Faculty of Science
University of Jaffna
Proposed New Degree Structure for BSc Hons in Molecular Biology, Biochemistry and Biotechnology

1.0.PREAMBLE

The Jaffna Campus of the University of Sri Lanka was established in 1974 with a ceremonial inauguration on 6th October 1974. Under the University Act No. 16 of 1978, the Jaffna Campus gained the status of an independent University in January 1979 and became the University of Jaffna.

The Faculty of Science was set up in October 1974 at Vaddukoddai in the premises taken over from the Undergraduates' Section of the Jaffna College. A course in Mathematics and Statistics was offered initially. After the appointment of Heads of Departments and a few Assistant Lecturers for some of the other disciplines in Science, courses in physical science and bioscience were started in 1975. Later, the Faculty of Science was shifted to current premises in 1978. Currently, the faculty has seven academic departments, namely, Botany, Chemistry, Computer sciences, Fisheries, Mathematics and Statistics, Physics, and Zoology.

The faculty offers BSc and BSc subject-specific honours degree programmes along with BSc honours degree programmes in Computer Science and Applied Sciences. The medium of instruction in the faculty is English or Tamil.

The faculty is enriched with subject-specific laboratories and other physical resources to cater for the students and in the process of developing more facilities as well.

2.0.JUSTIFICATION

The importance of diversifying the degree programmes in a faculty is a long-discussed priority. Intending to increase the intake of undergraduates and to establish the faculty as one of the regional centers of excellence in molecular biology teaching and research are two major driving forces behind the development of this new course. Besides, the proposed new degree will cater to the modern, global job market with the graduates produced through this degree programme. With the introduction of molecular biology into the school curriculum, there is a market need for the graduates specialized in the subject as well.

3.0.Vision and Mission Statements of the Faculty

3.1.VISION

"The vision of the faculty is to be recognized center of science learning in Sri Lanka".

3.2.MISSION

"The mission of the faculty is to produce competent graduates who excel in learning and research in basic sciences and who could contribute to the development of the nation".

4.0.Aims and Objectives Of The Programme

The programme is designed to provide learners an opportunity to develop into a biologist with in-depth knowledge of theoretical and practical components in molecular biology and biochemistry. The programme is designed with the framework within the SLQF standards and subject benchmark statement for the relevant subjects; Botany, Chemistry, and Zoology.

5.0.Graduate Profile

The Faculty of Science aims to instill in its graduate competencies in the subject discipline, personal and professional skills and citizenship attributes through its teaching and research activities and enhancement of the advice and support services, and cultural, social, and sports-related extracurricular activities. The faculty is committed to working hard to create the graduates with three different attributes namely; Discipline-specific competencies, Personal and professional skills, and Citizenship Attributes.

After the completion the graduates will have the ability to;

(i) undertake higher study at the postgraduate research level in their chosen field;
(ii) continue developing personally and professionally in their careers as a biochemist and/or molecular biologist; and
(iii) make potentially innovative, and important contributions to the country as an entrepreneur

The core abilities developed by degree programme will be;

Discipline-specific competencies

- In-depth knowledge in the subjects
- Independent and Life-long learning capabilities to update the knowledge base
- Appreciate and embrace modern development in the field of study
- Critically examine and analyze the problems
- Ability to solve the real-world problems related in the field of study with the synthesized knowledge
- Do scientific research with confidence

Personal and professional skills

- Apply gained knowledge in a wider context and real life
- Able to work in groups and being a leader with organizational skills
- Critique and evaluate the existing ideas
- Create original knowledge
- Effectively communicate science with different audiences
- Have modern, flexible and transferable skills

Citizenship Attributes

- Being ethical and moral in scientific activities and knowledge dissemination
- Being socially responsible, with civic consciousness
- Speak up for the good cause using the knowledge
- Committed for regional development
- Having high regard for human rights, equity, and ethics

6.0.Programme Outline

The programme is designed to meet the SLQF level 6. The programme consists of four years of coursework, laboratory and/or field sessions, industrial visits, and research. The courses are designed with the contribution of four departments, namely, Botany, Chemistry, Computer Science, and Zoology. Besides, skill development activities such as presentations and career guidance are also included in the curriculum.

7.0.The Structure of the Bachelor Degree Programme In Molecular Biology, Biochemistry, and Biotechnology in the Faculty of Science, University of Jaffna

7.1.Degrees

The Faculty offers a Bachelor's degree of three years duration (traditionally referred to as the General degree) and Bachelor's Honours degree of four years duration (one type of which is traditionally referred to as the Special degree).

The proposed Bachelor Degree Programme in Molecular Biology, Biochemistry, and Biotechnology is a three-year programme. Students will be selected to follow the fourth year based on the GPA at the end of the third year. The number of students selected to follow the fourth year shall be based on the available resources.

Biological Science stream students who have passed the G.C.E. (A/L) Examination and have satisfied all the respective entrance requirements will be admitted to the Bachelor's Degree Programme in Molecular Biology, Biochemistry, and Biotechnology by the University Grants Commission (UGC).

The medium of instruction is English.

The name of the degree shall be:

For the students who graduated after the third year: Bachelor of Science in Molecular Biology, Biochemistry and Biotechnology abbreviated as ***BSc (Molecular Biology, Biochemistry, and Biotechnology)***

For the students who graduated after the fourth year: Bachelor of Science Honours in Molecular Biology, Biochemistry, and Biotechnology abbreviated as ***BSc Hons (Molecular Biology, Biochemistry, and Biotechnology)***

7.2.Academic year, SLQF Levels and Faculty Descriptors

An academic year consists of two semesters, Semester 1, and Semester 2. The duration of each semester is 15 weeks, excluding any university approved vacation and periods of examinations (Table 1).

Table 1

	1st half*	**Mid-semester vacation**	**2nd half***	**Examination and Vacation**
1st Semester	8 weeks	1 week	7 weeks	6 weeks
2nd Semester	8 weeks	1 week	7 weeks	11 weeks

Different years of study are also indicated by the corresponding Sri Lanka Qualifications Framework (SLQF) levels and the faculty levels. These are given in Table 2.

Table 2

Year of Study	**SLQF Level**	**Faculty Descriptors**
First Year	SLQF Level 3	Level 1
Second Year	SLQF Level 4	Level 2
Third Year	SLQF Level 5	Level 3
Fourth Year	SLQF Level 6	Level 4

7.3.Subjects

7.3.1. Principal Subjects

The programme is offered by four departments, Botany, Chemistry, Computer Science, and Zoology.

7.3.2. English

The Faculty will arrange, with the help of the Department of English Language Teaching (DELT), to conduct 60 hours (2 hours per week) of English Language course during each of the first year and second year. A student should attend at least 80% of the classes.

7.3.3. Life Skills and Career Fair

The Faculty will arrange these programmes after the first half of the Second Semester in the first three years.

7.4.Courses

Courses in the Faculty are offered in the form of credit valued modules, based on SLQF, generally known as course units.

- For courses consisting of theory only, 15 hours of lectures and tutorials are equivalent to one credit.
- For courses involving laboratory work, 15 practical sessions each of 2 -3 hours duration is equivalent to one credit.
- The credit values of courses that have both theory and practical components are calculated by giving due weight to the components accordingly, as stipulated above.
- For courses involving fieldwork or industrial training, the assigned credit value shall be given in the approved syllabi
- For Research Projects the assigned credit value should be at least 6.

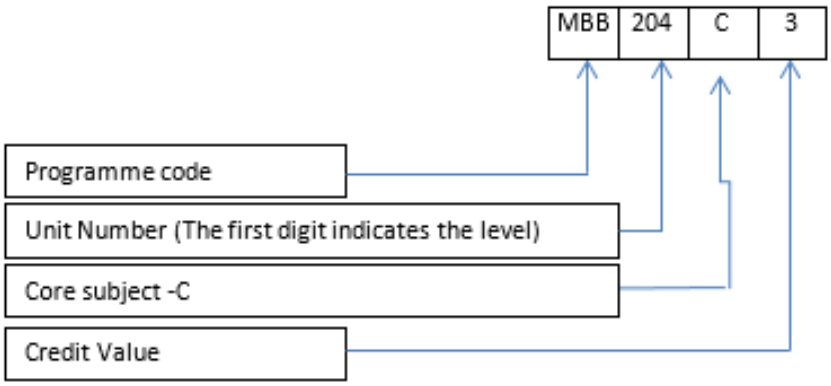
A course shall be of the credit value of any whole number from 1 to 8.

At each level a student should offer course units totaling to 30 credits* and attend at least 80% of the lectures and practical classes conducted in each course unit. He/She should sit for all the In-course Assessments and End of Semester examinations in those courses.

7.4.1. Course unit codes

Each course unit will be designated by a code made up of three letters indicating the programme.

Ex.



Example: MBB101G2: Origin of Life and Evolution

7.5.Selection to Four Year Degree Programmes

The selection to Four Year Degree Programmes is done at the end of the third year.

At the end of their third-year students may apply for admission to an Honours Degree programme.

The number of students admitted may be limited depending on the resources available.
However, students with the following **minimum** qualifications may apply.

- An overall GPA of 2.00 in the Levels 1G, 2G and 3G (First Semester only for Level 3G) combined

7.6.Evaluation Procedures and Examinations

Each course unit shall be evaluated using at least one In-course Assessment and an End of Course examination. For course units that run throughout the academic year, the End of Course examination shall be conducted at the end of the second semester.

For course units that have a practical component, there shall be an In-course Assessment and an End of Course examination in each of the theory component and the practical component. To secure any grade higher than E for the course unit, a student should obtain at least a D^+ Grade in the theory component and at least a D^+ Grade in the practical component.

Evaluation procedures for Research Project, Seminar, Field Work, and Industrial Training will be determined by the concerned Department (subject to the approval of the Faculty Board and the Senate) and will be included in the syllabi.

7.6.1. In-course Assessment

Each theory course and each course containing a theoretical component will be tested by at least one written examination of a minimum duration of half an hour. The time-table and the form of the examination will be announced by the respective departments.

In course Assessments of the practical course units and practical components of the course, units will be conducted during the semester (that is, during the first half or the second half). The time-table and the form of the examination will be announced by the respective departments.

The marks scored by the students in a particular In course Assessment shall be displayed in the Notice Board of the Department.

A student shall take an In course Assessment at the first opportunity afforded to him/her. If a student could not sit for an In-course Assessment he/she should inform the reason to the Head of the Department within three days of the date of resumption of attending the classes. If the reason is acceptable the Head of the Department shall arrange to hold that particular In-course Assessment on another date.

No In-course Assessment shall be conducted after the completion of the End of Semester examination in the relevant course unit.

7.6.2. End of Course Examination

An End of Course examination shall be conducted at the end of the semester for each course unit completed in that semester.

A student shall take an End of Course Examination at the first opportunity afforded to him/her. If a student fails to sit for any examination without giving valid reasons acceptable to the University Senate, he/she shall be considered to have forfeited a chance to sit the examination.

Absence at the End of Course Examination due to medical grounds or any other valid reason should be approved by the Faculty Board and the Senate. Medical certificates submitted by the students will be sent by the Dean's Office for the recommendation of the University Medical Officer.

Depending on the marks (for a total of 100) received by a student he/she shall be awarded one of the following Grades. The Grade Point Value (GPV) corresponding to each Grade is also given (Table 4).

Table 4

Grade	Marks	GPV
A^+	85 - 100	4.00
A	75 - 84	4.00
A-	70 - 74	3.70
B+	65 - 69	3.30
B	60 - 64	3.00
B-	55 - 59	2.70
C+	50 - 54	2.30
C	45 - 49	2.00
C-	40 - 44	1.70
D+	35 - 39	1.30
D	30 - 34	1.00
E	0 - 29	0.00

The marks for each unit or component of a unit (in the case where a course unit has both theory and practical components) shall be calculated by giving a weight of 70% to the End of Course examination and 30% to the In-course Assessment. When a course unit has the theory and practical components the final marks will be calculated by giving appropriate weights to these components.

A Pre-Examination Board of the Faculty constituted for each course shall finalize the results of that course. After this, the Grades obtained by the students in a particular course unit shall be displayed by the Dean with a note that the results are provisional and subject to confirmation by the Faculty Examination Board and the Senate.

The Grade Point Average (*GPA*) for a particular level is calculated using the formula,

$$GPA = \frac{\sum c_n g_n}{\sum c_n}$$

where c_n and g_n are the credit value and the grade point value of the n^{th} course unit. Any calculated *GPA* shall be rounded to the second decimal place. $\sum c_n$ will be 30 for any level.

7.6.3. Examination in English

An examination in English will be conducted at the end of Level 2. A student who has obtained a grade of D^+ or above in the examination is deemed to have passed the examination.

7.6.4. Repeating Examinations

If a student is absent for an End of Course examination of a particular course for reasons acceptable to the University Senate, then he/she can sit for that examination in the next opportunity and it will be considered as the first attempt. His/her present results will be recorded as WH (Withheld).

If a student is absent for an End of Course examination of a course and if the Senate does not accept the reasons submitted by the student or if the student did not give any reason, the student may repeat that examinations, and the maximum grade obtainable is C. His/her present results will be recorded as IC (Incomplete).

Table 5 summarizes what is stated in the two paragraphs above.

Table 5

Senate Decision on Student's appeal	Marks for End of Course Examination	Final Marks	Grade
Accepted	AB (Absent)	AB (Absent)	WH (Withheld)
Not accepted (also for no appeal)	AB (Absent)	AB (Absent)	IC (Incomplete)

A student will be permitted to repeat an examination only two times. The maximum period allowed for completing the three-year degrees shall be five academic years and that for the four-year degrees shall be six academic years excluding the period(s) of absence approved by the Senate.

7.7.Criteria for Awarding Degrees

Bachelor's degree (three years)

The conditions given in this section apples to the following degrees.
Bachelor of Science in Molecular Biology, Biochemistry and Biotechnology abbreviated as **BSc in Molecular Biology, Biochemistry, and Biotechnology**

For the award of the degree a student should possess:
(i) Pass in English
(ii) Grade D^+ or above in course units amounting to 81 credits or more subject to the condition that the total credit value of the courses in which the student obtains D or E in any level is not more than 4, and
(iii) Overall GPA (OGPA) of 2.00 or above.

