DIGS-BB: Setting the Standard for Modern PhD Training

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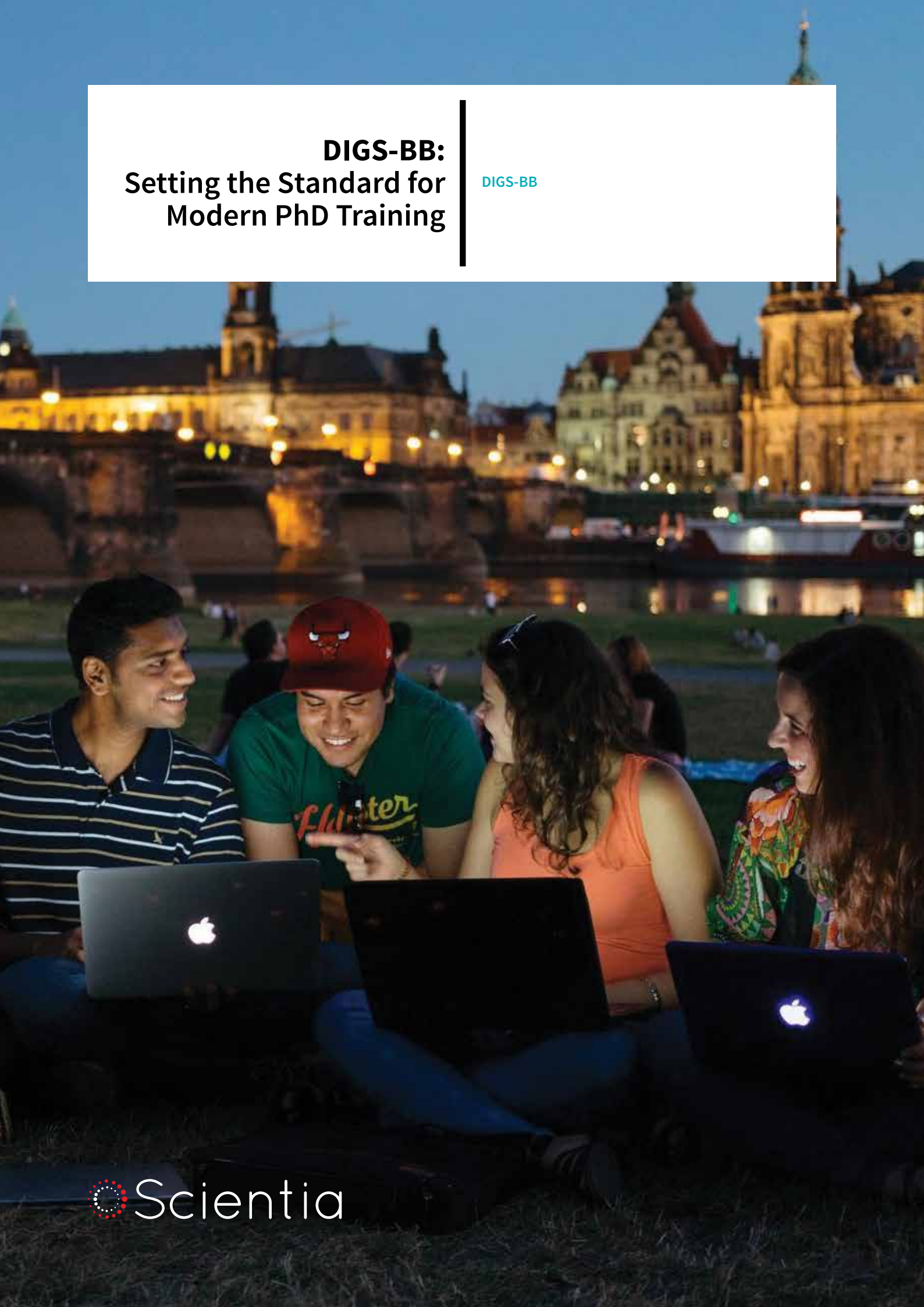

