Curriculum for

Masters of Science (M. Sc.) in Marine Biotechnology

Session:

Department of Genetic Engineering and Biotechnology

Bangabandhu Sheikh Mujibur Rahman Maritime University, Bangladesh

Contents

1. Introduction to the University

1.1 Introduction: The victory over maritime boundary delimitation with neighboring countries opened a new window in the maritime arena of Bangladesh. Vast sea area along with scarcity in land-based resources has made it imperative to boost up our economy through effective exploration of sea resources. Keeping this in perspectives honorable Prime Minister Sheikh Hasina outlined the concept of blue economy and underscored the importance of effective manpower in the maritime sector.

In order to create effective human resources, the first ever specialized university Bangabandhu Sheikh Mujibur Rahman Maritime University, Bangladesh (BSMRMU) was established in 2013 after the name of the Father of the nation Sheikh Mujibur Rahman. Our motto is "We strive for Maritime Excellence". The University aims at bringing all maritime professional to a common platform to share knowledge and carryout research for the advancement of maritime sector and developing effective human resources in this sector.

1.2 Mission: Bangabandhu Sheikh Mujibur Rahman Maritime University, Bangladesh is committed to provide quality education based on state-of-the-art technological support responsive to the emerging challenges at home and abroad.

The university is dedicated to nurture and develop world class professionals, who would serve the mankind with strong sense of ethical values and competence and ready to face the competitive world of maritime business, service and employment.

1.3 Vision: Our vision is to promote and create a learning environment for higher maritime education with excellence, through state- of- the- art facilities and gadgets, competent faculty and staff, expanded frontier of research based knowledge and international standards supportive of the new horizons in diverse fields by 2021.

1.4 Goals:

- Achieve sustainable development and progress of the university through cooperation with other related universities/ institutions.

- Continue to upgrade educational services and facilities responsive to the demands and requirements of the nation.

- Bring all types of marine professionals on a common platform to share knowledge and perform research and development works for the advancement of country's maritime sector.

- Enhance research consciousness in the maritime sector in discovering new dimensions with the upcoming challenges.

- Accelerate the participation of alumni students and professionals with educational programs and development of projects designed to expand and improve academic standards.

- Teach students on marine science and technology and guide them towards research to enhance contribution to the maritime profession.

- Conduct various educational programmes and research works for sustainable development of the maritime service and industrial sector of the country.

- Educate students on different subjects of maritime management, law and security and strategy and conduct research on allied fields.

- Create conducive environment for students to prepare themselves to serve the nation as future planners/ policy makers/ leaders in maritime sectors in coordination with national and international organizations including International Maritime Organization (IMO).

1.5 Faculties and Institutes: The University aspires to have seven teaching faculties and four research institutes. The faculties are:

- Faculty of Maritime Governance and Policy (FMGP)
- Faculty of Shipping Administration (FSA)
- Faculty of Earth and Ocean Science (FEOS)
- Faculty of Engineering and Technology (FET)
- Faculty of General Studies (FGS)
- Faculty of Computer Science &Informatics (FCSI)
- Faculty of Maritime Business Studies (FMBS)

Research institutes are: Institute of Professional Language, Institute of Bay of Bengal & Bangladesh Studies, Institute of Renewable Energy & Marine Resource and Institute of Disaster management.

2. Introduction to the Faculty of Earth and Ocean Science (FEOS):

Faculty of Earth and Ocean Sciences one of the pioneer faculties of the university. The faculty has special learning environment, innovative course curriculum, methods of teaching, and quality programs. The faculty has currently running one department named Department of Oceanography and Hydrography.

3. Introduction to the Department of Marine Biotechnology & Genetic Engineering

The Department of Marine Biotechnology started its journey from the very inception of this University under the Faculty of Earth & Ocean Science. The Department is committed to provide an excellent teaching and learning environment. Global standard curriculums are followed to impart quality education by the qualified and competent teachers. Graduates of this department will get a unique opportunity to develop their career in the different areas of job market like universities, professional organizations and government agencies, research, development and production in fields such as drug development, bioinformatics, biomedical engineering and manufacturing, genetics, agricultural research, plant breeding or biotechnology sales.

4. Introduction to the Program

4.1 General: Master's in marine biotechnology Program is a specialized post graduate course offered under the Department of Marine Biotechnology & Genetic Engineering. The duration of the program will be 18 months (3 semesters). The Program is designed to develop the students with an expertise in the field of Marine Biotechnology by imparting theory cum practically focused education of global standard. After successful completion of this Program a student will be professionally competent to choose his career as a teacher, researcher, development and production in fields such as drug development.

Program Duration: 18 Months
Number of Semester: 03
Semester Duration: According to ordinance
Total number of credit available: 54
Minimum credit to be earned for degree requirements:54

Division of Semester:

4.2 The duration of each semester is 26 weeks. Distribution is as follows:

a.	Classes	15 Weeks
b.	Mid Term Examinations	02 Weeks
c.	Preparatory Leave	02 Weeks
d.	Term Final Examination	03 Weeks
e.	Recess	04 Weeks

Admission Criteria:

4.3 Every applicant must fulfil the admission requirements as prescribed by BSMRMU. The minimum requirements for admission into the program are:

a. A candidate with B.Sc. Degree in (Botany, Marine Biology, Oceanography Zoology, Microbiology, Biochemistry, Biotechnology or Genetic Engineering) with minimum CGPA 3.00 or its equivalent from any public university or private university is eligible for admission.

b. A candidate must have passed SSC/equivalent examination and HSC/ equivalent examination from Board of Intermediate and Secondary Education/ Madrasa Education Board/ Technical Education Board in Science group with minimum GPA 4.00 in a 5-point scale.

c. Applicants with GCE must have passed at least five subjects in O level (including mathematics) and at least two subjects in A level. However, applicant having more than two 'D' grades in O level and/or more than one 'D' grades in A level shall not be eligible for admission.

d. Foreign applicants shall apply through their respective embassy.

Admission Test:

4.4 All eligible applicants shall be required to appear the admission test as per BSMRMU Admission Policy/regulations for MSc. in Marine Biotechnology. Admission test shall normally be

comprised of written test and viva voce. Only written test qualified applicant shall be called for viva voce.

Final Selection:

4.5 Candidates will be selected finally on the basis of their combined marks obtained in the written admission test and viva voce. Final merit list along with waiting list will be published on BSMRMU notice board as well as on BSMRMU website.

(a) Registration/Admission in the Program

After final selection, selected candidates shall be registered with the programme in accordance with the procedures as laid down by BSMRMU. The candidates have to go through a medical checkup at BSMRMU designated Medical Centre to ascertain their medical fitness. The selected candidates shall have to collect Admission Form from Admission Section and complete admission and registration formalities within the given time frame by paying required fees.

