at ER-PM contact sites with actin and endocytic machinery. *Nature Commun.* 10(1):5132. doi: 10.1038/s41467-019-12782-6.
3. Sassmann S, Rodrigues C, Milne SW, Nenninger A, Allwood E, Littlejohn GR, Talbot NJ, Soeller C, Davies B, **Hussey PJ,** Deeks MJ. (2018) An Immune-Responsive Cytoskeletal-Plasma Membrane Feedback Loop in Plants. *Current Biology.* 28(13):2136-2144.
4. Wang P, Richardson C, Hawes C, **Hussey PJ.** (2016) Arabidopsis NAP1 Regulates the Formation of Autophagosomes. *Current Biology*. 26(15):2060-2069.
5. Galva C, Kirik V, Lindeboom JJ, Kaloriti D, Rancour DM, **Hussey PJ,** Bednarek SY, Ehrhardt DW, Sedbrook JC. (2014) The microtubule plus-end tracking proteins SPR1 and EB1b interact to maintain polar cell elongation and directional organ growth in Arabidopsis. *Plant Cell.* 26(11):4409-25.
6. Wang P, Hawkins TJ, Richardson C, Cummins I, Deeks MJ, Sparkes I, Hawes C, **Hussey PJ.** (2014) The plant cytoskeleton, NET3C, and VAP27 mediate the link between the plasma membrane and endoplasmic reticulum. *Current Biology.* 24(12):1397-1405.




# Dr. Heather Knight

**Research Group:** MPS

**Area of Research:**
Plant response
to abiotic stress

## Abstract of Research Interests:

Plants respond to abiotic stress by making physiological and metabolic changes that help them survive further stress Many of these changes are brought about by transcriptional reprogramming My research focusses on the molecular mechanisms that bring about freezing tolerance in plants and the regulation of genes that protect plants against low temperature and other forms of abiotic stress We have been elucidating the roles of a number of genes in the model plant Arabidopsis thaliana that determine the plant's level of tolerance to freezing stress One of these genes, sensitive-to-freezing6 (SFR6) encodes a component of the Mediator transcriptional coactivator complex, and is essential for the transcriptional response to low temperature that protects plants from freezing.

My lab showed that specificity in plant Mediator function (the ability of the complex to "choose" which genes it switches on) is implemented through distinct individual subunit roles and we published work describing the molecular mechanism that allows this to happen (Hemsley et al, 2014) Recently we identified SFR8 as a gene that governs freezing tolerance by influencing cell wall structure and ongoing research is elucidating a role for this gene in desiccation tolerance. Currently we are working with Dr Gabriele Sosso and Dr Tom Whale in Warwick University to elucidate the relationship between plant cell wall composition and ice formation in plant tissues.

## Selected Research Publications


1. Panter, PE, Kent, O, Dale, M, Smith, S J, Skipsey, M, Thorlby, G, Cummins, I, Ramsay, N, Begum, R A, Sanhueza, D, Fry, S C, Knight M R & **Knight, H** (2019) MUR1-mediated cell-wall fucosylation is required for freezing tolerance in Arabidopsis thaliana. *New Phyt*. 224, 1518-31.
2. Pinneh, EC, Stoppel, R, **Knight, H,** Knight, MR, Steel, PG & Denny, PW (2019) Expression levels of inositol phosphorylceramide synthase modulate plant responses to biotic and abiotic stress in Arabidopsis thaliana. *PLoS ONE* 14, e0217087.
3. Calixto, CPG, Guo, W, James, AB, Tzioutziou, NA, Entizne, JC, Panter, PE, **Knight, H,** Nimmo H, Zhang, R, Brown, JWS (2018) Rapid and dynamic alternative splicing impacts the Arabidopsis cold response transcriptome. *Plant Cell* 30, 1424-44.
4. Sorek, N, Szemenyei, H, Sorek, H, Landers, A, **Knight, H**, Bauer S, Wemmer, DE, Somerville, CR (2015) Identification of MEDIATOR16 as the Arabidopsis COBRA suppressor MONGOOSE1. *Proceedings of the National Academy of Sciences USA*, 112, 16048-53.
5. Hemsley, PA, Hurst, CH, Kaliyadasa, E, Lamb, R, Knight, MR De Cothi, EA, Steele, JF and **Knight, H** (2014) The Arabidopsis Mediator complex subunits MED16, MED14 and MED2 regulate Mediator and RNA polymerase II recruitment to CBF-responsive cold-regulated genes. *Plant Cell* 26, 465-4.
6. Wathugala, DCL, Hemsley, PA, Moffat, CS, Cremelie, P, Knight, MR and **Knight, H** (2012) The Mediator subunit SFR6/MED16 controls defence gene expression mediated by salicylic acid and jasmonate responsive pathways *New Phyt,* 195, 217-230.
7. Wathugala, DCL, Richards, SA, **Knight, H** and Knight, MR (2011) OsSFR6 is a functional rice orthologue of SENSITIVE TO FREEZING-6 and can act as a regulator of COR gene expression, osmotic stress and freezing tolerance in Arabidopsis *New Phyt*, 191, 984-005.

Prof. Marc Knight
**Research Group:** MPS
**Area of Research:**
Stress Signalling in Plants

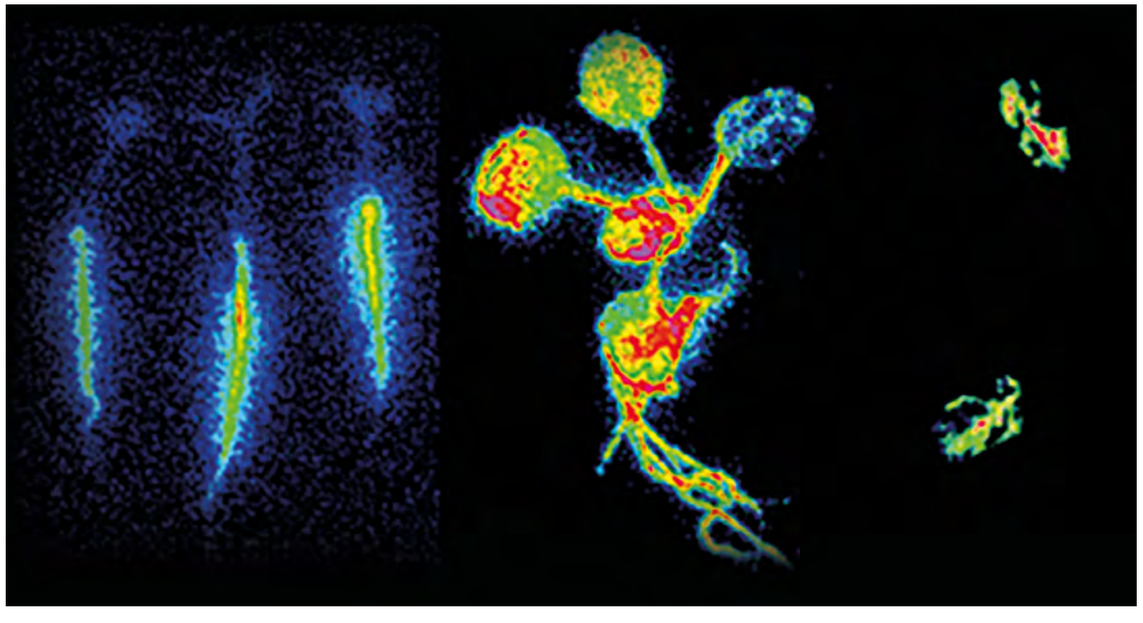
## Abstract of Research Interests:

There are 2 main areas of research in my lab: (1) **The role of calcium in plant gene expression** (in collaboration with Dr Junli Liu (Biosciences)). Most recently we have produced and experimentally validated a mathematical model explaining how specific calcium signatures lead to specific plant immune responses. We are currently investigating calcium signature-specific control of gene expression orchestrated by the circadian clock (Bryony Jacobs), and the role of calcium signalling in responses to multiple stresses in potato as part of a large EU consortium (ADAPT – Accelerated Development of multiple-stress tolerant Potato: https://adapt.univie.ac.at/) (postdoc to start 1/1/21); (2) **Chemical genetic approaches to understand hormone signalling** (in collaboration with Prof Patrick Steel (Chemistry) and Dr Ehmke Pohl (Biosciences).

We have been focusing on a growth-promoting chemical that targets the GA-DELLA pathway in plants and have been using a combination of genetic, molecular and biochemical approaches to identify its mode of action (Dan Bruce and Jonathan Reuven).

## Selected Research Publications


1. Sukiran, N.A., Steel, P.G. and **Knight, M.R.** (2020) Basal stomatal aperture is regulated by GA-DELLAs in Arabidopsis. J *Plant Physiol* 250: 153182.
2. Liu, J., Lenzoni, G. and **Knight, M.R.** (2020) Design Principle for Decoding Calcium Signals to Generate Specific Gene Expression Via Transcription. *Plant Physiol* 182: 1743-1761.
3. Pollastri, S., Jorba, I., Hawkins, T.J., Llusia, J., Michelozzi, M., Navajas, D., Penuelas, J., Hussey, P.J., **Knight, M.R.**, Loreto, F. (2019). Leaves of isoprene-emitting tobacco plants maintain PSII stability at high temperatures. *New Phytologist* 223: 1307-1318.
4. Lenzoni, G. and **Knight, M.R.** (2018) Increases in Absolute Temperature Stimulate Free Calcium Concentration Elevations in the Chloroplast. *Plant and Cell Physiology* 60: 538-548.
5. Lenzoni, G., Liu, J.L. and **Knight, M.R.** (2018) Predicting plant immunity gene expression by identifying the decoding mechanism of calcium signatures. *New Phytologist* 217: 1598-1609.

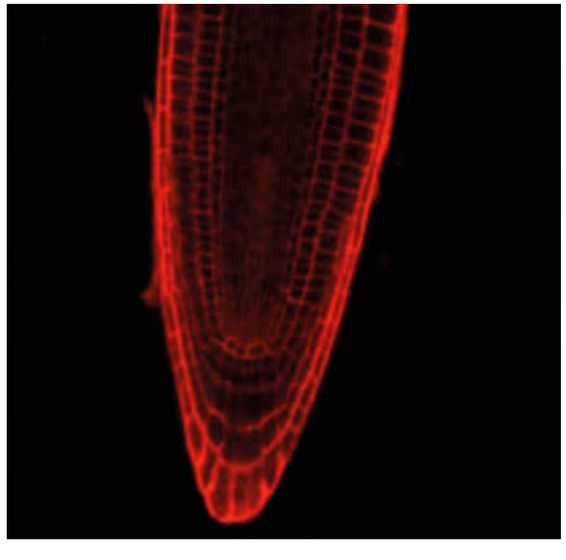


Prof. Keith Lindsey
**Research Group:** MPS
**Area of Research:**
Plant Developmental Biology

## Abstract of Research Interests:

Our research interests are broadly in understanding the molecular mechanisms controlling plant development. This has been characterized by an integrative approach, using genetics, genomics, proteomics, physiology and, most recently, mathematical modelling (with Junli Liu) to understand gene function during embryogenesis and in root development. Most of our work has been with the powerful genetic model Arabidopsis, but we are also now working with some economically important crop plants. Current work is primarily focused on the gene and signalling networks that regulate the activity of the primary root meristem of Arabidopsis, which has led us to try to understand how hormonal and gene systems interact to control cell identity, division and expansion, and how environmental stresses influence these processes to modulate root architecture. Current projects are on regulators of alternative splicing, hormone receptor function and osmotic and mechanical stress in relation to signalling and gene expression.

We also have a productive collaboration with Huazhong Agricultural University in China (where I am Visiting Professor), working on cotton development and genetics.



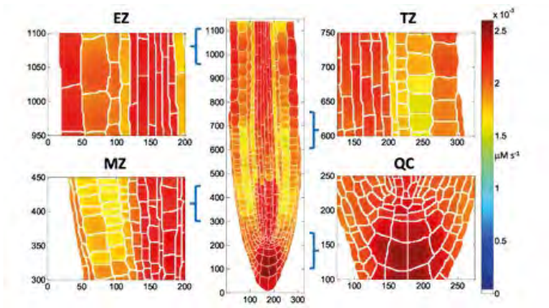
## Selected Research Publications


1. Jacobsen, A.G.R. Jervis, G., Xu, J., Topping, J.F., **Lindsey, K**. (2021) Root growth responses to mechanical impedance are regulated by a network of ROS, ethylene and auxin signalling in Arabidopsis. *New Phytologist* 231, 225-242.
2. Gu, X., Fonseka, K., Agneessens, J., Casson, S.A., Smertenko, A., Guo, G., Topping, J.F., Hussey, P.J., **Lindsey, K.** (2021) The Arabidopsis R-SNARE VAMP714 is essential for polarization of PIN proteins and auxin responses. *New Phytologist* 230, 550-566.
3. Short, E., Pullen, M., Imriz, G., Liu, D., Cope-Selby, N., Hetherington, F., Smertenko, A., Hussey, P.J., Topping, J.F., **Lindsey, K.** (2018) Epidermal expression of a sterol biosythesis gene regulates root growth by a non-cell autonomous mechanism in Arabidopsis. *Development* 145, dev160572.
4. Wang, M., Tu, L, Lin, M., Lin, Z., Wang, P., Yang, Q., Ye, Z., Shen, C., Zhou, X., Zhang, L., Li, J., Nie, X., Li, Z., Guo, K., Ma, Y., Jin, S., Zhu, L., Yang, X., Min, L., Zhang, Q., **Lindsey, K**. & Zhang, X. (2017) Asymmetric subgenome selection and cis-regulatory divergence during cotton domestication. *Nature Genetics* 49, 579-587.
5. Rowe, J., Topping, J.F., Liu, J. & **Lindsey, K.** (2016). Abscisic acid regulates root growth under osmotic stress conditions via an interacting hormonal network with cytokinin, ethylene and auxin. *New Phytologist,* 211, 225-239.
6. Wang, M., Yuan, D., Tu, L., Gao, W., He, Y., Hu, H., Wang, P., Liu, N., **Lindsey, K.** & Zhang, X. (2015). Long non-coding RNAs and their proposed functions in fibre development of cotton (Gossypium spp.). *New Phytologist,* 207, 1181.

Dr. Junli Liu
**Research Group:** MPS
**Area of Research:**
Systems Biology

## Abstract of Research Interests:

My research area is systems biology, and it covers both systems biology theory and its application to plants and microbes. My research studies important theoretical questions such as the underlying principles for plant signalling and maintenance of biological stable states under a changing environment. My research also develops various systems biology approaches to study biologically important systems: hormonal crosstalk in Arabidopsis, ion dynamics in the pollen tube, calcium signature in Arabidopsis, plant response to calcium signals, metabolism of herbicides and safeners in plants, metabolic response to oxidative stress in Arabidopsis. For example, we develop systems biology approaches to study how complex interactions of hormones regulate root development, analyse how pollen tube development is regulated by ions, and predict gene expression by identifying the decoding mechanism of calcium signatures




## Selected Research Publications


1. **Liu, J.***, Lenzoni, G., and Knight, MR* (2020). Design principle for decoding calcium signals to generate specific gene expression via transcription. *Plant Physiology* 182(4): 1743-1761.
2. Jackson, SE, Vernon, **Liu, J.** and Lindsey, K. (2020). Understanding hormonal crosstalk in Arabidopsis root development via emulation and history matching. *Statistical Applications in Genetics and Molecular Biology* 19(2): 20180053.
3. Vernon,I*, **Liu, J***, Goldstein, M, Rowe, J, Topping, J and Lindsey, K (2018). Bayesian uncertainty analysis for complex systems biology models: emulation, global parameter searches and evaluation of gene functions. *BMC Systems Biology* 12: 1.
4. Lenzoni, G., **Liu, J.***, and Knight, MR* (2018). Predicting plant immunity gene expression by identifying the decoding mechanism of calcium signatures. *New Phytologist* 217, 1598-2609.
5. Moore, S.#, **Liu, J.***,#, Zhang, X. & Lindsey, K.* (2017). A recovery principle provides insight into auxin pattern control in the Arabidopsis root. *Scientific Reports* 7: 43004. (#: joint first authors)
6. Rowe, J., Topping, J.F., **Liu, J.*** & Lindsey, K.* (2016). Abscisic acid regulates root growth under osmotic stress conditions via an interacting hormonal network with cytokinin, ethylene and auxin. *New Phytologist* 211: 225-239.
7. Moore, S.#, Zhang, X.#, Mudge, A., Rowe, J., Topping, J., **Liu, J.*** & Lindsey, K.* (2015). Spatiotemporal modelling of hormonal crosstalk explains the level and patterning of hormones and gene expression in Arabidopsis thaliana wildtype and mutant roots. *New Phytologist* 207: 1110-1122. (#: joint first authors)
8. **Liu, J.***, Whalley, H.J. & Knight, M.R.* (2015). Combining modelling and experimental approaches to explain how calcium signatures are decoded by calmodulin-binding transcription activators (CAMTAs) to produce specific gene expression responses. *New Phytologist* 208: 174-187.


*"*" Joint corresponding authors*



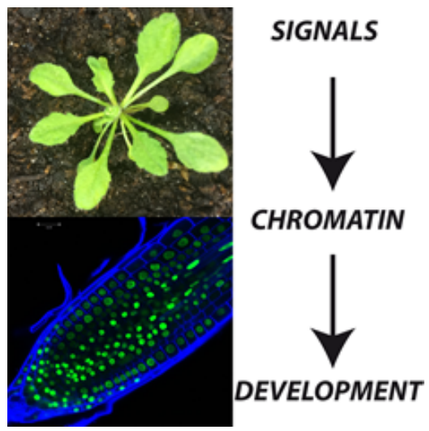
Dr. Miguel de-Lucas
**Research Group:** MPS
**Area of Research:**
Chromatin dynamics
& plant development

## Abstract of Research Interests:

The main focus of my scientific career has been the analysis of the molecular mechanism by which different signalling pathways are connected to regulate gene expression. I have come to realize that the mutual regulation between DNA-binding transcription factors and chromatin remodelling elements is key to providing an optimal expression level under different circumstances.

