Degree Program Documentation
Master's Program
Agricultural Biosciences

Part A
TUM School of Life Sciences
Technical University of Munich

General Information:

- Administrative responsibility: TUM School of Life Sciences
- Name of degree program: Agricultural Biosciences
- Degree: Master of Science (M.Sc.)
- Standard duration of study and credits: 4 semester of enrollment and 120 credit points (CP)
- Form of study: full time
- Admission: aptitude assessment (EV - Master's)
- Start: Winter semester (WiSe) 2020/2021
- Language(s) of Instruction: English
- Main Location: Weihenstephan (Freising)
- Academic administrator (program design): Prof. Dr. Ralph Hückelhoven
- Contact for further questions (regarding this document): Team Quality Management qm.co@ls.tum.de
- Status as of: 29.05.2024

Table of Contents

1 Degree Program Objectives

1.1 Purpose

Agricultural sciences offer solutions to major societal challenges. Securing food supplies, preserving natural resources, and mitigating the effects of climate change are only a few of many examples in which agricultural sciences make significant contributions. Research and development in agricultural sciences has undergone a paradigm change by adopting pivotal innovations during the last decade. A broad spectrum of molecular, biochemical, physiological, and biostatistical developments have opened new avenues. Among them are developments in functional analyzes leading to a mechanistic understanding of plant and animal metabolism and physiology, behavior as well as disease resistance. Advances in computational methods and predictive analytics allow the integration of heterogeneous data from molecular, physiological, and metabolic analyzes as well as a more profound understanding of the genetic diversity of crop and livestock species. Precision phenotyping yields novel insights on how plants and animals respond to environmental cues and on their interactions with antagonistic and beneficial microorganisms.

For the translation of these developments into innovation and agricultural production, it is pivotal to educate and train agricultural Master students in basic research in biology and data science. The advancement of agricultural biosciences requires integration and implementation of a comprehensive spectrum of key innovations such as targeted genetic and genomic improvement of crop and livestock species, advanced intervention strategies in crop and livestock physiology, a deeper understanding of cell biology and immunology in managed populations, and improved strategies for managing animal and plant health. The Master's program in Agricultural Biosciences aims to prepare students to become researchers whose responsibility is to apply the latest discoveries in molecular, biochemical, physiological, and biostatistical areas of agricultural science research. They will focus on creating sustainable plant and animal production methods to help reduce the impact of climate change. In comparison to other programs in the life sciences, this Master's degree is dedicated to crop and livestock species that serve as production entities and as model organisms for basic research.

1.2 Strategic Significance

The TUM School of Life Sciences is dedicated to education and research in agricultural sciences. The Master’s program Agricultural Biosciences complements the international Master’s portfolio offered at the TUM School of Life Science with AgriFood Economics, Policy and Regulation (Division Agricultural and Horticultural Sciences), Nutrition and Biomedicine (Division Nutritional Science), and Sustainable Resource Management (Division Forestry) with its focus on biological research as the basis of efficient and environmentally friendly agricultural production. It aims to understand the behavior of crop and livestock species from the level of cells up to whole organisms and populations and profits from the broad spectrum of basic research in the life sciences on the TUM School of Life Sciences campus.

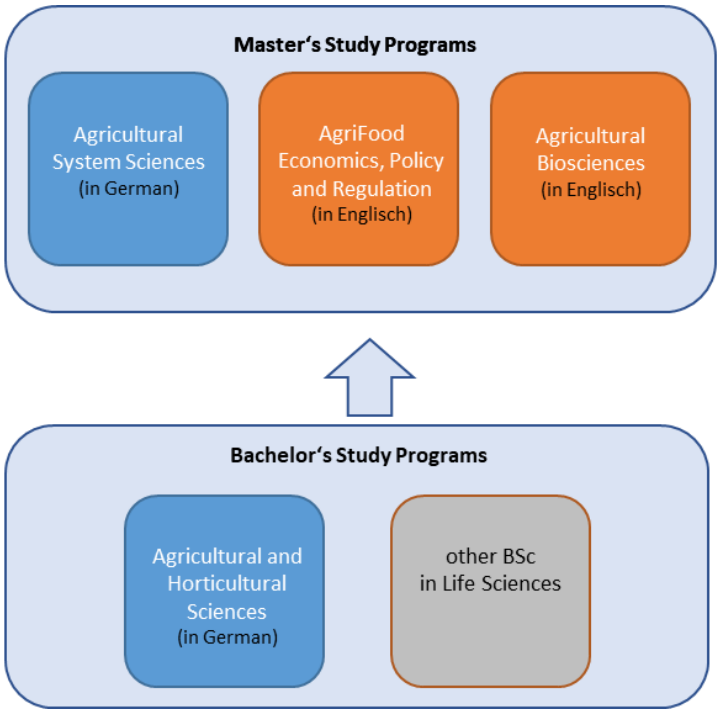
Addressing key issues of biological processes in agriculture, the Master’s program plays a major role in the TUM School of Life Sciences “One Health” concept, which is devoted to the production of healthy food and feed in an environment providing high-quality life. It contributes to the sustainable