(b) Cancellation of admission:(i) If any candidate fails to complete admission formalities within the prescribed date and time his/her selection will be cancelled automatically; (ii) If any student does not attend the class within two weeks of commencement of classes, his/her admission will be cancelled automatically.

Grading System:

4.6 Letter grades and corresponding grade points will be awarded in accordance with the provisions (unified UGC grading system) shown below:

Grade	Grade points	Numerical Markings
A+	4.0	80% and above
A	3.75	75% to below 80%
A-	3.50	70% to below 75%
B+	3.25	65% to below 70%
B	3.00	60% to below 65%

B-	2.75	55% to below 60%
C+	2.50	50% to below 55%
C	2.25	45% to below 50%
D	2.00	40% to below 45%
F	0.00	below 40%
I	Incomplete	-
W	Withdrawn	-
X	Projects/Thesis continuation	-
E	Expelled	Due to exam offence

Conduct of Courses:

5. In a semester, teacher/teachers shall be assigned to plan and teach a particular course. The following guidelines shall be followed to conduct the courses:

a. At the beginning of the semester, the course teacher will prepare a course outline incorporating the course syllabus, performance evaluation and grading system (as laid down in the policy), list of suggested text books/references, and a tentative schedule of classes, examinations and events.

b. **Assignment of Credits:** The assignment of credits to theoretical course is different from that of laboratory course, which is stated as follows:

(1) For theoretical courses one lecture of 60 minutes per week per term is equivalent to one credit.

(2) For laboratory courses four class hours per week per term is equivalent to one credit.

(3) Credits are also assigned to thesis work taken by the students. The amount of time assigned to such work may vary depending on the thesis.

c. A thesis work shall be assigned, either individually or in groups on any issue pertaining to the course.

d. A number of individual and group assignments, presentations, etc. shall be assigned to students as per the course requirements.

Performance Evaluations

6. i) Theory Courses:

Forty percent (40%) of marks of theoretical course shall be allotted for continuous assessment, i.e. quizzes, class tests, home assignments, class evaluation, class participation, mid-term exam etc. Term Final Examination is conducted centrally by BSMRMU. Term Final Examination will be normally of 3-hour duration. Distribution of marks for a given course is as follows:

a. Class Attendance: 05%

b. Class Participation/Observation: 05%

c. Term Paper/Assignment: 05%

d. Class Tests/Quiz: 10%

e. Mid Term Examination (01 Exam): 15%

f. Term Final Examination: 60%

The number of quizzes/class tests of a theory course shall be *n+1,* where *n* is the number of credit hours of the course. Evaluation of performance in quizzes/class tests will be based on the best *n* quizzes.

The scheme of continuous assessment that a particular teacher wishes to follow for a course will be announced as course outline on the first day of the term. The performance of a student will be evaluated in terms of two indices, viz. Semester Grade Point Average (SGPA), and Cumulative Grade Point Average (CGPA).

ii) Lab Courses:

The distribution of marks for Lab courses is given below:

a.	Lab test	40%
b.	Assignment / Report:	20%
c.	Viva/Presentation	10%
d.	Quiz	10%
e.	Attendance	10%
f.	Class Performance / Observation	10%

iii) Internship:

The distribution of marks for field trip is given below:

a.	Attendance	20%
b.	Participation	20%
c.	Report	30%
d.	Presentation	30%

iv) Dissertation/ Thesis:

The marks distribution for dissertation is as follows:

a.	Thesis Report	60%
b.	Presentation	30%
c.	Oral Exam	10%

The requirements for promotion to the Next term

7. The requirements for promotion to the next term are as follows:

a. A student has to take the required courses for a particular term/level as per the syllabus of the program.

b. A student shall be promoted to the second term (Term-II) of each level, irrespective of his/her results in the first term of the level provided he/she does not have 'F' grades in more than two subjects including backlog subjects (if any).

c. A student shall not be allowed to continue the next term if he/she obtains a total of **three or more** F grades in any term/semester.

Credit Earned

8. The Courses in which a student has obtained 'D' or a higher Grade shall be counted as credits earned by him/her. Any course in which a student has obtained 'F' grade shall not be counted towards his/her earned credits. 'F' grade must be cleared within designated period.

Degree Requirements

9. Degree requirements are as follows:

a. Completion of courses for the minimum required credits of 160 in maximum period of six academic years.

b. Appearing at the final examination in all the required courses as per syllabus of the programme.

c. Successful completion of defence of thesis paper.

d. Scoring a CGPA 2.20 or above.

Retaking a Course:

10. It is expected that students will obtain degree by clearing the entire offered courses of specified credit hours as per the syllabus within six academic year's period. In case of failure to do so by any student the following guiding policies shall be adopted:

a. A student obtaining F grade in a course may be allowed to repeat the course with the prior approval of Head of the Department on the recommendation of the course coordinator. Such approval shall be reported to the BUGSR and academic council.

b. Two courses of any semester may be repeated for improvement with the prior approval of the Head of the Department on the recommendation of the course coordinator. Such approval shall be reported to the BUGSR and Academic Council.

Course Designation System

11. Each course is designated by a maximum of four letter code identifying the department offering the course followed by a three-digit number having the following interpretation:

a. The first digit corresponds to the year/level in which the course is normally taken by the students.

b. The second digit corresponds to the semester/ term in which the course is normally taken by the students.

c. The last digit denotes various courses, where an odd number is used for theoretical courses and an even number for Laboratory/Practical courses.

Course Waiver:

12. A student with relevant degrees from reputed universities may get maximum 16 credits waiver provided they fulfill the following conditions:

a. Obtained at least a 'B' grade or 1st class in a similar course in the earlier program

b. Minimum least 70% of the course contents are similar

All applications for course waiver will be reviewed by Equivalence Committee on a case-by-case basis and finally shall be approved by the Academic Council of BSMRMU.

13. Course Schedule

Master's in Marine Biotechnology

1st Semester (18 Credits)					
Sl. No	**Sub. Code**	**Course Title**	**Credit**	**Revised Credit**	**Hours**
1.	MBTC 101	Marine Biotechnology and Marine Ecosystem		3.0	45
2.	MBTC 102	Marine Biodiversity, Bioprospecting and limnology		3.0	45
3.	MBTC 103	Marine Microbiology		3.0	45
4.	MBTC 104	Biochemistry, Molecular and Cellular Biology		3.0	45
5.	MBTC 105	Research Methodology		3.0	45
6.	MBTC 106	Lab Work 01		2.0	
7.	MBTC 107	Viva Voce		1.0	
		Total Credits		**18**	
2nd Semester (18 Credits)					
8.	MBTC 201	Advanced Analytical Techniques		3.0	45
9.	MBTC 202	Genetics and Immunology		3.0	45
10.	MBTC 203	Genetic Engineering and Industrial Biotechnology		3.0	45
11.	MBTC 204	Aquatic Biotechnology		3.0	45
12.	MBTC 205	Marine Natural Product		3.0	45
13.	MBTC 206	Lab Work 02		2.0	
14.	MBTC 207	Viva Voce		1.0	

		Total Credits		**18**	
3rd Semester (16 Credits)					
15.	MBTC 301	Entrepreneurship in Marine Biotechnology		2.0	30
16.	MBTC 302	Internship		2.0	
17.	MBTC 303	Dissertation		14.0	
		Total Credits		**18**	
			Grand Total Credits	**54**	

Note: Research proposal be submitted during 2nd semester during/after the 'Research Methodology course.