During my PhD research I uncovered the molecular mechanism linking light perception with growth via Gibberellin and Brassinosteroid hormones (1,2,6). The modulation of a single transcription factor was sufficient to alter the growing pattern of a plant!! However, to fully understand gene expression, transcription factor activity function must be integrated with the chromatin context where it occurs. Thus, for my postdoctoral research I investigated how transcriptional networks and chromatin remodelling complexes co-ordinately regulate cellular decisions (3,4,5).

Our current work aims to understand **how chromatin is dynamically regulated during development by environmental and intrinsic signals to guide cell fate decisions and development (7,8).**




## Selected Research Publications


1. Mesejo C., Marzal A., Martinez-Fuentes A., **de-Lucas, M**, Iglesias D.J., Primo-Millo E., Blazquez M.A., Agusti M. (2021). Reversion of fruit-dependent inhibition of flowering in Citrus requires sprouting of buds with epigenitically silenced CcMADS19. *New Phytologist*, doi.:10.1111/nph.17681.
2. Agusti, M., Mesejo, C., Fambuena, N.M., Sirera, F.V., **de-Lucas, M**, Fuentas, A.M., et al. (2019). Fruit-dependent epigenetic regulation of flowering in Citrus. *New Phytologist,* nph.16044
3. Martinez, C., Espinosa-Ruiz, A., **de-Lucas, M**, Bernado Garcia, S., Franco-Zorilla, JM., Prat, S. (2018). PIF4-induced BR synthesis is critical to diurnal and thermomorphogenic growth. *EMBO Journal* e99552-15.
4. **de-Lucas, M., et al.** (2016) Transcriptional Regulation of Arabidopsis Polycomb Repressive Complex 2 Coordinates Cell-Type Proliferation and Differentiation. *The Plant Cell,* 28, 2616-2631.
5. Taylor-Teeples, M.,* Lin, L.,* **de-Lucas, M**.,* Turco, G., Toal, TW., Gaudinier, A., Young, NF., *et al.* (2015) An Arabidopsis gene regulatory network for secondary cell wall synthesis. *Nature* 517: 571-575 *"*" Joint corresponding authors*
6. Ikeuchi, M., Iwase, A., Rymen, B., Harashima, H., Shibata, M., Ohnuma, M., Breuer, C., Morao, AK., **de-Lucas, M**., De Veylder, L., *et al.* (2015). PRC2 represses dedifferentiation of mature somatic cells in Arabidopsis. *Nature Plants* 1: 15089.
7. Bernado-Garcia, S., **de-Lucas, M**., Martinex , C., Espinosa-Ruiz, A., Daviere, J-M., Prat, S. (2014). BR-dependent phosphorylation modulates PIF4 transcriptional activity and shapes diurnal hypocotyl growth. *Genes Dev* 28: 1681-1694.
8. **de-Lucas, M**., Daviere, J-M., Rodriguez-Falcon, M., Pontin, M., Iglesias-Pedraz, JM., Lorrain, S., Fankhauser, C., Blazquez, MA., Titarenko, E., Prat, s. (2008). A molecular framewrok for light and gibberellin control of cell elongation. *Nature* 451: 480-484

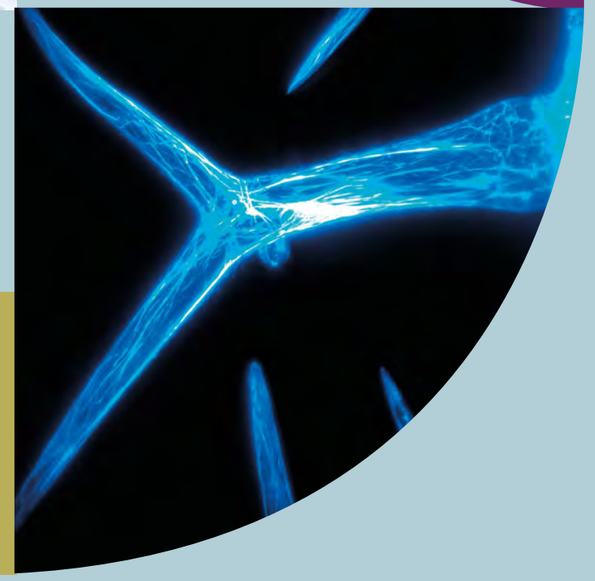
Prof. Ari Sadanandom
**Research Group:** MPS
**Area of Research:**
Plant Pathology

## Abstract of Research Interests:

I've had the privilege to discover novel molecular mechanisms in plant stress responses that have proven efficacy in boosting crop productivity. I am the co-director of the Durham Centre for Crop Improvement technology, a multi-disciplinary research centre that works with the Agritech industry to develop technology that is effective in field conditions. My laboratory has pioneered the area of SUMO modification of proteins in plants through an ERC Consolidator grant to define the role of this emerging system in crops. My laboratory has generated strong evidence that places SUMO at the core of adaptive responses in plants. This effort is generously supported by a broad portfolio of funding including grants from BBSRC, NERC, EU, NIH, Leverhulme Trust and the Gatsby Foundation along with industry research contracts. Our efforts to maintain excellence in protein modification research has been recently recognized with a UKRI Frontier Biosciences strategic Longer and Larger grant to decipher the SUMO code in plants.

### Selected Research Publications


1. Moumita Srivastava, Anjil K. Srivastava, Beatriz Orosa-Puente, Alberto Campanaro Cunjin Zhang, **Ari Sadanandom**. SUMO conjugation to BZR1 affords Brassinosteroid signalling to integrate environmental cues to shape plant growth. *Current Biology* (2020) Vol. 30(8):1410-1423.e3.
2. Beatriz Orosa-Puente, Nicola Leftley, Daniel von Wangenheim, Jason Banda, Anjil K Srivastava, Kristine Hill, Jekaterina Truskina, Rahul Bhosale, Emily Morris, Moumita Srivastava Britta Kümpers, Tatsuaki Goh, Hidehiro Fukaki, Joop EM Vermeer, Teva Vernoux, Jose Dinneny, Andrew F. French, Anthony Bishopp, **Ari Sadanandom*** & Malcolm J. Bennett*. *co-corresponding authors. Roots branch towards water by post-translational modification of transcription factor ARF7 *Science* (2018) 362(6421): 1407-1410.
3. B. Orosa, G. Yates, V. Verma, A. K. Srivastava, M. Srivastava A. Campanaro, D. De Vega, A. Fernandez, C. Zhang, J. Lee, M. Bennett, **A. Sadanandom**. SUMO conjugation to the pattern recognition receptor FLS2 triggers intracellular signalling in plant innate immunity. *Nature Communications* (2018) 9(1): 5185.
4. Anjil Kumar Srivastava, Beatriz Orosa, Prashant Singh, Ian Cummins, Charlotte Walsh, Cunjin Zhang, Murray Grant, Michael R. Roberts, Ganesh Srinivasan Anand, Elaine Fitches, **Ari Sadanandom**. SUMO Suppresses the Activity of the Jasmonic Acid Receptor CORONATINE INSENSITIVE1 *The Plant Cell*, (2018) Vol. 30: 2099–2115, S
5. Beatriz Orosa, Qin He, Joelle Mesmar, Eleanor M. Gilroy, Hazel McLellan, Chengwei Yang, Adam Craig, Mark Bailey, Cunjin Zhang, Jonathan David Moore, Petra C. Boevink, Zhendong Tian, Paul R. J. Birch, **Ari Sadanandom**. BTB-BACK Domain Protein POB1 Suppresses Immune Cell Death by Targeting Ubiquitin E3 ligase PUB17 for Degradation. *PLOS Genetics*. (2017) http://dx.doi.org/10.1371/journal.pgen.1006540
6. **Sadanandom, A.**, Ádám É, Orosa B, Viczián A, Klose C, Zhang C, Josse EM, Kozma-Bognár L & Nagy F*. (2015) SUMOylation of phytochrome-B negatively regulates light-induced signaling in Arabidopsis thaliana. *Proceedings of the National Academy of Sciences (USA)*. 112, 11108-13.

# Biomolecular Interactions (BI)

The Biomolecular Interactions (BI) group are bioscientists working at the interface of biology and chemistry who use biochemical, chemical and biophysical methods to investigate many of the world's most pressing problems relating to human health and industrial productivity. Divided into four core themes,

**Bacterial enzyme metalation and nutritional immunity**

**Bacterial toxin-antitoxin systems and bacteriophage proteins**

**Protozoan enzymes and drug discovery**

and **Post-translation modification and cellular responses**

The staff and some of their recent research which underwrites the BI group are listed over the following pages, ranging from projects to develop the fundamental understanding of bioscience to translational science for biotechnology and global health.

**Selected Recent Papers:**


**Chivers PT**, et al. (2019)
Bacterial sensors define intracellular free energies for correct enzyme metalation.
*Nature Chemical Biology.* 15(3):241-249.

**Young TR**, Robinson NJ, et al. (2021)
Calculating metalation in cells reveals CobW acquires CoII for vitamin B12biosynthesis while related proteins prefer ZnII. *Nature Communications.* 19;12(1): 1195.

**Blower TR**, et al. (2020).
A nucleotidyltransferase toxin inhibits growth of Mycobacterium tuberculosis through inactivation of tRNA acceptor stems. *Science Advances.* 6(31): eabb6651.

Brown M, **Schröder M**. et al. (2020)
Endoplasmic reticulum stress causes insulin resistance by inhibiting delivery of newly synthesized insulin receptors to the cell surface. *Molecular Biology of the Cell.* 31(23): 2597-2629.

**Djoko KY**, et al. (2020)
Role of Glutathione in Buffering Excess Intracellular Copper in Streptococcus pyogenes.
*mBio*. 11(6): e02804-20.

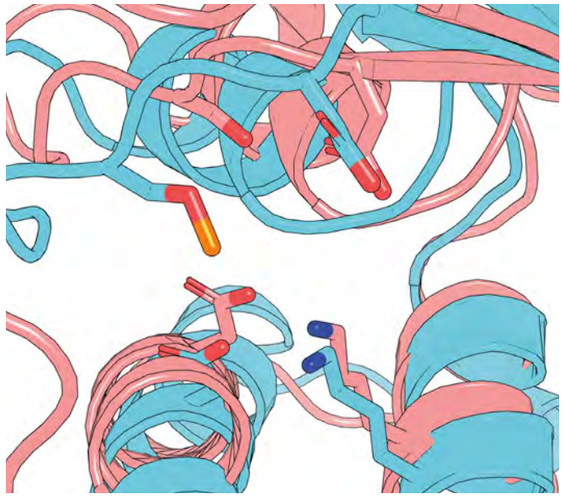

**Group Coordinator:** Professor Paul Denny

**Academic Staff:** Dr Tim Blower, Professor Martin Cann, Dr Peter Chivers, Professor Paul Denny, Dr Karrera Djoko, Dr Sushma Grellscheid, Professor Ehmke Pohl, Professor Nigel Robinson, Dr Martin Schröder, Dr Gary Sharples, Dr Brian Suarez-Mantilla, Dr Tessa Young.

Dr. Tim Blower
**Research Group:** BI
**Area of Research:**
Bacteriophage-resistance mechanisms and toxin-antitoxin systems

## Abstract of Research Interests:

Bacteria are outnumbered ten-to-one by viral predators called bacteriophages. This selection pressure has caused bacteria to evolve multiple resistance mechanisms. Many of these have been co-opted for biotechnological purposes; restriction enzymes and the CRISPR-cas systems have both revolutionised molecular biology. As antibiotic resistance increases it may also become necessary to turn to bacteriophages as an alternative means to treat infections. In which case, a better understanding of bacteriophage-resistance mechanisms is required. The first theme of our research is therefore to explore the biochemical activity and structures of bacteriophage-resistance proteins. The second theme aims to address antibiotic resistance with new drug molecules, by harnessing natural toxins that bacteria produce to inhibit their own growth – the "toxin-antitoxin systems". Bacteria activate these systems in the presence of antibiotics, to deliberately halt their own growth and thereby stop the fatal effects of the antibiotic. When the antibiotic concentration diminishes, the antitoxin takes over and the bacteria are resuscitated. We aim to determine how these toxins could be used to develop new antibiotics. We are an expanding research group, comprising four postgraduate students and a post-doc; see www.blowerlab.com.



Active sites of Mycobacterium tuberculosis MenT toxins (Cai, Usher et al., 2020)

## Selected Research Publications


1. Cai, Y., Usher, B., Gutierrez, C., Tolcan, A., Mansour, M., Fineran, P.C., Condon, C., Neyrolles, O., Genevaux, P. & **Blower, T.R.** (2020). A nucleotidyltransferase toxin inhibits growth of Mycobacterium tuberculosis through inactivation of tRNA acceptor stems. *Science Advances* 6(31): eabb6651.
2. Beck, I.N., Usher, B., Hampton, H.G., Fineran, P.C. & **Blower, T.R.** (2020). Antitoxin autoregulation of M. tuberculosis toxin-antitoxin expression through negative cooperativity arising from multiple inverted repeat sequences. *Biochemical Journal* 477(12): 2401-2419.
3. **Blower, T.R.**, Bandak, A., Lee, A.S.Y., Austin, C.A., Nitiss, J.L. & Berger, J.M. (2019). A complex suite of loci and elements in eukaryotic type II topoisomerases determine selective sensitivity to distinct poisoning agents. *Nucleic Acids Research* 47(15): 8163-8179.
4. Hampton, H.G., Jackson, S.A., Fagerlund, R.D., Vogel, A.I.M., Dy, R.L., **Blower, T.R.** & Fineran, P.C. (2018). AbiEi binds cooperatively to the Type IV abiE toxin-antitoxin operator via a positively-charged surface and causes DNA bending and negative autoregulation. *Journal of Molecular Biology* 430(8): 1141-1156.
5. **Blower, T.R.**, Williamson, B.H., Kerns, R.J. & Berger, J.M. (2016). Crystal structure and stability of gyrase–fluoroquinolone cleaved complexes from Mycobacterium tuberculosis. *Proceedings of the National Academy of Sciences* 113(7): 1706-1713.




Prof. Martin Cann
**Research Group:** BI
**Area of Research:**
Carbon dioxide sensing

## Abstract of Research Interests:

Carbon dioxide is essential for life. It is at the beginning of every life process as a fundamental substrate of photosynthesis or chemosynthesis and is at the end of every life process as the product of aerobic respiration and post-mortem decay. As such, it is not a surprise that this gas regulates such diverse processes as cellular chemical reactions, transport, maintenance of the cellular environment, behaviour and immunity. However, we know very little of the direct interactions of CO2 with the cell, despite the importance of the gas to biology.

CO2 can form a reversible non-enzymatic protein post-translational modification through carbamylation of neutral lysine -amino groups (Figure). We have developed triethyloxonium (TEO) ion as a tool to covalently 'trap' carbamates on protein enabling their identification by mass spectrometry.

Our current work is directed towards the use of TEO for the identification of CO2-binding proteins and the demonstration of the functional consequences of these binding interactions in vitro and in vivo.

## Selected Research Publications


1. Linthwaite, V.L., Pawloski, W., Pegg, H.B., Townsend, P.D., Thomas, M.J., So, V.K.H., Hodgson, D.R.W, Lorimer, G.H., Fushman, D., **Cann, M.J.** (2020) Ubiquitin is a carbon dioxide receptor. *Science Advances*. In Press.
2. Brotherton, D.H., Savva, C., Ragan, T., Linthwaite, V.L., **Cann M.J.**, Dale N., Cameron, A.D. (2020) Conformational changes and channel gating induced by CO2 binding to Connexin26. *bioRxiv doi*: 10.1101/2020.08.11.243964
3. Sukarta O.C.A., Townsend P.D., Llewelyn A., Dixon C.H., Slootweg E.J., Pålsson L.O., Takken F.L.W., Goverse A., **Cann M.J.** (2020) A DNA-Binding Bromodomain-Containing Protein Interacts with and Reduces Rx1-Mediated Immune Response to Potato Virus X. *Plant Communications* doi: 10.1016/j.xplc.2020.100086
4. Linthwaite, V.L., Janus, J.M., Brown, A.P., Wong-Pascua, D., O'Donoghue, A.C., Porter, A., Treumann, A., Hodgson, D.R.W., **Cann, M.J.** (2018) The identification of carbon dioxide mediated protein post-translational modifications. *Nature Communications* 9:3092 | DOI: 10.1038/s41467-018-05475-z
5. Townsend, P.D., Dixon C.H., Slootweg, E.J., Sukarta, O.C., Yang, A.W., Hughes, T.R., Sharples, G.J., Pålsson, L-O., Takken, F.L.W., Goverse, A., **Cann, M.J.** (2018) The intracellular immune receptor Rx1 regulates the DNA-binding activity of a Golden2-like transcription factor. *Journal of Biological Chemistry*, 293, 3218-33.

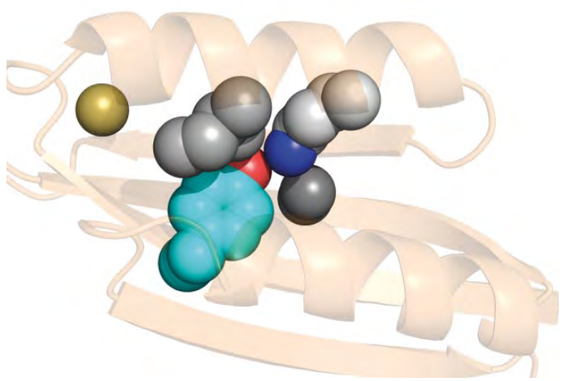

Dr. Peter Chivers
**Research Group:** BI
**Area of Research:**
Bacterial metal homeostasis

## Abstract of Research Interests:

My research explores the relationship between protein structure and biological function.

The research questions focus on the mechanisms by which bacteria acquire transition metal ions and regulate their intracellular levels. The systems we use to explore questions are bacterial nickel transport systems and their regulators, which we have previously discovered. We are particularly interested in the role of metal binding affinity in determining the fate of metal ions within the cell, how they are transferred between molecules, and the extent to which this property is conserved across different bacteria. By studying this fundamental question, we aim to provide insight in the mechanisms of metal partitioning with cells.

