

# For entrants in AY 2021

Appended Form 1

## Specifications for Major Program

Name of School (Program) [School of Engineering Cluster 3 (Applied Chemistry, Biotechnology and Chemical Engineering)]

Program name (Japanese)	生物工学プログラム
(English)	Program of Biotechnology
1. Academic Degree to be Acquired Bachelor's degree in engineering	
2. Overview In order to contribute to the advancement of the key industries that will play a role in the next generation, such as medicine, food, and environment, this program aims at developing engineers and researchers that possess professional expertise and technical skills in the elucidation and utilization of biological molecules and living organisms. Therefore, this program establishes a curriculum through which students can organically and systematically acquire comprehensive knowledge of the basic mechanisms of life and technical skills in the most-advanced fields, such as gene, protein, carbohydrate, and lipid engineering; microorganism, animal, and plant engineering; biochemical engineering; bioinformatics engineering; environmental biotechnology; immunology; and brewing technology. Students can also acquire the different abilities required for researchers and engineers, such as the ability to think logically, the ability to plan and conduct experiments, the ability to explain data analysis, the ability to discover and resolve the problems, and the ability to deal with practical issues. This program awards the Type-1 High School Teaching License (Industry) to students who have taken the required courses. Graduates gain employment and work actively for corporations in the pharmaceutical, food, brewing, environmental, and chemical industries, or in public research institutions. Graduates can go to graduate school (Graduate School of Integrated Sciences for Life) to obtain a higher degree of education and undertake research.	
3. Academic Awards Policy (Policy for awarding degrees and goal of the program) The Program of Biotechnology nurtures professionals that have acquired the basic knowledge, skills, and attitudes needed to work as bioengineering researchers and engineers and, further, to embrace opportunities for creativity in scientific thought. Therefore, this program offers education aimed at cultivating a broad range of general knowledge, a global perspective to seek peace, a general sense of judgment, and a well-rounded character. The program awards a bachelor's degree in engineering to students who have completed sufficient liberal arts education and specialized education to achieve the following goals from (A) to (E), as well as the number of credits necessary to meet the standard of the course. (A) The ability to understand the relationship between people, society, nature, and engineering, and to demonstrate multifaceted and logical thinking skills (B) The ability to understand basic natural science (C) The ability to acquire basic knowledge of biotechnology and biological science, and to expand it widely to applied technology (D) The ability to come up with conceptual ideas and to implement ideas, as well as the ability to transmit learning and research results (E) The ability to adapt to the highly sophisticated information society with high level communication skills	
4. Curriculum Policy (Policy for Preparing and Implementing the Curriculum)	

To achieve the goals from (A) to (E) set by this program, the Program of Biotechnology organizes and implements a curriculum in which liberal arts education and specialized education are closely connected. After acquiring basic academic abilities and knowledge in liberal arts education subjects, students must learn the specialized fields of engineering and biotechnology. Students mainly study these subjects until the first and second terms of the second year, and then after the third and fourth terms of the second year, when students are assigned to the program, they mainly study specialized subjects. Learning specialized basic subjects before being assigned to the program is effective in raising awareness of students' field of specialization, and in developing incentives for learning. Furthermore, receiving lectures by the faculties in charge of programs other than the Program of Biotechnology (Program of Chemical Engineering, Program of Applied Chemistry) provides students with knowledge about surrounding fields. Learning outcomes are evaluated based on the grade calculation for each subject and the level of attainment against the goals set by the educational program.

#### ○ Knowledge and Abilities

- Cultivation of understanding about the relationship between people, society, nature, and engineering, as well as an ethical outlook, which forms the basic knowledge that researchers and engineers are required to possess (Goal A). This is obtained through mastery of liberal arts education subjects, "Introductory Seminar for First-Year Students", "Peace Science Courses", "Introduction to University Education", "Information Subjects" and specialized basic subjects, "Introduction to Applied Chemistry, Chemical Engineering and Biotechnology", and "Introduction to Fundamental Industry" to be offered at the first year.

- Basic knowledge of mathematical theory, physics theory, and experimental methods required of researchers and engineers in natural science (Goal B). This is obtained through mastery of mathematical fundamental subjects such as "Calculus" and "Linear Algebra" and fundamental physics subjects such as "General Mechanics I · II" and "Experimental Methods and Laboratory Work in Physics" to be offered in the first year.