Course Profile: Semester 1

1st Semester (18 Credits)					
Sl. No	**Sub. Code**	**Course Title**	**Credit**	**Revised Credit**	**Hours**
1.	MBTC 101	Marine Biotechnology and Marine Ecosystem		3.0	45
2.	MBTC 102	Marine Biodiversity, Bioprospecting and limnology		3.0	45
3.	MBTC 103	Marine Microbiology		3.0	45
4.	MBTC 104	Biochemistry, Molecular and Cellular Biology		3.0	45
5.	MBTC 105	Research Methodology		3.0	45
6.	MBTC 106	Lab Work 01		2.0	
7.	MBTC 107	Viva Voce		1.0	
		Total Credits		**18**	

14.1.1: Course Title: Marine Biotechnology and Marine Ecosystem

Course code: MBTC101

Credit Hours: 3

Rationale: This course is designed to provide fundamental concepts of Marine Biotechnology and marine ecosystem **Course Objectives:** The objectives of the course are to: • To introduce Biotechnology together with application of biotechnology for industrial products, scope of marine biotechnology. • To introduce marine biotechnology, types of marine environment and their interaction with marine life; air-sea interaction. • To introduce the necessity of restoring marine ecosystems.	**Learning Outcomes:** At the end of the course the students will be able to- • Obtain an overview of important oceanographic processes • Comprehend major marine ecosystems, including trophic relationships of their inhabitants and adaptations for various environmental conditions • Build awareness of anthropogenic impacts in the marine environment and potential solutions • Explain important concepts of the water environment, including water chemistry, components of seawater and transmission of energy • Describe the factors that govern primary production in the oceans, and which areas typically have the highest rates of primary production • Understand simulation modelling and ecological applications for management of water systems • Recognize and describe major taxonomic groups and functional groups in the marine environment • Describe major marine ecosystems and their main characteristics and the need for its restoration • the current trends in Biotechnology
Course Content	
Marine biotechnology and its contribution to economic and social prosperity, how these advances improve our understanding of marine life and facilitate access to and study of marine organisms	
Ecosystems and their largely untapped potential. Important concepts of the water environment, including water chemistry, components of seawater and transmission of energy.	
Simulation modeling and ecological applications that offer solutions to complex management problems of water resources.	

Factors that govern primary production in the oceans. Challenges associated with the development of these resources, which exist in complex ecosystems and are distributed throughout a vast shared environment.	
Role of Blue Biotechnology in achieving sustainable development.	
References	1. Introduction to Biotechnology, 3rd ed. Author: William J. Thieman, Michael A. Palladino, Publisher: Pearson, 2012. Cambridge, UK 2. Recent Advances in Marine Biotechnology Volume 3 – Milton Fingerman et al., 1999 3. Environmental Biotechnology and cleaner Bioprocess–Olguni, E.J. et al., 2000 4. Environmental Biotechnology Theory and applications – Evans et al., 2000.

14.1.2: Course Title: Marine Biodiversity, Bioprospecting and limnology

Course code: MBTC 102

Credit Hours: 3

Rationale: The course will focus on the oceans regarding the organismal wealth it is bestowed with emphasizing on the unique gene pool and characteristics owing to extreme conditions such as high salt concentration and temperature variations. It will emphasize on marine biodiversity as an extremely rich resource for the development of a wide array of applications. **Course Objectives:** The objectives of the course are to: • To introduce the innumerable marine life forms and unique characteristics, richness of the ocean attributed towards high chemical and biological diversity. • To introduce the marine ecosystem asa prolific source for novel chemical compounds with potential biomedical applications that range from	**Learning Outcomes:** At the end of the course, students will be able to: • Understand Biodiversity values • Understand methods for assessment of biodiversity • Learn how to pre-treat data for biodiversity assessment • Assess marine ecosystem health • Understand threats to biodiversity • Understand IUCN conservation status assessment • Understand the Barcode of Life Initiative • Learn molecular tools for assessing genetic diversity • DNA markers for understanding marine genetics • Understand experimental methods used in Bioprospecting • Understand information of novel natural products, structures, bioactivity and ways to evaluate the potential use.

pharmaceuticals to Nutraceuticals to molecular probes and enzymes.	
Course Content	
Introduction to marine biodiversity. Complex nature of the process that affects and control marine biodiversity.	
Threats to marine biodiversity and mechanisms developed to identify and manage biodiversity loss.	
Protection and preservation of marine environment and conservation and utilization of marine living resources. Conservation and management of living resources in the High Seas.	
Identifying biological species by 'DNA barcode'.	
Marine bioprospecting as a source of new and sustainable wealth growth, the development from collection of marine organisms, preparation, categorization, storage and analysis to creation of a bioactive substance. Targeted and systematic search for components, bioactive compounds or genes within marine organisms.	
Introduction Limnology with a brief history and definition, ecosystem prospective on inland water; physical, chemical and biological parts.	
References	1. Biodiversity and Conservation (2012), David L. Hawksworth, Springer Science, Netherlands 2. Biodiversity Hotspots, (2011), Editors: Zachos Frank E. Habel Jan C. Publisher: Springer-Verlag Berlin Heidelberg. 3. Marine Bioprospecting and Natural Product Research, (2010) Author: Vanessa Sunkle, Published: LAP Lambert Academic Publishing 4. Limnology: Lake and River Ecosystem, 3rd edition, Robert Wetzel, Publisher: Academic Press, 2001

14.1.3: Course Title: Marine Microbiology

Course code: MBTC 103

Credit Hours: 3

Rationale: This course will focus on the exploration of the marine microbial population and understand their biodiversity. The topics covered will range from recent advances in our understanding of marine microbial ecology and metagenomics.	**Learning Outcomes:** At the end of the course, students will be able to • Understand the basics of microbial culture • Understand the classification and distribution of microorganisms in the marine habitats • Understand the basic outline of microbial metabolism

