Date :- 01/08/2024

# NOTIFICATION

Sub :- CBCS Syllabi of M. Sc. in Biotechnology (Sem. III & IV)

Ref. :- Decision of the Academic Council at its meeting held on 27/07/2024.

The Syllabi of M. Sc. in Biotechnology (Third and Fourth Semesters) as per **NATIONAL EDUCATION POLICY – 2020 (2023 Pattern)** and approved by the Academic Council as referred above are hereby notified for implementation with effect from the academic year 2024-25.

Copy of the Syllabi Shall be downloaded from the College Website (www.kcesmjcollege.in)

**Sd/-**
**Chairman,**
**Board of Studies**

**To :**

1) The Head of the Dept., M. J. College, Jalgaon.
2) The office of the COE, M. J. College, Jalgaon.
3) The office of the Registrar, M. J. College, Jalgaon.

Khandesh College Education Society's

# Moolji Jaitha College, Jalgaon

## An "Autonomous College"

## Affiliated to KBC North Maharashtra University, Jalgaon

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# SYLLABUS

# M.Sc. II Biotechnology

**Under Choice Based Credit System (CBCS)**

**and**

**as per NEP-2020 Guidelines**

**[w.e.f. AcademicYear:2024-25]**

**Preface**

Skilled human resources is a prerequisite in higher education, and it is to be acquired through in-depth knowledge of theoretical concepts and hands-on laboratory methods of the subject. The M.Sc. part I in Biotechnology syllabus has been prepared per the guidelines of UGC, NEP-2020, and the Government of Maharashtra. It cultivates theoretical and practical knowledge of different fields among biotechnology students. The contents of the syllabus have been prepared to accommodate the fundamental aspects and advanced developments in various biotechnology disciplines and to complement the needs of various biotechnology sector applications. Besides this, the students will be enlightened with knowledge in the newer areas of Bioinstrumentations, Biomolecules, Microbial Genetics, Virology, Immune response, Tissue culture, Microbial fermentations, IPR, Patents, Bioethics etc. Furthermore, the syllabus is structured to cater to Biotechnology's present and future needs in the research field, industrial and environmental sectors, and entrepreneurship, emphasizing imparting hands-on skills. Hence, the curriculum has more experiments that shall run hand-in-hand with theory. The detailed syllabus of each paper is appended with a list of suggested readings.

The M.Sc. II biotechnology curriculum is divided into one- and two-year courses, covering many topics. It starts with general concepts in biotechnology, biomolecules, and microbial metabolism, followed by in-depth studies in cell biology, extremophiles, molecular biology, and microbial genetics. The syllabus also includes immunology, industrial and applied Biotechnology, Environmental Biotechnology and various advanced bio techniques such as bioinformatics, immune techniques, Tissue culture, and biosensors. Each section is designed to provide a comprehensive understanding of the respective field.

## Program Outcomes (PO) for M.Sc. Program:

Program outcomes associated with an MSc degree are as follows:

1. Student has an in-depth understanding of advanced theories, concepts, and methodologies in their field of study.
2. Student should demonstrate advanced technical skills and proficiency in utilizing specialized equipment, software, and methodologies relevant to their field of study.
3. Studentsshould be capable of critically analyzing complex problems and synthesizing information from various sources.
4. Studentsshould be proficient in effectively communicating scientific information to technical and non-technical audiences. They should be able to present their experimental findings through oral presentations, scientific writing, and appropriate visual aids.
5. Students should demonstrate leadership qualities and the ability to work effectively as a team.

6. Students should have developed advanced research skills and the ability to design and conduct rigorous scientific investigations independently. They should be able to analyze scientific literature,formulate research questions, develop research plans, collect and analyze data, draw valid conclusions, and learn about IPR.
7. Students should understand and adhere to their field's ethical principles and professional standards.
8. Studentsshould recognize the importance of continuous learning and professional development. They should have the skills and motivation to stay updated with advancements in their field, engage in lifelong learning, and pursue further academic or professional opportunities.

**Program Specific Outcome PSO (M.Sc. Biotechnology):**

After completion of this course, students are expected to learn/understand the following:

| No | PSO |
|---|---|
| **1** | Various biomolecules, their transport, diverse metabolic reactions and bioenergetics |
| **2** | Bioanalytical, biophysical, biomolecule purification and immunological techniques |
| **3** | Molecular biology concerning DNA replication, central dogma, gene regulation and rDNA technique |
| **4** | Concept of environmental biotechnology, biodiversity and its conservation |
| **5** | Techniques of plant/animal tissue culture and biotechnology of animal and plants |
| **6** | Bioprocess technology for agriculture, Food, pharmaceutical, fermentation and environmental sectors |
| **7** | Newer and applied areas such as bioinformatics, biostatistics and cancer biology |
| **8** | Research methodology, IPR, Bioentreprenuership, bioethics, professional development |

## Credit distribution structure for two years/one-year PG MSc programme

| Level | Sem | Major (Core) Subjects | | Minor Subjects | OJT/Int, RP | Cumulative Credits/Sem | Degree/ Cumulative Cr. |
|---|---|---|---|---|---|---|---|
| | | Mandatory (DSC) | Elective (DSE) | | | | |
| 6.0 | I | DSC-1 (4T)<br>DSC-2 (4T)<br>DSC-3 (4T)<br>DSC-4 (2P) | DSE-1(2T) A/B<br>DSE-2(2P) A/B | RM (4T) | | 22 | First-year PG OR One year PG diploma after 3 years UG |
| | II | DSC-5 (4T)<br>DSC-6 (4T)<br>DSC-7 (4T)<br>DSC-8 (2P) | DSE-3(2T) A/B<br>DSE-4(2P) A/B | | OJT/Int (4) | 22 | |
| | Cum. Cr. | 28 | 8 | 4 | 4 | 44 | |
| | Exit option: PG diploma (44 Credits) after three-year UG degree | | | | | | |
| 6.5 | III | DSC-9 (4T)<br>DSC-10 (4T)<br>DSC-11 (4T)<br>DSC-12 (2P) | DSE-5(2T) A/B<br>DSE-6(2P) A/B | -- | RP (4) | 22 | Second-year PG after 3 years UG OR PG degree after 4 years UG |
| | IV | DSC-13 (4T)<br>DSC-14 (4T)<br>DSC-15 (2P)<br>DSC-16 (2P) | DSE-7(2T) A/B<br>DSE-8 (2P) A/B | ... | RP (6) | 22 | |
| | Cum. Cr. | 54 | 16 | | 4+10 | 88 | |
| 2 Years-4 Sem. PG Degree (80-88 credits) after Three Year UG Degree or 1 Year-2 Sem PG Degree (40-44 credits) after Four Year UG Degree | | | | | | | |

**Sem**- Semester, **DSC**- Department Specific Course, **DSE**- Department Specific Elective, **T**- Theory, **P**- Practical, **RM**- Research Methodology, **OJT**- On-Job Training, **Int**- Internship, **RP**- Research Project, **Cum. Cr.**:Cumulative Credits

## Multiple Entry and Multiple Exit options:

The multiple entry and exit options with the award of UG certificate/ UG diploma/ or three-year degree depending upon the number of credits secured;

| Levels | Qualification Title | Credit Requirements | | Semester | Year |
|---|---|---|---|---|---|
| | | Minimum | Maximum | | |
| **6.0** | One-year PG Diploma program after 3 Yr Degree | 40 | 44 | 2 | 1 |
| **6.5** | Two-year master's Degree program After 3-Yr UG OrPGDegreeafter 4-Yr UG | 80 | 88 | 4 | 2 |

# Examination Pattern for MSc

Theory Question Paper Pattern:

- 60 (External) +40 (Internal) for 4 credits
  - External examination will be of three hours duration
  - There shall be 5 questions, each carrying equal marks (12 marks each), while the tentative pattern of question papers shall be as follows;
  - Q1 Attempt any 3 out of 4 sub-questions; each 4 marks
  - Q 2, Q3, Q4 and Q5Attempt any 2 out of 3 sub-question; each 6 marks.
- 30 (External) +20 (Internal) for 2 credits
  - External examination will be of 1½ hours duration
  - There shall be 3 questions Q1 carrying 6 marks and Q2, Q3 carrying 12 marks each. while the tentative pattern of question papers shall be as follows;
  - Q1 Attempt any 2 out of 3 sub-questions; each 3 marks
  - Q 2 and Q3 Attempt any 2 out of 3 sub-question; each 6 marks.