- General understanding of biotechnology, life science, chemistry, and the basic knowledge required of experts in biotechnology (Goal B, C). This is obtained through mastery of specialized basic subjects, "Basic Life Science", "Basic Organic Chemistry I", "Basic Inorganic Chemistry" and "Basic Environmental Sciences" to be offered in the first year.

- Mathematical method required of experts in biotechnology (Goal B). This is obtained through mastery of specialized basic subjects, "Applied Mathematics I · II", and "Probability and Statistics" to be offered from the third and fourth term of the first year through the second year.

- The expertise and grasp of concepts required of researchers and engineers in biotechnology (Goal C). This is obtained through mastery of the specialized subjects of the Program of Biotechnology such as "Microbiology I · II", "Molecular Biology I · II · III", "Enzyme Chemistry", and "Biochemical Engineering" to be offered from the third and the fourth term of the second year through the fourth year.

#### ○ Abilities and Skills

- The ability to conduct experiments to resolve issues and problems that arise, and the ability to examine and resolve problems using experimental outcomes and related materials (Goal C, D, E). This is obtained through mastery of experimental subjects closely related to biotechnology, such as "Experimental Methods and Laboratory Work in Biology", "Basic Experiments in Chemistry", and "Training of Biotechnology I · II"

- The ability to make action plans on one's own initiative in response to practical issues and challenges, to make adjustments, and to resolve problems and challenges by using basic and specialized knowledge and methods (Goal C, D, E). These are obtained through mastery of "Graduation Thesis" to be offered in the fourth year.

#### ○ Overall Abilities

- The ability to organize and analyze information from the literature to discover and resolve practical problems and challenges, and the ability to logically make research plans and carry them out (Goal C, D, E). These are obtained through mastery of "Group Discussion of Current Biotechnology Topics" to be offered in the third year and

“Graduation Thesis” to be offered in the fourth year.

- The ability to organize research results and write logically, including about the significance and validity of the obtained outcome, and to prepare presentation data, present it, and discuss it verbally in an easy-to-understand manner (Goal E). These are obtained through mastery of “Group Discussion of Current Biotechnology Topics” to be offered in the third year, and “Graduation Thesis” to be offered in the fourth year.

- Teamwork ability, leadership ability, and communication ability in group work (Goal E). These are obtained through mastery of “Basic Experiments in Chemistry”, and “Training of Biotechnology I · II” to be offered from the third and fourth term of the second year through the third year, and through “Group Discussion of Current Biotechnology Topics” to be offered in the third year.

- The ability to read, write, and converse in the English language necessary for conducting research (Goal E). This is obtained through mastery of “Communication Basic · I · II” in the liberal arts education subjects, “Technical English” to be offered in the third and the fourth terms of the second year, and “Graduation Thesis” to be offered in the fourth year.

#### 5. Program Timing and Acceptance Conditions

- When to start the program:

The second semester of the second year

Cluster 3 offers distinctive education that organically integrates fields related to chemistry, biotechnology, and processes. Specifically, it aims at developing professionals that possess a wide range of basic knowledge about the development of new functional substances and materials, the biotechnology of plants, animals, and microbes, the design and control of chemical process, environmental preservation and bioremediation, and the development of resources and energy, as well as having a high level of expertise and technical skill in a harmonious way. To achieve this aim, in addition to the common subjects and a wide range of specialized basic education, three programs are prepared that provide specialized education about chemistry, biotechnology and processes. These are the Program of Applied Chemistry, the Program of Biotechnology, and the Program of Chemical Engineering. Registration to these three programs is to be made in the second semester of the second year, so that students are able to choose the suitable specialized field or program while acquiring a wide range of specialized basic knowledge.

- Requirements of Acquired Credits

In order to be assigned to each program, students must acquire 16 or more credits out of a total of 18 credits in compulsory specialized basic subjects (excluding Basic Chemical Experiment and Technical English) and must acquire an overall total of 60 or more credits (including in liberal arts education subjects).

- Program Quota

An upper limit is set for acceptance of students. Assignment to the Program of Applied Chemistry, the Program of Biotechnology and the Program of Chemical Engineering is decided after taking into account the requests of students and their academic results.

