

**iGRAD** *plant*

International  
Graduate  
Program  
for Plant Science



HEINRICH HEINE  
UNIVERSITÄT DÜSSELDORF

**iGRAD-Plant**

**Graduate Program for Plant Science**

**Graduate Student Handbook**

Heinrich Heine University Düsseldorf

# Graduate Student Handbook

## iGRAD-Plant

International Graduate Program for Plant Science  
„The Dynamic Response of Plants to a Changing Environment“

A joint program with  
Research Center Jülich (ICG-3 Phytosphere)  
and  
Graduate Program in Genetics  
Michigan State University, East Lansing, MI



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## 1 Welcome

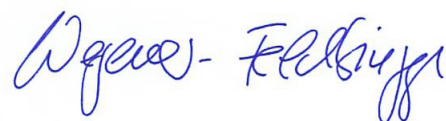
We are pleased to welcome you as a graduate student of the International Graduate Program “The Dynamic Response of Plants to a Changing Environment” (iGRAD-Plant). The aim of the iGRAD-Plant program is to provide graduate students with an outstanding scientific training in different areas of modern plant biology. To reach this goal, the scientific training includes lectures, seminars and workshops, a mentoring program tailored to your needs by your graduate guidance committee and, at the heart of the program, your scientific dissertation research project.

A particular strength of the iGRAD-Plant program is its close collaboration with the Graduate program in Genetics at the Michigan State University (USA). The international collaboration will provide you with a rich environment for graduate training and promote your mobility and integration into the international research community.

This handbook is designed to assist you in understanding the guidelines for degree completion and to provide you with information about the iGRAD-Plant program. If you have any questions, problems or suggestions, do not hesitate to contact the program spokesperson, managing director or members of your graduate guidance committee. We wish you enjoyable and successful years in the iGRAD-Plant program in Düsseldorf!



Prof. Dr. Andreas Weber  
iGRAD-Plant Spokesperson



Dr. Sigrun Wegener-Feldbrügge  
iGRAD-Plant Managing Director

## 2 Scientific Background

In contrast to most animals and microorganisms, plants are sessile organisms, and thus are not able to evade unfavourable environmental change by migration or flight. Instead, plants have evolved multiple complex mechanisms to cope with environmental change. These range from the production of dormant stages such as seeds, which enable plants to outlast adversarial growth conditions through the seed bank and distribution over long distances to explore new terrain, to rapid responses at the cellular level, such as the hypersensitive response to pathogen attack or production of antioxidants to cope with oxidative stress. In addition, due to allelic variation, many genetic traits show considerable plasticity in natural populations, thus defining a broad reaction norm (coping range) within which selection can operate to enable the fittest to survive. Consequently, the study of plant adaptation to changing environments is a broad field, ranging from population dynamics to cell biology. Within this broad context, the specific focus of iGRAD-Plant is on the dynamic molecular changes in response to environmental cues at the cellular and tissue levels, such as signal transduction pathways, metabolic and physiological responses, and biochemical adaptation. This focused approach is complemented by exploring the effects of allelic variation on specific cellular traits, such as the antioxidant defence system and by a comprehensive set of non-invasive and destructive phenotyping tools that have been developed and contributed by our partners at the Jülich Research Center (ICG-3 Phytosphere).

In addition, a profound understanding of the mechanisms that enable plants to dynamically respond to environmental challenges requires to link quantitative phenotypic and genotypic information at multiple levels and scales. This requires strong mathematical, statistical, computational, and bioinformatics skills, therefore formal training in quantitative and computational biology is mandatory for all iGRAD-Plant graduate students. The iGRAD-Plant program combines the expertise of a multidisciplinary research team ranging from ecophysiologicals, biochemists to bioinformaticians at Heinrich Heine University. Additional complementary expertise is provided by the international partner institution, Michigan State University (<http://www.genetics.msu.edu>) both at the level of formal training and for joint research projects.

### 3 General Concept

The iGRAD-Plant faculty consists of 11 junior and senior faculty members at HHU and the Jülich Research Center, 4 associated faculty members at HHU and 20 faculty members at MSU, one of the strongest plant research groups in the United States (you will find an address list of all the participating faculty members on page 27). Under the umbrella of the common research theme, the scaffold of iGRAD-Plant is built by two parallel and complementary research thrusts (i) Abiotic interactions and (ii) Biotic interactions. The research area *Abiotic Interactions* will concentrate on the adaptation of the photosynthetic apparatus to the requirements of optimal light energy utilization, as well as the effects of temperature on plant reproductive organs. In the research area *Biotic Interaction* the main focus will be on interaction of plants with symbionts and pathogens.

Table 1 below summarizes the two main research thrusts that form the scaffold for 6 projects that are in most cases conducted by teams consisting of two or more investigators.

