Humboldt-Universität zu Berlin
Department of Biology

1 General Overview

1.1 Recent History of the Department

In the two decades prior to German reunification, research interests of the Department of Biology were primarily focused toward behavioral biology, biophysics, freshwater ecology, plant genetics and plant physiology. During this period, the structural and taxonomic disciplines were organized within the Museum of Natural History (*Museum für Naturkunde*, *MfN*). The Institute for Systematic Botany with its botanical garden in Berlin-Blankenfelde and the arboretum in Berlin-Baumschulenweg was also part of the MfN. Following reunification the Commission for Structural Reform and Hiring (*Struktur- und Berufungskommission*, *SBK*) was established to define educational goals, identify areas of research specialization and supervise the hiring of new faculty members. The current interdisciplinary structure of the department and its research focus reflect the efforts of this commission.

Accompanying the reorganization of the Humboldt University, two Faculties of Mathematics and Natural Sciences were established (*Mathematisch-Naturwissenschaftliche Fakultät I und II*). The Department of Biology and the Departments of Chemistry, Pharmacy (to close December 2002) and Physics were incorporated into the Faculty of Mathematics and Natural Sciences I. In fulfillment of the goals set by the SBK, 23* professor chairs were established within the Department of Biology, representing research interests with a primary focus on biophysics, genetics, molecular biology and microbiology, and physiology**.** Realizing the importance of taxonomy and systematics for a modern biology, plant systematics was moved to the Department of Biology, and plays an integral role in our education and research efforts. To take advantage of the proximity of the Department of Biology to the MfN with its several chairs for zoology and palaeontology and its large collections, the SBK gave the zoology positions at the department an organismic rather than a molecular research profile so that both institutions could intensively cooperate with each other.

Summary of Positions as of 1993

Full Professors (C4)	Associate Professors (C3)	Temporary Scientific Positions	Permanent Scientific Positions	Positions for Technical and Support Staff
12*	11	56	14	74.75

*Plus a chair for Molecular Cell Biology (*S-Professur* C4, Max-Planck Research Group) with scientific, technical and support staff

Since 1993, the structure of the department has undergone major changes. As a consequence of severe fiscal limitations imposed by the State Government of Berlin, the personnel structure of the department was reduced in 1995 and once again in 1998. Important changes in the department have come with the integration of the chair for Molecular Cell Biology (C4), which was formerly a *S-Professur*, funded by the Max-Planck-Society and two chairs for Theoretical Biology (C3 & C4) in 2002, which were formerly part of the *Innovationskolleg Theoretische Biologie* (ITB, funded by BMBF/DFG).

A significant change in the departmental structure was the reduction of the Chair for Systematic Botany from C4 to C3. As a direct consequence of this reduction and because of the presence of a strong systematic research institute at the Free University with its extensive botanical collection and botanical gardens, the Chair for Systematic Botany was reorganized into the Chair for Botany and Biology Didactics. With support from the Chair of Palaeobotany (MfN) this group will carry the responsibility for the systematic training in botany. It is clear however, that as a result of the reorganization, specialized training in systematic botany leading to an advanced degree will no longer be possible in the Department of Biology.

Summary of currently approved positions

Full Professors (C4)	Associate Professors (C3)	Temporary Scientific Positions	Permanent Scientific Positions	Positions for Technical and Support Staff
10*	10§	40.5	17	57.25

*Plus a chair for Freshwater Ecology (*S-Professur* C4)
§Plus a chair for Endocrinology (*S-Professur* C3)

1.2 Current Chairs of the Department

The current structure of the department follows largely the recommendations of the SBK. Organized with respect to their teaching obligations, the chairs are as follows:

(A) Biophysics: Experimental Biophysics (C4, hiring in progress), Molecular Biophysics (C3), Theoretical Biophysics (C4)

(B) Microbiology: Bacterial Genetics (C3), Microbiology (C4), Physiology of Micro-organisms (C3)

(C) Molecular Biology and Biochemistry: Cytogenetics (C3), Genetics (C4), Molecular Cell Biology (C4, vacant), Plant Biochemistry (C4)

(D) Plant Sciences: Applied Botany (C3), Botany und Biology Didactics (C3, vacant), Cell Biology (C3, will terminate in 2011), Ecology (C3, vacant), Plant Physiology (C4)

(E) Theoretical Biology: Computational Neuroscience (C4), Molecular and Cellular Evolution (C3, formally associated with the Charité), Organismic Evolution (C3, will terminate in 2014)

(F) Zoology: Animal Physiology (C4), Behavioural Physiology (C3), Comparative Zoology (C3), Molecular Parasitology (C4), Sensory Biology (C3, will terminate in 2008)

In addition, a C3 professorship (formerly: Membrane Physiology) is currently vacant. Apart from these teaching-related ties between the different groups, various research interactions have been established during the last years (see also Section 2). In addition, a number of groups share large-scale equipment (such as an electron microscope; computer-facilities for genome evaluation, laser-scanning microscope, BIACORE) and jointly develop novel experimental and theoretical methods.

1.3 Study Options and Degrees

There are three major study options in the Department of Biology:

- Biology (diploma degree)
- Biophysics (diploma degree)
- Biology (*Lehramtsstudium*) for teachers at primary, secondary and high schools (The final *Staatsexamen* examination is carried out by the *Landesprüfungsamt*.)

Furthermore, biology can be studied as a minor in connection with other diploma courses.

The *Grundstudium*, encompassing the first two years of study and being completed with the *Vordiplom*, includes biochemistry, biophysics, botany, cytology, ecology, genetics, immunology, microbiology, molecular biology, plant and animal physiology and zoology. In addition, skills and knowledge in other scientific fields chemistry, mathematics and physics are acquired. In the *Hauptstudium*, an advanced study period following the *Vordiplom*, there is a wide range of possibilities for specialization with emphasis on animal and plant physiology, microbiology and molecular biology, as well as on experimental and theoretical biophysics and theoretical biology.

Besides lectures and seminars in the *Hauptstudium*, we teach laboratory courses (*Fachkurse*) in a modular form. These laboratory courses provide theoretical and practical skills within integrated units. They last for 2-4 weeks and include daily introductory lectures and seminars centred around a particular research topic. Furthermore, each student has to participate in an 8-10 week research project (*Projektstudium*) in one of the research groups; the results are documented in a short thesis. Normally the *Hauptstudium* is finished within two years and concludes with the diploma examinations. Beginning within three months after completion of all examinations, work on a diploma thesis (in Biology or Biophysics) is begun and completed as a written thesis within another 9 months.

Currently, each winter term 95 students of biology, 25 of Biophysics and Bioinformatics and 45 biology teaching students are admitted to the first semester. Over the last few years, the number of applicants for all options has exceeded by three to four fold (teaching students: more than five times) the number of admissions. Altogether roughly 1000 students are presently enrolled at the department. Every year more than 50 graduate students complete their Ph.D. thesis (Dr. rer. nat.) with specialization in Biology or Biophysics.