In the longer term, this research can be applied to the optimisation of protein metallation in industrially important heterologous expression hosts, for example.



## Selected Research Publications


1. Osman, D, Martini, M.A., Foster, A.W., Chen, J, Scott, A.J.P., Morton R.J., Steed, J.W., Lurie-Luke, E, Huggins, T.G., Lawrence, A.D., Deery, E, Warren, M.J., **Chivers, P.T.**, & Robinson, N.J. (2019). Bacterial sensors define intracellular free energies for correct enzyme metalation. *Nature Chemical Biology* 15, 241-249.
2. Huang, H-T., Bobst, C. E., Iwig, J. S., **Chivers, P.T.,** Kaltashov, I. A., and Maroney, M.J. (2018). Co(II) and Ni(II) binding of the Escherichia coli transcriptional repressor RcnR orders it N-terminus, alters helix dynamics, and reduces DNA affinity. *Journal of Biological Chemistry,* 293, 324-332.
3. Foster, A.W., Pernil, R., Patterson, C.J., Scott, A.J.P., Pålsson, L.-O., Pal, R., Cummins, I., **Chivers, P.T.**, Pohl, E. & Robinson, N.J. (2017). A tight tuneable range for Ni(II)-sensing and -buffering in cells. *Nature Chemical Biology,* 13, 409-414.
4. Moore, S., Sowa, S., Schuchardt, C., Deery, E., Lawrence, A., Ramos, J., Billig, S., Birkemeyer, C., **Chivers, P.T.**, Howard, J., Rigby, S., Layer, G. & Warren, M.J. (2017). Elucidation of the biosynthesis of the methane catalyst coenzyme F430. *Nature*, 543, 78-82.
5. Carr, C.E., Musiani, F, Huang, H-T, **Chivers, P.T.**, Ciurli, S & Maroney, M.J. (2017). Glutamate Ligation in the Ni(II)- and Co(II)-Responsive Escherichia coli Transcriptional Regulator, RcnR. *Inorganic Chemistry,* 56, 6459-6476.
6. Denby, K. J., Iwig, J., Bisson, C., Westwood, J., Rolfe, M. D., Sedelnikova, S. E., Higgins, K., Maroney, M. J., Baker, P. J., **Chivers, P.T.** & Green, J. (2016). The mechanism of a formaldehyde-sensing transcriptional regulator. *Scientific Reports*, 6, 38879.




Prof. Paul Denny
**Research Group:** BI
**Area of Research:**
Protozoan biochemistry & drug targets

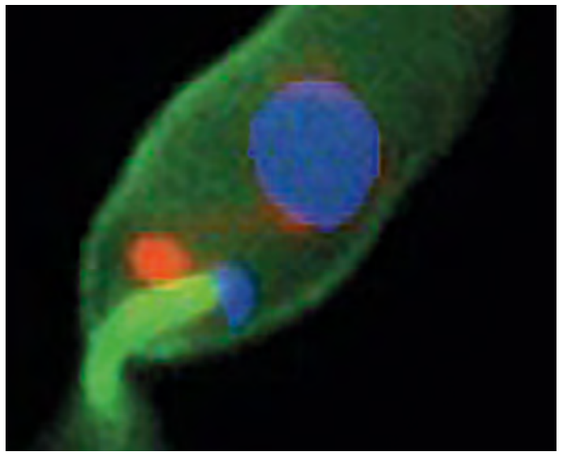
## Abstract of Research Interests:

Protozoan infections, including so-called Neglected Tropical Diseases (NTDs), affect billions of the World's poor. A lack of effective treatments and vaccines makes the discovery of new chemotherapeutic agents an urgent priority. In close collaboration with colleagues in the Department of Chemistry, my group studies the etiological agents of the NTD leishmaniasis (kinetoplastid Leishmania spp – see image) and a model for the apicomplexan malaria parasite, Toxoplasma gondii (itself a pathogen). This research is focused on developing understanding of the interaction of these parasites with their host cells, coupled with the identification and validation of novel drug targets. As an example, the sphingolipid biosynthetic pathway from kinetoplastid and apicomplexan parasites has been identified and characterised[5]. To exploit these findings, a novel enzyme inhibitor assay was developed, patented and utilised to screen the 1.8M compound GSK library against the Leishmania spp sphingolipid synthase[3]. This work highlights our interdisciplinary approach towards drug target validation and discovery[1,2,4]. Notably, it has become increasingly clear that target validation, a crucial step in drug discovery, is fraught with difficulty and expensive failure (Smith, Nature 2016). Uniting the physical and life sciences we now seek to create a chemical and genetic 'tool kit' to robustly validate targets for protozoan parasites, both for understanding and translational drug discovery.

Now our Durham collective is leading a £7.8M MRC GCRF Network with colleagues at York, São Paulo, Kolkata and Karachi to realise this vision and accelerate the vital downstream process of antiprotozoal drug discovery.

## Selected Research Publications


1. Anderson, O., Beckett, J., Briggs, C.C. et al & **Denny, P.W.** (2020) An investigation of the antileishmanial properties of semi-synthetic saponins. *RSC Medicinal Chemistry,* 11, 833-842.
2. Britt, H.M., García-Herrero, C.A., **Denny, P.W.**, Mosely, J.A. & Sanderson, J.M. Lytic reactions of drugs with lipid membranes (2019). *Chemical Science,* 10, 674-680.
3. Norcliffe, J.L., Mina, J.G., Alvarez, E. et al, Steel, P.G. & **Denny, P.W.** Identifying inhibitors of the Leishmania inositol phosphorylceramide synthase with antiprotozoal activity using a yeast- based and ultra-high throughput screening platform (2018). *Scientific Reports*, 8, 3983.
4. Armitage, E., Alqaisi, A.Q.I., Godzien, J., et al & **Denny, P.W.**, Barrett, M.J. & Barbas, C. A complex interplay between sphingolipid and sterol metabolism revealed by perturbations to the Leishmania metabolome caused by miltefosine (2018). *Antimicrobial Agents and Chemotherapy,* 65, e02095-e20117.
5. Mina, J., Thye, J., Alqaisi, A., et al, Pohl, E. & **Denny, P.W**. (2017). Functional and phylogenetic evidence of a bacterial origin for the first enzyme in sphingolipid biosynthesis in a phylum of eukaryotic protozoan parasites. *Journal of Biological Chemistry,* 292, 12208-12219.

Dr. Karrera Djoko
**Research Group:** BI
**Area of Research:**
Bacterial Infectious Diseases

## Abstract of Research Interests:

Metals (including trace elements such as iron, manganese, zinc, and copper) are crucial for the function of nearly half of all proteins but they are toxic to cells if present in excess or if inserted into the wrong proteins. During an infectious disease, both the infected host and the invading microbe fight to control metal availability within the infected host environments. These processes are known as "Nutritional Immunity" and there is growing interest in developing agents that manipulate metal level and location as new antimicrobial therapeutics.

My group studies host and bacterial biomolecules that participate in Nutritional Immunity. We focus on clinically significant bacterial pathogens, including a few multidrug-resistant strains that are considered the most critical threats to public health worldwide. We collaborate widely with researchers and clinicians from the UK, Australia, and USA and employ microbiological, biochemical, and chemical approaches to answer the following key questions: How does nutritional immunity impact bacterial physiology? How do bacterial pathogens adapt to the effects of nutritional immunity? When/where during the progress of infection do bacterial pathogens encounter metal ions? What human immune components contribute to nutritional immunity? Finally, can we use this knowledge to develop molecules that scavenge or deliver metals as new antibacterial approaches?

## Selected Research Publications


1. LJ Stewart, CY Ong, MM Zhang, S Brouwer, L McIntyre, MR Davies, MJ Walker, AG McEwan, KJ Waldron, **KY Djoko***. (2020) Role for glutathione in buffering excess intracellular copper in Streptococcus pyogenes. *mBio, in press.*
2. AG Turner, **KY Djoko**, CY Ong, TC Barnett, MJ Walker, AG McEwan. (2019) Group A Streptococcus co-ordinates manganese import and iron efflux in response to hydrogen peroxide stress. *Biochemical Journal* 476 (3), 595-611.
3. LJ Stewart, D Thaqi, B Kobe, AG McEwan, KJ Waldron, **KY Djoko***. (2019) Handling of nutrient copper in the bacterial envelope. *Metallomics 11* (1), 50-63.
4. **KY Djoko**, MES Achard, MD Phan, AW Lo, M Miraula, S Prombhul, Hancock SJ, Peters KM, Sidjabat HE, Harris PN, Mitić N, Walsh TR, Anderson GJ, Shafer WM, Paterson DL, Schenk G, McEwan AG, Schembri MA. (2018) Copper ions and coordination complexes as novel carbapenem adjuvants. *Antimicrobial agents and chemotherapy* 62 (2), e02280-17.
5. **KY Djoko***, MD Phan, KM Peters, MJ Walker, MA Schembri, AG McEwan. (2017) Interplay between tolerance mechanisms to copper and acid stress in Escherichia coli. *Proceedings of the National Academy of Sciences* 114 (26), 6818-6823.




Dr. Sushma Grellscheid
**Research Group:** BI
**Area of Research:**
RNA Genomics

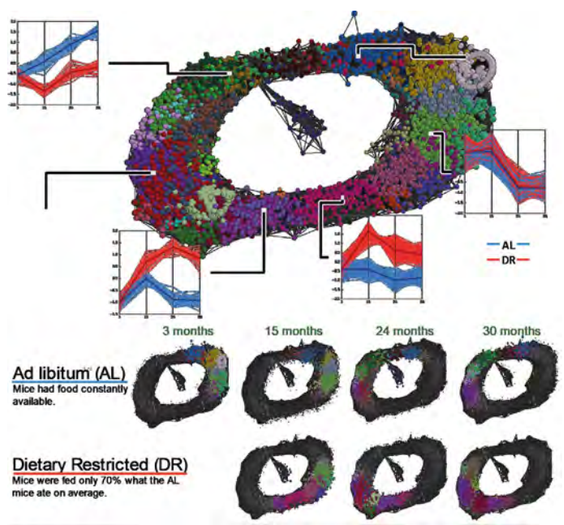
## Abstract of Research Interests:

RNA binding proteins (RBPs) are emerging as important regulators of development and health. In addition to being the primary causative gene in numerous genetic diseases, they are prime candidates for modifiers of phenotype due to their complex combinatorial control of gene expression from transcriptional regulation, alternative splicing and RNA localisation to translational control. My group employs interdisciplinary computational and experimental methods to understand how RBPs exert their regulatory functions, and their mis-regulation in ageing and disease. We extensively employ genome-wide transcriptomic approaches involving RNA-protein interactions such as RNA-seq, CLIP-seq, and Ribo-seq and integrate these with experimental animal, cellular and mathematical models, towards developing a mechanistic understanding of cellular processes involving RNA binding proteins.

Some members of this research group are located at the University of Bergen (UiB) as indicated below.

**Current Lab members:**
PhD Students: Maha Al Rushadi, Carl Jones, Thomas Stevenson (UiB)

**Post-Doc:**
Franziska Goertler (UiB)




## Selected Research Publications


1. M Vietri...**Grellscheid, S.N.** et al, Unrestrained ESCRT-III drives micronuclear catastrophe and chromosome fragmentation. *Nature Cell Biology*, (2020)
2. Buskin A...**Grellscheid, S.N.** et al, Disrupted alternative splicing for genes implicated in splicing and ciliogenesis causes PRPF31 retinitis pigmentosa. *Nature Communications*. (2019)
3. Ogrodnik, M...**Grellscheid, S.N.** et al.Cellular senescence drives age-dependent hepatic steatosis. *Nature Communications*, 8, (2017)
4. Feracci M...**Grellscheid, S.N**. et al. Structural basis of RNA recognition and dimerization by the STAR proteins T-STAR and Sam68. *Nature Communications*, 7, (2016)
5. Ghosh P, **Grellscheid, S.N.** & Sowdhamini R. A tale of two paralogs: human Transformer2 proteins with differential RNA-binding affinities. *J. Biomol. Struct. Dyn.*, 4, 1979-86. (2016)
6. Lahat, A. & **Grellscheid, S.N.** Differential mRNA Alternative Splicing. In: Field Guidelines for Genetic Experimental Designs in High-Throughput Sequencing. Edited by Ana M. Aransay, Jose ' Luis Lavi 'n Trueba. *Springer* (2016)
7. Zupanic, A. & **Grellscheid, S.N.** Ribosome Profiling. In: Field Guidelines for Genetic Experimental Designs in High-Throughput Sequencing. Edited by Ana M. Aransay, Jose ' Luis Lavi 'n Trueba.Heberle A.M. et al., *Springer*

Prof. Ehmke Pohl
**Research Group:** BI
**Area of Research:**
Structural Biology

## Abstract of Research Interests:

The overall goal of the group is to determine the 3-D structures of proteins with relevance to biomedicine or biotechnology. Our primary technique is protein crystallography complemented by a wide range of biophysical techniques ranging from small angle X-ray scattering to isothermal titration calorimetry and thermal shift assays. The key projects of the group include

**Virus-X: Viral Metagenomics for Innovation value**. As part of the EU Horizon2020 funded consortium of 14 academic and commercial partners we have explored the genomic diversity of bacteriophages from extreme environments (www.virus-X.eu). Our group has characterised a range of novel enzymes for applications in the bio-economy from protein production to the development of kits for protein stability commercialised by Molecular Dimensions Ltd. (https://www.moleculardimensions.com/products/durham-screensv2) and most recently for novel Covid19 test kits.

**Structure & mechanism of transcriptional regulator proteins.**
The viability of all organisms depends on their quick adaptation to the ever-changing environment. In many cases, gene-expression in response to internal and/or external signals is controlled by transcriptional regulators. Using a combination of crystallographic, biophysical and computational tools we investigate ligand binding and the mechanism of DNA recognition. Our work on the human Retinoic Acid Receptors (RAR), which represent important targets for the development of novel therapies for neurodegenerative diseases is aimed at the structure-based design of new synthetic retinoids. This work led to the foundation of the Durham spinout company Nevrargenics (www.nevrargenics.com).

**Global Network on Neglected Tropical Diseases**
As part of the Global Challenges Research Fund our multinational team, led by Durham (Graham Sandford, Steven Cobb and Patrick Steel, Chemistry, Paul Denny and Ehmke Pohl, Biosciences) with York (Jeremy Mottram), Ariel Silber, Sao Pauli, Brazil and Nahid Ali, Kolkata, India has won £8M to use chemical and biological tools to identify new targets to combat neglected tropical diseases including Chagas disease and Leishmaniasis. In this huge project, my group will focus on the biophysical and structural characterisation of targets identified by chemical, genetic and high-throughput screening approaches.

## Selected Research Publications


1. Zohib M, Maheshwari D, Kant Pal R, Freitag-Pohl S, Biswal BK, **Pohl E**, Arora A. (2020) Crystal structure of the GDP-bound GTPase domain of Rab5a from L. donovani. *Acta Cryst* F76:544-556
2. Freitag-Pohl S, Jasolionis A, Hakansson M, Svensson LA, Kovacic R, Welin M, Watzlawick H, Wang L, Altenbuchner J, Plotka M, Kaczorowska AK, Kaczorowski T, Nordberg-Karlsson E, Al-Karadaghi S, Aevarsson A, **Pohl E**. "Architecture and function of the *Bacillus subtillis* prophage lytic cassette proteins XepA and Yoms" *Acta Cryst* (2019) D75:1028-1039.
3. Bruce D, Cardew E, Freitag-Pohl S, **Pohl E**. "How to stabilize your protein: stability screens for thermal shift assays and nano differential scanning fluorimetry in the Virus-X project" (2019) *J. Vis. Exp.* (144) e58666
4. Chisholm DR, Tomlinson CWE, Zhou G-Z, Manning R, Holden C, Affleck V, Lamb R, Newling K, Ahston P, Valentine R, Redfern C, Erostyak J, Makkai G, Ambler C, Whiting A, **Pohl E**. "New fluorescent retinoic acid analogues as unique tools for understanding retinoid biology" (2019) *ACS Chem Biol* 14, 369-377.

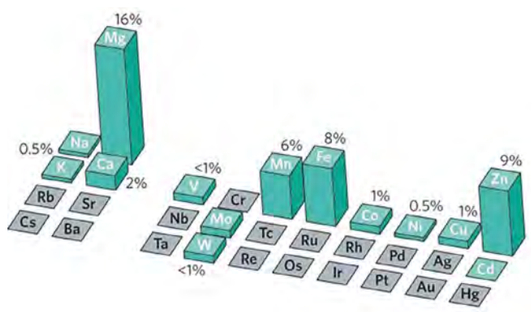



Prof. Nigel Robinson
**Research Group:** BI
**Area of Research:**
Cell Biology of Metals

## Abstract of Research Interests:

About a half of enzymes require metals and my research group has discovered how living cells locate these elements to proteins. I have studied the cell biology of metals for nearly four decades, and co-established (with Dennis Winge, Utah) the Gordon Research Conference series on the Cell Biology of Metals. I direct a metals-related BBSRC Network in Industrial Biotechnology and Bioenergy (IBBE), one of six renewed in 2019. My group cloned the ferric-chelate reductase for iron-uptake by plants (Nature, 1999, 397:694-697). Using bacterial model cells we found that two enzymes with similar metal-binding sites, similar cupin-folds and similar metal-affinities acquire different metals, copper or manganese, by folding in different compartments (Nature, 2008, 455:1138-1142). This demonstrates that metal availability at the site of protein folding dominates metal-protein speciation in vivo.

My research group have characterised components of the cellular machineries that sustain these metal-availabilities including DNA-binding metal-sensors (reviewed in Nature, 2009, 460:823-830), metal-transporters, metal storage-proteins (PNAS, 2001, 98:9593-9598), and metallochaperones for metal-delivery (PNAS, 2012,109: 95-100; reviewed in Ann Rev Biochem, 2010, 79:537-562). The group discovered that metal sensors are finely-tuned to the buffered activity of their cognate metal (Nature Chemical Biology, 2017, 13:409-414), providing a 'read-out' of the free energy of available metal inside cells (Nature Chemical Biology, 2019, 15: 241–249): These values now decode metalation of a half of the reactions of life.