transformation of our society by enabling more resilient production systems, thus strengthening the TUM Sustainable Futures Strategy 2030. Agricultural Biosciences are linked to human and veterinary medicine, nutrition and pharmaceutical biotechnology through common research interests leading to extensive synergies between disciplines and faculties paving the way for entrepreneurship in highly innovative fields related directly or indirectly to agricultural sciences. The demarcation of these disciplines originates from different translational targets.

Providing a Master's program with a strong focus on methods relevant for the biosciences reflects the TUM overall strategy to value innovative technologies as the basis for knowledge gain as well as for creating impact and translation of results into practice. Methods relevant for the Agricultural Biosciences encompass a broad spectrum from basic biochemistry to biostatistics. It is the integration of methods offering a mechanistic understanding of biology with quantitative data science that makes the Agricultural Biosciences program unique and links it to other seminal disciplines like molecular biology and bioinformatics.

The Master's program Agricultural Biosciences is part of the Study Division Agricultural and Horticultural Sciences. While the Master of Agricultural Science Systems covers agricultural production with a focus on the systemic interaction of many factors (biological, technological, economic), the Agricultural Biosciences program offers disciplinary depth in the biological disciplines relevant to crop and livestock production. It covers a broad spectrum of organisms (plants, animals, microbes) and quantitative and computational approaches in addition to molecular and cellular biology. Agricultural Biosciences are currently redefined through major technological breakthroughs (e.g., genome editing, machine learning), and programs that integrate these diverse research disciplines make the best use of available technologies and high-dimensional experimental data. An overview of the Master's programs offered by the Study Division Agricultural and Horticultural Sciences is given in Figure 1.

Figure 1: Consecutive Program offered by the Study Division Agricultural and Horticultural Sciences



2 Qualification Profile

The following qualification profile corresponds in terms of content to the requirements of the Qualifications Framework for German Higher Education Qualifications (HQR) and the requirements contained therein (i) knowledge and understanding, (ii) usage, application and generation of knowledge, (iii) communication and cooperation and (iv) scientific self-conception/professionalism. The formal aspects according to the HQR (admission requirements, duration, graduation options) are described in chapters 3 and 6 as well as in the corresponding subject examination and study regulations.

Students graduating from TUM Agricultural Biosciences understand the biological processes underlying agricultural crop and livestock production. They have a profound knowledge of molecular, biochemical and physiological processes contributing to sustainable production increase. Based on their methodological repertoire, they are able to optimize processes leading to genetic improvement of crops and livestock and optimize production environments through knowledge of the genotype-phenotype relationship. They can integrate heterogeneous data from different disciplines, are able to handle large experimental data sets, and have a good knowledge of predictive analytics. The students can evaluate the acquired methods concerning their impact and trade-offs in practice and communicate their relevance for agricultural production in a liveable environment.

The students have a profound **knowledge and understanding of the scientific basis** of biological processes relevant for agricultural production. They know and understand plant and animal metabolism, animal behavior and their interaction with the environment. They are capable of developing methods for functional analysis, genetic modification, and selection of crop and livestock species. They are also skilled in employing quantitative methods for biological data science and handling and analyzing big data volumes in a scientific context.

The students are able to **apply their knowledge to perform research** in the field of Agricultural Biosciences. They can develop research questions, design and analyze experiments, and integrate data from various disciplines including crop and livestock physiology, cell biology, immunology, genetics, bioinformatics, and statistics. Moreover, they have the ability to identify areas where knowledge is lacking and can modify and progress fundamental technologies from related fields such as biology, bioinformatics, and nutrition to conduct research and development in agricultural biosciences. Additionally, they are capable of conducting autonomous research on a well-defined project and gathering, analyzing, documenting, and discussing data obtained from their own experiments.

