THE UNIVERSITY of LIVERPOOL

MARIE CURIE ACTIONS

# sensible

# sensing and the biological response in plants

**Marie Curie Actions Host Fellowships for Early Stage Research Training (EST)**

## The sensible programme

The use of post-genomic technologies in agri-food and health research is of strategic importance to develop a strong European science base for these leading industrial sectors over the next 25 years. Sensible offers early stage researchers training in key post-genomic technologies namely proteomics, transcriptomics, biological imaging, bioinformatics and transgenic organisms. This will be integrated with classical approaches including biochemical and phenotypic analysis and population biology. Fellows will use these technologies to increase understanding of sensing and the biological response to the environment in plants (sensible). They will work with internationally-known researchers within the Integrative Biology Research Group (IBRG, head: Dr Mark Caddick) in the School of Biological Sciences at the University of Liverpool, UK.

Sensing and response to the environment is a fundamental determinant of plant growth and crop productivity. Studies in model plants, and microorganisms when appropriate, as well as crop plants will provide insight into the fundamental biological systems that respond to environmental change. This requires a multidisciplinary approach and researchers with broad knowledge.

We offer **six 3-year Fellowships** starting 2nd October 2006 that can lead to a doctoral degree, under the normal UK regulations of the University of Liverpool. The Fellows will undertake an initial structured programme including mini projects and innovative problem-based learning to gain practical experience of the potential of post-genomic technologies. The mini-projects will be selected to support each Fellow's doctoral project that will lead to a PhD thesis.

In 2007 – 2009 we offer **four 6-month Fellowships** to early stage researchers from European laboratories wishing to apply specific post-genomic technologies in their own research projects. These Fellowships will be centre on one technology that is not available in their home institution.

## Three-year Fellowships

Sensible has a more structured approach to doctoral training than most PhD programmes, while guiding and encouraging Fellows to develop their own doctoral projects. The objective is to build each Fellow's skill in working within a multidisciplinary team and their appreciation of post-genomic technologies and research leadership.

All Fellows will therefore be expected to fulfill the requirements for registration for a higher degree at the University of Liverpool (see Application procedure below).

Each Fellows will develop a doctoral projects within one of the following areas. Examples of projects are given, but the ethos of sensible is to involve the Fellows in identifying appropriate biological questions and devising experimental approaches.

**Nutrients**: Supplies are essential for all biological growth and maintenance. When nutrients are limited, changes occur in genome expression to optimise survival in the stressful environment. Computer simulation models can evaluate effects of changes in fitness traits in response to environment and resource limitation to predict crop yields. Technologies such as proteomics, transgenic organisms and bioinformatics are being used. (Group leaders: Dr Mark Caddick, Dr Meriel Jones)

> ***Example PhD project:*** Regulated degradation of mRNA is part of the biological response to environmental change. The challenge is to determine how the transcripts of individual genes are targeting for degradation, including the identification of signalling networks, protein complexes that mediate degradation and the specific sequence motifs that mediate the response. We and others have shown that in both fungal and plant species specific transcripts are differentially regulated at the level of mRNA degradation in response to nitrogen availability. The project will build on our experience in other model systems and exploit the extensive genomic resources available. It involves detailed analysis of mRNA degradation profiles, the identification of mRNA interacting proteins and the identification of putative signalling components utilising phosphoproteomics. Integral to this project will also be bioinformatics, gene cloning and characterisation, and the characterisation of transgenic organisms.

**Temperature**: In view of predicted climatic changes, understanding the consequences of both increased and reduced ambient temperature on plants is strategically important for the EU. Freezing conditions limit bioavailable water and can cause physical damage. Technologies such as proteomics, transcriptomics and metabolite analysis are applicable. (Group leaders: Dr Anthony Hall, Dr Mark Caddick)

> ***Example PhD project:*** Work conducted internationally has focused on understanding how plants sense and respond to temperature stress. This project will investigate the sensing and response to temperature over the physiological range (12-27ºC). The project will involve whole plant and cell imaging to monitor expression from multiple promoters in real time, building on work currently underway within the group. Secondly, through the analysis of our transcriptomic data sets, genes that are up or down regulated by temperature and share common promoter motifs will be identified. The transcriptomic analysis and luciferase technology will come together in the development of a robust luciferase assay for temperature dependent gene-expression. This assay will then be used in a screen to identify aberrant patterns of gene expression. Such a screening strategy should identify mutants involved in temperature sensing and signalling. The project will involve biological imaging, bioinformatics including the mining of transcriptomic data, forward genetics and phenotypic characterisation of plants

