

RNA interference and Epigenetics in Regulation of Gene expression in Plants

A Winter School under Global Initiative of Academic Networks (GIAN)

Overview

In eukaryotes, small regulatory RNAs derived from double-stranded RNA guide RNA interference (RNAi) and epigenetic modification through repression of complementary RNA and DNA. *Arabidopsis thaliana* has proved to be an excellent model species for uncovering the pathways and potential mechanisms of RNAi and epigenetics not only in plants, but in eukaryotes in general. In contrast to many other eukaryotic lineages including humans, gene duplication is a common feature of gene silencing pathways in flowering plants. For example, there is one *DICER* gene in humans compared to at least four *DICER-LIKE* (*DCL*) genes in flowering plants. This division of biological function between duplicated members of gene families involved in gene silencing has not only enabled the discovery of the function of individual genes, but also the composite biological function of the gene family as a whole. Case studies in plants will be used to highlight the mechanisms and evolutionary roles of RNAi and RNA-directed epigenetic modification in plants, but the relevance to humans and other eukaryotic species will also be covered. The potential of using topical application of dsRNA to manipulate gene silencing pathways in plants will also be covered.

The course is given by internationally known scientist, **Prof. Bernard Carroll** of The University of Queensland, Brisbane, Australia. In a recent **breakthrough research**, published in *Nature Plants*, Bernie and his collaborators shown that by combining clay nanoparticles with designer 'RNAs' (molecules with essential roles in gene biology), it is possible to silence certain genes within plants. The spray they have developed -- known as BioClay -- has been shown to give plants virus protection following a single application. When sprayed with **BioClay**, the plant 'thinks' it is being attacked by a disease or pest insect and responds by protecting itself. This new approach could have huge benefits for agriculture around the world in reducing pesticide use, crop protection and global food security. **Professor Bernie's** laboratory research focuses on role of RNA interference and epigenetics in regulation of gene expression, and its relevance to plant biology particularly, plant development, plant defence against viruses and transposons.

The host faculty, **Prof. Lingaraj Sahoo** focuses on genomics assisted improvement of Asiatic grain legumes for stress tolerance. His lab translates basic discoveries in plant genetic and genomics research to protect crops from diseases and adverse environment through manipulation of small RNA and regulatory

proteins (TFs) guided plant defence to plant pathogens and abiotic stress. He is a Guest Professor at **Gifu University, Japan**, active in facilitating international cooperation in academia-industry linkage for translational bioresource and food technology. Center has a high end Plant Biotech Research Facility, which is built to international biosafety requirements for research with Genetically Modified plants; a Plant Biotech Incubator Unit, which works closely with local industry and a molecular biology laboratory that offers basic molecular biology services.

COURSE OBJECTIVES:

- To explain the components and mechanisms of RNAi and epigenetic modification of gene expression in plants.
- To use case studies to demonstrate the evolutionary roles of RNAi and epigenetics in plants.
- To explain the key molecular approaches used in gene discovery, and detecting RNAi and epigenetic modification of genes.
- To discuss the relevance of RNAi and epigenetic studies in plants to humans and other eukaryotic species

Course details

| Day | Topics in Brief (November 11-20, 2019) |
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| 1 | Arabidopsis – a model eukaryotic organism for RNAi and epigenetics (Nov 11, 2019; Mon) |
| 2 | Transposable elements, RNAi and epigenetics (Nov 12, 2019; Tue) |
| 3 | Transposon activation and genome evolution in response to environmental stress (Nov 13, 2018; Wed) |
| 4 | RNAi and epigenetics in plant reproductive development (Nov 14, 2019; Thu) |
| 5 | RNA-directed chromatin modification and cell division in plants (Nov 15, 2019; Fri) |
| 6 | Modes of gene regulation, genome evolution and epigenomics (Nov 16, 2019; Sat) |
| 7 | Molecular basis of hybrid vigour and heterosis in plants (Nov 17, 2019; Mon) |
| 8 | Systemic RNAi in plants (Nov 18, 2018; Tues) |
| 9 | Topical application of double-stranded RNA and manipulation of gene silencing pathways in plants (Nov 19, 2018; Wed) |
| 10 | <i>Arabidopsis</i> as a model for understanding epigenetic disease in humans (Nov 20, 2018; Thu) |

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| Duration | November 11-20, 2019 |
| Who can attend | <p>College and University faculty members and scientists from research institutions, Post docs, PhD and M. Tech students interested in Plant Molecular Biology, Molecular Genetics, Developmental Biology.</p> <p>Number of participants for the course will be limited to 50</p> |
| Fees | <p>The participation fees for registering the course is as follows:</p> <p>Student Participants: INR 1,500/- (refundable), payment by demand draft Participants from abroad: US \$500 Industry/ Research Organizations: INR 20,000/- + 18% GST Academic Institutions: INR 10,000/- + 18% GST</p> <p>The above fees include all instructional materials, computer use for tutorials and assignments (if any), laboratory equipment usage charges, 24 hr free internet facility. The participants will be provided with accommodation on payment basis in hostels (details will be available later in the webpage).</p> |

The Faculty



Prof. Bernard Carroll is Professor in Molecular Genetics at the School of Chemistry and Molecular Biosciences, The University of Queensland, Australia. His area of interest is in the field of RNA interference and epigenetics in regulation of gene expression, and its relevance to plant biology particularly, plant development, plant defence against viruses and transposons.

<https://scmb.uq.edu.au/profile/228/bernard-carroll>



Prof. Lingaraj Sahoo is a Professor at Department of Biosciences and Bioengineering at Indian Institute of Technology Guwahati, India and a Guest Professor at Gifu University, JAPAN. His area of interest is in translational plant biology for crop improvement for biotic and abiotic stress tolerance.

<http://shiloi.iitg.ernet.in/~biotech/lis/index.html>