Course Objectives: The objectives of the course are to: • To introduce the fundamentals of marine microbiology. • To introduce the students to the characteristics of marine microorganisms, multiplication, growth in different media. • To introduce students to marine metabolic pathways. • To introduce students to the effects of microbes and their control.	• Learn the vital role of microbes in the environment with particular emphasis on marine habitats. • Explore the dynamic interactions that take place between microbial communities, the surroundings and higher organisms. • Understand contemporary environmental microbiology including sensing and adaptive responses of bacteria, biogeochemical cycling and microbial communities and interaction. • Learn the microbial degradation of complex carbon, microbes in changing carbon cycle • Appreciate the role of microorganisms in sea water habitats • Understand ocean acidification • Comprehend deep subsurface microbiology • Appreciate marine microbes as a major component of the plankton and in the formation of biofilms. • Explain the principle features of microbial biosphere, its diversity, habitats and ecology. • Describe and discuss marine microbes in terms of physiological and biogeochemical capability. • Comprehend microbial ecosystem function in pelagic and benthic marine habitats. • Understand microbe-mineral interaction, microbe and oil spill interaction to remove pollutants. • Understand the use of metagenomics as fundamental to revealing the abundance and composition of marine microbial ecosystems
Course Content	
Current understanding of microbial diversity, physiology and interactions with the environment	
Characterization, classification and identification of microorganisms, microscopic examination of microorganisms, morphology and fine structure of bacteria, cultivation of bacteria, pure cultures and cultural characteristics	
Fungal wealth of the marine system: fungi – importance, characteristics, and classification of fungi, molds.	
Algae – importance of algae – characteristics of algae.	
Viruses of bacteria: Bacteriophage- general characteristics-morphology and structure, classification and nomenclature	
Microbial physiology and genetics, Microbes as the foundations of marine trophic webs and biogeochemical processes.	
Microbial genomics for our current understanding of microbial ecology in marine environment	

References	1. Marine microbial ecology, by E. J. F. Wood (1965). 2. Microbiology, by Eugene Nester et al, McGraw-Hill Science/Engineering/Math, ISBN: 0077250419. 3. The microbial world, by Stanier et al, 1970. 4. Microbial interactions, edited by JL Reissig, Springer US (1977), ISBN: 978-1-4615-9700-1. 5. Microbiology, by Michael et al, 1986. 6. Marine Microbiology, by B. Austin, CUP Archive (1988), ISBN: 0521311306.

14.1.4: Course Title: Biochemistry, Molecular and Cellular Biology

Course code: MBTC104

Credit Hours: 3

Rationale: This course will focus on the fundamentals prepared to address problems in biochemistry and molecular biology of marine organisms. The course will highlight structure and function of biological molecules, especially proteins, lipids and carbohydrates and will include important concepts like bioenergetics, biological catalysis, and metabolic pathways. **Course Objectives:** The objectives of the course are to: • To provide an advanced understanding of the core principles and topics of biochemistry and their experimental basis. • To enable students to acquire a specialized knowledge and understanding of cell biology especially Biomolecules, protein-protein interactions, cell structure, cell-cell communication. • To provide students with a solid foundation, and an in-depth understanding of the current issues in biochemistry, cell, and molecular biology.	**Learning Outcomes:** At the end of the course, students will be able to: • Understand the inorganic chemistry of life. • Understand the cell-structure and organization. • Understand carbon as the basic for life on earth. • Understand amino acids and protein. • Understand the central dogma of biological systems. • Develop a thorough understanding of the structure and function of macromolecules and molecular machines. • Develop a thorough understanding of the structure, function and interactions of cells. • Develop a thorough understanding of different metabolic pathways, viz. glycolysis, Kreb's cycle, pentose phosphate pathway, Calvin cycle, etc. • Demonstrate a thorough understanding of how alterations in molecular and cellular structure and function cause diseases.
Course Content	

Organization of macromolecules and their hierarchical structure, and a study of their assembly into complexes responsible for specific biological processes.	
Major biomolecules and their role in metabolism.	
Characterization of major metabolic pathways, and their interconnection into networks	
Regulation and coordination of major metabolic pathways	
Current understanding of, methodological approaches for analyzing, and recent advances in the function of cellular macromolecules and macromolecular complexes in DNA replication, recombination, transposition and repair, gene expression and its regulation, signal transduction, protein synthesis, folding and degradation	
Alterations in molecular and cellular structure and function that cause diseases.	
References	1. Nelson DL, McKee MM, Lehninger's Principles of Biochemistry. W H Freeman (6th edition), 2012 2. McKee T, McKee JR. Biochemistry of Molecular Basis of life. Oxford (6th edition), 2015 Karp G, Cell and Molecular Biology: Concept and Experiments. Willey (6th Edition) 2009 Berg J, Tymoczko JL, Stryer L. Biochemistry. WH freeman (5th edition) 2010 3. Harvey Lodish, Arnold Berk, Chris A. Kaiser et.al Molecular Cell Biology 8th edition, Publisher: W.H. Freeman, 2016.

14.1.5: Course Title: Research Methodology

Course code: MBTC 105

Credit Hours: 3

Rationale: Research Methodology is a hands-on course designed to impart education in the foundational methods and techniques in marine biotechnology. The course will cover the meaning of scientific research, objectives of scientific research, and scientific methodology in terms of research in biology, current trends in research methodology, current areas of focus, and components of a scientific research article, reading and understanding a research article, presentation skills, going beyond a research article: future perspective, student presentations. Scientific	**Learning Outcomes:** At the end of the course the students will be able to- • Comprehend the vital concepts of biosciences and biotechnology and make rational perception about research in marine biotechnology and allied fields. • Evaluate and interpret current literature and research explorations in the relevant biological area. • Correlate and employ biological and molecular concepts learned through research methodology evaluations. • Understand various steps in a research

learning of biochemical, analytical and computational techniques that embrace the fundamental as well as applied knowledge to probe intricate patterns in latest biological research. Morality as applies to scientific practice. **Course Objectives:** The objectives of the course are to: • To cultivate an understanding of the basic framework of research process. • To develop an understanding of various research designs and techniques. • To identify various sources of information for literature review and data collection. • To grow an understanding of the ethical dimensions of conducting applied research. • To appreciate the components of scholarly writing and evaluate its quality. • Able to separate research into morally prohibited, required, permitted, and encouraged, thus illustrating an understanding of the role of the scientist in society.	process • Develop a research question • Construct a research hypothesis • Understand why ethical behaviour is entirely consistent with, and necessary for, good scientific methodology and reporting.
Course Content	
Planning, methods of data collection and analysis phases of the research process.	
Formulating a research problem, recognizing various steps in a research process, identifying variables, constructing hypotheses, developing a research design, developing a research question, constructing hypotheses.	
Literature review, surveying, synthesizing, critical analysis, reviewing, rethinking, critical evaluation, interpretation, research purposes	
Reviewing scientific, patent and industry related literature with an emphasis on understanding the commercial status and competition relevant to particular research areas in the marine biotechnology	
Ethics in research**.**	

References	1. Research Methodology A Step-By-Step Guide For Beginners By Ranjit Kumar, Sage Publishers

14.1.7: Course Title: Lab Work 01

Course code: MBTC- 106

Credit Hours: 2

Rationale: Laboratory sessions will allow students to gain experience in the experimental design and practical skills of research in the context of marine microbial issues. Lab work 1 is based on enhancing enquiry-based learning, and encouraging students to work on tasks in small groups by applying and integrating knowledge from biochemistry and microbiology. **Course Objectives:** The objectives of the course • To enhance learning the theoretical and practical aspects of advanced biochemistry techniques and microbial strain detection and isolation. • To make students familiar of the individual and group experiment and aware of laboratory ethics.	**Learning Outcomes:** At the end of the course, students will be able to: • Understand the value of experimentation and the scientific method as tools to advance the science of dealing with this subject. • Understand the concepts of microbiology, relating them to the other disciplines of the course. •

Course Content

- Identify bacteria based on their shape
- Learn to identify bacteria based on Gram staining
- Prepare bacterial media- culture- nutrient broth, agar medium, and agar slants.
- Learn methods of sample collection form marine environments; estimation of bacterial, fungal and actinomycetes population.
- Isolate pathogenic organisms from seafood water and sediment.
- Identify unknown bacteria- separation of mixed cultures.
- Isolate, maintain and preserve pure cultures.