The students are aware of **societal challenges and demands** in the context of Agricultural Biosciences and possess the **social skills** to **communicate and cooperate across disciplines and cultures**. They can evaluate novel methods adopted by agricultural research and development for their scientific and societal impact. They are able to evaluate their state of knowledge in an international context. They have a clear idea how the acquired knowledge and methods can be implemented in practice and are able to translate their knowledge into practice by devising applied projects. They can present and communicate their research results to a scientific as well as a general audience. Furthermore, they can act in an intercultural environment and work solution-oriented within international scientific teams. They have advanced science communication skills in English, can manage projects, and take on coordinating leadership roles. Additionally, they can communicate their knowledge and results to other disciplines and are able to enter into collaborations with them.

The students have developed a profound scientific **self-conception and professionalism** for navigating in a changing environment and managing complex projects. They can set their individual goals based on an analysis of their talents and interests and have learned to work strategically towards these goals and building an individual profile, e.g., by choosing electives in their curriculum have shown their capability of perseverance in long-term projects by completing their Master's thesis

3 Target Groups

3.1 Target Audience

The main target groups of the MSc Agricultural Biosciences are national and international students that hold an above-average bachelor's degree in the field of life sciences, such as agricultural sciences, horticultural sciences, life sciences biology, or molecular biotechnology, from a national or international university with a duration of study of at least six semesters.

3.2 Prerequisites

The above-mentioned entry qualifications ensure that the students have sufficient basic knowledge and academic skills in the field of life sciences to continue their academic education at Master-level. Students have successfully completed at least 60 credits in fundamentals and methods of biological sciences (e.g., cell biology, genetics, microbiology, physiology). At least 5 credits of these credits should have been gained in bioscience methods (e.g., laboratory courses, methods of biotechnology) and another 5 credits in applied plant and animal sciences, preferably in relation to the agricultural sector. Moreover, students have completed during their bachelor studies at least 10 credits in statistics, data science and bioinformatics and at least 5 credits in chemistry. This is checked as part of the so-called curricular analysis for applicants within the area of applicability of the Lisbon Convention.

For applicants outside the area of applicability of the Lisbon Convention, this analysis is replaced by an online TUM Test. It covers the following categories: "Statistics, data science, bioinformatics, chemistry", "Bioscientific basics", "Bioscientific methods", "Applied plant and animal sciences", "Problem-solving skills". The objective test makes international higher education qualifications (different higher education landscapes; different grade and credit systems) comparable. Students who are not directly admitted due to their results in the first stage of the aptitude procedure will be invited to an interview in the second stage (if they achieve a minimum score).

Students should be highly interested in deepening their knowledge at the interface of agricultural sciences and biosciences (focus on plant and/or animal science in a managed environment) and its linkage to agricultural production. They should be highly motivated to take part in further developing the agricultural biosciences by taking into account methodological and practical innovations and current societal challenges that need to be addressed by academia (see, e.g., the "One Health" concept). Furthermore, the students should have prior knowledge in handling data and quantitative data analysis. Proof of first research experience as shown via a Bachelor thesis or equivalent research projects are advantageous for admission (for more details, see appendix two (aptitude test) of the

master's program's Examination and Academic Regulations). Because the teaching language is English, qualified applicants need to show a level of fluent English skills, if the language of instruction in previously completed study programs was not English. In this case, applicants must submit results of a recognized English test such as the "Test of English as a Foreign Language" (TOEFL) (at least 88 points), the "International English Language Testing System" (IELTS) (at least 6.5 points) or the "Cambridge Main Suite of English Examinations".

3.3 Target Numbers

The number of students enrolled in the degree programs has risen continuously in recent years, indicating the topics' popularity. The target number of students for this program is 30 students per academic year (admission is only possible in the winter term). This target number is based on potential job-market assessments and, on the other hand, on capacities to assure best conditions for high-level mentoring and supervision that are necessary to provide optimal support to the students who have to pass a significant amount of research-oriented examinations.

Figure 2: Key figures for M.Sc. Agricultural Biosciences (Source: TUM Dashboard)

	Wintersemester 2020/21	Wintersemester 2021/22	Wintersemester 2022/23	Wintersemester 2023/24
Applications (Cases)	175	160	219	275
Admissions (Cases)	17	52	67	76
Admission rate (Cases) in %	9,7	32,5	30,6	27,6
Rejections (Cases)	114	103	148	196
Enrollments from Applications (Cases)	10	28	41	44
Percentage of Enrollments in Admissions (Cases) in %	58,8	53,8	61,2	57,9
Students (Cases)	10	37	73	107

4 Demand Analysis

The TUM School of Life Sciences is devoted to the strategic research concept „One health". One pillar of this research concept is the development of agricultural biosciences focusing on the environmentally friendly production of natural resources and healthy foods and feed. The sustainable development of this research field within and beyond TUM requires education and training of young talents passionate for the application and advances of the life sciences.

