



International Research Training Group 1902

*Intra- and interorgan communication of the
cardiovascular system*

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Educational concept

The Educational program of the IRTG1902 aims to support the development of young scientists to qualify them for future positions in research and development. Therefore, an interdisciplinary, systematic and ambitious training will be made available to medical and natural scientists in the area of cardiovascular biology including professional and transferable skills required for a successful future career.

Future professional area

Cardiovascular diseases are the leading cause of morbidity and mortality in the developed countries. Therefore, cardiovascular research is and will be among the most active fields in basic, clinical, and pharmaceutical research. Besides its core areas, cardiac and vascular function, cardiovascular research also addresses related fields including hemostasis, inflammation, tumor biology, etc. Research of the past decades has revealed that mechanisms underlying cardiovascular disease are rarely confined to exclusively affect only heart and vessels. Rather, cardiovascular dysfunction may be aggravated by interorgan communication or, inversely, may affect the function of remote organs. This mutual relationship led to definition of complex syndromes, such as cardio-renal-, cardio-renal-anaemic syndromes, and cardiac cachexia, a.o. Thus, cardiovascular research will move towards a more systemic analysis of intercellular and interorgan communication. The involvement of multiple organs and cell types in a specific pathology is not confined to the cardiovascular system. Similar mechanisms also apply for other pathologies, e.g. hepatic encephalopathy, hepato-renal syndrome, etc. Due to the general impact, integrative investigation of a disease-associated intercellular and interorgan communication is of increasing interest, both in the academic and industrial field.

Profile of IRTG1902 alumni

Our future alumni will therefore be attractive candidates for positions in academic and non-academic research because they will have experimentally addressed a medically relevant topic by using a combination of state-of-the-art technology for genomic, transcriptomic, proteomic and metabolomic analyses, imaging, and tools for functional analysis in combination with transgenic mouse models. Although not all of these technologies will be used in every single project, the tight interconnection of projects, the exchange phase, and the educational program ensure that our graduate students will acquire a comprehensive knowledge of modern techniques to analyze complex biological questions on a systemic level. Besides their scientific expertise alumni of the IRTG1902 will be characterized by proven flexibility and mobility, and have demonstrated to perform in an international environment. These personal qualities are particularly supportive for selection procedures by pharmaceutical companies.

In order to qualify for a future career in science we defined a set of key skills required by scientists. A scientist must be able to

- (1) plan, perform, conduct, and evaluate research.
- (2) develop (novel) experimental approaches to solve scientific problems.
- (3) analyze and integrate the scientific literature.
- (4) competently communicate and discuss own results and scientific data of other groups.
- (5) distinguish important scientific questions from less important ones.

We assume that the experience of young scientists entering the IRTG is mainly based on the textbook knowledge they acquired during their studies. In general, they have a limited experimental experience and contact with the primary literature. Although they may have performed in the context of laboratory and students seminars, their experience to give

scientific talks is rather limited. Thus, all key issues defining a successful scientist in the academic as well as the non-academic field must be developed during the PhD work by the educational program. The IRTG is prepared to fulfill this goal.

Aims of the IRTG-specific educational program

The educational program of IRTG1902 was designed to promote professional, i.e. science related, as well as supportive, transferable skills. The emphasis lies on the development of professional skills and therefore a ratio of approximately 80% of professional to 20 % of transferable skills have been implemented. A further important aspect was that the educational program should only minimally influence the laboratory work. Therefore, the total workload was restricted to 300 h per thesis (3 years) and courses have been planned as short block units to avoid substantial interruption of the experimental work. Participation in classes will be attested in a study book. An exemplary curriculum is shown in Fig. 2.

Professional skills

We define “professional skills” as all the essential properties and expertise to successfully perform in science:

Broad basic knowledge in the field: A solid basis of basic knowledge is the prerequisite for all further skills to be developed. Without knowing the important literature the scientist is unable to generate valid hypotheses, design the appropriate experiments and integrate the results of own research into the current scientific context. Therefore, based on the textbook knowledge it is important for a graduate student to collect and intellectually integrate the relevant literature concerning the own area of research and related fields. Given the topic of this IRTG which addresses the interaction of different cell types within the cardiovascular system as well as their interaction with remote organs, it will be mandatory for the graduate students to acquire the relevant knowledge of basic molecular and cellular mechanisms driving the function of the cardiovascular system. Since the graduate students entering the IRTG will have a very diverse background depending on their studies and master theses, the first aim will be to bring all of them to a comparable level of knowledge on **Basic principles and recent developments in cardiovascular biology**. Therefore, soon after admission the graduate students will participate in an intense lecture series on “Fundamentals of cardiovascular biology” held by all of the PI’s and junior scientists, including chapters on development, function, pathophysiology, signaling and repair of heart and vessels. Based on these fundamentals, the theoretical education will be continued by self-learning and **journal clubs** to be held throughout the further educational process. The journal club will be organized to address spotlight topics, i.e., a series of papers dealing with a specific topic, e.g. inflammation, metabolism, angio- and arteriogenesis, cell migration, cell-matrix-interactions etc.