## Rules of Continuous Internal Evaluation:

The Continuous Internal Evaluation for theory papers shall consist of two methods:

**1. Continuous & Comprehensive Evaluation (CCE):**CCE will carry a maximum of 30% weightage (30/15 marks) of the total marks for a course.Before the start of the academic session in each semester, the subject teacher should choose any three assessment methods from the following list, with each technique carrying 10/5 marks:

i. Individual Assignments
ii. Seminars/Classroom Presentations/Quizzes
iii. Group Discussions/Class Discussion/Group Assignments
iv. Case studies/Case lets
v. Participatory & Industry-Integrated Learning/Field visits
vi. Practical activities/Problem Solving Exercises
vii. Participation in Seminars/Academic Events/Symposia, etc.
viii. Mini Projects/Capstone Projects
ix. Book review/Article review/Article preparation
x. Any other academic activity
xi. Each chosen CCE method shall be based on a particular unit of the syllabus, ensuring that three units of the syllabus are mapped to the CCEs.

**2. Internal Assessment Tests (IAT):**IAT will carry a maximum of 10% weightage (10/5 marks) of the total marks for a course.IAT shall be conducted at the end of the semester and will assess the remaining unit of the syllabus that the CCEs did not cover.The subject teachercan decide which units will be evaluated using CCEs and which will be assessedbased on IAT.

The overall weightage of Continuous Internal Evaluation (CCE + IAT) shall be 40% of the total marks for the course. The remaining 60% of the marks shall be allocated to the semester-end examinations.

The subject teachersmust communicate the chosen CCE methods and the corresponding syllabus units to the students at the beginning of the semester to ensure clarity and proper preparation.

## Practical Examination Credit 2: Pattern (30+20)

### External Practical Examination (30 marks):

- Practical examination shall be conducted by the respective department at the end of the semester.
- Practical examination will be of 3 hours and shall be conducted as scheduled.
- There shall be 05 marks for journal and viva voce.A certified journal is compulsory to appear for practical examination.
- The practical examination will be of a minimum of 3 hours duration. It shall be conducted as per schedule for 2 consecutive days in case of practical where incubation conditions and allied aspects are essential.

### Internal Practical Examination (20 marks):

- The department will conduct an internal practical examination of 10 marks as per the schedule given.
- For internal practical examination, students must produce the laboratory journal of practicals completed along with the completion certificate signed by the concerned teacher and department head.
- There shall be continuous assessment of 30 marks based on student performance throughout the semester. This assessment can include quizzes, group discussions, presentations and other activities the faculty assigns during regular practicals. For details, refer to internal theory examination guidelines.
- Finally, 40 (10+30) students' performance will be converted into 20 marks.

# M.Sc. Biotechnology Course Structure

| Semester | Course Module | Credit | Hours/ week | THE/ PR | Code | TITLE |
|---|---|---|---|---|---|---|
| I | DSC | 4 | 4 | TH | BIT-DSC-511 | Biomolecules and metabolic reactions |
| | DSC | 4 | 4 | TH | BIT -DSC-512 | Bioanalytical and Biophysical Techniques |
| | DSC | 4 | 4 | TH | BIT-DSC-513 | Molecular biology and gene regulation |
| | DSE | 2 | 2 | TH | BIT-DSE-514A | Biodiversity and its conservation |
| | DSE | 2 | 2 | TH | BIT-DSE-514B | Cell and Cancer Biology |
| | DSC | 2 | **4** | **PR** | BIT-DSC-515 | Practical course on Biochemistry and Molecular biology |
| | DSE | 2 | **4** | **PR** | BIT-DSE-516A | Practical course on bio-diversity and biotechniques |
| | DSE | 2 | **4** | **PR** | BIT-DSE-516B | Practical course on cell biology |
| | DSC | 4 | 4 | TH | BIT-RM-517 | Research Methodology for Biotechnology |
| II | DSC | 4 | 4 | TH | BIT-DSC-521 | Advances in Immunology |
| | DSC | 4 | 4 | TH | BIT-DSC-522 | Plant and animal tissue culture |
| | DSC | 4 | 4 | TH | BIT-DSC-523 | r DNA technology |
| | DSE | 2 | 2 | TH | BIT-DSE-524A | Plant biotechnology |
| | DSE | 2 | 2 | TH | BIT-DSE-524B | Bioprocess Technology |
| | DSC | 2 | **4** | **PR** | BIT-DSC-525 | Practicals on Plant and animal tissue culture |
| | DSE | 2 | **4** | **PR** | BIT-DSE-526A | Practicals on plant biotechnology |
| | DSE | 2 | **4** | **PR** | BIT-DSE-526B | Practicals on bioprocess technology |
| | DSC | 4 | **8** | **OJT** | BIT-OJT-527 | Internship / On Job Training |
| III | DSC | 4 | 4 | TH | BIT-DSC-611 | Environmental and Agricultural Biotechnology |
| | DSC | 4 | 4 | TH | BIT-DSC-612 | Advanced Pharma and Process Biotechnology |
| | DSC | 4 | 4 | TH | BIT-DSC-613 | IPR, Biosafety and Bioethics |
| | DSE | 2 | 2 | TH | BIT-DSE-614A | Food Biotechnology |
| | DSE | 2 | 2 | TH | BIT-DSE-614B | Advances in enzymology |
| | DSC | 2 | 4 | PR | BIT-DSC-615 | Practicals on Environmental and pharma Biotechnology |
| | DSE | 2 | 4 | PR | BIT-DSE-616A | Practicals on Food Biotechnology |
| | DSE | 2 | 4 | PR | BIT-DSE-616B | Practicals on Enzymology |
| | DSC | 4 | 8 | RP | BIT-RP-617 | Research project I |
| IV | DSC | 4 | 4 | TH | BIT-DSC-621 | Genomics and proteomics |
| | DSC | 4 | 4 | TH | BIT-DSC-622 | Biostatistics and bioinformatics |
| | DSE | 2 | 2 | TH | BIT-DSE-623 A | Entrepreneurship for Biotechnology |
| | DSE | 2 | 2 | TH | BIT-DSE-623 B | Food technology and nutrigenomics |
| | DSC | 2 | 4 | PR | BIT-DSC-624 | Practicals on Biostatistics and Bioinformatics |
| | DSC | 2 | 4 | PR | BIT-DSC-625 | Practicals on Fermentation Technology |
| | DSE | 2 | 4 | PR | BIT-DSE-626A | Practicals on professional development |
| | DSE | 2 | 4 | PR | BIT-DSE-626B | Practicals on Food Technology and nutrigenomics |
| | DSC | 6 | 12 | RP | BIT-RP-627 | Research project II |

DSC: Department-Specific Core course DSE: Department-Specific elective
TH: Theory PR: Practical
RP: Research Project

# M.Sc. II (Biotechnology)

# Semester III

# MSc II (Biotechnology)
# Semester III
# BIT-DSC-611: Environmental and Agricultural Biotechnology

**Total Hours: 60** **Credits: 4**

| | | |
|---|---|---|
| **Course objectives** | • To learn the principles and methods of waste management.<br>• To know about contaminated environment and bioremediation<br>• To study agricultural biotechnology<br>• To familiarize students with advancedtechniques in agricultural biotechnology. | |
| **Course outcomes** | After successful completion of this course, students are expected to:<br>• Implement microbes-related strategies for waste management<br>• Use of microbes for bioremediation and Biodegradation<br>• Gain an insight into techniques of agricultural biotechnology<br>• Apply knowledge of advanced agricultural biotechnology | |
| **Unit** | **Contents** | **Hours** |
| **Unit I** | **Introduction to Environmental and Biotechnology**<br>• Global Environmental issues:<br>  o Ozone depletion, Greenhouse effect, UV, and Acid rain.<br>• Environmental resources and perturbation<br>  o water, soil, air, and atmospheric gases as resource<br>  o pollutants and pollution of air, water, soil and soil erosion<br>• Control of water pollution<br>  o Waste water treatments – Primary, Secondary and Tertiary.<br>  o Aerobic Biological Treatment – Activated Sludge Process, Rotating Biological Contactors, Trickling Filters<br>  o Anaerobic Biological Treatment – Packed bed reactor, Air lift membrane bioreactor, Fluidized bed reactor<br>• Managements of soil pollution and soil conservation<br>• Strategies for medical, solid waste management | **15** |
| **Unit II** | **Biodegradation and Bioremediation**<br>• Biodegradation<br>  o Concept and Definition<br>  o Types - ready, ultimate and inherent<br>  o Biodegradation of lignocellulosic waste<br>  ▪ Modular structure and Recalcitrancy, microbes, SSF<br>  o Concept of - Xenobiotic, its persistence and degradation mechanism<br>  o Pesticide degradation (Principle with suitable example)<br>• Bioremediation<br>  o Definition and Concept<br>  o Methods of bioremediation (In-situ and Ex-situ Methods)<br>  o Phytoremediation – Concept and Types<br>  o Bioabsorption as bioremediation approach, factors affecting and limitations | **15** |

