

This *English translation* is provided for *information purposes only*.

**Application Guidelines
for Master's Program
in Biomedical Science and Engineering**

April 2022 Enrollment

Graduate School of Biomedical Science and Engineering,
Hokkaido University

Admission Policy

Philosophy

Contribute to the realization of a healthy, long-lived society by promoting research on the development of new medical technologies utilizing cutting-edge science and engineering and by developing individuals who can pursue that research.

Educational Goals

Under the four basic philosophies of Hokkaido University (Frontier Spirit, Global Perspectives, All-round Education and Practical Learning), the Graduate School of Biomedical Science and Engineering aims to cultivate individuals who possess advanced expertise, broad perspectives and a strong sense of ethics, who are able to contribute to the sustainable development of society as specialists in biomedical science and engineering, who possess outstanding knowledge and excellent research abilities, and who are able to meet the demand for sophistication and globalization regarding various issues related to medical technology, medical device development and the like.

Desired Students

- (1) Knowledge, skills, interest and motivation
 - Desired students are those who are inquisitive and strongly interested in biomedical science and engineering and their underlying disciplines (science, engineering and medicine), and who have the basic academic and research abilities necessary for these studies
 - Desired students are those who are willing to contribute to the sustainable development of society as specialists in biomedical science and engineering by earnestly engaging in research utilizing acquired knowledge and technology
- (2) Thinking, judgment and expressive abilities
 - Desired students are those with basic scientific thinking, ethics and logical thinking
- (3) Openness to independent learning in collaboration with various people
 - Desired students are those who are willing to work independently on research that leads to the development of new medical technology in collaboration with people from various fields

What to learn before admission

For graduates from science and engineering departments

Basic knowledge and skills of medicine and medical care, general knowledge of science and engineering, and English skills sufficient for one to obtain internationally accepted information

For graduates from health science and life science departments

Basic knowledge and skills of science and engineering, general knowledge of medicine and medical care, and English skills sufficient for one to obtain internationally accepted information

Basic Policy for Entrant Selection

(1) General entrance examination and entrance examination for working students

Entrants are selected based on the following:

- Paper on a given topic, oral examination, external English proficiency test, and statement of purpose and research plan for knowledge and skills
- Oral examination and statement of purpose and research plan for interest and motivation
- Paper on a given topic, oral examination, and statement of purpose and research plan for thinking, judgment and expressive abilities
- Oral examination for openness to learning independently in collaboration with various people

(2) Special selection for international students

Entrants are selected based on the following:

- Oral examination, external English proficiency test, and statement of purpose for knowledge and skills
- Oral examination and statement of purpose for interest and motivation
- Oral examination, and statement of purpose and research plan for thinking, judgment and expressive abilities
- Oral examination for openness to learning independently in collaboration with various people

Entrance exam classification	Knowledge, skills, interest and motivation		Thinking, judgment and expressive abilities		Openness to learning independently in collaboration with various people	
General entrance examination and entrance examination for working students	◎	Paper on a given topic Oral examination External English proficiency test Statement of purpose and research plan	◎	Paper on a given topic Oral examination Statement of purpose and research plan	○	Oral examination
Special selection for international students	◎	Oral examination External English proficiency test Statement of purpose	◎	Oral examination Statement of purpose	○	Oral examination

The mark ◎ indicates elements that are particularly important, and the mark ○ indicates elements that are important.

Note: The exam content may include some changes from these guidelines in response to the Novel Coronavirus. An announcement will be made on the website (<https://www.med.hokudai.ac.jp/en/bme/admissions/index.html>) by July 30, 2021 (Friday) if we have decided to conduct the exam with different content from these guidelines.

The Second Round Examination mentioned in the guidelines may not be conducted depending on the outcome of the First Round Examination. Plans are slated to post an announcement regarding whether or not the Exam will be conducted on the website above around late September 2021.

Application Guidelines for
Master's Program in Biomedical Science and Engineering
Graduate School of Biomedical Science and Engineering
Hokkaido University
April 2022 Enrollment

1. Number of Students Admitted:

12 (including working students)

The outlined curriculum and research contents for this program are provided in “Organization and main research contents at Graduate School of Biomedical Science and Engineering, Hokkaido University” (page 15 and on).

2-1. Qualifications of Applicants (general examination)

Individuals who can enter this master's program are confined to those who satisfy one of the following requirements:

- (1) Those who have graduated or are expected to graduate from a university by March 2022;
- (2) Those who have acquired or are expected to acquire a bachelor's degree pursuant to Article 104 Paragraph 7 of the School Education Act by March 2022;
- (3) Those who have completed or are expected to complete the 16-year course of school education in a foreign country by March 2022;
- (4) Those who have completed or are expected to complete a distance course of the 16-year course of school education by an overseas school while residing in Japan by March 2022;
- (5) Those who have completed or are expected to complete the undergraduate course of an overseas educational institution in Japan by the said foreign country's school education system and specifically designated by the Japanese Minister of Education, Culture, Sports, Science and Technology (MEXT Minister) (confined to a course counted as completion of a 16-year course under the school education system of the foreign country concerned if completed) by March 2022;
- (6) Those who have acquired or are expected to acquire by March 2022 a degree equivalent to bachelor's degree from a foreign university or other foreign school (confined to those schools whose general situations related to education/research activities, etc. have been evaluated by a personnel accredited by the government or related organization of the said foreign country or authorized as equivalents to them by the MEXT Minister) through completing the 3-year or longer course (including completion of a distance course of that foreign school in Japan and completion of the course at an educational institution in Japan accredited as an overseas education under the school education system of the foreign country and authorized by MEXT Minister as mentioned above in (5));
- (7) Those who have completed on or after the date specified by the MEXT Minister or are expected to complete the professional course of a vocational school (a 4-year or longer course satisfying the other requirements set forth by the MEXT Minister) and authorized by the MEXT Minister by March 2022;
- (8) Those who designated by MEXT Minister (the Public Notice of Ministry of Education No. 5, 1953);
- (9) Those who deemed by our graduate school as having education covering a certain number of credits with excellent performance through 1) attending a university for 3 years or longer, 2) completing a 15-year course of school education in a foreign country, 3) completing a 15-year course of education under a foreign country school education system by a distance course in Japan, or 4) completing a overseas university course at an educational facility in Japan accredited as an overseas education under the school education system of the foreign country and authorized by the MEXT Minister (confined to a course counted as completion of a 15-year course under the school education system of the foreign country concerned if completed); (See Note.)
- (10) Those who deemed by our graduate school under individual qualification review as possessing academic ability equivalent to or greater than university graduates and will be 22 years of age or older by March 31, 2022. (See Note.)