Bachelor's Honours degree (Four Years)

The conditions given in this section applies to the following degrees.
Bachelor of Science Honours in Molecular Biology, Biochemistry, and Biotechnology abbreviated as **BSc Hons. In Molecular Biology, Biochemistry and Biotechnology**

For the award of the degree a student should possess:
(i) Pass in English
(ii) Grade D^+ or above in course units amounting to 108 credits or more subject to the condition that the total credit value of the courses in which the student obtains D or E in any level is not more than 4, and
(iii) Overall GPA (OGPA) of 2.00 or above.

7.8.Award of Class

Any student who followed the three-year degree programme and has fulfilled the requirements for the award of the BSc degree within three consecutive academic years excluding the period(s) of absence approved by the Senate, and any student who followed the four-year degree programme who has fulfilled the requirements for the award of the BSc Honours degree within four consecutive academic years, excluding the period(s) of absence approved by the Senate, shall be awarded Class on the following basis.

First Class	OGPA 3.70 or above
Second Class (Upper Division)	OGPA 3.30 or above
Second Class (Lower Division)	OGPA 3.00 or above

7.9.Fall-back options

Whenever a student is unable to fulfill the requirements for the award of a degree, he/she may be awarded any one of Diploma or Higher Diploma on request provided he/she satisfies the requirements.

For the award of Diploma, a student should possess a GPA of 2.00 or above calculated for all the course units in which the student has scored the highest grade and whose credit values aggregate to 30.

For the award of Higher Diploma, a student should possess a GPA of 2.00 or above calculated for all the course units in which the student has scored the highest grade and whose credit values aggregate to 60.

The qualification shall be designated as:
Diploma in *Molecular Biology, Biochemistry and Biotechnology abbreviated* as Dip (*Molecular Biology, Biochemistry, and Biotechnology)*, and
Higher Diploma in *Molecular Biology, Biochemistry and Biotechnology* abbreviated as HDip (*Molecular Biology, Biochemistry, and Biotechnology)*

7.10. Effective Dates of the Qualifications and Official Transcripts

The effective date of the Degrees awarded shall be the date on which the last of the End of Semester examinations of the corresponding final level examinations had been conducted in the academic year in which the candidate satisfied all the requirements for the award of Degree or the date on which the student had satisfied all the requirements for the award whichever is later.

In the case of Higher Diplomas and Diplomas, the effective date shall be the date at which the request has been received at the Dean's office.

In addition to the results sheets given to students after releasing the results of the examination results in a particular level, a student will be issued the Official Transcript. The Official Transcript shall contain all the course codes, names of the course units, the credit value of each course unit, and the grade obtained by the student in each course unit in a year-wise manner.

The Official Transcript shall also include the highest SLQF Level completed, overall GPA, the Class (if any), and a Table showing the Grade Point Value (GPV) assigned to each Grade.

8.0.SYLLABI

Level	Zoology	C	Botany	C	Chemistry	C	Computer Science	C
Level 1	Origin of Life and Evolution	02	Basic Biology	02	Biochemistry	02	Introduction to Bioinformatics	03
	Animal cell Biology and cell signalling	02	Plant Morphology and Systematics	02	Principles in Chemistry	02	Introductory computational Biology	03
	Science communication	02	General Microbiology	02				
	Animal Histology and tissue culture	02	Molecular Biology and Biotechnology	02				
			Biomathematics and Statistics	02				
	Diversity and Taxonomy			02				
TOTAL=30 credits								
Level 2	Animal phylogeny and biology	03	Molecular plant microbial interactions	02	Molecular Spectroscopy	03		
	Molecular genetics	02	Enzyme technology	02	Biochemistry Practical	03		
	Molecular laboratory techniques	02	Plant Biochemistry	02				

	Forensic biology	**02**	**Genetics**	**02**				
	Molecular Biomedical sciences	**02**	**Protein structure and function**	**02**				
	Animal physiology	**03**						
TOTAL=30 credits								
Level 3	**Molecular Embryology**	**02**	**Plant tissue culture**	**02**				
	Parasitology and medical entomology	**03**	**Molecular plant pathology**	**03**				
	Molecular immunology	**02**	**Genetic engineering**	**03**				
	Molecular toxicology	**02**	**Biotechnology**	**03**				
	Entrepreneurship	**02**	**Plant Breeding**	**02**				
			Plant physiology	**02**				
	Seminar and current topics			**02**				
	Group project			**02**				
TOTAL=30 credits								
Level 4	**Molecular ecology**	**3**	**Molecular plant virology**	**02**				
	Molecular phylogeny	**2**	**Applied microbiology**	**03**				
	Gene editing technology	**2**	**Environmental Biotechnology**	**03**				

	Nano biotechnology	**2**	**Fermentation technology**	**03**				
	Neurobiology	**2**						
	Research methodology			**02**				
	Research			**06**				
TOTAL=30 credits								
OVER ALL 120 credits								

Level 1

Zoology

Semester	First		
Title of the Course Unit	Origin of Life and Evolutionary Biology		
Course Code	MBB101C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	24	55hrs (Library work; group assignments; report writing; seminars on case studies and current topics)	21
Objective/s	• Introduce major principles of origin of life and evolution of life forms on earth		
Intended Learning Outcomes	• Describe molecular and biochemical process involved in origin of life • Explain theories and concepts of evolution • Identify evolution as the force driving for the continuity of life on earth • Explain the process of speciation and case studies related to the subject • Recognize different theories explaining evolution and speciation		
Contents	Introducing different theories and concepts in origin of life; Scientific merit of each theory Biochemical and molecular aspects and process led to the formation of life on earth; Historical background, modern theories, process and concepts involved in evolution – variation, natural selection, reproductive isolation and speciation Different types of speciation		
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, field based studies, take-home assignments, seminar and oral presentation by students, Problem based learning, debates, laboratory sessions		

Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	• Freeman Dyson.Origins of Life.Cambridge University Press.1997 • Nicholas H. Barton et al. Evolution. Cambridge University Press. 2007

Semester	First and Second		
Title of the Course Unit	Animal cell biology and cell signaling		
Course Code	MBB102C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	21	55 hrs (Library work; group assignments; report writing; seminars on case studies and current topics)	24
Objective/s	• Identify and describe the animal cellular components and their function		
Intended Learning Outcomes	• Classify the organelles in different types of animal cells • Explain the function of organelles and organization of cells in animals • Describe different kinds of bio-molecules found in animal cell • Recognize the types of enzymes, enzymatic inhibitors and the kinetic properties • Identify the cell signaling pathways in animal cellular communication		

Contents	Molecular structure of cells and organelles Cell structure and function in animals (invertebrates and vertebrates), Cell cycle, cell growth, cell death, micro filaments, microtubules, transport, cell migration and recent advances. Cellular communication: Cell signalling pathways and characteristics: receptors, signalling molecules and their roles
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, field based studies, take-home assignments, seminar and oral presentation by students, laboratory sessions
Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	• Spier, R. E. and J. B. Griffiths . Animal Cell Biotechnology. Elsevier Ltd. 1994 • Michael Butler. Animal Cell Culture and Technology. 2012 • Hancock, J. T. Cell signaling. Oxford University Press. 2017 • Wilson, K. and Walker, J.(Ed) . Principles and Techniques of Biochemistry and Molecular Biology (7th Edison). Cambridge University Press. 2010

Semester	First		
Title of the Course Unit	Scientific communication skills		
Course Code	MBB103C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	30	70hrs (Library work; group assignments; report writing; seminars on case studies and current topics)	00
Objective/s	• Practice English language skills in Listening, Reading & Writing for scientific communication effectively		
Intended Learning Outcomes	• Demonstrate effective listening, reading and speaking skills. • Analyze scientific material, take notes and make written summaries • Create essays based on scientific material and topics • Demonstrate effective presentation skills. • Analyze and critique scientific material in effective academic discussion • Make oral and written reports • Create different types of presentations of scientific material including posters and powerpoint.		
Contents	Listening and reading scientific material, taking notes and writing summaries, and presenting oral reports. Writing essays and/or reports. Listening and reading scientific material, taking notes and writing and presenting summaries. Writing essays and/or reports; Critical review of science; Effective presentation skills.		
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, field based studies, take-home assignments, seminar and oral presentation by students, laboratory sessions		

Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%)
Recommended References	Hargie, O. (Ed.). The handbook of communication skills. Psychology Press. 1997 E resources:https://www.nature.com/scitable/ebooks/english-communication-for-scientists-14053993/contentshttp://www.bbc.co.uk/learningenglish/

Semester	Second		
Title of the Course Unit	Animal Histology and Tissue culture		
Course Code	MBB104C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	24	55 hrs (Library work; group assignments; report writing; seminars on case studies and current topics)	21
Objective/s	• Recognize the characters and distribution of tissue from lower invertebrates up to higher vertebrates and to learn the histological techniques. • Impart the skills of laboratory techniques in cell and tissue culture.		
Intended Learning Outcomes	• Identify the tissue types and their distribution on the animal's body. • Describe the distribution of tissues with respect to their characteristic features. • Describe the laboratory techniques in histology.		

	• Explain the principles of animal cell and tissue culture and their applications
Contents	Tissues morphology and functions in epithelia, connectives tissues, muscle tissues and nervous tissues, their anatomical organizations in organ systems, their distribution and complexity from invertebrates to vertebrates ; Microscopy; Histological laboratory techniques: fixation, sectioning and microtomy and various staining procedures Cell and tissue culture techniques: isolation, propagation and maintenance of animal cell and tissue culture. Application of cell and tissue culture in genetic engineering, biotechnology and toxicology.
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, field based studies, take-home assignments, seminar and oral presentation by students, laboratory sessions
Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	• Functional Histology; P R Wheater, H G Burkitt and V G Daniels. Longman Group UK Ltd, Hong Kong; 3rd Edition. 1994 • Invertebrate Zoology; P. A. Meglitsch. Oxford University Press, USA. 2nd edition.1972 • Invertebrates; R. C. Brusca and G. J. Brusca. Sinauer Associates, Inc., Publishers, USA. 2nd Edition. 2002 • Histology: A text anx atlas, with correlated cell anxmolecularbiology. 7th edition. Wolters Kluwer Health Harper & Row, publisher, J.B.Lippincott Company.2016 • Bancroft, John D., and Marilyn Gamble, eds. Theory and practice of histological techniques. Elsevier health sciences, 2008. • Wilson, K. and Walker, J.(Ed) . Principles and Techniques of Biochemistry and Molecular Biology (7th Edison). Cambridge University Press. 2010

Level 1

Botany

Semester	First		
Title of the Course Unit	Basic Biology		
Course Code	MBB105C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	22	54 hrs (Library work; group assignments; report writing)	24
Objective/s	• Provide knowledge on cell structure and function • Introduce the macromolecules in the cell • Impart knowledge on cell cycle • Introduce the fundamentals of protein synthesis		
Intended Learning Outcomes	• Explain the cell structure and function • Discuss the macromolecules present in the cell • Recall the stages of cell division • Illustrate the stages in protein synthesis		
Contents	Introduction, scientific method; Prokaryotic and eukaryotic cells; Cell types; Cell architecture; Ultra structure of cell organelles and membranes: cell wall, cell membrane, nucleus, mitochondria, chloroplast, endoplasmic reticulum, ribosomes, golgi apparatus, cytoskeleton; Cell cycle and cell division; Structure of macromolecules: carbohydrate, protein and nucleic acids; DNA replication and protein synthesis; Structure and function of genes; Laboratory exercises based on above topics.		
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, take-home assignments, seminar and oral presentation by students, laboratory sessions		
Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%)		

	Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	• Carol Leth Stone. The Basics of Biology (Basics of the Hard Sciences). Greenwood press. 2004. • Harvey Lodish, Arnold Berk, Chris A. Kaiser, Monty Krieger, Anthony Bretscher, Hidde Ploegh, Angelika Amon, Matthew P. Scott and Kelsey Martin. Molecular Cell Biology, W. H. Freeman and Company. 2016 • George Plopper. Principles of Cell Biology. Jones & Bartlett Learning. 2014.

Semester	Second		
Title of the Course Unit	Plant Morphology and Systematics		
Course Code	MBB106C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	22	54 hrs (Library work; group assignments; report writing)	24
Objective/s	• Provide the fundamentals in morphology of Angiosperms • Provide knowledge on the basic principles of plant systematic and evolutionary history • Impart knowledge on trends in modern systematics		
Intended Learning Outcomes	• Explain the structure and function of plant parts • Explain the different types of system of classification		

	• Outline the role of phonetic and molecular characters of plants in Systematics • Demonstrate the method of herbarium preparation and preservation • Compare the selected plant families of Angiosperms
Contents	Reproductive morphology and vegetative (stem, root and leaf) morphology of plants; Embryogenesis. General definitions, nomenclature of plants; Principles of taxonomy; Taxonomic hierarchy; Phenetics; Cladistics; Different types of taxonomy; Systems of classification; Phylogeny of Angiosperms; Cladograms; Morphological, palynological, anatomical, phytochemical and molecular data; Trends in modern systematics; Role of systematics in biodiversity conservation and Management; Preparation of Herbarium specimens: collection of plant specimens, preservation, preparation of herbarium specimen and labeling; Use of keys for identification of flowering plants; Vegetative and floral characteristics of selected plant families of Angiosperms; Laboratory exercises based on above topics.
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, take-home assignments, seminar and oral presentation by students, laboratory sessions
Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	• Renu Edwin, Sekar. T, Sankar. P and Munusamy. Botany, Higher Secondary Second Year. Tamil Nadu Text Book Corporation. 2005. • Sing L.G. Plant Systematics an Integrated approach. Science Publishers. 2010. • Renu Edwin, Sekar.T, Sankar. P, and Munusamy S. Botany Higher Secondary Second Year, Tamil Nadu Text Book Corporation. 2005.