1.4 Support Mechanisms for Young Scientists

1.4.1 *Graduiertenkollegs*

The Department hosts the *Graduiertenkolleg* “Dynamics and Evolution of Cellular and Macromolecular Processes” (Spokesman: R. Heinrich), which includes 8 theoretical and 8 experimental groups in the fields of biophysics, physics and molecular cell biology (HU, FU, MDC and MPI for Molecular Genetics). Within the HU, participating groups come from the Department of Biology (R. Heinrich, A. Herrmann, A. Herz), the Charité (H. Herzel, K.-P. Hofmann, H.-G. Holzhütter) and the Department of Physics (L. Schimansky-Geier). The goal of this graduate program is to train Ph.D. students to successfully apply physical and mathematical methods in modern biology. This is achieved by concerted supervision and

interdisciplinary lectures, courses, and seminars. The *Graduiertenkolleg* was one of the first to develop an international cooperation with similar institutions, such as the Biocentrum Amsterdam and the Boston-Informatics-Program. Furthermore, our *Graduiertenkolleg* is the first GK to offer DFG-financed research positions (*Forschungsstudenten*) to highly motivated young students before they start their Diploma research thesis.

The department participates in three other *Graduiertenkollegs*. The *Graduiertenkolleg* „Evolutionary Transformations and Mass Extinctions" (Spokesman: U. Zeller, MfN – see also Section 3.2) pursues an integrative approach combining the fields of mineralogy, palaeontology and zoology to further understanding of the impact of geological and cosmic processes on patterns of organismic evolution. Within the Graduiertenkolleg „Signalling Cascades in Living Systems" (Spokesman: R. Menzel, FU Berlin), neuronal signalling chains and networks are analysed, from the subcellular to the system level, using molecular, neurophysiological and computational methods. The *Graduiertenkolleg* „Perspectives on Urban Ecology – the Example of the European Metropolis of Berlin" (Spokesman: W. Endlicher, HU Berlin) evaluates the ecological potential of a big city from an ecological, socio-economic and planning perspective. Special attention is given to mechanisms of maintaining biodiversity in urban areas and to the ecological significance of biodiversity in urban environments.

1.4.2 Junior Professorships

The Department of Biology has made a strong effort to establish junior professorships. The positions for junior professors have been recruited from postdoctoral positions (C1, BAT IIa) of individual departmental groups. The following positions are currently being filled:

Aquatic Bioacoustics

This junior professor will study the aquatic communication and neural processing of aquatic sounds in vertebrates, focusing on lower vertebrates. Since vertebrate hearing originated in water, these studies will further our understanding of basic principles of hearing. They will complement the research of the lateral-line system in the Sensory Biology group. A prerequisite for the planned studies is the large pond specifically built for high-precision underwater acoustics at the department's present location.

Cell Biophysics

The focus of this junior professor is on topics of cell biophysics, in particular, signal transduction, endocytosis, movement and trafficking of biomolecules. The professorship will combine approaches of molecular and cell biology with those of biophysics.

Molecular and Biochemical Eco-Toxicology

The focus of this junior professor is the interaction of biogeochemical freshwater matrices (humic substances, allelochemicals) with aquatic organisms. The group will try to elucidate quantitative structure activity relationships between structural features of the biogeochemical matrices and sub-acute effects in the organisms. It will closely collaborate with the molecular ecology group (see below).

Molecular Ecology

This professorship is funded by a special program at the Humboldt University for the promotion of women in science. The Junior Professor is expected to actively participate

in the cooperative research program on the role of bioactive secondary metabolites in aquatic ecosystems between the Department of Biology, the Institute of Aquatic Ecology and Fishery and other institutions in Berlin.

Theoretical Biophysics – Mathematical modelling of complex cellular processes

The focus of this professorship is the mathematical modelling of processes which are currently in the center of research in cell biology, such as cell differentiation, cell division and signal transduction.

1.4.3 Junior Research Groups

In the last two years, the *VolkswagenStiftung* has established a total of 18 Junior Research Groups - nationwide and in all fields of academic study. These independent research groups are supported for five years and consist of a group leader and (typically two or three) positions for Ph.D.-students, postdoctoral scientists and technicians. The group leaders are entirely free in their choice of the host institution. Dr. Laurenz Wiskott and Dr. Michal Or-Guil have been awarded two of the eighteen grants. We are proud that these excellent young scientists decided to carry out their research at the Department of Biology. Both groups focus on theoretical aspects and are hosted by the ITB:

Neural Computation (L. Wiskott) - established in 2000

This group is working on questions of unsupervised learning in artificial and biological neural systems on a network level. At the centre of the current research activities are models for learning invariance in the visual system, blind source separation, and the role of adult neurogenesis in the hippocampus (in cooperation with MDC, ITB and Charité).

Theoretical Immunology (M. Or-Guil) - established in 2002

This group aims at clarifying mechanisms of antigen recognition by cells of the adaptive immune system. The focus on investigating the selection mechanism of B-cells in germinal centres by means of experiments and mathematical modelling, as well as on defining features of sets of antibodies by means of simulations and analysis of protein-antibody binding data (in cooperation with German Arthritis Centre and ITB).

1.5 Awards, Honours, Offers and Special Professional Activities

Awards

A. Herrmann was awarded the “Prix Gay-Lussac/Humboldt” by the French Minister of Research in recognition of his contributions to the fields of protein-mediated fusion and lipid trafficking as well as his continuing efforts for development of French-German scientific cooperation (2001).

Honours

The University of Bordeaux II conferred the degree of honorary doctor on R. Heinrich (1996).

The University of Ulan Baata conferred the degree of honorary doctor on R. Glaser (2000).

Offers

T. Buckhout declined an offer of a chair for Plant Physiology (C4) at the University of Rostock (1997).

G. Fuhr accepted the offer to become the Director of the Fraunhofer Institute for Biomedical Engineering in Saarbrücken (2001).

H. Herzel declined an offer of a chair for Bioinformatics (C4) at the University of Jena (2001).

Special Professional Activities

B. Friedrich is currently vice-president of the German Research Foundation (DFG).

2. Exemplary Research and Teaching Activities

Recent advances in molecular biology have triggered radical changes in all branches of the life sciences. Various groups at the department have integrated the newly available tools and methods into their research and actively contribute to the ongoing molecular revolution. At the same time, it has become evident that an exhaustive biological interpretation of results achieved at the genomic and proteomic level requires an organismic point of view. In addition, modern theoretical concepts, advanced data analysis and quantitative (computer) modeling will be needed to understand the complexity of intricate biological systems such as molecular pathways and regulatory networks. Apart from individual groups efforts, research and teaching networks have been recently established in the Department for Biology to tackle specific aspects of this task.

2.1 Interdisciplinary Center for BioPhysics and BioInformatics (BPI)

Unravelling the physical principles behind the structure and dynamics of biological systems is a key step towards a quantitative understanding of their function. Realizing very early the importance and potential of biophysics, a special curriculum was created at the Humboldt University more than thirty years ago. More recently, other universities have followed and initiated similar courses to respond to the rapidly growing demand for well trained experimental and theoretical biophysicists.

As a recent step to provide both modern and comprehensive teaching, the Interdisciplinary Center for BioPhysics and BioInformatics (BPI) was founded in 2001 and unites various research groups working in the fields of biophysics, bioinformatics and molecular as well as cellular biology. The program attracts a large number of highly motivated young students.