Employment opportunities for students graduating from the Agricultural Biosciences Master's program will be found in tenure-track academic organizations and to a large extent in biotech, breeding and life science companies. International graduates with combined expertise in molecular biology and quantitative and computational methods are highly sought after in the job market. As in other MINT disciplines, the demand for qualified personnel is not met by the number of graduates. It can be expected that the demand will increase as molecular methods and machine intelligence will fundamentally change the agricultural sector and increase the demand for research and development.

New skills, such as programming and handling data-rich challenges and digital information, are in high demand. As there is a strong trend towards diversification in the job market, more and more young scientists with expertise in agricultural biosciences are finding employment in smaller companies and startups in areas such as biotechnology and machine intelligence, providing technologies or services to the agricultural sector. Due to their competence in quantitative analysis, graduates from the Agricultural Biosciences Master's program will also find employment opportunities outside the agricultural context, e.g., in the field of human genetics research and development with a different research focus but highly related research methods and tools.

As the Agricultural Biosciences Master's program is relatively new, it has produced only six graduates to date. Two of these graduates are pursuing a doctorate, one at TUM and the other in the USA. One graduate has found work in sales for a wholesaler in Lebanon, while another is employed in the equipment validation department of a pharmaceutical company. Additionally, one graduate serves as a research assistant for the Bavarian State Research Center for Agriculture (LfL), and another has taken on the role of Junior Scientist for a small company focused on researching phytopathology and food security in European sustainable agriculture.

Due to the growing world population, the global food sector itself is expected to grow considerably in the coming years.[1] This is dependent on a stable agricultural sector. Employers in the agricultural sector have repeatedly been reporting a shortage of well-trained specialists in recent years, as documented in studies conducted by the German VDL (Berufsverband Agrar, Ernährung, Umwelt e. V.)[2]. This shortage can be expected to get more pressing in the coming years due to demographic change.

5 Competition Analysis

5.1 External Competition Analysis

At the interface of agricultural sciences and biosciences several Master's programs are offered at universities in Germany and international institutions (listed in figure 2). The profile, focus and content of the TUM Master's program Agricultural Biosciences differs from Master's programs of other universities:

The TUM MSc Agricultural Biosciences is focused on basic biological research for an efficient and environmentally friendly agricultural production of crop and livestock species. Crop and livestock species are investigated at two levels: as model organisms for basic research and as production entities. In contrast, other Master's programs have a specialized view on basic research and distinguish between plant and animal science (e.g. MSc Plant Sciences/Molecular Plant Science/Plant

[1] Statista Market Insights projects an annual growth of more than 6 % (https://www.statista.com/outlook/cmo/food/worldwide)

[2] "Fach- und Führungskräfte in der Agrarbranche bald Mangelware?" (Juni 2014, https://www.vdl.de/fach-und-fuehrungskraefte-in-der-agrarbranche-bald-mangelware/); "VDL und BHGL: Parlamentarischer Abend: Für die Attraktivität des Grünen Studiums werben" (Oktober 2018, https://www.vdl.de/parlamentarischer-abend-fuer-die-attraktivitaet-des-gruenen-studiums-werben/)

Biology/Plant and Microbial Biology, and MSc Tierwissenschaften/Animal Sciences/Animal Biology, MSc Predictive and Integrative Animal Biology) or they are devoted to agricultural crop or livestock production systems (MSc Nutzpflanzenwissenschaften/Crop Sciences/Applied Plant Sciences/Crop Production and Physiology, MSc Horticulture, MSc Nutztierwissenschaften).

The TUM MSc Agricultural Biosciences covers a broad spectrum of organisms (plants, animals, microbes). Thus, the study program can take advantage of the synergistic effects created by integrated studies on plant and animal species teaching generic as well as specific biological concepts, methods and tools. Thus, it reflects the high level of complexity of agricultural biosciences and prepares graduates for a multi-path career allowing for flexibility and migration in the job market. Most other Master's programs investigate either plants or animals (list see above) or require a clear specialization on either of the two (list of programs to be added). At TUM we believe that a generic approach is more timely as recent research has shown that many biological mechanisms are shared between plants and animals. It has also been shown that molecular as well as computational methods follow a generic principle. The demarcation line does not run between animal and plant species but rather is determined by specific features of the respective livestock or crop, and in some cases, appropriate methods are more similar across than within the plant and animal kingdom.

