

Degree Program Documentation

Bachelor's Program Brewing and Beverage Technology

Part A

TUM School of Life Sciences
Technical University of Munich

General Information:

- Administrative responsibility: TUM School of Life Sciences
- Name of degree program: Brewing and Beverage Technology
- Degree: Bachelor of Science (B.Sc.)
- Standard duration of study and credits:
6 Semesters and 180 credit points (CP)
- Form of study: full time
- Admission: unrestricted admission
- Start: Winter semester (WiSe) 2008/2009
- Language of Instruction: German
- Main Location: Freising
- Academic administrator (program design):
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1 Degree Program Objectives

1.1 Purpose

In the 19th and 20th centuries, brewing and beverage technology developed from a craft trade into a modern industry that operates worldwide. Today's beer and beverage industry utilises modern production processes and large-scale technical systems that require an interdisciplinary combination of different specialist areas. Extensive engineering knowledge is required, particularly in the planning, design and automation of modern production facilities and the development of new technologies. The markets not only demand high-quality and safe products, but also regular innovations. Increased demands on the conservation of resources, constantly growing competition due to the diversity in the beverage and beer sector and the associated market changes are additional constant challenges. German companies continue to be world market leaders in product-related research and development, the establishment of new technologies, raw material production (raw materials, malt, hops) and fermentation technology, and in particular in plant engineering in this industry sector. These diverse demands on products and production processes require highly trained specialists with comprehensive expertise in traditional and innovative production systems and plant technologies as well as a profound overview of the entire value chain in beverage production, from raw materials to bottling.

The aim of the Brewing and Beverage Technology degree program is to train interdisciplinary engineers for the brewing and beverage industry. Graduates are tasked with the safe operation of beverage production plants and the development of new beverages and corresponding processing methods. They can pick up on new developments and turn them into innovations. Responsible use of resources in terms of sustainable management is also part of the profile.

1.2 Strategic Significance

For years, the TUM School of Life Sciences (LS) has been training process engineers who can design and conceptualise production processes in the brewing and beverage industry. The use of fermentative/biotechnological processes is a connecting element to other related Bachelor's degree programs at LS (Food Technology, Pharmaceutical Bioprocess Engineering). However, the subject-specific focus of those related Master's degree programs is on the food and pharmaceutical industry.

The Bachelor's degree program in Brewing and Beverage Technology is followed consecutively by the Master's degree program in Brewing and Beverage Technology at the Technical University of Munich (TUM), which is also based at the LS. The Bachelor's program lays the foundations for acquiring in-depth process engineering and methodological skills. Students also have the opportunity to specialise in certain areas of brewing and beverage technology and to gain their first guided experience in scientific work as part of their Bachelor's thesis. With responsibility, talent and scientific and technological excellence, TUM strives to play a leading role in the sustainable transformation of society and innovative value creation in order to enable prosperity in harmony with nature and the environment.

The consecutive degree program in Brewing and Beverage Technology uses the School's structures and competencies in the fields of engineering and biotechnology and complements them with a focus

on brewing and beverage technology. The thematic networking of the individual related degree programs mentioned above also enables students to gain an insight into different sectors of the biotechnology industry and thus acquire interdisciplinary skills.

With the **TUM Sustainable Futures Strategy 2030**, TUM aims to become a shaper of sustainable development - scientifically, economically, ecologically and socially. The Brewing and Beverage Technology degree program is committed to TUM's mission statement and makes a significant contribution to the implementation of its sustainability strategy in teaching. The program focuses on aspects of social transformation for sustainable and climate-resilient development. To this end, it deals with issues such as the production of high-quality, healthy and safe beverages, thereby contributing to a sustainable food and beverage supply. Product manufacturing in an industrial environment is based on the sustainable, climate-friendly utilisation of resources, including closed raw material cycles. Through a basic economic education and the possibility of using a TUM Food & Agro Centre for Innovation and Technology (FACIT) tailored to the needs of the relevant areas of application, we lay the foundation for independent, sustainable entrepreneurial action by graduates.

The integration of the study program bundle into the wider LS environment offers an additional special advantage for the training of brewing/beverage technologists. The Weihenstephan campus has interdisciplinary knowledge of life sciences, especially microbiology, biochemistry and molecular biotechnology. Due to this bundling of competences required for brewing and beverage technology, it is possible to train highly qualified graduates here. Synergies also result from the existing knowledge in the food sector and the good cooperation with the School of Engineering and Design and the Nutritional Sciences degree program for individual courses.