The core of the Center is formed by three professorships at the Department of Biology:

- Experimental Biophysics (N.N. – to be filled in 2002/2003)
- Theoretical Biophysics (R. Heinrich)
- Molecular Biophysics (A. Herrmann; managing director of BPI)

Two groups of the Institute for Theoretical Biology – Molecular and Cellular Evolution (H. Herzel) and Computational Neuroscience (A. Herz) – are strongly engaged in the BPI. In addition, various groups from the Departments of Physics (Physics of Macromolecules, J. Rabe), Chemistry (Physical and Theoretical Chemistry, V. Bonacic-Koutecky), Computer Science (Data Banks and Information Systems, J.-C. Freytag), Mathematics (Analysis, J. Brüning), the Charité (Medical Physics and Biophysics, K.-P. Hofmann; Biochemistry, C. Frömmel, W. Höhne, P.-M. Kloetzel) and the Fraunhofer Institute for Biomedical Research (G. Fuhr, who originally founded the BPI) contribute intensively to BPI's teaching program.

To attract young promising scientists, two junior professorships in "Theoretical Biophysics" and "Cell Biophysics" have been established in the BPI. Emphasis is also put on establishing junior research groups such as that of R. Beckmann (Biochemistry, Charité), which is funded by the *VolkswagenStiftung*.

Starting with the winter semester 2001/2002, a reshaped curriculum has been introduced. The new minors "Bioinformatics" and "Molecular Cell Biology" complement the main biophysics lectures. Through various practicals and the supervision by experimental as well as theory-oriented groups, students learn very early to combine experimental and theoretical approaches. The manifold involvement of the groups of the BPI in (network) projects offers students easy access to highly competitive research fields and "state-of-the-art" techniques - at the Humboldt University as well as at other institutions such as the Max-Planck-Institutes, MDC, Bessy II, the Protein Structure Factory and various Biotech companies. The BPI also strongly benefits from the Graduiertenkolleg "Dynamics and Evolution of Cellular and Macromolecular Processes" (see 1.4.1).

2.2 Molecular Physiology, Energetics, and Regulation of Primary Metabolism in Plants (*Sonderforschungsbereich 429*)

The integration and regulation of metabolic pathways at a genetic and epigenetic level and at the level of plant ontogeny poses many open questions. To address these questions, the *Sonderforschungsbereich 429* (spokesman: T. Börner) was formed and started its activities in 1999. The principal research goals within the SFB are directed toward an increased understanding of the functions of known and unknown proteins in primary plant metabolism.

The projects are focused on the investigation of energy transforming processes in photosynthesis with particular emphasis on the regulatory aspects of energy transformation; on the relationship between metabolic processes and control of gene expression including the double function of many metabolites as substrates or products in metabolism and as components in signal transduction pathways, and on the mechanisms of transport and storage of photoassimilates with particular emphasis given to source-sink relationships. *Arabidopsis*, either as wild-type or with mutations in specific metabolic pathways serves as the model organism, although specific problems are addressed by using also other higher plants, mosses, algae and cyanobacteria. The experimental approach is characterised by a combination of molecular, biochemical and biophysical techniques.

In addition to the Department of Biology, research groups participate in the SFB that are located at the Institute of Plant Physiology and Microbiology of the Free University Berlin, the Max-Volmer-Institute and Institute of Optics of the Technical University Berlin, the Institute of Biochemistry and Molecular Biology of the Potsdam University as well as the MPI for Molecular Plant Physiology at Golm and the Max-Born-Institute Berlin.

Our department contributes currently with 6 projects (T. Börner, B. Grimm, W. Hess, K. Liere, A. Weihe, A. Wilde) to the SFB. These projects also constitute a major part of the department´s research focus "Biomolecular Communication" (see below) and deal with aspects of photosynthesis, organellar transcription and regulation of tetrapyrrol biosynthesis in plants and cyanobacteria.

2.3 Institute for Theoretical Biology (ITB) and *Sonderforschungsbereich 618*

Over the last decades, biology has grown from a mainly descriptive to a more analytical science. New connections with the natural sciences and medicine have been forged, while theoretical biology has become a discipline in its own right. At German universities, however, centers for research and teaching in the theoretical biosciences are still rare.

To overcome this deficit, the *"Innovationskolleg Theoretische Biologie"* (spokesman: B. Ronacher) was founded in 1994 by a group of professors from the Departments of Biology (R. Heinrich and B. Ronacher), Physics (W. Ebeling) and the Charité (C. Frömmel). This step was made possible by a special grant from the BMBF (administered by the DFG). Following a successful mid-term review in 1997, the grant was extended for the maximal possible duration, until 2001. Rooted in the Mathematisch-Naturwissenschaftliche Fakultät I as well as in the Medizinische Fakultät Charité, the ITB was then renamed *"Institute for Theoretical Biology"* and has become a permanent institution of the Humboldt University. The ITB maintains close relations to the FU, TU, MDC, MPI for Molecular Genetics, and the Wissenschaftskolleg zu Berlin. Through its structure and organization, the ITB is well suited as a meeting place for scientists who seek to collaborate with theoretical biologists and, in turn, allows theoreticians to get critical feedback from experimental researchers.

Three professorships in key areas of Theoretical Biology have been established:

- Computational Neuroscience
- Evolution of Organismic Systems
- Molecular and Cellular Evolution

In addition, the ITB hosts two junior research groups funded by the VolkswagenStiftung:

- Neural Computation – established in 2000
- Theoretical Immunology – established in 2002

Following a long tradition in biophysics teaching at the Humboldt University, the ITB stresses the importance of theory courses and seminars. Already early in their career, students are exposed to unifying theoretical concepts and learn to apply mathematical methods and computational tools within their own research. Joint supervision by experimentalists and theoreticians, both during course work and diploma studies promotes theoretical as well as experimental competence. An introductory course in Theoretical Biology is offered to second-year students. The lecture also prepares students for advanced courses on special research topics covered by the ITB. Since 2001, Theoretical Biology can be taken as a "Nebenfach" (Minor). Lectures by guest scientists, round-table discussions, the ITB colloquium and annual winter schools complete the program.

Extending the scope of the ITB and ongoing collaborations between experimentalists and theoreticians, research groups at various scientific institutions in Berlin jointly submitted a grant proposal for a *Sonderforschungsbereich* entitled "Theoretical Biology: Robustness, Modularity and Evolutionary Design of Living Systems" (spokesman: P. Hammerstein): the Charité, the Fraunhofer Gesellschaft, the FU, the German Arthritis Centre, the MDC, the MPI for Molecular Genetics, the MPI for Molecular Plant Physiology and the TU. From the Department of Biology, P. Hammerstein, R. Heinrich, A. Herz, H. Herzel, T. Höfer, R. Lucius, B. Ronacher and L. Wiskott participated in this initiative. Following the approval of the proposal by the DFG, the *Sonderforschungsbereich 618* was established in July 2002.