## Selected Research Publications

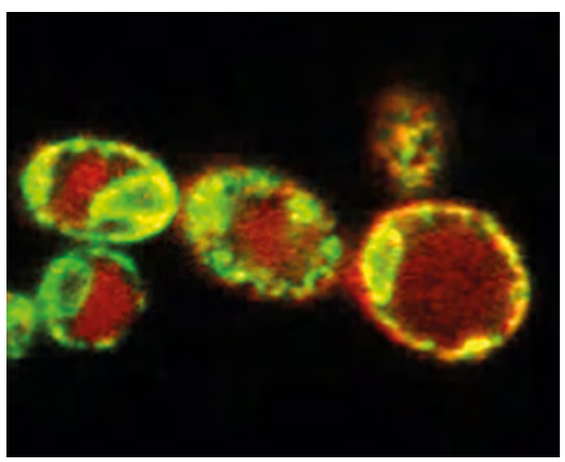

1. Young, T.R., Martini, M.A., Osman, D., Morton, R.J., Deery, E., Warren, M.J. & **Robinson, N.J.** (2020) Calculating metalation in cells reveals CobW acquires CoII for vitamin B12 biosynthesis upon binding nucleotide. BioRxiv, doi:10.1101/2020.06.26.173062, *revision for Nature Communications.*
2. Osman, D., Martini, M.A., Foster, A.W., Chen, J., Scott, A.J.P., Morton, R.J., Steed, J.W., Lurie-Luke, E., Huggins, T.G., Lawrence, A.D., Deery, E., Warren, M.J., Chivers, P.T., & **Robinson, N.J.** (2019) Bacterial sensors define intracellular free energies for correct enzyme metalation. *Nature Chemical Biology,* 15: 241–249.
3. Schorsch, M., Kramer, M., Goss, T., Eisenhut, M., **Robinson, N.**, Osman, D., Wilde, A., Sadaf, S., Brückler, H., Walder, L., Scheibe, R., Hase, T., Hanke, G.T. (2018) A unique ferredoxin acts as a player in the low-iron response of photosynthetic organisms. *PNAS*, 115: 12111-12120.
4. Osman, D., Foster, A.W., Chen, J., Svedaite, K., Steed, J.W., Lurie-Luke, E., Huggins, T.G. & **Robinson, N.J.** (2017). Fine control of metal concentrations is necessary for cells to discern zinc from cobalt. *Nature Communications*, 8, 1884. doi:10.1038/s41467-017-02085-z
5. Foster, A.W., Pernil, R., Patterson, C.J., Scott, A.J.P., Pålsson, L.-O., Pal, R., Cummins, I., Chivers, P.T., Pohl, E. & **Robinson, N.J.** (2017). A tight tuneable range for Ni(II)-sensing and -buffering in cells. *Nature Chemical Biology,* 13, 409-414.
6. Osman, D., Piergentili, C., Chen, J., Chakrabarti, B., Foster, A., Lurie-Luke, E., Huggins, T. & **Robinson, N.J.** (2015). Generating a metal-responsive transcriptional regulator to test what confers metal-sensing in cells. *Journal of Biological Chemistry,* 290, 19806-19822.
7. Foster, A.W., Osman, D. & **Robinson, N.J.** (2014). Metal preferences and metallation. *Journal of Biological Chemistry,* 289, 28095-28103.
8. Foster, A.W., Pernil, R., Patterson, C.J. & **Robinson, N.J.** (2014). Metal specificity of cyanobacterial nickel-responsive repressor aInrS: cells maintain zinc and copper below the detection threshold for InrS. *Molecular Microbiology*, 92, 797-812.

Dr. Martin Schröder
**Research Group:** BI
**Area of Research:**
Molecular Cell Biology

## Abstract of Research Interests:

My group is interested in signal transduction events in response to protein misfolding stress in the endoplasmic reticulum. We are specifically interested in:

- Identification of mechanisms through which the kinase domain of Ire1 controls the activity of its RNase domain.
- Characterisation of the role of the kinase domain of Ire1 in the ER stress response in yeast and mammals as well as control of ER stress-induced cell death responses by Ire1.
- Integration of ER stress signals into broader cellular stress responses, for example the general stress response in budding yeast.
- Identification of mechanisms through which unfolded protein response signalling controls cell fate.
- Identification of mechanisms of resolution of endoplasmic reticulum stress and unfolded protein response signalling.



## Selected Research Publications

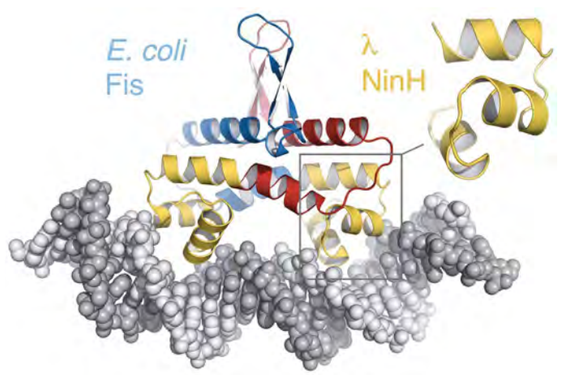

1. M. C. Armstrong, S. Šestak, A. A. Ali, H. A. M. Sagini, M. Brown, K. Baty, A. Treumann & **Schröder, M.** (2017) Bypass of activation loop phosphorylation by aspartate 836 in activation of the endoribonuclease activity of Ire1. *Molecular and Cellular Biology*, 37, e00655-16.
2. M. Brown, N. Strudwick, M. Suwara, L. K. Sutcliffe, A. D. Mihai, A. A. Ali, J. N. Watson & **Schröder, M.** (2016) An initial phase of JNK activation inhibits cell death early in the endoplasmic reticulum stress response. *Journal of Cell Science,* 129, 2317-2328.
3. D. Mihai & **Schröder, M.** (2015) Glucose starvation and hypoxia, but not the saturated fatty acid palmitate or cholesterol, activate the unfolded protein response in 3T3-F442A and 3T3-L1n adipocytes in vitro. *Adipocyte, 4*, 188-202.
4. Skipsey, M. Hack, G., Hooper, T.A., Shankey, M.C., Conway, L.P., **Schröder, M**. & Hodgson D.R.W. (2013) 5'-Deoxy-5'-hydrazinylguanosine as an initiator of T7 RNA polymerase-catalyzed transcriptions for the preparation of labeling-ready RNAs. *Nucleosides, Nucleotides, and Nucleic Acids* 32, 670-681.
5. N. Strudwick, M. Brown, V. M. Parmar & **Schröder, M.** (2010) Ime1 and Ime2 are required for pseudohyphal growth of Saccharomyces cerevisiae. *Molecular and Cellular Biology* 30, 5514-5530.




Dr. Gary Sharples
**Research Group:** BI
**Area of Research:**
Phage proteins
and new antibacterials

## Abstract of Research Interests:

I am interested in bacteriophages, their impact on the evolution of microbial pathogens and the identification and characterisation of activities that manipulate their bacterial hosts. Phage proteins studied include: a) Rap endonuclease involved in the resolution of branched DNA structures that arise during genetic exchange, b) NinH, a homologue of the Fis nucleoid-associated protein, which likely influences gene expression and genome architecture, and c) Kil proteins which disrupt bacterial cell division and have potential as new antibacterial agents. I am also engaged in diverse microbiology projects with the goal of developing new antibacterial agents and surfaces to combat increasingly drug resistant pathogens. Work in this area includes studies on the antibacterial properties and underlying mechanisms of plasma-modified surfaces, metal chelating agents, peptoids and other small molecules. These projects involve multiple collaborations with colleagues based in Biosciences, Chemistry, Physics and Earth Sciences. Work on a new enzyme-free approach to synthetic gene assembly with David Hodgson has made excellent progress. A recent Institute of Advanced Studies project on antibacterial clay therapy brought together researchers from across the sciences and humanities. These various projects are funded by BBSRC, EPSRC and MRC, with additional support from Northern Accelerator and P&G. Ongoing work with P&G on metal chelators may lead to an Impact Case Study and has already influenced their product formulations.




## Selected Research Publications


1. Chakraborti, S., Balakrishnan, D., Trotter, A.J., Gittens, W.H., Yang, A.W.H., Jolma, A., Paterson, J.R., Świątek, S., Plewka, J., Curtis, F.A., Bowers, L.Y., Pålsson, L.O., Hughes, T.R., Taube, M., Kozak, M., Heddle, J.G., **Sharples, G.J.** (2020) A bacteriophage mimic of the bacterial nucleoid-associated protein Fis. *Biochem J.*, 477, 1345-1362.
2. Jamie, K. and **Sharples, G.J.** (2020) The social and material life of medicinal clay: exploring antimicrobial resistance, medicines' materiality and medicines optimization. *Front. Sociol. (Med. Sociol.)*, 5, 26.
3. Mulla, R.S., Beecroft, M.S., Yufit, D.S., Pal, R. Aguilar, J.A., Pitarch-Jarque, J., García-España, E., Lurie-Luke, E., **Sharples, G.J.** and Williams, J.A.G. (2018) On the antibacterial activity of azacarboxylate ligands: lowered metal ion affinities for some bis-amide derivatives of EDTA do not necessarily mean reduced activity. *Chem. Eur. J.*, 24, 7137-7148.
4. Ritchie, A.W., Cox, H.J., Barrientos-Palomo, S.N., **Sharples, G.J.**, and Badyal, J.P.S. (2018) Bioinspired multifunctional polymer-nanoparticle-surfactant complex nanocomposite surfaces for antibacterial oil-water separation. *Coll. and Surf. A,* 560, 352-359.
5. Bolt, H.L., Eggimann, G.A., Jahoda, C.A.B., Zuckermann, R.N., **Sharples, G.J.** and Cobb, S.L. (2017) Exploring the links between peptoid antibacterial activity and toxicity. *Med. Chem. Commun.*, 8, 886-896.

# Dr. Brian Suarez-Mantilla
**Research Group:** BI
**Area of Research:**
Biochemistry and
Cell Signaling

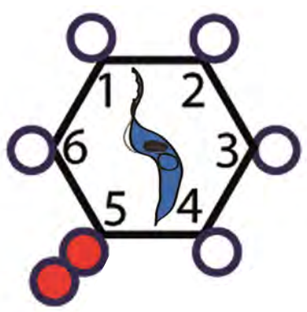
## Abstract of Research Interests:

**Metabolism of Inositol Phosphates (IPs)**
Phosphorous is an essential element present in virtually almost all reactions of cell metabolism and signal transduction events. There are different phosphate (Pi)-containing metabolites that enable cells to obtain, store and utilise this micronutrient. Inositol phosphates are a class of ubiquitous sugars containing phosphate substituents attached at different positions of the myo-inositol scaffold. The number and position of these Pi groups establishes a sort of inositide code that can be read by different proteins, thus playing regulatory or structural functions. How, where and why these metabolites are produced constitute one of the main focus of my research.

**Trypanosomatid parasites as a model to study IPs biology**
Trypanosomatids are a group of early-divergent eukaryotes with species that may cause diseases in animals or humans. They possess an intriguing cell organisation and metabolic features that are strikingly divergent from other 'model' organisms. The enzymology and regulation of their IPs-related kinase machinery make these organisms an excellent model to explore IP biology. My current research focuses on understanding these atypical metabolic traits and exploit their potential to design rationale intervention strategies against these disease-causing parasites. We integrate gene editing techniques, high-resolution microscopy, proteomics, and phosphate chemistry methods to underpin the biological functions of inositol phosphates with particular interest by inositol pyrophosphate (5-IP7).
ORCID id: **https://orcid.org/0000-0001-7839-1222**

## Selected Research Publications


1. **Mantilla BS**, Amaral LDD, Jessen HJ, Docampo R. The Inositol Pyrophosphate Biosynthetic *Pathway of Trypanosoma cruzi*. *ACS Chem Biol.* 2021 Jan 7.
2. **Mantilla BS**, Kalesh K, Brown NW Jr, Fiedler D, Docampo R. Affinity-based proteomics reveals novel targets of inositol pyrophosphate (5-IP7)-dependent phosphorylation and binding in *Trypanosoma cruzi* replicative stages. *Mol Microbiol.* 2020 Dec 22.
3. Marchese L, Olavarria K, **Mantilla BS**, Avila CC, Souza ROO, Damasceno FS, Elias MC, Silber AM. *Trypanosoma cruzi* synthesizes proline via a 1-pyrroline-5-carboxylate reductase whose activity is fine-tuned by NADPH cytosolic pools. *Biochem J.* 2020 May 29; 477(10):1827-1845.
4. Barisón MJ, Rapado LN, Merino EF, Furusho Pral EM, **Mantilla BS**, Marchese L, Nowicki C, Silber AM, Cassera MB. Metabolomic profiling reveals a finely tuned, starvation-induced metabolic switch in *Trypanosoma cruzi* epimastigotes. *J Biol Chem.* 2017 May 26; 292(21):8964-8977.
5. **Mantilla BS**, Marchese L, Casas-Sánchez A, Dyer NA, Ejeh N, Biran M, Bringaud F, Lehane MJ, Acosta-Serrano A, Silber AM. Proline Metabolism is Essential for *Trypanosoma brucei* brucei Survival in the Tsetse Vector. *Plos Pathog.* 2017 Jan 23;13(1):e1006158.
6. **Mantilla BS**, Paes LS, Pral EM, Martil DE, Thiemann OH, Fernández-Silva P, Bastos EL, Silber AM. Role of ö1-pyrroline-5-carboxylate dehydrogenase supports mitochondrial metabolism and host-cell invasion of *Trypanosoma cruzi*. *J Biol Chem.* 2015 Mar 20;290(12):7767-90.

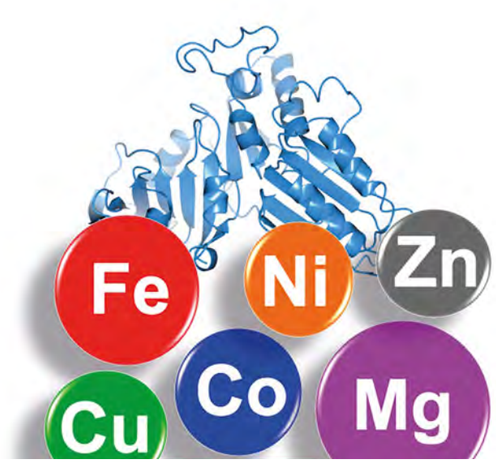

Cell
trIPnaling
Lab



# Dr. Tessa Young
**Research Group:** BI
**Area of Research:**
Metals in Biology

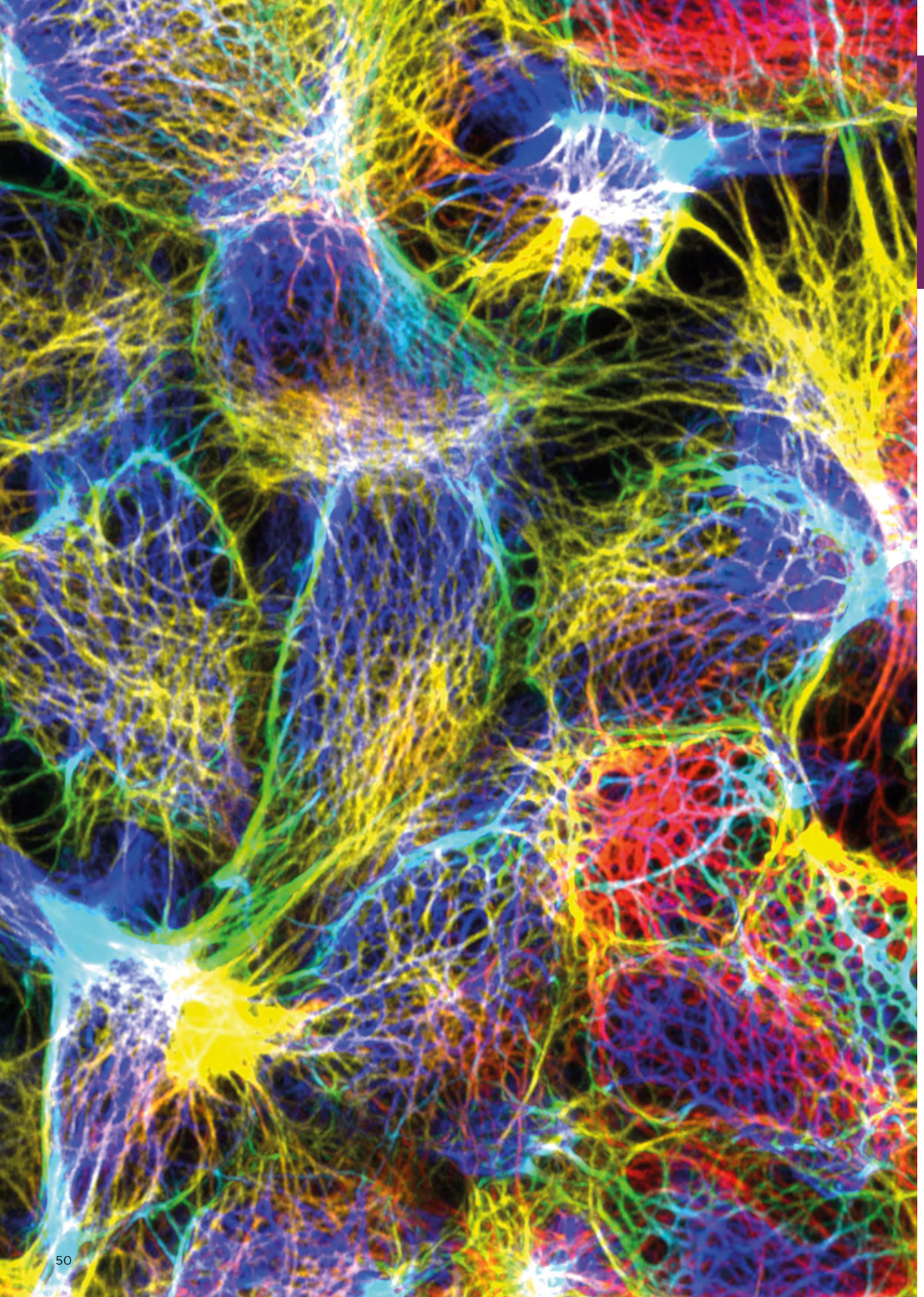
## Abstract of Research Interests:

My research focuses on understanding the role of transition metals in living cells. These essential trace elements offer unique reactivity that facilitates life's chemical reactions. However, living organisms require a complex suite of genes to control metal uptake, transport and reactivity, as well as to prevent in vivo metal toxicity. My research investigates the proteins and biomolecules that are responsible for cellular metal control using a range of chemical and biological techniques including the development of metal-responsive spectroscopic probes to study metal-binding interactions, in vitro biochemical studies of metal-binding proteins, and in vivo biological studies of the effects of metals on living cells (such as impacts on gene expression and cofactor biosynthesis). The laboratory work is combined with detailed mathematical modelling which, together, can be used to predict and optimise protein metalation inside living cells. Practical applications of the research include optimisation of bioprocesses: For example, I am currently investigating how cobalt is supplied to the cofactor vitamin B12 during biosynthesis, with relevance to improving the biomanufacturing of this essential dietary nutrient (**https://www.royalcommission1851.org/characterising-the-cobalt-delivery-pathway-for-vitamin-b12/**).