Semester	Second		
Title of the Course Unit	General Microbiology		
Course Code	MBB107C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	22	54 hrs (Library work; group assignments; report writing; field visits)	24
Objective/s	• Introduce the basic concepts in microbiology • Impart skills in microbiology techniques • Provide the fundamentals in the enumeration of microorganisms		
Intended Learning Outcomes	• Recall the structure, function and diversity of microorganisms • Classify the various groups of microorganisms • Apply the basic techniques in microbiology • Explain the role of control agents on microbial growth		
Contents	Introduction and scope of microbiology: discovery and diversity of microorganisms, classification of microorganisms; Enumeration of microorganisms; Structure and function of a microbial cell; Staining of bacteria and fungi; Sterilization techniques; Culturing, isolation, purification, characterization and identification of microorganisms; Microbial metabolism; Growth of microorganisms: bacterial growth curves, batch and continuous culture systems, factors influencing microbial growth; Concepts on controlling microorganisms: chemical		

	and physical antimicrobial agents, kinds and modes of action of antibiotics, antibiotic resistance; Laboratory exercises and field visits based on above topics.
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, take-home assignments, field based studies, seminar and oral presentation by students, laboratory sessions
Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	• Michael T.M, John M.M, Paul V. D and David P. C. Brock Biology of Microorganisms. Pearson Benjamin Cummings. 2009. • Tiwari R.P., Hoondal, G.S and Tewari R. Laboratory Techniques in Microbiology and Biotechnology. Abhishek Publications. 2009. • Ian Pepper, Charles Gerba and Terry Gentry. Environmental Microbiology Academic Press. 2014.

Semester	First -Second		
Title of the Course Unit	Molecular Biology and Biotechnology		
Course Code	MBB108C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	30	70 hrs (Library work; group assignments; report writing; field visits)	00
Objective/s	• Introduce the concept of biotechnology • Provide knowledge on complexity of genome • Screening for vectors and clones		

	• Impart skills on various electrophoretic techniques • Introduce the fundamentals of cloning
Intended Learning Outcomes	• Recall the fundamental concepts pertaining to basic principles of biotechnology • Interpret the structure and function of gene • Compare various vectors and selection of clones • Apply the electrophoretic techniques for the separation of nucleic acids and proteins • Build expression clones
Contents	Structure of Nucleic acids, Genome complexity, Extraction of plant, Plasmid, Animal and Phage DNA, RNA extraction, Restriction, digestion and ligation, Linkers, adapters, Gel electrophoresis, Polymerase chain Reaction, vectors, cloning, introduction to libraries, screening of clones, screening by DNA hybridization, blotting techniques, molecular markers, DNA finger printing, transgenic plants and animals.
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, take-home assignments, field based studies, seminar and oral presentation by students, laboratory sessions
Evaluation/Assessment Strategy	In – course assessment/s: 30% End of Course Examination: 70%
Recommended References	• Brown, T. A. Gene Cloning and DNA Analysis: An Introduction. John Wiley & Sons.2013 • Ravi Pathak.Introduction to Biotechnology. Atlantic publishers. 2007. • Bhabendra Kumar Patnaik, Tarani Charan Kara, Soumendra Nath Ghosh and Abhaya Kumar Dalai. Textbook of Biotechnology. Tata Mcgraw Hill. 2012.

Semester	Second		
Title of the Course Unit	Biostatistics		
Course Code	MBB109C2		
Credit Value	02		
Core/Optional	Core		
Hourly Breakdown	Theory	Independent Learning	Practical
	30	70 hr (Library work; group assignments; report writing)	00
Objective/s	Provide knowledge to correctly prepare experiments, verify conclusions and properly interpret results.		
Intended Learning Outcomes	• Recall variables, probability distributions, basic statistical tests and experimental designing • Explain how to analyze statistical problems and designing experiments • Perform data analysis by using statistical packages		
Contents	Introduction, Variables; populations and samples; descriptive statistics; probability distribution (binomial, poisson& normal probability distribution); Z score, t-distribution, hypothesis testing (Chi - square test, paired & unpaired t-test), ANOVA, Experimental designs: CRD, RCBD and LSD, correlation and regression; use of statistical package for data analysis (e.g. Minitab)		
Teaching learning Methods/Activities	Lecturers, tutorial discussion, practical demonstration		
Evaluation methods	In-Course Assessments (30%): End of Course Examination (70%)		
Recommended References	• Benard R. Fundamentals of Biostatistics.Cengage Learning. 2016. • Mcdonald J. H. Hand Book of Biological Statistics. Sparky publishing. 2014.		

Botany and Zoology

Semester	First		
Title of the Course Unit	Diversity and Taxonomy		
Course Code	MBB110C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	15	55 hrs (Library work; group assignments; report writing; seminars on case studies and current topics)	30

Objective/s	• Introduce the features and diversity of cyanobacteria, algae, fungi, bryophytes, vascular plants, and animals. • Recognize different concepts and applications of taxonomy • Impart knowledge on the evolutionary tendencies and life cycle patterns among the above groups.
Intended Learning Outcomes	• Describe the different types of taxonomy • Distinguish different groups of organisms based on morphology • Identify an organism based on their morphology • Define the basic concepts of hierarchical classification • Describe the levels of organization and body plan • Identify general characteristics of microbes, animal and plant groups • Identify skills in collection and preservation of animals from their specific habitats • Explain adaptive radiation • Describe the life cycle pattern of cyanobacteria, algae, fungi, bryophytes and lower vascular plants • Explain the differences between the above groups of plants • Express the importance of microbes, plants, and animals to human wellbeing
Contents	Introduction to animal kingdom; hierarchical classification General characteristics of animal phyla and variety of animal forms - organization of animal body plan; symmetry; segmentation; size and complexity; Characteristic morphological features from different classes of protozoa through mammals. Animal classification based on external anatomical features, variations among the groups, their roles in the environment, their specific habitats and adaptations for their habitats. Observation and investigation of living and preserved specimens Cyanobacteria: cell structure and differentiation, morphological diversity, cyanobacterial associations; heterocyst and nitrogen fixation; Algae and Fungi: characteristic features, classification, Representative genera of major algal groups, characteristic features, , reproduction, ecology, life cycle patterns Characteristics features, habitat, habit, distribution and adaptations, Classification, life cycle patterns and evolutionary tendencies of Bryophytes, Pteridophytes, Gymnosperms and Angiosperms, Economic importance of each group of organisms.

Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, field based studies, take-home assignments, seminar and oral presentation by students, laboratory sessions
Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (5MT+5MP)/10
Recommended References	• Sneath PH, Sokal RR. Numerical taxonomy. The principles and practice of numerical classification. 1973. • Simpson, George Gaylord. Principles of animal taxonomy. 1961. • Hickman, Cleveland P., Larry S. Roberts, and Allan Larson. Animal diversity. The McGraw hill, 2002. • Ruppert, Edward E., Robert D. Barnes, and Richard S. Fox. Invertebrate zoology: a functional evolutionary approach. No. 592 RUPi. 2004. Kiran Kapoor. Cyanobacteria : Antibacterial Activity. Oxford Book Company. 2010. • Sarma T.A. Hand book of Cyanobacteria. CRC Press. 2012. • Gilbert M. S. Cryptogamic Botany Algae and Fungi. McGraw-Hill Book Company.1955. • Pandey B. P. College Botany: 1: Algae Fungi and Bryophyta. S Chand Co Ltd. 2005. • Vashishta P.C.. Botany for Degree Students- Gymnosperms S Chand and Company.1996. • Vashishta P. C., Sinha A. K. and Anil Kumar. Botany for Degree Students - Pteridophyta (Vascular Cryptogams). S Chand and Company. 2010.

Level 1

Chemistry

Semester	First		
Title of the Course Unit	Biochemistry		
Course Code	MBB111C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	24	55hrs (Library work; group assignments; report writing; seminars on case studies and current topics)	21
Objective/s	Impart the knowledge of chemical nature of bio molecules		
Intended Learning Outcomes	• Describe molecular structure of major biomolecules • Explain the chemistry of major biomolecules • Explain the chemical functions of the biomolecules • Recognize different biomolecules in laboratory		
Contents	Carbohydrates: Introduction, natural occurrence and physiological importance; Classification and structure of carbohydrates Carbohydrate derivatives of biological importance: Amino sugars, deoxysugars, sugar phosphates, blood group polysaccharides, cell wall polysaccharides, teichoic acids, muramic acids, sialic acid, mucopeptides. Glycobiology: Glycosaminoglycans - Occurrence, structures and functions of hyaluronic acid, heparin, chondroitin sulphates (A, B and C), glycoproteins and proteoglycans, glycolipids. Fatty acids: Saturated & unsaturated fatty acids, Properties and biological importance, Amphipathic properties of phospholipids, Important phospholipids in biology, Phosphatidic acid and its derivatives such as lecithin, phosphatidylinositol, cardiolipin, Sphingomyelins, Cholesterol and its biological importance, Interactions of amphipathic lipids with water micelles, liposomes, lipid bilayers. Chemical constants of fats: saponification value, iodine number, Reichert Meissel number, acetyl number, acid number. Rancidity of fats due to hydrolysis, oxidation and lipolysis, prevention of rancidity; Waxes: properties and importance. Complex lipids and Sterols: Glycerophospholipids – classification, properties and functions of lecithin, lysolecithin, cephalins, plasmalogens		

	Amino acids - Introduction, structure and classification of amino acids, introduction to rare amino acids, non-protein amino acids, essential vs non-essential amino acids, Amino acids as ampholytes and its stereoisomerism. Chemical reactions of amino acids: Sanger's reaction, Edman's reaction, Nitrous acid reaction, Siegfried's carbamino reaction, Dansyl chloride reaction, oxidative deamination by oxides and ninhydrin etc. Proteins: Peptides – structure, formation and characteristics of peptide bond; Classification based on solubility, shape and composition; Functions of proteins; Properties – hydration, behaviour in solution, solubility, salting in and salting out, precipitation of proteins by acid reagents, heavy metals, heat, extreme pH changes, denaturation and renaturation of proteins. Structure of proteins – primary, secondary, super secondary, tertiary and quaternary structures; Determination of sequences of proteins, Curd formation, Denaturation of proteins, Buffering action of proteins, Importance of histidine in the buffering action. Enzymes: Introduction & classification; General characteristics of enzymes: Physical properties, Active site, Specificity; Mechanism of action, Enzyme activity; Enzyme kinetics; Inhibition of enzymes: Competitive, Non-competitive and suicide inhibition; Isoenzymes; Important diagnostic enzymes Nucleic Acids: Chemistry of purine & pyrimidine nitrogen bases, nucleosides and nucleotides; Structure and properties of DNA and RNA molecules.
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, field based studies, take-home assignments, seminar and oral presentation by students, laboratory sessions
Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	• J. M. Berg, J. L. Tymoczko, L. Stryer, "Biochemistry", 5th Edition, New York, W H Freeman, 2002. • Murray R.K., Granner, D.K., Mayes, P.A., Rodwell, V.W., "Harper's Biochemistry", 25th Edition, McGraw Hill, 2000.

	• Zubay, G.L., "Biochemistry", 4th Edition, McGraw Hill, 1998.

Semester	First		
Title of the Course Unit	Principles in Chemistry		
Course Code	MBB112C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	30	70hrs (Library work; group assignments; report writing; seminars on case studies and current topics)	00
Objective/s	• provide an introduction to the fundamental concepts of atomic theory and the construction of the periodic table • introduce the basic concepts of chemical bonding theory and the structure of molecules of biological relevance • give a broad overview of the kinds of structure and reactivity of the families of organic compounds relevant to biological chemistry • describe elementary ideas of stoichiometry in chemical reactions • provide an introduction to the fundamental concepts of thermochemistry, equilibrium in chemical systems and chemical catalysis		
Intended Learning Outcomes	• Demonstrate the basic principles of the structure of the atom • Describe the main types of chemical bonding as they relate to the structure of matter • Predict the structure and geometry of simple covalent compounds of biological relevance • Illustrate the various types of intermolecular force and their influence on the structure of matter • Discuss the range of organic molecules and the types of functional groups in it		

	• Describe the main types of chemical reactions undergone by organic molecules • Use fundamental principles to solve both qualitative and numerical problems • Demonstrate a knowledge of the basic principles of thermodynamics at an appropriate level • Discuss the process of equilibria in the context of chemical systems • Explain the role of catalysts in chemistry
Contents	• Atomic Structure – electromagnetic radiation, atomic spectra of hydrogen, Bohr model, Quantum mechanics and atomic orbitals • Electron Configurations and Periodicity – orbital energies and electron configurations; atomic properties and periodic trends • Basic Concepts of Chemical Bonding – ionic bonding; covalent bonding – octet rule, valency, bond polarity, Lewis structures, resonance, hypervalency, shapes of simple molecules; dipole moments; valence bond theory – hybrid orbitals ; bonding to metal ions – the donor/acceptor bond. • Intermolecular forces – London, dipole-dipole and hydrogen bonding interactions. • Oxidation/reduction chemistry – electron transfer reactions • Chemistry of carbon compounds – the common functional groups and their reactions; Reactions mechanisms, IUPAC Nomenclature • Structures of simple organic compounds – sugars, amino acids, fatty acids, purines, pyrimidines. • Determination of molecular structure – techniques of structural analysis e.g. UV, IR, NMR; structure determination using X-rays • Chemical calculations and Thermochemistry – units and dimensions; Stoichiometry: mass balance, charge balance; Solutions and Molarity; Thermodynamics: Systems, surroundings, universe, processes, laws of thermodynamics, work, heat, entropy, Gibbs energy; Derivation of the Nernst equation from ΔG, EMF • Chemical Equilibrium – Reactions in Aqueous Solutions: acid base reactions, pH, pKa, buffering of solutions • Catalysis in Chemistry – role of the catalyst in chemical reactions
Teaching and Learning Methods / Activities	Lectures, Tutorials and Assignments
Evaluation	In course assessment 30% End of course examination 70%

Recommended References	1. Atkins, P.; Rourke, T. O. J.; Weller, M. and Armstrong, F., *Inorganic Chemistry*, 5th Edition, Oxford University Press, 2010 ISBN: 9780199236176 2. Atkins, P. and Jones, L., *Chemical Principles*, 4th Edition, W. H. Freeman and Company, 2008. ISBN: 9780716773559 3. Miessler, G. L.; Fischer, P. J. and Tarr, D. A., *Inorganic Chemistry*, 5th Edition, Pearson Education, Inc 2014. ISBN : 978-0-321-81105-9 4. McMurry J. E.; *Organic Chemistry*. 9th Edition. Boston: Cengage Learning, 2016. 5. Atkins, P. and de Paula, *J. Elements of Physical Chemistry*, 11th edition, Oxford: Oxford University Press, 2017. 6. Price, G., *Thermodynamics of Chemical Processes*, Oxford: Oxford University Press, 1998.