2 Qualification Profile

Students on the Bachelor's degree program in Brewing and Beverage Technology receive a broad basic education in the natural sciences and mathematics. Microbiological aspects also play a central role here. In various parts parallel to this or building on it, they acquire a broad technical profile in the field of engineering sciences (together with the related Bachelor's degree programs at LS) and finally - especially for them - skills in the field of brewing and beverage technology. After completing the Bachelor's degree program, students are able to combine the specialist knowledge they have acquired from all areas and apply it in a problem-solving manner. The competences that graduates can demonstrate after successfully completing a Bachelor's degree are listed below.

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

Knowledge and Understanding

- Graduates know and understand the mathematical/scientific concepts required to solve brewing and beverage technology problems (e.g. statistical methods of data evaluation, microbiological principles).
- Graduates know and understand the engineering fundamentals in the fields of mechanics, fluid mechanics and thermodynamics (e.g. strength calculations, pipe flows and energy balancing).
- Graduates know and understand the technologies used in beverage production (e.g. fermentation, bottling plants).
- Graduates have a broad knowledge of a wide range of products and processes in the brewing and beverage industry (beer and non-alcoholic beverages, fermentation, mashing).
- Graduates know and understand the legal and hygienic framework conditions for the production of beverages.

Use, Application and Generation of Knowledge

- Graduates are able to apply the mathematical, scientific and engineering fundamentals they have learnt to a wide range of industrial problems.
- Graduates are able to use common fermentation technologies and produce beer according to the given requirements.
- Graduates are able to make microbiological and chemical-technical assessments of the starting and end products of beverage production.
- Graduates are able to work safely in the laboratory in accordance with analysis regulations.
- Graduates are able to analyse, monitor and design individual brewing processes in order to generate and/or ensure the desired beverage properties.
- Graduates are able to carry out experimental work in accordance with the state of the art under supervision and to reflect on, structure and document the results obtained.
- Graduates can analyse the economic efficiency of various process alternatives and plan production capacities.

Communication and Cooperation

- Graduates are familiar with the typical working methods of the specialised field and the relevant technical vocabulary.
- Graduates are proficient in interdisciplinary communication and are able to work constructively and solution-orientated in a team.
- Graduates are able to prepare, present and communicate research results in a way that is appropriate for the target group.

Scientific Self-Conception and Professionalism

- Graduates are qualified to work in the brewing and beverage industry as well as to continue their scientific education in the form of a subsequent Master's degree program.
- Graduates are able to select and apply suitable statistical methods for analysing and critically evaluating complex data and processes.
- Graduates are able to work on problems from industrial practice using basic scientific methods.
- Graduates are able to critically reflect on their actions in their professional environment, especially in relation to society's increasing expectations regarding health and sustainability.

3 Target Groups

3.1 Target Audience

The Bachelor's degree program in Brewing and Beverage Technology is aimed at first-year students with a keen interest in scientific and engineering issues and who enjoy solving interdisciplinary problems. A keen interest in biology, chemistry, maths and physics as well as the ability to think in an interdisciplinary way are therefore advantageous. They should also have a keen interest in production processes, creative development and the product quality of beverages.

Professionally qualified people, such as brewers or maltsters, also have access to this degree program, which underpins their practical expertise with scientifically sound skills, significantly expanding their career opportunities. When applying for the Bachelor's degree program, professionally qualified applicants need at least three years of professional experience in addition to their completed training, as well as proof of English and proven knowledge of mathematics ([information portal for professionally qualified](#) applicants).

Future brewing and beverage technologists should be willing to work in an interdisciplinary team in order to be able to work innovatively in a constantly changing industry and contribute responsibly to solving problems facing society as a whole.

3.2 Prerequisites

3.2.1 Basic Requirements

For the Bachelor's degree program in Brewing and Beverage Technology, the general admission requirements for studying at a university must be fulfilled in accordance with the Ordinance on Qualifications for Studies at Universities of the Free State of Bavaria and State-recognised non-state universities (Qualification Ordinance-QualV) (BayRS 2210-1-1-3-K/WK) in the currently valid version. Otherwise, admission to the degree program is not restricted.

Applicants should fulfil the following requirements:

- Ability to work in a scientific or basic research and method-orientated manner
- Recognisable interest and corresponding background knowledge for questions from the fields of brewing and beverage technology, related fields (e.g. food or biotechnology) as well as other fields (e.g. engineering, natural sciences, etc.)
- Ability to solve complex problems
- Interest in solving application problems

3.2.2 Language Skills

As the lectures are held almost exclusively in German, prospective students who have sufficient knowledge of German are addressed. Foreign students must submit a language certificate recognised by TUM (C2 (Goethe), DSH-2, B2 (DSD II), 4 (TestDaF), telc Deutsch C1 Hochschule) together with all other documents by the application deadline.