The planning and interpretation of experiments depends further on a *solid knowledge of the relevant analytical methods*. This includes also details such as suitability, resolution, sensitivity etc. To address this point in the Educational Program all participating institutions contribute to a methods course “**Functional analysis of the cardiovascular system**”, in which basal as well as high-end technology will be introduced to the graduate students. The courses will be held by expert scientists working in the different groups of the IRTG including our American partners (see below: *Educational program during exchange phases*). The topics of this course series include: Blood pressure measurement in mice, cardiac function (Langendorff, Echocardiography, conductance manometry), Magnetic Resonance Imaging, Angiogenesis Assays, Functional analysis of the kidney (isolated organ), confocal microscopy, and FACS analysis. When participating in courses, the students will rotate through the member labs which not only will enhance their specific knowledge but also support networking among the participating groups and graduate students to form a coherent research group

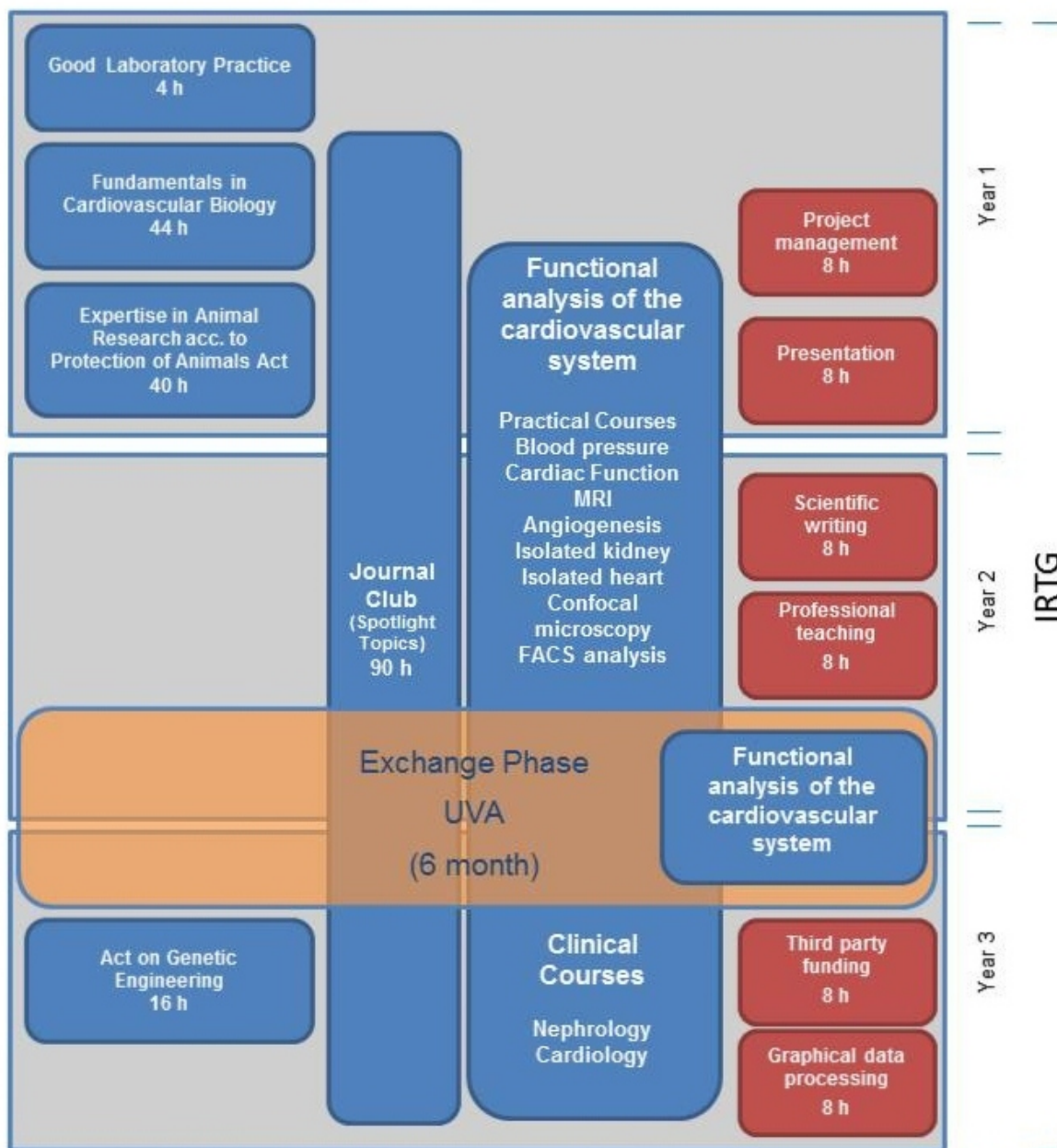


Fig 2: A prototype curriculum for a three year PhD work is shown. For transferable skills examples of courses have been filled in. Subjects may differ for individual students as long as the subject areas have been covered.

Clinical courses

Clinical courses for PhD students are a specific hallmark of the educational program and include cardiology and nephrology. Participants will be introduced to clinical topics, get in touch with principles of modern diagnostics and therapy (Echo, CT, heart catheter lab, valve replacement). The idea behind is to open the mind of our PhD students for “translational” research, to demonstrate the medical dimension of basic research and to encourage cooperativeness and interdisciplinary research.

Table.2: Courses of the educational program

Topic	Type	time	PhD	MD	Who?
Professional skills					
Good laboratory practice	workshop	4 h	X	X	iGRAD/medRSD trainers
Fundamentals in Cardiovascular Biology	Lecture Series	44 h (year 1)	X	X	PI's and junior scientists
Spotlight topics of cardiovascular research	Journal Club	30 h/year, weekly	X	X	PI's and junior scientists
Functional analysis of the cardiovascular system	Practical Course	8 h /subject	X (5)	X (3)	PI's and junior scientists of HHU and UVA
Clinical Courses	Course	1-day block	X (2)		Dpt. of Cardiology; Dpt. Of Nephrology