#### 6. Qualifications to be Acquired

- Type-1 High School Teaching License (Industry) (By mastering “Vocational Guidance”, the prescribed “liberal arts education subjects” and “specialized education subjects”, students can obtain the Type-1 High School Teaching License (Industry) upon graduation.)

Details are described in the student handbook and guidance materials.

#### 7. Class Subjects and Course Content

\* For class subjects, see the subject list in the attached Tables 1 and 2.

(Subject list to be attached.)

#### 8. Academic Achievements

At the end of each semester, evaluation criteria are applied to each evaluation item and indicate academic achievement by indicating the attainment level. Students' grade calculations for each subject, from admission to the university until the current semester, is given as one of the three levels: "Excellent," "Very Good," and "Good," based on evaluation criteria calculated by adding the weighted values to the numerically-converted values of their academic achievements (S = 4, A = 3, B = 2, and C = 1) in each subject being evaluated.

Result Evaluation	Conversion
S (90 points or more)	4
A (80 ~ 89 points)	3
B (70 ~ 79 points)	2
C (60 ~ 69 points)	1

Academic Results	Standard
Excellent	3.00 ~ 4.00
Very Good	2.00 ~ 2.99
Good	1.00 ~ 1.99

\* See the relationship between evaluation items and evaluation criteria in the attached sheet 2.

\* See the relationship between evaluation items and class subjects in the attached sheet 3.

\* See the curriculum map in the attached sheet 4.

#### 9. Graduation Thesis (Graduation Research) (Positioning, when and how it is assigned, etc.)

Students receive practical guidance through graduation work in a research laboratory where world-leading research is conducted in various fields of biotechnology, and acquire a fundamental capability as bioengineering researchers and engineers.

Students are to be assigned at the start of the fourth year. As requirements for undertaking a graduation thesis, students must acquire 8 credits in foreign languages and must have completed all experiment subjects and practical subjects to be taken. Furthermore, students must acquire a total of 115 or more credits (including liberal arts education subjects) including a total of 69 or more credits in specialized basic subjects and specialized subjects. (Refer to the attached Table 1 and Table 2)

#### 10. Responsibility System

##### (1) PDCA Responsibility System ("Plan," "Do," "Check," and "Act")

The Educational Evaluation Committee (in charge of examining and handling the faculties' evaluation of the curriculum and the content of lectures), The Student Evaluation Committee (in charge of examining and handling evaluation of the students, such as attainment levels against goals), and the Educational Improvement Committee (in charge of planning and handling curricula based on self-assessment and questionnaires) are set up within the committee for this program (see the attached sheet 54). Under the leadership and responsibility of the head of the program, all the teachers of this program work together in cooperation with each other to carry out the system.

##### (2) Program Assessment

- Criteria for program assessment:

Evaluation outcome of attainment levels against goals

Requests from students and demands of society

Evaluation outcome of self-assessment by faculties

- Method of assessment (connection with class evaluation to be described)

In addition to attainment levels evaluation summary sheet completed by the Education and Student Evaluation Committee, questionnaires by students and graduates, and self-assessment evaluation by faculties, an external evaluation will be conducted.

- Procedure on giving feedback to students

In the case of problems with class subjects, faculties deal with these problems after taking into account the learning conditions of each individual student. The tutors or the Educational Improvement Committee members handle matters comprehensively, which is reflected in the improvement of the program through discussions in the

committee.



## Cluster 3 Specialized Basic Subjects

⊙Required

Class Subjects	Credits	Type of course registration			Class Hours/ Week																note
		Applied Chemistry	Biotechnology	Chemical engineering	1st grade				2nd grade				3rd grade				4th grade				
					Spring		Fall		Spring		Fall		Spring		Fall		Spring		Fall		
					1T	2T	3T	4T	1T	2T	3T	4T	1T	2T	3T	4T	1T	2T	3T	4T	
Applied Mathematics I	2	⊙	⊙	⊙			4														
Applied Mathematics II	2	⊙	⊙	⊙					4												
Applied Mathematics III	2													4							
Basic Engineering Computer Programming	2	⊙	⊙	⊙					4												
Probability and Statistics	2												4								
Technical English	1	⊙	⊙	⊙								4									
Basic Environmental Sciences	2						4														
Chemical Stoichiometry	2	⊙	⊙	⊙						4											
Basic Organic Chemistry I	2	⊙	⊙	⊙			4														
Basic Organic Chemistry II	2								4												
Physical Chemistry I	2	⊙	⊙	⊙						4											
Biochemistry I	2	⊙	⊙	⊙						4											
Basic Experiments in Chemistry	4	⊙	⊙	⊙							12	12									
Basic Inorganic Chemistry	2	⊙	⊙	⊙				4													
Analytical Chemistry	2	⊙	⊙	⊙					4												
Basic life science	2						4														
<small>Introduction to Applied Chemistry, Chemical Engineering and Biotechnology</small>	2									4											
Introduction to Fundamental Industry	2									4											

