Modified in BOS Meeting, July 27, 2024

Veer Bahadur Singh Purvanchal University
Jaunpur -222003

(A State University - Government of Uttar Pradesh; Accredited A^{+} by NAAC)

Ordinance and Syllabus for

Master of Science in Biotechnology
(M. Sc. in Biotechnology)
Department of Biotechnology
Faculty of Science

Postgraduate Degree Programme (Full Time)
Duration: 2 Years (4 Semesters)

Under Choice Based Credit System (CBCS)
As per the guidelines of NEP-2020
w.e.f. 2024-25 (Academic Session)

27.7.2024 27/07/24 27.7.2024 27.7.2024 27.7.2024 27.07.24

Veer Bahadur Singh Purvanchal University, Jaunpur

Department of Biotechnology Faculty of Science

Vision

"Biotechnology department is committed to be a –Centre of Excellence focusing on education, research, innovation, training and entrepreneurship to create a world class talent pool of competent and curious biotechnologists, enabling them to take on national and global challenges.

Mission:

- Provide Biotechnology education to generate quality workforce which fulfill the professional and societal need nationally and globally.
- To create awareness about potentials of Biotechnology with socio-ethical implications.
- To impart quality education to the students and enhance their skills by instilling spirit of innovation and creativity, which make them nationally and globally competitive.
- To provide an environment for the students and faculty for personal and professional growth.
- To promote collaboration with academia, research institutions and industries at national and international level to enhance education and research.

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Veer Bahadur Singh Purvanchal University, Jaunpur

Ordinance governing 2 Years (4 Semesters) Postgraduate Degree Programme

M. Sc. in Biotechnology

Faculty of Science

Under Choice Based Credit System (CBCS)

w.e.f. 2024-25 (Academic Session)

The following ordinance has been framed governing the admission, course structure, examination and other allied matters relating to the 2 Years (4 Semesters) Postgraduate Degree Programme (M.Sc.) in Biotechnology being offered by Veer Bahadur Singh Purvanchal University.

1. ADMISSION AND EXIT

1.1. All matters related to admission to M.Sc.-Biotechnology programme shall be dealt by the Admission Committee constituted by the University.

1.2. The M.Sc.-Biotechnology programme is open to science graduates (with 3 years undergraduate degree) with minimum of 50% of marks, from a recognized University (45% in case of SC/ST). Those who are appearing in qualifying examination of B.Sc. in Biology/Life Sciences/Agriculture/Mathematics/ B.V.Sc. & A.H. /M.B.B.S./B.Pharm/, B.Tech. in Biotechnology/Bioinformatics/Food Technology and related subjects programme can also apply for admission and shall be eligible to appear in the Entrance Test for admission, but they will have to produce a proof of being a graduate at the time of admission. However, students of Veer Bahadur Singh Purvanchal University can be given provisional admission by the Admission Committee in case of delayed result.

1.3. Admission in M.Sc.-Biotechnology programme will be based on the Entrance Test or merit as per the rules of the university.

1.4. The intake of students in this programme shall be fixed by Veer Bahadur Singh Purvanchal University. The admission to M.Sc.-Biotechnology programme shall be made through a merit based on Written Test conducted by Veer Bahadur Singh **Purvanchal University Combined Admission Test (PUCAT)**. The reservation norms for admission in M.Sc.-Biotechnology programme shall be as per the Uttar Pradesh State Government/ University policy notified from time to time.

1.5. On selection for admission to the M.Sc.-Biotechnology programme, the candidate shall deposit the prescribed fees to get their admission confirmed within the stipulated time period by the Admission Committee of the Department. If the candidate fails to do so their admission shall be automatically liable to be cancelled and the seat falling vacant shall be offered to other candidate as per the merit/category. There is no provision of Fee concession/exemption under any circumstances except the case related to Social Welfare Department, Uttar Pradesh Government. Fee refund policy shall be applicable as per the university norms.

1.6. Admission to M.Sc.-Biotechnology programme cannot be claimed by any candidate as a matter of right. The Admission Committee of M.Sc.-Biotechnology programme of the University shall have power to refuse, reject or cancel any admission if it possesses sufficient reasons to do so.

1.7. All teachers of the department shall function as Student Mentor (Advisors). Every student will be assigned a mentor (advisor) before commencement of the academic session to support the students for their overall development in all possible way related to their

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academics/cocurricular/extracurricular/sports/personality development/soft skill/ cultural activities and offer all possible student support services.

2. COURSES OF STUDY AND EXAMINATION

2.1. M. Sc.-Biotechnology Programme will be based on CBCS (Choice Based Credit System) mode and conducted in semester system.

2.2. M.Sc. 1st semester - 4 theory papers of major/core courses (4 credit each)= 16 credits

1 practical (4 credits) = 4 credits

1 minor elective from other faculty (4 credits) = 4 credits

1st semester there will be 24 credits.

M.Sc. 2nd semester - 3 Theory papers of major/core courses (4 credits each) = 12 credits

1 Theory paper of major elective courses (4 credits) = 4 credits

1 Practical (4 credits) = 4 credits

1 Major/core Industrial Training/Surveys/Research Project = 8 credits

2nd semester there will be 28 credits.

Thus, 1st year of M.Sc. will be of 52 credits.

M.Sc. 3rd semester - 3 Theory papers of major/core courses (4 credit each) = 12 credit

1 Theory paper of major elective courses (4 credit) = 4 credit

1 Practical (4 credit) = 4 credit

3rd semester there will be 20 credits.

M.Sc. 4th semester - 4 Theory papers of major elective courses (4 credits each) = 16 credits

1 Practical (4 credits) = 4 credit

1 Major/core Industrial Training/Surveys/Research Project = 8 credits

4th semester there will be 28 credits.

Thus, 2nd year of M.Sc. will be of 48 credits.

Hence, two years (4 semesters) M.Sc.-Biotechnology programme is of 100 credits.

2.3. All four theory Major/core courses are compulsory in the first semester.

2.4. In the second and third semester, the student can choose one major elective course according to their interest and the resources available in the university /colleges.

2.5. All the theory papers in the fourth semester are major elective courses from which the student can choose any four elective courses as per their interest.

2.6. In the first year of post-graduation, the student will have to take only 1 minor elective course from other faculty of 4 (four) credits.

2.7. To conduct the M.Sc.- Biotechnology programme systematically and within a time bound frame, the department shall strictly adhere to academic calendar notified by the university in the beginning of academic session.

2.8. A candidate admitted to the M.Sc.-Biotechnology programme shall pursue a regular mode of study in all the four semesters and attend a minimum of 75% of the total classes held to be eligible for

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appearing in the semester examinations.

2.9. If a student fails to attend requisite classes (minimum of 75%) in a semester due to medical ground, there may be given relaxation of 15% attendance (5% at the level of Head of Department and 10% at the level of Vice-Chancellor) on production of medical certificate.

2.10. Semester examinations of the M.Sc.-Biotechnology programme shall be conducted by way of theory papers, practical and industrial training/surveys/research project. Each theory of major/core and elective paper will be of 100 marks out of which 75 marks shall be allocated for End Semester Examination (ESE) and 25 marks for Continuous Internal Evaluation (CIE). The pattern of question papers for theory examinations will be as per the University norms.

2.11. Continuous Internal Evaluation (CIE) is an integral part of the courses and is compulsory for all students. The academic performance of a student is evaluated by assessing day to day performance, attendance, assignments, periodic tests, seminar presentation, subject's quiz, class discussion, etc. There shall be no mid-term examination of CIE will be held rather a teacher assess the student along with the class teaching.

The **25 Marks of CIE shall be allocated as given below:**
10 marks for Test/Subject' quiz,
10 marks for presentation along with assignment
05 marks for Class interactions, discussion, performance, attendance.

2.12. The responsibility of evaluating the internal assessment is vested on the teacher(s) who teaches the course.

2.13. One practical (4 credits of 100 marks) examination shall be conducted which will be assessed jointly by the internal examiner of the department and the external examiner nominated by the university at the end of each semester of 75 marks and 25 marks of internal practical are assessed by concerned teacher of the course and will be averaged before online submission.