Applicants are expected to have the ability to think in an abstract, logical and system-orientated way. A good command of English is also very helpful, as specialised literature is often only available in English. Students with deficits in this area can improve their English language skills as part of the elective program.

3.3 Target Numbers

For the Bachelor's degree program in Brewing and Beverage Technology, the aim is to enrol 70-90 students. A basic and orientation examination in the first year of study helps students to determine their own suitability for the chosen degree program after a short time.

Figure 1 shows the number of first-year students on the Bachelor's degree program in Brewing and Beverage Technology in recent years.

The number of first-year students has fluctuated between 75 and 100 in recent years, which is in line with targets. In the 2011/12 winter semester, the double Abitur year was reflected in particularly high numbers of applicants. The "Weihenstephan" and "Technical University of Munich" brands contribute to the high demand for the degree program.

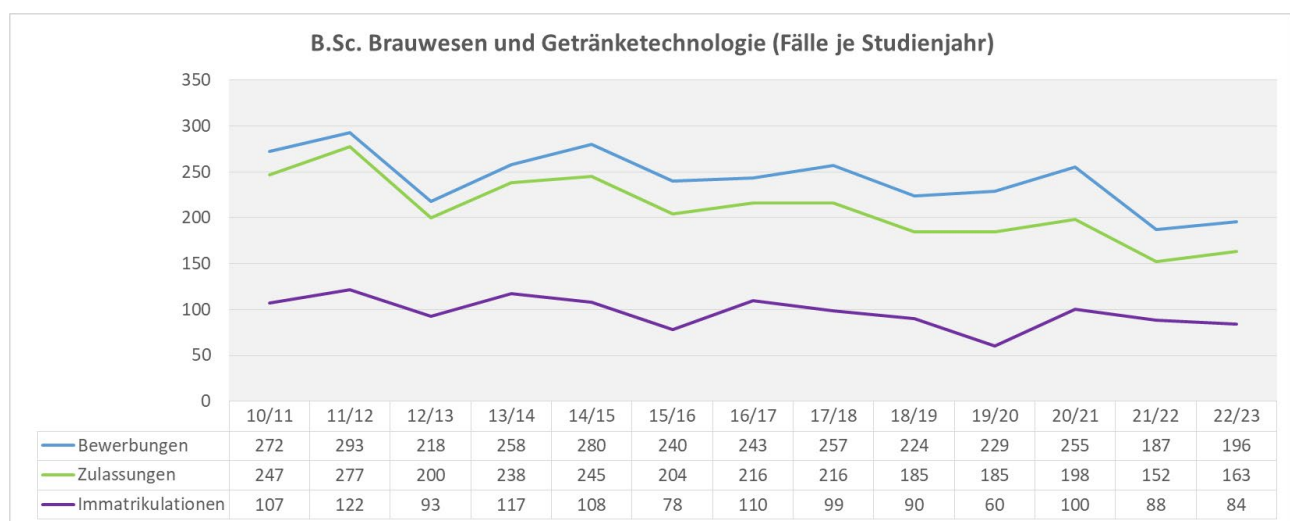


Figure 1: Applications, admissions and enrollments in the Bachelor's degree program in Brewing and Beverage Technology in relation to the respective winter semesters

Figure 1 shows the number of first-year students on the Bachelor's degree program in Brewing and Beverage Technology in recent years, which has ranged between around 60 and 140, which largely corresponds to the target corridor. At the beginning of the reporting period, the double Abitur year was reflected in particularly high numbers of applicants. The "Weihenstephan" and "Technical University of Munich" brands contribute to the high demand for the degree program.

Table 1: Key figures B.Sc. Brewing and Beverage Technology (Source: TUM key figure system)

	Winter term 2019/20	Winter term 2020/21	Winter term 2021/22	Winter term 2022/23
Applications (cases)	224	244	184	196
Admissions (cases)	184	194	152	163
Admission rate (cases) in %	82,1	79,5	82,6	83,2
Rejections (cases)	8	10	11	33
Enrollments from applications (cases)	59	96	88	84
Proportion of enrollments to admissions (cases) in %	32,1	49,5	57,9	42,9
Students (cases)	151	205	199	208

Table 2 Students in the Bachelor's degree program in Brewing and Beverage Technology by gender and origin for the winter semester 2022/2023 (source: TUM indicator system)

Total students	thereof male	Female	German	Foreigners	Educational nationals	Educational foreigners
208	154	54	181	27	8	19

Table 2 shows the origin and gender of students in the winter semester 2022/2023. Traditionally, the Brewing and Beverage Technology degree program is more in demand from male students. However, the proportion of female students is still around 25%. Compared to the related degree programs, the Brewing and Beverage Technology degree program also has a lower internationalisation rate. Nevertheless, the proportion of foreign students is around 10%.