Note) Those who apply under Qualifications of Applicants (9) or (10) must undergo Qualification Review. Refer to 3. (4) Qualification Review for further information.

The individual qualification review for applicants under qualification (10) is intended to review the research career, practical work experience, etc. of applicants not having graduated from a university (e.g., individuals having graduated from junior college, technical college, vocational school or other school or having completed the course at a Japanese satellite school of a foreign university, etc.).

2-2. Qualifications for Applicants (examination for working students)

The examination for working students is for individuals satisfying one of the qualifications (1) through (10) for the general examination in Page 3, having experienced expertise work at healthcare/public health/welfare facilities, educational/research facilities, government agencies, enterprises or others as of April 2022 and expected to be able to attend our graduate school while remaining at the current work place after entering our graduate school.

3. Application Procedure

(1) Application Period (Note that the Second Round Examination may not be conducted. For details, refer to page 2.)

First Round Examination: July 19, 2021 (Monday) to July 27, 2021 (Tuesday)

Second Round Examination: December 9, 2021 (Thursday) to December 15, 2021 (Wednesday)

Office hours: 9:00 am to 5:00 pm (JST) on weekdays

If the applicants send the application by post, send it by registered express mail. Application documents must reach our Student Affairs Office within the application period.

Qualifications of Applicants (9) or (10) must undergo Qualification Review. Refer to 3. (4) Qualification Review for further information. Apply for Qualification Review within the application period enclosing with all necessary documents described in 3. (4) Qualification Review.

(2) Application Documents and Examination Fee [general examination/examination for working students]

Please request Student Affairs Office for the original booklet: “Application Guidelines for Master’s Program in Biomedical Science and Engineering, Graduate School of Biomedical Science and Engineering, Hokkaido University” and its English translation reference.

If any of the necessary documents may not be submitted within the application period, contact Student Affairs Office, Graduate School of Biomedical Science and Engineering.

Application for Admission (入学願書)	Prescribed form. Included in the original booklet.
Statement of Purpose	Prescribed form. Included in the original booklet.
Score Sheet of TOEFL or TOEIC*	The original score sheet of one of the following (1) to (4). (score of the test you took after September 2019) (1) TOEFL-iBT (2) TOEFL-ITP (Level 2 and Digital Test unacceptable) (3) TOEIC Listening & Reading Test (Bridge and S&W unacceptable) (4) TOEIC-IP (Online unacceptable) If you only have a score sheet other than the above, contact the Student Affairs Office promptly as there are cases in which such a document may be accepted.
Academic Transcripts of Undergraduate School	*Not required if you have no history as an undergraduate student.
Certificate of Graduation (or expected Graduation)	Must be issued by a university/college president or Dean. (For graduates, be sure that the certificate includes information on your degree). *Those who graduated or will graduate from a university in China (excluding Taiwan, Hong Kong and Macau) must submit the following documents in addition to a Certificate of (Expected) Graduation (Completion).

	<p>Graduates:</p> <p>a. Online Verification Report of Higher Education Qualification Certificate (教育部学历证书电子注册备案表)</p> <p>b. Certified copies of your Graduation Diploma (毕业证书) and Degree Diploma (学位证书) that has been authorized by your university/college</p> <p>Expected Graduates :</p> <p>a. Online Verification Report of Student Record (教育部学籍在线验证报告)</p> <p>Obtain documents “a” above by requesting it at “中国高等教育学历证书查询”: http://www.chsi.com.cn/xlcx/bgys.jsp.</p> <p>Also be sure that there are 15 or more days left until the expiration date of the online verification at the time of its submission.</p> <p>*Not required if you have no history as an undergraduate student.</p>
Examination card / Photo ID card	<p>Fill in your information and paste your photograph taken within the last 3 months (full-face, 4 × 3 cm, applicant’s name printed on back) in the designated field.</p> <p>Included in the original booklet.</p>
Self-addressed Envelope	<p>Self-addressed envelope (23.5 × 12 cm) with 84 JPY stamp affixed to receive your Examination Card.</p>
Address Label Seal	<p>Prescribed form to receive the acceptance letter and documents for admission.</p> <p>Included in the original booklet.</p>
Examination Fee	<p>JPY30,000.</p> <p>Pay by the attached Remittance Form (for use at Japan Post Bank or other banks in Japan), which is attached to the original booklet.</p> <p>If you are a government-financed international student (person receiving MEXT Scholarship grants), you are exempted from this fee but must include a statement to this effect when submitting the application.</p>
Form to Paste the Payment Certificate	<p>Prescribed form. Included in the original booklet.</p> <p>Fill in your name and affix the payment certificate of examination fee (Certificate E) which is included in the original booklet and to be returned from the bank upon payment.</p>
(If applicable) Photocopy of Residence Card	<p>Applicants from abroad must submit photocopy of passport.</p>
(If applicable) Consent to Transfer and Process Personal Data	<p>Applicants from EEA must confirm the Handling of Personal Information on page 8-9 and submit the consent.</p>

Applicants for Working Students Admission must submit the following additional documents.