## Selected Research Publications


1. **Young, TR**, Martini, MA, Osman, D, Morton, RJ, Deery, E, Warren MJ & Robinson, NJ. (2020) Calculating metalation in cells reveals that CobW acquires Co(II) for vitamin B12 biosynthesis upon binding nucleotide *bioRxiv*, DOI: 10.1101/2020.06.26.173062
2. **Young, TR**, Pukala, TL, Cappai, R, Wedd, AG & Xiao, Z. (2018) The Human Amyloid Precursor Protein Binds Copper Ions Dominated by a Picomolar-Affinity Site in the Helix-Rich E2 Domain. *Biochemistry*, 57: 4165-4176.
3. **Young TR,** Wedd AG & Xiao Z (2018) Evaluation of Cu(I) Binding to the E2 Domain of the Amyloid Precursor Protein – a Lesson in Quantification of Metal Binding to Proteins via Ligand Competition *Metallomics* 10: 108-119.
4. Yako N, **Young TR,** Cottam Jones JM, Hutton CA, Wedd AG, and Xiao Z (2017) Copper Binding and Redox Chemistry of the Aß16 Peptide and its Variants: Insights into Determinants of Copper Dependent Reactivity *Metallomics* 9: 278-291.
5. **Young TR,** Wijekoon CJK, Spyrou B, Donnelly PS, Wedd AG, and Xiao Z (2015) A Set of Robust Fluorescent Peptide Probes for Quantification of Cu(II) Binding Affinities in the Micromolar to Femtomolar Range *Metallomics* 7: 567-578.
6. Wijekoon CJK, **Young TR,** Wedd AG, and Xiao Z (2015) The CopC Protein from Pseudomonas Fluorescens Sbw25 Features a Conserved Novel High Affinity Cu(II) Binding Site *Inorganic Chemistry* 54: 2950-2959.
7. **Young TR**, Kirchner A, Wedd AG, and Xiao Z (2014) An Integrated Study of the Affinities of the Aß16 Peptide for Cu (I) and Cu (II): Implications for the Catalytic Production of Reactive Oxygen Species *Metallomics* 6: 505-517.



# Animal Cells and Systems (ACaS)

We are a grouping of animal biologists working on a range of fundamental biological questions, most of which underpin biomedical interests relevant to the bioeconomy.

Our research ranges from the subcellular level to the whole animal system and is divided into three thematic areas:

**Mechanisms of development and ageing** - including stem cell biology and age related disease.

**Cell to system organization and function** – focusing on the cytoskeleton, membrane biology and signalling from subcellular to whole animal systems.

**Cell and tissue biotechnology** – incorporating tissue engineering, development and application of in vitro models and biomarkers of health and disease.

As a group our fundamental strengths are in basic bioscience and biotechnology using a variety of platform technologies from tissue culture to model organisms. We develop and use a range of state-of-the-art technologies including advanced bioimaging, omics-based approaches and computational strategies. Through interdisciplinary research we have and encourage strong links with other science and medical disciplines within our faculty and with external national and international organisations. These include major corporate industries, HE Institutes and NHS Trusts to develop the medical applications of our research and the fundamental knowledge it delivers. This enables us to realise the value and impact of our fundamental research in the health and wellbeing of our society.

**Selected Recent Papers:**


Allen, A.M et al & **Croset, V.** (2020). A single-cell transcriptomic atlas of the adult Drosophila ventral nerve cord. *eLife* 9: e54074.

**Riabinina, O**., et al (2020). An intestinal zinc sensor regulates food intake and developmental growth. *Nature* 580(7802): 263-268.

Carne, NA et al & **Benham AM** (2019). Reductive stress selectively disrupts collagen homeostasis and modifies growth factor-independent signalling through the MAPK/Akt pathway in human dermal fibroblasts. *Molecular and Cellular Proteomics* 18(6): 1123-1137.

**Clark, Rebecca I**. et al (2019). Rapamycin modulates tissue aging and lifespan independently of the gut microbiota in Drosophila. *Scientific Reports* 9(1): 7824.

**Riabinina, O**. et al. (2019). Commonly Used Insect Repellents Hide Human Odors from Anopheles Mosquitoes. *Current Biology* 29(21): 3669-3680.

**Goldberg, Martin**, et al. (2019). The intestinal intermediate filament network responds to and protects against microbial insults and toxins. *Development* 146(2): dev.169482.

**Croset, V.** et al (2018). An expression atlas of variant ionotropic glutamate receptors identifies a molecular basis of carbonation sensing. *Nature Communications* 9(1): 4252.

**Davies, Tim**. et al. (2018). Cell-intrinsic and -extrinsic mechanisms promote cell-type-specific cytokinetic diversity. *eLife* 7: e36204.

**Doupé, D.P.**, et al. (2018). Drosophila intestinal stem and progenitor cells are major sources and regulators of homeostatic niche signals. *Proceedings of the National Academy of Sciences* 115(48): 12218-12223.

**Przyborski, Stefan**, et al (2018). Disrupted alternative splicing for genes implicated in splicing and ciliogenesis causes PRPF31 retinitis pigmentosa. *Nature Communications* 9(1): 4234.


**Group Coordinator:** Dr Adam Benham

**Academic Staff:** Prof Carrie Ambler, Dr Adam Benham, Dr Paul Chazot, Dr Rebecca Clark, Dr Vincent Croset, Dr Tim Davies, Dr David Doupe, Dr Martin Goldberg, Prof. Colin Jahoda, Dr Akis Karakesisoglou, Dr Arto Maatta, Prof. Stefan Przyborski, Dr Susan Pyner, Dr Olena Riabinina, Dr David Weinkove.

# Prof. Carrie Ambler
**Research Group:** ACaS
**Area of Research:**
Biotechnology and
Skin Science

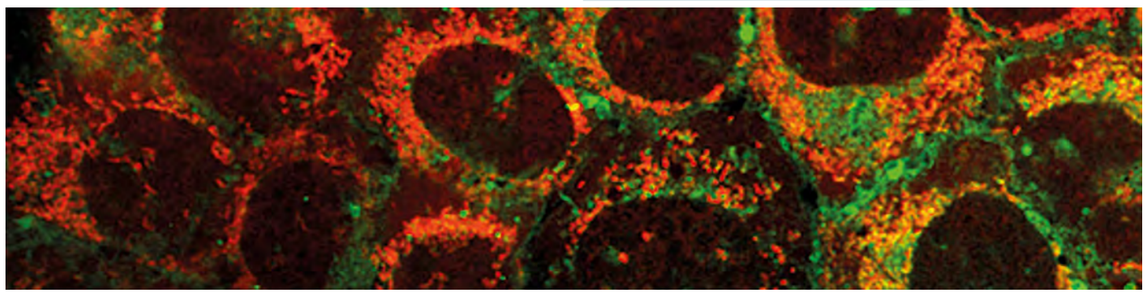
## Abstract of Research Interests:

Carrie Ambler's lab has been studying the interplay between epidermis and how surrounding cell types influence homeostasis and tissue repair. She has extensive experience using human 2D and 3D models to study aspects of epithelial stem cells biology including cell differentiation proliferation, cell division and migration and epithelial stratification. In published studies, the Ambler lab identified cell autonomous roles for Notch in differentiation and cell lineage choice of skin epidermal cells, but has also shown that Notch influences the wider in signaling networks important for maintaining dermal integrity and skin immunity. These projects arose from many clinical, academic and industrial collaborations.

A second focus of the Ambler group is collaborating with chemists and physicists to develop new fluorescence tools for imaging and light-based therapies. This led Prof Ambler to co-found LightOx Ltd in 2016 as a vehicle to exploit the commercial and clinical applications of these collaborations. As a Durham academic (50%) and Chief Scientific Officer (CSO) of LightOx (50%), Prof Ambler is in the position to be able to expand and develop additional inventions within her own academic research, that she will continue to publish in high profile papers and will push forward the translation of this work to help Durham University and LightOx to achieve maximal societal, health and economic impact of this work. To date, this has included initial research endeavours into wider fields including new academic collaborations with plant groups in Newcastle University, bacterial work in Liverpool School of Tropical Medicine, wound healing research in A-Star Singapore and clinical collaborations across oncology, wound healing and infectious diseases.

## Selected Research Publications


1. Li Z, Lamb, R, Coles MC, Bennett CL, **Ambler CA.** Inducible ablation of CD11c+ cells to determine their role in skin wound repair. *Immunology. (*2020)
2. Chisholm DR, Hughes JG, Blacker TS, Humann R, Adams C, Callaghan D, Pujol A, Lembicz NK, Bain AJ, Girkin JM, **Ambler CA.,** Whiting A. Cellular localisation of structurally diverse diphenylacetylene fluorophores. *Org Biomol Chem*. (2020) Sep 23. doi: 10.1039/d0ob01153c.
3. Gala de Pablo J, Chisholm DR, **Ambler CA.,** Peyman SA, Whiting A, Evans SD., Detection and time-tracking activation of a photosensitiser on live single colorectal cancer cells using Raman spectroscopy. *Analyst.* (2020) Aug 24;145(17):5878-5888. doi: 10.1039/d0an01023e. PMID: 32662453
4. Chisholm DR, Lamb R, Pallett T, Affleck V, Holden C, Marrison J, O'Toole P, Ashton PD, Newling K, Steffen A, Nelson AK, Mahler C, Valentine R, Blacker TS, Bain AJ, Girkin J, Marder TB, Whiting A, **Ambler CA.** Photoactivated cell-killing involving a low molecular weight, donor-acceptor diphenylacetylene. *Chem Sci.* (2019) Mar 21;10(17):4673-4683. doi: 10.1039/c9sc00199a. (2018)
5. Bennett CL, **Ambler CA**. Editorial: Langerhans Cells and How Skin Pathology Reshapes the Local Immune Environment.. *Front Immunol.* 2019 Feb 7;10:139. doi: 10.3389/fimmu.2019.00139. (2018)
6. Li Z, Gothard E, Coles MC, **Ambler CA.** Quantitative Methods for Measuring Repair Rates and Innate-Immune Cell Responses in Wounded Mouse Skin. *Front Immunol.* (2018) Feb 27;9:347. doi: 10.3389/fimmu.2018.00347.



# Dr. Adam Benham
**Research Group:** ACaS
**Area of Research:**
Protein Quality Control
in Health and Disease

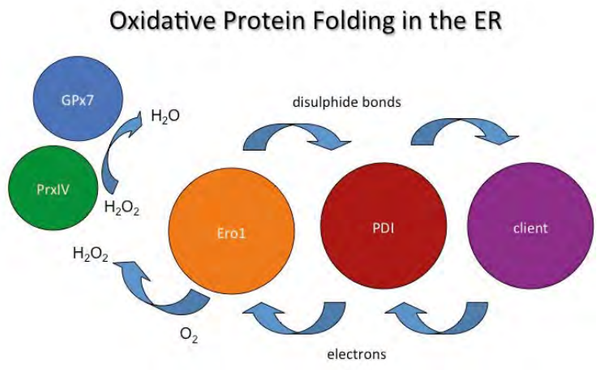
## Abstract of Research Interests:

My groups research focuses on the quality control (QC) of proteins with a focus on the endoplasmic reticulum (ER) and secretory pathway. We study the molecular chaperones and folding factors that regulate oxidative protein folding of a range of clients, and we have a long-standing interest in antigen presentation in the immune system.

We are elucidating the function of Protein Disulfide Isomerase (PDI) family proteins in disease, including a small PDI called AGR2 (oesophageal cancer); PDI itself (Cole-Carpenter syndrome); and PDILT, a tissue specific PDI (male infertility). These projects are in collaboration with James Cook University Hospital, UK; Sheffield University, UK; Osaka University, Japan and UNIFESP, Brazil.

We are working closely with Tim Hawkins, Arto Maatta and others to visualise collagen and melanosome-protein QC and trafficking, using novel imaging reporters in skin cells (with P&G); and we are collaborating with Akis Karakesisoglou and Martin Goldberg to understand redox regulation of the LINC nuclear membrane complex.

Together with Adrian Brown, we are also applying quantitative proteomic technologies to the skin and to the immune system: for example, we have identified a novel pathway of reductive stress signalling in fibroblasts (with P&G) and we are characterising the QC of neoantigen presentation by MHC class II molecules in melanoma, to develop bespoke cancer vaccines (with Scancell and Liverpool University).




## Selected Research Publications


1. Worfolk, JC; Bell, S; Simpson, LD; Carne, NA; Francis, SL; Engelbertsen, V; Brown, AP; Walker, J; Viswanath, YK & **Benham, AM.** (2019). Elucidation of the AGR2 interactome in esophageal adenocarcinoma cells identifies a redox sensitive chaperone hub for the quality control of MUC-5AC. *Antioxidants & Redox Signaling* 31: 1117-1132.
2. Carne, NA; Bell, S; Brown, AP; Maatta, A; Flagler MJ & **Benham AM.** (2019). Reductive stress selectively disrupts collagen homeostasis and modifies growth factor-independent signalling through the MAPK/Akt pathway in human dermal fibroblasts. *Molecular and Cellular Proteomics* 18: 1123-1137.
3. Tokuhiro, K., Satouh, Y., Nozawa, K., Isotani, A., Fujihara, Y., Hirashima, Y., Matsumura, H., Takumi, K., Miyano, T., Okabe, M., **Benham, AM** & Ikawa, M. (2015). Calreticulin is required for development of the cumulus oocyte complex and female fertility. *Scientific Reports*, 5: 14254.
4. Tokuhiro, K., Ikawa, M., **Benham, AM** & Okabe, M. (2012). Protein disulfide isomerase homolog PDILT is required for quality control of sperm membrane protein ADAM3 and male fertility. *Proc. Nat. Acad. Sci. U.S.A*. 109: 3850-3855.
5. van Lith, M., McEwen-Smith, RM & **Benham, AM.** (2010). HLA-DP, HLA-DQ and HLA-DR have different requirements for invariant chain and HLA-DM. J. *Biol. Chem.*, 285: 40800-40808.

Dr. Paul Chazot
**Research Group:** ACaS
**Area of Research:**
Novel rational therapeutics for chronic neurological disorders: drugs and beyond

## Abstract of Research Interests:

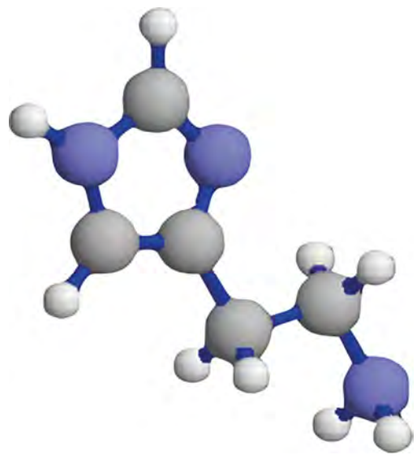
My research group focuses on the identification, characterisation and validation of novel therapeutic candidates (infra-red light & natural products), histamine- & retinoid based drug targets, as well as novel biopsychosocial strategies for the treatment of the major chronic CNS & peripheral disorders.

Chronic pain, delirium, post-concussion syndrome (PCS), motor neuron disease (MND) and diabetic nephropathy are currently lacking in effective treatments. We have validated histamine receptors as new tractable drug targets for these serious refractory medical conditions (eg. Patent: Novel uses for Histacalin in pruritis & neuropathic pain, with Akari (UK) in Europe & US (2017, 2020). In parallel, we have developed the Gabapentinoid & Opioid Tapering Toolbox (GOTT) to provide primary care a viable novel strategy and set of resources to address the UK opioid crisis & impending NICE policy change (www.livewellwithpain.co.uk) ESRC (UK).

We have established a new collaborative study with Dr Karen Hind (Dept. of Sports and Exercise) relating to current and retired elite rugby players health and wellbeing, including a novel rational Post-Concussion Syndrome (PCS) therapeutic (patent pending). We are also a core academic member of the Nevrargenics team focused on developing a novel therapy, based on a synthetic retinoid, for neurodegenerative diseases (https://nevrargenics.com/). We also have two ongoing ESRC DTP NINE projects with DU Anthropology colleagues, focused on following the opioid use and Complementary medicine in End of Life care, respectively. We are developing validated patented all-in-one AI-monitored behavioural tests for both animals (mice, flies - addressing the 3Rs), and humans. Notably, we secured recent funding to develop a new circadian lighting system (Circada) for intensive care, as part of Enlighten delirium project (Innovate UK). The clinical validation of near infra-red (1068 nm) PBM-T therapy for positively treating dementia has continued since 2017, with Dr Marvin Berman (QuietMind Foundation, USA), reporting on large FDA-approved Phase 3 dementia trial in 2021, based on our pre-clinical research since 2002. We are currently developing a rationale and PBM-T protocols for treating CV-19 in the brain.