• Isolate DNA from a number of biological samples. • Use restriction enzymes to digest DNA at specific sites. • Learn the techniques of cloning in plasmid vectors	
References	1. Brock's Biology of Microorganisms 9th edition. Author: Michael T. Madigan, John M. Martinko and J. Parker. Publisher: Prentice Hall College, 2000. California, USA 2. Microbiology, 5th Edition. Author: Michael J.Pelczar, Jr. E.C.S. Chan and Noel R. Krieg, 2001. Publisher: McGraw Hill Inc. New York. 3. Marine Microbiology: Bioactive and Biotechnological Application. 1st edition. Author: Se-Kwon Kim. Publisher: Wiley-VCH; 1 edition, 2013, Germany. 4. An introduction to Microbiology. P. Tauro, KK Kapoor, KS Yadav. New Age International Publishers (July 1, 2016), New Delhi, India 5. Microbiology: A Laboratory Manual. 11th edition. Author: James G. Cappuccino. Publisher: Pearson, 2017. Cambridge, USA. 6. J. Sambrook, E.F. Fritsch, T. Maniatis. Molecular Cloning: A Laboratory Manual (Vol. 3) 2nd edition. Publisher: Cold Spring Harbor

14.1.8

Course Title: Viva-voce **Course code: MBTC 107**

14.2. Semester 2

2nd Semester (18 Credits)					
1.	MBTC 201	Advanced Analytical Techniques		3.0	45
2.	MBTC 202	Genetics and Immunology		3.0	45
3.	MBTC 203	Genetic Engineering and Industrial Biotechnology		3.0	45
4.	MBTC 204	Aquatic Biotechnology		3.0	45
5.	MBTC 205	Marine Natural Product		3.0	45
6.	MBTC 206	Lab Work 02		2.0	
7.	MBTC 207	Viva Voce		1.0	
		Total Credits		**18**	

14.2.1: Course Title: Advanced Analytical Techniques

Course code: MBTC201

Credit Hours: 3

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<td>Rationale: This course is focused on the use of analytical techniques to understand the chemistry, structure, function of marine products, including the secondary metabolites. The course will provide a detailed understanding of advanced tools, resources and analytical techniques; an understanding of how these techniques are used to elucidate structure, function of bioactive compounds; an appreciation of how these techniques may be applied both in biotechnology and in advanced research; an appreciation of the information resources available to assess the usefulness of a particular technique; and acquire the knowledge to critically appraise new data arising from the use of these techniques and to interpret the implications of such data.

Course Objectives: The objectives of the course are to:

• It aims to provide students with an advanced understanding of the strategies and techniques used in analytical chemistry of relevance both to the biotechnology industry and to advanced molecular biology research.
• Introduce students to topics drawn from the current literature and ongoing research in analytical chemistry.
• This course will make students aware of the qualitative analysis of biologically active compounds together withan emphasis on the quantitative aspects of the techniques.</td>
<td>Learning Outcomes: At the end of the course the students will be able to-

• Understand Lambert-Beer law and its analytical application.
• Understand atomic absorption (AAS) and atomic emission (EAS-ICP) spectroscopy for trace and ultra-trace element analysis.
• Understand UV-VIS molecular spectroscopy: analytical application of Spectrophotometry and fluorescence spectroscopy.
• Understand FTIR and Raman spectroscopy, their application in biological system analysis.
• Appreciate analytical applications of NMR method.
• Comprehend mass spectrometry - determination and structural analysis of organic compounds.
• Understand Nuclear Magnetic Resonance (NMR) and Mass Spectroscopy (MS),
• Understand UV, IR and liquid and gas chromatography.
• Understand new “coupled” techniques like GC/MS, LC/MS and LC/NMR.
• Understand how analytical data are interpreted.
• Apply basic statistical methods for experimental data analysis.</td>
</tr>
<tr>
<td colspan="2">Course Content</td>
</tr>
<tr>
<td colspan="2">Absorbance and molar absorptivity relating to UV-visible absorption spectrometry.</td>
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</table>

Spectrophotometry and fluorescence spectroscopy	
Analytical applications of Spectrophotometry and fluorescence spectroscopy	
Atomic absorption (AAS) and atomic emission (EAS-ICP) spectroscopy for trace and ultra-trace element analysis.	
High-performance liquid chromatography (HPLC)	
Mass spectrometry (MS)	
Hybrid analytical techniques that combine high-performance liquid chromatography (HPLC) with mass spectrometry (MS)	
Understanding of nuclear magnetic resonance (NMR) spectroscopy.	
Efficient elucidation of known and new natural-product structures by NMR, AAS and other relevant techniques	
Statistical tools used in the interpretation of analytical data	
References	1. Handbook of Analytical Techniques, volume 2, 2012, Author: Helmut Gunzler and Alex Williams. Wiley-VNH.

14.2.2: Course Title: Genetics and Immunology
Course code: MBTC202
Credit Hours: 3

Rationale: The course will help combine genetics and immunology, with an aim to instill a broad base of knowledge at molecular, cellular and organismal levels among the students. Additionally, students will gain an in depth understanding of selected aspects of genetics and immunology.This course will make students aware of marine related genetics, immunology and medical science. **Course Objectives:** The objectives of the course are to: • To introduce students to the concept of chromosomes, genes and genomes, including a concept on cell	**Learning Outcomes:** At the end of the course, students will be able to: • Demonstrate broad knowledge of genetic basis of cellular function. • Identify mechanistic principles of expression/replication of genetic information. • Demonstrate basic knowledge of human genetic diseases and disorders. • Identify the major cellular and tissue components which comprise the immune system; • Describe the major cellular and molecular processes which promote immediate host responses to pathogens and also lead to long-term immunological protection;

molecular biology, gene expression and regulation, human genetics, DNA technology, genetic variation and evolution and introduce students to Bioinformatics. • To introduce students to immunology, immunoglobulin genes and antibody diversity; theories of antibody formation, generation of antibody diversity; membrane receptor for antigen, B-cell, T-cell activation; NK receptor; mechanisms of cytotoxicity; induction of apoptosis by cytotoxic T-cell and NK cells, apoptosis mediated by caspases; major histocompatibility complex (MHC) genomic organization and expression; HLA-disease association; and signal transduction by the TCR complex, cytokine and cytokine receptor, B-cell development and immune response, regulation of immune response. • To introduce students to focus on marine biomass as a source of raw materials, a large dependable and economical supply of essential biomass for industrial products viz. biodiesel/Biofuel.	• Demonstrate a broad knowledge of immunopathologies, including autoimmune diseases and immunodeficiency diseases, and describe the underlying cellular mechanisms or processes.