2.14. The end semester examinations shall be held as per academic calendar notified by the university.

2.15. Industrial Training/Surveys /Research Project: In the first and second year, the student will have to do a major research project including internship/technical report/comprehensive review/online or field surveys work/training in industry or institute.

2.16. Industrial Training/Surveys/Research Project can also be interdisciplinary or multi-disciplinary.

2.17. The research project will be done under the guidance of a teacher (supervisor) of the department. In case of topic of the research project is interdisciplinary/ multidisciplinary, the student may carry out their research work under a Co-supervisor from outside the department viz Industry/Company/Technical Institute/Research Institute.

2.18. Bachelor's Degree (with Research) and postgraduate students will be required to undertake a research project of four credits (4 hours per week) in each semester.

2.19. Students will submit the final report (project report/dissertation) of the research project carried out in both the semesters at the end of the year, which will be assessed out of 100 marks - 8 credits jointly by the respective supervisor and the external examiner nominated by the university or as per the directive of university at the end of the academic year. The student has to submit a project report/dissertation/technical report in hard bound form duly certified by the supervisor. The

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evaluation of the project/dissertation/technical report/comprehensive review of the student will be done through presentation and viva-voce examination.

2.20. If a student publishes any research papers from their research project work in the UGC-CARE listed Journals and published during the Programme, then they can be given additional marks up to 25 in the evaluation of the research project (out of 100). The maximum received will be 100.

2.21. The marks obtained in the research project will be marked as grades and they will also be included in the calculation of CGPA.

2.22.It will be necessary to take the exam for credit validation. Credit will be incomplete without the examination.

2.23.If a student qualifies for the examination on the basis of attendance in the class, however, is not able to give the examination due to any reason, then they can appear for the qualifying examination as per university PG ordinance- 2023, however, they will not need to attend the classes again.

2.24.Matters pertaining to the syllabi and conduct of examination shall be dealt with by the Board of Studies (BoS) constituted by the Vice-Chancellor.

2.25.The BoS shall recommend the panel of paper setters/examiners to the Vice-Chancellor. After getting approval from the Vice-Chancellor, the appointment letters shall be issued to the concerned paper setters/examiners by the Registrar/Controller of Examination of University.

2.26. Question papers for theory examination in sealed envelope shall be handed over/sent by registered post to the Registrar/Controller of Examination by the Examiners. Controller of Examinations will ensure the printing of question papers and fair conduct of the examinations.

2.27.The Registrar/Controller of the Examinations, with the approval of the Vice-Chancellor shall associate one or two members of the BoS for the moderation of the papers. The moderated papers shall have to be printed by the Registrar/Controller of the Examinations well before commencement of the Examinations.

2.28.After printing the questions papers in sealed covers, shall be handed over to the Examination Superintendent who will ensure the smooth and fair conduct of the examinations.

2.29.For appearing in the M.Sc.- Biotechnology semester examination each student shall have to deposit a prescribed examination fee along with a copy of online filled examination form for online verification. Separate fees will also be charged for back and improvement papers as per university norms.

2.30.After the examinations, Controller of Examinations/Technical Cell for campus courses shall ensure the evaluation of the answer books and declaration of results of semester examinations within a reasonable time so as to enable the department to adhere to the Academic Calendar.

2.31.Practical examinations of semester VII (M.Sc.-I sem), VIII(M.Sc.-II sem), IX (M.Sc.-III sem) and X(M.Sc.-IV sem) shall be conducted by one internal and one external examiner nominated by the university.

2.32.The students of M.Sc.- Biotechnology Programme shall be examined in the subjects in accordance with course curriculum and per the University PG programs ordinance-2023.

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3. RESULTS, PROMOTION AND IMPROVEMENT

3.1. If a student wants to leave after passing the first year of post-graduation by earning a minimum of 52 credits, then he will be awarded a bachelor's (with research) degree. After earning a minimum of 52+48 credits in the first and second year of post-graduation, the student will be awarded a master's degree in that main subject of that faculty.

3.2. The results of M. Sc.-Biotechnology semester examination shall be declared pass as per the University PG programs ordinance-2023.

3.3. If a student fails in more than 4 papers in an academic year, he/she will not be promoted to the next year. Such student should be re-admitted as Ex. Student with coming batch and their seat will be counted as supernumerary.

3.4. Students, who failed in 4 or lower number of papers in the academic year will be awarded back' and given two chances to reappear and pass in respective paper(s) in next year and the following year with regular semester examination. There will not be any supplementary/special examination for back/improvement papers. However, all such papers must be cleared within two years ending fourth semester.

3.5. In order to pass the 2-year M.Sc.-Biotechnology programme the students must pass both the year separately. The final result shall be declared on the basis of the combined marks secured by a candidate in all the four semesters as per the University PG programs ordinance-2023.

3.6. Student securing highest number of marks during the course in the first attempt will be awarded the University Gold Medal for the same.

3.7. Conversion of Marks into Grades, Grade points and CGPA calculation shall be applicable as per University PG programs ordinance-2023.

Veer Bahadur Singh Purvanchal University, Jaunpur 222003

Syllabus

Master of Science in Biotechnology (M. Sc.-Biotechnology)

Syllabus Designed as per Guidelines of National Education Policy-2020 (NEP-2020)

Syllabus Developed by				
Name	**BoS Convener/ Member/ Experts**	**Designation**	**Department**	**University**
Dr. Manish Kumar Gupta	Convener-BoS - Biotechnology	Associate Professor	Biotechnology, Faculty of Science	Veer Bahadur Singh Purvanchal University, Jaunpur
Prof. Ashok Kumar	External Expert	Professor	School of Biotechnology, Institute of Science	Banaras Hindu University, Varanasi
Prof. Bechan Sharma	External Expert	Professor	Biochemistry, Faculty of Science	University of Allahabad, Prayagraj
Prof. Ram Naraian	Member	Professor	Biotechnology, Faculty of Science	Veer Bahadur Singh Purvanchal University, Jaunpur
Prof. Rajesh Sharma	Member	Professor & Head, and Dean, Faculty of Science	Biotechnology, Faculty of Science	Veer Bahadur Singh Purvanchal University, Jaunpur
Prof. Pradeep Kumar	Member	Professor	Biotechnology, Faculty of Science	Veer Bahadur Singh Purvanchal University, Jaunpur

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Fourth Year / M.Sc. – Biotechnology 1st Year									
Programme	**Semester**	**Course Code**	**Course Type**	**Paper Title**	**Theory/ Practical / Project**	**Credits**	**Maximum Marks**		
							CIE	**ESE**	**Total Marks**
Bachelor's Degree (with Research)	VII (M.Sc.-I)	B100701T	Major/ Core	Cell Biology	Theory	4	25	75	100
		B100702T	Major/ Core	Genetics	Theory	4	25	75	100
		B100703T	Major/ Core	Biochemistry	Theory	4	25	75	100
		B100704T	Major/ Core	Biophysics	Theory	4	25	75	100
			Minor Elective	Other Faculty	Theory	4	25	75	100
		B100705P	Major/Core	Practical	Practical	4	25	75	100
						24			**600**
	VIII (M.Sc.-II)	B100801T	Major/ Core	Molecular Biology	Theory	4	25	75	100
		B100802T	Major/ Core	Microbiology	Theory	4	25	75	100
		B100803T	Major/ Core	Immunology	Theory	4	25	75	100
		B100804T	Elective Course 1*	Enzymology	Theory	4	25	75	100
		B100805T	Elective Course 2*	Plant Biotechnology	Theory	4	25	75	100
		B100806P	Major/Core	Practical	Practical	4	25	75	100
		B100807R	Major/Core	Industrial Training/Surveys /Research Project	Project	8	-	100	100
						28			**600**
				Credit (1st Year of M.Sc.)		**52**			**1200**