2.4 Participation in Other Research Networks

The Department of Biology is also represented in various other research networks:

- Bioinformatics Platform for Functional Proteome Analysis (BMBF)
  H. Herzel
- EU Programme Environment and Climate: Cyanobacterial Toxins
  T. Börner
- EU Programme Quality of Life and Management of Living Resources: "Combinatorial Biosynthesis: Generation of Novel Therapeutic Substances by Combining Genes from Actinomycetes and Cyanobactria"
  T. Börner
- EUREED II – Dynamics and Stability of Reed-Dominated Ecosystems (EU)
  M. Henning, J.-G. Kohl (deceased)
- EU Thematic Network "Computational Neuroscience and Neuroinformatics"
  A. Herz
- EU Training and Mobility Programme: "Toxin Production in Cyanobacteria"
  T. Börner
- Forschergruppe 466 „Zellulärer Signaltransfer in physiologischen Grenzbereichen"
  B. Grimm
- Forschergruppe 475 "Bildung und Stabilität von ß-Faltblättern"
  A. Herrmann
- InnoRegio „Pflanzenbiotechnologie Nordharz/Börde" (BMBF)
  B. Grimm
- Kompetenzzentrum für Methylierungs- und Expressionsarrays (Stifterverband)
  H. Herzel
- National competence network "Genome Research on bacteria for analysis of diversity and use to develop novel production technologies" (BMBF)
  R. Borriss, B. Friedrich
- Schwerpunktprogramm 1046 "Processing of time in the central auditory system"
  M. Hennig, B. Ronacher
- Schwerpunktprogramm 1070 „Structure of Functional Modules from Energy-Transducing Complexes in Procaryotes"
  B. Friedrich, E. Schneider
- Sonderforschungsbereich 344 „Regulationsstrukturen von Nukleinsäuren und Proteinen" (TU Berlin)
  H. Saumweber
- Sonderforschungsbereich 363 „Molekularbiologie pflanzlicher Systeme" (University Halle-Wittenberg)
  G. Grimm
- Sonderforschungsbereich 498 „Protein-Cofactor Interactions" (TU Berlin)
  B. Friedrich
- Sonderforschungsbereich 515 „Mechanisms of developmental and experience-dependent plasticity in the nervous system" (FU Berlin)
  A. Herz, B. Nixdorf-Bergweiler, H. Saumweber

- Sonderforschungsbereich 555 „Complex Nonlinear Processes" (HU Berlin)
  R. Heinrich
- Verbund Synchrotron CD BESSY II (BMBF)
  A. Herrmann

3 Future scientific orientation and structure of the department

The Department of Biology is currently in the process of reorganizing and focusing its research activities in order to pool resources and improve synergistic interactions. This will improve the quality of research and increase the critical mass needed to attract funding. Based on the current profile of the department with its existing activities (among others the BPI, SFB 429, SFB 618, and the ITB) research within the department will be grouped into two areas which complement each other, have strong links and encompass both experimental and theoretical approaches. The focus „Biomolecular Communication" represents an activity centred around molecular aspects, while the focus „Organismic Evolution and Communication" studies organisms and their interaction with the natural environment. With these two foci, the department will have a unique research profile, that also allows all groups to participate with a significant part of their activities. The research is strengthened by existing cooperation with other groups of our university (mostly from the Mathematisch Naturwissenschaftiche Fakultät I and the Charité), other universities in and around Berlin and many national and international research institutions. The two foci will also provide a framework for the development of the department in the sense that future professorial positions (see 3.3) will be filled considering the defined research needs, and future study programs (see 3.4) will be centred around them.

3.1 Research Focus "Biomolecular Communication"

Subject

The capability of living organisms to cope with changes in the environment or within their cells is of utmost importance for survival. Thus, organisms have at their disposal a multitude of molecular reactions to sense and respond to deviations from the norm. Such reactions that are observed upon recognition of intra- or extracellular signals include regulation of gene expression, the uptake of alternative nutrients, the installation of new metabolic pathways, the onset of cell differentiation or the induction of defence mechanisms. The whole process can be envisaged as a signalling cascade in which the individual partners interact with each other via biomolecules, a process requiring the coordination of biomolecules within complex structures or regulatory networks. These target-specific interactions have been termed "Biomolecular Communication". Combined efforts of cell and molecular biology and biophysics in conjunction with experimental and theoretical approaches are a promising basis to unravel those processes.

Biomolecular communication takes place at different levels:

- within a cell
- between organelles of a cell
- between cells of an organism or between different organisms
- between organisms and their environment

Information uptake by cells is usually initiated by highly organized protein complexes, which may consist of several subunits and many cofactors. Stimuli are then transduced through complex signalling cascades, which lead to differential activation of genes via activated transcription factors, to changes in protein structure and assembly or to activation of enzymes. In plants and animals molecular machines are established which alter the transcription of chromatin or the processing of RNA by changes of their conformation. To understand the roles of the individual components, the pathways as such and the mechanisms of gene activation, experimental studies in conjunction with mathematical modelling are required.

The homeostasis of a cell depends on a multitude of interactions between organelles. The transport and targeting of biomolecules between and into organelles is highly regulated and specific. Cargo vesicles are delivered to designated organelles and release their content upon fusion, which is mediated by a specific protein complex. The genesis, the intermolecular interaction of complexes as well as their capacity to mediate fusion are still a challenge for future research.

Communication between cells of an organism or between different organisms is mediated by transmembrane or secreted proteins, which trigger events upon contact with specific receptors. For example, the cells of the immune system communicate through a complex network of regulatory cytokines with stimulatory or inhibitory capacity. These cytokines can among others lead to proliferation and activation of immune effector cells, which attack tumours or infectious organisms.

Communication with their environment is vital for all organisms and in many cases the signal transduction pathways leading from sensing of a stimulus to cellular responses have been elucidated. Microorganisms but also plants have particular requirements to sense stimuli, e.g. the availability of nutrients or light in order to react adequately. The key elements of the stress response networks are conserved, since already the early unicellular forms of life were exposed to a plethora of environmental stimuli. However, intricate programs of biomolecular communication and differentiation were subsequently developed by plants as an adaptation to their specific challenges. Research on this topic provides a link to the organismic view as studied in the second research focus of our department "Organismic Evolution and Communication".

Structure of the research focus

Currently, the focus encompasses activities of 17 groups from 14 chairs of the Department of Biology. It provides an infrastructure for cooperation within the department and numerous other groups inside and outside of the university. The majority of the groups are engaged in intensive cooperations as reflected by common research projects, common publications and common teaching activities. Parts of these activities are organized in research networks such as SFB 429 (”Molecular Physiology, Energetics, and Regulation of Primary Metabolism in Plants”) and two initiatives within the university (“Biomolecular Recognition” and “Infection Biology”). Other joint activities including the “Molecular Biological and Biochemical Seminar”, the “Molecular Biological and Biochemical Colloquium”, the seminar “Molecular Strategies of Pathogenic Microorganisms” are also based upon mutual scientific interest and research activities.

Within the Department of Biology, the research focus is structured in three areas:

- Basic mechanisms of biomolecular communication
- Biophysical and theoretical aspects of biomolecular communication
- Biomolecular communication in plants

These areas complement each other with respect to their methodology and approaches. They are linked within the department and strengthened by external cooperation.