## Selected Research Publications


1. Hind, K. Konerth, N., Entwistle I., Theadom, A., Lewis, G., King, D., **Chazot, P.L.**, Hulme, P. (2020) Cumulative Sport-Related Injuries and Longer Term Impact in Retired Male Elite- and Amateur-Level Rugby Code Athletes and Non-contact Athletes: A Retrospective Study. *Sports Med.* Jul 16. doi: 10.1007/s40279-020-01310-
2. Ohiomokhare, S., Olaolorun, F., Ladagu, A., Olopade, F., Howes, M-J R., Okello, E., 5 James Olopade, **Chazot, P.L.** (2020) The Pathopharmacological Interplay between Vanadium and Iron in Parkinson's Disease Models. Int J *Mol Sci*. 21(18): 6719.
3. Obara I, Telezhkin V, Alrashdi I, **Chazot P.L.** (2020) Histamine, histamine receptors, and neuropathic pain relief. *Br J Pharmacol.* 177(3):580-599.
4. **Chazot P.L,** Johnston L, Mcauley E, Bonner S. (2019) Histamine and Delirium: Current Opinion. *Front Pharmacol*. Apr 9;10:299. doi: 10.3389/fphar.2019.00299
5. Pini, A., Grangeb, C., Vegliac, E., Argenzianoc, M., Cavallic, R., Guastia, D., Calosia, L., Ghèc, C., Solarinoc, R., Thurmondd, R.L., Camussib, G., **Chazot, P.L.*** & Rosa, .C.* (2017) Overactive histamine H4Rs contribute to the progression of diabetic nephropathy in mice. *Pharmacol*. Res
* Corresponding author.



Dr. Rebecca Clark
**Research Group:** ACaS
**Area of Research:**
Host-microbe interactions during ageing

## Abstract of Research Interests:

Host-associated microbial populations have a significant and wide-ranging influence on the physiology of the host organism. We aim to identify the drivers of this dynamic host-microbe association through the use of the fruit-fly, Drosophila melanogaster, as a simple model organism. We have a particular interest in the impact of the intestinal microbial population on the aging process of the host, and on the maintenance of health, or development of disease, in aged animals.

Our current focus is on dissecting the complex interplay between the intestinal microbial population and immune function. Microbial imbalance and inflammation are tightly linked both during ageing and during disease development.

Our work demonstrates that microbial imbalance drives inflammation and inflammation drives microbial imbalance, setting up a 'death-spiral' that results in rapid decline and mortality. Further, this work has shown that inappropriate immune activation is a driving force in physiological decline and determines much of the impact of microbial imbalance on health. This work highlights the importance of developing interventions that can maintain or restore balance in immune function in aged animals.

## Selected Research Publications


1. Schinaman, J. M., Rana, A., Ja, W. W., **Clark, R. I.**, Walker, D. W (2019) Rapamycin modulates tissue aging and lifespan independently of the gut microbiota in Drosophila. *Science Reports* 9(1): 7824
2. Salazar, A., Resnik-Docampo, M., Ulgherait, M., **Clark, R. I.**, Shirasu-Hiza, M, Jones, D. L., and Walker, D. W. (2018) Intestinal Snakeskin limits microbial dysbiosis during aging and promotes longevity. *iScience* 9: 229-243
3. **Clark, R. I.** & Walker, D. W. (2017) Role of gut microbiota in age-related decline: insights from invertebrate models. *Cell and Molecular Life Sciences*, DOI: 0.1007/s00018-017-2671-1.
4. Resnick-Docampo, M., Koehler, C. L,. **Clark, R. I.**, Schinaman, J. M., Sauer, V., Wong, D. M., Lewis, S., D'Alterio, C., Walker, D. W. & Jones, D. L. (2017) Tricellular junctions regulate intestinal stem cell behavior to maintain homeostasis. *Nature Cell Biology*, 19, 52-59.
5. **Clark, R. I.**, Salazar, A., Yamada, R., Fitz-Gibbon, S., Morselli, M., Rana, A., Alcaraz, J., Rera, M., Pellegrini, M., Ja, W. W. & Walker, D. W. (2015). Distinct shifts in microbiota composition during Drosophila aging impair intestinal function and drive mortality. *Cell Reports*, 12, 1-12.


# Dr. Vincent Croset
**Research Group:** ACaS
**Area of Research:**
Neurogenetics

## Abstract of Research Interests:

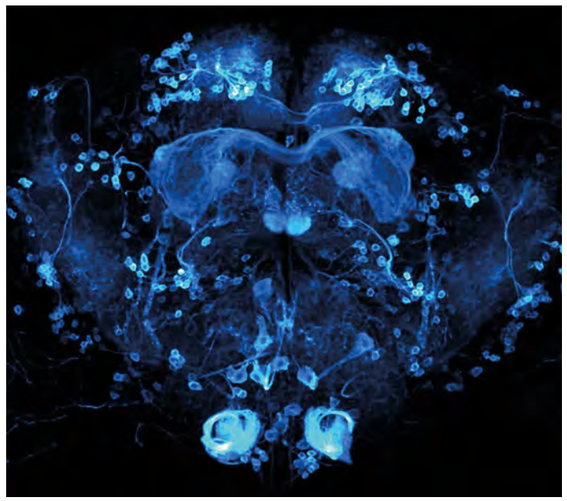
Synaptic plasticity is an essential component of learning and memory because it modifies how neurons respond to stimuli after experience. Whereas synthesis of new proteins is often required to maintain plasticity over time, transcriptional changes linked to neuronal activity and plasticity remain poorly understood.

Psychostimulant drugs such as cocaine and amphetamine target the monoaminergic neurotransmitters dopamine and serotonin, which play essential roles in learning and memory. Repeated use of psychostimulants provokes sensitisation, a learning process resulting in increased drug-induced behavioural responses. In my research group, we use an innovative approach with tools such as single-cell transcriptomics, behavioural assays and neuronal imaging to discover molecular mechanisms linked with stimulant-driven neuronal activity and plasticity, and understand how these contribute to the formation of psychostimulant sensitisation.

Our model of choice is the fruit fly Drosophila melanogaster. The fly brain is 500,000 times smaller than the human brain, and multiple tools exist to manipulate its genes and neuronal circuits. This and the unparalleled knowledge about the anatomy and function of monoaminergic neurons gives us the opportunity to investigate the molecular impact of drug consumption at a resolution that would be impossible to achieve in other organisms. Altogether, our research provides a better understanding of the molecular machinery underlying learning and memory, and highlights potential new targets for treatments against drug dependence.

## Selected Research Publications


1. Allen AM, Neville MC, Birtles S, **Croset V**, Treiber CD, Waddell S, Goodwin SF. (2020) A single-cell transcriptomic atlas of the adult Drosophila ventral nerve cord. *Elife*. Apr 21;9:e54074.
2. Sánchez-Alcañiz JA, Silbering AF, **Croset V**, Zappia G, Sivasubramaniam AK, Abuin L, Sahai SY, Münch D, Steck K, Auer TO, Cruchet S, Neagu-Maier GL, Sprecher SG, Ribeiro C, Yapici N, Benton R. (2018) An expression atlas of variant ionotropic glutamate receptors identifies a molecular basis of carbonation sensing. *Nat Commun.* Oct 12;9(1):4252.
3. **Croset V**, Treiber CD, Waddell S. (2018) Cellular diversity in the Drosophila midbrain revealed by single-cell transcriptomics. *Elife*. Apr 19;7:e34550.
4. Knecht ZA, Silbering AF, Cruz J, Yang L, **Croset V**, Benton R, Garrity PA. (2017) Ionotropic Receptor-dependent moist and dry cells control hygrosensation in Drosophila. *Elife*. Jun 16;6:e26654.
5. **Croset V**, Schleyer M, Arguello JR, Gerber B, Benton R. (2016) A molecular and neuronal basis for amino acid sensing in the Drosophila larva. *Sci Rep*. Dec 16;6:34871

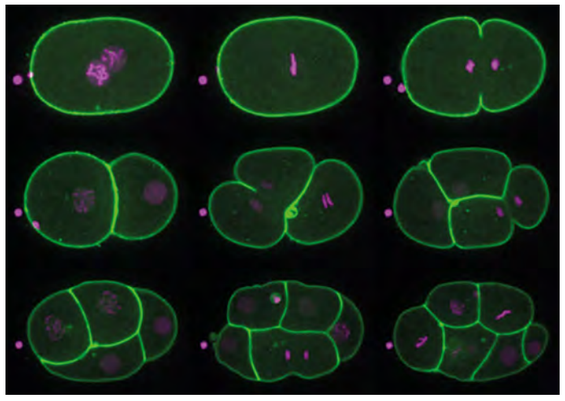


# Dr. Tim Davies
**Research Group:** ACaS
**Area of Research:**
Cell Division

## Abstract of Research Interests:

My research focuses on cytokinesis, the process by which one cell physically divides into two at the end of mitosis. This process is fundamental for life, and errors can result in abnormal chromosomal numbers, developmental defects, and cancers. Work over the last century has shown that cytokinesis in animal cells requires a carefully synchronised set of molecular signals that promote the formation of a contractile ring around the cell equator, which then constricts to divide the cell. Although this appears to occur similarly in a variety of animal model systems and cell types, clinical studies have shown tissue-specific division failure due to mutations in cytokinetic proteins. My previous work has shown that in the early *Caenorhabditis elegans* embryo the requirement for an 'essential' cytokinesis protein varies between specific cells. These results highlight an under-appreciated intersection between cell identity and cell division. Therefore, our lab is expanding work in this area, analysing cell division in a multicellular context to identify how cells from the same organism are regulated in different ways during cytokinesis.

Our primary model is *C. elegans*, a small (1mm) nematode worm that has been extensively studied over the last fifty years. This model has several features that make it an excellent model, including a stereotyped development, well-characterised genetic tools and signalling pathways, and large embryos that can be monitored by live-cell fluorescence microscopy (shown below). Taking advantage of these features, we investigate how cell identity influences cytokinesis in the early C. elegans embryo.



## Selected Research Publications


1. Hirsch SM, Sundaramoorthy S, **Davies T**, Zhuravlev Y, Waters JC, Shirasu-Hiza M, Dumont J, and Canman JC. 2018. FLIRT: Fast Local InfraRed Thermogenetics for subcellular control of protein function. *Nature Methods* (15) 921–923 DOI: 10.1038/s41592-018-0168-y
2. **Davies T**, Kim HX, Romano Spica N, Lesea-Pringle BJ, Dumont J, Shirasu-Hiza M, and Canman JC. (2018) Cell-intrinsic and -extrinsic mechanisms promote cell-type-specific cytokinetic diversity. *eLife* 2018;7:e36204 DOI: 10.7554/eLife.36204
3. Sundaramoorthy S, Garcia Badaracco A, Hirsch S, Park JH; **Davies T**, Dumont J, Shirasu-Hiza M, Kummel A, and Canman JC. (2017) Low efficiency upconversion nanoparticles for high-resolution coalignment of near-infrared and visible light paths on a light microscope. *ACS Applied Materials & Interfaces* (9) 7929 – 7940 DOI: 10.1021/acsami.6b15322
4. Jordan SN, **Davies T**, Zhuravlev Y, Dumont J, Shirasu-Hiza M, and Canman JC. (2016) Cortical PAR polarity proteins promote robust cytokinesis during asymmetric cell division. *Journal of Cell Biology* (212) 39 – 49 DOI: 10.1083/jcb.201510063
5. **Davies T**, Kodera N, Kaminski Schierle GS, Rees E, Erdelyi M, Kaminski CF, Ando T, and Mishima M. 2015. CYK4 promotes antiparallel microtubule bundling by optimizing MKLP1 neck conformation. *PLoS Biology* 13(4):e1002121 DOI: 10.1371/journal.pbio.1002121
6. **Davies T**, Jordan SN, Chand V, Sees JA, Laband K, Carvalho AX, Shirasu-Hiza M, Kovar DR, Dumont J, and Canman JC. 2014. High-Resolution Temporal Analysis Reveals a Functional Timeline for the Molecular Regulation of Cytokinesis. *Developmental Cell* (30) 209 – 223 DOI: 10.1016/j.devcel.2014.05.009

Dr. David Doupé
**Research Group:** ACaS
**Area of Research:**
Regulation of Epithelial Stem Cells

## Abstract of Research Interests:

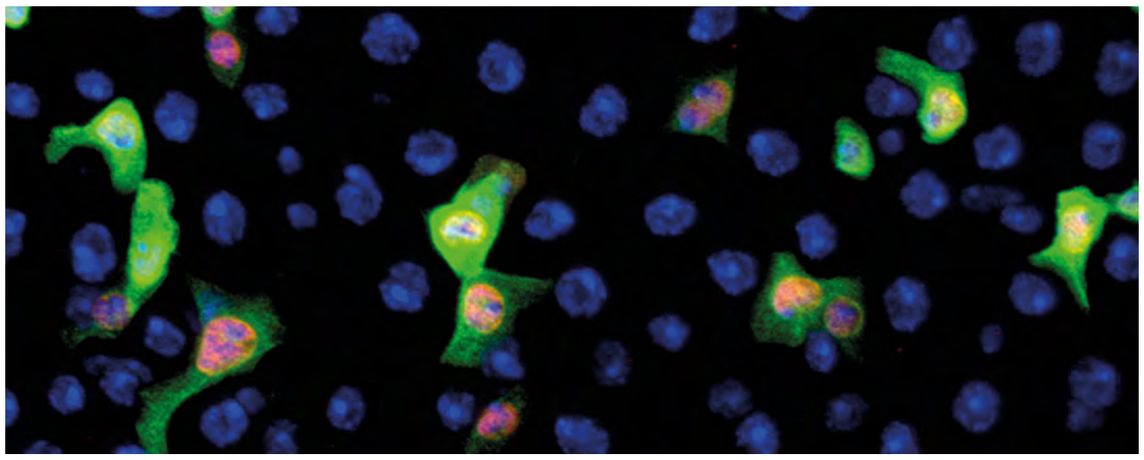
The epithelia that line the surface of the skin and our internal organs are constantly turned over. Cells are lost from the surface and replaced by the proliferation of stem cells. These stem cells must be tightly regulated as an overproduction of new cells can lead to cancer, and the majority of cancers are of epithelial origin.

We use the intestinal stem cells of the fruit fly, *Drosophila melanogaster*, to better understand epithelial stem cell regulation. Fly intestinal stem cells behave in similar ways to mammalian epithelial stem cells and are regulated by many of the same, conserved signalling pathways. Combined with the powerful genetic tools in the fly, this conservation makes them an excellent model. Research in the lab uses a combination of genetic screens, confocal imaging, and genomics approaches to study genes and mechanisms involved in maintaining stem cell homeostasis that may be mis-regulated in ageing or cancer.

Current projects include identification and characterization of new epithelial stem cell regulators, and analysing changes in gene expression and chromatin states in ageing stem cells.

## Selected Research Publications


1. **Doupé, D.P.**, Marshall, O.J., Dayton, H., Brand, A.H. and Perrimon, N. (2018) Drosophila intestinal stem and progenitor cells are major sources and regulators of homeostatic niche signals. *Proceedings of the National Academy of Sciences of the U.S.A.*, 115, 12218-12223.
2. Cliffe, A., **Doupé, D.P.**, Sung, H., Lim, I.K.H., Ong, K.H, Cheng, L., & Yu, W. (2017) Quantitative 3D analysis of complex single border cell behaviors in coordinated collective cell migration. *Nature Communications*, 8, #14905.
3. **Doupé, D.P.** & Perrimon, N. (2016) Toward a systems understanding of signaling pathway function. *Essays on Developmental Biology, Part B*, 117, #221.
4. **Doupé, D.P.** & Perrimon, N. (2014) Visualizing and manipulating temporal signaling dynamics with fluorescence-based tools. *Science Signaling*, 7(319), re1.
5. **Doupé, D.P.** & Jones, P.H. (2013) Cycling progenitors maintain epithelia while diverse cell types contribute to repair. *Bioessays*, 35, 443-451.
6. **Doupé, D.P.**, Alcolea, M.P., Roshan, A., Zhang, G., Klein, A.M., Simons, B.D. & Jones, P.H. (2012) A single progenitor population switches behavior to maintain and repair esophageal epithelium. *Science*, 337, 1091-1093.

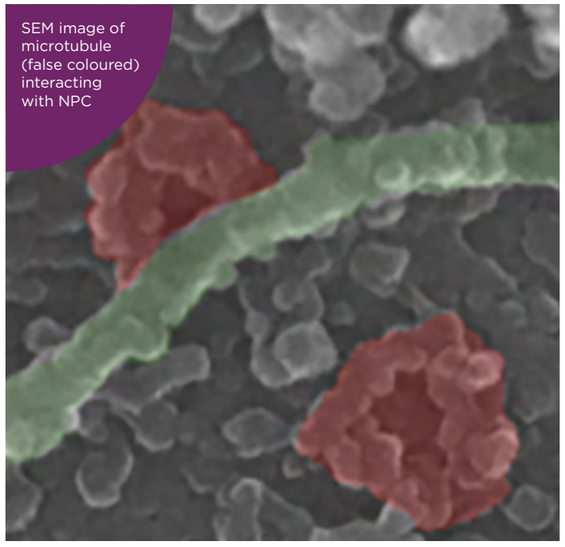





Dr. Martin Goldberg
**Research Group:** ACaS
**Area of Research:**
Cell structure/dynamics, nuclear envelope, electron and light microscopy

## Abstract of Research Interests:

My research focuses on cell structure and dynamics, and methods to image cellular processes. We have a particular interest in the nuclear envelope, the nuclear pore complex, nucleocytoplasmic transport and their associations with the cyto- and nucleo-skeletons (with Karakesisoglou). We study membrane trafficking, e.g. endocytosis in yeast (Ayscough, Sheffield), and dis/re-assembly of nuclear membranes (Schirmer, Edinburgh).
We have developed methods to image biological surfaces, such as the interaction between nuclear pore complexes and microtubules at high resolution, with complementary 3D “super resolution” light microscopy (with Tim Hawkins). With Christine Richardson, we are developing methods to directly correlate super resolution light microscopy with both transmission and scanning electron microscopy, as well as cryo-preparation methods for electron microscopy, for optimal structural preservation and immuno-labelling, particularly in model organisms such as yeast, worms, flies and plants, as well as mammalian systems. Using these methods we are studying the role of intrinsically disordered protein domains in transport through the nuclear pore complex, the role of nucleoporins in cancer, and how the cytoskeleton interacts with the nuclear pore complex.