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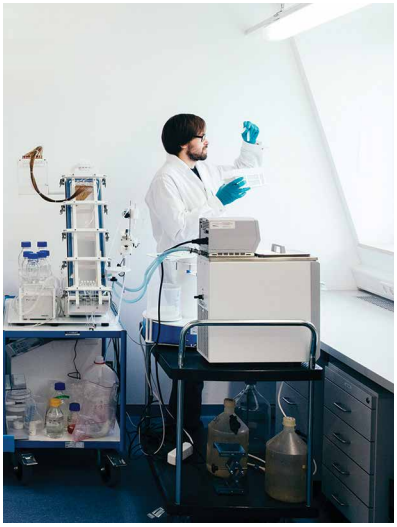


Over the past decade, the **Dresden International Graduate School for Biomedicine and Bioengineering (DIGS-BB)** has risen to the forefront of PhD student training. The program combines cutting edge research projects with innovative mentoring strategies to train well-rounded, interdisciplinary scientists, poised to be leaders in the global scientific community.

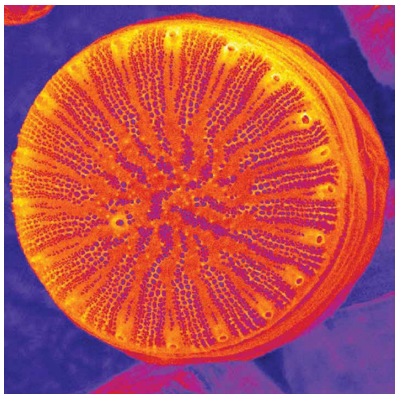
The Formation of DIGS-BB at TU Dresden

In 1828, the TU Dresden first opened its doors as the Saxon Technical School, a college devoted to the education of mechanics and engineers. Over the next 100 years, the college grew and diversified in subjects, officially becoming the Technische Universität Dresden (TU Dresden) in 1961. In 2006, the TU Dresden successfully applied to the German Excellence Initiative, a federal program aimed at promoting cutting-edge research and exemplary scholarly training for young scientists. The TU Dresden is now one of only 11 excellent ranked universities in Germany. One of the achievements to become an excellent university was the establishment of the Dresden International Graduate School for Biomedicine and Bioengineering (DIGS-BB). Since 2006, students of the DIGS-BB have generated over 792 publications with an average impact factor of 8.4. Of these publications, 462 had students as first authors and 263 were in collaboration with other research groups from the DIGS-BB or local partner PhD programs.

The DIGS-BB has quickly become a world leader in PhD training for biomedicine and bioengineering, coupling innovative research with unsurpassed mentoring and training. The program admits 15–25 new PhD students twice a year, and the current student body represents 27 nationalities covering a wide range of educational backgrounds. Students enrolled in the program benefit from extensive collaborative relationships with mentors and scientists in labs within the Dresden life science campus.

Leading the Way in Biomedical and Bioengineering Research

Research at the DIGS-BB focuses on six interdisciplinary fields: Developmental Cell Biology, Biomedicine, Regenerative Biology, Biophysics, Bioengineering & Biomaterials, and Computational Biology. These disciplines are tied together by the desire to understand how organisms form, function, and self-repair on different molecular scales, from individual cells to whole organisms, with the ultimate goal of translating findings into medical practice. This goal is accomplished by combining depth of expertise across multiple cutting-edge fields to accelerate interdisciplinary discovery and the development of new technologies. DIGS-BB researchers recognise that innovative scientific discovery is not an individual pursuit, but only possible



through the collaboration of many minds and perspectives. This belief in the power of collaboration instils an incredible sense of community among DIGS-BB students and faculty, that spills over into interactions with laboratories beyond TU Dresden walls.

The DIGS-BB offers graduate students state-of-the-art dedicated facilities and world class faculty mentors. The multidisciplinary research projects at the DIGS-BB often pull expertise from laboratories and experts in neighbouring fields, providing PhD students with a diverse offering of techniques and mentoring when approaching some of biology's most intricate problems. All students have access to cutting-edge research equipment and technologies through the Joint Technology Platforms. The program offers an open-door policy, whereby students can easily learn to utilise a multitude of techniques and technology from experts across the campus. Current student Ramya Ravindranathan describes her take on the program: 'What I like the most about DIGS-BB PhD program is how it has an international and dynamic work environment, providing students with access to state-of-the-art research facilities and exceptional resources. Every single student's intellectual potential can be fully explored owing to the rigorous training and constant mentorship one gets from program.'