Written Consent to school attendance	<p>Prescribed form.</p> <p>Issued by the head of your department.</p>
Certificate of Employment	<p>Documents to confirm your occupation and work period (free format)</p>

* The score sheet needs to be an original. If you cannot submit the original score sheet, contact Student Affairs Office, Graduate School of Biomedical Science and Engineering.

(3) Applicants with Physical Disability

Physically disabled applicants who require special attention during tests and classes should contact Student Affairs Office, Graduate School of Biomedical Science and Engineering at the time of submitting application.

(4) Qualification Review

Qualifications of Applicants (9) or (10), must undergo Qualification Review. Apply for Qualification Review within the application period enclosed with all the necessary documents.

A) Application period (Note that the Second Round Examination may not be conducted. For details, refer to page 2.)

First Round Examination: June 8, 2021 (Tuesday) to June 14, 2021 (Monday)

Second Round Examination: November 2, 2021 (Tuesday) to November 8, 2021 (Monday)

Office Hours: 9:00 am to 5:00 pm (JST) on weekdays

If the applicants send the application by post, send it by registered express mail. Application documents must reach our faculty within the application period.

B) Documents to be submitted

“Application for Qualification Review” (prescribed form) needs to be submitted, enclosed with the following documents in addition to the documents listed in “3. (2) Application Documents and Examination Fee.”

In such cases, the examination fee needs to be remitted after receipt of the qualification review result, using the attached Remittance Form by the deadline. Paste the payment certificate (Certificate E) on the form included in the original booklet, which is then to be submitted to “(5) Application Documents for both Entrance Examination and Qualification Review should be submitted to:” specified in Page 6-7 within the application period (if submitted by post, it needs to reach us within the application period).

1	Self-addressed envelope	Self-addressed envelope (23.5×12cm) with 374 JPY stamp affixed to receive the results of Qualification Review.	
The following documents need to be submitted depending on the qualification of individual applicant.		Qualification for Application	Documents to be submitted
2	Certificate and other information related to the final educational career	(9)	Academic transcripts
		(10)	(1) Certificate of graduation (2) Academic transcripts (3) Documents stating qualification for enrollment, academic requirements for graduation, and study term.
3	Certificate to prove your academic ability to be equivalent to or higher than university graduates	(10)	For those having graduated from 2-year junior college or the like, a certificate of research, practical work, etc. of 2 years or more needs to be submitted. For those having graduated from 3-year junior college or the like, a certificate of research, practical work, etc. of 1 year or more needs to be submitted. *If documents, etc. allowing judgment of the applicant’s academic ability (e.g. paper) are available, submit them.

C) Procedure of Qualification Review

On the basis of the information about the number of credits earned, performance and details of research, work experience, etc., given in the documents submitted, the qualification is examined in individual cases.

If deemed necessary, submission of some other documents may be requested.

D) Announcement of Results

Results of Qualification Review will be notified by postal mail.

(5) Application Documents for both Entrance Examination and Qualification Review should be submitted to:

4. Selection of Entrants

Selection shall be determined on the basis of general evaluation of the documents submitted, the paper written on the given topic and the results of oral examination.

5. Date, Time and Place of Entrance Examination (Note that the Second Round Examination may not be conducted. For details, refer to page 2.)

Date	Time	Examination	Category	Place
First Round Examination: August 24, 2021 (Tuesday)	9:20-9:30	(Instruction)*1		Information of place and examination card will be sent by post beforehand.
	9:30-11:30	Writing a paper on a given topic	Writing	
Second Round Examination: January 25, 2022 (Tuesday)	13:00-	Oral examination*2	Oral	Instructed on the day of examination

*1 Each applicant is required to come to the examination room by 9:10.

*2 Applicants who have the second preference in the preferred laboratory shall take oral examinations in two fields.

6. Announcement of Successful Applicants (Note that the Second Round Examination may not be conducted. For details, refer to page 2.)

First Round Examination: September 3, 2021 (Friday) 10:00 am (JST)

Second Round Examination: February 25, 2022 (Friday) 10:00 am (JST)

To be posted on the bulletin boards of the Graduate School of Biomedical Science and Engineering (Administration Building, 1F, Faculty of Medicine). At the same time, individual applicants will be notified by postal mail.

Around 10:00 am, the applicant No. for each accepted applicant will be made public at our graduate school website (<https://www.med.hokudai.ac.jp/news>). Any inquiry about acceptance/rejection over telephone or the like will not be accepted.

7. Admission Procedure

Admission procedure is outlined below (details will be notified separately to each applicant accepted for entry).

(1) Registration Period

March 2, 2022 (Wednesday) to March 8, 2022 (Tuesday) on weekdays

(2) Admission Fee and Tuition Fee

A) Admission Fee: JPY282,000 [estimate]

This fee does not apply if you are a government-financed international student (receiving a scholarship of the Ministry of Education, Culture, Sports, Science and Technology). You need to state so when taking the entrance procedure.