## Cluster 3 Specialized Subjects (Program of Biotechnology)

◎Required subjects

○Compulsory Elective subjects

Class Subjects	Credits	Type of course registration	Class Hours/ Week																Note
			1st grade				2nd grade				3rd grade				4th grade				
			Spring		Fall		Spring		Fall		Spring		Fall		Spring		Fall		
			1T	2T	3T	4T	1T	2T	3T	4T	1T	2T	3T	4T	1T	2T	3T	4T	
Training of Biotechnology I	4	◎									12	12							
Experiments on Biotechnology II	4	◎											12	12					
MicrobiologyI	2	◎								4									
MicrobiologyII	2	◎										4							
Molecular biology I	2	◎								4									
Molecular biology II	2	◎										4							
Biochemistry II	2	◎								4									
BiochemistryIII	2	◎										4							
Enzyme Chemistry	2	○								4									
Bioorganic Chemistry	2	○										4							
Fermentation Technology	2	◎										4							
Biochemical Engineering	2	◎											4						
Glycotechnology & Immunotechnology	2	○												4					
Molecular BiologyIII	2	○												4					
Genetic and protein engineering	2	○												4					
Molecular Bioinformatics	2	○												4					
Biotechnology	2	○												4					
Group Discussion of Current Biotechnology Topics	2	◎												2	2				
FoodProcess Engineering I	1											2							
Food Process Engineering II	1													2					
FermentationProcess Engineering I	1														1	1			
Fermentation process engineeringII	2											4							
Fermentation Process Engineering III	1													2					
Physical Chemistry II	2									4									
Chemical Kinetics	2	○										4							
Organic Structural Analysis	2											4							
Advanced Organic Chemistry IV	2													4					
Chemical Engineering Exercise I	2	○								4	4								
Chemical Engineering Fundamentals	2	○								2	2								
Green Technology	2													4					
Recycling engineering	2													4					
Graduation Thesis	5	◎																	

Academic Achievements in Biotechnology Program  
The Relationship between Evaluation Items and Evaluation Criteria

Academic Achievements		Evaluation Criteria		
Evaluation Items		Excellent	Very Good	Good
Knowledge and Understanding	(1) Understanding of relations among human, society, nature, and engineering. (Target A)	Being able to fully understand diversity of sense of values and ways of thinking in areas other than engineering and able to take various consideration.	Being able to understand the relations and differences between engineering and other areas and being to take consideration to the standard level.	Being able to well understand the relations and differences between engineering areas and other areas and take various consideration to the standard level.
	(2) Understanding of basic natural science (target B)	Being able to fully understand mathematics and physics which are a base of engineering.	Being able to understand mathematics and physics in the standard level.	Being able to understand mathematics and physics well.
	(3) Acquisition of basic and advanced knowledge relating to biotechnology and life science. (Target/Lecture class)	Being able to understand chemistry, applied mathematics, process engineering, basic biological science, and applied biological science, which are essential to biotechnologists.	Being able to understand chemistry, applied mathematics, process engineering, basic biological science and applied biological science to the standard level.	Being able to understand basic and advanced discipline described on the left well.
Abilities and Skills	(1) Acquisition of basic and advanced skills relating to biotechnology and life science. (Target/ Research class)	Being able to display abilities required for biotechnological engineers: logical thinning ability, ability to conduct experiment along with a plan, ability to analyze data and explanation.	Being able to demonstrate standard level abilities to think logically, to plan and carry out research and to analyze data.	Being able to well demonstrate the ability described on the left.
Overall Abilities	(1) Cultivation of ability creating concept and solving problems (achievement target D)	Being able to display abilities, required for biotechnologists, such as to make plan and carry out research, to demonstrate research outcome, to discuss, and to solve problems.	To be able to demonstrate standard level abilities to make plan and carry out research, to show outcomes and to solve problems.	Being able to demonstrate the ability described on the left.
	(2) Cultivation of communication skills (achievement target E)	Being able to show logical writing abilities, information transmission abilities to domestic and overseas, debating and information utilization.	To be able to demonstrate standard level abilities to make plan and carry out research, to show outcomes and to solve problems.	Being able to demonstrate the ability described on the left.