What is Unique About DIGS-BB's PhD Training Program?

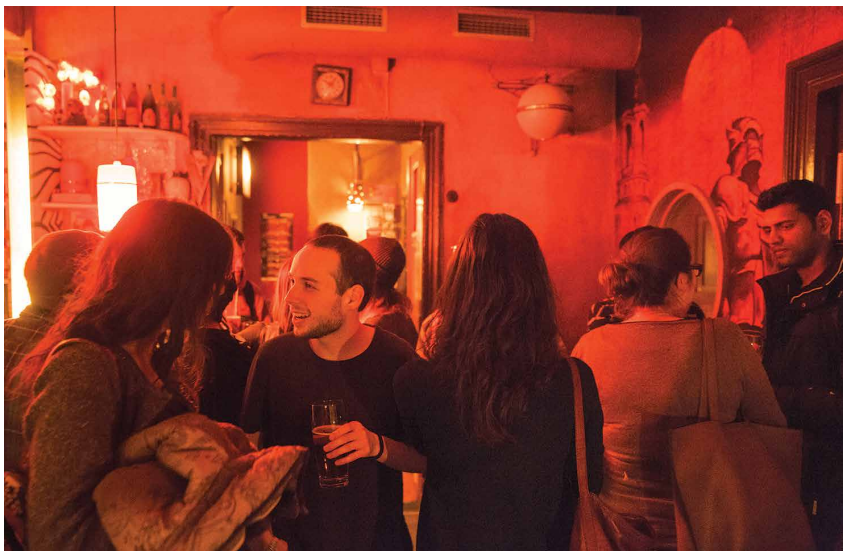
The DIGS-BB program combines novel research projects with advanced training courses to produce PhD students who are confident and capable of engaging in multidisciplinary research on the forefront of biomedical and bioengineering research. First year PhD students complete two obligatory courses, and students have the option to take additional elective courses during their PhDs to continue developing strengths that will contribute to the success of their research careers.

The mandatory first year curriculum is designed to bridge disciplines to promote multidisciplinary thought, introduce students to a range of techniques, faculty, and the scientific community at large, and build essential skills tailored to the unique demands of research careers. The *Introductory Predoc Course* exposes students to the wide range of laboratories and techniques available to them through the DIGS-BB's Dresden International PhD Program (DIPP) affiliation, which includes research groups from DIGS-BB and its neighbouring partner the Max Planck Research School for Cell, Developmental and Systems Biology (IMPRS-CellDevoSys). During the course, students complete four week-long practical rotations, choosing at least one practical in their field and at least one practical in another field. During each practical, students learn about a current topic within that field and practice working with relevant techniques. Past topics have ranged from stem cell techniques and cellular biophysics, to machine learning.

Scientific writing is the backbone of modern research and academic careers, so first year DIGS-BB students also complete a *Foundation Level Scientific Writing Course* aimed at developing the essential writing skills that will enable them to communicate their ground-breaking research discoveries. This course is the first component of the excellence in communication program, a thoughtfully designed program with the aim of helping students master scientific writing and communication, to the profit of their PhD thesis and research career as a whole. Through these courses, DIGS-BB prepares PhD students to be confident, well-rounded scientists in today's highly competitive job market.

For the remainder of the four-year program, students have the freedom to enrol in additional elective courses as needed while they work on their individual research projects. Students also have the option to participate in many programs designed to facilitate career development and position students for successful job placement upon completion of their PhD. The Research Exchange Program places students in prestigious laboratories worldwide to participate in collaborative research or to learn novel methods not available on the Dresden campus. Competitive awards are available to fund student conference travel and participation in specialised training workshops, and to recognise outstanding work. Students at the end of their PhD have the option to participate in Springboard-to-Postdoc and Wrap-Up programs, which provide additional support for the transition from PhD student to postdoctoral positions.