4 Demand Analysis

The beverage industry and the brewing industry in particular represent an important branch of industry in Germany.

The German beverage industry, one of the leading in Europe, employs around 60,000 people in around 500 companies (with more than 20 employees) with an annual turnover of around 21 billion

Euros in Germany alone¹. Around 27,000 people are employed in the production of beer and almost the same number are employed in the production of soft drinks and mineral water in companies with more than 20 employees. Spirits distilleries and wineries represent a further field of employment.

The brewing industry in particular has a large number of different companies. There are currently over 1,500 breweries in Germany, but over 50% of these are small and medium-sized companies². The brewing industry is characterised by the growth of small (micro) breweries. Across Europe, there were over 10,000 breweries (in 2021). In the United States, the number of breweries more than doubled between 2014 and 2020 and currently stands at around 9,000 businesses.

The global beverage market is of great and steadily growing importance with an average annual growth rate of 2-3% and will reach a total sales volume of around US\$ 1.8 trillion in 2026. Alcoholic beverages have the largest market share with around 76%. Among alcoholic beverages, beer is the largest category, followed by spirits, wine and then cider, hard seltzer and other fermented beverages³.

Graduates have other fields of employment in the non-alcoholic beverage industry. For example, there are around 330 fruit juice producers across Germany with around 7,500 employees⁴, which also represents an important industry.

Germany continues to be Europe's largest market for non-alcoholic beverages such as drinking water, soft drinks, fruit juices, functional drinks, iced tea and ready-to-drink coffee, so there is also a need for trained beverage technologists in this area.

In addition, the world's leading companies in plant engineering (especially brewery production plants, packaging and bottling plants, etc.) are based in Germany. The supply industry (e.g. malting plants, beverage base material manufacturers, etc.) also provides numerous fields of employment.

With a Bachelor's degree that qualifies them for a career, graduates mainly find employment in the field of production. However, the majority of graduates decide to continue their education with the consecutive Master's degree program on offer.

Graduates of the Master's degree program can find employment in leading positions in production companies (e.g. breweries, malt houses, hop refiners, raw material/raw material manufacturers, etc.), in plant engineering and construction (e.g. production plants, bottling and packaging plants, etc.), logistics and the flavour industry. Graduates of the Master's program are also employed in the areas of planning, quality control and research and development.

¹ Source: 2021 [Federal Statistical Office](#)

² Source: 2021 [Federal Statistical Office](#)

³ Source: 2021 [Federal Statistical Office](#)

⁴ Source: 2020 [Association of Fruit Juice Producers](#)

5 Competition Analysis

5.1 External Competition Analysis

In brewing and beverage technology, there are all levels of training - "from apprenticeships to doctorates". The classic, globally unique craft path is characterised by training as a brewer and maltster and a subsequent master brewer. This level of training is covered by the general state vocational schools, of which there are currently over seven locations in Germany. In addition, there are also private academies and training centres that offer a comparable master craftsman training course for school fees (e.g. Doemens Academy GmbH).

Doemens Academy GmbH also offers a study-orientated variant of a brewing and beverage technologist with a state final examination. However, all of these fee-based programs are primarily designed to provide basic training with a focus on theoretical and practical content and therefore offer neither university-oriented teaching nor academic degree options.

There is another university Bachelor's degree program in Germany entitled "Brewing and Beverage Technology". This is based at the Technical University of Berlin and has a number of similarities. For example, the combination of engineering and natural sciences is also a central aspect of the academic program there. Like the program at the TU Munich, it has been in existence for a long time. Due to the geographical distance, however, there is no direct competition, but rather a co-existence based on partnership (e.g. through joint research projects). The universities of Geisenheim, Lemgo and Köthen as well as the Justus Liebig University Giessen should also be mentioned, which each offer a bachelor's degree program in beverage technology. However, the focus here is on general beverage production, with brewing technology playing no role (Giessen) or only a very minor but increasing role (Geisenheim, Lemgo, Köthen).