Expertise in animal research acc. to Animal Protections Act	Professional Skills/ Practical course with theory	5 days, (year 1)	X	(X)	Veterinarians of the Animal Facilities HHU
Act on Genetic Engineering	Workshop	2 days	X		External course (Bochum or Bonn)
Transferable Skills					
Project Management/ Self Management	Workshop	1 days block	X (1)*		iGRAD/medRSD trainers
Presentation/ Communication	Workshop	1 days block	X (1)*		iGRAD/medRSD trainers
Professional Teaching/Didactics	Workshop	1 days block	X (1)*		iGRAD/medRSD trainers
Career relevant skills	Workshop	1 days block			iGRAD/medRSD trainers
<p>X: participation obligatory; (1) (2) (5) Number of obligatory courses; *one obligatory course from each topic of transferable skills; a total of six courses is required. Obligatory courses will be complemented by three courses of choice.</p>					

Transparent and focused communication in form of oral presentations, written manuscripts or grant applications is essential for scientists. It requires to critically review and structure the own data, to deal with related external work and to integrate all of the findings into a common or controversial hypothesis. Thus, training of communication is intimately linked to structured and analytical thinking. Since scientific communication is at the interface of professional and transferable skills the basics of oral and written communication will be addressed in specific courses organized by the Medical Research School and iGRAD. Professional trainers will introduce the graduate students into **Rules for oral presentations** as well as to the **Principles of scientific writing**. Based on these fundamentals the communication skills will be further evolved in the context of journal clubs, progress seminars, and retreats under the guidance of the PI's.

Professional Qualifications. An important task of the IRTG educational program is to supply our alumni with professional qualifications enhancing their chances to position themselves among top candidates in a competitive field of applicants. Certificates according to “**Protection of Animals Act**”, “**Act on Genetic Engineering**”, and “**Act on Radiation Protection**” may represent important qualifications which might enhance the job ability of our graduate students. Since there is an emphasis on the analysis of animal models throughout the IRTG a course to obtain the expertise for execution of animal research according to German “Protection of Animals Act” will be offered at the beginning of the practical work. There is a commitment of the veterinarians of the animal facilities at HHU to offer a special course for IRTG fellows.

