Department of BIOTECHNOLOGY

School of Biological Sciences

Curriculum Framework

M.Sc. Biotechnology

Based on National Education Policy- 2020

Date of BoS: 04 Dec 2023

Doctor Harisingh Gour Vishwavidyalaya
(A Central University)
Sagar-Madhya Pradesh-470003

About the Department:

The Department of Biotechnology was established in 2001-02 with UGC approval. The Department acquired an independent status in 2009 upon the up gradation of the University to Central University. The Department took a new shape in the year 2013 when the appointed faculty established fully functional research laboratories and sophisticated instruments were installed. The Department is a full-fledged independent unit under the School of Biological Sciences. Currently, the department has two faculty members specialized in Genetic Engineering and Plant Biotechnology, Nanotechnology, Molecular Virology, Bacteriology, Proteomics and Genomics. The Department is well equipped to impart Master and PhD advanced education and training. The Department faculty adopts advance pedagogy techniques such as flip learning and laboratory-based teaching.

The Department has published significant number of publications in the leading national and international peer reviewed scientific journals. The Department regularly organizes several hands-on workshops, national and international conferences and special lectures. At the Department of Biotechnology research is being pursued in both basic and applied areas of Biotechnology. The Departmental is inclined towards inter disciplinary research; faculty members in the Department have forged active national & international collaborations. The Departmental faculties have secured funding various funding agencies of UGC, DST, DBT, etc.

During the COVID-19 pandemic the Department quickly adapted to the online teaching mode using various ICT tools, online classroom platforms and other resources to continue the teaching and learning process. This ensured that students did not suffer any academic loss.

Vision:

The Department of Biotechnology foresees itself to emerge as a Department of national and international repute through its education and research. The Department aspires to make seminal contribution to health and food security of the society. We aim to become the center of innovative and cutting-edge research. One of the important objectives of the Department is to cultivate distinguished future academicians and scientists. It is our endeavor to become a model of public private partnership.

Mission:

The Department is developing robust research environment in the areas of plant genetic engineering and physiology; and infectious disease biology. We are striving to secure intramural and extramural funding to foster research in the Department. We pursue to enhance pedagogy to achieve higher objectives of teaching and learning. The focus is to cater to the need of efficient human resource of the country by producing skilled biotechnology professions.

Curriculum Framework based on National Education Policy-2020

NEP-2020 has conceptualized the idea to develop well rounded competent individuals for making the nation a self-reliant and global leader. In the same spirit, we at Department of Biotechnology

have developed a curriculum framework to encompass the goals of NEP 2020. To this end, we have incorporated choice of subject/disciplines of study, creating academic pathways having constructive combinations of disciplines for study with multiple entry and exit points as well as focus on **experiential learning** for students by introducing **multidisciplinary and skill enhancement courses** and actual Hand's on training in the recent and trending aspects of Biotechnology.

M.Sc. Biotechnology: 04 Semester Course as per NEP 2020
Curriculum: 2022 Onwards

A) General:

1. Name of the Program: **M. Sc. Biotechnology**

2. Duration of the Program:

a) Minimum duration: 2 years
b) Maximum duration: 4 years

3. Structure of the Program:

a) Number of Major courses: 09 (54 credits)

b) Skill Enhancement courses: 03 (12 credits)

c) Compulsory Skill enhancement course in IV semester (14 Credit)

Total Credits: 80

4. Scheme of Examination:

a) Mid Sem I Examination: 20 marks (As per University Norms)

b) Mid Sem II examination- Internal Assessment: 20 marks (As per University Norms)

* To appear in the End Semester Examination the student must appear in all the Mid Semester Examinations.

End semester Examination for Laboratory courses is of 60 Marks.

Mode of Examination for all Skill Enhancement Courses (SEC) is Internal.

a) Assessment of performance in the experiment : 40 marks

b) Viva-voce of experiment : 10 marks

c) Maintenance of lab records and attendance : 10 Marks

Biotechnology: M. Sc. Program Structure and Scheme (NEP 2020)