#### Overview of iGRAD-Plant research projects:

Project description		Principal Investigator HHU/FZJ	Cooperation MSU
<b>Abiotic Interaction</b>			
A1	Environmental control of biochemical carbon pumps in land and aquatic seed plants	<b>Linka, Weber, Westhoff</b> <i>Als: Hussner, Maurino</i>	Benning, Buell, Farré, Hu, Montgomery, Sharkey, Wilkerson
A2	Light acclimation of plants: Photoprotection, ABA metabolism and the role of the circadian clock	<b>Jahns, Matsubara</b> <i>Als: J. Zeier</i>	Farré, Kramer, Sharkey, Thomashow
A3	Function of receptor kinases and peptide ligands in the temperature dependent control of ovule and seed number	<b>Groth, Simon</b> <i>Als: Rose, Schubert</i>	Brandizzi, Shiu
<b>Biotic Interaction</b>			
B1	Infection of <i>Brassicaceae</i> by smut fungi: Investigating the <i>Arabidopsis ciliata</i> / <i>Thecaphora thlaspeos</i> pathosystem	<b>Feldbrügge, Lercher</b> <i>Als: Göhre, Rose</i>	Day, He, Walton
B2	Subcellular production and transport of the plant defense signal pipecolic acid	<b>Zeier</b> <i>Als: Linka, Simon, Weber</i>	He, Last, Hoffmann-Benning
B3	Molecular evolution of LysM gene family in Lotus species	<b>Rose</b> <i>Als: Göhre</i>	Buell, Friesen, He, Lau, Shiu

A more detailed description of the iGRAD-Plant research projects can be found on the iGRAD-Plant website at: <http://www.igrad-plant.hhu.de/research.html>.

A particular strength of our training program is that it has a strong emphasis on the quantitative aspects of biology, including bioinformatics and computational biology, and biostatistics. The iGRAD-Plant graduate program teams up with the Graduate Program in Genetics at MSU to provide a joint innovative and structured framework for the study program. The student's guidance committees consist of two local members and one professor from the partner university to facilitate coordinated research. All graduate students complete six to nine-months research stays at the partner institution that includes taking classes and seminar courses and participation in an off-campus student and faculty retreat. Faculty exchange visits and international workshops further promote the integration of the research and training programs of the partner institutions. Thus, the international collaboration provides a rich environment for graduate training and promotes mobility and integration of graduate researchers into the international research community.

#### 4 Program outline for students entering iGRAD-Plant with a bachelor's degree

The iGRAD-Plant program consists of two different studying periods, the qualification and the research period (Table 1). The program is designed to be completed within four years in case of students entering with a bachelor's degree.

Qualification period		Research period					
1. Semester	2.Semester	3. Semester	4.Semester	5. Semester	6. Semester	7. Semester	8. Semester
Three 6 week lab rotations		Developing research proposal	PhD research project + 6-9 month research stay at MSU				Project + dissertation completion
Two Master Modules (6 weeks each)		One class in "Quantitative Biology"		Two workshops in "Advanced methods in Plant Biology"			
External and internal lecturer program							
Regular practice in scientific writing, communication and presentation skills							
One workshop in "Good Scientific Practice"		Three workshops in "Transferable Skills"					

**Table 1:** Program outline for students entering the PhD program with a bachelor's degree

##### 4.1 Qualification Period

The basic philosophy of our qualification program is that all incoming students with a bachelor's degree are initially trained in a structured one-year program consisting of formal class work and lab rotations that is completed by an oral exam in front of the master admission committee. The qualification period consists of three 6-week rotation periods in three different laboratories (chosen according to the students scientific interests) and the successful participation in at least two 6-week modules out of the Master's program. Performance in lectures, seminar courses and lab rotations will be assessed by exams and a grade average of 1.5 or better has to be maintained. During the rotation period the graduate students are provisionally guided by the spokesperson and the managing director of the graduate program, until a final guidance committee has been chosen.

## 4.2 Research Period

After successfully passing the final oral exam in front of the master admission committee, the students select a laboratory for PhD research and will have up to six months to start their dissertation project and to develop a research proposal that they will submit to their guidance committee in writing, followed by a discussion in their first committee meeting. The guidance committee consists of three academic advisors, including one faculty member of the partner institution. Afterwards the students move on to the research part of their Ph.D., which is accompanied by mandatory and optional seminars and workshops, and by regular meetings with their guidance committee. In order to promote the independence of the doctoral researchers and train them to work in an international research team all graduate students will perform a six-to nine-month research stay at collaborating laboratories of the Michigan State University.

Therefore, also part of the study program can be integrated with the research stay in the host lab at MSU. For successful careers in academia and science also a number of “transferable” skills are important. These include scientific writing and speaking (in German and English), project management, preparation of a curriculum vitae, preparation for job interviews, and personnel management. iGRAD-Plant is an institutional member of the “Interdisciplinary Graduate and Research Academy Düsseldorf” (iGRAD) at the *Faculty of Mathematics and Natural Sciences*. It especially benefits from iGRAD’s central services regarding the organization of courses in transferable skills for PhD candidates. The *iGRAD basis curriculum* of three courses in transferable skills is also guaranteed and required for the iGRAD-Plant program. Additionally, iGRAD-Plant doctoral researchers will benefit from the individual services of iGRAD like the central doctoral researcher’s help desk, conflict counselling, or the career development program.

