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Professor Chris Franklin

Professor of Plant Molecular Biology
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School of Biosciences (/schools/biosciences/index.aspx)

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About

Chris Franklin is a leading expert on meiosis in plants. Work in his laboratory has made a major contribution to the understanding of how meiotic recombination is controlled in the model plant *Arabidopsis thaliana*. This knowledge is currently being transferred to crop species where the ability to modify genetic recombination will help plant breeders develop the new varieties that will be needed to ensure global food security during the 21st century.

Qualifications

- BSc (Hons) University of Wales (Cardiff)
- PhD University of Wales (Cardiff)

Biography

Chris Franklin initially trained as a microbiologist at the University of Cardiff . He then worked as postdoctoral scientist in the UK, Germany and Switzerland during which time he gained experience in molecular biology and genetics. He was then appointed to the Department of Genetics (now part of the School of Biosciences) here in Birmingham. Since then he has worked in the area of plant molecular cell biology and molecular cytogenetics.

Teaching

Genetics degree label leader. Teaches genetics and molecular biology in 2nd and 3rd year modules and MSc.

Postgraduate supervision

For a list of possible PhD projects offered by Prof Franklin **www.findaphd.com/search/customlink.asp?inst=birm-Biol&supersurname=Franklin (http://www.findaphd.com/search/customlink.asp?inst=birm-Biol&supersurname=Franklin)**

Research

Research Theme within School of Biosciences: **Plant Genetics and Cell Biology (/research/activity/cellbiology/index.aspx)**

Control of recombination during meiosis

Meiosis occupies a central role in the life cycles of all sexually reproducing eukaryotes. An understanding of this process is critical to furthering research on reproduction, fertility, genetics and breeding. Meiosis is a specialized form of cell-division during which a single round of DNA replication is followed by two cell-divisions thereby reducing the chromosome content from diploid to haploid. Accurate segregation of homologous chromosomes at the first meiotic division is dependent on the formation of physical connections, known as chiasmata, between homologous chromosome pairs (homologues). Chiasmata arise from homologous recombination during prophase I of meiosis and are the physical manifestation of genetic crossovers. In their absence the homologues segregate at random leading to the formation of aneuploid gametes following the separation of the sister chromatids at the second meiotic division.

The Franklin lab is using a combination of molecular cytogenetics, molecular cell biology and systems biology to elucidate the mechanisms that control the frequency and distribution of crossover events along the chromosomes using the model plant *Arabidopsis thaliana*. We are particularly interested in the relationship between the proteins that modulate meiotic chromosome organization during prophase I and the recombination pathway machinery.

We are developing strategies to manipulate recombination frequency and distribution in crop species such as barley and brassica. Studies have shown that large segments ~70% of cereal chromosomes are recombinationally silent. This has a severe impact on the genetic variation available to plant breeders. Hence the aim of the work is modify recombination to free-up this variation. This work is likely to make an important contribution to efforts to ensure food security in the 21st century. Research in the lab is funded by the BBSRC and EU.

Self-incompatibility in flowering plants. I have an ongoing collaboration with Prof Noni Franklin-Tong (School of Biosciences) in the study of self-incompatibility (SI) in *Papaver rhoeas*. We are currently developing approaches to transfer the *Papaver* SI system to other plant species including the model plant *Arabidopsis thaliana* and cereal crops to explore its potential use in the production of F1 hybrid varietie

Publications

Selected publications:

Yant L, Hollister JD, Wright KM, Arnold BJ, Higgins JD, Franklin FC, Bomblies K. (2013) Meiotic adaption to genome duplication in *Arabidopsis arenosa*. Current Biology PMID: 24139735

Choi K, ZhaoX, KellyKA, VennO, HigginsJD, YelinaN, HardcastleT, Piotr Ziolkowski P, CopenhaverGP, Franklin FCH, McVeanG and Henderson IR. *(2013) Meiotic recombination* hotspots overlap with H2A.Z nucleosomes and CTT-repeat motifs at gene promoters. *Nature Genetics* doi: 10.1038/ng.2766

Osman K, Roitinger E, Yang J, Armstrong S, Mechtler K, Franklin FCH (2013) Analysis of meiotic protein complexes from Arabidopsis and Brassica using affinity-based proteomics. Methods Mol Biol. 2013;990:215-26. doi: 10.1007/978-1-62703-333-6_21.