Semester	First		
Title of the Course Unit	**Introduction to Bioinformatics**		
Course Code	MBB113C3		
Credit Value	03		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	**Theory**	**Independent Learning**	**Practical session**
	30	96 hrs (Library work; Group assignments; report writing; seminars on case studies and current topics)	24
Objectives	Provide theoretical and practical knowledge in Bioinformatics including analysis of protein and genome sequences by various computational tools.		
Intended Learning Outcomes	• Describe computational genomics and phylogenetic concepts • Demonstrate the use of computational tools for sequence analysis in bioinformatics • Perform Data analysis and Pattern recognition in biological data • Formulate a biological problem as a computational problem		
Contents	• Introduction to bioinformatics: Aims and tasks of bioinformatics, scope of bioinformatics and its applications, bioinformatics databases, bioinformatics and computational biology software. • Structural bioinformatics: Protein structure and its visualization, comparison and classification, protein structure prediction, RNA structure prediction, compression of genomic sequences such as Burrows–Wheeler transform, etc. • Pairwise sequence alignments and database search: Scoring matrix, Needleman-Wunsch algorithm, Smith-Waterman algorithm, Gotoh algorithm, heuristic methods • Phylogenetic tree and multiple sequence alignment: Neighbour-joining and UPGMA algorithms, phylogenetic tree, Sequence profile & profile based alignments • Pattern Recognition: Clustering and visualisation, Hidden Markov models and Viterbi algorithm • Genomics and proteomics: Genome mapping, genome assembly, genome comparison, functional genomics, proteomics and metabolomics		
Teaching learning Methods	Lectures, practical demonstration, take-home assignments, recitation oral questions, vocabulary drills, and simulations in laboratory.		

Evaluation Strategy	• In-course Assessment (Theory) ——————— 30% • In-course Assessment (Practical) ——————— 30% • End-of-course Examination ——————— 70% Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	• M.J. Zvelebil and J.O. Baum, Understanding bioinformatics, Garland Science, 2008. • K. Stephen, Introduction to Bioinformatics: A Theoretical and Practical Approach, 1st Ed, 2003. • F. Azuaje and J. Dopazo, Data Analysis and Visualization in Genomics and Proteomics, John Wiley, 1st Ed, 2005. • M. Kellis, Computational Biology: Genomes, Networks, Evolution., MIT course 6.047/6.878, 2016.

Semester	First		
Title of the Course Unit	**Introductory Computational Biology**		
Course Code	MBB114C3		
Credit Value	03		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	15	45hrs (Library work; group assignments; report writing; seminars on case studies and current topics)	90
Objective/s	Introduce computational biology by emphasizing the fundamentals and analysis of complex biological systems.		
Intended Learning Outcomes	• Describe the principles and methods for sequence alignment of biological systems • Apply structural modeling approaches on Biological systems • Sketch structural prediction of Biological systems • Construct network modeling of systems using computer scripting languages • Solve current research problems in computational Biology using computer programming		
Contents	• Introduction to complex biological systems, fundamentals of nucleic acid and protein sequence and structural analysis; basic principles of biochemistry, molecular biology, genetics, and recombinant DNA, DNA motifs • Principles and methods used for sequence alignment, motif finding, structural modeling, structure prediction and network modeling; Gene expression, clustering / classification, EM / Gibbs sampling, motifs, Bayesian networks, microRNAs, regulatory genomics, epigenetics • Introduction to scripting using Python programming language: string processing, lists and directories, scripts in Python to biological data processing, visualization tools in Python, graph plotting using Python • Algorithmic modeling of biological analysis using Python scripting: algorithms for sequence analysis and their implementation in Python, Markov modeling in Python, libraries for molecular data analysis		
Teaching learning Methods/Activities	Lecture, tutorial discussion, take-home assignments, seminar and oral presentation by students, laboratory sessions, library assignments, problem based laboratory sessions		
Evaluation/Assessment Strategy	In-Course Assessments (30%), End of Course Practical Examination (70%)		

Recommended References	1. Tim J. Stevens, Wayne Boucher, Python Programming for Biology: Bioinformatics and Beyond, 1st ed., Cambridge University Press, 2015 2. Tiago Antao, Bioinformatics with Python Cookbook: Learn how to use modern Python bioinformatics libraries and applications to do cutting-edge research in computational biology, 2nd Edition Paperback, Packt Publishing2018

Level 2

Zoology

<table>
<tr><td>Semester</td><td colspan="3">First and Second</td></tr>
<tr><td>Title of the Course Unit</td><td colspan="3">Animal Phylogeny and Biology</td></tr>
<tr><td>Course Code</td><td colspan="3">MBB201C3</td></tr>
<tr><td>Credit Value</td><td colspan="3">03</td></tr>
<tr><td>Core/Optional</td><td colspan="3">Core</td></tr>
<tr><td>Prerequisites</td><td colspan="3">None</td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Independent Learning</td><td>Practical session</td></tr>
<tr><td>28</td><td>95hrs (Library work; group assignments; report writing; seminars on case studies and current topics)</td><td>27</td></tr>
<tr><td>Objective/s</td><td colspan="3">• Provide knowledge on the animal phylogeny relationship and the relationship between different characters</td></tr>
<tr><td>Intended Learning Outcomes</td><td colspan="3">• Describe various evolutionary life histories
• Analyze the phylogenetic and biological relationship among the animals and animal groups
• Develop an understanding on the biological relationship between invertebrates and vertebrates
• Discuss the economic importance of invertebrates and vertebrates
• Describe various evolutionary life histories
• Analyze the phylogenetic and biological relationship among the animals and animal groups
• Develop an understanding on the biological relationship between invertebrates and vertebrates
• Discuss the economic importance of invertebrates and vertebrates</td></tr>
<tr><td>Contents</td><td colspan="3">Morphology, phylogeny, evolutionary relationships, biology, life history, adaptive radiations within the invertebrate phyla (Protozoa, Porifera, Colenterata, Platyhelminthes, Nematoda, Annelida, Arthropoda, Mollusca, Echinodermata and minorphyla) and vertebrate classes (Osteichthyes, Chondrichthyes, Amphibia, Reptilia, Aves and Mammalia).</td></tr>
<tr><td>Teaching learning Methods/Activities</td><td colspan="3">Lecture presentation , tutorial discussion, field based studies, take-home assignments, seminar and oral presentation by students, laboratory sessions</td></tr>
</table>

Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	• Hickman, C.P. Jr. Animal Diversity. Mc-Graw Hill publishes. 2015 • Kardong, K. V . Vertebrates comparative anatomy, function and evolution... Mc-Graw Hill publishes. 2002 • Linsey D. W .Vertebrate Biology.. Hopkins University Press. 2012. • Ruppert, E.E., R. S. Fox and R. D. Barnes. . Invertebrate Zoology: A Functional Evolutionary Approach.2004 • Young, J. Z . The life of vertebrates.. Oxford University Press. 1994

Semester	First		
Title of the Course Unit	Molecular genetics		
Course Code	MBB202C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	21	55hrs (Library work; group assignments; report writing; seminars on case studies and current topics)	24
Objective/s	• Introduce the principles of inheritance via basic genetics principles and molecular nature of inheritance		
Intended Learning Outcomes	• Describe how the genetic information in organisms is organized • Compare different inheritance mechanisms and the anomalies in animals • Develop and understanding of the molecular biology in inheritance • Acquire basic knowledge about the methods used in molecular genetics. • Describe the structure and functions of genetic materials Appraise the principles of population genetics • Apply molecular biological methods in genetics experiments		
Contents	Basic genetics principles: Mendelian genetics and chromosomal inheritance; Chromosome theory of inheritance; Extensions of Mendelian Genetics: Complexities in relating to phenotypes and genotypes; Linkage and mapping; Sex determination; Extra chromosomal inheritance. The genetic material and its organization and regulation: Molecular structure and Replication of the genetic material: DNA and RNA; Chromosome organization and molecular structure; Mitochondrial DNA; Genetic code; DNA replication; Molecular Properties of Genes: structure and organization; Gene expression: Gene transcription and RNA modification; Translation of mRNA; Gene regulation in Eukaryotes; Gene mutation and repair; Genetics disorders and gene therapy; Genetic Analysis of individuals & populations. DNA sequencing; DNA cloning and microarrays; genomics and genome projects; overview of genome mapping		

Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, field based studies, take-home assignments, seminar and oral presentation by students, laboratory sessions
Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	• Klug, W. S., Cummings, M. R., Spencer, C. A., Palladino, M. A., & Killian, D.. Concepts of genetics. Upper Saddle River, NJ: Prentice Hall.2006 • Nei, M.. Molecular population genetics and evolution. North-Holland Publishing Company.1975 • Brooker, Robert J. . Genetics: analysis & principles, fourth edition. The McGraw-Hill Companies, Inc.USA. 2012 • Krens, J.E., Goldstein, E.S. and Kilpatrick, S.T. Lewin's Genes XI. Jones and Bartlett Publishers.2014 • Griffiths, A.J.F., Miller, J.H., Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M; W.H. An Introduction to Genetic Analysis. Freeman and Company, New York, USA. 1996 • Hartwell, L., Hood, L., Goldberg, M.L., Reynolds, A. E., Silver, L.M. and Veres, R.C. Genetics: From Genes to Genomes. McGraw Hill Companies. 2000 • Wilson, K. and Walker, J.(Ed) . Principles and Techniques of Biochemistry and Molecular Biology (7^{th} Edison). Cambridge University Press. 2010

Semester	First and second		
Title of the Course Unit	Molecular laboratory techniques		
Course Code	MBB203C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	00	40hrs (Library work; group assignments; report writing; seminars on case studies and current topics)	60
Objective/s	• Introduce different tools and techniques in molecular biology		
Intended Learning Outcomes	• Identify the molecular biology laboratory safety • Outline the application of different tools in the laboratory • Describe various techniques using DNA • Review the role of proteins and other macromolecules in molecular biology laboratory		
Contents	Introduction to DNA and macromolecules. DNA based applications; principles and techniques (Extraction; PCR and downstream applications) Gel electrophoresis: Principles and applications Sequencing: Principles and applications		
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, field based studies, take-home assignments, seminar and oral presentation by students, laboratory sessions		
Evaluation/Assessment Strategy	Practical: In-Course Assessments (30%), End of Course Examination (70%)		
Recommended References	• Dieffenbach, C. W., &Dveksler, G. S. . PCR primer: a laboratory manual (No. Ed. 2). Cold Spring Harbor Laboratory Press.2003 • Bregman, A. A. . Laboratory investigations in cell biology.1987		

Semester	Second		
Title of the Course Unit	Forensic biology		
Course Code	MBB204C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	21	55hrs (Library work; group assignments; report writing; seminars on case studies and current topics)	24
Objective/s	• Impart knowledge on the different biological tools used in forensic sciences		
Intended Learning Outcomes	• Identify forensic sciences • Describe the role of biological samples in forensic analysis • Recognize the role of molecular biology tools in forensic science • Explain the DNA profiling • Recognize the role of accreditation in molecular biology application		
Contents	Introduction to forensic sciences DNA profiling: Principles and methods; examples Biological samples/ organisms: Organisms in forensic science; biological evidences and serology, distribution and spattering of blood and other useful biological samples Sample isolation: isolation of DNA from forensic samples Tools and techniques: DNA analysis technique; forensic DNA databases; population data analysis, forensic genetics, challenges; case studies (local and international) Accreditation and quality control, applications such as criminal investigations and paternity analysis, implications in law enforcements, future trends.		
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, field based studies, take-home assignments, seminar and oral presentation by students, laboratory sessions		
Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10		

Recommended References	• Buckleton, J. S., Bright, J. A., & Taylor, D. (Eds.). Forensic DNA evidence interpretation. CRC press. 2016 • Li, R. Forensic biology. CRC Press. 2015

Semester	First Second		
Title of the Course Unit	Cancer biology		
Course Code	MBB205C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical/ filed session
	21	55hrs (Library work; group assignments; report writing; seminars on case studies and current topics)	24
Objective/s	• Impart knowledge on the application of the cellular and molecular mechanism of formation and spread of cancer		
Intended Learning Outcomes	• Identify the major types of cancer worldwide. • Describe the cell biology and how genes contribute to the risk and growth of cancer. • Define metastasis, and identify the major steps in the metastatic process. • Describe the role of imaging in the screening, diagnosis, staging, and treatments of cancer.		
Contents	Cellular and molecular biology of cancer (oncogenes and tumor suppressor genes) Biological hallmarks of cancer. Risk factors for the major cancers worldwide, including lung cancer, breast cancer, colon cancer, prostate cancer, liver cancer, and stomach cancer. Identification tools Future and current trends in identifying and treating cancer		

Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, field based studies, take-home assignments, seminar and oral presentation by students, laboratory sessions
Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	• Kaiser, C. A., Krieger, M., Lodish, H., &Berk, A. Molecular cell biology. WH Freeman. 2007 • Pelengaris, S., Khan, M., &Blasco, M. A. . The molecular biology of cancer.2006

Semester	First and second		
Title of the Course Unit	Animal physiology		
Course Code	MBB206C3		
Credit Value	03		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	27	94 hrs (Library work; group assignments; report writing; seminars on case studies and current topics)	36
Objective/s	• Familiarize with the principles and basic facts of Animal Physiology and with some of the laboratory techniques and equipment used in the acquisition of physiological data		
Intended Learning Outcomes	• Describe the major physiological mechanisms of various system in invertebrates and in Vertebrates • Compare the adaptive variations of physiological patterns with respect to different life styles		