## 4.3 Teaching concept

The student will enter the program by enrolling in the Master of Science in Biology program at HHU. The teaching program consists of five different parts (Table 1):

- Research project
- Scientific training courses
- Lecture series
- Regular practice in scientific writing, communication and presentation skills
- “Transferable Skill” training courses

### **4.3.1 Research project**

#### **Qualification period**

Being the basis of the PhD study the research project spans throughout the whole period of the students stay in the program. The research project aims at qualifying the student for independent and professional scientific work. At the beginning of the qualification period the student will choose three different laboratories for the rotation period, according to his/her research interests. The time of the research stay in each of the laboratories has to be a minimum of 6 weeks. During this period the student will learn the fundamentals of scientific methodologies and theories and is getting introduced into independent scientific work. At the end of each rotation the students present their work in a public seminar followed by a closed oral exam for which a grade will be assigned. After the rotation period the student will declare preference for a PhD project in one of the laboratories in which s/he has completed a rotation. The student is required to prepare a written research proposal, outlining the planned PhD project and defend the proposal in an oral exam in front of the master admission committee (pass/fail). A requirement for entering the research period of the iGRAD-Plant program and starting the PhD research project is to maintain a grade of 1.5 or better throughout the qualification period.

#### **Research Period**

To facilitate coordinated and interdisciplinary research, the student will select a graduate guidance committee, consisting of at least three faculty members, with one faculty member serving as the major professor. The guidance committee will consist of at least one member of the partner university (MSU). Main supervision will be given by the leading scientist of the hosting research group in which the individual doctoral researcher is affiliated institutionally. The main supervisor together with his/her research group guarantees daily supervision, embedding in the required social and infrastructures (e.g. regular progress reports and journal clubs, mandatory occupational medical examination, safety instructions, write and work areas). The additional supervisors will be available to the doctoral researcher to complement the first supervisor's expertise. Depending on the individual research project the respective supervision teams may be expanded by a complementing scientist, experienced postdoc or an external collaborator. The supervision team members are in close contact with each other and cooperatively organize all relevant work and project discussions of the corresponding project.

Supervision takes place in a clearly defined, transparent and structured process. A training and supervision agreement has to be signed at the beginning of the project. This agreement defines, amongst others, the rights and responsibilities of doctoral researchers and supervisors. Within the first three to five months of the research project, the doctoral researcher writes a

proposal of his/her research project, which will be discussed in the first committee meeting. In the following annual committee meetings supervisors and researchers review the achieved objectives, decide on possible adjustments and develop a project and training plan for the following year. If possible committee meetings should be scheduled during joint retreats with the partner institution or at jointly attended conferences, in order to allow the faculty from MSU to attend the meetings. In case the committee members from MSU are not able to attend the annual committee meetings they contribute their comments in a *Skype*-meeting or in a written form. A written progress report is prepared by the doctoral researcher for each meeting, as well as a written protocol documenting the outcome of the meeting, which will be signed by all participants and submitted to the iGRAD-Plant management office.

All students will complete a 6 to 9 months research stay at the Michigan State University. Students will be prepared for the international experience, if necessary, by language classes at HHU. Supervision of graduate students at MSU will be guaranteed by the MSU faculty member, being part of the student's guidance committee.

In the last semester of the iGRAD-Plant program the student will complete the research project and prepare the PhD thesis report. The student will have to defend the PhD thesis in a public oral exam. The exam has to be taken at least 6 month after handing in the PhD thesis report.

### 4.3.2 Scientific training courses

#### Qualification period

All graduate students entering the program with a bachelor degree must enroll in the Master of Science in Biology program of HHU. According to the “Prüfungsordnung” of the Faculty of Mathematics and Natural Sciences at HHU qualification (Fast-Track) students will have to successfully complete the following classes and exams in order to qualify for transition to the PhD program:

- Two practical courses (7 CP each)
- 2 Master Modules (14 CPs each, out of the master program)
- One comprehensive oral exam in front of the master admission committee

Since the iGRAD-Plant graduate program requires the student to take three laboratory rotations (7 CP each), two of the rotations equal to two practical courses (7CP each), one can get integrated in the Master Module 4439 “Integrative Topics in Plant Science”. The iGRAD-Plant spokesperson, the managing director and/or the student’s guidance committee will consult with the student to assist in selection of classes. Performance in lectures and seminar courses will be assessed by a comprehensive exam (see section 4.3.1) and a grade of 1.5 or better has to be maintained.

#### Research Period

The core research groups of iGRAD-Plant offer practical workshops in modern methods and topics of advanced plant biology. During their study the students will be trained in these methods qualifying them to select, apply, and adapt them to solve their scientific questions. A particular strength of the iGRAD-Plant program is its strong emphasis on the quantitative aspects of biology, including bioinformatics and computational biology, and biostatistics. Part of the study program will be taken at HHU, whereas other parts can be integrated in the research stay at MSU. The student is required to take the following training courses:

- One class in “Quantitative Biology” at HHU or MSU out of the following options:
  - PC based analysis and presentation of biological data (HHU)
  - Statistical computing for Biology: Introduction into PERL and R (HHU)
  - Introduction of Bioinformatics (MSU)
  - Statistical Problems (MSU)
- At least two additional workshops in “Advanced methods of plant biology” such as:

- Advanced Microscopy
- Studying Protein-Protein Interaction via FRET
- Non-destructive plant phenotyping
- Biochemical analysis of membrane protein complexes by native gel electrophoresis and epitope tagging
- RNA-Seq in bio-medical research
- Wheat germ cell-free expression system for protein production
- Statistical analysis of experimental data

Workshops in “Advanced methods of plant biology” can also be taken externally. The guidance committee will assist the student with selecting the class work. The guidance committee will also decide if the student will have to take language classes to prepare for the stay abroad.