Mentoring at DIGS-BB begins with acceptance of a position in a DIGS-BB research group, attaching students to a core faculty mentor who will provide individualised one-on-one guidance and support for the student's independent research on their assigned PhD thesis project.



During the foundational first year, students also form a Thesis Advisory Committee (TAC) composed of three experienced faculty members. The TAC provides multidisciplinary mentorship and guidance to the PhD student throughout their thesis work. Students typically meet with and update their TAC formally once a year, but the TAC members are available to work with the student individually at any time during their PhD project when guidance is needed. Outside a student's TAC, every two years an ombudsperson is elected to act as a mentor for personal situations outside of the PhD project or delicate situations such as conflicts of interest with a supervisor. Quality mentorship is a critical component of a successful PhD project, and the DIGS-BB faculty members are dedicated to not only providing scientific direction, but also guidance to help students' personal development.

It's Not Just About the Project

When asked to imagine a PhD student, the common image that comes to mind is a downtrodden academic locked away in a lab. The DIGS-BB works to break this stereotype by encouraging students to step away from their thesis work and engage in social and community activities outside the laboratory. The campus is a supportive and friendly community for PhD students, providing social support for the rigors of graduate school while encouraging students to forge connections to build a strong scientific network that will profit them for the span of their careers. DIGS-BB student representatives are elected twice yearly to represent the interests of the PhD student community at program board meetings.

As student representative Jelena Popovic describes, 'I became a student representative as I am very interested in knowing all the small details of how our great program came to be. I wanted to help improve it even further, build a stronger bond with the PhD office and all predocs, including the very young new arrivals. And of course, being a part of the amazing group of people, which student representatives are!'

Student-driven activities, such as 'Science Goes to School', 'Ask the Expert', and 'Career Day Symposium', are at the heart of the DIGS-BB PhD student experience. Once a month, the 'Science Goes to School' program places a group of PhD students in local grade school classrooms to engage schoolchildren with science. This program ignites curiosity about science and science careers in children, while giving PhD students the opportunity to develop their skills in communicating science to a broad audience. Twice a year, PhD students have an opportunity to interact with academic, management and industry leaders at the 'Ask the Expert event'. The informal setting in which this event takes place allows students to learn about and discuss topics such as current conditions for scientists in academia or balancing a family with a science career. The annual 'Career Day Symposium' serves to further expose students to the wide range of career options available to them following graduation. This highly praised event provides students with networking opportunities across multiple scientific fields and industries.

For modern scientists, laboratory skills and academic knowledge are not enough to secure a successful career. To be competitive on the global scientific stage, scientists must also be compelling communicators and avid networkers. They must be able to work collaboratively with researchers across a wide range of cultures, while maintaining the ability to work independently, think critically, and approach challenges with an open mind and enthusiasm. Student-driven activities, coupled with innovative mentoring strategies, help ensure that PhD students in the DIGS-BB program grow both personally and professionally during their time in Dresden. The DIGS-BB's multifaceted approach to student development turns out well-rounded scientists that are both intellectually and emotionally prepared to become leaders in the scientific community at large.

What Makes a DIGS-BB PhD Student?

Staying at the cutting edge of innovative science and discovery requires an academic environment that values diversity in people and ideas. This is one of the reasons the DIGS-BB prides itself on having a culturally diverse student community, hosting doctoral students from many different countries, each bringing unique educational backgrounds and viewpoints. Over 75% of current PhD students hail from outside of Germany, and of the current 68 research groups, a third are led by international primary investigators. Interactions between students and research groups both within and outside of TU Dresden are encouraged as students engage in the DIGS-BB's dynamic interdisciplinary training.

The DIGS-BB wants to attract the brightest minds from all corners of the globe, and thus offers excellent support for students, both international and domestic. PhD students at the TU Dresden are offered competitive awards and do not pay any tuition or fees. Additionally, international students are offered extensive support with obtaining visas, finding housing, and all of the other potential difficulties that come with moving to a new country. While curriculum and research at the DIGS-BB is performed in English, first year international students have the option to complete an intensive German language course to help them adjust to life outside the lab in Dresden. DIGS-BB mentors foster a learning environment that champions both personal and professional development, ensuring that students graduate with the skills necessary to be both renowned scientists and leaders within the scientific community.