	• Explain the cellular and molecular basis of selected animal physiological mechanisms • Explain the laboratory tests perform to measure the variations in physiology of human and animals
Contents	A comparative study of physiological phenomena or mechanism in the animals with respect to life styles (terrestrial, aquatic and aerial) such as feeding, digestion and assimilation, senses and nerves, defense, respiration, excretion, reproduction, hormonal action, circulation, immune system, muscular and skeletons. Introduction to selected topics in cellular and molecular physiology: ion channels, transporters and pumps, nerve impulse, metabolism, protein trafficking, signal transduction pathways; Molecular physiological basis of certain diseases: osteoporosis, wound healing, pulmonary and cardiovascular diseases, spinal cord generation, cell aging and genetic diseases: cystic fibrosis, polycystic kidney disease; lysosomal storage diseases; Genetic basis of selected diseases: hypertension, diabetes mellitus, obesity, breast cancer and Alzheimer's disease
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, field based studies, take-home assignments, seminar and oral presentation by students, laboratory sessions
Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	• Kenneth Kardong.Vertebrates: Comparative anatomy, Function, Evolution. McGraw-Hill Education.2018 • Knut Schmidt-Nielsen. Animal Physiology: Adaptation and Environment. Cambridge University Press.2014. • Richard Owen. Lectures on the Comparative Anatomy and Physiology of the Invertebrate Animals. Andesite Press. 2015 • Gomperts, B. D., Kramer, I. M. and Tatham. Signal transduction. Academic Press- Elsevier Inc., USA. 2009

Botany

Level 2

Semester	Second		
Title of the Course Unit	Molecular plant microbial interactions		
Course Code	MBB206C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	30	70 hrs (Library work; group assignments; report writing; field visits)	00
Objective/s	• Provide knowledge on diversity of microorganism present on and in the plant surfaces • Impart knowledge on various interactions between microbes and plants • Provide knowledge to utilize microorganisms to enhance crop production		
Intended Learning Outcomes	• Describe the molecular mechanisms of both pathogenic and symbiotic interactions between microbes and plants, • Discuss the genetic and molecular mechanisms of disease resistance in plants. • Apply this knowledge to solve problems in research relevant to plant microbe interactions • Develop models to utilize beneficial microorganisms to improve crop production		
Contents	Diversity of phyllosphere, rhizosphere and endophytic microorganisms; Microbial cell surfaces and secretion systems; Molecular basis of recognition of plants by microbes and plant response to microbial invasion; Cell-to-cell signaling; Virulence factors and pathogenesis; Modulators of resistance and susceptibility; Plant-microbes co-evolution; Plant growth promoting microbial interactions: biological nitrogen fixation, microbial phosphate metabolization, arbuscular mycorrhizal associations, plant hormones producing microbes; Control of plant diseases using beneficial microbes; Techniques for analysis of microbial and visualization of		

	plant microbe interactions; Applications of beneficial microorganisms in crop production: Trichoderma, Agrobacterium, beneficial Pseudomonads, Bacillus.
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, take-home assignments, seminar and oral presentation by students, laboratory sessions
Evaluation/Assessment Strategy	In-Course Assessments 30% End-of- Course Examination 70%
Recommended References	• Lugtenberg, B. Principles of Plant-Microbe Interactions: Microbes for Sustainable Agriculture. Springer, Cham. 2015. • Singh D. P., Singh H. B and Prabha R. Plant-Microbe Interactions in Agro-Ecological Perspectives, Springer, Singapore. 2017. • Hakeem K. R and Akhtar M. S. Plant, Soil and Microbes, Volume 2: Mechanisms and Molecular Interactions, Springer, Cham. 2016. • de Bruijn F. J. Molecular Microbial Ecology of the Rhizosphere. John Wiley &Sons, Inc. 2013.

Semester	Second		
Title of the Course Unit	Enzyme Technology		
Course Code	MBB207C2		
Credit Value	02		
Core/Optional	Core		
Hourly Breakdown	Theory	Independent Learning	Practical classes
	20	58 (Library work; group assignments; report writing; seminars on case studies and current topics)	22
Objective/s	To introduce advanced skills and efficiency in application technology of enzymes		
Intended Learning Outcomes	• Understand the important propertiesand structure of enzymes • Analyzemechanisms and kinetics of enzymatic function • Apply enzymatic reactions in the industrial life • Evaluate different practical applications of enzymes		
Contents	Enzyme properties,structure and classification of enzymes, mode of action and mechanism of catalysis, co-factors, prosthetic groups and co-enzymes; enzyme inducers and repressors, Enzyme regulation,Enzyme kinetics, Effect of chemical and physical factors on kinetics, allosteric effects; enzymes used in Molecular Biology, Laboratory exercises based on above topics.		

Teaching learning Methods/Activities	Lecture delivery, practical sessions, tutorial discussion, assignments/ presentations/ group discussion by students
Evaluation/Assessment Strategy	Theory: In-course assessment(s): 30%, End of Course Examination: 70% Practical: In-course assessment(s):30%, End of Course Examination: 70% Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	1. Lewis Stevens and Nicholas C. Price. Fundamentals of Enzymology. Oxford University Press.1989. 2. David L. Nelson and Michael Cox. Lehninger Principles of Biochemistry. Macmillan Learning Publisher. 2017. 3. Buchholz K., Bornscheuer U., Kasche V. Biocatalysts and Enzyme Technology. Wiley-VCH Verlag GmbH. 2012.

Semester	Second		
Title of the Course Unit	Plant Biochemistry		
Course Code	MBB208C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	22	54 hrs (Library work; group assignments; report writing)	24
Objective/s	• Provide knowledge on structure and classification of enzymes • Impart knowledge on catabolic and anabolic pathways		

Intended Learning Outcomes	• Explain different techniques in biochemistry • Recall the mechanism of enzymes catalysis • Describe the various metabolic pathways in plants • Apply basic techniques in enzymology
Contents	Enzymes as biological catalysts: the structure and classification of enzymes, mode of action and mechanism of catalysis, co-factors, prosthetic groups and co-enzymes; Kinetics of enzymatic reactions; Effect of chemical and physical factors on kinetics, inhibitors, allosteric effectors; Structure and classification of respiratory substrates; Oxidative phosphorylation; Respiratory pathways: EMP pathway, Kreb cycle, Pentose phosphate shunt, β oxidation and the glyoxylate cycle; Oxidation of proteins, Energy balance and inter-relationship of catabolic and anabolic paths, Respiratory Quotient, factors affecting respiration, nitrogen metabolism, Synthesis of primary metabolites; Techniques in Biochemistry; purification of proteins; Laboratory exercises based on above topics.
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, take-home assignments, seminar and oral presentation by students, laboratory sessions
Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	• David L. Nelson and Michael M. Cox. Lehninger Principles of Biochemistry. Macmillan Learning Publisher. 2017. • David Hames and Nigel Hooper. Biochemistry, Taylor and Francis Group. 2005

Semester	Second		
Title of the Course Unit	Genetics		
Course Code	MBB209C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session

	22	54 hrs (Library work; group assignments; report writing)	24
Objective/s	• Provide the fundamentals of Mendelian laws of inheritance • Familiarize with deviations from Mendelian inheritance • Impart knowledge on microbial genetics		
Intended Learning Outcomes	• Explain the Mendelian inheritance and deviations • Discuss linkage and mapping of chromosomes • Describe the fundamentals of microbial and population genetics • Interpret various types of mutations		
Contents	Introduction; Mendel experiments and deviations; Linkage and chromosomal mapping, sex determination, genetics of viruses, fungal genetics, bacterial genetics, mutations and DNA repair, population genetics, extra chromosomal inheritance, laboratory exercises based on above topics		
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, take-home assignments, seminar and oral presentation by students, laboratory sessions		
Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10		
Recommended References	• Gardner M. J. Simmons and Snustad D. P. Principles of Genetics. Wiley India Pvt. Limited. 2006. • Robert Brooker. Genetics: Analysis and Principles. Mc Graw-Hill Education. 2012. • Tamarin Robert. Principles of Genetics. William C Brown Publishers. 1998.		

Course Code	MBB210C2		
Title of the Course Unit	Protein structure and function		
Credit Value	02		
Hourly Breakdown	Theory	Practical/ Field visit	Independent Learning

	30	-	70
Objective/s	➢ Provide the knowledge and skills on working with proteins		
Intended Learning Outcomes	➢ Recall different structures and functions of proteins. ➢ Explain the regulation of protein folding. ➢ Classify different types of protein modification ➢ Interpret the characterization of proteins.		
Contents	Hierarchical structure of proteins, protein folding, protein function, relationship between structure and function, regulating protein function, expression, modifications and degradation of proteins, purifying, detecting and characterizing proteins, proteomics.		
Teaching learning Methods/Activities	Lectures, practical, E- learning, take-home assignments, seminar and oral presentation by students.		
Evaluation/Assessment Strategy	Theory: In-course assessment(s): 30%, End of Course Examination: 70%		
Recommended References	➢ Engelbert Buxbaum, Fundamentals of Protein Structure and Function, Second edition, Springer, 2015. ➢ Harvey F. Lodish, Molecular Cell Biology. 7th edition. W.H. Freeman & Company, 2012. ➢ Amit Kessel, Nir Ben-Tal, Introduction to Proteins: Structure, Function and Motion, Second Edition, Chapman & Hall, 2018.		

Level 2

Chemistry

Semester	First and Second	
Title of the Course Unit	Molecular Spectroscopy	
Course Code	MBB212C3	
Credit Value	03	
Core/Optional	Core	
Hourly Breakdown	Theory	Independent Learning
	45	105
Objective/s	• Understand the basic principles of molecular spectroscopy and their applications • Outline different spectroscopic techniques • Elucidate the structure of organic compound in the bio-molecules	
Intended Learning Outcomes	• Deduce the structure of organic compounds using spectroscopic techniques • Identify the transitions between rotational, vibrational and electronic states to the spectra of diatomic and polyatomic molecules • Solve realistic problems related to molecular spectroscopy	
Contents	Introduction to molecular spectroscopy of diatomic and polyatomic molecules Electronic spectroscopy UV-Vis Spectroscopy: Basic principles, types of electronic transitions, Parameters of absorption spectra, selection rules for conjugated olefins and carbonyl compounds, calculation of λmax for linear and circular conjugated molecules Fluorescence Spectroscopy: Basic principles, Jablonski diagram; Stokes shift; fluorescence emission parameters, fluorescence quenching, polarization and anisotropy, effect of solvent on fluorescence emission, fluorescence resonance energy transfer (FRET). Chiral molecules and optical activity: Physical basis of circular dichroism (CD) and optical rotatory dispersion (ORD), CD and ORD instruments, parameters of optical activity, advantages of CD relative to ORD, CD spectra of interacting chromophores, conformational analysis of DNA via CD spectroscopy, induced CD with typical applications to studies of biomolecular interactions.	

<table>
<tr><td></td><td colspan="2">Rotational spectroscopy: Basic principles, Moment of inertia, rotors and their symmetry, quantization of rotational energy, selection rule, isotope effects, intensity
Vibrational spectroscopy: Basic principles, Harmonic oscillator, quantization of vibrational energy, selection rule, isotope effects, anharmonicity, fundamental and overtone transition, hot bands, vibrational modes.
Raman spectroscopy: Raman and Rayleigh scattering, Stokes and anti-Stokes scattering, rotational and vibrational Raman spectra
Nuclear magnetic resonance (NMR) Spectroscopy: Basic principles, chemical shifts, spin-spin coupling AMX, AB, AX couplings, interpretation of ^{1}H-NMR spectra and applications., Relaxation, Spin decoupling, Applications of NMR in macromolecules, Multi-dimensional NMR; COSY, Basic principles and interpretation of ^{13}C-NMR.
Mass Spectroscopy: Basic principles, instrumentation, different methods of fragmentation, interpretation of mass spectra and applications..</td></tr>
<tr><td>Teaching learning Methods/Activities</td><td colspan="2">In-person lectures by using power point slides, Marker pen and white board, small group assignment, oral presentation.</td></tr>
<tr><td rowspan="2">Evaluation/Assessment Strategy</td><td>Continuous Assessment</td><td>Final Written Examination</td></tr>
<tr><td>30 %</td><td>70 %</td></tr>
<tr><td>Recommended References</td><td colspan="2">Atkins, P. and de Paula, Physical Chemistry, 10th edition Oxford: Oxford University Press, 2014
Atkins, P and Paula, J. D., Physical Chemistry, 9th Edition, Oxford University Press, 2010
Ira N. Levine, Physical Chemistry, 6th Edition, Mr Graw Hill Education, 2009
Aruldhas, G., Molecular Structure and Spectroscopy, 2nd Edition, PHI Learning Pvt. Ltd., 2011.
Brown, J. M., Molecular Spectroscopy, 1st Edition, Oxford University Press, 1998.
Sruve, W. S., Fundamentals of Molecular Spectroscopy, Wiley Inter science, 1st Edition, 1989.
Williams D.H. and Fleming I. Spectroscopic methods in organic chemistry. McGraw-Hill, 2008.</td></tr>
</table>

	• Silverstein R.M., Webster F.X., Kiemle D. and Bryce D. L. Spectrometric Identification of Organic Compounds, 8th Edition, Wiley, 2004.

