

Marie Curie

**John Innes Centre International Student Bursaries  
for Early Stage Training**

JICISBEST

MEST-CT-2004-504273

**Final Report  
March 2008**

## SUMMARY

### 1. Project Outline

The contract ran from 1<sup>st</sup> April 2004 to 31<sup>st</sup> March 2008, providing research training in the field of plant molecular biology and microbiology (total 396 training months). The John Innes Centre served as a host mono-site for this multidisciplinary training programme. It was able to do this effectively because of its size, scope and international reputation as a high quality environment for research training. From the final reports of EST Fellows, 8 rated the quality of research training received as “Excellent”; 6 as “Very Good”; 1 as “Satisfactory”; and none as “unsatisfactory”.

### 2. Scientific Highlights

The main research objectives associated with the EST programme were: - to discover basic biological processes in plants and microorganisms; to develop and apply the platform technologies that underpin modern molecular biology, and to create plants and bacteria of enhanced value. Research undertaken by EST Fellows has led to important discoveries in the fields of plant breeding, developmental biology and biotechnology. For all EST Fellows, a combination of taught courses and a wide range of research seminars provided opportunities for a broad-based scientific and technical training. This was supported by an extensive programme designed to enhance complementary professional skills. Some research training also involved links with industry, and the development of patents in the field of biotechnology.

### 2. Outstanding Achievements

High quality scientific research and science communication was recognized in many instances: -

- Three national science communication awards;
- Four invitations to speak at international meetings;
- Eight awards for best posters at national/ international/ local meetings;
- Five short-term visits to international laboratories;
- Four international postdoctoral research fellowships awarded (with more applications currently being prepared).

### 3. Economic and Social Impact of the Project

This programme has provided an excellent training environment and a springboard for careers in academic or industrial research. All EST Fellows have received extensive training in research methods, thus contributing to an enhancement of knowledge and skills in the labour pool in the European Research Area. Fourteen EST Fellows have progressed towards PhD degrees; and one took a Masters-level degree in computational biology before progressing to an MBA.

As a result of research conducted under this training contract, there have been important scientific advances some of which will lead directly to commercial application. There has been a significant advance in the understanding of chromosome pairing in meiosis which could have applications in the development of strategies for plant breeding, for example of hexaploid wheat. One patent has been filed that describes a high level expression system for production of introduced proteins in plant tissues from plant virus vectors. There have also been major advances in the use of plant viruses as agents for nano-technology: this has a wide range of potential applications in therapeutic medicine, electronics, materials science and bioinorganic chemistry.

### 4. Dissemination of Knowledge

Research has already led to 20 publications in high quality refereed journals with many more manuscripts in preparation. EST Fellows have attended over 30 international conferences and workshops: in the majority of cases they were active (rather than passive) participants. EST Fellows have also taken an active role in the communication of science to schools and to the general public, for example through the meeting of the British Association for the Advancement of Science (Norwich, 2006).

### 5. Equal Opportunities

Fifteen EST Fellows were recruited from nine countries: The gender balance (M:F) was 7:8.

## SCIENTIFIC AND TECHNICAL HIGHLIGHTS

The John Innes Centre (and the associated Sainsbury Laboratory) is acknowledged internationally as one of the premier institutes for fundamental and strategic studies of plant and microbial sciences. JIC is a very open scientific environment in which knowledge and skills are freely shared. This means that EST Fellows have been exposed to a truly interdisciplinary research environment, including specialities ranging from bio-inorganic chemistry, biochemistry, cell biology and molecular biology, through to genetics, plant and microbial physiology and whole plant studies in the field. Through their Early Stage Training, Fellows have made significant contributions to research and development in the following fields:-

**Biological Chemistry:** Fellows were trained in the molecular understanding and engineering of key plant and microbial processes, leading to the delivery of improved biological properties and new materials. Using Cowpea Mosaic Virus (CPMV) as a model system, Nicole Steinmetz undertook a project on viral capsids as programmable nanobuilding blocks with a variety of applications in medicine and nanotechnology.

**Cell and Developmental Biology:** EST Fellows undertook research to determine the function of genes in model plant species such as *Arabidopsis* and *Antirrhinum*. Research exploits genome sequences and other information-intensive activities. Veronika Mikitova analysed molecular components interacting with CDK-A in the control of the cell cycle in plants, while Christian Breuer investigated BIN4, a novel component of the plant DNA topoisomerase VI complex. Sonia Bosca carried out the positional cloning of Mur9, a gene that affects the assembly of plant cell walls. Ulises Rosas investigated the evolution of organ shape and size using floral asymmetry in *Antirrhinum* as a model system for genetic analysis.