Research Areas at DIGS-BB

Developmental Cell Biology

Within the program on Developmental Cell Biology, we want to understand the nuts and bolts of how cells work and get together to generate complex tissues. The Dresden campus has a strong core of basic scientists working on a number of different model organisms including fly, fish, newt and mouse. Here, molecular and cellular approaches are integrated with evolutionary and developmental cell biology to understand how the differentiation of stem cells and the behaviour of their progeny function to build a complete body. The insights obtained within this research area feed extensively into other programs in Dresden to facilitate applied and translational science.

Biomedicine

The goal of Biomedicine is to use a variety of life science research approaches to benefit human health. Basic research feeds into translational research, which extends into clinical trials and medical applications. Prominent biomedical research areas in Dresden include immunology, metabolism, tumour biology, neuroscience, bone research, and germ-cell biology, and there is a special emphasis on stem- and progenitor-cell research. To address the great complexity of basic and disease-related mechanisms and factors, we use a wide range of tools, including high-end microscopy and other imaging and cell-sorting methods, sophisticated mouse manipulation including humanised animal models, iPS and other stem cell technologies, molecular approaches, and innovative screening technologies.

Regenerative Biology

Regeneration is the renewal of degenerated or lost cells, tissues or organs within an organism. Such regenerative processes are mainly based on the action of specific stem or progenitor cells that possess the capacity to proliferate and differentiate into the required cell-types. In Dresden, the mechanisms of regeneration and stem cell function are studied to understand general principles of cellular and tissue repair with the aim to use this knowledge to develop novel therapies. Diverse strategies for in depth genetic, molecular and cellular analysis are used to dissect fundamental pathways of tissue regeneration. Animals with high regenerative capacities are utilised to understand intrinsic mechanisms of regeneration as models to induce tissue repair also in mammals. Additionally, the controlled expansion and directed differentiation of stem cells towards specific target cell-types is assessed to develop cell replacement strategies for currently incurable diseases.

Biophysics

Biophysics is an increasingly popular discipline that applies the approaches and methods of physics to unravel the underlying organisational principles of biological systems. Research in Dresden has a strong emphasis on investigating phenomena across all relevant scales – from individual molecules, to sub-cellular organisation, to cellular properties, and on to tissues, organs, and organisms. Our strength lies in the close collaboration between theoretical physicists, providing the conceptual and modelling framework, experimental groups, developing and applying state-of-the-art techniques to obtain quantitative data, and cell and developmental biologists, who contribute the necessary biological expertise.

Bioengineering & Biomaterials

Bioengineering is the application of life science, physical science, mathematics and engineering principles to define and solve problems in biology, medicine, the environment, materials and other fields. In Dresden, we focus on the application of nanotechnological tools to broaden our understanding of biology and medicine, as well as using the wide variety of molecular functions provided by nature's 'nanomachines' as a basis for an innovative nanobiotechnology. The tools we use to characterise and engineer molecular-scale systems include single-molecule imaging and manipulation tools, cutting-edge technologies for the micro/nano-structuring of organic/inorganic materials, and a wide range of biomolecular synthesis techniques.

Computational Biology

Computational Biology addresses problems in biology, biomedicine and ecology through image analysis, theory, computer simulations and data visualisation. In Dresden, we focus on dynamic processes in cells and embryos but also on biomedical questions like tissue regeneration. An overarching question is how complex system behaviour at a large scale can emerge from simpler physical and chemical interactions at smaller scales. In close collaboration with experimentalists, our research groups develop and apply computational tools including image analysis and image quantification algorithms, model-based image segmentation and cell tracking algorithms, adaptive particle methods for spatiotemporal simulations, parallel high-performance computing, multi-scale mechanistic model simulations and deep learning.

Website:

W: http://www.digs-bb.de/

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