Basic mechanisms of biomolecular communication

The research effort of this subgroup focuses on protein-protein interactions and signalling pathways as a prerequisite for the reaction of cells to stimuli. The uptake of signals may result in changes of conformation or chemical modifications of specific proteins which alter their interaction with partner proteins and, in the case of eukaryotes, often leads to signal transduction into the nucleus, followed by differential gene activation. This regulation triggers various reactions of cells and organisms. The projects include:

- Promoter recognition by transcription factors and protein-protein interaction during transcription (T. Börner).
- Functional analysis of sensors and gene regulation in bacteria that utilize hydrogen as an energy source and oxidized nitrogen compounds including nitric oxide as electron acceptors (B. Friedrich).
- Signal transduction in the cell nucleus: alteration of target gene chromatin by signal transduction pathways in *Drosophila* (H. Saumweber).
- Establishment and maintenance of chromosomal borders (H. Saumweber).
- Functional analysis of microbial transport systems (E. Schneider).
- Communication and transport events associated with a mutualistic interaction between plants and root bacteria (R. Borriss).
- Immunobiology of host-parasite interactions (R. Lucius)
- Defects in recognition and transmission of TGF-ß signals in tumorogenesis (S. Boeckh).
- Down-regulation of immune responses associated with antitumor gene therapy (R. Cichon).

Cooperation within the university is organized in two research networks:

- ”Biomolecular Recognition” including research groups in the Department of Chemistry (M. Linscheid: Analysis of molecules) and of Physics (W. Rabe: atomic force microscopy), the Charité (W. Höhne, J. Schneider-Mergener, C. Frömmel: Structural aspects; P.-M. Klötzel: Biochemistry).
- ”Infection Biology” which includes laboratories in the Charité (D. Krüger: Virology; U. Göbel: Microbiology; W. Presber: Parasitology; H.-D. Volk: Immunology; M. Suttorp: Infectiology).

Biophysical and theoretical aspects of biomolecular communication

Although a the numbers of molecular components known to be involved in cellular processes and their corresponding three dimensional structures have dramatically increased, the interplay of these components and the mechanisms of their interactions are far from being understood. Research groups in the Center for Biophysics and Bioinformatics employ experimental and theoretical approaches to unravel biophysical principles behind molecular as well as supra-molecular interactions. Specific projects, for example, are:

- Protein-protein and protein-lipid interaction in membrane fusion and endocytosis (A. Herrmann)
- Protein-mediated lipid translocation and trafficking (A. Herrmann)
- Modelling of signal transduction and cytokine expression in T-helper cells (R. Heinrich)
- Modelling of signal transduction pathways and of calcium oscillations and waves (R. Heinrich)
- Evolutionary optimisation of cellular networks (R. Heinrich)
- Collective properties of cellular dynamics (A. Herz)
- Information theoretical analysis of signalling mechanisms (A. Herz)
- Mathematical modelling of the RAS signalling cascade (H. Herzel)
- Statistical analysis of genomes and DNA arrays (H. Herzel)

Within the university, the subgroup ”Biophysics and Theoretical Biology” is integrated and cooperates in the following research networks:

- *Graduiertenkolleg 268* "Dynamics and evolution of cellular and macromolecular processes" (Spokesman: R. Heinrich, see also Section 1.4.1)
- Center of Biophysics and Bioinformatics (Spokesman: A. Herrmann, see also Section 2.1)
- *Sonderforschungsbereich 555* "Complex Nonlinear Processes" (Spokesman: L. Schimansky-Geier, Department of Physics, Humboldt University)
- *Sonderforschungsbereich 618* "Theoretical Biology: Robustness, Modularity and Evolutionary Design of Living Systems" (Spokesman: P. Hammerstein, Department of Biology, Humboldt University, see also Section 2.3)

Biomolecular communication in plants

In comparison to most animals, plants are more dependent on adaptation to the prevailing environmental conditions and are, therefore, expected to display a unique set of molecules and processes for interaction with the environment. Endogenous tissue-specific and development-dependent processes are tightly connected to environmental stimuli. This subgroup investigates (1) intracellular communication between nucleus and plastids for the control of nuclear gene expression of primary metabolic processes in plants as well as (2) the sensing of changes in nutritional status, assimilate availability and environmental conditions. Specific projects are:

- Function of phytochrome homologues in the cyanobacterium *Synechocystis* and their role in signal transduction (T. Börner, A. Wilde)
- Catabolism of carbohydrates and photosynthetic pigments (W. Lockau)
- Intracellular communication and regulatory cross-talk between metabolic pathways (B. Grimm)
- Mechanisms of metal ion transport and expression analysis during adaptation to nutrient deficiency (T. Buckhout)
- Transformation of gymnosperms and risk assessment associated with release of transgenic trees (K. Zoglauer)
- Transport of assimilates between sink and source tissue (R. Ehwald)
- Biomolecular communication by apoplasmic and symplasmic transport (R. Ehwald)
- Signalling upon abiotic stress induces transcriptional activities (B. Grimm)
- Function of secondary metabolites and endogenous clock for the communication with the environment and among cyanobacterial cells (T. Börner, W. Hess)

Cooperation within the Department and with research groups in the Berlin area is mainly organized in the SFB 429 "Molecular Physiology, Energetics, and Regulation of Primary Metabolism in Plants". Four different laboratories currently participate with six projects in this *Sonderforschungsbereich*. Lectures and laboratory courses for basic and advanced levels in plant physiology and botany have been efficiently reorganized and updated. In connection with this research focus and a new appointment these lectures and courses are offered more and more in joint action of Plant Biochemistry, Genetics, Applied Botany, Cell Biology and Plant Physiology.

Methodological profile of the focus

Diversity in the research object and purpose is reflected in the wide spectrum of technical approaches chosen. The methods include:

- Genomics, i. e. large scale sequencing and sequence analysis
- Detection and analysis of general genome structures (e.g. periodicities in DNA- und protein sequences, long-range correlations)
- Proteomics using 2D-gel electrophoresis and MALDI-mass spectrometry
- Gene expression and large scale production of recombinant proteins"
- Protein-protein as well as protein-DNA interaction
- Plant and animal cell culture and transformation techniques
- Analysis of metabolites and proteins using FPLC and HPLC
- Confocal laser scanning microscopy
- Mutant generation and screening
- Optical spectroscopy and video imaging
- Cryoelectron microscopy and image reconstruction

Perspectives

At the present stage, the research focus already provides a platform for intensive cooperation between the groups within the department and beyond. Research activities in the areas "Basic Mechanisms of Biomolecular Communication", "Biophysical and Theoretical Aspects of Biomolecular Communication" and "Biomolecular Communication in Plants" are closely interwoven and will be intensified, thereby developing an attractive profile in research and teaching. Synergistic effects will allow the acquisition of additional funds (in this respect, the installation of a *Sonderforschungsbereich* is intended) and will attract interested (Ph.D.) students from Germany and abroad. One promising aspect of the focus lies in the field of molecular medicine. Here, a joint Ph.D. program with the MDC ("Molecular Cell Biology and Pathology") and Bachelor, Master and Ph.D. programs with the Charité ("Molecular Medicine") will strengthen the already existing contacts and open new areas of common research. The infrastructure of the campus in Berlin-Adlershof (e.g. Bessy II) will enlarge our research capacities regarding protein structure and function. The third direction of research addresses metabolism, stress physiology as well as functional genomics in plants. These aspects will be studied in close collaboration with the institutes at the MPI for Molecular Plant Physiology, PU, TU and FU. Without any doubt, the future location of the department will have a major impact on the development of our research activities, since the location will in the long run influence the choice of strategic partners.