| | | |
|---|---|---|
| | ○ Applications of bioremediation | |
| **Unit III** | **Introduction to Agricultural Biotechnology**<br>• Importance of Agriculture inthe national economy<br>• Advantages of biotechnological methods over conventional methods of crop improvement<br>• Basic microbial ecology and its components<br>• Microbial interactions: positive and negative<br>• Indicators of soil health<br>• Microbial reclamation of saline and sodic soils<br>**Microbial interactions with plant roots**<br>• Rhizosphere and Rhizosphere engineering<br>• Mycorrhizae: VAM, ericoid and orchid mycorrhiza, Ectomycorrhiza<br>• Plant Growth Promoting Rhizobacteria (PGPR)<br>• Strategies for rhizosphere and mycorrhizae community study<br>• Nitrogen fixation symbiotic and symbiotic nodule formation, mechanism of nitrogen fixation, *nif*operon<br>• Classification of plant diseases based on symptoms, crop and parts affected<br>• Disease Triangle (Host, environment and pathogen)<br>• Concept of Disease cycle<br>• Improvement of crop quality (FlavrSavr tomato, Golden rice)and yield | **15** |
| **Unit IV** | **Advances in agricultural Biotechnology**<br>• Breeding for disease resistancevarieties<br>○ Nature, causes and resistance<br>○ Breeding methods<br>• Crop improvement<br>○ Concepts, conventional &non conventional methods.<br>○ Mechanism: Exclusion, Eradication, Reduction of Inoculum, Protection and Resistant varieties<br>• Biotechnological methods in Pest Control<br>○ repellents, antifeedants, hormones, attractants, gamma radiation, genetic control, transgenic plant<br>• Integrated pest management – Inspection, Identification, Threshold, Employment control and Evaluation<br>• Agro-based industries: Scope, types, role,employment and future potentials.<br>• Village Industry: Concept and reasons for underdevelopment. | **15** |

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# MSc II (Biotechnology)
# Semester III
# BIT-DSC-612: Advanced Pharma and Process Biotechnology

**Total Hours: 60** **Credits: 4**

| | | |
|---|---|---|
| **Course objectives** | • To acquaint the student with knowledge of vaccine<br>• To inculcate techniques used for drug designing<br>• To learn about various Bioprocess Technology<br>• To introduce the concept of biopharmaceutical production. | |
| **Course outcomes** | After successful completion of this course, students are expected to:<br>• Understand advances in vaccine production techniques<br>• Get aware of different tools and techniques used for drug designing.<br>• Apply knowledge of biopharmaceuticals for industrial production<br>• Understand about transgenic production of biopharmaceuticals | |
| **Unit** | **Contents** | **Hours** |
| **Unit I** | **Vaccinology**<br>• Historical vaccination<br>• Overview of the immune system and fundamental aspects of immune response(s) to vaccines<br>• Conventional approaches to vaccine development<br>  o Live, attenuated and killed vaccines<br>• Quality control, preservation and monitoring of microorganisms in seed lot systems.<br>• Newer vaccine approaches: sub-unit vaccines, synthetic vaccines, DNA vaccines, virus-like particles, recombinant vaccines, edible vaccines, Nanoparticles in vaccine delivery systems,<br>• Adjuvants: Concept, history and types.<br>• Overview of bacterial and viral vaccines and their importance to public health. | **15** |
| **Unit II** | **Drug Designing and Biopharmaceutical Industry**<br>• Concept and economics of drug discovery, identification and validation of target, role of transgenic animals in target validation.<br>• Tools and techniques in drug designing:<br>  o Computer-aided drug designing, the role of bioinformatics in genome-based therapy, antisense DNA technology, role of genomics research<br>• Biopharmaceutical industry: Definition and characteristics<br>• Biopharmaceutical market, products, manufacturing and research | **15** |
| **Unit III** | **Concept of Fermentation and Bioprocess Technology**<br>• Fundamental concept of fermentation and bioprocess technology<br>• Bioreactors<br>  o Bioreactor design, criteria, operation and types of bioreactors.<br>• Concept of scale up, scale up challenges.<br>• Influence of various bioprocess parameters | **15** |

| | | |
|---|---|---|
| | ○ pH, temperature, and medium components on product synthesis.<br>• Bioprocess monitoring and control, automated control vs manual control of bioprocesses<br>• Commercial production of various bioprocess-based products (Penicillin, Streptomycin, Single cell protein) | |
| **Unit IV** | **Transgenic production of Biopharmaceuticals**<br>• Concept and advantage<br>• Progress in transgenic animal-producing biopharmaceuticals<br>• Selected tissue and expression<br>• Challenges and issues<br>• Animals of interest for transgenesis<br>• Transgenic plant for production of biopharmaceuticals<br>• Status of transgenics | **15** |

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# MSc II (Biotechnology)
# Semester III
# BIT-DSC-613: IPR, Biosafety and Bioethics

**Total Hours: 60** **Credits: 4**

| | | |
|---|---|---|
| **Course objectives** | • To impart knowledge on intellectual property<br>• To give an insight intothe patent filling,different treaties signed<br>• To understand various aspects of biosafety regulations<br>• To describe the ethical perspective related to biotechnology. | |
| **Course outcomes** | After successful completion of this course, students are expected to:<br>• Gain Knowledge about Intellectual Property Rights<br>• Understand the process of filing a patent<br>• Get an insight into Biosafety guidelines for industrial applications<br>• Gain familiarity withcritical ethical issues | |
| **Unit** | **Contents** | **Hours** |
| **Unit I** | **Introduction to Intellectual Property**<br>• General Introduction, Importance and history<br>• IPR and Traditional Knowledge.<br>• Concept of - Patents, Trademarks, Copyright, Trade secrets, Industrial Design and Rights<br>• Patentable and non-patentable items<br>• Geographical Indications<br>o Objectives and rights conferred<br>• World Intellectual Property Rights Organization (WIPO),<br>• Ethics, Pros and Cons of IP protection. | **15** |
| **Unit II** | **Grant of patents, patenting authorities and treaties**<br>• Basic requirements of Patentability<br>• Patent filing procedures<br>• Patent licensing and agreement<br>• Patent infringement- meaning, scope, litigation<br>• Patenting of biological materials (life)<br>• Agreements and Treaties: GATT, TRIPS, WIPO Treaties, Patent Co-operation Treaty (PCT) | **15** |
| **Unit III** | **Biosafety**<br>• Concept and historical background<br>• Different levels of Biosafety, Biosafety levels of specific Microorganisms<br>• Biosafety guidelines and regulations (National and International)<br>• Biological Safety Cabinets<br>• Containments – Types.<br>• Biosafety Issues in Biotechnology | **15** |

| | | |
|---|---|---|
| | • Role of Institutional Biosafety Committees (IBSC). | |
| **Unit IV** | **Bioethics**<br>• Concept, importance and scope<br>• Paradigms of Bioethics – National & International.<br>• Ethical issues against the molecular technologies<br>• Animal ethics and Rights,<br>• Ethical guidelines for animal research<br>• Bioethics in Biotechnology<br>• Social and ethical implications of biological weapons | **15** |

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# MSc II (Biotechnology)
# Semester III
# BIT-DSE-614A: Food Biotechnology