Course Content
Introduction to molecular biology, including proteins, carbohydrates, lipids and nucleic acid; water; and other compounds that makes up the cell.
Detailed study of the cell membrane, mitosis and meiosis, genetics and gene expression, transcription and translation and cellular metabolism.
An overview of human genetic concepts and clinical disorders and how genetic disorders are initiated and inherited
Mechanism of antibody mediated inactivation and activation; hormone, receptor, ligand; neutralizing antibody – cause and effect
Protective function of inactivating antibodies.

Inflammation: Nonimmune and immune inflammation;	
immune specific protection against infection; Interaction of immune mechanism in infectious disease; evasion of immune mechanisms	
References	1. Lehninger Principles of Biochemistry, Albert L. Lehninger, David L. Nelson, &Micheal M. Cox. 7th Ed. Publisher: W.H Freeman, 2017. 2. Text book of Genetics, William Hovanitz, Houston, New York: Elsevier Press; Inc.; 3. Immunology (6th edition). Ivan Roitt, Jonathan Brostoff and David K Male, Publishers: London Gower Medical, UK, 1985. 4. Cellular and Molecular Immunology (8th ed.). Abul K. Abbas, Andrew H. Lichtman 5. Saunders, Publisher: Elsevier Science, 2014 6. Clinical Immunology. Provash Sen Gupta, Oxford University Press. 7. Marine Biomass (1981) Ivan T. Show Jr. Science Applications, Inc, LaJolla, USA. Publisher: Plenum Press, New York

14.2.3: Course Title: Genetic Engineering and industrial Biotechnology
Course Code: MBTC 203
Credit Hours: 3

Vision: The course will help students appreciate genetic engineering as a useful tool for marine biotechnology and its application in the industry. It will allow students acquire knowledge and abilities to apply genetic engineering tools necessary in the development of products involving marine organisms or components, from genetic engineering techniques to the use of bioprocesses, along with applications to healthcare agriculture and industry. It will describe the industrial advances made possible by recombinant DNA technology **Course Outcomes:** • To make students aware of the advanced tools, resources and techniques in molecular biology; an understanding of	**Learning Outcomes:** Upon Completion of the course, the students will be able to— • Describe and understand a range of techniques in genetic manipulation, cloning vectors available and the containment procedures required; • Identify strategies for gene isolation, construction of libraries, • Understand DNA and peptide synthesis and DNA sequencing. • Understand DNA Sequencing and Gene Synthesis Sanger's method of DNA sequencing – Manual and automated methods, Pyrosequencing–massively parallel 454-sequencing, Illumina sequencing, SOLiD sequencing, single

how these techniques are used to study gene and protein functions in cells and organisms. • To make students aware of how these techniques may be applied both in biotechnology and in advanced research; an appreciation of the information resources available to assess the usefulness of a particular technique. • To help students gather knowledge so that they can critically appraise new data arising from the use of these techniques and to interpret the implications of such data, be able to describe how to work with an ethical and scientific approach and use the same in industrial applications.	molecule sequencing including tools of genetic manipulation: • Understand DNA and peptide synthesis; protein engineering; cloning DNA libraries and genomic libraries; *In vitro* mutagenesis and elucidation of gene function; • Comprehend gene-editing techniques including zinc finger nucleases (ZFN), TALENs, CRISPR/Cas, meganucleases and oligonucleotide-directed mutagenesis (ODM). Apply genetic techniques in industry; recombinant vaccine; food and beverage improvement etc. • Apply genome mining knowledge to the production of novel bioactive compounds. • Understand genetic engineering as used in mass-production of insulin, human growth hormones, monoclonal antibodies, vaccines, and many other drugs.

Course Content
DNA synthesis, next generation nucleic acid sequencing methods, separation, cloning, molecular tools and their applications
restriction enzymes, modification enzymes, DNA, and RNA markers, restriction mapping of DNA fragments and map construction
Formation of point mutations and molecular mechanisms of site-directed mutagenesis and protein engineering.
Expression strategies for heterologous genes by vector engineering and codon optimization, host engineering.
In vitro transcription and translation, expression in bacteria and yeast.
Gene-editing techniques using zinc finger nucleases (ZFN), TALENs, CRISPR/Cas, meganucleases and oligonucleotide-directed mutagenesis (ODM).
Recombinant vaccine; food and beverage improvement etc.
Application of genome mining knowledge to the production of novel bioactive compounds.
Industrial Microorganisms & Bioprocessing**:** Isolation, screening and strain improvement of industrially useful microorganisms, Culture preservation, Biosynthesis and growth. Bioreactor design and operation, Substrates for bioconversion processes and design of media, methods in analysis and optimization of fermentation processes, bioreactor scale-up, modes of bioreactor operation (batch, fed batch, continuous, dialysis culturing systems and perfusion systems).
Recombinant DNA technology for the production of insulin, growth hormones, vaccines
Biomass production: Production of single cell protein; analysis of the failures and successes in this field.
Industrial enzymes: Microbial production of industrial enzymes-glucose isomerase, protease etc.