### **4.3.3 Lecture Series**

In order to deepen and broaden the theoretical background in plant biology all students need to attend the following lecture series every year throughout the study program:

- Plant Biology Seminar (PBS) and Lounge
- Integrative Topics in Plant Sciences Seminar and Lecture
- iGRAD-Plant Fellow Seminar (iFS)

The iGRAD-Plant students should organize at least once per semester a lecture unit of the Plant Biology Seminar at HHU. This will allow the students to practice active scientific networking, including selection and invitation of a guest speaker (student invited speaker). The graduate students will also be responsible to host the meeting with the speaker in the PBS Lounge after the seminar.

### **4.3.4 Regular practice in scientific writing, communication and presentation skills**

During their PhD study the students are obliged to practice communication and presentation skills on several occasions:

- Progress reports on a regular basis for their academic advisors and members of the hosting research group.
- Scientific writing classes, where the students will submit research papers and proposals to peer review by other students and professional experts to ensure quality throughout the process. The scientific writing classes can be chosen from the program of the

“Interdisciplinary Graduate and Research Academy Düsseldorf (<http://www.uni-duesseldorf.de/iGRAD/>).

- Project presentations at the jointly organized symposium of all faculty and students from the US and German laboratories.
- Attendance of international scientific conferences where the students will actively communicate and discuss their project data either by oral or by poster presentation.

#### **4.3.5 “Transferable Skill” workshops**

The program considers a broad range of national and international demands and suggestions regarding an up to date and forward looking training of PhD students. During one- to two-day workshops the students will be trained by professional experts in the fundamentals of a broad range of transferable skills. They will attend at least three workshops of the program from the fields of:

- Presentation/Communication
- Professional Basics of Teaching and Learning (didactics) or Work/Project/Self organization and management
- Scientific writing

In addition, the students will have to take a half-day course in “Good scientific practice”. Workshops can be chosen from the program of the “Interdisciplinary Graduate and Research Academy Düsseldorf (iGRAD) of the Faculty of Mathematics and Natural Sciences (<http://www.uni-duesseldorf.de/iGRAD/>). iGRAD is offering workshops in fields like communication, presentation, rhetoric, scientific writing, scientific proposals, professional teaching/didactics for university teaching, language courses in English or German, project and work management, information management, time management, team work and moderation, biosecurity, good scientific practice, science ethics, quality management systems (GLP/GMP/GCP), basics of copyright and patent law, career management, etc.. All attended workshops will be documented and included in an accumulated PhD supplement.

A distinguishing characteristic of the Transferable Skills Program is that a number of workshops will be approvable by other certified and further qualifying training programs, such as the program "Professional Teaching Competence for Universities" offered by the University Didactics Network of North-Rhine Westphalia. Those workshops are realized in cooperation and in accordance with the regarding institutions and networks. In addition, specifically for women scientists the Equal Opportunity Office of the HHUD offers a comprehensive program of seminars

and workshops to promote and advance female students. The Transferable Skills Program in combination with daily practice in the course of the research projects and other areas of the iGRAD-Plant Teaching Program enables the students to build up an individual and sustainable profile of diverse key competences next to an exceptional scientific expertise and professionalism.

### 4.3.6 Outline of a typical study program for students entering the iGRAD-Plant program with a bachelor's degree

#### Qualification period:

- 1<sup>st</sup> and 2<sup>nd</sup> semester:
- 2 lab rotations (7 CP each)
  - Master module 4439 "Integrative Topics in Plant Science" (14 CP; includes 1 lab rotation)
  - 1 Master module (14CP, freely selectable)
  - Plant Biology Seminar (PBS)
  - iGRAD-Plant Fellow Seminar (iFS)
  - 1 workshop "Transferable Skills"
  - 1 workshop in "Good Scientific Practice"
  - Final oral exam
  - Grade of 1.5 or better

#### Research period:

- 3<sup>rd</sup> semester:
- Developing research proposal
- 4<sup>th</sup> to 7<sup>th</sup> semester:
- PhD research project
  - 6 to 9 month research stay at MSU
  - 1 class "Quantitative biology"
  - 2 workshops "Advanced Methods in Plant Biology"
  - 1 class "Scientific writing"
  - 1 workshop "Transferable Skills"
  - Plant Biology Seminar (PBS)
  - iGRAD-Plant Fellow Seminar (iFS)
  - Seminar series "Integrative Topics of plant science"
  - Attendance of annual joint retreat of iGRAD-Plant students and faculty
  - Attendance of international scientific conferences
- 8<sup>th</sup> semester:
- Preparation of PhD thesis report
  - Defending PhD thesis report in final oral exam

## 5 Program outline for students entering iGRAD-Plant with a master’s or diploma degree

Students entering the program with a master’s or diploma degree will immediately enter the research period of the iGRAD-Plant program, developing their research proposal within the first 3 to 6 months in the program. In the beginning of the program each student will be supervised by the iGRAD-Plant spokesperson and/or the managing director, who will guide and consult the student in the first months until they have selected their final graduate guidance committee. The iGRAD-Plant program will usually be completed within three years (Table 2).