We plan to redirect the teaching activities of the department according to the profile of this focus. To this end, we will develop additional joint seminars which link the different research

areas, such as an Oberseminar on "Signal transduction" which will comparatively analyze signal pathways in microbes, vertebrates and plants. Among others, a Graduiertenkolleg covering aspects of biomolecular communication is in preparation.

The future hiring of academic staff will conform to the research focus. For example, filling the vacant chair in "Molecular Cell Biology" will substantially strengthen our impact. Furthermore, it is indispensable to appoint additional personnel in order to build core units, e.g. in the areas of (1) protein biochemistry and chromatography techniques (MS, GC, CE, HPLC), (2) electron microscopy and sophisticated fluorescence microscopy, and (3) functional genomics of bacteria and plants and plant tissue culture work. These measures will among others attract young and highly motivated researchers and help them to establish their own groups and provide a basis to integrate new research directions. We expect that developing the research focus along this line will establish a productive, internationally renown landmark of research and teaching in the biosciences.

3.2 Research Focus "Organismic Evolution and Communication"

Subject

Understanding the enormous diversity of organisms and the evolution of their *Baupläne* has been one of the main challenges in biology ever since the times of Linné and Darwin. This enterprise requires theoretical concepts and experimental techniques that extend far beyond those of molecular analysis. Furthermore, insight obtained at higher levels of organization is indispensable for assessing the biological relevance of results achieved at the genomic and proteomic levels. With the accumulation of rapidly growing amounts of molecular data, the organismic view will gain even more importance in the future.

To cope with this challenge, molecular biology has started to seek an understanding of genomic function and of the intricate relationships between genotypes and phenotypes. The high complexity of entire organisms, their manifold interactions with the environment and their long evolutionary history require an even broader view. In addition, we will not grasp the very nature of living systems without combining questions of the proximate and ultimate aspects of organismic structures and functions. We will, for example, never understand *why* a polar bear is white by only analysing the bear's genome and proteome - even if this analysis is carried out to the finest detail. Hence, a synthesis of various fields of investigation resulting in an organismic approach will be a key feature of future research.

Using microbial, animal, and plant model systems, more than 14 research groups in the department address phenomena emerging at the organismic level. To intensify their integrated approach, the research focus "Organismic Evolution and Communication" has been founded and will complement the focus "Biomolecular Communication". There is also significant overlap between the two research directions. For example, the rich repertoire of molecular techniques will increasingly be used within organismic approaches. Moving beyond a mere exchange of experimental tools, we plan to jointly discuss molecular and cellular results and to put them into the context of an organismic systems-level analysis. Together with the strong theoretical component provided by the ITB and SFB 618, and the large potential of the Museum of Natural History (MfN), the department is therefore in the position to establish a unique centre for Organismic Biology.

Groups within the organismic research focus already collaborate intensively in teaching and offer joint lectures and seminars on interdisciplinary topics such as bioacoustics, theoretical biology, sexual selection, conflict and cooperation, life histories, and parasite strategies. A series of laboratory courses covering the morphology and phylogeny of the animal kingdom is organized by G. Scholtz (Department of Biology) and the groups of U. Zeller, H.-P. Schultze and H. Hoch (MfN). An important contribution to teaching organismic aspects comes from the department's zoological collection which is organized and maintained by the group of G. Scholtz. This collection is used by scientists from both, the Department of Biology and the MfN. The biology and physiology of vertebrates is covered by integrated courses and seminars of A. Elepfandt with the Institute for Zoo- and Wildlife research (IZW) and Institute of Freshwater Ecology and Inland Fisheries (IGB). Theoretical Biology helps to bridge the gap between mechanistic and functional interpretations, a topic with large potential for additional research and teaching collaborations with groups at the MfN and the IZW. On the other side of the spectrum, lectures and seminar series on genomics, postgenomics and bioinformatics (by R. Borriss, W. Hess and H. Herzel) promote a comparative view within structural and functional genome analysis. A lecture series on RNA metabolism in Pro- and Eukaryota directly transports new aspects about the function of ncRNAs. With respect to the organismic focus, the goal of teaching efforts in microbiology is to provide a working knowledge of the enormous physiological and ecological diversity of microbes, a field of paramount importance to agriculture, traditional industries as well as to the expanding biotechnology-based economy. Lecture courses on general and industrial microbiology lay the conceptual groundwork for advanced lecture and practical courses in microbial physiology, genetics, and molecular biology (B. Friedrich, E. Schneider).

Structure of the research focus

Research at an integrated organismic level is carried out in three main areas:

- Communication and bioacoustics
- Arthropod evolution
- Comparative structural and functional genome analysis

Communication and bioacoustics

Acoustic communication has a long tradition in the research of B. Ronacher and his co-workers, with a focus on the mating calls of orthopteran insects. More recently, the electrophysiological and behavioural studies of this group have been complemented by online approaches for data generation and analysis, computational modelling and theoretical studies carried out in the group of A. Herz. The collaboration between both groups has resulted in several joint publications and is supported by the *Graduiertenkolleg* "Signalling Cascades in Living Systems". Members of H. Herzel's group investigate biophysical mechanisms of vocalization in birds and mammals. In the research group of A. Elepfandt, the lateral-line system and auditory system of lower vertebrates are investigated using behavioural, psychophysical and electrophysiological methods. For that purpose a unique laboratory for underwater acoustics has been established. To further strengthen the field, a junior professorship for aquatic bioacoustics has been advertised. The sound archives, founded by G. Tembrock, harbour many thousands of tapes and digitalized transcriptions. The archives were transferred to the Museum for Natural History in 1994 and are currently managed by the

curator K.H. Frommolt (in association with A. Elepfandt). Within the Museum, H. Hoch's group is working on insect communication based on vibratory signals. P. Hammerstein plans to enrich this field by game theoretic approaches: In the frequent case that communication involves the two sexes of a species, the interests of sender and receiver usually do not agree and result in conflicts between the two sexes – a situation well suited for evolutionary game theory.

Acoustic and biomolecular communication have also important direct relations in that basic principles of interactions between sender and receiver are universal across many levels of organization. This is shown by the problem of protection against interferences within the transmission channel. Furthermore, if one examines how parasites modulate the information flow of an organism, this requires a strategic analysis of molecular communication. In a collaborative project linking molecular parasitology (R. Lucius) with organismic evolution (P. Hammerstein), game-theoretic models are specifically modified to perform this task We expect that many such links will connect the two focal research areas of our department.

Arthropod evolution

The second organismic research area concerns the evolutionary history of arthropods. A number of groups at the department and the MfN use morphological, developmental, and physiological approaches to study this topic. Due to the large overlap of interests in the theoretical foundations, phylogenetic and evolutionary methodology, morphological and ontogenetic questions, and the investigated animal species, close connections have been established in the last few years. At the department, G. Scholtz is investigating data from the genetic, cellular, embryonic and morphological levels. The main interest lies in the analysis of evolutionary alterations of character complexes such as cleavage patterns, gene expression and segmentation, limb formation, and eye and mouth-part structures. At the MfN, H. Hoch studies speciation and evolution of insects, C. O. Coleman focuses on crustacean morphology and systematics, and J. Dunlop's research concerns the palaeontology and phylogeny of chelicerates. These activities nicely complement each other. Further interactions exist with the groups of H.-P. Schultze (MfN, Paleontology) and U. Zeller (MfN, Zoology).