B) Tuition Fee: JPY267,900 for half a year (JPY535,800 yen for a year [estimate])

(a) The tuition fee needs to be remitted using the sheet which will be sent from our school to you around the middle of the month after your entrance.

(b) If the entrance fee or the other fee to be paid by students has been modified before or after entrance, the new amount of such a fee begins to be applied at the time of modification.

* There is a system for postponement or exemption of paying the admission fee and tuition fee. Further details will be informed at the time of notification of admission procedure, etc.

8. Important Notice

- (1) The column “preferred department” of Application for Admission should be filled in after prior inquiry and confirmation with your prospective instructor concerning detailed contents and plan of the research, referring to “Organization and main research contents at Graduate School of Biomedical Science and Engineering, Hokkaido University)” (Page 15 and on of this application guidelines).
- (2) Application will not be accepted if incomplete. Therefore, sufficient care needs to be taken to avoid error in entry or missing entry.
- (3) Once submitted, the application cannot be revised.
- (4) Once paid, the examination fee cannot be refunded except the following cases:
 - A) The application was not submitted after the payment of the examination fee or the application was not accepted due to the documents being incomplete.
 - B) The examination fee has been erroneously paid twice.

* In the above-mentioned cases, you need to place a request to Student Affairs Office, Graduate School of Biomedical Science and Engineering.
Refunding will take a considerable number of days.
When you request refunding, the “examination fee payment certificate E” or “transfer remittance request and receipt” (remittance amount and charge) receipt D,” you receive from the financial institution, will be needed. Be reminded not to lose them.
- (5) If any information given in the application form differs from the fact, admission may be canceled.
- (6) Any inquiry about entrance or examination needs to be sent by postal mail, enclosing a self-addressed return correspondence envelope with a postage stamp affixed.

9. Educational Program

Our graduate school offers two program options. The medical physics education program aims to produce accomplished medical physicists. Whereas the medical device development program aims to produce professionals capable of researching and developing techniques for diagnostic radiology and radiotherapy. Upon successful completion of each program, students will be given the certificate of completion. For more information, please refer to our website at <http://www.med.hokudai.ac.jp/en/bme/>.

10. Long-Term Study Program

Our graduate school has a Long-term Study Program. If you desire to utilize such a system, you need to file an application after carefully reading the “Long-Term Study Program” stated in page 10.

11. Handling of Personal Information

- (1) All personal information collected by Hokkaido University will be completely protected in compliance with the Act on the Protection of Personal Information Held by Independent Administrative Agencies, and the EU General Data Protection Regulation (GDPR) pursuant to the Hokkaido University Regulations on Personal Information Management.
- (2) Your name, address, and other personal information you provide to the university through application and individual admissions screening processes will be used solely for ① enrollee selection (application processing and the screening process), ② the announcement of exam results, ③ admission procedures, ④ surveys and research on enrollee selection methods, and ⑤ other related processes.
- (3) The personal information in section (2) above will also be used after enrollment, only for those who pass the exam, for processes related to ① academic affairs (registration, academic guidance), ② student support services (health management, scholarship applications, dorm admission selection, welfare services, etc.), ③ job search support services, ④ tuition, ⑤ use of the university library, ⑥ use of information education facilities, ⑦ confirming your safety and communication in a disaster or emergency situation, and ⑧ public relations (distributing newsletters, information on events, etc.).
- (4) Personal information contained in exam results will be used to conduct surveys and research on enrollee selection methods.
- (5) For recruiting purposes, when we receive a request for information from the Hokkaido University

Frontier Foundation (Kita 8 Nishi 5, Kita-ku, Sapporo, Hokkaido; Tel: +81-(0)11-706-2017) or Hokkaido University Athletic Union (Kita 17, Nishi 7, Kita-ku, Sapporo, Hokkaido; Tel: +81-(0)11-716-4815), the only personal information listed in section (2) will be provided for use within the scope of that organization's activities.

- (6) The personal information set forth in (2) will be retained for five years from the next academic year of our acquirement.
- (7) The university shall use Article 6, Paragraph 1 (a) of the EU GDPR as the basis for handling personal information and obtaining consent to use it. Personal information will only be used for the purpose for which consent has been given, except when required by laws and regulations.
- (8) The consent set forth in (7) may be revoked at any time. However, this does not affect the legal handling of personal information before consent was revoked.
- (9) Individuals who provide personal information may make the following requests to the university based on the EU GDPR and related laws and regulations:
 - ① Disclosure of personal information, ② Correction of personal information, ③ Erasure of personal information, ④ Limitation of the handling of personal information, ⑤ Objection to the handling of personal information, ⑥ Transfer of personal information to other service providers
- (10) If you have provided personal information within the European Economic Area, you may file an objection to a supervisory authority in accordance with Article 51, Paragraph 1 of the EU GDPR if you are dissatisfied with the university's handling of your personal information, etc.
- (11) Some of the processes in (2)–(5) mentioned above may be outsourced by the university to a contracted service provider (hereinafter referred to as “contractor”). All or some of the personal information provided by applicants may be provided to the contractor only as needed to perform the tasks for which it has been contracted.
- (12) This university is subject to Japan's Law for the Protection of Personal Information Retained by Independent Administrative Institutions, but not subject to adequacy decisions by the European Commission

12. Others

Some past entrance exam papers of the Graduate School of Biomedical Science and Engineering have been published. For details such as how to request for them, refer to the following website:
<https://www.med.hokudai.ac.jp/bme/>

Graduate School of Biomedical Science and Engineering, Hokkaido University,
Kita 15, Nishi 7, Kita-ku, Sapporo 060-8638 JAPAN

Address for contact: Student Affairs Office,
Graduate School of Biomedical Science and Engineering,
Hokkaido University
Telephone number: +81-(0)11- 706-5523

Long-Term Study Program

1. Purposes

The standard term is two years. Long-Term Study Program (longer than two years) is offered for those who wish to study and acquire a degree through a long-term enrollment due to time limitations. Applicants are individually screened for eligibility.