The Weißenstephan-Triesdorf University of Applied Sciences also offers a Bachelor's degree program in Brewing and Beverage Technology, which is definitely a competitor due to its immediate geographical proximity. However, the curriculum is primarily aimed at a typical university of applied sciences education, neglects the classic university career path and prepares students less specifically for the consecutive Master's program.

Internationally, there are few degree programs with a comparably specific, undergraduate profile. While the University of Nottingham, KU Leuven and UC Davis offer post-graduate programs in brewing and malting, there is no undergraduate bachelor's degree that systematically combines basic subjects with specialist knowledge. Heriot-Watt University (Scotland) and the South East Technological University (Ireland) both offer a BSc Brewing and Distilling, but this gives more space to the production of spirits than the program at TUM, which focuses more on beer and non-alcoholic beverages. There is practically no direct competition due to the different national and regional target groups.

5.2 Internal Competition Analysis

In addition to the Bachelor's degree program in Brewing and Beverage Technology, the Technical University of Munich also offers the related Bachelor's degree programs in Food Technology and Pharmaceutical Bioprocess Technology mentioned above, as well as the additional degree program

"Brewing with a Master Brewer's Degree". The three Bachelor's degree programs form a joint Professional Profile Life Science Engineering. Large parts of the scientific and engineering fundamentals are covered in the Brewing and Beverage Technology degree program together with the Food Technology and Pharmaceutical Bioprocess Technology degree programs, particularly in the early phases of the degree program. Despite the relationship and the structural and content-related similarities in the first semesters, a specialisation in the chosen subject area emerges during the course of study. The brewing and beverage technology content taught on the bachelor's degree program in Brewing and Beverage Technology is only available on this program and thus enables a clear specialisation. The degree programs are therefore not in competition with each other, but also offer students the opportunity to change their focus by switching between the degree programs relatively easily. Students who are committed to this are also always looking for the possibility of a double degree.

At the Technical University of Munich, only the Brewing and Beverage Technology degree program teaches equal parts natural sciences and engineering paired with a specialisation in brewing and beverage technology. The gradual development of brewing-specific skills from the first semester of the degree program enables students to obtain a sufficient professional qualification with their Bachelor's degree.

6 Program Structure

The interdisciplinary, German-language Bachelor's degree program "Brewing and Beverage Technology" is a full-time degree program with a total of 180 ECTS credits. The standard period of study is six semesters. The Bachelor's degree program consists of a foundation and orientation examination in the first year of study, followed by the Bachelor's examination in the second and third years. The compulsory modules guarantee a consistently good basic education. The focus in the first year of study is on the natural sciences, which are essential for a successful Bachelor's degree. In the following years of study, the basis is laid for the brewing and beverage-specific as well as engineering training. The Bachelor's degree qualifies graduates for activities in production, quality assurance and commissioning and lays the foundation for the scientifically oriented Master's degree program. The following illustration shows an exemplary course of study.

Figure 2: Exemplary curriculum of the Bachelor's degree program Brewing and Beverage Technology for the subject examination and study regulations 20221.

Semester	Modules								Credits/ Exams
1.	LS30033 Einführung in die Ge- tränke-tech- nologie (GOP) K 5 CP	MA9615 Calculus (GOP) (5 CP) K (3 CP) 8 CP	PH9035 Physics for Life Science Engineers 1 (GOP) K + LL (SL) 7 CP	LS30037 Cell Biology K 5 CP	WZ5322 General and Inorganic Experimental Chemistry with Lab (GOP) K (4 CP)	LS30041 Seminar on Good Scientific Practice LP 4 CP			6 30
2.	LS30038 Economics für Life Sci- ence Engi- neering K 5 CP		PH9036 Physics for Life Science Engineers 2 K 5 CP	WZ5426 Organic and Biological Chemistry (3 CP)		WZ5442 Applied Me- chanics (2 CP)	WZ5047 Energetic Use of Bio- mass K 5 CP	WZ5005 Materials En- gineering K 5 CP	6 30
3.	WZ5303 Raw Material K 5 CP	WZ5299 Statistics K 5 CP	LS30000 Introduction to Microbiol- ogy (2 CP)		LS30059 Beverage Analytics 1 K 5 CP				6 29
4.	LS30072 Wort Tech- nology K 5 CP				LS30021 Labor Law K 3 CP	WZ5013 Fluid Me- chanics K 5 CP	LS30023 B.Sc. Lemi BrauBPT -In- dustrial In- ternship B (SL) 10 CP	LS30011 Business Ad- ministration in the Beverage Industry K 5 CP	7 31
5.	LS30049 Yeast and Beer Tech- nology K + LL (SL) 8 CP	LS30034 Beverage Bottling plants and Biological Plant Moni- toring K 7 CP				LS30036 Thermo-dy- namics K 5 CP	LS30039 Packaging Technology K 5 CP	WZ5063 Basics in Pro- gramming ÜL (SL) 6 CP	6 31
6.	LS30044 Bachelor's Thesis W 12 CP	CLA30258 Jazzprojekt ÜL 3 CP	CLA21023 Passing Ex- ams in Re- laxed Mode B 2 CP			LS30035 Hygienic Processing K 6 CP	WZ5435 Ma- chine and Plant Engi- neering K 6 CP		5 29
Key	Dark Blue = Mandatory Bachelor's Thesis Light Blue = Elective Modules Grey = Mandatory Modules Green = Basic and Orientation Exams (GOP) Orange = General Education Subject								PR = Practical Course; CP = Credit Points; SL = coursework; K = written exam ; M = oral exam; LL = lab work; ÜL = exercise work; W = scientific research paper LP = learning portfolio; B = report