The collaboration of G. Scholtz with the MfN has been instrumental for setting up the *Graduiertenkolleg* "Evolutionary Transformations and Mass Extinctions". This training grant also involves groups at the FU, the German Entomological Institute (DEI) and the IZW. Within the Department of Biology there exists an interesting connection with research on acoustic communication. In many species, acoustic communication constitutes a major barrier against hybridisation. As a consequence, the evolution of communication signals (and the corresponding neuronal receiver structures) is often considered as a pacemaker for speciation. We will therefore attempt to establish a close interaction between phylogeny, physiology and behavioural ecology. The exchange with H. Saumweber on methodological aspects serves as one bridge to the focus "Biomolecular Communication". Another link is provided by theoretical aspects of cladistic methodology (H. Herzel). Of special interest are algorithms to calculate phylogenetic relationships from embryological, morphological and molecular data.

Comparative structural and functional genome analysis

The increasing importance of structural and functional genomic analyses is reflected by the recent foundation of the BMBF-Network „Genomics". This formalized cooperation between a large group of German research groups aims to evaluate the biodiversity of microorganisms

and their use for biotechnology and medical applications. Data gained by these investigations will also improve our understanding of evolutionary processes, in particular about the adaptation of phenotypes in response to changes in their environment.

In our department, the group of B. Friedrich analyses the genome of *Ralstonia eutropha*. This bacterium is able to use hydrogen as a source for energy and is one of the model organisms for lithoautotrophic metabolism. The current studies on the structure of the hydrogen-oxidizing enzymes also aim at the production of efficient catalysts for hydrogen technology. Furthermore, *R. eutropha* has the ability to denitrify, i.e. it can metabolise nitrate to gaseous nitrogen compounds. This process is highly important for agriculture since it often sets the limits for the presence of nitrogen used by cultivated plants. For this reason, unravelling the complex regulation mechanisms of denitrification is one of the major goals of this research. Another aspect of the *R. eutropha* genome project is a comparative genomics study. The genome organization of *R. eutropha* and the closely related *R. metallidurans* and *R. solanacearum* will be compared with a view to elucidating the basis of the different biological properties (e.g. metal resistance and pathogenicity) of these bacteria. This should provide interesting insights into bacterial evolution. The comparison of the genomes of *Bacillus amyloliquefaciens,* a root bacterium, and its close relative *Bacillus subtilis* should reveal the genomic traits which allow *B. amyloliquefaciens* to influence the growth of associated plants. Studies carried out by the group of R. Borriss therefore focus on the molecular basis for the interactions during the induction of growth supporting traits in *B. amyloliquefaciens* by the plant cells. T. Börner and W. Hess investigate evolutionary adaptations of cyanobacteria, all the way from the genomic level to physiology and ecology. *Prochlorococcus*, a marine cyanobacterium, is an excellent novel model organism to explore organismic communication and evolution based on the total genome sequences of three *Prochlorococcus* "species". These three sequences from a group of closely related cyanobacteria provide a unique data set to study basic evolutionary trends and their relation to ecological and physiological constraints. A current genome project on *Microcystis aeruginosa* serves, among other aspects, the evaluation of data concerning the evolution of secondary metabolism (non-ribosomal peptide synthesis) in cyanobacteria.

Associated groups within the Department of Biology

The organismic view is also reflected in the work of further departmental research groups. One is the chair of Animal Physiology (N. Heisler) which concentrates on the physiology of ion regulation, gas exchange and tissue respiration in arthropod and vertebrate (teleosts, amphibians, amniotes) model organisms. In addition to questions dealing with physiological mechanisms, the group studies the ontogenetic development of these mechanisms within a comparative evolutionary approach. An overlapping of interests and a promising field for collaboration concerns research on the biology of aquatic macrophytes, algae, invertebrates and fish, which is studied by groups in the IGB (C. Steinberg) and several palaeontological and systematic zoological groups at the MFN (H.-P. Schultze, P. Bartsch). Furthermore, the interest in the evolution of physiological processes in arthropods match is shared by G. Scholtz and groups at the MFN. The research in the systematic botany group currently led by C. Brückner is focused on the evolutionary biodiversity of angiosperm plants. Comparative morphological, molecular and phylogenetic methods are applied. The molecular systematic studies are undertaken in cooperation with other groups of the department and with the FU. The interest in the evolution of angiosperms is also shared by B. Mohr at the MFN (Palaeontology). This cooperation will be further strengthened once the chair of Palaeobotany in the MfN has been filled.

Methodological aspects of the focus

- intracellular electrophysiology including on-line stimulus generation
- computer-based psychophysical and behavioural analysis
- bioacoustic signal analysis
- field studies of acoustic communication under water
- game-theoretical and population dynamical analysis
- computational modelling on the single-cell and network level
- nonlinear dynamics and information theoretical approaches
- light and electron microscopy
- immunocytochemistry
- cell lineage tracing with fluorescent markers
- computational cladistic analyses and molecular phylogenetics
- DNA-array and proteomic analyses

Perspectives

To intensify our research collaborations, we already offer various common seminars, colloquia that involve both theoretical and experimental aspects, and seminars within the Graduiertenkolleg "Evolutionary Transformations and Mass Extinctions". All these courses help to make students aware of the wide range of traditional and novel organismic approaches and attract them to the field. In this context, the large group of about 40 curators at the MfN could play an important role in the future. Many of these curators do not only have strong scientific interests but are also interested to participate in teaching. Special lectures and courses for diploma students would nicely complement flourishing initiatives such as those within the Graduiertenkolleg. These activities could also lead to further collaborations within the Department for Biology and between the department and the MfN, for example regarding the biodiversity of animals and plants or the ontogeny and phylogeny of vertebrates. Based on computational approaches that play an increasingly important role in the Neurosciences, a number of cooperations between the ITB and the Charité and MDC have been initiated. Focusing on various aspects of hippocampal dynamics and plasticity, these projects are also of clinical relevance, for example regarding epilepsy research. Similar opportunities exist regarding the study of infectious diseases. The present location of the department in Berlin-Mitte is particularly well suited for these collaborative research activities. In order to meet the modern challenges for organismic biology, it would thus be highly desirable to keep the Life Sciences together within the same campus.

3.3 Future Profile of Currently Open Positions

Apart from the position in Experimental Biophysics (hiring in progress), four or 20% of the departmental chairs are vacant at present. Three of these positions represent disciplines that are basic and essential for the education of diploma and teaching students. These are:

(I) Botany and Biology Didactics (C3)

(II) Molecular Cell Biology (C4)

(III) Ecology (C3)

(I) Following the recommendation of the SBK, the chair for Botany and Biology Didactics was established to provide training in basic aspects of botany and in theoretical and practical aspects of didactics. The combination of botany and didactics underlines the responsibility of the chair not only in education of teaching students but also for education in botanical biodiversity. Both tasks were successfully coordinated by Professor Wiedenroth until his retirement in September 2000. The chair is currently vacant. In the final report of the external *Kommission zur Evaluierung der Lehre in der Biologie an der Humboldt-Universität zu Berlin* (see Appendix II), the re-hiring of the chair for Botany and Biology Didactics was given highest priority. This recommendation is based on the critical importance of this chair in education. The Department of Biology concurred with the recommendation of this commission, and a proposal to advertise this position has been sent to the Mathematisch-Naturwissenschaftliche Fakultät I for approval.