**Computational Biology:** Several EST Fellows undertook short training projects in the Computational Biology Group which provides an underpinning framework for computational biology and bioinformatics at JIC/SL. Meifang XU developed a computational model for a plant extracellular matrix glycoprotein involved in the interaction of symbiotic *Rhizobium* bacteria with their legume hosts

**Crop Genetics:** EST Fellows received training in fundamental research on the biology of cereals, brassicas and legumes to understand the genetic and molecular basis of phenotypic variation. Isabelle Colas used genetic and cytological techniques to study the mechanisms of meiosis in wheat and Violaine Pinon characterised *PIGGYBACK1*, a gene that encodes a ribosomal protein that is apparently involved in leaf development and morphogenesis.

**Gene silencing:** Tomasz Poprawka investigated the roles of small RNAs in the control of transition steps during plant shoot apex development. Linfeng Huang studied the biochemistry of RNA polymerase IV in gene silencing in plants and Susi Heimstaedt undertook a functional analysis of *Arabidopsis* Argonaute proteins.

**Metabolic Biology:** Fellows were involved in research on fundamental aspects of plant metabolism, on the nutritional and industrial application of plant products and on the development of plant 'factories' for valuable materials. Carle Cle undertook a research project based on the detection of glycan synthesis and polymer initiation on surfaces which provides a model for activities on the surface of starch granules in plants. Frank Sainsbury developed new ways for enhancing expression and accumulation of therapeutic proteins in plants using the CPMV vector.

**Molecular Microbiology:** Genome sequences, functional genomics technology and developments in bioinformatics have given a new thrust to molecular microbiology and these opportunities were fully exploited by EST Fellows. Alexandre DeCorps studied membrane targeting of the *E. coli* ammonium channel protein AmtB which involves a cleavable N-terminal signal peptide in the inner membrane protein. Stefan Mann investigated the importance of the Tat protein secretion pathway in the virulence of the plant pathogen *Streptomyces scabie*.

### Research Highlights

Five high-profile research publications are listed below: -

1. **Isabelle Colas** demonstrated that effective chromosome pairing requires chromatin remodelling at the onset of meiosis (PNAS, 2008 105: 6075-6080);
2. **Violaine Pinon** demonstrated that three *PIGGYBACK* genes that specifically influence leaf patterning encode ribosomal proteins (Development, 2008 135, 1315-1324);
3. **Christian Breuer** showed that BIN4, a novel component of the plant DNA Topoisomerase VI complex, is required for endoreduplication in *Arabidopsis* (*Plant Cell*, 2007 19: 3655-68)

4. **Nicole Steinmetz** developed a method for the assembly of multilayer arrays of viral nanoparticles via biospecific recognition: (*Biomacromolecules*, 2008 9, 456–462).
5. **Frank Sainsbury** developed methods for expression of multiple proteins using full-length and deleted versions of cowpea mosaic virus RNA-2 (*Plant Biotechnology Journal*, 2008 6, 82-92).

## RESEARCH TRAINING ACTIVITIES

### FINAL REPORTS FROM EST FELLOWS

From the final reports of EST Fellows, 8 rated the quality of research training received at JIC as “Excellent”; 6 as “Very Good”; 1 as “satisfactory; and none as unsatisfactory.

Some examples of comments from EST Fellows are set out below:-

1. *I really enjoyed my time at the John Innes Centre. It is a fantastic place to do research, with lots of additional training opportunities.*
2. *The John Innes Centre provides a great place for interactions with scientists in other research areas. This became very useful for technical advice and sharing resources for my research work.*
3. *During the training, I was planning and managing my own experiments. I have also successfully had experience in writing my own grant applications during my third year to secure independent funding after completion of my PhD.*
4. *From daily lab work I learned basic laboratory skills, especially in molecular biology and plant biochemistry. I also learned advanced bioinformatics knowledge especially in protein modelling and attended an advanced course on epigenetics.*
5. *Twice a year, I presented my results and future objectives to a lab meeting using powerpoint presentations. I also presented posters at national and international conferences.*
6. *I have increased my management skills; I have demonstrated that I can plan my work and meet deadlines. I am currently writing proposals and fellowship applications.*
7. *A 4-week research visit to a lab in Amsterdam allowed me to get interesting experience both on techniques and ideas from a very influential lab in my area of interest.*
8. *Attending international conferences helped me to establish productive collaborations and put me in touch with scientists in my field from around the world.*
9. *I have communicated with the press through articles about my work in local and national media. Furthermore, I have given talks at two British schools, explaining to school children what biotechnology is.*
10. *Taking part in the Biotech YES scheme was a great chance to make use of the transferable skills that I had learned through the programme of professional skills training.*
11. *JIC exposes the students to a huge range of research possibilities. Ambitions are always kept high so students know what they should be aiming for.*
12. *The facilities at JIC are remarkable and I never suffered any delays due to a lack of resources.*

### RESEARCH EXPERIENCE:

For each EST Fellow, a supervised research project served as the vehicle for an intensive training in research techniques and gave practical experience of how to develop strategies for scientific analysis and how to design and execute experiments to pursue a meaningful line of enquiry. Fellows also attended and participate in a wide range of seminar programmes designed to improve their knowledge of the research field and develop their skills in science communication.