Semester		Paper Code	Title of the Paper	Credits			
				L	**T**	**P**	**C**
I	Discipline Specific: Major-1	BIT-DSM-121	Cell Biology	**4**	**0**	**0**	**4**
		BIT-DSM-122	Laboratory -1	**0**	**0**	**2**	**2**
	Discipline Specific: Major-2	BIT-DSM-123	Bioinstrumentation & Bioinformatics	**4**	**0**	**0**	**4**
		BIT-DSM-124	Laboratory-2	**0**	**0**	**2**	**2**
	Multi-Disciplinary: Major-3	BIT-MDM-121	Biochemistry and metabolic regulation	**4**	**0**	**0**	**4**
		BIT-MDM-122	Laboratory-3	**0**	**0**	**2**	**2**
	Skill Enhancement: Course (SEC)	BIT-SEC-121	Basics of Research Methodology	**2**	**0**	**0**	**2**
		BIT-SEC-122	Tools for Scientific Communication and presentation	**0**	**0**	**2**	**2**
				Total Credit = **22**			
II	Discipline Specific: Major-1	BIT-DSM 221	Genetics & Molecular Biology	**4**	**0**	**0**	**4**
		BIT-DSM 222	Laboratory-4	**0**	**0**	**2**	**2**
	Discipline Specific: Major-2	BIT-DSM 223	Animal & Plant Biotechnology	**4**	**0**	**0**	**4**
		BIT-DSM 224	Laboratory-5	**0**	**0**	**2**	**2**
	Multi-Disciplinary: Major-3	BIT-MDM 221	Microbial Technology	**4**	**0**	**0**	**4**
		BIT-MDM 222	Laboratory-6	**0**	**0**	**2**	**2**
	Skill Enhancement: Course (SEC)	BIT-SEC 221	Lab based Project Work	**0**	**0**	**4**	**4**
				=22 **Exit with PG Diploma**			
III	Discipline Specific: Major-1	BIT-DSM 321	Immunology	**4**	**0**	**0**	**4**
		BIT-DSM 322	Laboratory-7	**0**	**0**	**2**	**2**
		BIT-DSM 323	Genetic Engineering	**4**	**0**	**0**	**4**

	Discipline Specific: Major-2	BIT-DSM 324	Laboratory-8	**0**	**0**	**2**	**2**
	Multi-Disciplinary: Major-3	BIT-MDM 321	Genomics & Proteomics	**0**	**0**	**4**	**4**
		BIT-MDM 322	Laboratory-9	**0**	**0**	**2**	**2**
	Skill Enhancement: Course (SEC)	BIT-SEC 321	Bioentrepreneurship	**2**	**0**	**0**	**2**
		BIT-SEC 322	Field Visit of Bio-startups and project	**0**	**0**	**2**	**2**
				Total Credit= 22			
IV	Skill Enhancement Course (SEC)	BIT-SEC 421	**Semester Long Dissertation/Project Work/Practical Training and Technical Writing**	**14 Credits**			

Total Credits

I +II+III+IV

22+22+22+14= 80 Credit

L: Lecture **P:** Practical **T:** Tutorial **C:** Credits

Semester-III
Discipline Specific: Major 1

Class	Subject	Semester	Course Code	Course Title	Marks	Credit
M.Sc	Biotechnology	III	BIT-DSM-321	Immunology	Mid Sem 40 End Sem 60	04

Objectives: To introduce the students to the basics of immunology. The course will provide an overview of coordinated functioning of immune organs, cells and cytokines to protect the body from infections. The course also introduces student to the basics of immune tolerance and autoimmunity.
Outcomes: The student would be able to analyze and connect the collective ability of various organs, cells, macromolecules and pathways to protect and eliminate human body from infectious agents.

UNIT	Content	Contact hours
I	Overview of the Immune System, Cells and Organs of the Immune System, Types of Immunity, Antigen, Antibody structure and function.	12
II	The Organization and Expression of immunoglobulin Genes, Antigen-Antibody Interaction principle and application, ELISA, RIA, IHC, western blots Flow Cytometry	12
III	Antigen capture and presentation: major histocompatibility complex (MHC), Antigen Processing and presentation, Major Histocompatibility classification, T- cell receptors, T cell and B cell maturation activation, differentiation. Hypersensitivity reactions.	12
IV	Cell mediated effector response: cytotoxic T cell, Natural Killer cells, Antibody-Dependent cell mediated cytotoxicity, immunological memory.	12
V	Allergy, Tolerance, Autoimmune diseases, mechanism of induction of Autoimmunity, treatment of Autoimmune diseases. Transplantation, Infectious Diseases and Vaccines, Immunodeficiency Disorders: AIDS, Cancer and the Immune System.	12

Essential Reading:

1) A. K. Abbas, et. al., Basic Immunology: Functions and Disorders of the Immune System, Elsevier, 2015, 5th edition
2) A. K. Abbas, et. al., Cellular and Molecular Immunology, Elsevier, 2017, 9th edition
3) J. A. Owen, et. al., Kuby Immunology, W H Freeman & Co, 2013, 7th edition
4) I. Tizard, Immunology: An Introduction, Cengage Learning, 2005
5) M. A. Khan, Elements of Immunology, Pearson Education.