**Total Hours: 30** **Credits: 2**

| | | |
|---|---|---|
| **Course objectives** | • To understand new advances in food biotechnology<br>• To know the ethics of genetically modified foods | |
| **Course outcomes** | After successful completion of this course, students are expected to:<br>• Apply the knowledge of advances infood biotechnology<br>• Understand the applications of GM food in the food industry | |
| **Unit** | **Contents** | **Hours** |
| **Unit I** | **Introduction to Food Biotechnology**<br>• Quality attributes in food: sensory, nutritional and safety properties.<br>• Role of enzymes in baking, meat and meat processing<br>• Fermentative production of enzymes used in the food industry<br>• Cheesemaking and whey processing<br>• Enzymatic processing of fruit juices.<br>• Biotechnological modification of nutritional value of foods. Fundamentals of food flavour and its biotechnological modification. | **15** |
| **Unit II** | **Genetically Modified Foods and Ethics**<br>• Ethics in food product development<br>• Regulatory and social aspects of biotechnology in genetically modified foods.<br>• Ethical issues concerning GM foods; testing for GM foods<br>• Current guidelines for the production, release and movement of GM foods<br>• Safety evaluation of novel food products. Benefits and risks of GM foods<br>• Public perceptionof GM foods.<br>• GeneticallyModifiedCropsManagementAct2004 | **15** |

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# MSc II (Biotechnology)
# Semester III
# BIT-DSE-614B: Advances in enzymology

**Total Hours: 30** **Credits: 2**

| | | |
|---|---|---|
| **Course objectives** | • To study fundamental concepts in enzymology and enzyme kinetics<br>• To learn the regulatory mechanism of enzyme catalysis | |
| **Course outcomes** | After successful completion of this course, students are expected to:<br>• Relate the concepts in enzymology for advanced applications<br>• Understand Catalytic mechanisms and regulation | |
| **Unit** | **Contents** | **Hours** |
| **Unit I** | **Concepts in Enzymology and Enzyme Kinetics**<br>• Properties and chemical nature of enzyme<br>• Concept: enzyme activity, specific activity, catal, substrate specificity, turnover number and active site.<br>• Ribenzyme, Abzyme, Zymogens and Coenzymes<br>• Factors affecting enzyme activity: pH, temperature, substrate concentration,activator and Inhibitor.<br>• Isoenzyme: Concept and properties e.g. LDH<br>• Theories of enzyme kinetics: Michaelis-Menten Equation and concepts of Equilibrium and steady-state assumption, Km – Vmax<br>• Transformation of MM equation: Double reciprocal plot, EadieHoffstee plot, Hans-wolf plot | **15** |
| **Unit II** | **Enzyme Inhibition and Regulation**<br>• Enzyme Inhibition<br>o Irreversible and Reversible<br>o Competitive, Non-competitive, Uncompetitive and Mixed Inhibition.<br>• Enzyme regulation<br>o Allosteric regulation (ATCase), Feedback inhibition, enzyme induction and repression, regulation by proteolytic cleavage, enzyme regulation by cAMP, covalent modification<br>• Significance and biotechnological applications of Cellulases (Cellulose hydrolysis) and proteases (protein hydrolysate). Amylases (maltodextrin preparation), Lipases (oil industry), Enzymes in diagnosis (dehydrogenase, alkaline phosphatase) | **15** |

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# MSc II (Biotechnology)
# Semester III
# BIT-DSC-615: Practicals on Environmental and Pharma Biotechnology

**Total Hours: 60** **Credits: 2**

| | | |
|---|---|---|
| **Course objectives** | • To acquaint knowledge of different water analysis methods<br>• To impart training related toenvironmental microbiology<br>• To familiarize quality activities required in the pharmaceutical industry | |
| **Course Outcomes** | After successful completion of this course, students are expected to:<br>• Execute various test for environmental biotechnology<br>• Undertakevarious quality control tests of pharmaceutical products<br>• Exemplify microbial analysis in applied experiments | |
| **Sr. No.** | **Contents** | **Hours** |
| **1** | Determination of acidity and alkalinity of water/soil. | 4 |
| **2** | Measuringthe salinity of water/soil sample | 4 |
| **3** | Determination of COD of sewage/ wastewater | 4 |
| **4** | Determination of BOD of sewage/ wastewater | 4 |
| **5** | Estimation of total nitrogen of soil by any suitable method. | 4 |
| **6** | Estimation of chemical parameters of vermicompost/biogas slurry C:N ratio/ P/K/Organic carbon | 4 |
| **7** | Determination of soil microbial activity by $CO_2$ evolution method | 4 |
| **8** | Determination of total organic matter in soil. | 4 |
| **9** | Determination of pH value of different types of soil/ Determination of water holding capacity of soil. | 4 |
| **10** | Estimation of TS/TDS of the water sample. | 4 |
| **11** | Estimation of penicillin/streptomycin by biological assay | 4 |
| **12** | Estimation of penicillin/streptomycin by chemical assay. | 4 |
| **13** | Determination of Minimum Inhibitory Concentration (MIC) of given Antibiotic | 4 |
| **14** | Sterility testing of commercial pharmaceuticals (Injectable/ Parental/ Ophthalmic) | 4 |
| **15** | Synthesis of nano-particles using Biological process | 4 |

**References**


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# MSc II (Biotechnology)
# Semester III
# BIT-DSE-616A: Practicals on Food Biotechnology

**Total Hours: 60** **Credits: 2**

| | | |
|---|---|---|
| **Course objectives** | • To acquaint the student with changes occurring in raw food<br>• To inculcate techniques to estimate microbes in a food item<br>• To get aware about the fermentative production of microbial products | |
| **Course Outcomes** | After successful completion of this course, students are expected to:<br>• Gain skills required to work in the food industries<br>• Learn various microbial techniques used in food industries<br>• Apprise the techniques for the production of microbial fermented food | |
| **Sr. No.** | **Contents** | **Hours** |
| **1** | Estimation of carbohydrate content of food materials | 4 |
| **2** | Estimation of protein content of milk/food materials | 4 |
| **3** | Estimation of the fat content of food samples | 4 |
| **4** | Determination of microbial count in the food sample by DMC/SPC method | 4 |
| **5** | Determination of the quality of milk by MBRT assay | 4 |
| **6** | Determination of efficiency of pasteurisation by phosphatase assay | 4 |
| **7** | Estimation of mycotoxin in food sample by Thin layer chromatography | 4 |
| **8** | Isolation of microorganisms from spoiled milk/meat products by suitable culture techniques | 4 |
| **9** | Isolation of microorganisms from fermented food sample | 4 |
| **10** | Fermentative production of acetic acid at laboratory scale | 4 |
| **11** | Fermentative production of alcohol at laboratory scale | 4 |
| **12** | Analysis of milk adulterations (urea, starch, salt, oil, etc.) | 4 |
| **13** | Isolation and identification of food poisoning causing *S. aureus/ Bacillus cereus/ Clostridium botulinum* from a spoiled food sample | 4 |
| **14** | Isolation and characterization of food fermenting microorganisms from idli batter/Curd. | 4 |
| **15** | Preparation and analysis of Bread/Jam/Idli/Dhokala | 4 |

**References**


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- Reinert J. and Yeoan M.M., (1989) Plant Cell and Tissue Culture: A Laboratory Manual,springervelag publication, New York.
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# MSc II (Biotechnology)
# Semester III
# BIT-DSE-616B Practicals on Enzymology

**Total Hours: 60** **Credits: 2**

| | | |
|---|---|---|
| **Course objectives** | • To study techniques for the detection of various microbial enzymes<br>• To understand the effect of various factors on enzyme activity<br>• To purifythe enzymes with different techniques | |
| **Course Outcomes** | After successful completion of this course, students are expected to:<br>• Experiment with screening of microbe for enzyme and enzyme assay<br>• Find the optimum temperature, pH, etc., for enzyme activity.<br>• Purify and characterizeenzymes using the appropriate method | |
| **Sr. No.** | **Contents** | **Hours** |
| **1** | Detection of microbial enzymes from microbes: Catalase, Urease, Coagulase. | 4 |
| **2** | Detection of microbial enzymes from microbes: Amylase, Lipase, Gelatinase | 4 |
| **3** | Determination of enzyme activity and specific activity of crude enzyme amylase | 4 |
| **4** | Determination of protein content of crude amylase enzyme | 4 |
| **5** | Immobilization of yeast cells/enzyme and detection of immobilization activity | 4 |
| **6** | Effect of pH on enzyme activity | 4 |
| **7** | Effect of temperature on enzyme activity | 4 |
| **8** | Effect of organic solvent on enzyme activity | 4 |
| **9** | Effect of activator on Enzyme activity | 4 |
| **10** | Effect of inhibitors on Enzyme activity | 4 |
| **11** | Purification of the enzyme by salting out and dialysis | 4 |
| **12** | Demonstration of structural prediction of suitable enzyme with ExPasy server | 4 |
| **13** | Production of maltodextrin using amylase (% conversion method/Degree of hydrolysis method) | 4 |
| **14** | Electrophoretic determination of Molecular weight of enzyme by PAGE: SDS | 4 |
| **15** | Production of commercially essential enzymes from microbial sources | 4 |

**References**


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- Kenneth Sauer, (1995) Biochemical Spectroscopy. Methods in Enzymology Vol 46, Academic Press, USA.