2. Eligibility

Those who have difficulties in completing the program within the standard term due to personal reasons such as (1) full time jobs, (2) part time jobs (3) child-raising or a long-term nursing care, or (4) visual disabilities, auditory disabilities, physical disabilities or other disabilities are eligible to apply for this program.

3. Period of enrollment

Students in master's program may extend their term of study up to four years, and extension of study term can be applied by the year as a unit.

Students in a Long-Term Study Program are allowed to have two years leave as well as regular students.

4. Application procedure

(1) Application Period

Please request at the time of application for admission. Application form is available at Student Affairs Office, Graduate School of Biomedical Science and Engineering.

(2) Application Documents

Please submit the following documents to Student Affairs Office of the Graduate School of Biomedical Science and Engineering.

- i) Application for the Long-Term Study Program (Form 1-1)
- ii) Reasons to apply to the Long-Term Study Program (Form 2)
- iii) Study plan of the Long-Term Study Program (Form 3)
- iv) Documents to prove the need for the Long-Term Study Program

5. Shortening or re-extension of Long-Term Study Program

If deemed necessary by our graduate school, study term of Long-Term Study Program could be either shortened or re-extended once during the program.

Regarding its procedure, contact Student Affairs Office, Graduate School of Biomedical Science and Engineering.

6. Tuition Fees

Annual tuition fee of the Long-Term Study Program is determined by dividing the total fees of the regular program of standard term (annual fee × 2 years) by the number of years allowed for the Long-Term Study Program. Tuition fee is non-refundable, and the tuition already been paid will not be adjusted.

* Please do NOT pay tuition fee of the long-term study program before receiving a notice of determination.

1. Course of Education Outlined

At our graduate school, towards the goal of realizing a curriculum capable of cultivating researchers/engineers having reliable knowledge and high levels of expertise capabilities, instructors belonging to multiple graduate schools, hospitals and research institutes cooperate beyond the border of specialties (science, engineering, medicine, health science and dentistry) to provide education covering fundamentals to latest aspects of biomedical science and engineering, to foster talents familiar with the hybrid field of biomedical science and engineering (interdisciplinary field of multiple specialties, including science, engineering, medicine, health science and dentistry) instead of researchers/engineers in one specific field.

The curriculum for master's program can be characterized by: (1) "Common Required Subjects (5 subjects)" aimed at acquiring knowledge base about fields relating to biomedical science and engineering (compulsory subjects for both courses), (2) "Required Subjects (6 subjects in total)" consisting of two subject groups, i.e. "Subjects for Quantum Biomedical Science and Engineering Course (3 subjects)" aimed at acquiring expert knowledge and skills on radiation/particle beam therapy and relevant medical devices by students of the "Quantum Biomedical Science and Engineering Course" and "Subjects for Molecular Biomedical Science and Engineering Course (3 subjects)" aimed at acquiring expertise knowledge/skills on molecular diagnostic imaging, molecular biology, radiation biology, etc. by students of the "Molecular Biomedical Science and Engineering Course", and (3) "Elective Subjects (31 subjects)" aimed at cultivation of talents familiar as well as with other fields through acquisition of extensive knowledge beyond the framework of courses. The subjects provided as "Required Subjects" may also be selected as "Elective Subjects" (credits can be earned) by those students of the course in which such subjects are not required subjects.

The curriculum for doctoral program consists of "Required Subjects (2 subjects)" and "Elective Subjects (3 subjects)".

Details of the curriculum follows below.

[Master's Program]

(1) Common Required Subjects

As subjects applicable for both two courses, "Introduction for Cooperation in Biomedical Science and Engineering," "Research and Development of Medical Devices" and "Advanced Course of Medical Device Clinical Research" will be provided. Latest trends in biomedical science and engineering will be outlined in an easily understandable manner to help students acquire frontier knowledge needed as researchers/engineers in the field of biomedical science and engineering.

In addition, for the goal of writing a master's thesis, "General Research on Biomedical Science and Engineering I" and "General Research on Biomedical Science and Engineering II" will be provided as subjects involving advanced learning and training aimed at cultivating practical and expertise capabilities needed to resolve issues.

(2) Required Subjects

- Subjects for Quantum Biomedical Science and Engineering

"Radiation Physics for Biomedical Science and Engineering" serving as the basis for quantum biomedical science and engineering and "Particle Therapy Physics" and "Physics and Engineering for Radiation Therapy" aimed at acquiring knowledge needed for radiotherapy are provided to stimulate students acquire expertise knowledge on quantum biomedical science and engineering.

- Subjects for Molecular Biomedical Science and Engineering

"Diagnostic Radiology for Biomedical Science and Engineering" and "Functional Imaging for Diagnosis in Biomedical Science and Engineering" aimed at acquiring knowledge etc. needed for diagnostic imaging for molecular biomedical science and engineering and "Basic Physics for Diagnostic Radiology and Nuclear Medicine" serving as the basis of radiological diagnosis and nuclear medicine are provided to guide students to acquire expertise knowledge to resolve issues in the field of molecular biomedical science and engineering.