CIE- Continuous Internal Evaluation ESE – End Semester Examination

Fifth Year / M.Sc. – Biotechnology 2nd Year									
Programme	**Semester**	**Course Code**	**Course Type**	**Paper Title**	**Theory/ Practical/ Project**	**Credits**	**Maximum Marks**		
							CIE	**ESE**	**Total Marks**
Master of Science in Biotechnology	IX (M.Sc.-III)	B100901T	Major/ Core	Genetic Engineering	Theory	4	25	75	100
		B100902T	Major/ Core	Environmental Biotechnology	Theory	4	25	75	100
		B100903T	Major/ Core	Bioinformatics and Biostatistics	Theory	4	25	75	100
		B100904T	Elective Course 1*	Industrial Biotechnology	Theory	4	25	75	100
		B100905T	Elective Course 2*	Applied Molecular Biology	Theory	4	25	75	100
		B100906P	Major/ Core	Practical	Practical	4	25	75	100
						20			**500**
	X (M.Sc.-IV)	B1001001T	Major Elective Course 1#	Bioentrepreneurship	Theory	4	25	75	100
		B1001002T	Major Elective Course 2#	Medical Biotechnology	Theory	4	25	75	100
		B1001003T	Major Elective Course 3#	Food Biotechnology	Theory	4	25	75	100
		B1001004T	Major Elective Course 4#	Intellectual Property Rights, Biosafety and Bioethics	Theory	4	25	75	100
		B1001005T	Major Elective Course 5#	Agricultural Biotechnology	Theory	4	25	75	100
		B1001006T	Major Elective Course 6#	Systems Biology	Theory	4	25	75	100
		B1001007T	Major Elective Course 7#	Bioprocess engineering	Theory	4	25	75	100
		B1001008T	Major Elective Course 8#	Nanobiotechnology	Theory	4	25	75	100
		B1001009P	Major/ Core	Practical	Practical	4	25	75	100
		B1001010R	Major/ Core	Industrial Training /Surveys/Research Project	Project	8	-	100	100
						28			**600**
					Credit (2nd Year of M.Sc.)	**48**			**1100**
					Total Credit	**100**			**2300**

* Student must opt for any one of the two elective courses.

\# Student must opt for any one of the Four elective courses.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs)

PEO1 :To increase and update students' knowledge as per the requirement of academia and Industry through flexible, multidisciplinary, innovative and intensive research programme.

PEO2 : To enhance skills of various biotechnological tools and techniques along with research training to solve health, environment and industry related problems.

PEO3 : To prepare students for global competitions by enhancing innovative and entrepreneurship abilities.

PEO4 : To inculcate human values, ethics and code of professional practice.

PROGRAMME OUTCOMES (POs)

The programme outcomes that a student should be able to demonstrate on completion of a post degree level programme may involve academic, personal and behavioral as well as entrepreneurial and social competencies. After completion of the M. Sc.-Biotechnology programme, the candidate should be able to:

PO 1: Gain traditional, basic and advanced knowledge of diverse domains of biotechnology

PO 2: Equip with laboratory tools and techniques of biotechnology

PO 3: Ability to design and plan research independently

PO 4: Ability for multidisciplinary and collaborative research

PO 5: Ability to integrate technological skills in health, environment and industrial problem solution

PO 6: Ability to independent lifelong learning and think critically

PO 7: Ability to implement scientific approach for development of entrepreneurship skills

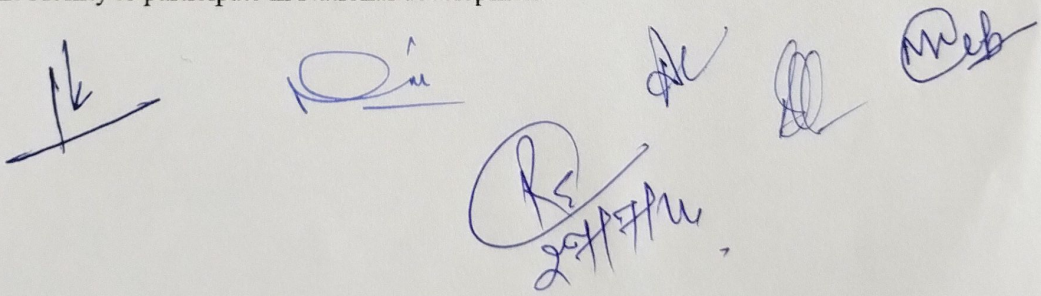
PO 8: Equip with effective listening, reading, writing and speaking skills

PO 9: Awareness towards contemporary issues of life sciences

PO 10: Ability to design and develop sustainable solutions for major local, regional, national and global issues

PO 11: Equip with ethics and code of scientific research and professional life

PO 12: Ability to participate in National development



PROGRAMME SPECIFIC OUTCOMES (PSOs)
Bachelor's Degree with Research /M. Sc.-Biotechnology

This course introduces the knowledge of cell biology, genetics, molecular biology and genetic engineering. After completion of this course, students will be able to –

PSO1: demonstrate and apply biotechnology knowledge (molecular and micro biology, immunology and recombinant DNA technology, bioprocessing, enzymology and bioinformatics) and its application in core and allied fields.

PSO2: perform practical in different biotechnology courses.

PSO3: understand the applications of biotechnology in self, society and national development.

Programme/Class: Bachelor's Degree with Research / M. Sc.-Biotechnology (I)	**Year:** First (1)	**Semester:** First (I)
Course Code: B100701T	**Course Title: CELL BIOLOGY**	
Credits: 4	**Major/ Core**	

Course Outcomes (COs)

This course introduces the principles of cell biology and after completion of this course, students will be able to:

CO 1: Understand the basic structure of cell, cell wall, cell division and structure and function of plasma membrane role of cytoskeleton and cell adhesion molecules

CO 2: Understand structure and function cell organelles involve in cell secretion and protein segregation- ER and Golgi Network

CO 3: Understand the endosymbiosis theory and cellular energy synthesis

CO 4: Understand the structure and function of nucleus, structure of chromosomes and causes and effects of structural and numerical changes in chromosomes

CO 5: Understand the causes and genes involved in Cancer and also learn different cell biology techniques like karyotyping, chromosome banding techniques

Unit	**Topics**	**No. of Lectures (Hr)**
I	Cell theory, organization of eukaryotic cell and plant cell wall, C-value paradox ,Centrosome and spindle apparatus ,and mitosis and meiosis cell division, brief account of structure and function of plasma membrane. Cytoskeleton: Microfilaments, microtubule and intermediate filaments, Cell interaction: Cell-cell adhesion.	12
II	Golgi complex, glycosylation and cell secretion and Endoplasmic reticulum and protein segregation, Lysosomes, peroxisomes, glyoxisomes, and their role in the cellular metabolism.	12
III	Endosymbiotic theory, Mitochondria structure and a brief description of functions, Chloroplast and its function	12

IV	Nuclear envelope, chromatin and chromosomes organization, euchromatin and heterochromatin, metaphase chromosome, genes and chromosomes, centromere, telomere, karyotype	12
V	Cancer – chromosomal disorders, oncogenes and tumor suppressor genes: Leukemia, retinoblastoma, and breast cancer, chromosome banding, in situ hybridization and chromosome painting.	12

Suggested Reading

1. The Cell - A molecular approach, , G.M. Cooper & R. E. Hausman, **Pub:** ASM Press Washington D.C.
2. Molecular Biology of The Cell, – Bruce Albert, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts & Peter Walter, **Pub**: G.S. Garland Science Taylor & Francis Group NY 10001-2299
3. Cell and Molecular Biology, – G. Karp, **Pub**: Johnwiley& Sons, Inc. NY
4. Molecular Biology of the Gene , – J.D. Wastson, T.A. Baker, S.P. Bell, A. Gann, M. Levine, R. Losick, **Pub:** Pearson Education (Singapore) Pvt. Ltd. Delhi
5. Molecular Cell Biology, H. Lodish, A. Berk P. Matsudaira Chris A. Kaiser, M.Krieger. M. P. Scott, L. Zipursky, J. Darnell. **Pub:** W.H. Freeman & Com., NY.
6. Cell and Molecular Biology – P.K. Gupta **Pub**: Rastogi Publication India.
7. Genetics: Principles and Analysis – Hartl and Jones.
8. Principles of Genetics – Gardner et al.
9. Principles of Genetics – Snustand et al.