6.1 Scientific Basics

In order to be able to understand the engineering and advanced brewing/beverage technology modules in the further course of study, a subject-specific introduction and mathematical/scientific basics are taught in the first two semesters of the degree program (modules marked in green in Figure 2). The success of this basic training is assessed in the first year of study as part of the basic and orientation examination (GOP). The basic and orientation examination is used for this degree program instead of an admission restriction. All examinations within this GOP must be taken at the scheduled time and may only be repeated once. Students should use the GOP to show whether they are suitable for the Brewing and Beverage Technology degree program.

The **Physics 1+2** and **Advanced Mathematics/Statistics** modules lay the foundations for the subsequent engineering modules. The focus in physics is on basic mechanics, electrical engineering, thermodynamics and optics and is therefore the starting point for mechanical and thermodynamic considerations. Advanced mathematics provides the mathematical tools for engineering and thermodynamics.

In the **Inorganic Chemistry** module, students are taught the chemical fundamentals of reaction kinetics and atomic models, which are essential for **organic and biological chemistry and chemical-technical analysis**. The **Organic and Biological Chemistry** module covers the correct nomenclature as well as formation and reaction pathways. The hydrocarbon compounds dealt with here are involved in all cell biological and physiological processes in biology. Furthermore, students learn the detailed structure of such molecules involved in metabolism and the metabolic mechanisms.

The scientific foundations are rounded off by the **cell biology** module. Students are shown the cellular structure of single and multi-cell organisms and their function. This knowledge is then taken up again in general **microbiology** and in the module on **beverage bottling plants and biological plant monitoring**. Here, the classification of microorganisms and their biotechnological usability and pathogenicity are discussed at a glance. Knowledge of the properties of microorganisms is very important for the subsequent biotechnological production of beverages, such as beer in particular. In addition to the production-positive and therefore useful microorganisms, microorganisms that are harmful to beverages are also dealt with, which must be prevented during production with suitable hygiene measures.

6.2 Engineering Sciences

The engineering sciences are one of the focal points of the Bachelor's degree program in Brewing and Beverage Technology. The starting point for all engineering and process technology considerations is **technical mechanics**. This module is at the beginning of the Bachelor's examination. Here, the mechanical approaches from physics are taken up and deepened by means of static and kinetic problems. It thus forms the basis for further engineering modules such as **fluid mechanics** or in-depth electives.

When designing beverage technology systems, one of the main professional fields of graduates, an understanding of fluid dynamic systems is naturally indispensable. The calculation and design of such systems are learnt in the **fluid mechanics** module. **Thermodynamics** provides a basis for

understanding the design of auxiliary material flows (steam, energy), in which students learn, for example, how to calculate thermodynamic cycle and ideal gas processes.

Hygienic working is necessary to ensure product quality and shelf life. Undesirable microorganisms can only be kept away from the product if the work is carried out cleanly. In the beverage industry, these potential germs must not be allowed to accumulate in the system, as they could be transferred to the product during the manufacturing process. On the one hand, it is therefore important to design the systems in such a way that there are as few dead spaces as possible for germs to accumulate. On the other hand, training in the correct cleaning and sterilisation of the system is necessary. This topic is covered in the **Hygienic Processing** module.

Students can achieve a further engineering profile by choosing engineering elective modules from the so-called profile area.