Semester	First and Second	
Title of the Course Unit	Biochemistry Practical	
Course Code	MBB213C3	
Credit Value	03	
Core/Optional	Core	
Hourly Breakdown	Laboratory	Independent Learning
	45	105
Objective/s	• Understand the quantitative and qualitative aspects of Biochemical analyses. • Develop basic practical biochemical skills for the handling and analysis of bio molecules • Ability to design experiments.	
Intended Learning Outcomes	• Accustom with laboratory skills related to biochemistry. • Competent with the knowledge and basic skills that would enable the students to undertake further studies in biochemistry and related areas.	
Contents	The laboratory tests will be preformed by the students to identify different biocehmoical components. The following tests will be performed; • Solubility Tests • Xanthoproteic Test: • Millon's Test: • Hopkin's Cole Test: • Lead-Sulfide Test: • Ehrlich Test: • Sakaguchi Test: • Nitroprusside Test:Biuretic reaction for detection of peptide bond. • Ninhydrin Test • The chromatographic method of determination of amino acids • Molisch's Test: • Fehling's Test: • Barfoed's Test:	
Teaching and Learning Methods / Activities	Laboratory demonstrations and hands on experiments, Assignments	

<table>
<tr><td rowspan="3">Evaluation/Assessment Strategy</td><td colspan="2">Continuous Assessment</td><td>Final Practical Examination</td></tr>
<tr><td>Theory</td><td>Practical</td><td rowspan="2">70 %</td></tr>
<tr><td>10 %</td><td>20 %</td></tr>
<tr><td>Recommended References</td><td colspan="3">1. Introduction to Practical Biochemistry by D.T. Plummer, Tata McGraw-Hill Edition, 1988
2. Biochemical Guide to Principles & techniques of Practical Biochemistry - Keith Wilson & Kenneth Goulding, Cambridge Press, 1994</td></tr>
</table>

Level 3

Zoology

Semester	First		
Title of the Course Unit	Molecular Embryology		
Course Code	MBB301C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	21	55hrs (Library work; group assignments; report writing; seminars on case studies and current topics)	24
Objective/s	• Introduce the cellular and molecular nature of development in animals		
Intended Learning Outcomes	• Describe the key concepts of the structure and function of animal reproductive system • Compare the differences existing in the developmental biology of different animal groups • Explain the cellular and molecular mechanism involved in the developing embryo • Analyze the molecular tools in the laboratory assays related to developmental biology		
Contents	Animal reproductive system; an overview Comparative animal developmental biology- gametogenesis, fertilization; cleavage; gastrulation; differentiation, cellular basis for competence, organogenesis and morphogenesis; Cellular physiology and biology of animal development Developmental genetics: Gene control in development; Application of embryological techniques: In-vitro fertilization (IVF), embryo transfer, embryo modification and transgenic animals.		
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, field based studies, take-home assignments, seminar and oral presentation by students, laboratory sessions		

Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	• Edelman, G. M. . Topobiology: An introduction to molecular embryology (pp. 3-55). New York: Basic Books.1988 • Arey, L. B. . Developmental anatomy: a textbook and laboratory manual of embryology (7th ed., p. 22). Philadelphia: Saunders.1965 • Scott F Gilbert. Developmental Biology, 6th edition. 2000 • Lewis Wolpert and Cheryll Tickle.Principles of Development 2015

Semester	First and Second		
Title of the Course Unit	Medical entomology and parasitology		
Course Code	MBB302C3		
Credit Value	03		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	28	95hrs (Library work; group assignments; report writing; seminars on case studies and current topics)	27
Objective/s	• Impart knowledge on the different forms of parasites and insects involved in epidemiology and the molecular biology application in diagnosis and eradication of them		
Intended Learning Outcomes	• Describe different forms of parasites and their lifecycles • Analyze the molecular tools in diagnosis of theses parasites		

	• Interpret the molecular biology tools in identifying and eradication medically important insects • Analyze the role of molecular virology tools in vaccine and drug development
Contents	Parasite biology: Major forms of parasites found in Sri Lana and globe; life cycle and diagnosis and control Parasite and vectors: Molecular interaction between them; host-parasite interaction Molecular biology tools- diagnosis and eradication pof the parasites and vectors Drug and vaccine development for major parasitic disease: process and quality control
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, field based studies, take-home assignments, seminar and oral presentation by students, laboratory sessions
Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	• Markell, E. K., &Voge, M.. Medical parasitology. 1976 • Kennedy, C. R. . Ecological animal parasitology. Blackwell Scientific Publications.1975 • Eldridge, B. F., &Edman, J. D. (Eds.). . Medical entomology: a textbook on public health and veterinary problems caused by arthropods. Springer Science & Business Media. 2012

Semester	Second		
Title of the Course Unit	Molecular Immunology		
Course Code	MBB303C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	21	55 hrs (Library work; group assignments; report writing; seminars on case studies and current topics)	24
Objective/s	• Describe the cellular and molecular basis of defensive mechanisms exist in animals.		
Intended Learning Outcomes	• Describe the structure and function of immune system • Explain the role of different components of immunity • Analyze the different immune responses • Illustrate the cellular and molecular principles of immune responses • Demonstrate the laboratory skills related to immunology		
Contents	Basic structure and Development of the immune system. Organs, cells and molecules of the immune system. Type of immunity: innate, acquired, humoral and cell mediated immunity. Antigen recognition, capture and presentation. Complement system. Immunologic tolerance and autoimmunity. Congenital and acquired immuno-deficiencies. Organization and expression of genes and receptors related to immunity and selected molecular pathways: Toll, IMD, and JACK/STAT. Laboratory techniques commonly used in Immunology: Animal handling and immunization techniques; serum separation; immuno-blotting: ELISA, Western Blotting, immuno-fluorescence and Immuno-histochemistry; Isolation of antigen by Immuno-precipitation and affinity chromatography, Flow cytometry and fluorescence-activated cell sorting, Blood grouping and Immunological diagnosis.		
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, field based studies, take-home assignments, seminar and oral presentation by students, laboratory sessions		

Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	• Sell, S., Max, E. E., &Berkower, I. Immunology.immunopathology and immunity (Vol. 19, p. 20). Washington, DC: ASM press. 2001 • Benjamini, E., Leskowitz, S., & Sunshine, G. Immunology: a short course (Vol. 77, p. 92). New York: Wiley-Liss.1996 • Abbas, A.K., Lichtman, A, H. and Pillai, S. Cellular and Molecular Immunology, 8th Edition. Elsevier Limited.2014 • Male,D., Brostoff,J., Roth, D.B. and Roitt, I. . Immunology, 7th Edition. Elsevier Limited. 2007 • Wilson, K. and Walker, J.(Ed). Principles and Techniques of Biochemistry and Molecular Biology (7th Edison). Cambridge University Press. 2010

Semester	First		
Title of the Course Unit	Molecular toxicology		
Course Code	MBB304C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	21	55 hrs (Library work; group assignments; report writing; seminars on case studies and current topics)	24
Objective/s	• Impart knowledge in toxicology to support a basic understanding of the principles governing toxic responses to chemical exposures		
Intended Learning Outcomes	• Describe the sources, levels and mechanisms of action for toxic substances. • Explain exposure, uptake, metabolism, distribution and excretion of toxicants • Illustrate the effects of toxic substances on molecular and cellular levels, on individual health and on natural populations and communities, including the use of biomarkers. • Discuss the major issues, concepts and subject areas in Eco-toxicology: effects of oil pollution, agrochemicals, industrial effluents and pharmaceuticals. • Demonstrate effective laboratory skills necessary to conduct a toxicology based assay		
Contents	Principles of toxicology, with particular emphasis on the principles governing toxic responses to chemical exposures, including the disposition of toxicants, and the nature and effect of toxicity. Classification of toxicants. Toxicant transport and their nature in the environment: bioaccumulation and ecological impacts. Dose-response, toxico-kinetics and metabolism of major toxicants in animals. Geno-toxicity and biomarkers for environmental toxicants and their impacts at cellular and molecular levels. Impact of toxicants on molecular pathways. Application of toxicology: pharmaceutical industry or related areas, such as government drug regulatory affairs and clinical trial centres.		

Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, field based studies, take-home assignments, seminar and oral presentation by students, laboratory sessions
Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	• Viccellio, P. (Ed.). Handbook of medical toxicology. Little, Brown, and Company.1993 • Sunshine, I. (Ed.). CRC Handbook Series in Analytical Toxicology. Crc Press.1969 • Stahr, H. M., &Stahr, H. M. Analytical methods in toxicology (No. V590 STAa). New York etc.: Wiley.1991 • Mikko Nikinmaa. An introduction to aquatic toxicology. Academic press, USA.2014

Semester	Second		
Title of the Course Unit	Entrepreneurship		
Course Code	MBB305C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Industrial visits
	33	55hrs (Library work; group assignments; report writing; seminars on case studies and current topics)	12
Objective/s	• Introduce the cellular and molecular nature of development in animals		
Intended Learning Outcomes	• Understand the traits, skills, attitudes and drive necessary to be a successful entrepreneur. • Identify personal strengths and weaknesses matching the profiles of successful small business owners. • Develop personal growth plans to address weaknesses and capitalize on strengths in order to increase their potential to succeed in small business.		

	• Understand the needs of target markets related to potential viable business idea. • Size the potential market for potential viable idea. • Develop initial sales, profit, competitive landscape and future growth for potential viable business idea. • Match potential viable idea to personal assessment profile.
Contents	Entrepreneurship : Definition of a "business"; Evolution of entrepreneurship in today's economy Personal Evaluation: Definition of "success"; Entrepreneurial attributes, traits, skills for success; Personal assessment; Personal development plans; Learned entrepreneurial traits; Personal potential as an entrepreneur Ideas to Opportunities: Generating business ideas; Locating business ideas; Expanding the ideas Validating the opportunity: Feasibility analysis; Customer identification; Environmental scan; Competitive assessment; Profitability
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, industrial visits, invited talks; take-home assignments, seminar and oral presentation by students.
Evaluation/Assessment Strategy	Theory: In-Course Assessments: Industrial visit report and quiz (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	•

Level 3

Botany

Semester	First		
Title of the Course Unit	Plant tissue culture		
Course Code	MBB306C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	22	54 hrs (Library work; group assignments; report writing; field visits)	24
Objective/s	• Provide knowledge on basic to comprehensive cell and tissue culture propagation techniques • Develop the practical skills and confidence of students to successfully culture plant cells and tissues.		
Intended Learning Outcomes	• Explain the basic requirements to establish plant tissue culture media • Explain and perform some of the more advanced techniques for plant cell and tissue culture • Establish and maintain plants in tissue culture		
Contents	Fundamentals of plant tissue culture: role of tissue culture in rapid clonal propagation, laboratory requirements, sterilization techniques, media preparation, explant selection, growth requirements; Technology and potential applications of various tissue culture techniques: callus culture, cell suspension culture, meristem culture, embryo culture, anther/pollen culture, protoplast techniques and somatic hybridization; Somatic embryogenesis; production, preservation and use of somatic embryos as propagules; artificial seeds and their applications; cell suspension culture and secondary metabolite production, cryopreservation and germplasm conservation of plant genetic resources; micropropagation of economically important plants; Laboratory exercises based on above topics.		

Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, field based studies, take-home assignments, seminar and oral presentation by students, laboratory sessions
Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	• Smith R. H. Plant Tissue Culture: Techniques and Experiments. Elsevier Academic Press. 2013. • Bhojwani S. S and Dantu P. K. Plant tissue culture: An introductory text. Springer, India . 2013. • Neumann K., Kumar, A and Imani, J. Plant cell and tissue culture - A tool in biotechnology. Springer-Verlag. 2009.

Semester	First		
Title of the Course Unit	Molecular plant pathology		
Course Code	MBB307C3		
Credit Value	03		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	33	81 hrs (Library work; group assignments; report writing; field visits)	36

Objective/s	• Provide fundamental to comprehensive knowledge on plant diseases • Impart knowledge on identification, characterization and management of diseases using molecular biological approaches
Intended Learning Outcomes	• Recall the knowledge on classic plant pathology • Discuss molecular aspects of host resistance and pathogen virulence mechanisms • Explain various molecular techniques available to identify disease causing agents • Construct highly effective protocols to diagnose plant diseases
Contents	Fundamentals of plant pathology: history, principles, concepts and terminology, symptomatology, causes of plant diseases; Techniques involved in the study of plant diseases: laboratory culturing, isolation and identification of bacteria and fungi; Diseases caused by major taxonomic groups; Koch's postulates; Epidemiology. Molecular techniques used in plant disease diagnosis: immunoassays, nucleic acid based diagnosis; Molecular aspects of plant-pathogen interaction: fungal and bacterial biotrophy and necrotrophy, pathogen-associated molecular patterns, role of PR proteins, small noncoding RNA, phytohormones and antimicrobials in plant defence; Signalling in plant resistance; Transgenic approaches for crop protection; Laboratory exercises and field visits based on above topics.
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, field based studies, take-home assignments, seminar and oral presentation by students, laboratory sessions
Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	• Agrios G.N. Plant Pathology. Elsevier Academic Press. 2005. • Walters D. R. Plant Defense: Warding off Attack by Pathogens, Herbivores, and Parasitic Plants. Blackwell Publishing Ltd. 2011. • Lacomme C. Plant pathology: Techniques and protocols. Humana Press. 2015.

Semester	First		
Title of the Course Unit	Genetic Engineering		
Course Code	MBB308C3		
Credit Value	03		
Core/Optional	Core		
Hourly Breakdown	Theory	Independent Learning	Practical
	33	70 hr (Library work; group assignments; report writing; seminars on case studies and current topics)	36
Objective/s	To provide the practical skills on various cloning vehicles, recombinant protein expression and purification		
Intended Learning Outcomes	• Explain the role of DNA technology and its uses in synthesizing new recombinant products • Contrast different cloning vectors • Describe application of genetic engineering in human life. • Differentiate the various mechanisms involved in gene transfer • Judge the problems of protein expression • Apply the knowledge of construction of molecular maps using markers		
Contents	Introduction to recombinant DNA technology and genetic engineering , artificial synthesis of genes, gene synthesis using mRNA , enzymes used in genetic engineering, cloning vectors such as bacterial plasmids, bacteriophages, cosmids, phagemids, yeast plasmids, yeast artificial chromosomes (YAC), bacterial artificial chromosomes (BAC), plant and animal viruses, transposons, shuttle vectors, and expression vectors etc., gene cloning in prokaryotes and eukaryotes, expression of cloned DNA in the host, post-transcriptional and translational modifications, DNA libraries, Molecular markers (AFLP, RFLP, RAPD, SSCP, microsatellite etc.) western blotting, southern blotting and northern blotting, DNA sequencing, polymerase chain reaction (PCR), application of genetic engineering in plants, ethical issues in the implications of genetic engineering.		
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, assignments, seminar and oral presentation by students		

Evaluation methods	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	• Brown T. A. Gene Cloning and DNA Analysis: An Introduction. Wiley-Blackwell. 2010. • Richard J. Reece. Analysis of Genes and Genomes. Wiley-Blackwell. 2003. • Power C. B. Molecular cell biology. Himalaya publishing house. 2013.