Suggested Reading:

1) P. J. Delves, Roitt's Essential Immunology, Wiley-Blackwell, 2017, 13th edition
2) W. E. Paul, Fundamental Immunology, Lippincott Williams & Wilkins, 2012, 7th edition

Semester-III
Discipline Specific: Major 1

Class	Subject	Semester	Course Code	Course Title	Marks	Credit
M.Sc	Biotechnology	III	BIT-DSM-322	Laboratory-7	Mid Sem 40 End Sem 60	02

Objectives: To introduce the students to the basics of experimental immunology. This experimental course will provide actual understanding immune organs, cells and cytokines important for protection against pathogens.
Outcomes: The student would be able to understand and connect the collective ability of various organs, cells, macromolecules and pathways to protect and eliminate human body from infectious agents.

List of Practical:

1. Blood film preparation and identification of cells.
2. Determination of Total Leucocyte count (TLC).
3. Isolation of WBCs using density gradient centrifugation.
4. Determination of Blood group.
5. Radial immunodiffusion
6. Demonstration of flow cytometer.

Essential Reading:

1. A. K. Abbas, et. al., Cellular and Molecular Immunology, Elsevier, 2017, 9th edition
2. J. A. Owen, et. al., Kuby Immunology, W H Freeman & Co, 2013, 7th edition
3. I. Tizard, Immunology: An Introduction, Cengage Learning, 2005

Suggested Reading:

1. F. C. Hay and O. M. R. Westwood, Practical Immunology, Wiley-Backwell, 2002, 4th edition
2. W. E. Paul, Fundamental Immunology, Lippincott Williams & Wilkins, 2012, 7th edition

Semester-III
Discipline Specific: Major 2

Class	Subject	Semester	Course Code	Course Title	Marks	Credit
M.Sc	Biotechnology	III	BIT-DSM-323	Genetic Engineering	Mid Sem 40 End Sem 60	04

Objectives: To teach students about the fundamentals of genetic engineering and their applications with various approaches of Biotechnology.
Outcome: The students would be able to make changes at the genetic level of organisms for the development of novel genetically modified organisms.

UNIT	Content	Contact Hours
I	Enzymes used in cloning including restriction endonucleases, Polymerases, Klenow enzyme Kinases, ligases, phosphatases and topoisomerases. Vectors used in cloning and expression-Cloning vectors: Plasmid vectors including binary vectors, Lambda vectors, phagemids, cosmids, artificial chromosome vectors (YAC, BAC)	12
II	Gene cloning method: cohesive and blunt end ligation, linkers, adaptors, PCR based cloning: T/A cloning, TOPO cloning and gateway cloning Insertion of foreign DNA into host/bacterial cells: transformation using electroporation, transfection; construction of gene libraries: cDNA and genomic libraries	12
III	Method of genetic transformation of plant direct gene transfer in plant & animal cells- electroporation, particle bombardment and alternative methods, *Agrobacterium* mediated transformation; Genome editing: CRISPER Cas9, Pros and cons of GE organism	12
IV	Polymerase chain reaction: Thermal profile and reaction components: Types of PCR and their applications: Conventional PCR, Anchored-PCR, Inverse-PCR, Multiplex-PCR, Reverse Transcription-PCR, Real Time-PCR & applications.	12
V	Gene silencing techniques; introduction to siRNA; siRNA technology; principle and application of gene silencing; gene knockouts and gene therapy; introduction to methods of genetic manipulation in different model systems.	12

Essential Reading:
1) D. S. T. Nicholl, Introduction to Genetic Engineering, Cambridge University Press, 2008 3rd edition
2) T. A. Brown, Gene Cloning and DNA Analysis, Wiley-Backwell, 2016, 7th edition
3) J. Hammond, Plant Biotechnology: New products and applications, Springer, 2000
Suggested Reading:
1) M. R. Green and J. Smbrook, Molecular Cloning: A Laboratory Manual (3 Volumes), Cold Spring Harbor Laboratory Press, 2012, 4th edition

Semester-III
Discipline Specific: Major 2

Class	Subject	Semester	Course Code	Course Title	Marks	Credit
M.Sc	Biotechnology	III	BIT-DSM-323	Laboratory-8	Mid Sem 40 End Sem 60	02

Objectives: To provide experimental knowledge on the fundamentals of genetic engineering and their applications.
Outcome: The students would be able to make changes at the genetic level of organisms for the development of novel genetically modified organisms.