Biopolymers (Microbial hydrocolloids): Structure/function relationships in microbial polysaccharides: properties of xanthan, bacterial cellulose and hyaluronic acid. Applications of microbially-produced hydrocolloids (gums) in food and other industries, including dextran from Leuconostocmesenteroidesand xanthiian from Xanthomonascampestris. Brief notes on bacterial plastics and PHAs.	
Biofilms: Microbial activity in aqueous environments occurs at solid-liquid or air-liquid interfaces. The nature and composition of biofilms. Beneficial applications in trickling bed filters, natural water purification and vinegar fermentation. Problems of bacterial biofilms in heat exchangers, aqueous fluid transport lines, dental surfaces etc. Role of biofilms in the natural environment.	
Downstream processing: recovery, extraction and purification of fermentation products.	
References	1. Edited by AnjanaMunshi, DNA Sequencing-Methods and Application Publisher: Janeza Trading, Crotia. 2. Jean Peccoud (ed), Gene Synthesis: Methods and Protocol, Methods in Molecular Biology, Vol 852, Publisher: Springer Science, 2012 (eBook). 3. The entrepreneur's guide: to patents, copyrights, trademarks, trade secrets & licensing. By Jill Gilbert. Berkley Books, 2004. (KF2980 .G55 2004, Library 4 West) 4. Kubr, T., Marchesi, H. and Ilar, D. (1998) Starting up. Achieving success with professional business planning. Zurich: McKinsey & Company, Inc., pp. 230 5. Comprehensive Biotechnology Vol. 1-4: M. Y. Young (Eds.), Pergamon Press. 6. Biotechnology: A Text Book of Industrial Microbiology: T. D. Brock, Smaeur Associates, 1990. 7. Industrial Microbiology: L. E. Casida, Willey Eastern Ltd., 1989. 8. Industrial Microbiology: Prescott & Dunn, CBS Publishers, 1987. 9. Bioprocess Technology- fundamentals and applications, S O Enfors& L Hagstrom (1992), RIT, Stockholm. 10. Biotechnology, Economic & Social Aspects: E. J. Dasilva, C. Ratledge& A Sasson, Cambridge Univ. Press, Cambridge. 11. Biotechnology-a hand book of industrial microbiology: W. Crueger and A. Crueger. 12. Microbial Biotechnology: A. N. Glazer and H. Nikaids.

14.2.4: Course Title: Aquatic Biotechnology

Course code: MBTC204

Credit Hours: 3

<table>
<tr>
<td>Rationale:This course will help to develop an understanding of commonly used culture systems, to become familiar with the fundamentals of fish and shellfish husbandry, and to gain an appreciation of aquaculture's roles in natural resource management, the human food supply, and the global economy. Understanding competitive ability principles of aquaculture and fisheries, affair in aquaculture production increasing methods, implementation of new technological innovation; able to flexibly respond to the business environment and technological developments and needs.

Course Objectives: The objectives of the course are to:

• To prepare competent/highly qualified and high caliber students of aquaculture technologies with broad range of knowledge in development principles of fisheries and aquaculture.
• 2. To make students capable of applying the modern methods and techniques in planning, design, management and operation of these farms.</td>
<td>Learning Outcomes: At the end of the course the students will be able to

• Understand qualitative inheritance – Selection of phenotypes in aquaculture.
• Understand genetics of quantitative inheritance.
• Understand hybridism – design of hybridism experiments in aquaculture.
• Appreciate inbreeding – incidences of inbreeding in aquaculture.
• Understand interaction of genotype with environment, genetic improvement for disease resistance.
• Understand how to control and induce gonadal maturation in fish.
• Learn mechanisms of sex determination, sex determination in fish.
• Understand induction of triploidy and tetraploidy.
• Understand androgenesis, gynogenesis.
• Learn methods of sex inversion, production of all-females and all-males fish populations.
• Understand marine sustainability and climate change i.e. impacts of exploitation, role of biodiversity, water quality and climate change measures.
• Appreciate the importance of disease diagnosis in aquaculture, and the applicability of RNAi and genome editing strategies to address diseases of fish, crustaceans and shellfish.
• Understand stress and disease diagnosis in aquaculture: detection of stress and disease, possibility of treatment via RNAi or genome editing.</td>
</tr>
<tr><td colspan="2">Course Content</td></tr>
<tr><td colspan="2">Biology and physiology of aquatic organisms and their pathology, fish farming.</td></tr>
<tr><td colspan="2">Selectingphenotypes in aquaculture. Interaction of genotype with environment. Genetic</td></tr>
</table>

improvement for disease resistance.	
Control and induction of gonadal maturation in fish	
Mechanisms of sex determination in fish. Induction of triploidy and tetraploidy	
Mechanisms underlying the process of making meiotic diploids and DH individuals, and problems associated with the making and characteristics of doubled haploids and clones in fishes	
Disease diagnosis in aquaculture, and the applicability of RNAi and genome editing strategies to address diseases of aquatic organisms.	
Towards the development of genetically modified fish, transgenic fish as experimental model, improving strains for aquaculture, enhancing the quality and safety of seafood, genetic techniques and aquatic organisms (e.g, anti-freeze proteins, green genes, cloning of genome of marine pathogens etc), genetic manipulations of finfish and shellfish, medical applications of aquatic biotechnology (bioprospecting to isolate medicine from sea), Nonmedical products (a potpourri of products, biomass and bioprocessing), Environmental applications of aquatic biotechnology (antifouling agents, biosensors, environmental remediation), controversies of aquaculture and genetically engineered species.	
References	1. Handbook on Fisheries and Aquaculture Technology; Printed and Published by Ajay Gupta. New Delhi. 2. Bagenal, T. (ed.). 1978. Methods of assessment of fish production in fresh water. Blackwell Scientific Publications Ltd. Oxford, IBP Hand b., (3): 365 pp. 3rd ed. 3. Bell, F.W. and E.R. Canterbury. 1976. Aquaculture for the developing countries: A feasibility study. Belinger Publ. Co., Cambridge, Mass. 264. 26 pp.

14.2.5: Course Title: Marine Natural Product
Course code: MBTC 205
Credit Hours: 3

Rationale: This course will explore natural product biosynthesis and will focus on metabolic pathways associated with prominent marine products to illustrate major metabolic trends in the marine environment. Students will gain deep insights into the major classes of marine secondary metabolites and the biosynthetic processes used in their creation. The course will make a study of the seas to discover a new generation of bioactive products for a variety of practical applications ranging from industry,	**Learning Outcomes:** At the end of the course, students will be able to: • Understand the scope of marine natural products and biotechnology application. • Understand marine resources (biological and chemical diversity), history of marine natural products, marine natural product classes. • Appreciate the chemical ecology of marine invertebrates. • Understanding the classification of chemical metabolites and chemical defence systems. • Understand the role of alkaloids in the

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<td>agriculture to health. It will help to develop an understanding of how large-scale collection, screening and discovery of novel marine natural products have propelled new chemical entities into the clinic. It will provide innovative approaches to marine-based biomedical research.

