CSC-RUB PhD Project Proposal

Title: Molecular mechanisms of metal homeostasis in the model plant *Arabidopsis thaliana*

**Sector of research:** Plant biology, molecular plant physiology, metal homeostasis networks

**Degree awarded:** PhD in Biology (Integrated Graduate School of Biology, IGB)

**Keywords:** nutrition, Arabidopsis, genomics, abiotic stress, heavy metals, iron, zinc, copper, forward genetics, reverse genetics, physiology, molecular cloning, cell biology, biochemistry, confocal laser scanning microscopy

**Supervisors of PhD project:**

Prof. Dr. Ute Krämer, Chair of Molecular Genetics and Physiology of Plants, Faculty of Biology and Biotechnology, Ruhr University Bochum, web: www.rub.de/mgpp/kraemer.html

Email: Ute.Kraemer@ruhr-uni-bochum.de; ORCID: 0000-0001-7870-4508; Google Scholar: https://scholar.google.de/citations?user=EAeobDEAAAAJ&hl=de: 18,697 citations (H: 55).

**Research focus of supervisor:**

Our research focuses on the molecular-physiological understanding of plant metal homeostasis networks. Deficiencies in the essential metals iron, zinc and copper have severely detrimental effects on the health of one-third of the human population, and they dwarf stress resilience and yields of crops on a substantial proportion of agricultural soils worldwide. Moreover, crop plants take up contaminant heavy metals, for example cadmium and lead, because of their similarity to nutrient metals, thus increasingly contributing to human disease burden worldwide. An improved understanding of plant metal homeostasis is mandatory to meet the global challenges of the future. In our group, we work on ecological-evolutionary aspects as well as towards an improved fundamental molecular understanding of metal homeostasis networks and their interactions with metabolism and development in land plants. Our laboratory combines molecular biology, genomics and genetics with biochemical, cell biology and physiological expertise, based primarily on laboratory experiments, with common garden experiments and fieldwork when appropriate, complemented by some entirely computational work. As model organisms, we mostly employ the genetic model plant *Arabidopsis thaliana*, the closely related extremophile *Arabidopsis halleri*, and occasionally barley as a model crop.

**Publications:**


**H-index of the last 5 years:** 45; **number of publications in the last 5 years:** 22
Second supervisor: In the International Graduate School of Biosciences, PhD candidates select the second supervisor within the first three months, with advice from the first supervisor. For example, Prof. Dr. Christopher Grefen, Prof. Dr. Berit Ebert, Prof. Dr. Sacha Baginsky, Prof. Dr. Franz Narberhaus or Dr. Minou Nowrousian often act as second supervisors of PhD students in our group.

Summary of research plan

Background: Without a tightly controlled metal homeostasis, plants cannot survive, grow or reproduce, and they cannot acclimate to nutrient imbalances in soil. Metal homeostasis involves temporally and spatially controlled transmembrane metal transport and metal chelation events, as well as their tight regulation according to endogenous needs and external supply. While a number of metal homeostasis genes have been functionally characterized, the regulation and spatio-temporal organization of metal homeostasis processes remain poorly understood, and some critical functions remain to be discovered.

Study objective: The objective of the PhD project is to establish the molecular functions and biological roles of specific gene products with key roles in metal homeostasis and/or its integration with plant growth, metabolism and development. In forward genetic screens and through other approaches, we have identified a number of genes of critical importance in Fe, Zn and Cu homeostasis. The goals of the project are 1. to pursue molecular biology, cell biology and biochemical approaches for identifying the molecular function of a specific metal homeostasis gene or a small group of functionally interconnected genes, 2. to identify the physiological function in planta in space and time in an organismic context.

Expected Results: Students will accomplish a significant advance in the mechanistic understanding of plant metal homeostasis at the molecular level.

Methods: Molecular cloning, heterologous expression, generation, validation and characterization of transgenic Arabidopsis lines, generation/identification and characterization of single and multiple mutant lines at the genetic and physiological levels, RT-qPCR, digital PCR, light and confocal laser scanning microscopy, plant cultivation under defined nutrient conditions, immunoblotting, immunolocalization, protein purification, metabolite and enzyme activity assays, RNA-seq and/or other sequencing-based genomics techniques.

Candidate Requirements: Candidates should have an MSc in biology, plant sciences, biochemistry or crop science. Molecular biology knowledge and practical experience are mandatory. Programming and bioinformatics skills are welcome. Hands-on experience in working with plant models would be helpful. Adequate English language skills are required.

Motivation for CSC application: The successful applicant will receive in-depth training in design and implementation of state-of-the-art research in plant biology, more specifically genetics-enabled molecular plant physiology. Stringent scientific thinking, exchange of thoughts, constructive discussion and collaboration within our research group as well as intense interactions with other groups in the faculty and external cooperation partners are key components of our activities. We emphasize the development of excellent academic writing and presentation skills. The Department of Molecular Genetics and Physiology of Plants provides a vibrant diverse international environment that hosts scientists from all over the world and from a variety of scientific disciplines. PhD candidates will be supported by a highly skilled team of technicians and well-trained scientists. The PhD project will be supervised by Prof. Dr. Ute Krämer, who is among the worldwide leading researchers in the field of Molecular Plant Physiology. State-of-the-art infrastructure and expertise are available for all elements of the project. PhD candidates are integrated into the internationally renowned structured graduate programme of the International Graduate School of Biology (IGB) dedicated to training in both scientific and complementary skills.