Suggested link

- https://nptel.ac.in/courses/102/103/102103012/
- https://nptel.ac.in/courses/102/106/102106025/
- https://nptel.ac.in/courses/102/103/102103015/

Programme/Class: Bachelor's Degree with Research /M. Sc.-Biotechnology (I)	**Year:** First (1)	**Semester:** First (I)
Course Code: B100702T	**Course Title: GENETICS**	
Credits: 4	**Major/ Core**	

Course Outcomes (COs)

On successful completion of this course, student will be able:

CO 1: Describe fundamental molecular principles of genetics;
CO 2: Describe the basics of genetics mapping;
CO 3: Understand how gene expression is regulated.
CO 4: Three fundamental aspects in biological phenomenon: a) what to seek; b) how to seek; c) why to seek?

Unit	Topics	No. of Lectures (Hr)
I	Mendel's principles, Mendel's laws of Inheritance (Monohybrid &Dihybrid crosses), Back crosses, test- crosses, Law of segregation , Law of independent assortment, Incomplete dominance and codominance, Multiple alleles, lethal alleles, Synthetic lethality,Penetrance and expressivity, Probability. Analyses of Autosomal and sex linkages.	12

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II	Concept of a gene in pre- DNA era; Gene- Gene Interaction, Genetic epistasis in context of developmental mechanism, Genetic dissection of a biochemical pathway, Complementation analysis, Pleiotropy, Genetic crosses using phenotypic markers; phenotype to genotype connectivity prior to DNA – based understanding of gene, Genetic linkage and gene mapping, Genetic mapping from two point and three point crosses, mapping of genes in bacterial and phage chromosomes by classical genetic crosses, Tetrad analysis, analysis of ordered tetrad, analysis of unordered tetrad, Microbial Genetics.	12
III	Sex Chromosomes and sex determination, sex determination in animal and in plants, genetic mosaics, hypomorphy, sex linked traits and sex linked inheritance, Sex limited traits, sex Influenced traits, Pedigree analysis, Quantitative traits locus analysis, Heritability, Extranuclear inheritance and maternal effect, Genetic code: deciphering genetic code; degeneracy, unusual codons in mitochondria and prokaryotes.	12
IV	Mutation, Mutagen, Types of Mutation and mechanism, Mapping mutagens, Fluctuation test, Replica plating experiments, Ames test for mutagens, Transposable element, transposon mutagenesis, Mapping mutagen, Development of genetics, Genetic control of embryonic development in Drosophila, Genetic control of vulva development in C. elegans,	12
V	Chromosomal Aberrations, Genetic Recombination, Molecular mechanism of Genetic recombination in Prokaryotes and in Eukaryotes, Models of genetic recombination, yeast mating type switch; dominant and recessive genes/ mutations, suppressor or modifier screen, Genetic variation, Genetic drift, neutral evaluation; mutation selection, balancing selection, Fishers theorem, Hardy-Weinberg equilibrium. Linkage disequilibrium; inbreeding depression & mating system; population bottlenecks, migration, Genetic fitness.	12

Suggested Reading

1. Molecular biology of the cell, – Bruce Albert, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts & Peter Walter, **Pub**: G.S. Garland science Taylor & Francis Group New York – NY 10001-2299
2. Molecular Biology of the gene (5thEdtion), – J.D. Wastson, T.A. Baker, S.P. Bell, A. Gann, M. Levine, R. Losick,**Pub:** Pearson Education (Singapore) P. Ltd. Delhi
3. Molecular Cell Biology, H. Lodish, A. Berk P. Matsudaira Chris A. Kaiser, M.Krieger. M. P. Scott, L. Zipursky, J. Darnell. **Pub:** W.H. Freeman & Com., NY.
4. Gene XII, – Benjamin Lewin, **Pub:** Oxford Univ. Press, U.K..
5. Essentials of Molecular Biology – D. Friefelder. **Pub**: Jones and Barllett Publications
6. Cell and Molecular Biology – DeRobertis&DeRoberties, **Pub**: B.I. Publishers Pvt Ltd. N. Delhi
7. Cell and Molecular Biology – P.K. Gupta**Pub**: Rastogi Publication India.
8. Genetics: Principles and Analysis – Hartl and Jones.
9. Principles of Genetics – Gardner et al.
10. Principles of Genetics – Snustand et al.

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Programme/Class: Bachelor's Degree with Research / M. Sc.-Biotechnology (I)	**Year:** First (I)	**Semester:** First (I)
Course Code: B100703T	**Course Title: BIOCHEMISTRY**	
Credits: 4	**Major/Core**	

Course Outcomes (COs)

On successful completion of this course, student will be able:

CO 1: Understand chemical foundation of biology pH, pK, acids, bases and buffers & introduction to important instruments routinely used in biochemistry/biochemical assays.

CO 2: Will have to learn about the catabolism of carbohydrates with special emphasis on glucose catabolism, secondary oxidation of glucose and Regulation of carbohydrate metabolism.

CO 3: Understand the structure and oxidation of various type of fatty acids, amino acids and urea cycle.

CO 4: Will focus on de-novo biosynthesis of amino acids, purines and pyrimidines bases, and peptide sequencing and also learn about structure and functions of animals and plant hormones.

CO 5: Will understand about basics of photosynthesis phosphorylation (oxidation & photo).will also learn about the basics of enzyme kinetics of enzyme catalyzed reactions, zymogens, isozymes, coenzymes and enzyme inhibitions.

Unit	Topics	No. of Lectures (Hr)
I	Introduction to biochemistry and biomolecules. Chemical foundations of biology - pH, pK, acids, bases and buffers. Introduction to pH meter, electrophoresis, spectrophotometer and centrifugation.	12
II	Metabolism of carbohydrates: Gluconeogenesis, Glycolysis and Feeders pathways, secondary pathways of glucose oxidation Pentose phosphate pathway (Non- oxidative & Oxidative) reaction, Glucuronic acid pathway & TCA, Glyoxylate cycle, regulation of carbohydrates metabolism.	12
III	Fatty acid oxidation: Saturated, Unsaturated (poly & mono Unsaturated fatty acids, oxidation of odd chain and even chain fatty acids. Oxidation of amino acid and urea cycle.	12
IV	Introduction to biosynthesis of amino acids, purines and pyrimidines, general properties of amino acids, peptide sequencing. Introduction to animal and plant hormones.	12
V	Photosynthesis: C3-cycle, C4- cycle, Oxidative and photophosphorylation, photorespiration, CAM cycle, factors affecting photosynthesis. Classification, Nomenclature and general properties of enzyme, kinetics of enzyme catalyzed reaction, with special reference to M-M equation, factors affecting enzyme activity (pH, T, substrate, coenzyme, Isozymes, and Zymogens, Enzyme inhibitions (competitive, Non-competitive & Uncompetitive)	12

Suggested Reading

1. Harper's Illustrated Biochemistry, – R.K. Murray, D.K. Garner, P.A. Mayers& V.W. Rockwell, **Pub:** McGraw Hill International Edition.
2. Principles of Biochemistry –Lehninger, Nelson & Cox. **Pub**: Macmillan
3. Biochemistry – G. Zubay., **Pub**: Wm. C. Brown Pub.
4. General Biochemistry – Weil, **Pub**: New Age Intl. Ltd.

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5. Biochemistry – LubertStryer. **Pub:** W.H. Freeman & Com., NY.
6. Biochemistry – D. Voet and J.G. Voet**Pub:** John Willy & Sons
7. Biochemistry – West & Todd **Pub**: Oxford IBH,
8. Biochemistry – Debjyoti Das.–**Pub:** Academic Publishers Kollkata
9. Practical Biochemistry – David Plummer. **Pub**: Tata McGraw Hill
10. Practical Biochemistry – K. Wilson and J. Walker.**Pub**: Cambridge Univ. Press, (U.K.)