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- Benson, H. (2001) Microbiological Applications Lab Manual, 8th edition, The McGraw-Hill Companies, New York.

# MSc II (Biotechnology)
# Semester III
# BIT-RM-617: Research Project I

**Hours: 120** **Credits: 4**

| | | |
|---|---|---|
| **Course objectives** | 1. To give exposure to the students to research culture and technology<br>2. To introduce students to how to select a research topic, plan, perform experiments, collect and analyze the data<br>**3.** To foster self-confidence and self-reliance in the students as they learn to work and think independently | |
| **Course outcomes** | After successful completion of this course, students are expected to:<br>• Conceive a problem based on published research and conduct a comprehensive literature survey.<br>• Learn handling of instruments, use of chemicals and how to conduct the experiments<br>• Learn how to present the project in PowerPoint and answer the queries to examiners and the science of writing. | |
| **Unit** | **Contents** | **Hours** |

**Credit distribution (1 credit for each unit)**

- Identification of a research topic, formulation of research problem, objectives, sample size and hypothesis, etc
- Preparation of Outline
- Review of literature
- Bibliography

**The systematic approach towards the execution of the project should be as follows:**
**(Wherever applicable)**

1. The complete tenure of the research project should be one year. It should be allotted during the third semester and completed in the fourth semester.
2. Weekly 8 hours should be allotted to the research project in a regular timetable.
3. In the third semester, students will be evaluated based on a credit distribution mentioned above. In the fourth semester, students should perform further research work, collect and analyze the data, compile the results and prepare and submit the final dissertation.
4. Students may be given an opportunity to participate in ongoing research activities in the respective Departments/Schools/Supervisors' laboratories. This will familiarize them with the literature survey and give them a fundamental understanding of designing and executing a research project.
5. Students may work individually or in groups (not more than 3 students) to be decided by the concerned department/supervisor.
6. Each research group should have a different research topic with some possible level of novelty.
7. The student should select the topic relevant to priority areas of concern or allied subjects with the guidance of supervisor/ head of the department.
8. Students are encouraged to work on multidisciplinary and applied projects, but it is not mandatory criteria.
9. At the beginning, students should submit the outline of the research work to be carried out in the project. (Writing in order: Title, Aim and objectives, Literature to be collected, Experimental plan or method design, expected outcome etc.)

10. Write and submit a Literature Review Report and Research outline
    Tentative order for review: Title of the Project, Certificates, Acknowledgment, Abstract and Keywords, Contents, Introduction, Literature Review, Aim of the Project, Materials and Methods, Bibliography/reference etc.
    Tentative order for research outline: Title page, introduction, background and significance of study, problems to be investigated, objective, hypothesis, chapter scheme, bibliography.
11. At the end of the third semester, each student should submit a detailed Literature Review Report and research outline.
12. An appropriate and essentialconclusive statement must be drawn at the end of the study.
13. Students should maintain lab notebooks, and the Supervisor may ask them to submit the mid-semester progress report.
14. For documents related to project submission: Font- Times New Roman, Heading Font Size-14, Normal Text Size-12, spacing-1.5, both sides justified and 1 inch margin on all side, both side printing on A-4 size.
15. Three copies of the Literature Review Report, research outline should be prepared (one copy for each department, guide, and student).
16. At the end of the semester, the candidate should prepare and present research work using a PowerPoint presentation with modern ICT tools and present the same in front of his/ her respective department during the Internal Examination.
17. For external examination the candidate will have to present the research work and face viva voce.
18. Students may present their research work in Avishkar/Webinars/Conferences.
19. Students should note that plagiarism is strictly prohibited.

**Internal examination (40 marks)**: Components of continuous internal assessment:

- Draft Research Outline (10 marks)
- Draft Review of literature (10 marks)
- Working Bibliography (10 marks)
- PowerPoint presentation, and oral examination (10 marks)

**External examination (60 marks)**and Components of external assessment:

- Final submitted review report, research outline in bound form at the time of examination **(40 marks)**
- Overall presentation reflecting the contribution of work, response to questions **(20 marks)**

**References**


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- Gurumani, N. (2014). Research methodology for biological science, MJP Publisher, Chennai
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- Krishnaswamy O. P & Reddy, D. Obul. (2010). Research Methodology and Statistical Analysis, Himalaya Publishing House

# M.Sc. II (Biotechnology)

# Semester IV

# MSc II (Biotechnology)
# Semester IV
# BIT-DSC-621: Genomics and Proteomics

**Total Hours: 60** **Credits: 4**

| | | |
|---|---|---|
| **Course objectives** | • To acquaint the student with knowledge of Genomics<br>• To familiarize with comparative genomics<br>• To introduce the concept and types of proteomics<br>• To introduce thetechnique used for protein sequence and analysis. | |
| **Course outcomes** | After successful completion of this course, students are expected to:<br>• Understand the concept and applications of genomics<br>• Get aware of techniques and application of comparative genomics.<br>• Understand proteomics with bioinformatics tools<br>• Learn the techniques used in proteomics | |
| **Unit** | **Contents** | **Hours** |
| **Unit I** | **Basic concept of Genomics**<br>• Concept of Genomics<br>• Genome overview at the level of Chromosome (with model organisms example)<br>• Impact of bioinformatics and functional genomics on biology in the 'Post genomic era'<br>• Strategies for large scale DNA sequencing- Whole genome analysis techniques<br>• Next-generation sequencing methods; Organization, structure and mapping of genomes (with model organisms example)<br>• Structural and functional genomics –Goals, methods, applications<br>• Genomic variations: Variation in the human genome, Ethical Consequences of Genomic Variations<br>• Next Generation Sequencing: Introduction, Types | **15** |
| **Unit II** | **Comparative genomics**<br>• Introduction to Comparative Genomics<br>• Concept of orthologues and paralogues<br>• Techniques in comparative genomics:<br>o Exon shuffling, horizontal gene transfers, genomes similarity, SNPs, 16S rRNA typing/ sequencing, phylogenetic footprinting<br>• Computational tools for comparative genomics<br>• Application of comparative genomics<br>o Pharmacogenomics, use of genomes to understand evolution of eukaryotes, track emerging diseases and design new drugs; determining gene location in genome sequence, Human and other vertebrate Genome, Personal genomics<br>• The minimal genome and the Barcode of Life. | **15** |

| | | |
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| **Unit III** | **Proteomics**<br>• Concept, advantages and limitations<br>• Type of proteomics: Structural and functional Proteomics with at least one explanatory example for each<br>• Large scale preparation of proteins and peptides, Merrifield Synthesis of peptides, use of peptides as probes.<br>• Proteomics and Microarray databases (Preparation, working and analysis)and allied bioinformatics tools.<br>• Pharmaceutical Applications, Proteomics in drug development and and toxicology, phage antibodies as tools, Glycobiology and Proteomics in plant genetics and breeding.<br>• Applications of proteomics to human disease studies, Clinical proteomics | **15** |
| **Unit IV** | **Techniques in Proteomics**<br>• Protein separation techniques<br>• Strategies in protein identification<br>o 2D Gel electrophoresis, Isoelectric Focusing (IEF).<br>o Mass spectrometry in proteomics –Principle, techniques, components and variations (HPLC, ESI, MALDITOF,FT-MS, MS/MS, Quadrupole) and analysis, applications.<br>o Edman protein microsequencing<br>• Protein-protein interactions- experimental and computational<br>o Protein Chip technique, Yeast and Bacterial 2-hybrid systems, Protein-ligand interactions and Protein fragment complement assays, solid ELISA, pull-down assay, and coimmunoprecipitation,<br>• Mining of protein databases | **15** |

**References**


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- Pennington, S, and Dunn, M. J. (2001) Proteomics: From Proteins Sequence to Function, Springer Publications.
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- Jones, Neil and PavelPevzner; (2004) An Introduction to Bioinformatics Algorithms: A Bradford Book, The MIT Press, USA.