The TUM MSc Agricultural Biosciences offers disciplinary depth in biological disciplines relevant to crop and livestock production. It integrates molecular, biochemical, physiological, genetic and genomic knowledge and quantitative and computational approaches in a unique, interdisciplinary agricultural study program. Study programs of other universities specialize on certain agricultural key aspects such as breeding or crop protection (MSc Integrated plant and animal breeding, MSc Plant Breeding/Plant Breeding and Plant Genetics, MSc Crop Protection, MSc Animal Breeding and Genetics). The growing importance of biotechnology is reflected in several curricula which focus entirely either on plants (MSc Plant Biotechnology), or on plant and animal production and nutritional sciences (MSc Agrobiotechnology). The study program MSc AgriGenomics is concentrating on the clearly defined area of genomics in plant and animal production systems.

The analysis shows that the research-oriented, interdisciplinary Master's program Agricultural Biosciences is unique in the landscape of agricultural study programs. It is shaped by the TUM School of Life Sciences vision, offering a basic, mechanistic understanding of biological processes underlying agricultural crop and livestock production combined with expertise in handling data-rich challenges and quantitative data analysis.

Figure 3: Master's programs at German and selected international universities with focus on plant/animal sciences and agrobiotechnology. Systems-oriented agricultural programs not included.

National institutions	Selected international institutions
Rheinische Friedrich-Wilhelms-Universität Bonn MSc Plant Sciences (E) MSc Tierwissenschaften MSc Nutzpflanzenwissenschaften	**Wageningen University** MSc Animal Sciences MSc Plant Biotechnology MSc Plant Breeding (online) MSc Plant Sciences
Justus-Liebig-Universität Gießen MSc Agrobiotechnology (E) MSc Nutzpflanzenwissenschaften MSc Nutztierwissenschaften	**University of Natural Resources and Life Sciences (BOKU) Wien** European M.Sc. Animal Breeding and Genetics MSc Horticultural Sciences MSc Nutzpflanzenwissenschaften MSc Nutztierwissenschaften
Georg-August-Universität Göttingen MSc Integrated Plant and Animal Breeding (E) MSc Crop Protection (E)	**AgroParisTech** MSc Predictive and Integrative Animal Biology
Martin-Luther-Universität Halle MSc Nutzpflanzenwissenschaften	**UC Davis** MSc Animal Biology MSc Integrative Genetics and Genomics MSc Horticulture and Agronomy MSc Plant Biology MSc Plant Sciences
Universität Hamburg MSc Molecular Plant Science (E)	**Cornell University** MSc Animal Science MSc Horticultural Biology MSc Plant Sciences
Universität Hannover MSc Pflanzenbiotechnologie	**University of Wisconsin-Madison** MSc Animal Science MSc Horticulture MSc Plant Breeding and Plant Genetics
Universität Hohenheim MSc Crop Sciences (E)	**University of Minnesota** MSc Applied Plant Sciences MSc Animal Sciences MSc Plant Sciences MSc Plant and Microbial Biology MPS Horticulture (MPS=Master in Professional Studies)
Christian-Albrechts-Universität Kiel MSc AgriGenomics (E)	**Iowa State University** MSc Animal Breeding and Genetics MSc Animal Science MSc Crop production and physiology MSc Plant Biology MSc Plant Breeding MSc Horticulture
Ludwig-Maximilians-Universität München MSc Plant Sciences (E)	
Humboldt-Universität Berlin MSc Horticultural Sciences	

5.2 Internal Competition Analysis

The Agricultural Biosciences program aims to train young people who understand the fundamental genetic and physiological processes of crops and livestock in the context of their interaction with the environment and agricultural production processes, who can analyze crops and livestock and develop them further through breeding or biotechnology. The concept of the Master's degree program in Agricultural Biosciences is based on the integration of modern agricultural biosciences disciplines (e.g., agricultural biotechnology, molecular and statistical genetics, bioinformatics, immunology). The degree program uses synergies that arise at the TUM School of Life Sciences site through the bioscientific and nutritional science disciplines and ensures an educational concept with a clear focus on research and development in the area upstream of agricultural production. It is geared towards disciplinary depth and the progressive development of biological production goods.

The TUM School of Life Sciences offers different Master's degree programs in agriculture and biosciences that are relevant for internal competition analysis. The Study Program Division Agricultural and Horticultural Science refers to the MSc Agrarsystemwissenschaften and the MSc AgriFood Economics, Policy, and Regulation, the Study Program Division Molecular Biotechnology refers to the MSc Molecular Biotechnology and MSc Biology.