**Light**: Sensing of light quality and quantity results in changes to gene expression with effects on development of individual plants and populations. Most light responses are modulated by circadian rhythms, affecting crop development and yield. Technologies such as transcriptomics, bioinformatics and image analysis are used in this area. (Group leaders: Dr Anthony Hall, Dr James Hartwell)

***Example PhD project:*** The biological clock is an adaptation to living in a cyclic environment. Through physiological and molecular studies it is clear that the clock plays an important role in the regulation of the biology of plants. This project will explore the mechanism by which the clock is buffered against temperature change in the model plant *Arabidopsis thaliana*, specifically the role of photoreceptors. We have already identified a role for the photoreceptor phyB in temperature buffering the clock, although the molecular mechanism underlying its function and the role of other photoreceptors is unclear. The project will use bio-informatics, biological imaging, mining of transcriptomic data, real-time PCR and RNAi.

**Stress and Metabolism**: Regulation of metabolism to optimise growth in the changing environment is essential for plants. High temperatures can expose plants to drought stress in addition to heat stress and may lead to osmotic stress through accumulation of salts from irrigation water. Modulation of central metabolic pathways including glycolysis and photosynthesis, especially by the circadian rhythm. Technologies such as transgenic organisms, transcriptomics, proteomics and metabolite analysis are used (Group leaders: Dr James Hartwell, Dr Meriel Jones).

***Example PhD project:*** Intensive agriculture and its associated irrigation practices are leading to increasing levels of soil salinity in many important agricultural regions of the world. Within Europe, soil salinity is an increasing problem in member states such as Hungary where up to 25% of soils are contaminated with salt. Improving the salt tolerance of agriculturally important crops is therefore a major goal for sustaining crop productivity in saline soils. This project will investigate the molecular basis of adaptations that allow plants to grow in saline soils. Through studies on the model halophyte *Mesembryanthemum crystallinum*, we have already identified a number of transcription factors that are responsive to salt stress. By studying the orthologues of these genes in the model glycophytic plant *Arabidopsis*, we have been able to study their role in salt-tolerance using a molecular-genetic approach. One particular transcription factor knockout line is more tolerant to salt stress and this project will focus on understanding the function of this transcription factor in salt-tolerance using knockout mutants, transgenic overexpressor lines, transcriptomics, proteomics, bioinformatics and biological imaging.

**Biotechnology**: Plants can be sources of medicinal compounds and nutriceuticals, and also provide novel enzymes for industry. Directed evolution can produce enzymes for pharmaceutical products. Relevant technologies include transgenic organisms, bioinformatics and metabolite analysis. (Group leaders: Dr Lesley Ann Iwanejko, Dr Andy Bates)

***Example PhD project:*** Enzymes as biocatalysts offer an alternative to traditional organic synthesis since they are environmentally friendly, cost effective and can demonstrate exquisite substrate specificity and enantioselectivity, making them particularly useful in the synthesis of chiral compounds. This project will combine expertise in organic chemistry, plant metabolism, bioinformatics and molecular biology. We will use a proteomic and bioinformatics approach to identify enzymes responsible for the synthesis of secondary metabolites from plants with known pharmacological activity, such as *Artemisia* species. These will be candidates for further development for specific substrates using technologies such as directed evolution and pathway engineering.

**Responses to Biological Damage**: Predators such as animals and insects, as well as pathogens, restrict plant growth. Responses to counter this damage include production of secondary metabolites and altered growth. Molecular sensors co-ordinate growth at cell and organ level and respond to environmental inputs. Technologies such as proteomics, transcriptomics, transgenic organisms and metabolite analysis are applicable (Group leaders: Prof Brian Tomsett, Dr Martin Mortimer)

***Example PhD project***: Our model system uses the specialist insect herbivore *Plutella xylostella,* a major agricultural pest found worldwide, and the model plant *Arabidopsis thaliana*, a close relative of several important EU Brassica crops. We have identified plants that are resistant and sensitive to this pest. These plants will be characterised by a combination of phenotypic and molecular techniques that could include genomic, transcriptomic, proteomic, and metabolite analyses to identify genes and their products responsible for the differences in response to *Plutella*. Genes whose products show differences that correlate to insect tolerance will be isolated and used to make overexpressing/knock-out transgenic plants to determine their relative ecological contribution to the total response to insects. The project will provide training in molecular techniques including bioinformatics and post-genomic technologies that will allow the Fellow to apply their generic skills to a wide range of biological R&D, and their specific skills to the improvement of European agriculture.