(3) Elective Subjects

- So that students can acquire extensive expertise knowledge, information on latest trends, etc. needed as basic knowledge and for involvement in industry-academic linkage/enterprise linkage,

- diverse subjects will be provided: “Physics for Biomedical Science and Engineering,” “Radiologic Anatomy for Biomedical Science and Engineering,” “Radiation Protection for Biomedical Science and Engineering,” “Information Programming Advanced Course” and so on.
- To guide students to acquire extensive knowledge, etc. about quantum biomedical science and engineering, “Radiation Measurement in Clinical Practice,” “Medical Informatics and Information Engineering,” “Image Processing for Biomedical Science and Engineering,” “Accelerator Science for Biomedical Science and Engineering” and a subject given in English “Medical Physics School” are provided.
 - In addition, subjects needed for scientific/engineering research of human body are provided: “Radiation Biology,” “Radiation Oncology for Cooperation with Biomedical Science and Engineering,” “Basic Physics for Radiation Therapy,” “Molecular Tumor Therapeutics,” “Molecular Probe Science,” “Advanced Physics for Diagnostic Radiology and Nuclear Medicine” and two subjects given in English: “Molecular Tumor Pathology” and “Molecular Biomedical Science and Engineering School” are provided.

Course Outline, etc. [Graduate School of Biomedical Science and Engineering (Master's Course)]									
Subject	Subject	Year & Semester to Take Subject	No. of Credits			Type of Class			
			Required	Elective	Free	Lecture	Seminar	Experiment/Training	
Common Required Subjects	Introduction for Cooperation in Biomedical Science and Engineering	1 first	2			✓			
	Research and Development of Medical Devices	1 second	1			✓			
	Advanced Course of Medical Device Clinical Research	1 first	1			✓			
	General Research on Biomedical Science and Engineering I	1-2 throughout	2				✓		
	General Research on Biomedical Science and Engineering II	1-2 throughout	8					✓	
Required Subjects	Course of Quantum Biomedical Science and Engineering	Radiation Physics for Biomedical Science and Engineering	1 first	2			✓		
		Particle Therapy Physics	1 second	2			✓		
		Physics and Engineering for Radiation Therapy	1 first	2			✓		
	Course of Molecular Biomedical Science and Engineering	Diagnostic Radiology for Biomedical Science and Engineering	1 first	2			✓		
		Functional Imaging for Diagnosis in Biomedical Science and Engineering	1 second	2			✓		
		Basic Physics for Diagnostic Radiology and Nuclear Medicine	1 first	2			✓		
Elective Subjects	Basic Physics for Biomedical Science and Engineering	1/2 first		2			✓		
	Radiologic Anatomy for Biomedical Science and Engineering	1 first		1			✓		
	Introduction to Biomedical Science and Engineering Research	1 first		1			✓		
	Research planning for Biomedical Science and Engineering Research	1 first		1			✓		
	Statistics for Biomedical Science and Engineering	1/2 first		1			✓		
	Radiation Protection for Biomedical Science and Engineering	1 first		2			✓		
	Information Programming Advanced Course	2 first		1			✓		
	Biomedical Human System Engineering	1/2 first		2			✓		
	Biomedical Engineering I	1/2 first		1			✓		
	Biomedical Engineering II	1/2 second		1			✓		
	Nuclear Physics I for Biomedical Science and Engineering	1/2 first		2			✓		
	Nuclear Physics II for Biomedical Science and Engineering	1/2 second		2			✓		
	Special Lecture of Nuclear Physics for Biomedical Science and Engineering I	1/2 throughout		1			✓		
	Special Lecture of Nuclear Physics for Biomedical Science and Engineering II	1/2 throughout		1			✓		
	Applied Physics for Biomedical Science and Engineering	1/2 second		2			✓		
	Radiation Measurement in Clinical Practice	1 second		2			✓		
	Medical Informatics and Information Engineering	1 second		1			✓		
	Image Processing for Biomedical Science and Engineering	1/2 second		2			✓		
	Accelerator Science for Biomedical Science and Engineering	1/2 first		2			✓		
	Medical Physics School	1/2 throughout		2			✓		
	Radiation Biology	1 first		1			✓		
	Radiation Oncology for Cooperation with Biomedical Science and Engineering	1 second		2			✓		
	Basic Physics for Radiation Therapy	2 first		2			✓		
	Molecular Tumor Pathology	1 second		2			✓		
	Molecular Tumor Therapeutics	2 second		2			✓		
	Molecular Probe Science	1 second		2			✓		
	Advanced Physics for Diagnostic Radiology and Nuclear Medicine	1 second		2			✓		
	Molecular Biomedical Science and Engineering School	1/2 throughout		2			✓		
	Special Seminar on Biomedical Science and Engineering	1/2 throughout		1				✓	

2. Requirements for completion of master's program

Passing the defense of master's thesis review and the relevant test after attending the graduate school for 2 years or more (1 year or more if performance is distinguished), acquiring 30 credits or more and receiving necessary research guidance under instructor's supervision.