List of Practical:

1. Bacterial culture and antibiotic selection media for growth selection of bacterial cells.
2. Isolation of plasmid DNA and restriction digeston
3. Cloning in plasmid and screening.
5. RNA isolation and synthesis of c-DNA
6. DNA amplification using Polymerase Chain Reaction (PCR).

Essential Reading:
1. K. Lindsey, Molecular Biology Laboratory manual, Springer, 2007
2. J. S. Vennison, Laboratory manual for Genetic Engineering, PHI Learning, 2010, 1st edition

Suggested Reading:
1. M. R. Green and J. Smbrook, Molecular Cloning: A Laboratory Manual (3 Volumes), Cold Spring Harbor Laboratory Press, 2012, 4th edition
2. D. S. T. Nicholl, Introduction to Genetic Engineering, Cambridge University Press, 2008 3rd edition

Semester-III
Multi-Disciplinary: Major 3

Class	Subject	Semester	Course Code	Course Title	Marks	Credit
M.Sc	Biotechnology	III	BIT-MDM-321	Genomics & Proteomics	Mid Sem 40 End Sem 60	04

Objectives: to provide adequate knowledge about principles of basic methods of genomic, transcriptomic and proteomic analysis with extensive knowledge of various methodologies of next generation sequencing, and microarray technologies

Outcome: On completion of the course, the students will be able to understand the basic concepts of genomics, transcriptomics and proteomics and learn the solution to theoretical and experimental problems in Genomics and proteomics.

UNIT	Content	Contact Hours
I	Introduction to Genomics, Anatomy of prokaryotic and eukaryotic genome, content of genome, C-value paradox, CoT curve analysis, repetitive DNA, chromosome walking and characterization of chromosomes	12
II	accessing and retrieving genome project information from the web such as rice genome project, Vectors for large scale genome projects, Strategies adopted for major genome sequencing projects, NGS methods of genome sequencing and advantages	12
III	Methods and techniques used for gene mapping, markers for gene mapping (RFLP, SSLP, SNP); Concept of microarray and application, Gene mapping in prokaryotes (Restriction mapping, FISH), Identification and classification of organism using molecular markers: 16S RNA typing/sequencing.	12
IV	Concept of proteomics, Impotence of proteomics, Database and Search Engines in Proteomic, Aims strategies and challenges in proteomics; strategies in analysis of proteome: 2D PAGE, Mass Spectrometry; Protein sequencing methods (Edman degradation, MALDI TOF/TOF)	12
V	Protein solubility and interactions, Protein DNA interaction (Electrophoretic mobility shift assay; Chromatin immunoprecipitation; assay DNase footprinting), Concept of Protein-protein interaction using yeast two hybrid system, solid ELISA and coimmunoprecipitation assay. Annotation of posttranslational modifications.	12

Essential Reading:

1. Robert Weaver, Molecular Biology, 5th Edition, McGraw-Hill, 2012.
2. Genomes, by T.A. Brown, Garland Science, 3rd Edition, 2006
3. Anthony J.F. Griffiths, Susan R. Wessler, Richard C. Lewontin, William M. Gelbart, David T. Suzuki, Jeffrey H. Miller, An Introduction to Genetic Analysis, Eleventh Edition,
4. Primrose, S. B., Twyman, R. M., Primrose, S. B., & Primrose, S. B. (2006) Principles of Gene Manipulation and Genomics. Malden, MA: Blackwell Pub.

Suggested Reading:

1. Liebler, D. C. (2002). Introduction to Proteomics: Tools for the New Biology. Totowa, NJ: Humana Press.
2. Campbell, A. M., & Heyer, L. J. (2003). Discovering Genomics, Proteomics, and Bioinformatics. San Francisco: Benjamin Cummings.

Semester-III
Multi-Disciplinary: Major 3

Class	Subject	Semester	Course Code	Course Title	Marks	Credit
M.Sc	Biotechnology	III	BIT-MDM-322	Laboratory-9	Mid Sem 40 End Sem 60	02

Objectives: To provide adequate experimental training of basic methods of genomic, transcriptomic and proteomic analysis with extensive knowledge of various methodologies of next generation sequencing, and microarray technologies

Outcome: On completion of the course, the students will be able to understand the basic concepts of genomics, transcriptomics and proteomics and learn the solution to theoretical and experimental problems in Genomics and proteomics.