**Plant-plant interactions**: Understanding the implications of variation in gene expression and regulation is central to understanding evolutionary adaptation. Molecular tools can measure gene flow between crop cultivars, which is affected by environmental factors. Competitiveness is a key aspect of plant invasiveness and thus important to both agriculture and the natural environment. Technologies such as proteomics, transgenic organisms, phenomics and bioinformatics are applicable (Group leaders: Dr Martin Mortimer, Professor Brian Tomsett)

***Example PhD project***: Understanding the complex mechanisms underlying the competitiveness of phenotypes of plants requires a multi-dimensional approach. Mathematical plant growth models now provide tools by which the impact of alterations in individual growth traits can be assessed as overall plant competitiveness. Understanding plant growth dynamics and their response to environment change is important agriculturally in the context of global climate change and natural resource management and in assessing invasiveness. This project will utilise plant growth models and experimental studies in *A. thaliana* to measure the fitness of genotypes in a range of controlled environments focusing on the impact of individual genes on growth and competition for resources and phenology. The project will use mathematical modelling, knock-out plant lines and growth studies. This training will provide tools enabling Fellows to understand, and integrate, the consequences of changes in the environment to plant growth dynamics and phenotypic plasticity. As such it will provide both generic and specific skills for value to the improvement of European crops and agriculture.

**Research skills and complementary training:** Working within one of these areas, the Fellows will develop and carry out a doctoral research project with guidance from the Group Leaders acting as scientific mentors. The Fellows will gain the skills and knowledge to do this by following an intensive structured programme during the first 6 months of the Fellowship as well as additional activities during the remainder of the programme. They will carry out two mini-projects, selected to support the doctoral project, from within the areas of gene identification and isolation, analysis of transgenic plants, plant phenomics, transcriptomics, proteomics, bioinformatics, metabolite analysis and gene expression and engineering. There will also be theoretical techniques workshops on post-genomic technologies, problem-based learning workshops to improve learning and study skills, creative thinking and the ability to work with others, tutorials and complementary training provided by the University of Liverpool Graduate School. The Fellows will be expected to present their work and attend scientific conferences as well as contributing to a scientific publication. They will also make a short study-visit to a European laboratory.

**Terms:** This is a full-time research position for 36 months, starting salary at least £19,645 (under review: approx €28,500) per annum, with travel and other allowances dependent on personal circumstances. See the Marie Curie Fellowships for Early Stage Research Training Handbook (available at: http://europa.eu.int/comm/research/fp6/mariecurie-actions/action/stage_en.html for further information.

## Six-month Fellowships

These Fellowships allow early stage researchers already employed as research assistants or doctoral students in Europe to work in an area that is not available within their home institution, before returning to apply the training in their own academic or industrial research. The projects will be based on one mini-project (gene identification and isolation, analysis of transgenic plants, plant phenomics, transcriptomics, proteomics, bioinformatics, metabolite analysis or gene expression and engineering) , accompanied by technical and complementary training.

The 6-month Fellowships are available during 2007 – 9 at times negotiated to provide the best fit between the Fellow's own research and work at Liverpool. We therefore encourage early applications to allow these Fellowships to be planned to best advantage.

**Terms:** This is a full-time research position for 6 months, salary approx £1,600 (under review; approx €2300) per month, with travel and other allowances dependent on personal circumstances. See the Marie Curie Fellowships for Early Stage Research Training Handbook (available at: http://europa.eu.int/comm/research/fp6/mariecurie-actions/action/stage_en.html for further information.

# The Research Environment

**The School of Biological Sciences:** The School was rated as 5, internationally excellent, during the most recent national research assessment exercise. It occupies the new €34 million Biosciences Building, with all the facilities of a major biosciences research centre including core facilities in Genomics/Transcriptomics, Functional Proteomics, Cell Imaging and Bioinformatics. There are also temperature and photoperiod controlled growth rooms and transgenic plant glasshouses.

**The University of Liverpool:** This is one of the UK's leading research-led Universities. It is in the top 10 UK universities in terms of research income. There are 3,100 post-graduate students, contributing to a lively research culture. The Graduate School co-ordinates complementary training in research skills and techniques and also runs University-wide social events.