Yang J, Osman K, DJ, Zewei Luo Z, Armstrong SJ and Franklin FCH (2013) Inferring the *Brassica rapa* interactome using protein-protein interaction data from *Arabidopsis thaliana*. Frontiers in Plant Genetics and Genomics 3; 297 doi: 10.3389/fpls.2012.00297

Higgins JD, Perry RM, Barakate A, Ramsay L, Waugh, R, Halpin C, Armstrong, SJ and Franklin FCH (2012) Spatiotemporal Asymmetry of the Meiotic Program Underlie the Predominantly Distal Distribution of Meiotic Crossovers in Barley. The Plant Cell 2012 Oct;24 (10):4096-109. doi: 10.1105/tpc.112.102483. (BBSRC website feature: **http://www.bbsrc.ac.uk/news/food-security/2012/121214-f-turning-up-heat-on-plant-sex.aspx (http://www.bbsrc.ac.uk/news/food-security/2012/121214-f-turning-up-heat-on-plant-sex.aspx)**

Knoll A, Higgins JD, Seeliger K, Reha SJ, Dangel NJ, Bauknecht M, Schröpfer S, Franklin FCH, and Puchta H. (2012) The Fanconi Anemia Ortholog *At*FANCM Ensures Ordered Homologous Recombination in Both Somatic and Meiotic Cells in *Arabidopsis thaliana.* The Plant Cell 24(4):1448-64. Epub 2012 Apr 30. (Press release (**http://www.sciencedaily.com/releases/2012/04/120430105353.htm (https://owa.bham.ac.uk/owa/redir.aspx?C=70f7e522b82a4060a497ea58c4e71d51&URL=http%3a%2f%2fwww.sciencedaily.com%2freleases%2f2012%2f04%2f120430105353.htm)**)

de Graaf BHJ, Sabina Vatovec S Javier Andrés J D-A, Chai L, Kooblall K, Wilkins KA, Zou Franklin FCH* and Franklin-Tong VE* (2012) The *Papaver* self-incompatibility pollen *S*-determinant, *PrpS*, functions in *Arabidopsis thaliana* Current Biology (* joint-senior authors) 24:154-9. 10.1016/j.cub.2011.12.006

FerdousM, HigginsJD, Osman K, Lambing C, Roitinger E, Mechtler M, ArmstrongSJ, PerryR, PradilloM, CuñadoN and Franklin FCH (2012) Inter-homolog crossing-over and synapsis in *Arabidopsis* meiosis is dependent on the chromosome axis protein AtASY3. PLoS Genet. e1002507

Chen Z, Higgins JD, Hui JTL, Franklin FCH and Berger F.(2011) Retinoblastoma protein is essential for early meiotic events in Arabidopsis. EMBO J. doi: 10.1038/emboj.2010.344

Higgins JD., Ferdous M., Osman K. and Franklin FCH. (2011)The RecQ helicase AtRECQ4A is required to remove inter-chromosomal telomeric connections that arise during meiotic recombination in *Arabidopsis.* The Plant Journal DOI: 10.1111/j.1365-313X.2010.04438.

Wheeler MJ, de Graaf BH, Hadjiosif N, Perry RM, Poulter NS, Osman K, Vatovec S, Harper A, Franklin FC, Franklin-Tong VE (2009) Identification of the pollen self-incompatibility determinant in *Papaver rhoeas*. Nature 459: 992-995.

Osman K., Sanchez-Moran E., Mann SC. Jones GH and FranklinFCH. (2009) Replication protein A (AtRPA1a) is required for Class I crossover formation but is dispensable for meiotic DNA break repair. EMBO J. 28(4):394-404.

Higgins JD., Buckling EF., Franklin FCH. and Jones GH (2008) Expression and functional analysis of AtMUS81 in Arabidopsis meiosis reveals a role in the second pathway of crossing-over. The Plant Journal 54, 152-162.

Sanchez-Moran E., Santos JL., Jones GH. and Franklin FCH (2007) ASY1 mediates AtDMC1-dependent interhomolog recombination during meiosis in Arabidopsis. Genes and Development 21, 2220-2233.

Jones GH. and Franklin FCH. (2006) Meiotic crossing over: obligation and interference. Cell 126, 10-12.

Jackson N., Sanchez-Moran E., Buckling E., Armstrong SJ., Jones GH. and Franklin FCH. (2006) Reduced meiotic crossovers and delayed prophase I progression in AtMLH3-deficient Arabidopsis. The EMBO Journal 25, 1315-1323.

Higgins JD., Sanchez-Moran E., Armstrong SJ., Jones GH. and Franklin FCH. (2005) The Arabidopsis synaptonemal complex protein ZYP1 is required for normal fidelity of crossing-over and chromosome synapsis (2005) Genes and Development 19, 2488-2500.

Higgins JD., Armstrong SJ., Franklin FCH and Jones GH. (2004) The Arabidopsis MutS homolog AtMSH4 functions at an early step in recombination: evidence for two classes of recombination in Arabidopsis. Genes and Development 18, 2557-2570.

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