Semester	First		
Title of the Course Unit	Biotechnology		
Course Code	MBB309C3		
Credit Value	03		
Core/Optional	Core		
Hourly Breakdown	Theory	Independent Learning	Practical classes
	33	81 hr (Library work; group assignments; report writing; seminars on case studies and current topics)	36
Objective/s	To provide advanced skills and technology for commercial exploitation		
Intended Learning Outcomes	• Understand the important principles of biotechnology • Analyze different methods of crop improvement practices • Apply various techniques in biotechnology and their merits and demerits • Evaluate different practical applications of biotechnology in the industrial life		

Contents	Basics of biotechnology, Recombinant DNA technology, Production of transgenic plants with beneficial traits (biotic stresses, virus resistance, abiotic stresses), Methods of crop improvement, Hydroponics, Plant breeding, Extra chromosomal inheritance, Bioremediation, Biofertilizers, Biofuel, Bioleaching, Biofuels, Biosensors, Bioindicators, Biodegradable plastics, Single cell protein, DNA finger printing, Biological detoxification and hazardous waste management.
Teaching learning Methods/Activities	Lecture delivery, practical sessions, tutorial discussion, assignments/ presentations/ group discussion by students
Evaluation/Assessment Strategy	Theory: In-course assessment(s): 30%, End of Course Examination: 70% Practical: In-course assessment(s): 30%, End of Course Examination: 70% Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	1. Das H. K. Textbook of Biotechnology. Wiley India Pvt. Ltd. 2010. 2. Adrian Slater, Nigel W. Scott, Mark R. Fowler. Plant Biotechnology, An Introduction to Genetic Engineering. Oxford University Press. 2008.

Semester	First
Title of the Course Unit	Plant Breeding
Course Code	MBB310C2
Credit Value	02

<table>
<tr><td>Core/Optional</td><td colspan="3">Core</td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Independent Learning</td><td>Practical, field and laboratory visit</td></tr>
<tr><td>22</td><td>70 hr (Library work; group assignments; report writing; seminars on case studies and current topics)</td><td>50</td></tr>
<tr><td>Objective/s</td><td colspan="3">• Impart knowledge of different plant breeding techniques
• Provide knowledge of botanical garden and germplasm conservation
• Introduce statistical methods in plant breeding</td></tr>
<tr><td>Intended Learning Outcomes</td><td colspan="3">• Discuss different conservation methods
• Explain the merits and demerits of different plant breeding techniques
• Test new plant cultivars.</td></tr>
<tr><td>Contents</td><td colspan="3">Role of plant breeding in society; Modes of reproduction and types of cultivar; Germplasm conservation, Botanic Gardens, Plant Breeding Organizations; Statistical methods in plant breeding.
Techniques in plant breeding: classic and modern methods; Selected breeding objectives; cultivar release and commercial seed production; The role of gene technology in plant breeding, molecular markers and marker-assisted breeding in plants, Breeding of major crops: Cereal grains and fruit crops in Jaffna.</td></tr>
<tr><td>Teaching learning Methods/Activities</td><td colspan="3">Lecture presentation , tutorial discussion, laboratory and field visit, assignments, oral presentation by students</td></tr>
<tr><td>Evaluation/Assessment Strategy</td><td colspan="3">Theory: In-Course Assessments (30%), End of Course Examination (70%)
Practical: In-Course Assessments (30%), End of Course Examination (70%)
Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10</td></tr>
<tr><td>Recommended References</td><td colspan="3">• Brown J. and Caligari P, An Introduction to Plant Breeding. Blackwell Publishing, 2008.
• Acquaah G, Principles of Plant Genetics and Breeding. Wiley – Blackwell, 2012.
• Schlegel, R.H.J, Encyclopedic Dictionary of Plant Breeding and Related Subjects, Haworth Press, New York, 2003.
• Allard R.W, Principles of Plant Breeding. John Wiley and Sons, 1999. Sleper, D.A. and Poehlman, J.M, Breeding Field
• Crops, Blackwell, Iowa, 2006.</td></tr>
</table>

Semester	First		
Title of the Course Unit	Plant physiology		
Course Code	MBB311C2		
Credit Value	02		
Core/Optional	Core		
Hourly Breakdown	Theory	Independent Learning	Practical, field and laboratory visit
	20	58 hr (Library work; group assignments; report writing; seminars on case studies and current topics)	22
Objective/s	• Provide deeper insights of plant physiology and novel applications, • Impart knowledge on gene regulation in plant physiology.		
Intended Learning Outcomes	• Discuss the evolution of photosynthetic system and organization of chloroplast. • Explain photosystems and mechanism of ATP and NADPH synthesis. • Analyze CO2 concentrating mechanisms and plant productivity. • Apply water balance, osmotic stress and phenotypic plasticity. • Describe the role of hormones in plant development.		
Contents	Plant cell as a functional unit, Ultra structure of plant cell, Genetics, assembly and evolution of photosynthetic system, organization of chloroplast, chloroplast genome and proteins, Light signal, Photosystem 1 and 11, Photosynthetic pigments, Mechanism of electron transport, proton transport and ATP synthesis, repair and regulation of photosynthetic machinery, CO_2 concentrating mechanisms, C_2 oxidative photosynthetic carbon cycle, structure, synthesis, mechanism and regulations of Rubisco, photosynthesis and plant productivity, water balance, osmotic adjustment of cells, osmotic stress and gene expression, regulation of stress response genes, adaptations and phenotypic plasticity. Hormonal regulation in plant development, signal transduction pathways of hormones, novel applications of plant physiology. Laboratory sessions, Laboratory and field visit related to the above topics.		

Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, laboratory and field visit, assignments, oral presentation by students
Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	• Taiz L and Zeiger E. Plant physiology. Sinauer Associates Inc, USA. 2010. • Taiz L., Zeiger E., Moller M and Murphy A. Plant physiology and development. Associates Inc, USA. 2014.

Semester	First and Second		
Title of the Course Unit	Seminar and current topics		
Course Code	MBB312C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Seminar presentations	Independent Learning	
	30	70hrs (Library work; report writing; preparing seminars on case studies and current topics)	
Objective/s	• Introduce the cellular and molecular nature of development in animals		
Intended Learning Outcomes	• Understand the traits, skills, attitudes and drive necessary to be a successful entrepreneur. • Identify personal strengths and weaknesses matching the profiles of successful small business owners.		

	• Develop personal growth plans to address weaknesses and capitalize on strengths in order to increase their potential to succeed in small business. • Understand the needs of target markets related to potential viable business idea. • Size the potential market for potential viable idea. • Develop initial sales, profit, competitive landscape and future growth for potential viable business idea. • Match potential viable idea to personal assessment profile.
Contents	Students will carry out a literature survey using print and electronic scientific journals and periodicals on assigned topics and present the information as an oral presentation and an essay. The selection of topics is done by students and the titles shall be discussed with the teacher and peers prior to the preparation of the seminar.
Teaching learning Methods/Activities	Seminar by students; critique; group discussion
Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	• Any current science material with scientific merit

Semester	First and second
Title of the Course Unit	Group Project
Course Code	MBB313C2

<table>
<tr><td>Credit Value</td><td colspan="3">02</td></tr>
<tr><td>Core/Optional</td><td colspan="3">Core</td></tr>
<tr><td>Prerequisites</td><td colspan="3">None</td></tr>
<tr><td rowspan="2">Hourly Breakdown</td><td>Theory</td><td>Independent Learning</td><td>Practical/ project session</td></tr>
<tr><td>05</td><td>Assignments; Library work; report writing; seminars and presentations</td><td>195</td></tr>
<tr><td>Objective/s</td><td colspan="3">Impart concepts and training to undertake a research study with respect to develop a research proposal, setting up experiments, data collection and analysis, and presentation of findings.</td></tr>
<tr><td>Intended Learning Outcomes</td><td colspan="3">Articulate a clear research question or problem and formulate hypothesis
Conduct a literature survey, using print & electronic media
Prepare a project proposal giving objectives, research design/ methodology
Analyse the data related to the methodology
Demonstrate and apply problem solving skills
Construct the project report and present the findings</td></tr>
<tr><td>Contents</td><td colspan="3">An introductory session of 5 lectures will be conducted to introduce the following concepts:
Iendtifying the problem
Creating hypothesis
Design experiments
Wiritng reports
A guided group research project is done in groups (maximum of 5 in a group) from identified research topic/problem in consultation with a Senior Lecturer/supervisor at the beginning of the Level 3. The duration of the project is 2 semesters. Each student in a group will be given to study a specific objective of the identified problem. Each student should present their part of the proposal and the findings On completion of the research work a report, in a specified format, must be submitted within the stipulated period for evaluation. Each student is required to deliver two presentations, (a) pre-project presentation, based on preparatory work and research plan and (b) end of the project presentation, based on the outcome of research and prepare a report containing Title page, Abstract, Introduction and Literature Review,</td></tr>
</table>

	Objectives, Materials & Methods, Results, Discussion and References. The project shall be conducted by the Departments of Botany and Zoology.
Teaching learning Methods/Activities	Library and laboratory work, field visits, software and internet resource application, consultation with supervisor, presentation (oral and poster), Report writing
Evaluation/Assessment Strategy	In-Course Assessments (30%) Pre-project presentation (10%) Final Presentation- oral and poster (10%) Project report (60%)
Recommended References	• Myers JL and Well AD. Research design and statistical analysis. Lawrence Erlbaum Associates. 2003 • Cargil, M. and P O'Connor. Writing scientific researcharticles – strategy and steps.2009

Level 4

Semester	First and Second		
Title of the Course Unit	Molecular Ecology		
Course Code	MBB401C3		
Credit Value	03		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	27	97hrs (Library work; group assignments; report writing; seminars on case studies and current topics)	36
Objective/s	• Describe different forms of ecology and the application of molecular biology in ecology based studies		
Intended Learning Outcomes	• Describe different forms of ecosystems • Analyze the services and values provided by the ecosystems • Categorize the molecular biology tools in the ecology based studies and population biology • Analyze the role modern technology in conservation		
Contents	Ecology: Major forms and their characteristics Ecosystem services: types and values Molecular biology tools- recall the tools and study new techniques such as computational biology in ecology based studies Environmental DNA and its applications: Modern tools and techniques in conservation- DNA meta-barcoding; meta genomics and other related technologies		
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, field based studies, take-home assignments, seminar and oral presentation by students, laboratory sessions		
Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10		

Recommended References	• Smith, R. L., Smith, T. M., Hickman, G. C., & Hickman, S. M. Elements of ecology. 1998 • Baker, A. (Ed.). Molecular methods in ecology. John Wiley & Sons.2009

Semester	First		
Title of the Course Unit	Molecular phylogeny		
Course Code	MBB402C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	09	55hrs (Library work; group assignments; report writing; seminars on case studies and current topics)	36
Objective/s	• Explain the molecular evolutionary process and use the computational techniques in tree building		
Intended Learning Outcomes	• Describe evolutionary process at the molecular level • Apply molecular methods to study genetic variation within and between species • Explain and justify different models of sequence evolution • Explain and evaluate different phylogenetic optimality criteria, and select adequate criterion to solve a given problem • Map and apply the process to do and evaluate a phylogenetic analysis		

Contents	DNA based changes: Mutational processes, evolution of mutation rates, evolution of DNA sequences, the molecular clock, selection and genetic drift on the molecular level, nucleotide composition, polymorphism and SNPs. Tree construction and interpretation: Phylogenetic trees and other models, optimality criteria for selecting phylogenetic hypothesis. Substitution models for DNA and other data types. Super trees, consensus trees, tree compatibility. Algorithms for evaluating the tree space; Markov Chain Monte Carlo, genetic algorithms. Evaluation of results from phylogenetic analyses, phylogenetic dating.
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, field based studies, take-home assignments, seminar and oral presentation by students, laboratory sessions
Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (4MT+6MP)/10
Recommended References	• Wheeler, Q., &Novacek, M. J. . Extinction and phylogeny (pp. 205-215). NewYork: Columbia University Press.1992 • Baum, D. A., & Smith, S. D. Tree thinking: an introduction to phylogenetic biology. Greenwood Village, CO: Roberts.2013

Semester	First		
Title of the Course Unit	Gene editing technologies		
Course Code	MBB403C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	21	55hrs (Library work; group assignments; report writing; seminars on case studies and current topics)	24
Objective/s	• Describe the technologies and application of gene editing		
Intended Learning Outcomes	• Explain the procedures of gene editing • Describe the methods of gene editing • Review the diseases that might be treatable by gene therapy • Illustrate the basic principles of genetic manipulation • Explain the differences between somatic and germline gene therapy and some of the problems involved in these potential treatments • Analyze how genetics may be used in the design of drugs.		
Contents	Introduction to DNA and macromolecules.		