How to take the course:

- (1) Quantum Biomedical Science and Engineering Course: Acquiring 30 credits or more in total, including 14 credits of Common Required Subjects and 6 credits of Required Subjects (Subjects for

Quantum Biomedical Science and Engineering)

- (2) Molecular Biomedical Science and Engineering Course: Acquiring 30 credits or more in total, including 14 credits of Common Required Subjects and 6 credits of Required Subjects (Subjects for Molecular Biomedical Science and Engineering Subjects)

(Reference Information)

[Doctoral Program]

(1) Required Subjects

With a goal of writing a doctoral dissertation, “Advanced Research on Biomedical Science and Engineering I” and “Advanced Research on Biomedical Science and Engineering II” are provided as subjects aimed at training the students for further advancing the extensive knowledge/basic academic abilities and the practical expertise capabilities allowing contribution to frontier biomedical research and development acquired through master’s program.

(2) Elective Subjects

For students desiring to acquire the qualification of medical physicist, “Clinical Medical Physics Training (Quality Assurance), “Clinical Medical Physics Training (Proton/Image-guided Radiation Therapy)” and “Clinical Medical Physics Training (Treatment Planning)” are provided as subjects, involving treatment planning simulation using medical images and training at the Hokkaido University Hospital.

Course Outline, etc.								
[Graduate School of Biomedical Science and Engineering (Doctoral Program)]								
Subjects	Subject	Year& Semester to Take Subject	No. of Credits			Type of Class		
			Required	Elective	Free	Lecture	Seminar	Experiment/ Training
Required Subjects	Advanced Research on Biomedical Science and Engineering I	1-3 throughout	2				✓	
	Advanced Research on Biomedical Science and Engineering II	1-3 throughout	8					✓
Elective Subjects	Clinical Medical Physics Training (Quality Assurance)	1/2/3 throughout			4			✓
	Clinical Medical Physics Training (Proton/Image-guided Radiation Therapy)	1/2/3 throughout			4			✓
	Clinical Medical Physics Training (Treatment Planning)	1/2/3 throughout			4			✓

Organization and main research contents at Graduate School of Biomedical Science and Engineering, Hokkaido University

Quantum Biomedical Science and Engineering Course

Department: Particle Beams for Biomedical Science and Engineering		
1	Laboratory	Radiation Oncology
	Instructor	SHIRATO Hiroki, Professor HASHIMOTO Takayuki, Associate Professor NISHIOKA Kentaro, Assistant Professor
	Outline	Radiotherapy can be characterized by the possibility of preserving the function originally possessed by the living body and maintaining the function of individual patients through induction of disappearance of neoplasm/tumor, unlike surgical treatment which treats cancer by removing organs/tissues out of the body. Radiotherapy with X-ray and particle beam therapy with charged particles achieve treatment through utilization of the physical characteristics of these rays in medicine by means of scientific/engineering technology. Development of more practically useful and effective devices and therapeutic techniques will be enabled if we view and discuss the frontier technology of engineering and science on the basis of deep understanding of human body structure/function and medical/physiological viewpoints, focusing for example on dose concentration for the purpose of tumor control, dose reduction to normal tissues/organs to minimize adverse reactions and dealing with body and organ movements that always change their location under the influence of respiration, cardiac beating, peristalsis, etc. This laboratory is aimed at cultivating talents capable of contributing to improvement in disease curing rate and QOL (quality of life) of patients with cancer and other diseases through research on technology dealing with motion of organs during radiotherapy, research on particle beam therapy and development of new medical technology, as well as cultivating globally active researchers and educators on these topics.
2	Laboratory	Radiation Medical Physics
	Instructor	TAKAO Seishin, Associate Professor
	Outline	Following recent improvement in the outcome of treatment thanks to advances in medical/scientific/engineering technology, the need to radiotherapy has been increasing remarkably. Among others, particle beam therapy, which applies accelerators to healthcare, is receiving much expectation as a means of minimizing the patient's physical stress through achieving dose concentration on the target cancer. Recently, the use of image guiding technology has made it possible to provide treatment in a way tailored to the patient's motions during treatment, morphological changes of the tumor, bioreactions and other factors. This laboratory is aimed at utilization of the technology of science/engineering (radiation physics, quantum beam applied engineering, image engineering, etc.) to healthcare. Specifically, in collaboration with the Hokkaido University Hospital Proton Beam Therapy Center, this laboratory will engage in development of irradiation technology/devices capable of reducing adverse reactions and improving therapeutic efficacy, development of image guiding technology incorporating detailed information about patient's motions and tumor's morphological changes, development of dose calculation/optimization techniques for realization of high precision treatment, and comprehensive education/research through links of medicine, science and engineering (verification of therapeutic efficacy, taking into account also the cellular level reactions, etc.). Through these activities, this laboratory will cultivate researchers of medical physics and engineers for medical device development.
Department: Radiation for Biomedical Science and Engineering		
3	Laboratory	Medical Applied Basic Physics
	Instructor	AIKAWA Masayuki, Professor
	Outline	In medical fields, such as radiation therapy and particle therapy, a basic understanding of natural science, especially physics, can play an important role to solve problems and develop new technologies. For example, it is necessary to investigate probabilities (cross sections) of nuclear reactions systematically to accurately estimate the necessary amount of radioactive isotopes (RI) for medical care while minimizing unnecessary by-products. We focus particularly on charged-particle induced reactions, and experimentally measure production cross sections of the RI for medical use. In this manner, we train specialists to obtain new knowledge for medical care from the viewpoints of basic physics.
4	Laboratory	Medical Physics and Engineering
	Instructor	ISHIKAWA Masayori, Professor
	Outline	Although medical physics is an indispensable element for radiotherapy, it seems to be less mature in Japan than in other countries. In the United States, leading the world in terms of radiotherapy, each facility providing radiotherapy has medical physicists, who is in charge of quality control of radiotherapy and development of new radiotherapy techniques. In Japan, there is no sufficient environment for such active roles of medical physicists. Radiation measurement is a core technology not only for radiotherapy, but also diagnostic radiology and nuclear medicine. Expertise education on these topics is an element indispensable for cultivation of researchers in