Course Objectives:

• To provide a detailed introduction to marine natural products (MNPs).
• To provide a fundamental understanding of the different classes of MNPS.
• To give an intriguing knowledge into the subject, focusing on the key improvements that have shaped the field.
• To introduce students to isolation, purification and structure elucidation of the bioactive secondary metabolites produced by marine organisms.
• To make students aware of the methods of natural products synthesis and synthetic methodology for bioactive compounds.</td>
<td>development of natural products.
• Isolate and analyze of marine natural products.
• Understanding the role of genomics in elucidating gene clusters.
• Understand the complex interactions between marine organisms leading to major advances in marine bio-products.
• Apply biosynthetic principles / knowledge to marine natural products (discovery, structure elucidation, enzymology, genetics, synthesis, etc.)
• Understand microbiological conversion of chemical compounds, activity guided isolation and fractionation.
• Comprehend recent development in the research on natural medicinal products.
• Understand extraction and isolation techniques: principle and applications of different extraction and isolation methods.
• Understand how drugs are made from sea resources: marine pharmacology and potential for novel chemical leads for treatment of diseases including the discovery of new pharmaceutical candidates from marine microbes.</td>
</tr>
<tr><td colspan="2">Course Content</td></tr>
<tr><td colspan="2">Diversity and evolution of secondary metabolism in marine organisms, classes of natural products</td></tr>
<tr><td colspan="2">Isolation, structure and biosynthesis of four main classes of secondary metabolites: polyketides</td></tr>
<tr><td colspan="2">shikimate derivatives, isoprenoids and alkaloids as well as metabolites of mixed origin.</td></tr>
<tr><td colspan="2">The polyketide pathway and polyketide synthases</td></tr>
<tr><td colspan="2">Non ribosomal peptides and amino acid-derived compounds and Non Ribosomal Peptide Synthetases (NRPS).</td></tr>
<tr><td colspan="2">Application of genomics to secondary metabolism. Identification of secondary metabolism gene clusters</td></tr>
<tr><td colspan="2">Fluorescent proteins from oceans as advanced imaging tools for biomedical research</td></tr>
</table>

References	1. Chemistry of Marine Natural Products, Author: Paul J. Scheuer, 2012. Academic Press. New York. 2. Handbook of Marine Natural Products. Editors: Fattorusso, Ernesto, Gerwick, William H., Taglialatela-Scafati, Orazio (Eds.), 2012, Springer. 3. Marine Natural Products: Chemical and Biological Perspectives, 1989, 1st edition. Editor: Paul J. Scheuer. Elsevier 4. Bioactive Marine Natural Products. 2005, Author: D. S. Bhakuni and D.S. Rawat, Publisher: Springer, New York, USA

14.2.6: Course Title: Lab Work 02

Course code: 206

Credit Hours: 2

Rationale: Lab work 02 is based on enhancing enquiry-based learning and encouraging students to work on tasks in small groups by applying and integrating knowledge from basic molecular biology, recombinant DNA technology, PCR technology and protein isolation and detection. **Course Objectives:** The objectives of the course • To enhance learning the theoretical and practical aspects of molecular biology, recombinant DNA technology, PCR technology and protein isolation and detection. • To make students familiar of the advanced molecular techniques and aware of laboratory ethics.	**Learning Outcomes:** At the end of the course the students will be able to- • Demonstrate nucleic acid isolation and agarose gel electrophoresis • Appreciate the conventional methods for isolation of nucleic acids - plasmid DNA – Genomic DNA from bacterial cells, plant tissue, blood–RNA isolation and mRNA purification – agarose gel electrophoresis – staining techniques – Pulse field gel electrophoresis • Understand PCR techniques: Principle of polymerase chain reaction (PCR)- Components of PCR reaction and optimization of PCR -Gene specific primer and degenerate Reverse transcription PCR and Real time PCR, Chemistry of primer synthesis. • Understand Hybridization Methods: Probes–Labeling of probes- non-radioactive probes - Detection techniques, Southern hybridization, Northern hybridization, Western blotting • Understand Protein Techniques: Electrophoresis of protein – native and denaturing conditions, gel electrophoresis, ELISA.

	• Understand sea water element analysis using AAS and ICP techniques.

Course Content

- Isolation of nucleic acids - plasmid DNA – Genomic DNA from bacterial cells, plant tissue, blood
- by conventional Methods and agarose gel electrophoresis
- RNA isolation and mRNA purification – agarose gel electrophoresis –
- staining techniques
- Pulse field gel electrophoresis
- Principle of polymerase chain reaction (PCR)-Components of PCR reaction and optimization of PCR - Gene specific primer
- degenerate Reverse transcription PCR and Real time PCR,
- Chemistry of primer synthesis.
- Probes–Labelling of probes- non-radioactive probes
- Detection techniques, Southern hybridization, Northern hybridization, Western blotting
- Electrophoresis of protein – native and denaturing conditions, gel electrophoresis
- ELISA.
- Water element analysis using AAS and ICP techniques.

References	1. J. Sambrook, E.F. Fritsch, T. Maniatis. Molecular Cloning: A Laboratory Manual (Vol. 3) 2nd edition. Publisher: Cold Spring Harbor

14.2.7

Course Title: Viva-voce

Course code: MBTC 207

14.3: Semester 3

3rd Semester (18 Credits)			
MBTC 301	Entrepreneurship in Marine Biotechnology	**2.0**	**30**
MBTC 301	**Internship**	2.0	
MBTC 302	**Dissertation**	14.0	
	Total Credits	**18**	
	Grand Total Credits	**54**	

14.3.1: Course Title: Entrepreneurship in Marine Biotechnology
Course code: MBTC 206
Credit Hours: 2

Rationale:	**Learning Outcomes:**
This course will cover aspect such as: intellectual property protection (IPP), technology commercialization and licensing deals, market analysis training, analysis of competition in the market etc. The course will also cover; finding potential customers in the market, designing pilot trials, business models, evolution of the company values, striating partnership and alliances.	• Demonstrate major consideration in establishment of marine biotechnological start-up • Understand the intellectual property • Display business potential • Understand the management for a marine biotechnological start-up company • Understand new business in marine biotechnology and how to raise seed money • Understand the development process of

<table>
<tr><td>Course Objectives: The objectives of the course are to:
To enhance learning the theoretical and practical aspects of entrepreneurship in the sector of marine biotechnology.
To encourage the process of multiple stages since the initiation of the novel technological idea till the establishment of a successful start-up company.
To promote collaboration with national and International industries and how to protect Intellectual Property Rights (IPR) for commercialization.</td><td>marine biotechnological tools for biological and medical sector
Demonstrate ethical concerns regarding the use of marine biotechnology
Understand the Intellectual Property Protection (IPP) of marine derived products</td></tr>
<tr><td colspan="2">Course Content</td></tr>
<tr><td colspan="2">Marine biotechnology in Bangladesh and the world,</td></tr>
<tr><td colspan="2">Major consideration in establishing biotechnological start-ups, IPR and fundamentals to preserve intellectual property right.</td></tr>
<tr><td colspan="2">Mechanisms for raising seed funds for a new company set-up and understanding business potential.</td></tr>
<tr><td colspan="2">Development processes of biological drugs, and ethical issues regarding the use of marine organisms.</td></tr>
<tr><td colspan="2">Meet inventors and investors, entrepreneurs, national think tank to seek advice for investments in a new company.</td></tr>
<tr><td>References</td><td>Biotechnology Entrepreneurship 2nd Edition by Craig Shimasaki Elsevier
Handbook of Marine Biotechnology by Kim, Se-Kwon, Springer</td></tr>
</table>

14.3.2: Internship: MBTC302

Course Code: MBTC302

Credits: 2.0

14.3.2: Dissertation: MBTC303

Course Code: MBTC303

Credits: 14.0

Contact Hours: 150
Research based Dissertation.