Placement of the Liberal Arts Education in the Major Program

Liberal Arts Education in this program assumes the role of establishing the academic foundation on which the specialized education will be built. It respects a voluntary, self-reliant attitude and cultivates scientific thinking based on information gathering abilities, analytical abilities, and critical thinking abilities. It establishes perspectives that make it possible to provide insight on the inner nature of things and their background from a wide broad viewpoint, and enhances linguistic abilities to the level appropriate for living as a global citizen. It also strengthens interest in peace, and integrates a broad range of knowledge into a body of knowledge that will be truly useful in solving problems. It cultivates the ability to explore and promote cross-disciplinary /comprehensive research that goes beyond the established frameworks of biotechnology.



Subject type	Class subjects	credits	Type of course registration 区分	Period	Evaluation items											Total weighted values of evaluation items in the subject	
					Knowledge and Understanding					Abilities and Skills		Comprehensive Abilities					
					(1)		(2)		(3)	(1)		(1)		(2)			
					Weighted values of evaluation items in the subject	Weighted values of evaluation items	Weighted values of evaluation items in the subject	Weighted values of evaluation items	Weighted values of evaluation items in the subject	Weighted values of evaluation items	Weighted values of evaluation items in the subject	Weighted values of evaluation items	Weighted values of evaluation items in the subject	Weighted values of evaluation items	Weighted values of evaluation items in the subject		
Specialized Education	Glycotechnology & Immunotechnology	2	Elective	6semester					100	1						100	
Specialized Education	Molecular BiologyIII	2	Elective	6semester					100	1						100	
Specialized Education	Genetic and protein engineering	2	Elective	6semester					100	1						100	
Specialized Education	Molecular Bioinformatics	2	Elective	6semester					100	1						100	
Specialized Education	Biotechnology	2	Elective	6semester					100	1						100	
Specialized Education	Group Discussion of Current Biotechnology Topics	2	Required	6semester	40	1						40	1	20	1	100	
Specialized Education	FoodProcess Engineering I	1	Elective	5semester	20	1			80	1						100	
Specialized Education	Food Process Engineering II	1	Elective	6semester	20	1			80	1						100	
Specialized Education	FermentationProcess Engineering I	1	Elective	7semester	20	1			80	1						100	
Specialized Education	Fermentation process engineeringII	2	Elective	5semester	20	1			80	1						100	
Specialized Education	Fermentation Process Engineering III	1	Elective	6semester	20	1			80	1						100	
Specialized Education	Physical Chemistry II	2	Elective	4semester					100	1						100	
Specialized Education	Chemical Kinetics	2	Elective	5semester					100	1						100	
Specialized Education	Organic Structural Analysis	2	Elective	5semester					100	1						100	
Specialized Education	Advanced Organic Chemistry IV	2	Elective	6semester					100	1						100	
Specialized Education	Chemical Engineering Exercise I	2	Elective	4semester					100	1						100	
Specialized Education	Chemical Engineering Fundamentals	2	Elective	4semester					100	1						100	
Specialized Education	Green Technology	2	Elective	6semester					100	1						100	
Specialized Education	Recycling engineering	2	Elective	6semester					100	1						100	
Specialized Education	Graduation Thesis	5	Required	7,8semester	10	1					50	1	20	1	20	1	100