Programme/Class: Bachelor's Degree with Research /M. Sc.-Biotechnology (I)	**Year:** First (1)	**Semester:** First (I)
Course Code: B100704T	**Course Title: BIOPHYSICS**	
Credits: 4	**Major/Core**	

Course Outcomes (COs)

Upon completion of this course, the students will be able to:

CO 1: Understand the basic of chemical interactions and bioenergetics and thermodynamics.
CO 2: Understand the structure and classification of carbohydrates.
CO 3: Understand the nucleic acid composition and structure of DNA and RNA , glycosidic bonds
CO 4: Understand the structure and properties of amino acids and protein and Hierarchies of protein Structure.
CO 5: Understand the structure and function of lipid, biological membrane and transport across the Membrane.

Unit	Topics	No. of Lectures (Hr)
I	Chemical Interactions: Structures of atom, molecules and chemical bonds. Characteristics of chemical bonds, Types and importance of weak and strong chemical interactions, Intra and intermolecular interactions; Bioenergetics and Thermodynamics: Gibbs free energy, enthalpy, entropy, common biochemical reactions. Phosphoryl group transfers and ATP. Biological oxidation-reduction reactions.	12
II	Carbohydrates: Structure of Carbohydrates: Monosaccharides – classifications, optical activity, mutarotation, and isomerism: Disaccharides, Polysaccharides – Homopolymers&Heteropolymers; Glycoproteins.	12
III	Nucleic acid: Nucleic acid composition, Glycosidic bond rotation, Sugar ring conformation, backbone torsional angles and forces stabilizing ordered secondary structures. Topology of DNA. A, B and Z type of DNA, DNA melting curves and hyperchromicity, tRNA, micro-RNA.	12
IV	Proteins: structure and general properties of amino acids, classification and characteristics, peptide bonds, disulfide cross-links, conformational properties of dipeptides. Ramachandran plots & its use to predict sterically permissible structures. Hierarchies of protein structure, primary structure, secondary structure (helix, sheet), Domains, Motifs and folds. Forces stabilizing molecular structure, tertiary structure and quaternary structure. Fibrous and Globular proteins.	12
V	Lipids: Classification, Structure and function; Biological transport: Theory and thermodynamics of biological transport, principles of biological transport, different types of transports across membrane, simple diffusion, facilitated diffusion, primary & secondary active transport and group translocation.	12

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Suggested Reading

1. Cantor, C. R., and Schimmel, P. R. (1980). Biophysical Chemistry Vol. I, II & III. W. H. Freeman and Company.
2. Nelson DL, Cox MM, Hoskins AA. (2021) Lehninger Principles of Biochemistry, 8th Edition. WH Freeman & Co., New York.
3. Berg JM, Tymoczko JL, Gatto GJ and Stryer L (2015) Biochemistry, 8th Edition, WH Freeman & Co., New York.
4. Voet D, Voet JG and Pratt CW (2011). Fundamentals of Biochemistry, 5 th Edition. John Wiley & Sons. New York.
5. Bender DA, Botham KM, Kennelly PJ, Rodwell VW and Weil PA (2015) Harper's Illustrated Biochemistry, 30th Edition, McGraw-Hill Medical Canada.
6. Zubay GL. (1997) Biochemistry 4th Edition. Wm. C. Brown Pub
7. Plummer DT (2017) an Introduction to Practical Biochemistry 3rd Edition. Tata McGraw Hill
8. Hofmann A and Clokie S. (2018). Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology 8th Edition. Cambridge Univ. Press, (U.K.)
9. Lodish H, Berk A, Kaiser CA, Kreiger M, Bretscher A, Ploegh H, Martin KC, Yaffe MD, Amon A.(2021). Molecular Cell Biology 9th Edition. WH Freeman & Co., New York.
10. Alberts B, Heald R, Johnson A, Morgan D, Raff M, Roberts K, Walter P(2022). Molecular Biology of the Cell 7th Edition. Garland Science, Taylor & Francis Group New York

Suggested link

- https://ocw.mit.edu/courses/findbytopic/#cat=science&subcat=biology&spec=biochemistry
- https://ocw.mit.edu/courses/find-by-topic/#cat=healthandmedicine&subcat=spectroscopy
- https://ocw.mit.edu/courses/chemistry/5-07sc-biological-chemistry-i-fall-2013/module- i/session-4/
- https://ocw.mit.edu/courses/biology/7-016-introductory-biology-fall-2018/lecture- videos/lecture-4-enzymes-and-metabolism/
- https://ocw.mit.edu/courses/chemistry/5-07sc-biological-chemistry-i-fall-2013/module- i/session-3/
- https://nptel.ac.in/courses/104/105/104105076/
- https://nptel.ac.in/courses/102/106/102106087/
- https://www.swayamprabha.gov.in/index.php/higheredu
- https://swayam.gov.in/nc_details/NPTEL
- https://heecontent.upsdc.gov.in/Home.aspx
- https://ocw.mit.edu/
- https://vidyamitra.inflibnet.ac.in/index.php/uploaded_content

Programme/Class: Bachelor' Degree with Research / M. Sc.-Biotechnology (I)	**Year:** First (I)	**Semester:** First (I)
Course Code: to be provided by other faculty	**Course Title: MINOR (OTHER FACULTY)**	
Minor Other Faculty: 1(one) minor elective paper from any other faculty (a subject other than the main subject)		
Credits: 4	**Minor elective (Optional)**	

Programme/Class: Bachelor's Degree with Research /M. Sc.-Biotechnology (I)	**Year:** First (I)	**Semester:** First (I)
Course Code: B100705P	**Course Title: PRACTICAL**	
Credits: 4	**Major**	

	Topics	No. of Lectures
	CELL BIOLOGY LAB	120
1.	Karyotype preparation.	
2.	Mitotic metaphase chromosome preparation from bone marrow of mouse/rat.	
3.	C-banding of mitotic chromosomes of mouse/rat.	
4.	G-banding of mitotic chromosomes of mouse/rat.	
5.	Fluorescence banding of mitotic chromosomes of mouse/rat.	
6.	Observation of budding yeast and fission yeast cells (phase contrast microscope).	
7.	Demonstration of septum in fission yeast by calcoflour (Tinopal).	
8.	Vital Staining of Mitochondria with Janus green B.	
9.	Demonstration of diversity of cell types (Muscle, Neuron)	
10.	Demonstration of Sex chromatin in buccal smear.	
	GENETICS LAB	
11.	Study of mitosis (smear and squash method, root tip of onion).	
12.	Study of meiosis (pollen grain), Maize, Rat testis.	
13.	Genetics problems: (i) Mendel's law (ii) Gene mapping (iii) Transposable elements.	
14.	Ames test for mutagenesis.	
15.	Genetic experiment – Drosophila model	
	BIOCHEMISTRY LAB	
16.	Determination of pK_a value of a weak acid by titrating with strong base.	
17.	Estimation of DNA by Diphenylamine and RNA by Orcinol methods.	
18.	Estimation of reducing and total sugar by DNS and H_2SO_4-phenol methods.	
19.	Determination of R_f values of amino acids by TLC using ninhydrin.	
20.	Enzyme production and its activity measurement.	
21.	Effect of pH and temperature on enzyme activity.	
22.	Titration of ascorbic acids using 2, 6 dichloropheno-endophenol dye.	
23.	Determination of acid value of fats.	
	BIOPHYSICS LAB	
24.	Introduction to Biotechnology laboratory, Instruments, and general laboratory safety rules.	
25.	Pipetting Techniques, Calculations/Dilutions/ Conversion/ Solutions.	
26.	Introduction to Basic principles and handling of Balances	
27.	Introduction to Basic principles and handling of pH meter	
28.	Introduction to Basic principles and handling of Centrifuges	
29.	Introduction to Basic principles and handling of Colorimeter	
30.	Introduction to Basic principles and handling of Spectrophotometer	
31.	Estimation of Protein by UV-Vis Spectrometer	
32.	Lowry et al. method for estimation of protein (ii)Biuret method for estimation of protein	
33.	Estimation of DNA by spectrophotometer	
34.	Assessment of the purity of nucleic acids (260/280 Ratio)	