	Genes and genomes. Gene editing technologies; history and principles Gene therapy- Diseases which are treated with gene editing: Potential and application Genetic engineering and drugs development		
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, field based studies, take-home assignments, seminar and oral presentation by students, laboratory sessions		
Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10		
Recommended References	• Dunlop, M. G.. Gene therapy protocols (Vol. 7). 1997 • RNA editing (Vol. 34). Frontiers in Molecular Biology.ns (Ed.). Totowa, NJ: Humana Press. 2017		
Semester	Second		
Title of the Course Unit	Nano biotechnology		
Course Code	MBB404C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	21	55hrs (Library work; group assignments; report writing; seminars on case studies and current topics)	24
Objective/s	• Provide basic knowledge in the interface between chemistry, physics and biology on the nanostructure level with a focus on biotechnological usage.		
Intended Learning Outcomes	• Explain the interaction of biomolecules with surfaces of different chemical and physical species. • Describe the production and the applications of various types of nanostructured materials. • Illustrate the methods for the design of enzyme reactors and other bio-conjugates on surfaces and second carriers, and		

	explain the carrier's influence on the activity of the biomolecule. • Analyze applications within the field of bioelectronics and account for the basic principles they are based on. • Evaluate the risk and benefits of a nanobiotechnological project.
Contents	Examples and production of various types of nanostructured materials with usage and potential within biotechnology. Using biomaterials and biomolecules as bases for inorganic structures. Introduction to surface physics and biomaterials. Methods for derivatisation and characterization of surfaces and other carrying structures. Theory and methods for studies of the interaction with surfaces and fibers of biomolecules. Applications within bio separation, diagnostics, the drug delivery and bio implants. Theory for how lipid/polymer nanoparticles can be utilized as model membranes and for formulation/administration of drugs. Molecular prints of biomolecules. Production and applications of inorganic replicas of biological materials. Enzyme reactors based on nanostructured materials.
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, field based studies, take-home assignments, seminar and oral presentation by students, laboratory sessions
Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	• Ferrari, M., & Martin, D. K.. Nanobiotechnology of biomimetic membranes. Springer Science, New York.2007 • Mirkin, C. A., & Niemeyer, C. M. (Eds.). Nanobiotechnology II: more concepts and applications. John Wiley & Sons.2007 • Zahavy, E., Ordentlich, A., Yitzhaki, S., &Shafferman, A. (Eds.). . Nano-biotechnology for biomedical and diagnostic research (Vol. 733). Springer Science & Business Media.2011

Semester	Second		
Title of the Course Unit	Neurobiology		
Course Code	MBB405C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	21	55hrs (Library work; group assignments; report writing; seminars on case studies and current topics)	24
Objective/s	• Provide knowledge on structure and function of neurons and nervous system • Introduce the neuro-cellular mechanism at molecular level • Impart knowledge genetic basis of neurological disorders • Introduce the current trend in neurological research		
Intended Learning Outcomes	• Describe the structure and function of neurons and nervous system • Explain the function of nervous system at molecular level for selected physiological conditions • Describe the genetic and molecular basis of neurological disorders • Discuss the current trend in neurological science and ethical issues related to neurological research		
Contents	Introduction to cells of the nervous system and neuroanatomy of vertebrates with special reference to human; development of nervous system; basic neuro-cellular mechanism: chemical and electrical signaling and neurotransmission; advanced functions of the nervous system from the molecular to the integrated level: vision, olfaction and taste, emotions and pain, etc.; Introduction to neurogenetics: aging at molecular level; complex behaviours and disorders; genetic basis of neuronal disorders such as Alzheimer's disease, Huntington's disease, fragile X syndrome, etc.; current research trend in neurobiology at molecular level; introduction to invertebrate and vertebrate model organisms and ethics in neurobiological research.		
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, group assignments, take-home assignments, seminar and oral presentation by students, laboratory sessions		
Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%)		

Recommended References	• Levitan, Irwin B., and Leonard K. Kaczmarek. *The Neuron: Cell & Molecular Biology*. 3rd ed. New York, NY: Oxford University Press, 2001. ISBN: 9780195145236. • Gomperts, B. D., Kramer, I. M. and Tatham. Signal transduction. Academic Press- Elsevier Inc., USA. 2009 • Kenneth Kardong.Vertebrates: Comparative anatomy, Function, Evolution. McGraw-Hill Education.2018 • Knut Schmidt-Nielsen. Animal Physiology: Adaptation and Environment. Cambridge University Press.2014.. • Brooker, R. J. 2012. Genetics Analysis & Principles. Fourth Edition. The McGraw-Hill companies, New York, USA. ISBN 978–0–07–352528–0

Semester	First		
Title of the Course Unit	Research methodology		
Course Code	MBB406C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	30	70hrs (Library work; group assignments; report writing; seminars on case studies and current topics)	00
Objective/s	• Understand the research as an organized process and carryout a supervised research		
Intended Learning Outcomes	• Explain principles of Molecular biological research problems • Describe different research methods and designs in Molecular biological • studies • Map accurate data collection methodology • Analyze, interpret and construct data • Assemble and present data and results		
Contents	Research - Purpose, types and characteristics; Process of		

	research -identifying research questions/problems, formulation of objectives, postulating and testing hypothesis, Research plan and its components (survey, observation, case study, experimental, historicaland comparative methods) - Components of an Experiment,Randomization and Design, Multiple Comparisons, CheckingAssumptions, Power and Sample Size, Factorial Treatment Structure,Nesting, Completely Randomized Designs, Complete Block Designs, Incomplete Block Designs, Split-Plot Designs, Latin Squares. Surveydesign and analysis: Random sampling, stratified sampling,questionnaire construction, data base management; Mean separation,Regression and correlation, ANOVA, Multivariate analysis,Covariance analysis, Analysis of counts and log linear models,Analysis of binary data, Probit analysis and bootstrap methods,Animal diversity indices and distribution analysis; Use of statisticalcomputer software to analyze data from animal research. Ethical, legaland social issues in biological research.
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, field based studies, take-home assignments, seminar and oral presentation by students, Problem based leartning, group discussions, laboratory sessions
Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%)
Recommended References	• Graziano, A. M., &Raulin, M. L. Research methods: A process of inquiry. HarperCollins College Publishers.1993 • Newman, I., Benz, C. R., & Ridenour, C. S. Qualitative-quantitative research methodology: Exploring the interactive continuum. SIU Press.1998

Semester	First and second		
Title of the Course Unit	Research project		
Course Code	MBB407C6		
Credit Value	06		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical/ project session
	00	510 Library work; report writing; seminars and presentations	90
Objective/s	• Impart concepts and training to undertake a research study with respect to develop a research proposal, setting up experiments, data collection and analysis, and presentation of findings.		
Intended Learning Outcomes	• Articulate a clear research question or problem and formulate hypothesis • Conduct a literature survey, using print & electronic media Prepare a project proposal giving objectives, research design/ • methodology • Analyse the data related to the methodology • Demonstrate and apply problem solving skills Construct the project report and present the findings		
Contents	A guided research project is an integral component of the degree programme; Student must identify a research topic/problem in consultation with a Senior Lecturer/supervisor at the beginning of the level 4M. The duration of the project is 2 semesters in parallel to the 4M academic year. On completion of the research work a report, in a specified format, must be submitted within the stipulated period for evaluation. The student is required to deliver three presentations, (a) pre-project presentation, based on preparatory work and research plan (b)progress presentation and (c) end of the project presentation, based on the outcome of research and prepare a comprehensive report containing Title page, Abstract, Introduction and Literature Review, Objectives, Materials & Methods, Results, Discussion and References.		

Teaching learning Methods/Activities	Library and laboratory work, field visits, software and internet resource application, consultation with supervisor, presentation (oral and poster)
Evaluation/Assessment Strategy	In-Course Assessments (30%) Pre-project presentation (10%) Mid-project Presentation (20%) End of Course Examination (70%) Final Presentation- oral and poster (10%) Project report (60%)
Recommended References	Myers JL and Well AD. Research design and statistical analysis. Lawrence Erlbaum Associates. 2003 Cargil, M. and P O'Connor. Writing scientific researcharticles – strategy and steps.2009

Level 4

Botany

Semester	First		
Title of the Course Unit	Molecular plant virology		
Course Code	MBB408C2		
Credit Value	02		
Core/Optional	Core		
Prerequisites	None		
Hourly Breakdown	Theory	Independent Learning	Practical session
	22	54hrs (Library work; group assignments; report writing; field visits)	24
Objective/s	• Provide comprehensive view on structural, functional and molecular details of plant viruses • Impart knowledge on identification, characterization and management of virus diseases using molecular biological approaches		
Intended Learning Outcomes	• Recall the knowledge on classic and molecular plant virology • Apply the skills important for decision making on choosing techniques needed to diagnose plant viral diseases • Explain the conventional and non-conventional practices in management of plant viral diseases • Distinguish the viruses and viral like disease causing agents		
Contents	An overview of viruses; Virus structure: morphology, genome organization; Properties used for characterization of viruses; Symptomatology; Common virus diseases that affect crop cultivation; Transmission of plant viruses; Replication strategies of viruses; Taxonomy of virus; Molecular techniques for detection and identification of plant viruses: Extraction and purification of plant viruses, nucleic acids based methods; movement of viruses in plant; molecular aspects of plant, virus and vector interaction; Control measures of plant viral disease: conventional and molecular level methods; Virus-like disease in plants: phytoplasma, viroids, satellite viruses; Laboratory exercises based on above topics.		
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, field based studies, take-home assignments, seminar and oral presentation by students, laboratory sessions		

Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	• Agrios G.N. Plant Pathology. Elsevier Academic Press. 2005. • De Costa D. M. A monograph on Plant viruses. Faculty of Agriculture, University of Peradeniya. 2009. • Hull R. Comparative plant virology. Academic Press. 2009. • Hull R. Plant Virology. Academic Press.2014. • Uyeda I and Masuta C. Plant virology protocols: New approaches to detect viruses and host responses. Humana Press. 2015.

Semester	First		
Title of the Course Unit	Applied Microbiology		
Course Code	MBB409C2		
Credit Value	03		
Core/Optional	Core		
Hourly Breakdown	Theory	Independent Learning	Practical
	45	70 (Library work; group assignments; report writing; seminars on case studies and current topics)	00
Objective/s	• Provide Knowledge on diversity of microorganisms in different environment • Impart knowledge on the application of microorganisms in different environment		
Intended Learning Outcomes	• Apply the knowledge in choosing appropriate microorganism for different purposes • Explain how the microorganisms are used to clean pollutants, sewage treatment, plant growth promotion and in sustainable agriculture • Describe the role of microorganisms in industries to produce various products • Explain the use of microorganisms in the processing of foods and food industries		
Contents	Microbial diversity in the environment, Techniques for studying air microorganisms, Air borne infections, Control of microorganisms in air,		

	Water pollution, water borne diseases, testing for microbiological quality of water, Water treatment processes, microbiology of sewage treatment, Biological cleanup of pollutants, Industrial microorganisms and their products and alternative energy source development Microbial inoculants and sustainable crop production, Role of microbes in composting, Microbes in food processing and food preservation, Microbes as indices of food sanitary quality and microbial standards, Laboratory exercises and field visits.
Teaching learning Methods/Activities	Lecture presentation, tutorial discussion, assignments, seminar and oral presentation by students
Evaluation methods	In-Course Assessments (30%) End of Course Examination (70%)
Recommended References	• Michael T. Madigan, John M. Martinko, Kelly S. Bender, Daniel H. Buckley, David A. Stahl and Thomas Brock. Brock Biology of Microorganisms. Pearson Education Limited. 2014. • Eugene Nester, Denise Anderson and Evans Roberts. Microbiology: A Human perspective. McGraw-Hill Education. 2011. • Jean C. Bertrand, Pierre C., Philippe L., Robert M., Philippe N. and Telesphore S. N. Environmental Microbiology: Fundamentals and Applications. Springer Science. 2011. • Geoffrey R. Dixon and Emma L. Tilston. Soil Microbiology and Sustainable Crop Production. Springer Publications. 2010. • Sharma P. D. Environmental Microbiology. Alpha Science Publishers. 2005. • James M. Jay. Modern food Microbiology. CBS publishers and distributers. 2003.

Semester	Second		
Title of the Course Unit	Environmental Biotechnology		
Course Code	MBB410C2		
Credit Value	03		
Core/Optional	Core		
Hourly Breakdown	Theory	Independent Learning	Practical
	45	70(Library work; group assignments; report writing; seminars on case studies and current topics)	00
Objective/s	Impart knowledge on components of environment and biological processes occurring in environment.		

Intended Learning Outcomes	• Discuss the global environmental problems • Describe the interactions between man and environment • Recall effects of environmental pollution • Explain laws regarding environmental management
Contents	Components of Environment, Interaction of man and environment, Global environmental problems; Green house effect, Acid rain, El Nino, Ozone depletion, deforestation, biodiversity loss, Chemical and radiation hazards, Environmental pollution and degradation: nature of pollution, Biotechnological methods for pollution detection, Genetically engineered microorganisms in bio treatment of wastes; environmental damage by agriculture, Environmental Management; Concept of heath and sanitation, infectious diseases, health hazards due to pesticide and metal pollution, environment standards and quality monitoring, Environmental Protection act ; Environmental laws, sustainable development, environmental protection and conservation and IUCN –role in environmental protection.
Teaching learning Methods/Activities	Lecture presentation , tutorial discussion, assignments, seminar and oral presentation by students
Evaluation methods	In-Course Assessments (30%) End of Course Examination (70%)
Recommended References	• Gareth M. Evans and Judith C. Furlong. Environmental Biotechnology. Wiley publication. 2002. • Bhattacharyya and Rintu Banerjee. Environmental Biotechnology. Oxford University Press. 2008.

Semester	Second		
Title of the Course Unit	Fermentation Technology		
Course Code	MBB411C3		
Credit Value	03		
Core/Optional	Core		
Hourly Breakdown	Theory	Independent Learning	Practical
	33	70 hr (Library work; group assignments; report writing; seminars on case studies and current topics)	36
Objective/s	To introduce various upstream and downstream processes of fermentation and industrial application of this technology.		
Intended Learning Outcomes	• Understanding every important upstream and downstream components of fermentation process • Analyze fermenter's design, different types of fermentations for the need		

	• Design fermentation process for cost effective products in biotechnology industry
Contents	Introduction to fermentation technology, Principles of fermentation, Agents for fermentation, Microbial growth kinetics, Selection of Microbes for fermentation, Fermenter and bioreacter, Anaerobic respiration, metabolism & fermentation mechanism, Production of fermented products and the technology, Vitamins, Organic acids, Ethanol fermentation, Lactic acid fermentation, alcoholic beverages, dairy products, meat products, vegetable products, cereal products, Bio-ethanol production, Microbial enzyme preparation, purification, stabilization, immobilization and industrial applications, Differences for the fermentative preparation of primary and secondary metabolites and their isolation, Application of fermentation technology in industry
Teaching learning Methods/Activities	Lecture delivery, practical sessions, tutorial discussion, assignments/ presentations/ group discussion by students
Evaluation/Assessment Strategy	Theory: In-Course Assessments (30%), End of Course Examination (70%) Practical: In-Course Assessments (30%), End of Course Examination (70%) Marks obtained in theory component (MT) and practical component (MP) will be computed into Overall Marks as (6MT+4MP)/10
Recommended References	• Stanbery PF, Whitaker A and Steve Hall. Principles of Fermentation Technology. Elesvier. 2016. • Shuler M and Kargi F. Bioprocess Engineering Basic Concepts, Prentice Hall Press. 2015. • Vogel HC and Todaro CM. Fermentation and Biochemical Engineering Handbook. Elesvier. 2014.