		the field of medical physics and engineers engaged in development of radiotherapy devices. This laboratory will cultivate researchers and engineers capable of contributing to healthcare through development of clinically useful technologies, in collaboration with the Hokkaido University Hospital.
5	Laboratory	Clinical Medical Physics
	Instructor	SUZUKI Ryusuke, Assistant Professor TAMURA Masaya, Assistant Professor
	Outline	New discovery for the next generation can be achieved if problems with clinical practice are viewed as research seeds and attempts are made to find solution to such problems through utilization of the knowledge/skills of science and engineering while adhering to the medical ethics. To this end, students will carry out research in areas closer to a hospital, and check the ideas arising from such research through experiments, simulation, etc. at our laboratory, followed by translational research in collaboration with the industry, towards the goal of acquiring research capabilities leading to development of medical devices. In this laboratory, optimization of treatment planning for radiation therapy, development of database to manage whole information of treatment planning and other topics will be conducted as educational and research activities. In addition, development of novel technique and algorithm for real-time image guided radiation therapy will also be conducted. During the course of such activities, students acquire the capabilities needed for medical physicists. In this way, talents capable of contributing to the society will be cultivated.

Molecular Biomedical Science and Engineering Course

Department: Biomedical Imaging		
6	Laboratory	Medical Image Analysis
	Instructor	KATOH Chietsugu, Professor
	Outline	This laboratory involves research on computerized processing of images yielded from nuclear medicine tests (PET, SPECT (Single Photon Emission Computed Tomography)), CT, MRI and so on aimed at precisely collecting medical information from such visual data. Regarding tumor images, research is made on estimation of tumor malignancy and volume, estimation of the periphery of lesions, estimation of appropriate range of irradiation, correction of artifacts on images arising from respiratory motions and cardiac beats, and so on. Regarding images of myocardium and brain, compartment model analysis is carried out on serial dynamic images following a dose of contrast material or radioisotope for the purpose of quantitative evaluation of ischemic lesions and quantitative analysis of tissue blood flow, oxygen consumption, etc. New technique is under studying using Artificial Intelligence (AI) with Deep Learning for analyses of medical image data. Talents capable of developing programs for achievement of these goals will be cultivated.
7	Laboratory	Integrated Molecular Imaging
	Instructor	KUGE Yuji, Professor MIZUNO Yuki, Assistant Professor
	Outline	For realization of diagnostic molecular imaging, it is indispensable to develop a probe (molecular probe) for conversion of molecular information of the living body into measurable signals. This laboratory is aimed at developing clinically applicable molecular imaging technology through research of new molecular probes, i.e., through exploration of functional molecules, designing of probes, development of probe synthesis technology and synthesis devices, and translational research using experimental disease models for clinical application. This laboratory is also actively conducting research on linking diagnostic molecular imaging technology to accurate treatment, that is, precision medicine and theranostics. Through these research and development activities, this unit will guide students to acquire necessary knowledge/skill systematically so that they can contribute to healthcare and society.
8	Laboratory	Biomarker Imaging Science
	Instructor	THA Khin Khin, Associate Professor Kenneth Lee Sutherland, Assistant Professor
	Outline	In recent years, close attention has been paid to tailored medical care technology through molecule-targeted treatment and pin-point irradiation of proton beam, etc. Noninvasive or least-invasive imaging modalities such as MRI and CT have been extensively used for selection of treatment methods, treatment planning and prediction/assessment of responses to treatment. This laboratory is aimed at utilization of latest MRI and CT techniques for development of image diagnosis techniques with high resolution and precision, imaging methods enabling detection of early subtle changes of the living body conventionally difficult to find, noninvasive or least-invasive imaging techniques reflecting not only morphological information but also information on physiological changes of living body at cellular/molecular level and frontier high precision and noninvasive or least-invasive image diagnosis technology with little burden on patients. Education and research on normal radiologic anatomy making use of these imaging techniques will also be provided.

Department: Biology for Biomedical Science and Engineering		
9	Laboratory	Molecular Oncology
	Instructor	HIGASHINO Fumihito, Associate Professor
	Outline	Correct understanding of the mechanism for carcinogenesis at the molecular level is necessary for sufficient control of cancer, the leading cause of death among Japanese people. Such understanding is indispensable for development of new cancer diagnosis/treatment methods. In recent years, thorough analysis of RNA including non-coding RNA has been advanced after the end of genome project, and the diverse relationships between carcinogenesis and RNA have been revealed increasingly. At this laboratory, new mechanisms for carcinogenesis are explored on the basis of molecular biological analysis covering RNA, viruses, etc., and systematical education/research, ranging from basics to applied one, will be provided concerning development of new cancer diagnosis/treatment methods making use of the findings from such exploration.
10	Laboratory	Molecular and Cellular Dynamics Research
	Instructor	ONODERA Yasuhito, Associate Professor
	Outline	Nowadays, radiation therapy is commonly used for treatment of cancer. However, the radiation effects and its molecular mechanisms on cancer or normal tissues still remain elusive. We have been investigating the acquisition process and molecular mechanisms of invasiveness on cancer cells in the presence of stress such as radiation considering three-dimensional cell structure and microenvironment using the experiment techniques of molecular biology, cell biology and biochemistry. Through the research program, we train students to be world-leading scientists and educators with great expertise in cancer research and experimental techniques.