(II) The interdisciplinary field of molecular cell biology is one of the most interesting and fast growing areas in modern biology. The chair of Molecular Cell Biology will meet the demands of modern student education and play an instrumental role for the research focus "Biomolecular Communication". Furthermore it will support cell biological aspects of all groups, provide an important link with the planned study program of "Molecular Medicine" at the Charité and will take on a substantial role in the joint Ph.D. program "Molecular Cell Biology and Pathology" with the MDC (see below). It is of fundamental importance to re-hire this C4 chair as soon as possible and in close vicinity to the other groups.

The current solution of an endowed chair at the MDC (C3 professor, financed by the Schering company for 5 years, hiring in progress) with teaching obligations at the Department of Biology has to be considered as a relative expensive interim solution; the personnel of this chair (3 scientists, 3 technicians, 1/2 secretary, all located at the MDC) are provided by the Department of Biology. However, the spatial distance to the MDC makes a full integration into our Department difficult. To improve this situation, the following agreement between the Humboldt University and the MDC has been recently reached: The Humboldt University intends to fill the position for Molecular Cell Biology as soon as possible. Provided that the chair can be filled within the 5-year period of the Schering endowment, the HU personnel currently working at the MDC (see above) will re-locate to Berlin-Mitte, while the MDC will provide the full personnel for the endowed chair.

(III) Ecology is an essential part of the teaching research program of the Department of Biology for diploma and teaching students and guarantees specialized training leading to an advanced degree (*Haupt- und Nebenfachprüfung*). The chair is vacant since 1999. Traditionally, its research focus has been aquatic botany, and as such this group is closely tied to the S-Professor Aquatic Ecology (IGB, C. Steinberg). Upon re-hiring of this position, the research focus should be directed toward evolutionary and molecular aspects of terrestrial ecology. This will ensure cooperation in the teaching and research program of the junior professors and Genetics, Plant Biochemistry, Comparative Zoology, Applied Botany, Theoretical Biology as well as Animal and Plant Physiology.

Filling all currently open professorship positions as soon as possible will be crucial for strengthening the two research foci. Taking the structure of the department and its future research areas into account, we consider the following professorships (in alphabetical order)

to be of similar importance for the profile of the department:

(IV) Developmental Biology (C3)

(V) Protein Biochemistry (C3)

(IV) The lack of a chair for Developmental Biology has been criticized for a number of years. Filling this position would open an interesting chance to combine molecular and organismic approaches and utilise the synergistic potential of both departmental foci. Preferably the focus of this chair would be on animal development. This would nicely complement the chair for Cytogenetics concerned with molecular mechanisms of *Drosophila* development and the chair for Comparative Zoology interested in evolutionary aspects of development. Joint activities would result in a significant representation of developmental biology within the department. In addition, together with Molecular Cell Biology, Molecular Parasitology and Cytogenetics, Developmental Biology would serve the increasing demands for education in molecular medicine (see below).

(V) Within the research focus "Biomolecular communication" there will be an increasing demand to elucidate the structure and dynamics of newly identified molecular components of signal transduction cascades etc. Therefore, it would be desirable to establish a chair in protein biochemistry that would also cover sophisticated methods of protein isolation and preparation. Modern approaches of characterizing the three dimensional structure of proteins would also provide a significant impact for the research focus. A joint appointment together with the Department of Chemistry would take advantage of its NMR equipment and foster interdisciplinary cooperation.

In summary, there are 4 vacant chairs in the Department of Biology. To realise the planned structure and research orientation of the Department, three of these positions have been tentatively assigned to the chairs of Botany and Biology Didactics, Molecular Cell Biology and Ecology. The Department will regularly re-evaluate its research structure and use its employment policy regarding further faculty positions as flexibly as possible to adapt its hiring to future opportunities, in particular in the fields of Developmental Biology and Protein Biochemistry. As another example, a chair of Immunology would meet the growing demand for this field and create strong ties to clinically oriented groups of the Charité, the MPI for Infection Biology and the German Arthritis Centre, all in close vicinity to the Biology Campus in Berlin-Mitte.

3.4 Future Study Programs

Within the framework set by the Bologna Declaration, we will reorganize the biology and biophysics study programs in close coordination with the *Verband Deutscher Biologen*. The high degree of modularity of both diploma courses (biology and biophysics) provides the flexibility to introduce new forms of study and respective degrees. In particular, based on our modular course system within the *Hauptstudium*, we aim at Masters programs that directly reflect our research profile. Possible specialisations include: Molecular Biology, Infection Biology (jointly with the Charité, German Arthritis Centre and MPI for Infection Biology), Molecular Medicine (jointly with the Charité), Biophysics and Bioinformatics (jointly with the Departments of Computer Science and Physics and the Charité), Theoretical Biology and

Organismic Zoology and Biodiversity (jointly with MfN). To foster international exchange, we intend to gradually shift towards teaching advanced courses in English.

On the postgraduate level, our research foci are reflected by the following training programs:

Medical Neurosciences (Master and MD/Ph.D. program)

In 2001, the Charité established an international Master and MD/Ph.D. program in Medical Neurosciences. The program includes experimental, computational and clinical research directions and is partially funded through the DAAD. At the Master's level, both an "Ergänzungsstudium" and an "Aufbaustudium" have been implemented. Participating groups come mainly from the Charité but also from the Department of Biology, the FU and the MDC. Ten to 20 students will enter the program per year.

Molecular Cell Biology and Pathology (Ph.D. Program)

In this planned joint Ph.D. program with the MDC, ten fellowships will be awarded per year for international applicants that are selected by a review board from both institutions. An intensive scientific program (including courses and seminars) will support the fellows. Their progress will be monitored by a committee that will also take part in the thesis defence in the Department of Biology.

Molecular Medicine (Bachelor, Master and Ph.D. Program)

The Charité plans to establish a Bachelor, Master and Ph.D. Program in Molecular Medicine in cooperation with the Department of Biology, the MDC, the MPI for Molecular Genetics and various biotech companies. This interdisciplinary program will combine basic research in molecular biology, genomics, proteomics and bioinformatics with clinical aspects. Every year 20 students will enter the program after having finished their basic studies in a natural science (*Vordiplom*) or medicine (*Physikum*).

GK 120 "Signalling Cascades in Living Systems" (See Section 1.4.1)

GK 268 "Dynamics and Evolution of Cellular and Macromolecular Processes" (See Sect.1.4.1)

GK 503 "Evolutionary Transformations and Mass Extinctions" (See Sections 1.4.1 and 3.2)

GK 780 "Perspectives on Urban Ecology – the Example of the European Metropolis of Berlin" (See Section 1.4.1)

SFB 429 "Molecular Physiology, Energetics, and Regulation of Primary Metabolism in Plants": Special seminars (See Section 2.2)

Planned SFB 1904 "Theoretical Biology: Robustness, Modularity and Evolutionary Design of Living Systems": Special seminars (See Section 2.3)

Havel-Spree-Colloquium: Since more than ten years, the institutes in Plant Science of HU, TU, FU, PU and MPI for Molecular Plant Physiology organize a yearly scientific meeting in which diploma and Ph.D. students present their research data.