**Supervisory Committees and Personal Career Development Planning:** Within the first two weeks of arrival, the Fellow’s supervisor established a Supervisory Committee (comprising the supervisor plus at least two other academic staff). This Committee met periodically to discuss the Fellow’s research objectives and individual training needs, both technical and generic. These meetings normally followed the submission of written or oral research progress reports by the Fellow.

### LECTURES AND SEMINARS

Experience gained through the Fellows’ own research project was complemented by the development of a deeper understanding of contemporary developments in plant and microbial sciences. This was made

possible through the rich training environment provided by JIC. All Fellows engaged in a wide variety of scientific interactions, ranging from student contributions to research group and departmental seminars, to an Annual JIC Science Meeting (at which Fellows each present a poster); to the weekly high-profile JIC seminar with top-class speakers from anywhere in the world. EST Fellows and other PhD students at JIC also organised their own programme of monthly seminars: these are focussed on the general theme “Science in Society” with a wide range of outside speakers on contemporary science issues and career opportunities.

**Training in Research Techniques:** EST Fellows attended courses that provided an introduction to a wide range of basic research methods and techniques used at JIC. In many cases they also attended specialist courses/ workshops at other institutions in Europe order to acquire specialist technical training. Fellows had access to a wide range of courses introducing advanced research techniques in molecular biology and biological chemistry. They selected their courses individually, following discussion with their Supervisory Panel. Fellows also attended specialist modules on statistical analysis, IT systems and information handling.

**Wider Scientific Horizons:** EST Funding was available to enable Fellows to attend at least one major international conference. These opportunities were highly valued by the Fellows themselves. In addition, several Fellows visited different laboratories for a few weeks/months in order to develop their independence in a different laboratory environment. In many cases, research undertaken by Fellows at JIC formed part of broad-based international networks.

## PROFESSIONAL TRAINING

**Complementary (Professional) Skills:** All EST Fellows attended a training programme to enhance the professional skills of researchers. The programme covered all aspects of the training template for early-stage researchers provided by the UK Research Councils. Modules in the first year covered aspects of the research environment; teamwork; time management and action planning; communication; professional writing; personal and interpersonal skills; presentation skills; IT and information handling; statistics and experimental design; career development; science and ethics in the 21<sup>st</sup> century. In the second year, Fellows were encouraged to put their professional skills into practice and to improve their performance using the technique of “reflective learning”. The final modules (relating to preparation of the PhD thesis and long term issues of career development) were retained for the final year. As part of their “Science in Society” seminar series, JIC students organized occasional “alumni” events to explore the range of career opportunities available at the postdoctoral stage.

**Science in a Commercial Environment:** All Fellows on the EST programme gained some exposure to the entrepreneurial environment through seminars and visits from representatives of large and small commercial institutions engaged in relevant scientific research. On the JIC site itself, there is Plant Bioscience Ltd., a technology transfer company that deals with intellectual property from JIC and elsewhere. There is also a Bio-incubator that houses up to six start-up companies involved in the commercialisation of ideas and technologies arising from JIC and elsewhere. These two groups combined to present an interesting 1-day seminar on intellectual property and entrepreneurship entitled “making money from science”. In addition, several Fellows have attended the BBSRC Biotechnology Young Enterprise Scheme, which is intended to raise awareness of the excitement and challenges associated with the commercialisation of research. The competition is run as a weekend workshop for teams of young bioscientists. Participants were given insights into business and commercialisation processes from those who have already established Biotech start-ups. The culmination of the competition is the preparation and presentation by each team of a hypothetical business plan for a new start-up company. ( <http://www.biotechnologyyes.co.uk> ).

**Links with Schools:** Many EST Fellows engaged with local schools and scholars, either by hosting scholars at JIC over a 4-week period or through visits to an affiliated school in the vicinity of JIC. Contacts between EST Fellows and schools have served to develop the communication and teaching skills of EST Fellows as well as providing an excellent service to science in the community.

**Opportunities for University Teaching:** All EST Fellows had the chance to teach in undergraduate practical classes at the University of East Anglia (Schools of Biology and Chemistry). EST Fellows will also had the opportunity to attend a University-based training course on “Teaching Skills”. Free English lessons were also available if required.