6.3 Brewing and Beverage Technology

In addition to the basic scientific training, subject-specific teaching is anchored right from the start. As early as the first semester, students are given an initial overview of different types of beverages, their legal differentiation and their basic production in the sub-module **Introduction to Beverage Technology**. The module thus creates a sense of identity for the students and allows them to reflect on their own study choices.

The subject-specific focus of the degree program is traditionally on beer production. The various process steps and special features of beer production are covered in the three consecutive modules **Raw Materials Technology**, **Wort Technology** and **Yeast and Beer Technology**. In the raw **materials technology** module, the raw materials for the production of beer, i.e. brewing water, malt and hops, and their properties are discussed. This includes the production of malt from various types of grain (barley, wheat, etc.), hop processing, the technological use of various hop products and possible forms of water treatment. In this context, students learn about possible technologies and the legal framework at national and international level.

The wort is produced from the raw materials in the process steps of crushing, mashing, lautering, wort boiling and subsequent clarification. These process steps are covered in the **wort technology** module. There are a large number of technological variants and systems in these production stages, for which students are sensitised. After cooling and dosing the yeast, the wort is fermented. The resulting green beer is stored and, if necessary, filtered and is then ready for bottling and distribution. These work steps are carried out in the **yeast and beer technology** module. The three consecutive brewing technology modules not only show students how beer is produced, but also how they can identify and resolve the causes of any technological difficulties that arise later in their careers. The challenge lies in producing a consistent beer quality from natural products that always vary in quality and properties. The above-mentioned courses are accompanied by laboratory practicals in which students carry out process steps in beer production, apply the associated analytics and learn the technological evaluation of the analysis results.

In addition to analytical quality assurance, microbiological operational control in particular is an essential part of quality control. It includes checking the raw materials right through to the finished container. Filling the beverages is the final process step in the brewery. The technical design and characteristics of the systems required for bottling and keg filling, knowledge of possible filling units and bottling-specific system planning, taking into account economic and energy-related aspects and optimisation

options as well as weak point analysis, are included in the **Beverage Filling Systems and Biological Operational Monitoring** module.

6.4 Overarching Content

The general principles of scientific work are taught in the module **Seminar on Good Scientific Practice**. Both techniques for acquiring information (literature research, literature management) and project management tools such as time management are practised. Students are encouraged to learn and plan independently right from the start of their studies. Later on, necessary skills such as word processing systems, mathematical software packages and presentation techniques are used, and academic texts are analysed, written and mutually assessed. In this way, students acquire the skills they need to prepare experimental reports, discuss researched information and present their own scientific work.

For the professional practice of many graduates, knowledge of business contexts is of essential importance in today's corporate world and is therefore of the highest practical relevance. The **Economics** module teaches students basic economic and business contexts so that they understand companies as the subject of business administration. In addition, the use of internal and external accounting is explained, with the help of which they can master current challenges for companies in an economic context.

The **general education** module offers a wide range of further education, interdisciplinary, personality-building and horizon-broadening courses, from which students can choose the content that is most compatible with their personal and professional goals, based on their individual interests. To this end, students can choose from various areas, such as courses offered by the Carl von Linde Academy or the Language Centre.

6.5 Elective Modules

Students can use the electives to sharpen their own degree profile. A total of 45 credits can be earned within the framework of specialised electives. Of these 45 credits, 35 must be selected from **profile electives**, which are specified in a catalogue. Up to 10 credits from **industrial internships** can also be included here. Within the framework of the **free elective modules** totalling a maximum of 10 credits, modules can be taken flexibly, provided they serve to develop the student's profile. A further 5 credits must be taken as part of the **General Studies** module.

6.6 Bachelor's Thesis

In the third year in particular, the previously acquired skills in the subject areas of natural sciences, engineering and brewing and beverage technology are combined. The application-orientated, but at the same time scientifically based degree program concludes with the **Bachelor's thesis**, in which a subject-relevant topic is worked on under supervision. After structuring and preparing the results in writing, a presentation is given.

6.7 Mobility Window

The 4th semester (summer semester) is recommended for a stay abroad. When designing the curriculum, care was taken to ensure that the compulsory module **Working Technology** can alternatively be completed in the 6th semester. The practical course of the 2-semester module **Microbiology** can also be moved to the 6th semester. The compulsory module **Fluid Mechanics** is a standard module that can also be completed at other technical universities. In addition, the 18 ECTS to be completed from elective modules can be taken at the host university and subsequently recognised (on application). It is expressly pointed out that a further 6 CP of elective modules from the 6th semester must already be completed during the stay abroad (4th semester) in order to achieve the required 29 CP in the 4th semester and 31 CP in the 6th semester. The Student Advisory Service at the Campus Office is available for individual planning of the stay abroad.