Research period					
1. Semester	2. Semester	3. Semester	4. Semester	5. Semester	6. Semester
Three 3 week lab rotations & Developing research proposal	PhD research project + 6-9 month research stay at MSU				Project + dissertation completion
One class in “Quantitative Biology”			Two workshops in “Advanced methods in Plant Biology”		
External and internal lecturer program					
Regular practice in scientific writing, communication and presentation skills					
One workshop in “Good Scientific Practice”	Three workshops in “Transferable Skills”				

**Table 2:** Program outline for students entering the PhD program with a masters or diploma degree

### 5.1 Teaching-concept

The teaching program consists of five different parts (Table 2):

- Research project
- Scientific training courses
- Lecture series
- Regular practice in scientific writing, communication and presentation skills
- “Transferable Skill” training courses

### 5.1.1 Research project

Being the basis of the PhD study the research project spans throughout the whole period of the students stay in the program. The research project aims at qualifying the student for independent and professional scientific work. In the beginning of the research period the student will choose three different laboratories for the rotation period, according to his/her research interest. The time of the research stay in each of the laboratories has to be 3 weeks and is completed by a progress report given as a public presentation. During the rotation period the student will learn the fundamentals of scientific methodologies and theories and is getting introduced into independent scientific work.

After the rotation period the student will declare preference for a PhD project in one of the laboratories in which s/he has completed a rotation. The student will have to select a graduate guidance committee, consisting of at least three faculty members, with one faculty member serving as the major professor. The guidance committee will have at least one member of the partner university. Main supervision will be given by the leading scientist of the hosting research group in which the individual doctoral researcher is affiliated institutionally. The main supervisor together with his/her research group guarantees daily supervision, embedding in the required social and infrastructures (e.g. regular progress reports and journal clubs, mandatory occupational medical examination, safety instructions, write and work areas). The additional supervisors will be available to the doctoral researcher to complement the first supervisor's expertise. Depending on the individual research project the respective supervision teams may be expanded by a complementing scientist, experienced postdoc or an external collaborator. The supervision team members are in close contact with each other and cooperatively organize all relevant work and project discussions of the corresponding project.

Supervision takes place in a clearly defined, transparent and structured process. A training and supervision agreement has to be signed at the beginning of the project. This agreement defines, amongst others, the rights and responsibilities of doctoral researchers and supervisors. Within the first three to five months of the research project, the doctoral researcher writes a proposal of his/her research project, which will be discussed in the first committee meeting. In the following annual committee meetings supervisors and researchers review the achieved objectives, decide on possible adjustments and develop a project and training plan for the following year. If possible committee meetings should be scheduled during joint retreats with the partner institution or at jointly attended conferences, in order to allow the faculties from MSU to attend the meetings. In case the committee members from MSU are not able to attend the annual committee meetings they contribute their comments in a *Skype*-meeting or in a written form.

A written progress report is prepared by the doctoral researcher for each meeting, as well as a written protocol documenting the outcome of the meeting, which will be signed by all participants and submitted to the iGRAD-Plant management office.

All students will complete a 6 to 9 months research stay at the Michigan State University. Students will be prepared for the international experience, if necessary, by language classes at HHU. Supervision of the graduate students at MSU will be guaranteed by the MSU faculty member, being part of the student's guidance committee.

In the last semester of the iGRAD-Plant program the student will complete the research project and prepare the PhD thesis report. The student will have to defend the PhD thesis in a public oral exam. The exam has to be taken at least 6 month after handing in the PhD thesis report.

### **5.1.2 Scientific training courses**

The core research groups of iGRAD-Plant offer practical workshops in modern methods and topics of advanced plant biology. During their study the students will be trained in these methods qualifying them to select, apply, and adapt them to solve their scientific questions. A particular strength of the iGRAD-Plant program is its strong emphasis on the quantitative aspects of biology, including bioinformatics and computational biology, and biostatistics. Part of the study program will be taken at HHU, whereas other parts can be integrated in the research stay at MSU. The student is required to take the following training courses:

- One class in “Quantitative Biology” at HHU or MSU out of the following options:
  - PC based analysis and presentation of biological data (HHU)
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  - Statistical Problems (MSU)
  
- At least two additional workshops in “Advanced methods of plant biology” such as:
  - Advanced Microscopy
  - Studying Protein-Protein Interaction via FRET
  - Non-destructive plant phenotyping
  - Biochemical analysis of membrane protein complexes by native gel electrophoresis and epitope tagging
  - RNA-Seq in bio-medical research
  - Wheat germ cell-free expression system for protein production
  - Statistical analysis of experimental data

Workshops in “Advanced methods of plant biology” can also be taken externally. The guidance committee will assist the student with selecting the class work. The guidance committee will also decide if the student will have to take language classes to prepare for the stay abroad.