SEM image of microtubule (false coloured) interacting with NPC

## Selected Research Publications


1. Saiz-Ros N, Czapiewski R, Epifano I, Stevenson A, Swanson SK, Dixon CR, Zamora DB, McElwee M, Vijayakrishnan S, Richardson CA, Dong L, Kelly DA, Pytowski L, **Goldberg MW,** Florens L, Graham SV, Schirmer EC. Host Vesicle Fusion Protein VAPB Contributes to the Nuclear Egress Stage of Herpes Simplex Virus Type-1 (HSV-1) *Replication. Cells. (*2019) 8:120.
2. James C, Müller M, **Goldberg MW,** Lenz C, Urlaub H, Kehlenbach RH. Proteomic mapping by rapamycin-dependent targeting of APEX2 identifies binding partners of VAPB at the inner nuclear membrane. J *Biol Chem. (*2019) 294:16241-16254.
3. de Castro,Ines. Budzak,James. Di Giacinto,Maria L. Ligammari,Lorena. Gokhan,Ezgi. Spanos,Christos. Moralli,Daniela. Richardson, Christine., de las Heras,Jose I. Salatino,Silvia. Schirmer,Eric C. Ullman,Katharine S. Bickmore,Wendy A. Green,Catherine. Rappsilber,Juri. Lamble,Sarah. **Goldberg, M.W.**, Vinciotti, Veronica. & Vagnarelli, Paola. (2017). Repo-Man/PP1 regulates heterochromatin formation in interphase. *Nature Communications* 8, #14048.
4. **Goldberg MW.** (2017) Nuclear pore complex tethers to the cytoskeleton. *Semin. Cell Dev. Biol.* 68, 52-58.
5. Smaczynska-de Rooij, Iwona I., Marklew, Christopher J., Allwood, Ellen G., Palmer, Sarah E., Booth, Wesley I., Mishra, Ritu, **Goldberg, M.W.** & Ayscough, Kathryn R. (2016). Phosphorylation Regulates the Endocytic Function of the Yeast Dynamin-Related Protein Vps1. Molecular and Cellular *Biology*, 36, 742-755.
6. Liu, Hebin, Schneider, Helga, Recino, Asha, Richardson, Christine, **Goldberg, M.W.** & Rudd, Christopher E. (2015). The Immune Adaptor SLP-76 Binds to SUMO-RANGAP1 at Nuclear Pore Complex Filaments to Regulate Nuclear Import of Transcription Factors in T Cells. *Molecular Cell,* 59, 840-849.

Prof. Colin Jahoda
**Research Group:** ACaS
**Area of Research:**
Development, growth & regeneration of skin

## Abstract of Research Interests:

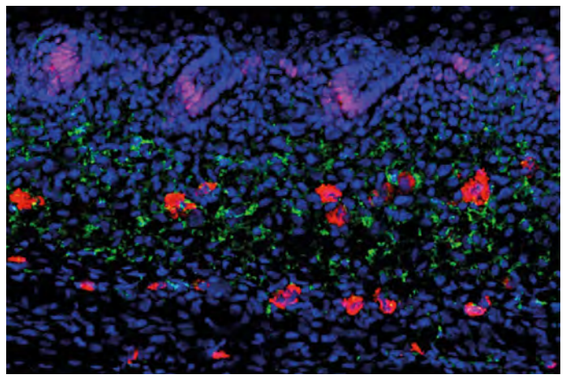
My research profile spans developmental biology, translational skin biology and stem cell biology. A key area of my research is on the development, growth and regeneration of skin, and the principal experimental model that I have worked on throughout my career is the hair follicle. Indeed the multifaceted nature of hair follicle biology has given me a rich choice of questions to pursue.

Much of my basic experimental work has involved unpicking the epithelial-mesenchymal interactions that control the induction of skin appendages, at the cellular and molecular level. These studies, together with, work on individual stem cell/progenitor populations from hair follicles, have underpinned more translational research projects on wound healing and regeneration, the production of in vitro skin models for skin replacement and human hair follicle regneration. However they have also permitted me to branch out into other epithelial models such as the eye cornea, and one of my current questions of interest is the epigenetics of epithelial transdifferentiation, where one type of epithelia such as skin epidermis, is turned into cornea. My other current preoccupation is with skin adipose tissue (fat) that we and others have recently shown derives developmentally from the skin dermis. The wide-ranging developmental, physiological and evolutionary implications of this finding are fascinating.

Work performed by my group in Durham (and a collaborator at Columbia University in New York) on hair follicle induction, has provided the platform for research and commercialisation of this concept worldwide. It also underpinned the major element of an Impact case submitted by the department in the 2104 REF. I am also co-chair of NESCI, a virtual stem cell institute largely spearheaded by Newcastle University.

## Selected Research Publications


1. Liu, Jun, Higgins, Claire A., Whitehouse, Jenna C., Harris, Susan J., Crawford, Heather, Christiano, Angela M., Lako, Majlinda, Hole, Nicholas & **Jahoda, Colin A. B.** (2018). Hair Follicle Dermal Cells Support Expansion of Murine and Human Embryonic and Induced Pluripotent Stem Cells and Promote Haematopoiesis in Mouse Cultures. *Stem Cells International* 2018: 8631432.
2. Abaci, Hasan Erbil, Coffman, Abigail, Doucet, Yanne, Chen, James, Jacków, Joanna, Wang, Etienne, Guo, Zongyou, Shin, Jung U., **Jahoda, Colin A.** & Christiano, Angela M. (2018). Tissue engineering of human hair follicles using a biomimetic developmental approach. *Nature Communications* 9(1): 5301.
3. Glover JD, Wells KL, Matthäus F, Painter KJ, Ho W, Riddell J, Johansson JA, Ford MJ, **Jahoda C.A.B.**, Klika V, Mort RL, Headon DJ. (2017) Hierarchical patterning modes orchestrate hair follicle morphogenesis. *PLoS Biol*, 15, e2002117.
4. Higgins CA, Roger MF, Hill RP, Ali-Khan AS, Garlick JA, Christiano AM, **Jahoda C.A.B.** (2017) Multifaceted role of hair follicle dermal cells in bioengineered skins. *Br. J. Dermatol.*, 176, 1259-1269.
5. Mardaryev, A.N., Liu, B., Rapisarda, V., Poterlowicz, K., Malashchuk, I., Rudolf, J., Sharov, A.A., **Jahoda, C.A.**, Fessing, M.Y., Benitah, S.A., Xu, G.-L. & Botchkarev, V.A. (2016). Cbx4 maintains the epithelial lineage identity and cell proliferation in the developing stratified epithelium. *The Journal of Cell Biology* 212(1): 77-89.



Dr. Akis Karakesisoglou
**Research Group:** ACaS
**Area of Research:**
Nuclear biomechanics in skin tissue homeostasis and breast cancer metastasis

## Abstract of Research Interests:

**Research:** The role of the nuclear envelope (NE) and associated structures (LINC complex) in physiological ageing and in ageing-associated disorders such as breast cancer.

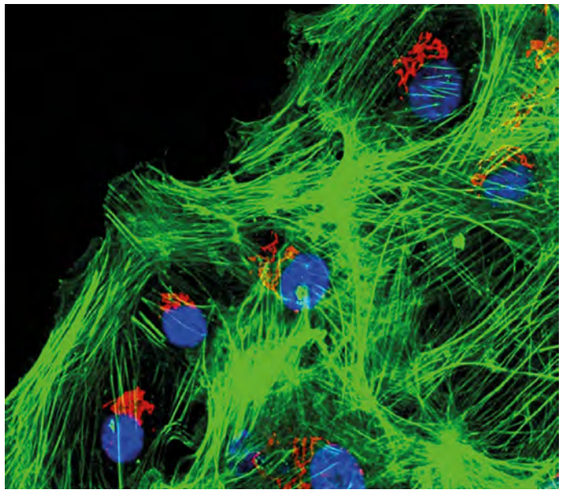
**Aim:** Develop innovative research platforms and conduct multidisciplinary studies to understand how healthy nuclei control cell behaviour, sense and elicit protective responses to environmental stress-factors including time, specify cell-fates and command assembly into complex life forms.

**Hypothesis:** Nuclei contain sensory devices on their surface that empower them with key structural and communication properties that determine genome (cell) "blueprint", enable multi-cellular assembly and protect cells from damage.

**Results:** We showed that the LINC complex is absent in cells that extra-vasate or intra-vasate (e.g. granulocytes), arguing that LINC complex protein downregulation increases nuclear malleability and favours migration in restrictive 3D environments (Olins et al 2009, **Eur. J. Cell Biol.** 88, 203-214). We have recently expanded on this and have strong data suggesting that in aggressive breast cancers the LINC complex is significantly deregulated favouring transmigration of cells by softening the cancer nuclei (**Papers in preparation**). Moreover, we have data that the LINC complex is key in the stratification of epithelia. We published recently a paper showing that LINC complex components are under p63 control (Rapisarda et al 2017). p63 is a master transcription factor that regulates skin formation. Finally, we have invented a new method (**Patent Application No.:** GB1701438.2) to create model skin tissue, which surprisingly and counterintuitively, does not require a biomimetic scaffold to simulate the extracellular microenvironment of skin tissue. The method works through a subtle intervention to disrupt the biophysical/molecular pathway through which external physical stimuli are transmitted through a cell's cytoskeleton to produce signal responses within the nucleus. Cells become effectively 'blinded' to their external mechanical environment and form tissue without the need for external cues.

## Selected Research Publications


1. Rapisarda V., Malashchuk I., Asamaowei I.E., Poterlowicz K., Fessing M.Y., Sharov A.A., **Karakesisoglou, I.**, Botchkarev V.A., Mardaryev A. (2017) p63 transcription factor regulates nuclear shape and expression of nuclear envelope-associated genes in epidermal keratinocytes. *Journal of Investigative Dermatology,* doi: 10.1016/j.jid.2017.05.013.
2. Cartwright, S. & **Karakesisoglou, I.** (2014). Nesprins in health and disease. *Seminars in Cell and Developmental Biology* 29, 169-179.
3. Lu W., et al. & **Karakesisoglou I.** (2012) Nesprin interchain associations control nuclear size. Cell. Mol. *Life Sci.*, 69, 3493-3509.
4. Lui-Roberts W., et al. incl. **Karakesisoglou I.** (2012) CTL effector function is independent of nucleus-centrosome dissociation. *Eur. J. Immunol*., 42, 2132-2141.
5. Rashmi R.N. et al. incl. **Karakesisoglou I.** (2012) Roles for nuclear envelope associated Nesprin-2 Giant in cell differentiation, proliferation and chromatin association in a mouse model. *Nucleus*, 3, 172-186.
6. Schneider M., et al. & **Karakesisoglou I.** (2011) Molecular mechanisms of centrosome and cytoskeleton anchorage at the nuclear envelope. *Cell. Mol. Life Sci*., 68, 1593-1610.

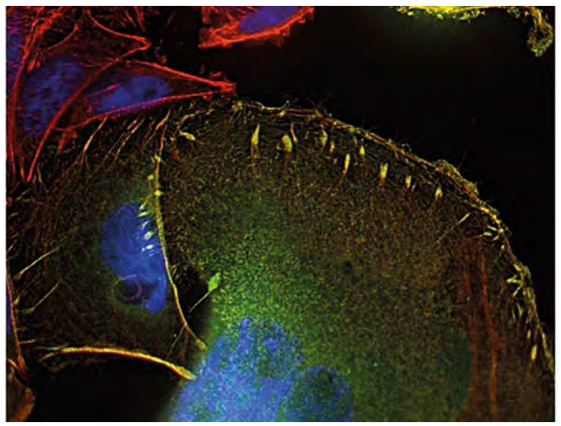



Dr. Arto Maatta
**Research Group:** ACaS
**Area of Research:**
Epithelial Cell Biology

## Abstract of Research Interests:

My research is focused on the cell biology of the cytoskeleton in mammalian skin and other epithelial organs. The two main areas that we are interested in are the differentiation of epidermal cells and the biology of epithelial cancers. We have investigated the function of cytoskeletal linker proteins, such as plectin and periplakin, that connect cytoskeletal networks to cell adhesion sites and make bridges between the different networks. Currently we are especially interested in how cell-matrix interactions and matrix density can influence keratinocyte differentiation and proliferation. In our studies on epithelial carcinomas we aim to understand how cytoskeletal linker proteins and intermediate filament cytoskeleton regulate cell migration. To this end we are studying breast, colon and skin cancer cell lines and utilising RNA interference to knock down expression of proteins implicated in migration and invasion.

Another key research area is the developmental acquisition and maintenance of the epithelial barrier function, again with an emphasis on cytoskeletal proteins. This research interest has also been a catalyst for an industrial collaboration with P&G. In these industrial projects, we have investigated skin ageing and the use of skin culture models with Prof Stefan Przyborski and Dr Akis Karakesisoglou, novel imaging methods to investigate and quantify structural organisation and damage in human hair, and skin cell biomechanics and intracellular trafficking with Dr Tim Hawkins and Dr Adam Benham.



## Selected Research Publications


1. Johnson S, Cowley K, Hawkins TJ, **Määttä A.** (2019) Pulling force deforms hair follicle root sheath nuclei and surrounding dermal collagen matrix differently at infundibulum, isthmus and suprabulbar regions. *Exp Dermatol*. 28, 862-866
2. Carne NA, Bell S, Brown AP, **Määttä A**, Flagler MJ, Benham AM. (2019) Reductive stress selectively disrupts collagen homeostasis and modifies growth factor-independent signalling through the MAPK/Akt pathway in human dermal fibroblasts. *Mol. Cell. Proteomics*. 18, 1123-1132
3. Roger M, Fullard N, Costello L, Bradbury S, Markiewicz E, O'Reilly S, Darling N, Ritchie P, **Määttä A**, Karakesisoglou I, Nelson G, von Zglinicki T, Di Colandrea T, Isfort R, Bascom C, Przyborski S. (2019) Bioengineering the microanatomy of human skin. *J. Anatomy*, 234, 438-455
4. Duit R, Hawkins T, **Määttä A.** (2019) Depilatory chemical thioglycolate affects hair cuticle and cortex, degrades epidermal cornified envelope and induces proliferation and differentiation responses in keratinocytes. *Exp Dermatol.* 28, 76-79
5. Marsh J, Whitaker S, Felts T, Shearouse W, Vatter M, **Määttä A**, Thompson M, Hawkins TJ. (2018) The role of internal lipids in hair health. *J. Cosmetic Science*. 69, 347-356
6. Maruthappu T, McGinty LA, Blaydon DC, Fell B, **Määttä A**, Duit R, Hawkins T, Braun KM, Simpson MA, O'Toole EA, Kelsell DP. (2018) Recessive Mutation in FAM83G Associated with Palmoplantar Keratoderma and Exuberant Scalp Hair. *J Invest Dermatol*. 138, 984-987.
7. Boczonadi, V. & **Määttä, A**. (2016) Functional analysis of envoplakin and periplakin, cytoskeletal linkers and cornified envelope precursors. *Methods Enzymol.,* 569, 309-329.

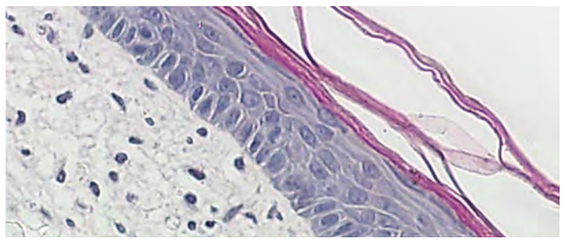



Prof. Stefan Przyborski
**Research Group:** ACaS
**Area of Research:**
Advanced Tissue Technologies

## Abstract of Research Interests:

Engineering human tissues in the laboratory creates multiple opportunities to advance basic research and discovery, develop new platforms for testing drugs and the safety assessment of chemicals and importantly replacing the use of animals in research and development. My research group researches and develops innovative new strategies that enable the construction of human tissues in vitro from cell lines, primary tissues and stem cells. We have pioneered the development of a novel membrane technology that can be used in multiple ways, including construction of layered structures that simulate the anatomy of tissues such as skin, intestine, etc. We focus heavily on validation of such models ensuring that their anatomy and physiology align with real human tissue. Moreover, we consider how other factors in the microenvironment in vitro, such as oxygen, perfusion, topography, influence cell structure and function during tissue formation. Our research is highly collaborative with academic and industrial partners. It has far-reaching applications and we produce outputs relevant to both basic and applied science. Our technology has been fully commercialised and our product, Alvetex Scaffold, is available via Reprocell Europe and is the market-leading scaffold technology for 3D cell culture with a wide variety of uses. For further details concerning Alvetex technology visit **https://www.reprocell.com/brand-alvetex-i26**

Research continues to further improve the culture environment to enhance human tissue growth in vitro enabling the construction of new tissue equivalents, such as specialised skin systems (e.g. pigmentation, UV exposure), buccal mucosa, nasal epithelium, etc. These models are applied to investigate fundamental questions in cell biology such as in human skin ageing, the formation of the epidermal barrier, epithelial/stromal signalling, immunology, and the mechanisms by which cells alter their structure and function in response to changes in their physical surroundings.