# Curriculum Map of Biotechnology

Academic Achievement Evaluation Items		1st grade		2nd grade		3rd grade		4th grade		
		Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	
Knowledge and Understanding	Understanding of relations among human, society, nature, and engineering. (Target A)	Introductory Seminar for First-Year Students(◎)				FoodProcess Engineering I (△)	Food Process Engineering II(△)	Graduation Thesis (◎)	Graduation Thesis (◎)	
		Introduction to University Education (◎)	Peace Science Courses (○)			Fermentation process engineeringII (△)	Fermentation Process Engineering III(△)	FermentationProcess Engineering IV(△)		
		Area Courses (○)	Area Courses (○)				Group Discussion of Current Biotechnology Topics(◎)			
		Health and Sports Courses(○)	Health and Sports Courses(○)							
		Area Courses (○)	Area Courses(○)	Area Courses (○)	Area Courses (○)					
	Understanding of basic natural science (target B)	Basic language I (○)	Basic Environmental Sciences (△)	Introduction to Applied Chemistry / Chemical Engineering and Biotechnology (△)						
		Basic language II (○)	Basic life science (△)	Introduction to Fundamental Industry (△)						
		CalculusI(◎)	CalculusII(◎)	Experimental Methods and Laboratory Work in Physics I-Ⅱ (◎)						
		Linear AlgebraI (◎)	Linear AlgebraII(◎)							
		(2T)General Mechanics I(◎)	(3T)General Mechanics II(◎)							
Acquisition of basic and advanced knowledge relating to biotechnology and life science. (Target/Lecture class)										
		Experimental Methods and Laboratory Work in Biology I-Ⅱ (△)		Technical English (◎)	Probability and Statistics (△)	Glycotechnology & Immunotechnology (○)				
	Basic Organic Chemistry I (◎)	Basic Organic Chemistry II (△)	Basic Engineering Computer Programming (◎)	Physical Chemistry II (△)	Applied Mathematics III (△)	Molecular BiologyIII (○)				
	Basic Inorganic Chemistry(◎)	Applied Mathematics I (◎)	Applied Mathematics II (◎)	MicrobiologyI (◎)	MicrobiologyII (◎)	Genetic and protein engineering (○)				
		Basic life science (△)	Physical Chemistry I (◎)	Molecular biology I (◎)	Molecular biology II (◎)	Molecular Bioinformatics (○)				
		Basic Environmental Sciences (△)	Chemical Stoichiometry (◎)	Biochemistry II (◎)	BiochemistryIII(◎)	Biotechnology (○)				
			Biochemistry I (◎)	Enzyme Chemistry (○)	Bioorganic Chemistry(○)	Advanced Organic Chemistry IV (△)				
			Analytical Chemistry (◎)	Chemical Engineering Fundamentals (○)	Fermentation Technology (◎)	Green Technology (△)				
			Introduction to Applied Chemistry / Chemical Engineering and Biotechnology (△)	Chemical Engineering Exercise I (○)	Biochemical Engineering(◎)	Recycling engineering (△)				
			Introduction to Fundamental Industry (△)		Chemical Kinetics (○)	Food Process Engineering II(△)				
Abilities and Skills	Acquisition of basic and advanced skills relating to biotechnology and life science. (Target/ Research class)		Experimental Methods and Laboratory Work in Biology I-Ⅱ (△)		Basic Experiments in Chemistry (◎)	Training of Biotechnology I (◎)	Experiments on Biotechnology II (◎)	Graduation Thesis (◎)	Graduation Thesis (◎)	
Comprehensive Abilities	Cultivation of ability creating concept and solving problems (achievement target D)	Introductory Seminar for First-Year Students(◎)	Experimental Methods and Laboratory Work in Biology I-Ⅱ (△)		Basic Experiments in Chemistry (◎)	Training of Biotechnology I (◎)	Experiments on Biotechnology II (◎)	Graduation Thesis (◎)	Graduation Thesis (◎)	
							Group Discussion of Current Biotechnology Topics (◎)			
	Cultivation of communication skills (achievement target E)	Introductory Seminar for First-Year Students(◎)				Technical English (◎)	Training of Biotechnology I (◎)	Experiments on Biotechnology II (◎)	Graduation Thesis (◎)	Graduation Thesis (◎)
		Communication IA (◎)	Communication IIA (◎)					Group Discussion of Current Biotechnology Topics(◎)		
		Communication IB (◎)	Communication IIB(◎)							
	Basic English UsageI(◎)									
	Basic English UsageII (◎)									

(Ex) Liberal Arts Education Subjects    Basic Specialized Subjects    Specialized Subjects    Graduation Thesis    (◎)Required    (○)Compulsory elective    (△)Free elective