# MSc II (Biotechnology)
# Semester IV
# BIT-DSC-622: Biostatistics and Bioinformatics

**Total Hours: 60** **Credits: 4**

| | | |
|---|---|---|
| **Course objectives** | • To impart an understanding of elementary aspects of bio-statistics<br>• To learn various statistical techniques applicable to biology<br>• To introduce an overview of bioinformatics<br>• To analyse the output data to predict a biologically relevant function | |
| **Course outcomes** | After successful completion of this course, students are expected to:<br>• Apply basic biostatistical techniques for biological data<br>• Practice biostatistics for the interpretation of experimental data<br>• Use fundamentals of bioinformatics for analysis of database<br>• Access and interpret theinformation from databases | |
| **Unit** | **Contents** | **Hours** |
| **Unit I** | **Sampling and central tendency(theoretical concepts)**<br>• Applications of biostatistics to biological database<br>• **Concepts**: population, sample, probability, central tendency, dispersion, variance<br>• **Sampling** types: simple random, stratified, systematic, cluster<br>• **Data**: collection (primary and secondary), classification and tabulation of data<br>• Graphical techniques: one-dimensional, two-dimensional, pictograms<br>• Graphical presentation of data: histogram, frequency polygon, frequency curve, ogive curve<br>• **Measures of Central tendency**: Mean, Mode, Median<br>• **Measures of dispersion:** range, mean deviation, standard deviation, coefficient of variation, skewness | **15** |
| **Unit II** | **Correlation, Regression, probability, ANOVA (theoretical concepts)**<br>• **Correlation**: definition, types, methods of measuring<br>• **Regression**: definition, equation, coefficient,Simple linear regression,<br>• **Analysis of Variance:** One and two-way analysis of variance, Intro experiments, Multivariate statistical analysis<br>• **Probability:** Definition, concepts: experiment, event (simple, compound, mutually exclusive, independent, dependent)<br>• **Discrete distributions**: Bernoulli, Binomial, Poisson. Continuous distributions: Normal, Exponential, sigma limits, and probability coverage.<br>• Concepts: Hypothesis testing, t-test, F test, Chi-square test, Design of experiments, multivariate statistics | **15** |
| **Unit III** | **Overview of Bioinformatics**<br>• Concept of Bioinformatics: definition, scope, application and limitations | **15** |

| | | |
|---|---|---|
| | • Introduction to biological databases<br>  • Primary (GenBank, EMBL, SWISS-PROT)<br>  • Secondary (PROSITE, pfam)<br>  • Specialized ( GenBank EST and Microarray Gene Expression)<br>  • UNIPROT database<br>• Structural databases: PDB, MMDB<br>• Sequence retrieval system - SRS, ENTREZ, Expasy<br>• Software for Data Visualization: CN3D,Rasmol, Chimera, SWISS PDB Viewer<br>• Application of programming Language in Biology: Bioperl, Biojava and R Programming<br>• Protein structure prediction: Secondary structure (Globular, Transmembrane), 3D Structure prediction (X-ray Crystallography,NMR Spectroscopy)<br>• Classification of protein Structure: SCOP | |
| **Unit IV** | **Unit-IV: Sequence analysis and phylogeny**<br>• Sequence analysis: Concept of % Identity, Twilight Zone and mid-night zone<br>• Concept of homology, analogy, othology and paralogy<br>• Sequence alignment: pairwise (local, global) and multiple sequence (Clustal W editing and interpretation)<br>• Alignment Algorithms: Dot Matrix and Dynamic Programming, Gap Penalties<br>• Introduction to scoring matrices-PAM and BLOSSUM<br>• Database similarity searching: BLAST(Variants and statistical Significance) FASTA (statistical Significance)<br>• Phylogenetic analysis: Definition, Choice of Molecular Markers<br>• Phylogenetic tree: Terminology, construction methods(maximum Parsimony, Maximum Likelihood), Evaluation (Bootstrapping and Jackknifing, Phylogenetic Programs). | **15** |

**References**


- Armitage, P. and David, H.A. (1996) Advances in Biometry, John-Wiley & Sons Inc, New York.
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- Daniel, W. W. (1999) Biostatistics: A foundation for analysis in health science, 7th Ed. John Wiley,
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# MSc II (Biotechnology )
# Semester IV
# BIT-DSC-623A: Entrepreneurship forBiotechnology

**Hours: 30** **Credits: 2**

| | | |
|---|---|---|
| **Course objectives** | • To impart an understanding of business management and entrepreneurship<br>• To understand the basics of business ethics, safety and IPR | |
| **Course outcomes** | After successful completion of this course, students are expected to:<br>• Understand fundamental business, management, marketing, operation and HRM<br>• Understand the concept related to business ethics and safety and IPR | |
| **Unit** | **Contents** | **Hours** |
| **Unit I** | **Introduction to Business and Management**<br>• Management: Definition, concept, importance<br>  o Levels, Functions and Skills<br>  o Decision making<br>  o Strategic management: characteristics, importance<br>  o SWOT analysis<br>• Production and operation management, concept of TQM<br>• Marketing and Marketing research<br>• Financial management: Concept of capital budgeting and working capital<br>• Human resource management and planning<br>**Business development and skills for bio-entrepreneurship**<br>• Characteristics for being an entrepreneur in microbiology.<br>• Factors affecting microbiology/ biotechnology business:<br>• Role of government and schemes and Financial institutions.<br>• Personality, attitude, organizational behavior, leadership<br>• Principles of effective communication.<br>  o Body language, public speaking, presentations<br>• Business proposal writing.<br>• Case studies of successful and unsuccessful bio-entrepreneurship. | **15** |
| **Unit II** | **Ethics, regulation and safety**<br>• Business ethics: meaning, principals & Ethical dilemmas in Bioindustry<br>• Current regulatory bodies and laws/regulations for industry<br>• Biologics License Application (BLA)<br>• Safety and precautions Biological, Chemical and Personal<br>• Biosafety: levels (BL 1, 2, 3, 4), GMOs and risks<br>**Intellectual property and IPR**<br>• IPR- Concept, Forms of IPR, patentable and non-patentable items<br>• Legislations covering IPR's in India<br>• Steps in filing a patent, provisional and complete specification<br>• Valuation of patent and business concerns<br>• Protection of biotechnological inventions<br>• Overview of GATT, WTO, TRIP and Indian Patent Act | **15** |

| | | |
|---|---|---|
| | • Protection of plant varieties and farmer's rights | |

**References**


- Mehta, S. S. (2008) Commercializing successful biomedical technologies: basic principles for the development of drugs, diagnostics and devices. Cambridge University Press.
- Patzelt, H., & Brenner, T. (Eds.). (2008) Handbook of bioentrepreneurship (Vol. 4). Springer Science & Business Media.
- JogdandS N (2007) Entrepreneurship And Business Of Biotechnology, Himalaya Publisher, Mumbai
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- Modi H.A. (2008) Fermentation Technology (Vol 1 & 2), Pointer Publishers, Jaipur.