## Selected Research Publications


1. Darling NJ, Mobbs CL, Gonzáles-Hau AL, Freer M, **Przyborski S.** Bioengineering novel in vitro co-culture models that represent the human intestinal mucosa with improved Caco-2 structure and barrier function. *Frontiers in Bioengineering and Biotechnology* (2020) https://doi.org/10.3389/fbioe.2020.00992
2. Hoyle HW, Smith LA, Williams RJ, **Przyborski SA**. Applications of novel bioreactor technology to enhance the viability and function of cultured cells and tissues. *Interface Focus*. (2020) Apr 6;10(2):20190090. doi: 10.1098/rsfs.2019.0090.
3. Costello L, Fullard N, Roger M, Bradbury S, Dicolandrea T, Isfort R, Bascom C, **Przyborski S**. Engineering a Multilayered Skin Equivalent: The Importance of Endogenous Extracellular Matrix Maturation to Provide Robustness and Reproducibility. *Methods Mol Biol*. (2019) ;1993:107-122. doi: 10.1007/978-1-4939-9473-1_9.
4. Anzilotti C, Swan DJ, Boisson B, et al. An essential role for the Zn2+ transporter ZIP7 in B cell development. *Nat Immunol*. (2019) Mar;20(3):350-361. doi: 10.1038/s41590-018-0295-8.
5. Roger M, Fullard N, Costello L, Bradbury S, Markiewicz E, O'Reilly S, Darling N, Ritchie P, Määttä A, Karakesisoglou I, Nelson G, von Zglinicki T, Dicolandrea T, Isfort R, Bascom C, **Przyborski S.** Bioengineering the microanatomy of human skin. *J Anat*. (2019) Feb 10. doi: 10.1111/joa.12942.
6. Clarke, K.E., Tams, D.M., Henderson, A.P., Roger, M.F., Whiting, A. & **Przyborski, S.A.** (2017). A robust and reproducible human pluripotent stem cell derived model of neurite outgrowth in a three-dimensional culture system and its application to study neurite inhibition. *Neurochemistry International*, 106, 74-84.

Dr. Susan Pyner
**Research Group:** ACaS
**Area of Research:**
Autonomic Neuroscience

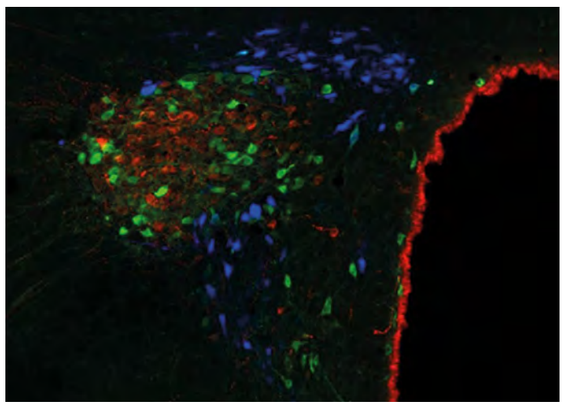
## Abstract of Research Interests:

In mammals, the balance of activation between the sympathetic and parasympathetic branches of the autonomic nervous system is essential for homeostatic control of many end organs.
A characteristic of aging and certain pathological conditions such as heart failure sees a disturbance in this balance, whereby sympathetic activity becomes dominant over parasympathetic. The autonomic dysregulation while viewed as a normal consequence of aging, however, is negatively correlated with survival in heart failure. Therefore, identifying the mechanisms responsible for normal autonomic regulation are crucial in order to understand the shift towards sympathetic dominance in old age let alone in pathological states.

Autonomic controlled end organ homeostasis comprises a complex central neural circuit. Afferent (sensory) information concerning blood flow, temperature, oxygen saturation, for example is received centrally, integrated and the efferent outflow (sympathetic and parasympathetic) adjusted to maintain end organ function. We use neuroanatomical techniques such as tract tracing and immunohistochemistry to identify the neural circuits and cellular components needed to keep autonomic regulation in balance. For example, we have identified mechanosensitive ion channels in the heart associated with nerves that signal blood volume status to the brain. In partnership with collaborators in University College Dublin, we are investigating the functional implications of this for cardiovascular homeostasis. Other projects explore the mechanisms integrating body fluid osmolality with central autonomic activation within the paraventricular nucleus of the hypothalamus. The overall aims of the research are to mechanistically understand autonomic end organ homeostasis and how inappropriate autonomic adjustments lead towards pathological disturbances with poor prognosis.

## Selected Research Publications


1. Shenton FC, Campbell T, Jones JFX & **Pyner S.** (2020). Distribution and morphology of sensory and autonomic fibres in the subendocardial plexus of the rat heart. *J. Anat., Doi*:10.1111/joa.13284.
2. Shenton FC & **Pyner S.** (2018). Transient receptor potential vanilloid type 4 is expressed in vasopressinergic neurons within the magnocellular subdivision of the rat paraventricular nucleus of the hypothalamus. *J. Comp. Neurol*., 526, 3035-3044.
3. Cork, S.C., Chazot, P.L. & **Pyner, S.** (2016). Altered GABAA a5 subunit expression in the hypothalamic paraventricular nucleus of hypertensive and pregnant rats. *Neurosci. Letts.*, 620, 148-153.
4. Kataky, R., et al. incl. **Pyner, S.** & Shenton F. (2015). Graphene oxide nanocapsules within silanized hydrogels suitable for electrochemical pseudocapacitors. *Chem. Comms.*, 51, 10345-10348.
5. Shenton FC & **Pyner S** (2014). Expression of transient receptor potential channel TRPC1 and TRPV4 in venoatrial endocardium of the rat. *Neuroscience*, 267, 195-204.
6. Affleck VS, Coote JH, **Pyner S** (2012). The projection and synaptic organization of NTS afferent connections with presympathetic neurons, GABA and nNOS neurons in the paraventricular nucleus of the hypothalamus. *Neuroscience*, 219, 48-61.



Dr. Olena Riabinina
**Research Group:** ACaS
**Area of Research:**
Sensory neuroscience, Sensory Ecology, Genetic tools

## Abstract of Research Interests:

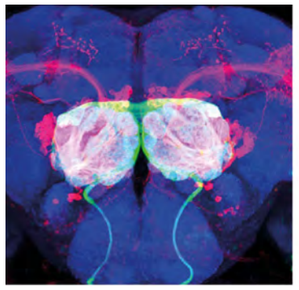
I set up my group at Durham in 2019, and currently we are 5 people, including 2 undergraduate researchers. My research interests are in insect sensory neuroscience, sensory ecology and genetic tools. Currently my lab focusses on figuring out how adult and larval mosquitoes detect and process various smells. We are also interested in the chemicals (volatile and non-volatile) that mosquitoes and other insects produce, because these chemicals often serve as insects pheromones. We also continue my previous work on the Q-system – a genetic tool for transgene expression that works in various organisms from flies to mosquitoes to fish and plants. In the lab we rear Drosophila and malaria mosquitoes Anopheles gambiae, and a range of projects are always available on these two species. We are also interested in insects more broadly, and are considering a variety of fieldwork-based comparative projects on e.g. mosquitoes and bumblebees.

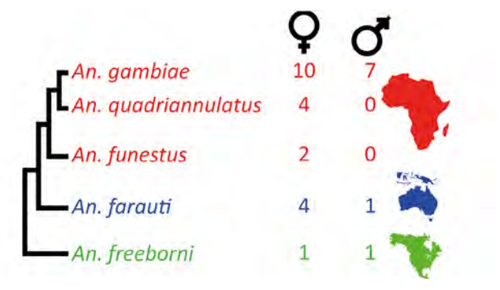
We employ techniques of molecular biology, behavioural assays, live fluorescent imaging, immunohistochemistry, confocal and light sheet imaging, field collections of insects and GC/MS analysis (in collaboration with the University of Würzburg, Germany). In the future we also plan to set up electrophysiology recordings in the lab.

I am always keen to support undergraduate and Master projects and applications for scholarships and fellowships. More about my lab is available here: **insectneurolab.com.**

## Selected Research Publications


1. Redhai S, Pilgrim C, Gaspar P, van Giesen L, Lopes T, **Riabinina O**, Grenier T, Milona A, Chanana B, Swadling JB, Wang Y-F, Dahalan F, Yuan M, Wilsch-Brauninger M, Lin W-H, Dennison N, Capriotti P, Lawniczak MKN, Baines RA, Warnecke T, Windbichler N, Leulier F, Bellono N, Miguel-Aliaga I (2020) An intestinal zinc sensor regulates food intake and developmental growth. *Nature*, 580, 263–268
2. Afify A, Betz J, **Riabinina O**, Lahondere C, Potter CJ (2019) Commonly used insect repellents hide human odors from Anopheles mosquitoes. *Current Biology*, 29, 1-12
3. Mansourian S, Fandino R, **Riabinina O** (2019) Progress in the use of genetic methods to study insect behaviour outside Drosophila. *Current Opinion in Insect Science*, 36, 45-56. Invited review.
4. **Riabinina O**, Vernon S, Dickson BJ, Baines RA. (2019) Split-QF system for fine-tuned transgene expression in Drosophila. *Genetics*, 212, 1, 53-63
5. **Riabinina O**, Task D, Marr E, Lin C-C, Alford R, O'Brochta DA, Potter CJ. (2016) Organization of olfactory centers in the malaria mosquito Anopheles gambiae. *Nature Communications*, 7, 13010
6. **Riabinina O**, Luginbuhl D, Marr E, Liu S, Wu MN, Luo L, Potter CJ. (2015) Improved and expanded Q-system reagents for genetic manipulations. *Nature Methods*, 12, 219-222
7. Gao XJ, **Riabinina O**, Potter CJ, Clandinin TR, Luo L (2015) A transcriptional reporter of intracellular Ca2+ in Drosophila. *Nature Neuroscience*, 18, 917-925.



Dr. David Weinkove
**Research Group:** ACaS
**Area of Research:**
Ageing and microbes using *C. elegans*

## Abstract of Research Interests:

My research is focussed on understanding how bacteria influence ageing. We discovered that inhibiting folate synthesis in E. coli slows ageing in the nematode worm C. elegans and conducted the first systematic screen of E. coli mutants for increase in C. elegans lifespan which revealed E. coli mutants that extend lifespan. We found that folic acid supplements contain breakdown products that can only be taken up by gut bacteria, with possible negative consequences for health (Maynard et al. 2018). We have shown that E. coli accelerate ageing, and current projects in the lab (James Groombridge and Giulia Zavagno) are working out the mechanisms to identify suitable drug targets for age-related disease.

In collaboration with Chris Saunter, Physics, we have developed imaging technology to monitor worms non-invasively, and measure healthspan in large numbers of C. elegans populations. This technology led to the establishment of a spinout company Magnitude Biosciences, which investigates compounds and other interventions for biotech companies and academics.

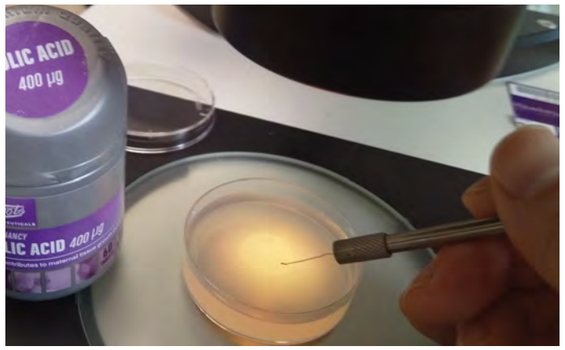
Another project is developing methods to use C. elegans as a bioprocessing tool for immunomodulating proteins from parasitic nematodes.

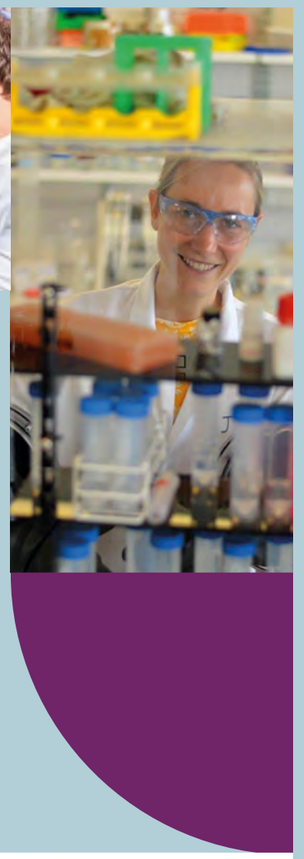
**Impact:** Our spinout company, Magnitude Biosciences has gained £625k and has a workforce of 10 people at its base at NETPark in Sedgefield. It has industrial customers across Europe and the US.

We are in discussions with clinicians at Kings College London (Twin studies) to work on how folic acid supplements impact the microbiome and health. I was a Keynote speaker at the London Microbiome Meeting to discuss our research with a clinical audience.

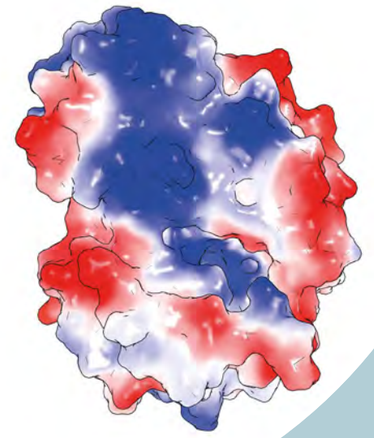
### Selected Research Publications

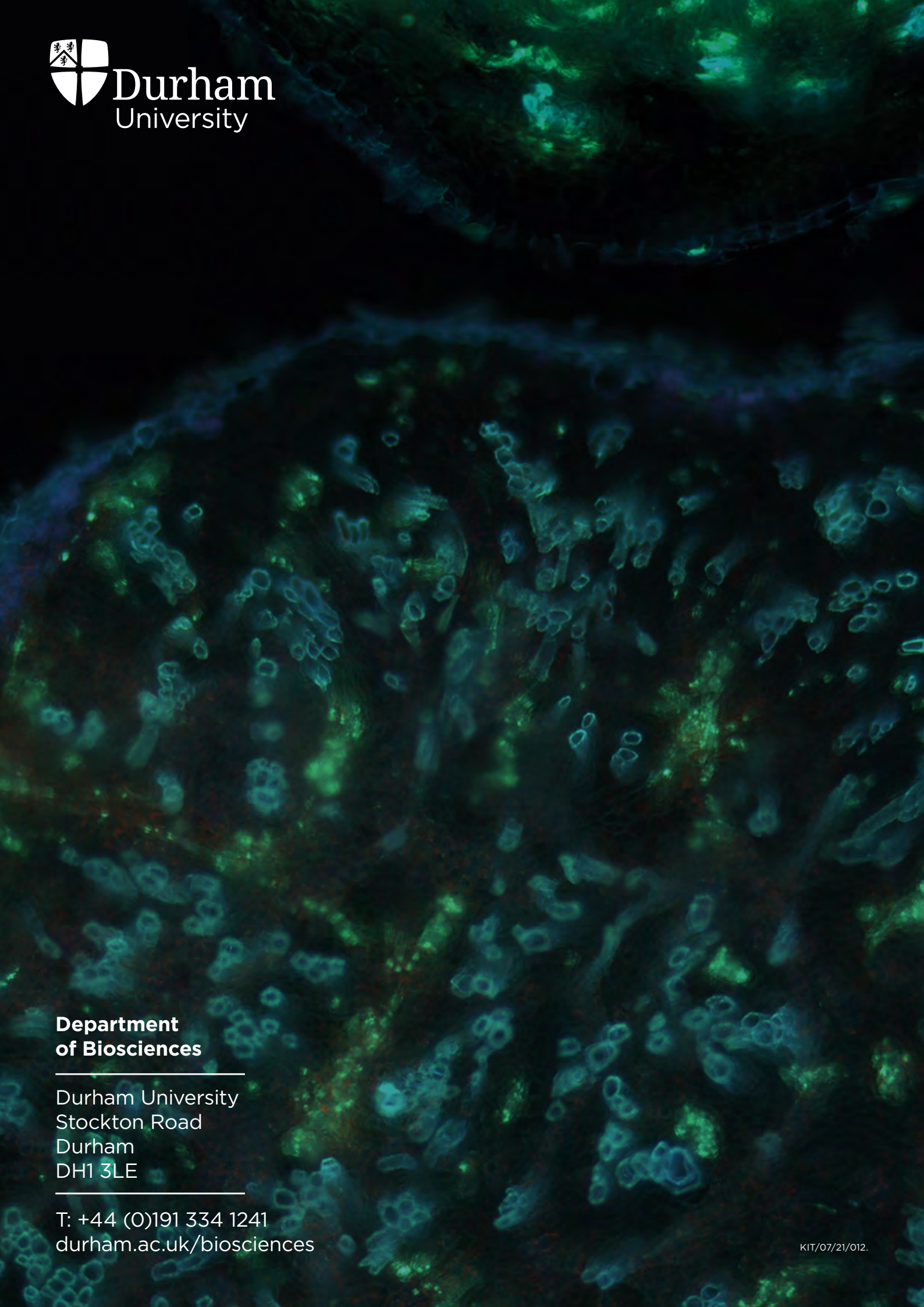

**1.** Maynard C, **Weinkove D**. (2020) Bacteria increase host micronutrient availability: mechanisms revealed by studies in C. elegans. *Genes & Nutrition* 15 (1), 1-11.
2. I Reigada, C Moliner, MS Valero, **D Weinkove**, E Langa, C Gómez Rincón (2020). Antioxidant and Antiaging Effects of Licorice on the Caenorhabditis elegans Model. *Journal of Medicinal Food* 23 (1), 72-78.
3. C Maynard, I Cummins, J Green, **D Weinkove** (2018). A bacterial route for folic acid supplementation. *BMC Biology* 16 (1), 67
4. M R Lundquist, M D Goncalves, R M Loughran, E Possik, T Vijayaraghavan, A Yang, C Pauli, A Ravi, A Verma, Z Yang, J L Johnson, J CY Wong, Y Ma, K Seo-Kyoung Hwang, **D Weinkove**, N Divecha, J M Asara, O Elemento, M A Rubin, A C Kimmelman, A Pause, L C Cantley, B M Emerling (2018) Phosphatidylinositol-5-phosphate 4-kinases regulate cellular lipid metabolism by facilitating autophagy. *Molecular Cell* 70 (3), 531-544.
5. C Maynard, **D Weinkove** (2018). The gut microbiota and ageing. *Biochemistry and Cell Biology of Ageing: Part I Biomedical Science*, 351-371.
6. Virk, B., Jia, J., Maynard, C.A., Raimundo, A., Lefebvre, J., Richards, S.A., Chetina, N., Liang, Y., Helliwell, N., Cipinska, M. & **Weinkove, D**. (2016). Folate acts in E. coli to accelerate C. elegans aging independently of bacterial biosynthesis. *Cell Reports*, 14, 1611-1620.







Durham University

**Department of Biosciences**

Durham University
Stockton Road
Durham
DH1 3LE

T: +44 (0)191 334 1241
durham.ac.uk/biosciences

KIT/07/21/012.