### **5.1.3 Lecture Series**

In order to deepen and broaden the theoretical background in plant biology all students need to attend the following lecture series every year throughout the study program:

- Plant Biology Seminar (PBS) and Lounge
- Integrative Topics in Plant Sciences Seminar and Lecture
- iGRAD-Plant Fellow Seminar (IFS)

The iGRAD-Plant students should organize at least once per semester a lecture unit of the Plant Biology Seminar at HHU. This will allow the students to practice active scientific networking, including selection and invitation of a guest speaker (student invited speaker). The graduate students will also be responsible to host the meeting with the speaker in the PBS Lounge after the seminar.

### **5.1.4 Regular practice in scientific writing, communication and presentation skills**

During their PhD study the students are obliged to practice communication and presentation skills on several occasions:

- Progress reports on a regular basis for their academic advisors and members of the hosting research group.
- Scientific writing classes, where the students will submit research papers and proposals to peer review by other students and professional experts to ensure quality throughout the process. The scientific writing classes can be chosen from the program of the “Interdisciplinary Graduate and Research Academy Düsseldorf (<http://www.uni-duesseldorf.de/iGRAD/>).
- Project presentations at the jointly organized symposium of all faculty and students from the US and German laboratories.
- Attendance of international scientific conferences where the students will actively communicate and discuss their project data either by oral or by poster presentation.

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- Professional Basics of Teaching and Learning (didactics) or Work/Project/Self organization and management
- Scientific writing

In addition, the students will have to take a half-day course in “Good scientific practice”. Workshops can be chosen from the program of the “Interdisciplinary Graduate and Research Academy Düsseldorf (iGRAD) of the Faculty of Mathematics and Natural Sciences (<http://www.uni-duesseldorf.de/iGRAD/>). iGRAD is offering workshops in fields like communication, presentation, rhetoric, scientific writing, scientific proposals, professional teaching/didactics for university teaching, language courses in English or German, project and work management, information management, time management, team work and moderation, biosecurity, good scientific practice, science ethics, quality management systems (GLP/GMP/GCP), basics of copyright and patent law, career management, etc.. All attended workshops will be documented and included in an accumulated PhD supplement.

A distinguishing characteristic of the Transferable Skills Program is that a number of workshops will be approvable by other certified and further qualifying training programs, such as the program "Professional Teaching Competence for Universities" offered by the University Didactics Network of North-Rhine Westphalia. Those workshops are realized in cooperation and in accordance with the regarding institutions and networks. In addition, specifically for women scientists the Equal Opportunity Office of the HHUD offers a comprehensive program of seminars and workshops to promote and advance female students. The Transferable Skills Program in combination with daily practice in the course of the research projects and other areas of the iGRAD-Plant Teaching Program enables the students to build up an individual and sustainable profile of diverse key competences next to an exceptional scientific expertise and professionalism.

### 5.1.6 Outline of a typical study program for students entering the iGRAD-Plant program with a masters or diploma degree

1<sup>st</sup> semester:

- 3 lab rotations
- Plant Biology Seminar (PBS)
- iGRAD-Plant Fellow Seminar (iFS)
- Lecture series “Integrative Topics of plant science”
- 1 workshop in “Good Scientific Practice”
- Developing research proposal

2<sup>th</sup> to 6<sup>th</sup> semester:

- PhD research project
- 6 to 9 month research stay at MSU
- 1 class “Quantitative biology”
- 2 workshops “Advanced Methods in Plant Biology”
- 1 workshop in “Scientific writing”
- 2 workshops in “Transferable Skills”
- Plant Biology Seminar (PBS)
- iGRAD-Plant Fellow Seminar (iFS)
- Seminar series “Integrative Topics of plant science”
- Attendance of annual joint retreat of iGRAD-Plant students and faculty
- Attendance of international scientific conferences
- Preparation of PhD thesis report
- Defending PhD thesis report in final oral exam

## 6 Selection and function of the guidance committee

Entering the program the graduate students are supervised by the iGRAD-Plant spokesperson and/or the managing director, who will guide and consult the student during the first year, until the student has selected a major professor. Selecting the major professor requires mutual consent between the professor and student. If the student has trouble finding a willing faculty member to serve as the major professor, he/she should consult the iGRAD-Plant spokesperson to help find a suitable match. The major professor should be a regular faculty member of iGRAD-Plant at HHU or FZJ. Main supervision will be given by the leading scientist of the hosting research group in which the individual doctoral researcher is affiliated institutionally. The main supervisor together with his/her research group guarantees daily supervision, embedding in the required social and infrastructures (e.g. regular progress reports and journal clubs, mandatory occupational medical examination, safety instructions, work and work areas). The additional supervisors will be available to the doctoral researcher to complement the first supervisor's expertise. Depending on the individual research project the respective supervision teams may be expanded by a complementing scientist, experienced postdoc or an external collaborator. The supervision team members are in close contact with each other and cooperatively organize all relevant work and project discussions of the corresponding project.