MSc Agrarsystemwissenschaften

The scientific focus of the master's program Agrarsystemwissenschaften is agricultural production systems, their complex nature, and their interaction between plant, animal, technology and environment. Within the study program, areas of studies are crop production systems, animal production systems, agricultural ecosystems, agricultural economy and agricultural system technology. In the degree program, knowledge and competencies are imparted to empower students to analyze, evaluate and further develop agricultural production systems in their correlation with the environment and society using innovative technologies. The degree program addresses bachelor students who are interested in agricultural problems and their solutions, as well as in innovative technologies and their translation to agricultural production systems. In contrast to the Master's program in Agricultural Biosciences, the focus is less devoted to the fundamental functional, biological mechanisms but to the interaction within the agricultural system soil – plant – animal – economy.

MSc AgriFood Economics, Policy and Regulation

The AgriFood Economics, Policy and Regulation Master's degree program differs significantly in its objectives and requirements. Graduates of this course are clearly oriented towards the international, social science, and socio-technological fields of action as well as socio-economic and political effects. The international Master's degree course in Agricultural Biosciences has little overlap with the AgriFood Economics, Policy and Regulation Master's degree program due to its focus on biological disciplines.

MSc Molecular Biotechnology

The Master's program Molecular Biotechnology is devoted to producing and constructing natural and artificial biomolecules by means of cells or organisms. These biomolecules include macromolecules such as proteins, nucleic acids, and polysaccharides (carbohydrates and sugars). The degree program combines methods of genetic engineering, protein chemistry, and biophysics with bioinformatics in one interdisciplinary approach. Students of the program have the possibility to specialise in

five different areas – namely biomolecules, cells, organisms, and technology and industrial application. The target group of the Master's program are bachelor students who have prior knowledge in molecular biotechnology, biochemistry, biotechnology and bioprocess technology. The implications of the managed environment, which are typical for agricultural production systems, are not the focus of the study program.

MSc Biology

The Master's program Biology addresses a wide range of study fields, such as molecular biology, biochemistry, immunobiology, microbiology, genetics, cell biology, morphology, taxonomy, animal and plant physiology, behavioral biology, ecology, neurobiology or neuronal foundations of behavior. Students of this interdisciplinary program can specialize in at least three of seven focus areas - namely biochemistry and cell biology, genetics/biostatistics, medical biology, microbiology, ecology/ environmental management, plant sciences and animal sciences. Bachelor students with prior knowledge in biology are considered suitable for this master's program.

Other Master's degree programs with points of contact are the Master's degree programs **Bioeconomy and Technology of Biogenic Resources** at the Straubing campus and **Sustainable Resource Management** at the TUM School of Life Sciences. However, these are more strongly focused on the value chain or technological utilization of renewable raw materials or forestry systems, so there is little overlap in the qualification objectives and target groups.

The TUM School of Life Sciences offers a broad spectrum of basic research in the life sciences. This is of special value for the implementation of the MSc Agricultural Biosciences insofar as the master's program can profit from the import of teaching from already existing study programs. These overlaps, e.g., in cell biology, are well thought-through and are necessary to implement the integrated study concept that combines plant and animal sciences by offering modules in generic as well as specific biological concepts, methods, and tools and by imparting expertise in handling data and quantitative data analyzes. (The aim of the master's program Agricultural Biosciences is to train graduates who understand fundamental biochemical, genetical and physiological processes of crop plants and livestock in the context of the interaction with the environment in general and of agricultural production systems. By imparting profound knowledge in modern molecular methods and quantitative data analysis, the students should be prepared for research in modern Agricultural Biosciences.)

The MSc Agricultural Biosciences is hence unique in its profile and content not only out-side but also within the TUM. Furthermore, it is of high relevance for the TUM School of Life Sciences as it complements its agricultural portfolio that is devoted to biological research as the basis of efficient and environmentally friendly agricultural production by taking into account key innovations in agricultural biosciences and societal challenges that must be addressed in the future.

Overall, the Master's degree courses at the TUM School of Life Sciences are optimally coordinated in their respective subject areas. Each course has a clear profile that can be distinguished from the others, appeals to different prospective students, and qualifies them for different fields of work and professions.

6 Program Structure

The Master's program Agricultural Biosciences offers lectures, lab courses, seminars, and independent study projects in biological disciplines relevant for agricultural production. It comprises four semesters, including the Master's Thesis.