7 Organization and Coordination

The Bachelor's Program Brewing and Beverage Technology is offered by the TUM School of Life Sciences.

Administrative aspects of study organisation are partly the responsibility of the central departments of the TUM Center for Study and Teaching (TUM CST) and partly of the TUM School of Life Sciences/Campus Office Weiherstephan (see overview below):

- Student Advising: Student Advising and Information Services
(TUM CST)
(via Hotline/Service Desk)
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+49 (0)89 289 22245
- Departmental Student Advising: Team Student Advising
brew-food-bpt.co@ls.tum.de
Campus Office Weiherstephan
- Academic Programs Office (within department/school), Infopoint, etc: [Contact form](#) Campus Office Weiherstephan
- Study Abroad Advising/
Internationalization: TUM-wide: TUM Global & Alumni Office
internationalcenter@tum.de
Departmental: Student Counselling Team
[Contact form](#) Campus Office Weiherstephan
- Gender Equality Officer: Prof Aphrodite Kapurniotu
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- Advising – Barrier-Free Education: TUM-wide: Service Office for Disabled and Chronically Ill
Students (TUM CST), handicap@zv.tum.de
+49 (0)89 289 22737
- Admissions and Enrollment: TUM-wide: Admission and Enrollment (TUM CST)
studium@tum.de
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Admission, Enrollment, Student Card,
Leave of Absence, re-Registration, de-Registration
- Aptitude Assessment: TUM-wide: Admissions and Enrollment (TUM CST)
Departmental: Student Advisory Service Team
Dr Sabine Köhler, Tel: +49 (0)8161 71 3336
[Contact form](#) Campus Office Weiherstephan
- Semester Fees and Scholarships: TUM-wide: Fees and Scholarships (TUM CST)
beitragsmanagement@zv.tum.de

- Examination Office: TUM-wide: Central Examination Office (TUM CST)
Departmental: Team Examination
[Contact form](#) Campus Office Weißenstephan
- Examination Board: Prof Dr Thomas Becker (Chairman)
Ivan Babić (acting secretary)
- Quality Management –
Academic and Student Affairs: TUM-wide: Studies and Teaching -
Quality Management (TUM CST)
www.lehren.tum.de/startseite/team-hrs/
Departmental: Team Quality Management
qm.co@ls.tum.de Campus Office Weißenstephan

8 Enhancement Measures

There were practically no changes to the current statutes, which came into force in the winter semester 2022/2023. As part of the reaccreditation of the consecutive Master's degree program carried out at this time, various changes were made to the statutes in order to harmonise the consecutive course. These amendments to the statutes are now due for reaccreditation.

In general, the conversion of the degree programs of the entire degree program bundle was characterized by enabling students to individualise their own skills profile to a greater extent. The wide range of methodological and technical skills typical of the degree program continues to serve as the basis for profiling. In addition to the mathematical and scientific skills and the brewing/beverage technology specialisation, the traditionally important basic engineering orientation is retained. A standardised economic education is also guaranteed.

On the other hand, the previously customary control of the acquisition of competences in the elective area has been largely dispensed with. Whereas previously certain credits always had to be selected from competence-specific catalogues, now only one elective area with profile subjects defined by the examination board is specified. For example, an industrial internship is no longer compulsory, but can of course still be included in the degree program as part of the acquisition of skills. The new structure is intended to meet the demand for graduates with a generalist education through the broad-based compulsory courses, but at the same time also to meet the increasingly differentiated professional fields for which students can prepare themselves by specifically choosing their own profile. A small proportion of credits can even be chosen completely freely from the TUM's range of courses, provided that the modules chosen make a recognisable contribution to sharpening the profile of the respective student. Of course, students still have the option of diversifying their electives in order to achieve the broadest possible generalist range of competences.

As early as the 2019/2020 winter semester, the decision was made to move automation engineering and process engineering (module from thermal process engineering and process engineering of

disperse systems) to the Master's program. The flexibility this created in the Bachelor's degree program was not filled with compulsory courses, but also allows the above-mentioned greater elective options and the improved integration of a mobility window into the degree program.

A compulsory seminar module on good scientific practice has been integrated into the interdisciplinary program, in which students are introduced to scientific work in a coordinated manner right at the beginning of their studies. The integration of a compulsory general education subject has been retained.

All changes were discussed in detail in the internal and external quality circles and received broad support from all stakeholders.