Transferable Skills

As mentioned above, two programs dedicated to support structured doctoral theses have been established at HHU which are highly supportive for IRTG1902: the „**Interdisciplinary Graduate and Research Academy Düsseldorf (iGRAD)**“ and the “**Medical Research School Düsseldorf (MedRSD)**”, respectively. The central aims of iGRAD and MedRSD are the coordination as well as advancing the quality and diversity of doctoral education, and the promotion of interdisciplinary cooperation. iGRAD and MedRSD successfully cooperate to develop common programs but also refer to the demands specific for medical and scientific doctoral students. iGRAD and medRSD offer a broad spectrum of classes in transferable skills including “**Introduction to principles of good scientific practice**”, presentation, scientific discussion, scientific writing etc. All of the courses are subject to quality control according to common standards allowing a faculty-independent acceptance of courses. The subtopic ‘Transferable Skills’ of the Educational program can therefore use existing courses and evaluated trainers which guarantees an efficient transfer of knowledge. Four thematic clusters have been built which cover many skills required to become a competitive scientist.

According to the doctorate rules of HHU’s Medical Faculty and the Faculty of Mathematics and Natural Sciences, participation in a course ‘*Good Scientific Practice for Doctoral Researchers*’ is obligatory for all doctoral students of both faculties. Courses are offered by iGRAD and medRSD. For IRTG1902 this course will be included in the kick-off retreat. During workshops, doctoral researchers are trained by professional experts in areas such as:

(1) *Project management/Self-management/Organization:*

e.g., ‘Getting started with the doctoral project’, ‘Introduction to project management’, time management, information management, teamwork, ‘Introduction to leadership principles’.

(2) *Presentation/Rhetoric/Communication:*

e.g., ‘Presenting science’, ‘Intercultural communication’, debating and rhetoric, scientific writing, negotiation, ‘preparing for potential conflict’, moderation techniques, graphical data processing.

(3) *Professional Teaching and Learning/Didactics:*

e.g., ‘shaping up teaching’, basics of professional teaching, teaching methods.

A distinguishing characteristic of these workshops is that they will also be approved by the certified training program ‘Professional teaching competence for universities’ for further education, which is offered by the University Didactics Network of North-Rhine Westphalia and organized in collaboration with the university didactics department of HHU.

(4) *Special Career Relevant Skills:*

e.g., intellectual property rights, applying for third party funding, leadership skills, entrepreneurial thinking, career management, applying for jobs.

Furthermore, courses of the University Language Centre, the Department for Teaching at University Level, and other institutions can be chosen as additional workshops.

It is important to note that the educational program is planned to supplement the development of young scientists. Doctoral researchers of IRTG1902 attend at least 6 workshops in transferable skills. Three of these workshops must be chosen from the thematic areas (1)-(3). The remaining workshops can be selected from the annual program according to individual career development plans drawn up in connection with regular career development consultations.

Each attended workshop is documented individually. In cooperation with the iGRAD and medRSD additionally a 'PhD/ doctorate transcript' will be issued to successful IRTG1902 alumni, documenting all attended workshops, and additional qualifications achieved during the doctoral phase (e.g., teaching activities, conference presentations and attendance, publications) for potential future employers.

Specific regulations for medical students (Dr.med.)

Given the short time to finish the practical work, medical students will have to complete a shortened curriculum. According to the regulations of the medRSD, they will participate in three courses for transferable skills. Moreover, they have to attend three modules of the course "Functional analysis of the cardiovascular system". Since the medical students will be members of the IRTG beyond their active laboratory phase, the participation in these classes is also possible at later time-points in parallel to their studies. Participation in journal clubs and progress seminars/retreats is obligatory during the active phase in the IRTG.

Specific regulations for qualification phases (Fast track bachelor; MD/PhD program)

IRTG1902 will offer access for excellent bachelors of science (fast track), bachelors of technical universities and medical doctors who want to acquire the degree Dr.rer.nat. (MD/PhD program). However, before admission to doctoral studies, these applicants have to pass a qualification program which is defined by the doctorate regulations of the FMNS (also see *admission to the IRTG*, p. 34). In addition to their qualifying studies these candidates will participate in the IRTG-specific educational program in that they will attend journal clubs as well as progress seminars. After successful completion of the qualification phase the general regulations for PhD students apply also to fast track bachelors and MD/PhD candidates.

Integration of Research Students

IRTG1902 will integrate highly motivated research students to attract gifted students to the field of cardiovascular research and to integrate them early into running projects. Due to their limited experience in research, they will be introduced into basic techniques which are routinely used in specific projects (e.g. nitrite measurements, preparation of protein samples, gel electrophoresis, PCR, etc.). As soon as they are able to reliably use these methods the research students will participate in a specific project. To promote their scientific development, research students will have access to all parts of the educational program. A position as Research Student may be an excellent opportunity for students to enter the IRTG and to test their enthusiasm and talent for practical laboratory work in a research oriented environment. Especially, medical students with their limited practical experience will experience "scientific reality" and improve their practical skills, which will facilitate their progress when they have entered the IRTG as a doctoral student.