Supervision takes place in a clearly defined, transparent and structured process. A training and supervision agreement has to be signed at the beginning of the project. This agreement defines, amongst others, the rights and responsibilities of doctoral researchers and supervisors. Within the first three to five months of the research project, the doctoral researcher writes a proposal of his/her research project, which will be discussed in the first committee meeting. In the following annual committee meetings supervisors and researchers review the achieved objectives, decide on possible adjustments and develop a project and training plan for the following year. If possible committee meetings should be scheduled during joint retreats with the partner institution or at jointly attended conferences, in order to allow the faculties from MSU to attend the meetings. In case the committee members from MSU are not able to attend the annual committee meetings they contribute their comments in a *Skype*-meeting or in a written form. A written progress report is prepared by the doctoral researcher for each meeting, as well as a written protocol documenting the outcome of the meeting, which will be signed by all participants and submitted to the iGRAD-Plant management office.

## **7 Degree requirements**

### **7.1 Comprehensive examination**

The purpose of the oral comprehensive exam at the end of the qualification period (for students entering with bachelors degree only) is to determine whether the student has mastered the subject of plant biology and related fields, has a good understanding of the scientific method, and is prepared to do independent doctoral research. The oral exam of the student in front of the master admission committee should be taken at the end of the first year in the iGRAD-Plant program. Passing the qualification period of the iGRAD-Plant program with a grade of 1.5 or better is necessary to become a Ph.D. candidate.

### **7.2 Credit requirements / Seminar and course requirements**

For a list of actual credits and courses required please refer to Sections 4.3 and 5.1 Teaching concept.

### **7.3 Teaching requirements**

The communication skills associated with teaching are essential regardless of whether the student will go on to work in academia, the public sector or the private sector. Therefore, in addition to the seminar requirements, each graduate student must gain teaching experience by participating in the teaching of at least one course of the bachelors or masters program at HHU.

### **7.4 Publication requirements**

It is expected that graduate theses resulting from iGRAD-Plant - associated research are cumulative theses, consisting of at least two manuscripts published (or accepted for publication) in peer-reviewed quality journals. On at least one of these publications, the graduate student must be the lead author. The graduate student will certify that s/he has independently written the initial manuscripts leading to the publications. The rules with respect to the number of publications required for a cumulative thesis will serve as guidelines, because not all publications are equal. Therefore, the guidance committees are encouraged to also accept a single publication with the graduate student as the lead author in a top journal as satisfactory. Along the same lines, less credit should be given for publications in minor journals. Generally, quality is more important than quantity. Conflicts will be solved by the iGRAD-Plant steering committee.

## **7.5 Time limits**

Students entering the program with a bachelor's degree should complete all requirements of the dissertation program within at least four years, whereas students entering with a masters or diploma degree should be finished after three years. The iGRAD-Plant spokesperson may, in special cases, extent the time limits for a student to complete the requirements.

## **7.6 Dissertation**

The HHU will serve as the degree granting institution for the iGRAD-Plant students. Therefore, they have to fulfil the requirements for obtaining a Ph.D. degree from HHU. A detailed description of the requirements can be found in the "Promotionsordnung der Math. Nat. Fakultät" der HHU (<http://www.math-nat-fak.hhu.de/promotion/promotionsordnung-und-formulare-zur-promotion.html>). The student will have to prepare a written Ph.D. thesis. The Ph.D. thesis can be a cumulative thesis consisting of manuscripts published or submitted to peer-reviewed journals and a general introduction part, which deepens and broadens the scientific context of the separate publications. (For number of publications see publication requirements). The student has to defend his/her thesis in a public oral exam.

## **8 Gender equality program**

A number of measures will be taken to ensure gender equality and the compatibility of work and family in iGRAD-Plant. To this end the iGARD-Plant program works closely with the Equal Opportunity Commissioner of the HHU. The Office for Equal Opportunities at the HHU offers a comprehensive program to promote and advance the universities female students and employees. The courses and seminars are open to all female iGRAD-Plant students. In order to provide an environment that is supportive of combining family and career, the HHU offers four day-care center on the campus. The HHU family counselling office supports student parents in finding solutions for gaps in childcare schedules. The office also offers opportunities for childcare during school vacations and serves as a contact and support center in case of exceptional circumstances and emergencies.

## 9 Organisation and contact information

The iGRAD-Plant consists of the PhD students, iGRAD-Plant faculty, iGRAD-Plant PostDoc's and the iGRAD-Plant managing director. Contact information for the iGRAD-Plant management can be found at <http://www.igrad-plant.hhu.de/>.