Figure 4: Sample curriculum of the Master's program Agricultural Biosciences

Semester							Credits / Exams
1.	WZ0624 Plant and Animal Cell Biology K 5 CP	WZ0625 Immunology: Crop and Livestock Health and Disease K 5 CP	CIT5130001 Applied Statistics and Data Analysis Applied Statistics and Data Analysis K 5 CP	LS10043 Lab Course Animal Immunology and Physiology K 5 CP	WZ1720 Crop Breeding K 5 CP	WZ0635 Genetic Engineering of Livestock M 5 CP	30/6
2.	WZ0623 Physiology K 5CP	WZ0626 Genetics and Genomics K + PRÄ 5 CP	WZ1589 Marker-assisted Selection K 5 CP	WZ2581 Plant Biotechnology PRÄ 5 CP	WZ2401 Research Project 'Molecular Plant Breeding' B 10 CP		30/6
3. Mobility Window	WZ1696 Crop Genomics K 5 CP	WZ1584 Quantitative Genetics and Selection K 5 CP	WZ1185 Plant Epigenetics and Epigenomics K 5 CP	SZ0426 Englisch - Professional English for Business and Technology - Marketing Module C1 LP 3 CP	CLA20710 Global Diversity (Successful in International Teams) LP 2 CP	WZ0632 Research Internship Plant Immunology B 10 CP	30/6
4.	LS10046 Master´s Thesis W 30 CP						30/1
Key	dark blue = final thesis blue = elective modules grey = required modules			CP = credit points K = Klausur (written exam); M = oral exam; B = report; PRÄ = presentation; W = research paper; LP = learning portfolio			

Compulsory Modules

A total of 25 credit points (CP) has to be obtained in five required core courses during the first and second semester. In four of the required modules (Physiology, Plant and Animal Cell Biology, Immunology: Crop and Livestock Health and Disease, Genetics and Genomics) a profound understanding of the scientific basis of biological processes relevant for crop and livestock production will be offered as a lecture covering generic and specific topics of plant and animal sciences complemented by seminars allowing students to specialize on plants or animals. In the fifth required course “Applied Statistics and Data Analysis” students will learn advanced quantitative methods as employed in biological data science and predictive analyzes.

After completion of the five compulsory modules during the first and second semester, students possess solid knowledge in basic biological concepts relevant for agricultural production. They have advanced knowledge of plant and animal metabolism, understand determinants and consequences of animal behavior, and the interaction of plants and animals with their managed environment.

Elective Modules

A total of at least 65 credit points has to be obtained in the elective modules. Therefore, at least one method-oriented **lab course** (5 CP), counting as an elective module, is required. Students can choose from a list of lab courses covering molecular or computational techniques.

In addition, at least two **research tools** counting as elective modules have to be successfully completed with at least 10 CP. These courses offer independent study projects and enable students to perform research in the field of agricultural biosciences. Students learn how to formulate research questions, design and analyze experiments, interpret results, and present them orally and in writing.

The core modules train students for additional **free elective modules**. These elective modules enable students to integrate heterogeneous methods and data and to link research topics and methods to adjacent fields, e.g., nutrition, medicine, bioinformatics, and data science. They provide orientation to students inclined to choose a field of specialization and, at the same time, prepare them to link their knowledge across several disciplines. Electives convey knowledge of molecular, biochemical, physiological, genetic, and statistical concepts contributing to sustainable production growth in agriculture. In addition, the broad spectrum of elective modules trains students for multiple career paths. Students can choose the necessary 50 CP or less (depending on credits of the research tools chosen) from a list of lectures, practical courses, and independent research projects offering a balanced selection of molecular, biochemical, physiological, biostatistical, bioinformatics, and computational topics. Here, students learn how to perform research on selected topics. Through their individual choices, they can build a highly focused study program developing in-depth expertise in one area of specialization (e.g., molecular animal science, computational plant science, horticultural science), or they can build an interdisciplinary program in which they acquire profound knowledge and analytical skills in seminal technologies from adjacent fields and combine them with profound knowledge on agricultural research questions. Through seminars, they learn to critically evaluate novel methods adopted by agricultural research and development for their scientific and societal input.

Furthermore, an elective module, Research Internship Agricultural Biosciences, completes the research-oriented elective options with the opportunity to gain practical experience at external research institutions to the extent of 5 credits as coursework.

Students can choose elective courses from the TUM-wide offer (maximum 30 CP) or from other international institutions (maximum 30 CP) as long as they are not redundant to already completed courses and in line with the goals and qualification profile of the TUM Master's program Agricultural Biosciences.

By opening a **mobility window** in the third semester, students are encouraged to gain international study experience through exchange programs such as Erasmus+ or TUM-exchange. If approved by the Examination Board and under the supervision of a professor within the TUM School of Life Sciences, they can take up a research internship outside TUM, e.g., with a qualified industry partner or in an external research organization (e.g., Max Planck Institute).