The University has extensive Student Support Services, including advice on health-care, accommodation, child-care facilities, careers and assistance for students with disabilities. The University of Liverpool attaches the greatest importance to its policies and activities to promote Diversity and Equality of Opportunity. The University is also committed to arrangements and schemes to help individuals balance their work and domestic commitments.

**The City of Liverpool:** The City, chosen as European Capital of Culture for 2008, is a cosmopolitan and exciting city. The city is famous for its musical (both classical and popular) and football culture but also has a strong maritime history and more listed buildings than any other English city outside London. Art galleries (including the Tate Liverpool) and museums add to the culture. There is a lively night-life of pubs, clubs, restaurants, theatre and film. Liverpool offers direct flights to over 40 European destinations from John Lennon airport and is only about 2 and a half hours from London by train. The local people are renowned for their friendliness and sense of humour.

## Application procedure

### 3-Year Fellowships

**Deadlines:** Applications will be reviewed from 3 April 2006. Applications after 3 April will be considered until all Fellowships are filled.
Fellowships commence 2 October 2006.

**Essential requirements for applicants:**

- Letter of application indicating intended research area(s), mentor(s), career aspirations and why you wish to come to Liverpool. If you have had a career break please include brief details.
- *Curriculum vitae*
- Eligible for Marie Curie EST Fellowship (through questionnaire, below)
- Two supportive academic references
- Fulfilment of requirements for higher degree registration at the University of Liverpool
    - Fluent English ( IELTS 6.5 or TOEFL 580 if first language is not English)

**Desirable requirements for applicants:**

- Evidence of interest in interdisciplinary research
- Evidence of willingness to work abroad and enjoy new cultures

### 6-month Fellowships

**Deadline:** Applications will be reviewed from 3 April 2006, but will generally be made later in 2006, and in 2007 or 2008.
Fellowships held 2007 – 2009

**Essential requirements for applicants:**

- Letter of application indicating how training in a specific post-genomic technology will enhance your research project, career aspirations and why you wish to come to Liverpool. If you have had a career break please include brief details.
- *Curriculum vitae*
- Eligible for Marie Curie EST Fellowship (through questionnaire, below)
- Two supportive academic references

**Desirable requirements for applicants:**

- Evidence of interest in interdisciplinary research
- Evidence of willingness to work abroad and enjoy new cultures

**Send a letter of application, CV, contact details of two academic referees and a completed Marie Curie eligibility questionnaire to: Dr Meriel G Jones, sensible co-ordinator**

**The School of Biological Sciences**
**The Biosciences Building**
**University of Liverpool**
**Liverpool**
**L69 7 ZB, UK**

**Email: m.g.jones@liv.ac.uk**

**Questionnaire to determine eligibility for appointment to EST Fellowship**

**Name of applicant:** ………………………………………………………………….…

We would particularly encourage applications from women and eligible students from **all** EU Member or Associated States (excluding the UK).

Your answers to the questions below should indicate whether you are eligible for an EST Fellowship. If your answers to questions 1, 2 and 3 are 'Yes', you are probably eligible. However, you may also be eligible if you can answer 'Yes' to question 4.

Return this form (electronic or printed) with your application. Write on extra lines if necessary.

1. **Do you have a qualification that entitles you to embark on Ph. D. studies in the country where it was obtained and also less than 4 years research experience?**

***Name of qualification:*** ……………………………………………………………………….

***Length and description of research experience from date of degree award:*** ……….......................
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2. **Are you a national of an EU member or associated state, <u>but not</u> a national of the UK?**

***Nationality:*** ……………………………………………………………………………..

3. **If you are a non-UK national, have you been resident or active in the UK for less than 12 out of the last 36 months?**

***Time and country of residence for the last 36 months:*** …………………………………………..
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4. **If you are a UK national, have you been resident outside the EU member and associated states for at least 4 of the past 5 years?**

***Time and country of residence for the last 5 years:*** …………………………………....................
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Please consult the Marie Curie Fellowships for Early Stage Research Training Handbook (available at: http://europa.eu.int/comm/research/fp6/mariecurie-actions/action/stage_en.html (particularly pages 20 -28) for further explanation of the eligibility conditions.

If, after consulting the Marie Curie EST Handbook, you think that you are eligible despite answering 'No' to questions 1 - 4, please explain why:

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