List of Practical:

1. Method of retrieving the genome projects from the data base
2. SGS-PAGE for protein separation
3. Experimental demo of RAPD marker using general RAPD primers
4. Instrumental demonstration of Mass Spectrometry
5. Genomic DNA isolation from plant/animal cells
6. Isolation of gene of interest using the gene specific primers

Essential Reading:
1 Genomes, by T.A. Brown, Garland Science, 3rd Edition, 2006
2. Anthony J.F. Griffiths, Susan R. Wessler, Richard C. Lewontin, William M. Gelbart, David T. Suzuki, Jeffrey H. Miller, An Introduction to Genetic Analysis, Eleventh Edition

Suggested Reading:
1. Liebler, D. C. (2002). Introduction to Proteomics: Tools for the New Biology. Totowa, NJ: Humana Press.
2. Campbell, A. M., & Heyer, L. J. (2003). Discovering Genomics, Proteomics, and Bioinformatics. San Francisco: Benjamin Cummings.

Semester-III
Skill Enhancement Course

Class	Subject	Semester	Course Code	Course Title	Marks	Credit
M.Sc	Biotechnology	III	BIT-SEC-321	Bioentrepreneurship	Mid Sem 40 End Sem 60	02

Objectives: To teach students about concepts of entrepreneurship including identifying a business opportunity in the area of biotechnology through resource generation and launching a biotech business, growing and nurturing the organization as well as harvesting the rewards.
Outcomes: The students should be able to visualize and consider bioenterpreneurship as a viable career option.

UNIT	Content	Contact Hours
I	Introduction to Bioentrepreneurship – biotechnology in a global scale; Importance of entrepreneurship; advantages of being entrepreneur; types of bio-industries – Animal biotech, plant biotech, environmental biotech, microbiology, Molecular biology, Enzyme engineering, agribio and biopharma	06
II	Innovation – types, out of box thinking; skills for successful entrepreneur – creativity, leadership, managerial, team building, decision making; Concept of incubation center	06
III	Business Strategy: SWOT analysis of bio based-product, concept of designing product and quality control; Arrangement of financers and negotiations, General understanding of banking finance procedure, Understanding of law enforcement authorities	06
IV	Understanding business opportunity in the area of biotechnology through resource generation and launching a biotech business, pros and cons of biotechnology product business	06
V	Case study of successful Bioentrepreneur/ business, Project development and submission	06

Mode of Examination: Internal

Essential readings:
1. Adams, D. J., & Sparrow, J. C. (2008). Enterprise for life scientists: Developing innovation and entrepreneurship in the biosciences. Bloxham: Scion.
2. Shimasaki, C. D. (2014). Biotechnology entrepreneurship: Starting, managing, and leading biotech companies. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier.
Suggested Reading:
1. Jordan, J. F. (2014). Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press.
2. Desai, V. (2009). The Dynamics of Entrepreneurial Development and Management. New Delhi: Himalaya Pub. House.

Semester-III
Skill Enhancement Course

Class	Subject	Semester	Course Code	Course Title	Marks	Credit
M.Sc	Biotechnology	III	BIT-SEC-322	Field Visit of Bio-startups and project	Mid Sem 40 End Sem 60	02

Objectives: To teach students about concepts of entrepreneurship including identifying a business opportunity in the area of biotechnology and actual visit to the bio-industries.

Outcomes: The students should be able to visualize and consider bioenterpreneurship as a viable career option.

List of activities:

Visit of bio-industries to understand the product and business opportunity
Submission and presentation of detailed project on visit of industries

Mode of Examination: Internal

Essential readings:

1. Adams, D. J., & Sparrow, J. C. (2008). Enterprise for life scientists: Developing innovation and entrepreneurship in the biosciences. Bloxham: Scion.
2. Onetti, A., & Zucchella, A. (n.d.). Business modeling for life science and biotech companies: Creating value and competitive advantage with the milestone bridge. Routledge.

Suggested Reading:

1. Jordan, J. F. (2014). Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press.
2. Shimasaki, C. D. (2014). Biotechnology entrepreneurship: Starting, managing, and leading biotech companies. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier.

Semester-IV

Skill Enhancement Course

Class	Subject	Semester	Course Code	Course Title	Marks	Credit
M.Sc	**Biotechnology**	**IV**	**BIT-SEC-421**	**Semester Long Dissertation/Project Work/Practical Training and Technical Writing**	**End term examination 100 marks**	**14**

Objective: To provide students to conceptualize, design, plan and performed a short-term research project.

Outcome: The student should be able to answer research questions.

Course Instructors: The faculty members of the Department/ interdisciplinary Department/ relevant Department/ Faculty, Scientists of other govt. funded Institutions/ Established private companies etc

Evaluation:

End semester examination will consist of

i) Evaluation of project report/presentation : 80 marks

ii) Viva-Voce of the project : 20 marks