In addition to professional competence, personal development is also promoted. Students can complete up to 5 CP in general knowledge offering them an interdisciplinary perspective on their field of studies. This includes courses from the TUM Language Center and the TUM School of Social Sciences and Technology (Kontextlehre WTG: Science, Technology, Society), to improve their language competencies or soft skills.

Teaching Concepts in the context of (inter)disciplinary qualifications

In seminars, students learn to discuss subject-specific and methodological content with fellow students and lecturers in academic discourse. They acquire additional professional skills in the areas of conversation and presentation techniques. Students are trained in teamwork and conflict resolution in an intercultural environment in the seminars and as part of their final thesis. They acquire cooperation and communication skills in contact with academics at an international level. By working in study groups with fellow students from different countries with diverse linguistic and cultural backgrounds, they also acquire skills in international communication.

Master's Thesis

The fourth semester is devoted to preparing the Master's thesis that concludes the study program. In their thesis, students identify and address a research question in agricultural biosciences by choosing and implementing appropriate molecular, experimental, or data methods. They develop an appropriate research design and show competence in interpreting the research outcome. By choosing a topic, the thesis raises the student's professional profile. The thesis is defended in a colloquium.

7 Organization and Coordination

The TUM School of Life Sciences offers the Master's Program Agricultural Bio Sciences.

Areas of responsibility might be listed as follows:

The following administrative tasks are performed partly by the TUM Center for Study and Teaching (TUM CST) and its administrative units, partly by offices in the schools or departments:

• Student Advising:	Student Advising and Information Services (TUM CST), studium@tum.de, +49 (0)89 289 22245 Provides information and advising for prospective and current students (via hotline/service desk)
• Departmental Student Advising:	Dr. Kai Hartwig abs.co@ls.tum.de +49 (0)8161 71 4044
• Academic Programs Office:	Campus Office Weihenstephan campus.office@ls.tum.de
• Study Abroad Advising/ Internationalization:	TUM-wide: TUM Global & Alumni Office internationalcenter@tum.de Departmental: Team International (Campus Office Weihenstephan) international.co@ls.tum.de
• Gender Equality Officer:	Prof. Aphrodite Kapurniotu akapurniotu@mytum.de
• Advising – Barrier-Free Education:	Service Office for Disabled and Chronically Ill Students (TUM CST), handicap@zv.tum.de +49 (0)89 289 22737
• Admissions and Enrollment:	Admissions and Enrollment (TUM CST) studium@tum.de, +49 (0)89 289 22245
• Aptitude Assessment (EV)	TUM-wide: Admissions and Enrollment (TUM CST) Departmental: Campus Office Weihenstephan application.co@ls.tum.de
• Semester Fees and Scholarships:	Fees and Scholarships (TUM CST) beitragsmanagement@zv.tum.de Tuition fees for students from Non-EU Countries.
• Examination Office:	TUM-wide: Central Examination Office (TUM CST) Departmental: Team Examination Office (Campus Office Weihenstephan) examination.co@ls.tum.de

- Examination Board: Prof. Dr. Chris-Carolin Schön (Chair)
  Dr. Ulrike Utans-Schneitz (Secretary)
- Quality Management – Academic and Student Affairs: TUM-wide: Quality Management (TUM CST), www.lehren.tum.de/startseite/team-hrsl/
  Departmental: Team Quality Management (Campus Office Weihenstephan)
  qm.co@ls.tum.de

8 Enhancement Measures

The revision of the program was developed with the intensive participation of the student representatives both during the course of reaccreditation and within the internal quality management circles. In addition, professional representation was also involved within an external quality management circle.

For winter semester of 2/25, the aptitude assessment was updated and a TUM test (online) was introduced for applicants with Higher Education Entrance Qualifications outside the area of applicability of the Lisbon Convention. This was necessary in order to manage the increasing number of international applicants, within a reasonable time frame. Admitted applicants are now able to apply for their visas at an early stage. The objective test also makes international higher education qualifications (different higher education landscapes; different grade and credit systems) comparable, which means that prior knowledge is more uniform.

New for winter semester 24/25, the Immunology and Physiology lab courses (WZ0628 + WZ0627) in the elective module area will be split and set up separately for "plant" and "animal" within three new modules. Students raised the idea for the Immunology and Physiology modules at previous iQMZ meetings, as the content for these modules is very different for crops and livestock. As a result, the overall offer of Lab Courses will also be expanded.

In addition, the number of research tools was increased to accommodate the high number of students. The General Education module has been replaced by the TUM School of Life Sciences' generally applicable template, "Interdisciplinary Qualification," including modules from the Language Center and the Carl von Linde Academy.

Internal and external quality management circles are held regularly with the participation of the student council to keep the degree program at an excellent level.