Programme/Class: Bachelor's Degree with Research /M. Sc.-Biotechnology (I)	**Year:** First (1)	**Semester: Second (II)**
Course Code: B100801T	**Course Title: MOLECULAR BIOLOGY**	
Credits: 4	**Major/Core**	

Course Outcomes (COs)

On successful completion of this course, student will be able:

CO 1: DNA replication in Prokaryotes and Eukaryotes

CO 2: Transcription in Prokaryotes and Eukaryotes

CO 3: Post translation and transcriptional mechanism

CO 4: Gene expression in prokaryotes using Lap operon and in Eukaryotes by Trp operon CO5 Cell cycle and its regulation

Unit	Topics	No. of Lectures (Hr)
I	Genetic Code: deciphering genetic code; degeneracy, unusual codons in mitochondria and prokaryotes. Replication of genetic material in prokaryotes and eukaryotes, A brief description of initiation at replication origins and its cell cycle regulation.	12
II	DNA damage and repair. Types of damage and their repair (repair by proofreading, mismatch repair (Mut HLS system of *E. coli*.), Excision repair (Uvr ABC mechanism of *E. coli*.), repair of double strand breaks, photo reactivation, SOS repair.	12
III	Gene organization in prokaryotes and eukaryotes, polycistronic genes, split genes promoters, enhancers. Mechanism of transcription in prokaryotes and eukaryotes: transcription factors, RNA polymerases, initiation, elongation and termination. RNA processing: processing of mRNA, tRNA and rRNA.	12
IV	Translation. Regulation of gene expression: Prokaryotes: lac and trp operons in *E. coli*. An overview of regulation of gene expression in eukaryotes	12
V	Signaling: An introduction to signaling, different type of ligands, receptors, G proteins, second messengers, Ras and RTK signaling. Cell cycle and its regulation: role of growth factors, cyclins, Cdks with yeasts and higher eukaryotic cells as examples.	12

Suggested Reading

1. Lodish H, Berk A, Kaiser CA, Kreiger M, Bretscher A, Ploegh H, Martin KC, Yaffe MD, Amon A.(2021). Molecular Cell Biology 9th Edition. WH Freeman & Co., New York.
2. Alberts B, Heald R, Johnson A, Morgan D, Raff M, Roberts K, Walter P(2022). Molecular Biology of the Cell 7th Edition. Garland Science, Taylor & Francis Group New York.
3. Watson JD, Gann A, Baker TA, Levine M, Bell SP, Losick R, Harrison SC(2014). Molecular biology of the gene 7th edition Cold Springer Harbor Laboratory Press, Cold Spring Harbor, New York.
4. Karp G, Iwasa J, Marshall W (2019). Karp's Cell and Molecular Biology 9th edition. Johnwiley& Sons, Inc. NY.
5. Cooper GM, HausmanRE(2018) The Cell - A molecular approach-8th edition. ASM Press Washington D.C.
6. Gupta PK(2017). Cell and Molecular Biology 5th edition. Rastogi publications, India.
7. Singh BD(2011) Biotechnology (Hindi). Kalyani Publishers, India.
8. Singh BD(2020) Biotechnology-Expanding Horizons. Kalyani Publishers, India.

Programme/Class: Bachelor's Degree with Research / M. Sc.-Biotechnology (I)	**Year:** First (1)	**Semester:** Second (II)
Course Code: B100802T	**Course Title: MICROBIOLOGY**	
Credits: 4	**Major/Core**	

Course Outcomes (COs)

On successful completion of this course, student will be able:

CO 1: Will have to learn about the history of microbiology, culturing of microbes, study of growth kinetics and about the principle and instrumentation of different types of microscopes.

CO 2: Under this it will have to understand about the genetics of bacteria with emphasis to the transformation, transduction and conjugation. It will also have to know about the detailed knowledge of viruses, replication and their taxonomy.

CO 3: Will have to learn about the microbial taxonomy and evolution of diversity, classification of microorganisms of different environments.

CO 4: Will have to understand about the different types of sterilization techniques including physical and chemical control methods.

CO 5: Under this it will have to learn about the mechanisms of Host-pathogen interactions and different nutrient cycles.

Unit	Topics	No. of Lectures (Hr)
I	Introduction to microbiology and microbes, history & scope of microbiology, morphology, structure, growth and nutrition of bacteria, growth kinetics, bacterial culture methods. Brief description of light, phase contrast, fluorescence microscopy, confocal microscopy, transmission and scanning electron microscopy.	12
II	Bacterial genetics: mutation and recombination in bacteria, plasmids, transformation, transduction and conjugation; antimicrobial resistance. Virus and bacteriophages, general properties of viruses, viral structure, taxonomy of virus, viral replication, cultivation and identification of viruses; sub-viral particles – viroids and prions.	12
III	Microbial taxonomy and evolution of diversity, classification of microorganisms, criteria for classification. Archaea: Halophiles, Methanogens, Hyperthermophilicarchae, Thermoplasm; eukarya: algae, fungi, slime molds and protozoa; extremophiles and unculturable microbes.	12
IV	Sterilization, disinfection and antisepsis: physical and chemical methods for control of microorganisms, antibiotics, antiviral and antifungal drugs, biological control of microorganism.	12
V	Host-pathogen interaction, ecological impact of microbes; symbiosis (Nitrogen fixation and ruminant symbiosis); microbes and nutrient cycles; microbial communication system; bacterial quorum sensing; microbial fuel cells; prebiotics and probiotics.	12

Suggested Reading

1. Prescott, Harley & Klein's Microbiology, – Willey, Sherwood and Woolverton. **Pub:**McgrawHill, International Ed.
2. Microbiology – M.J. Pelczar, E.C.S. Chan & N.R. Kreig. **Pub:** Tata McgrawHill.
3. Microbiology – Principles &Exploration , J.G. Black, **Pub**: John Wiley & Sons, Inc.Tortora, Funk, Case.
4. General Microbiology – R.Y. Stanier, J.L Ingraham, M.L. Wheelis, P.R. Painter, **Pub**: The MacMillan Press Ltd.

Programme/Class: Bachelor's Degree with Research / M. Sc.-Biotechnology (I)	**Year:** First (I)	**Semester:** Second (II)
Course Code: B100803T	**Course Title: IMMUNOLOGY**	
Credits: 4	**Major/Core**	

Course Outcomes (COs)

This course introduces the basic principles of Immunology and after completion of this course, students will be able to-

CO 1: Understand the basic principles of immunology and also able to identify the cellular and molecular basis of immune responsiveness.

CO 2: Understand the structure, function and diversity of antigen and antibodies, and antigen processing and presentation by the cells

CO 3: Understand the basic techniques for identifying antigen antibody interactions.

CO 4: Understand and explain the basis of allergy and allergic diseases and role of complement system

CO 5: Understand the importance and molecular action of vaccines, causes of graft rejection and causes of acquired immunodeficiency diseases.

Unit	Topics	No. of Lectures (Hr)
I	Basic concepts of Immunology, Innate & Acquired Immunity, Concept of Humoral & Cell Mediated Immunity. Organization and structure of Lymphoid organs and Cells of the Immune System: B-Lymphocytes, T-Lymphocytes, Macrophages, Dendritic Cells, N K Cells, Eosinophils, Basophils, Neutrophils, Mast Cells.	12
II	Nature and biology of antigen, super antigen, Major Histocompatibility Complex and Antigen Processing & Presentation. Immunoglobulins: Structure, types & function, Generation of Antibody Diversity, BCR, TCR.	12
III	Antibody-Antigen Interaction:-Precipitation reactions, Agglutination reactions, Radio immunoassay, ELISA and Fluorescence activated cell sorting and Hybridoma Technology and Monoclonal Antibodies.	12
IV	Generation of humoral and cell mediated immune responses, Cell Mediated Cytotoxicity: Mechanism of T cell and NK cell mediated lysis. ADCC, macrophage mediated cytotoxicity. Complement System: Components, activation, regulation and biological consequences. Hypersensitivity; Classification, mediators, regulation, detection & therapy	12
V	Immunization: Active & Passive, Vaccines: Types & importance; Acquired Immuno Deficiency Syndrome (AIDS); Transplantation Immunology.	12

Suggested Reading

1. Punt J, Stranford SA, Jones PP Owen JA. (2019) Kuby Immunology, 8th Edition. WH Freeman & Co., New York.
2. Delves PJ, Martin SJ, Burton DR, Roitt IM, (2017). Roitt's Essential Immunology 13th edition John Wiley & Sons, Ltd, UK
3. Abbas AK, Lichman AH, Pillai S. (2021) Cellular and Molecular Immunology 10th edition, Elsevier.
4. Murphy K, Weaver C, Berg L (2022). Janeway' Immunobiology 10th Edition. W. W. Norton & Company, New York.
6. Singh BD(2011) Biotechnology (Hindi). Kalyani Publishers, India.
7. Singh BD(2020) Biotechnology-Expanding Horizons. Kalyani Publishers, India.