# MSc II (Biotechnology)
# Semester IV
# BIT-DSE-623B: Food Technology and Nutrigenomics

**Total Hours: 30** **Credits: 2**

| | | |
|---|---|---|
| **Course objectives** | • To impart an understanding of food spoilage and preservation<br>• To understand the concept of nutraceuticals and nutrigenomics | |
| **Course outcomes** | After successful completion of this course, students are expected to:<br>• Understand the fundamentals of food spoilage and preservation<br>• Get aware of the role of nutrigenomicsin disease prevention | |
| **Unit** | **Contents** | **Hours** |
| **Unit I** | **Biochemical changes in raw food and Food processing**<br>• **Cereals and legumes:** composition, mobilization of cereal starches by alpha-amylase, alpha-amylase activity in germinated seeds.<br>• **Legumes: c**omposition, effects of germination<br>• **Fruits and vegetables**: Respiration, initiation of ripening, colour changes, texture<br>• **Meat and fish:** Nature of muscle, conversion of muscle to meat<br>• **Browning reactions in food:** Non-enzymatic browning, pigment formation, heterocyclic compounds, Ascorbic acid oxidation, inhibition of non-enzymatic browning<br>• Raw material preparation: cooling crops and carcasses, cleaning foods, sorting and grading and peeling<br>• Extraction and separation of food components: centrifugation, filtration, extraction using solvents, membrane separation, effects on food and microorganisms<br>• Minimal processing methods: high-pressure processing, irradiation, ozone, pulsed electric field processing, processing by removal of heat<br>• Post processing: packaging, filling and sealing of containers, material handling, storage and distribution | **15** |
| **Unit II** | **Nutraceuticals and Nutrigenomics**<br>• Concept of nutraceuticals, infant and baby foods, adolescent/ teen age foods, foods for pregnant ladies and nursing mothers, geriatric foods<br>• Concept of nutrigenomics<br>• Food recommended and restricted in metabolic disorders and disturbances: gastrointestinal disorders; fever and infection; liver, gall, bladder and pancreatic disturbances; blood, circulatory and cardiac diseases; urinary and musculoskeletal diseases; allergies.<br>• Nutrigenomics aspect in vitamins and trace metals<br>• Application of neutrigenomics for disease prevention and better health | **15** |

**References**


- Eskin, N. M., &Shahidi, F. (2012). Biochemistry of foods. Academic Press.
- Fellows P.J. (2017). Food processing technology (Fourth edition), Woodhead publishing.
- Nollet, L. M., Toldrá, F., Benjakul, S., Paliyath, G., &Hui, Y. H. (2012). Food biochemistry and food processing. John Wiley & Sons.
- Raffaele De Caterina, Martin Kohlmeier (2020) Principles of Nutrigenetics and Nutrigenomics, Academic Press.
- Pathak, Y. V., &Ardekani, A. M. (Eds.). (2017). Nutrigenomics and Nutraceuticals: Clinical Relevance and Disease Prevention. CRC Press.

# MSc II (Biotechnology )
# Semester IV
# BIT-DSC-624: Practicals on Biostatistics and Bioinformatics

**Total Hours: 60** **Credits: 2**

| | | |
|---|---|---|
| **Course objectives** | • To impart training about elementary aspects of statistics used in microbiology<br>• To introduce a variety of computational methods for predicting functional behaviour of a biological system<br>• To analyse the output data to predict a biologically relevant function | |
| **Course Outcomes** | After successful completion of this course, students are expected to:<br>• Able to analyse experimental data with central tendency, its dispersion and presentation graphically<br>• Access biological databases, interpret structural aspects<br>• Familiar with statistical and bioinformatics software | |
| **Sr. No.** | **Contents** | **Hours** |
| **1** | Calculate the mean, median, mode, range, variance, standard deviation, standard error, and confidence interval using MS Excel/suitable software | 4 |
| **2** | Plot straight Lines (Linear Least squares) using the LINEST Function of MS Excel/ suitable software | 4 |
| **3** | Plot-line, scatter graphs, bar graphs, and error bars using MS Excel/ suitable software | 4 |
| **4** | Determine linear regression, Correlation and their coefficients using MS Excel/ suitable software | 4 |
| **5** | Compute F-test (paired and unpaired), t-test using MS-Excel/ suitable software | 4 |
| **6** | Compute ANOVA, Chi 2-test using MS-Excel/ suitable software | 4 |
| **7** | Demonstrate multivariate analysis of process parameters using statistical tools. | 4 |
| **8** | Exploring Biological databases – Genbank& Protein Data Bank | 4 |
| **9** | Exploring data retrieval systems –Entrez and SRS | 4 |
| **10** | Structural prediction of protein using ExPASy software | 4 |
| **11** | Primary and tertiary structure analysis of protein/ DNA using BLAST | 4 |
| **12** | Multiple sequence alignments using Clustal W | 4 |
| **13** | Phylogenetic tree analysis using MEGA | 4 |
| **14** | Primer designing using biological software | 4 |
| **15** | Determination of primary/ secondary structure of amino acid sequence using SOPM/GOR/ChauFasman, etc. software | 4 |

**References**


- Bailey NTJ (1959) Statistical methods in Biology, ELBS and The English Universities Press Ltd., UK.
- Irfan Ali Khan and AtiyaKhanum (2004) Fundamentals of biostatistics, Ukaaz Publication, Hyderabad.
- Gupta SC (2019) Fundamentals of Statistics, Himalaya Publishing House, New Delhi.
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- Gore A, Paranjpe S and Kulkarni M (2009) Statistics for everyone, SIPF Academy Publishers, Nashik.
- Baxevanis AD and Ouellette BFF (2001) Bioinformatics: A practical guide to the analysis of genes and proteins. Second Edition. John Wiley & Sons, New York.
- Ewens WJ. and Gregory RG (2004) Statistical Methods in Bioinformatics, An Introduction, Springer, New York.
- Lacroix Z and Critchlow T (Eds.) (2003) Bioinformatics. Managing Scientific Data, Morgan Kaufmann Publishers.
- Misener S and Krawetz SA (Eds.). (2000) Methods in Molecular Biology, Volume 132.
- Stephen Misener, Stephen A. Krawetz (1999) Bioinformatics: Methods and Protocols. Humana Press, New Jersey.
- Mount DW (2001) Bioinformatics: sequence and genome analysis. Cold Spring Harbor Laboratory Press, New York.

# MSc II (Biotechnology)
# Semester IV
# BIT-DSE-625: Practicals on Fermentation Technology

**Total Hours: 60** **Credits: 2**

| | | |
|---|---|---|
| **Course objectives** | • To know general considerations for the fermentation process<br>• To learn statistical applications in process optimization<br>• To produce the fermentative product in a laboratory | |
| **Course Outcomes** | After successful completion of this course, students are expected to:<br>• Use the knowledge of laboratory fermentations<br>• Perform the optimization of the fermentation process<br>• Demonstrate various fermentative production of microbial products | |
| **Sr. No.** | **Contents** | **Hours** |
| **1** | Fermentor: demonstration of parts, cleaning, sterilization and assembling | 4 |
| **2** | Aseptic techniques in inoculation of fermenters and Aseptic sampling from fermentors | 4 |
| **3** | Calibration of fermentatorelectrodes/probes | 4 |
| **4** | Production and quantification of biomass (yeast/ Fungal /algae) | 4 |
| **5** | Laboratory-scale fermentation of antibiotics/enzyme | 4 |
| **6** | Down Stream processing with an enzyme: filtrations, centrifugation, TFF | 4 |
| **7** | Optimization of fermentation parameters using one factor at a time (OFAT) design | 4 |
| **8** | Screening of fermentation parameters using a statistical method | 4 |
| **9** | Application of response surface methodology for statistical optimizations of factors. | 4 |
| **10** | Production of fermentation products using chemically defined and crude economical raw material (molasses, agro-waste, food/dairy industry) | 4 |
| **11** | Production of probiotics/yoghurt/curd/buttermilk | 4 |
| **12** | Production, application and efficacy determination of biofertilizer /siderophore (Pseudomonas biofertilizer in talc powder/ Azo/ Rhizo) | 4 |
| **13** | Culturing and characterization of actinomycetes used in the pharmaceutical industry | 4 |
| **14** | Laboratory production of edible mushroom | 4 |
| **15** | Production of fermented products from SSF | 4 |

**References**


- Aneja, K. R. (1996) Experiments in Microbiology, Plant Pathology, Tissue culture and Mushroom cultivation, 2nd Ed., WishwaPrakashan, New Delhi (New Age International, Pvt. Ltd.).