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Prof. Dr. rer. nat.	Biochemistry, HHU	Fax: +49-211-81-13706 Email: Andreas.Weber@hhu.de <a href="http://www.plant-biochemistry.hhu.de/">http://www.plant-biochemistry.hhu.de/</a>	Cellular Compartmentation, Intracellular Metabolite Transport
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Jürgen Zeier Prof. Dr. rer. nat.	Institute of Molecular Plant Ecophysiology, HHU	Tel: +49-211-81-14733 Email: juergen.zeier@hhu.de <a href="http://www.molekulare-oekophysiologie-der-pflanzen.hhu.de/">http://www.molekulare-oekophysiologie-der-pflanzen.hhu.de/</a>	Plant Pathology; Systemic acquired resistance in plants, metabolic regulation of plant immunity

### Participating Researchers at MSU in alphabetic order

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Federica Brandizzi Prof. PhD	MSU-DOE Plant Research Laboratory, MSU	Tel: 001-517- 353-7872 Email: fb@msu.edu <a href="http://www.prl.msu.edu/faculty/brandizzi_federica">http://www.prl.msu.edu/faculty/brandizzi_federica</a>	Plant secretory proteins, live cell imaging, cell wall, endoplasmic reticulum stress
Robin Buell Prof. PhD	Dept. of Plant Biology, MSU	Tel: 011-517-353-5597 Fax: 011-517-353-1926 Email: buell@msu.edu <a href="http://www.plantbiology.msu.edu/faculty/faculty-research/robin-buell/">http://www.plantbiology.msu.edu/faculty/faculty-research/robin-buell/</a>	Systems biology in plants, genome variation in plants
Yuehua Cui Prof. PhD	Dept. of Statistics and Probability, MSU	Tel: 001-517-432-7098 Fax: 001-517-432-1405 Email: cui@stt.msu.edu <a href="http://www.stt.msu.edu/~cui/">http://www.stt.msu.edu/~cui/</a>	Systems Biology, Computational biology, Bioinformatics, Statistical genetics
Brad Day, Prof. PhD	Dept. of Plant Pathology, MSU	Tel: 001-517-353-7991 Email: bday@msu.edu <a href="http://www.plantpathology.msu.edu/DayBrad">http://www.plantpathology.msu.edu/DayBrad</a>	Plant-pathogen interactions; actin cytoskeletal dynamics; alternative splicing in plant pathogens; biotic-abiotic stress adaptation
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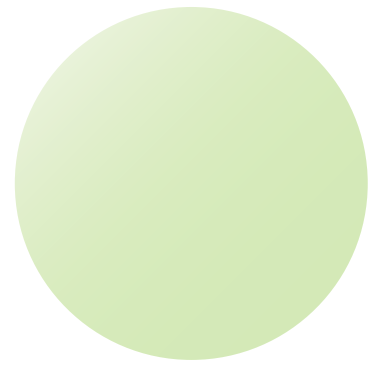
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Jennifer Lau Prof. PhD	Dept. of Plant Biology & Kellogg Biological Station, MSU	Tel:001-517-432-3278 Email: jenlau@msu.edu <a href="http://www.kbs.msu.edu/&lt;br/&gt;people/faculty/lau">http://www.kbs.msu.edu/ people/faculty/lau</a>	Species interactions and environmental change; evolutionary ecology; rapid evolution
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Michael Thomashow Prof. PhD	MSU-DOE Plant Research Laboratory, MSU	Tel:001-517-355-2299 Email: thomash6@msu.edu <a href="http://www.prl.msu.edu/faculty/thomashow_michael">http://www.prl.msu.edu/faculty/thomashow_michael</a>	Plant Acclimation to Low Temperature: global regulation of gene expression, energy signaling, photosynthetic acclimation, natural variation, adaptive traits
Jonathan D. Walton Prof. PhD	MSU-DOE Plant Research Laboratory, MSU	Tel: 001-517-353-4885 Fax:001-517-353-9168 Email:walton@msu.edu <a href="http://waltonlab.prl.msu.edu">http://waltonlab.prl.msu.edu</a>	Enzymes for biofuel applications, Identification of novel biomass enzymes, Genetic engineering for novel cyclic peptides
Curtis Wilkerson Prof. PhD	Dept. of Plant Biology, MSU	Tel: 001-517-432-8283 Email:wilker13@msu.edu <a href="http://plantbiology.msu.edu/faculty/faculty-research/curtis-wilkerson">http://plantbiology.msu.edu/faculty/faculty-research/curtis-wilkerson</a>	Plant cell wall biosynthesis; hemicelluloses and lignin biosynthesis

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Andreas Hussner Dr. rer. nat.	Institute of Plant Biochemistry; HHU	Tel: +49-211-81-14290 Fax: +49-211-81-13706 Email: andreas.hussner@hhu.de <a href="http://www.photosynthesis.hhu.de/">http://www.photosynthesis.hhu.de/</a>	Invasive aquatic plants; role of carbon on aquatic plant growth; single cell C <sub>4</sub> in submerged plants and other HCO <sub>3</sub> <sup>-</sup> use strategies; effects of abiotic stressors on submerged plants
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	and Biotechnology of Plants; HHU	hhu.de <a href="http://www.pmpb.hhu.de/">http://www.pmpb.hhu.de</a> /	Effects of chloroplastic originated-H <sub>2</sub> O <sub>2</sub>
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