Suggested link

- https://ocw.mit.edu/courses/find-by-topic/#cat=healthandmedicine&subcat=immunology
- https://nptel.ac.in/courses/102/103/102103038/
- https://nptel.ac.in/courses/102/105/102105083/
- https://nptel.ac.in/courses/102/103/102103015/
- https://nptel.ac.in/content/storage2/courses/102103013/pdf/mod7.pdf
- https://nptel.ac.in/content/storage2/courses/102103015/module1/lec1/1.html
- https://nptel.ac.in/courses/104/105/104105076/
- https://nptel.ac.in/courses/102/106/102106087/
- https://www.swayamprabha.gov.in/index.php/higheredu
- https://swayam.gov.in/nc_details/NPTEL
- https://heecontent.upsdc.gov.in/Home.aspx
- https://ocw.mit.edu/
- https://vidyamitra.inflibnet.ac.in/index.php/uploaded_content

Programme/Class: Bachelor's Degree with Research / M. Sc.-Biotechnology (I)	**Year:** First (1)	**Semester:**Second (II)
Course Code: B100804T		**Course Title:ENZYMOLOGY**
Credits: 4		**Major Elective Course 1***

Course Outcomes (COs)

After completion of the course, student will be able to:

CO 1: Will understand the history and scope of enzyme, classification as per IUBMB norms. Different hypothesis proposed for enzyme catalyzed reactions

CO 2 : Will focus on monomeric enzyme and its important example, polymeric enzyme with example giving special emphasis on reaction mechanism

CO 3 : Will understand about steady state kinetics along with primary and secondary plots

CO 4 : Will know about various type of reversible and irreversible inhibition with its important example and application in chemotherapy

CO 5: Will know about multisubstrate enzyme catalyzed reaction, different type of catalysis, metal activated and metallozyme and important applications of industrial enzymes and acquaintance with immobilized systems

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Unit	Topics	No. of Lectures (Hr)
I	Brief history of enzymes, classification, Nomenclature and general properties of enzymes. Types of enzyme specificity, active site. Lock & Key hypothesis, induced fit hypothesis. Hypothesis involving strain of transition state stabilization.	12
II	Monomeric enzymes: serine protease, pepsin A carboxypeptidases A and B, ribonuclease and lysozyme. Oligomeric enzyme: lactate dehydrogenase, lactose synthase, tryptophan synthase, pyruvate dehydrogenase.	12
III	The relationship between initial velocity and substrate concentration, Michaelis-Menten equation, Lineweaver -Burk plot, Eadie- Hofstee& Hanes plot, Eisenthal&Corish- Bowden plot	12
IV	Enzyme inhibition: Competitive type inhibition, uncompetitive type of Inhibition, Non- competitive type of inhibition, mixed inhibition, partial inhibition, substrate inhibition, allosteric inhibition, irreversible inhibition.	12
V	Multisubstrate enzyme catalyzed reaction Ping- Pong bi- bi mechanism, Random Order Mechanism. Compulsory order mechanism. mechanism of catalysis : Acid base catalysis, electrostatic catalysis, current catalysis,catalysis without cofactor metal activated and metallozymes, biotechnological applications of enzymes, immobilized enzymes.	12

Suggested Reading

1. T. Palmer and P.L. Bonner, (2007), Enzymes: Biochemistry, Biotechnology and Clinical Chemistry, Woodhead publishing limited.
2. N.C. Price and L. Stevens, (2002), Fundamentals of Enzymology,Oxford University Press.
3. Wolfgang Aehle, (2004), Enzymes in Industry: Production and Applications (Ed.) Wiley-VCH Verlag GmbH & Co. KGaA.
4. Branden and Tooze, (1999), Introduction to Proteins Structure, Garland Publishing Group Gary Walsh, (2014), Proteins: Biochemistry and Biotechnology, John Wiley & Sons Ltd.

Programme/Class: Bachelor's Degree with Research / M. Sc.-Biotechnology (I)	**Year:** First (1)	**Semester:** Second (II)
Course Code: B100805T	**Course Title: PLANT BIOTECHNOLOGY**	
Credits: 4	**Major Elective Course 2***	

Course Outcomes (COs)

Students should be able to gain the

CO 1: Fundamental knowledge in plant Cell culture technique and their applications
CO 2: Fundamental knowledge in PlantCell Culture technique
CO 3: Knowledge of Transgenic and Genetic transformation of plants
CO 4: Knowledge of Application of plant transformation for productivity
CO 5: Information regarding Plant secondary metabolites

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Unit	Topics	No. of Lectures (Hr)
I	Introduction to the techniques of plant tissue culture. Concept of cellular totipotency, Laboratory requirement and basic aseptic techniques, Plant Culture media: composition and preparation	12
II	Cell culture: Initiation and maintenance of callus and suspension cultures Organogenesis, somatic embryogenesis, factors affecting somatic Embryogenesis, Artificial Seeds. Protoplast isolation, culture and fusion, selection of hybrid cell Somaclonal and Gameto clonal variation Clonal propagation (Micropropagation)	12
III	Transgenesis: Methodologies, in plants, recent plant transformation technologies, basis of tumor formation, hairy root, features of Ti & Ri plasmids, mechanisms of DNA transfer, role of virulence genes, use of Ti and Ri as vectors, binary vectors	12
IV	Application of plant transformation for productivity and performance: Herbicides resistance, phosphoinothricin, glyphosate, sulfonyl urea, atrazine, insect resistance, Bt genes, non-Bt like protease inhibitors, virus resistance, coat protein mediated, disease resistance, long shelf life of fruits and flowers.	12
V	Plant secondary metabolites: Control mechanisms and manipulationof alkaloids and industrial enzymes (Shikimate and PHA pathway),biodegradable plastics, therapeutic proteins, Edible vaccines,purification strategies. Green house Technology. Biotic and Abioticstress.	12

Suggested Reading

1. An Introduction To Plant Tissue Culture: M K Razdan. , **Pub:**Oxford(India).
2. Plant Tissue Culture H D Kumar, ,**Pub:** Agro Bios. India
3. Plant Tissue Culture: Kalyan Kumar De: **Pub:** The New Central Book Agency, Calcutta, India
4. Fundamentals of Plant Biotechnology – AmlaBatra, **Pub**: Capital Publishing Co.