- Dubey R.C. and Maheshwari D.K. (2004), Practical Microbiology, S.Chand and Co. Delhi
- Sharma Kanika, Manual of Microbiology Tools and Techniques, 2nd Ed. 2007, Ane's Book India, New Delhi
- Reddy M. G., Reddy M. N., Saigopal D. V. R. and Mallaiah K. V. (2008) Laboratory experiments in Microbiology, Himalaya Publishing House, Mumbai
- Anuradha De, (2014) Practical and Applied Microbiology, 5th Edition, National Book Depot, Mumbai

# MSc II (Biotechnology )
# Semester IV
# BIT-DSE-626A: Practical on Professional development

**Total Hours: 60** **Credits: 2**

| | | |
|---|---|---|
| **Course objectives** | • Develop effective communication skills for scientific presentations<br>• Enhance career planning and job search strategies.<br>• Learn the essentials of project writing, business skill | |
| **Course Outcomes** | After successful completion of this course, students are expected to:<br>• Write concise scientific reports and deliver informative presentations.<br>• Create professional and targeted CVs and cover letters<br>• Be well-prepared to advance in their professional careers | |
| **Sr. No.** | **Contents** | **Hours** |
| **1** | Prepare the MS PowerPoint-based presentations. | 4 |
| **2** | Demonstrate the working of the MS Word application. | 4 |
| **3** | Preparation of graph and table using MS Excel. | 4 |
| **4** | Preparation of standard operating procedure for the instrument. | 4 |
| **5** | Preparation ofCurriculum Vitae. | 4 |
| **6** | To learn the interview techniques through a mock activity. | 4 |
| **7** | Discussion of a topic through group discussion activity/ | 4 |
| **8** | Preparation of application letter for interview/ leave etc. | 4 |
| **9** | To learn the process of report writing / Effective scientific writing | 4 |
| **10** | Practical based on Grammar / Vocabulary/plagiarism | 4 |
| **11** | To learn the technique of communication skills - Speaking | 4 |
| **12** | Practical based on Self-assessment/goal setting/career planning | 4 |
| **13** | Practical based on Marketing skill: advertisement/ video making and selling product | 4 |
| **14** | Practical based on team building/management/leadership skill | 4 |
| **15** | Case study / analytical - logical thinking skills | 4 |

# MSc II (Biotechnology )
# Semester IV
# BIT-DSE-626 B: Practicals on Food technology and neutrigenomics

**Total Hours: 60** **Credits: 2**

| | | |
|---|---|---|
| **Course objectives** | • To learn various milk and food testing procedure<br>• To know food associated pathogen and spoilage<br>• To aware about food safety | |
| **Course Outcomes** | After successful completion of this course, students are expected to:<br>• Examine milk and food samples<br>• Infere about quality of various food samples<br>• Apply good practices for food safety | |
| **Sr. No.** | **Contents** | **Hours** |
| **1** | Estimation of ascorbic acid in food | 4 |
| **2** | Estimation of calcium (titrimetric method) | 4 |
| **3** | Estimation of iron(wong's method) | 4 |
| **4** | Preparation of Aids for Diet Counseling and Planning and preparation of diets in the following disease conditions: • Diabetes Mellitus and hypoglycaemia | 4 |
| **5** | Pasteurization of milk and determination of efficacy using alkaline phosphatase test | 4 |
| **6** | Estimation of mycotoxin in food sample by TLC | 4 |
| **7** | Isolation and identification of microorganism fromspoiled milk. | 4 |
| **8** | Isolation of food borne bacteria/ fungi from food products/ Canned food. (*Salmonella/ E. coli/ S. aureous/ coliform* etc. ) | 4 |
| **9** | Isolation of microorganisms from spoiled bread. | 4 |
| **10** | Isolation of bacteria/ fungi fromspoiled fruits and vegetables. | 4 |
| **11** | Effect of temperature on the spoilage of food products | 4 |
| **12** | Study of strategies for food / milk sampling –liquid/ solid | 4 |
| **13** | Isolation of bacterial probiotics from curd and development of probiotics in vitro | 4 |
| **14** | Description of common practices for food safety in Hazard analysis criteria control points | 4 |
| **15** | Field visit / study tour to milk/ food industry / bakery | 4 |

**References**


- Aneja, K.R., (2007). Experiments in Microbiology, Plant Pathology, Tissue Culture andMushroom Cultivation, 4th Edition, WishwaPrakashan, New Age International PvtLtd.,New Delhi
- Harley, J.P. and Prescott, L. M (1996), Laboratory Exercises in Microbiology, 3rd Ed, W.C.B. / McGraw Hill Inc.

- Jayaraman, J (1981), Laboratory Manual in Biochemistry, Wiley Eastern Ltd., New Delhi.
- Parija, S. C., (2007), Textbook of Practical Microbiology, Ahuja Publishing House New Delhi.
- Plummer, D. T. (1992), An Introduction to Practical Biochemistry, Tata McGraw Hill Publisher, New Delhi

# MSc II (Biotechnology)
# Semester IV
# BIT- 627: Research Project II

**Hours: 180** **Credits: 6**

| | |
|---|---|
| **Course objectives** | 1. To give exposure to the students to research culture and technology<br>2. To introduce students to how to select a research topic, plan, perform experiments, collect data and analyze the data<br>**3.** To foster self-confidence and self-reliance in the students as they learn to work and think independently |
| **Course outcomes** | After successful completion of this course, students are expected to:<br>• Conceive a problem based on published research and carry out a comprehensive survey of the literature<br>• Learn handling of instruments, use of chemicals and how to conduct the experiments<br>• Learn how to present the project in PowerPoint and answer the queries to examiners as well as the science of writing |

**The systematic approach towards the execution of the project should be as follows: (Wherever applicable)**

The complete tenure of the research project should be one academic year. It should be allotted during the third semester and completed in the fourth semester.

1. Weekly 12 hours should be allotted to the research project in a regular timetable.
2. In the fourth semester, students should perform further experimental work, analyze the data and compile the results.
3. Students may be given an opportunity to participate in ongoing research activities in the respective Departments/Schools/Supervisors' laboratories. This will familiarize them with the literature survey and give them a fundamental understanding of designing and executing a research project.
4. Students may work individually or in groups (not more than 3 students) to be decided by the concerned department/supervisor.
5. Each research group should have a different research topic with some possible level of novelty.
6. The student should select the topic relevant to priority areas of concern or allied subjects.
7. Students are encouraged to work on multidisciplinary and applied projects, but it is not mandatory criteria.
8. Students are expected to work in line with the research outline and literature review,which was submittedin the third semester.
9. Students are expected to learn how to execute the research work systematically and overcome the hurdles. Students will get the opportunity to learn about practical aspects of many characterization techniques or models and further how to effectively employ them in the research work. Students should be able to critically evaluate the literature on the topic, identify the research gaps, plan and perform the experiments, interpret the results, understand the limitations of the work and draw conclusions.
10. At the end of the semester, each student should submit a detailed Research Report.
11. The format of the final research report shall be as per the guidelines of respective department. (**Example**:Title of the Project, Certificates, Acknowledgment, Abstract and Keywords, Contents, Introduction, Literature Review, Aim and objective, Materials and Methods, Result,

Data analysis and Discussions, conclusion, limitations, suggestion, future scope, Bibliography, Appendix etc.)

12. An appropriate and essential conclusive statement must be drawn at the end of the study.
13. Students should maintain lab notebooks, and the supervisor may ask them to submit the mid-semester progress report.
14. For documents related to project submission: Font- Times New Roman, Heading Font Size-14, Normal Text Size-12, spacing-1.5, both sides justified and 1 inch margin on all side, both side printing on A-4 size.
15. Three copies of the dissertation should be prepared (one copy for each department, guide, and student).
16. At the end of the semester, the candidate should prepare and present research using a PowerPoint presentation using modern ICT tools during the Internal and External Examination.
17. Besides writing a dissertation, students are encouraged to write a manuscript/patent if the results obtained are worthy of publication.
18. Students may present their research work in Avishkar/Webinars/Conferences.
19. Students should note that plagiarism is strictly prohibited.

**Internal examination (60 marks)**: Components of continuous internal assessment:

- Literature collected, methodological planning, analysis of data, design and work, progress reports etc (30 marks)
- Presentation in Webinars/Conferences/publication and departmental presentationetc(20 marks)
- Oral examination (10 marks)

**External examination (90 marks)**and Components of external assessment:

- Evaluation of dissertation submitted in bound form at the time of examination **(60 marks)**
- Presentation (PPT format) **(15 marks)**
- Overall presentation reflecting the contribution of work, Response to questions **(15 marks)**