Programme/Class: Bachelor's Degree with Research /M. Sc.-Biotechnology (I)	**Year:** First (1)
Course Code: B100806P	**Course Title: PRACTICAL**
Credits: 4	**Major/Core**
Topics	**No. of Lectures (Hr)**
MOLECULAR BIOLOGY LAB 1. Preparation of solutions for Molecular Biology experiments 2. Study of semi-conservative replication of DNA through micrographs/schematic representations 3. Isolate genomic DNA from bacteria 4. Preparation of bacterial growth medium (L.B., 2XYT) 5. Competent cell preparation **MICROBIOLOGY LAB** 1. Instruments/equipments commonly used in Microbiology. 2. Washing and Sterilization of Lab wares. 3. Media preparation for growing (i) Bacteria (ii) Moulds (iii) Yeast. 4. Culturing of Microorganisms – (i) Slant preparation (ii) Suspension culture	120

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(iii) Streaking (iv) Plating. 5. Isolation of soil organisms, plate streaking method. 6. Counting of microorganisms using Haemocytometer in given sample (serial dilution) 7. Size measurement of microorganisms using stage and ocular micrometer. 8. Growth measurement by optical density/plating method. 9. Simple and Gram staining **IMMUNOLOGY LAB** 1. Blood film preparation & Identification of cells 2. ABO blood grouping. 3. Immunization 4. Antigen-Antibody reaction, precipitation. 5. ELISA 6. Immunoelectrophoresis. **ENZYMOLOGY LAB** 1. Isolation and quantification of activity of – Amylase / Invertase / Alkaline phosphatase (salivary / yeast/ plant source). 2. Determining the Molecular Weight of Amylase by Gel Filtration/Size Exclusion Chromatography. 3. Determination of specific activity of enzyme (Amylase/Protease/ Invertase). 4. Determination of temperature coefficient & energy of activation. 5. Determination of activity of enzyme in presence of activator and inhibitor. 6. Induction and assay of beta-galactosidase in *E. coli*. 7. Enzyme production, purification and assay (Protease/ Invertase). **PLANT BIOTECHNOLOGY LAB** 1. Preparation of stock solutions of MS (Murashige&Skoog, 1962) basal medium 2. To prepare MS media with different concentration of 6- Benzyl amino purine (BAP) for regeneration from leaf of Tobacco 3. Surface sterilization and inoculation of tobacco leaf explants on MS medium for shoot regeneration. 4. Isolation of plant genomic DNA by modified CTAB method 5. To perform DNA fingerprinting by random amplification of polymorphic DNA (RAPD) technique by PCR	

Programme/Class: Bachelor's Degree with Research / M. Sc.-Biotechnology (I)	**Year:** First (1)	**Semester:** Second (II)
Course Code: B100807R	**Course Title: INDUSTRIAL TRAINING/SURVEYS/RESEARCH PROJECT**	
Credits: 4	**Major/Core (Project)**	
This research project can be interdisciplinary / multi-disciplinary. This research project can also be in the form of industrial training/internship / survey work etc.		

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Programme/Class: M. Sc.-Biotechnology (II)	**Year:** Second(2)	**Semester: Third** (III)
Course Code: B100901T	**Course Title: GENETIC ENGINEERING**	
Credits: 4	**Major/Core**	

Course Outcomes (COs)

Upon completion of this course, the students will be able to;

CO 1: understand various cloning vectors-plasmid derived vectors, bacteriophage derived vectors hybrid vectors & high capacity vectors with suitable examples

CO 2: understand methods for gene cloning

CO 3: understand methods for DNA variations and creation of mutagenesis

CO 4: understand the methods for gene expression modulation and genomic library synthesis

CO 5: understand the techniques for DNA- protein and protein- protein interaction and application of Recombinant DNA techniques in different fields of Biotechnology

Unit	Topics	No. of Lectures (Hr)
I	Vector-Host System, cloning vectors (plasmids, phages, cosmids, bacterial artificial chromosomes and yeast artificial chromosomes, shuttle vectors, expression vectors)	12
II	Isolation of DNA (Plasmid, Cosmid, Phage and Genomic DNA) and RNA from prokaryotes and eukaryotes, Electrophoresis of proteins and nucleic acids; Ligation, preparation of competent cells and their transformation. Screening and characterization of cloned DNA	12
III	Enzymes used for manipulating DNA (restriction endonucleases, methylases, polymerases, ligases, kinases and nucleases);Restriction mapping and RFLP analysis; PCR and its applications; DNA Sequencing; Site directed mutagenesis	12
IV	Southern, Northern and Western Blotting, probe preparation and hybridization; Construction of genomic and cDNA libraries; Modulation of gene expression – RNAi, antisense RNA	12
V	Protein-protein interaction: Immunoprecipitation, Yeast Two-Hybrid System; DNA-Protein interaction: Gel Shift Assay, Foot-printing.	12

Suggested Reading

1. Brown TA (2018) Genomes 4 Garland Science, Taylor & Francis Group New York
2. Brown TA (2020) Gene Cloning and DNA Analysis: An Introduction. 8th Edition. John Wiley and Sons, Ltd.
3. Primrose SB, TwymanR.(2006) Principals of Gene Manipulation Blackwell Publishing New York
4. Micklos DA, Freyer CA, Crotty DA, (2003). DNA Science A first course in recombinant DNA technology 2nd edition. Cold Springer Harbor Laboratory Press, Cold Spring Harbor, New York
5. Glover DM, HamesBD(1998). DNA cloning a practical Approach 2nd edition. IRL press Oxford
6. Sambrook J, Green MR (2012). Molecular Cloning: A Laboratory Manual 4th Edition. Cold Spring Harbor, New York.
7. Primrose SB, TwymanR.(2013) Principals of Gene Manipulation and Genomics 7thEdiotnJohn Wiley and Sons
8. Primrose SB (1999). Molecular Biotechnology 2nd Edition Blackwell Publishing New York
9. Singh BD(2011) Biotechnology (Hindi). Kalyani Publishers, India.
10. Singh BD(2020) Biotechnology-Expanding Horizons. Kalyani Publishers, India.

Suggested link

- https://youtu.be/Yh9w_fyvpUk https://youtu.be/fTFoqDn5E1w https://youtu.be/HmzyI73ZW0U
- https://youtu.be/LB99cFUl18U
- https://youtu.be/Etgdrrl-RQs https://youtu.be/Kkk1_06irz0 https://youtu.be/Arko4K6wqN4
- https://youtu.be/I4uaBXwaXXw https://youtu.be/PKvApGseTdg https://youtu.be/NyLdU1F-cQ8
- https://youtu.be/dTrjhJJMpYM https://youtu.be/-IRnKD0oP-E
- https://www.swayamprabha.gov.in/index.php/higheredu https://swayam.gov.in/nc_details/NPTEL
- https://heecontent.upsdc.gov.in/Home.aspx https://ocw.mit.edu/
- https://vidyamitra.inflibnet.ac.in/index.php/uploaded_content

Programme/Class: M. Sc.-Biotechnology (II)	**Year: Second** (2)	**Semester:** Third (III)
Course Code: B100902T	**Course Title: ENVIRONMENTAL BIOTECHNOLOGY**	
Credits: 4	**Major/Core**	

Course Outcomes (COs)

Upon completion of this course, the students will be able to:

CO 1: Will have an overview of till date development in the field of Environmental Biotechnology with special emphasis on the role of microbes in initiatory environment pollution along with basic ideas of component of environment

CO 2: Will be able to describe the role of soil microbes in nutrient transformation, plant microbe interaction and biotechnological applications and also know about portability of water

CO 3: Understand the role of microbes in waste plant biomass and can apply knowledge in designing microbes based process for pulp, textiles, biofuels and animal food production industry

CO 4: Will able to describe the role of microbes in liquid and solid waste management

CO 5: Understand the role of microbes in bioremediation of environmental pollutants

Unit	Topics	No. of Lectures (Hr)
I	Development in the field of Environmental Biotechnology. Introduction to water, soil and air as a component of environment. Ecological pyramids.	12
II	Importance of soil microorganism, nutrient transformation process, plant microbes' symbiosis, microbial antagonism, biofilms and their biotechnological applications, drinking water microbiology and quality control.	12
III	Lignocellulytic microorganism, enzyme and their biotechnological applications in biopulping, bioleaching, textiles, biofuels and animal food production.	12
IV	Treatment of sewage (primary, secondary and tertiary treatment), treatment of industrial effluent (distillery, antibiotics, pulp& paper, leather) Solid waste management.	12
V	Environmental management, biological monitoring programme, Introduction to bioremediation, biodegradation of Xenobiotic compounds.	12

Suggested Reading

1. Mohapatra PK, (2006). Environmental Biotechnology , IK International
2. Khan MS, Zaidi A, Musarrat J, (2009). Microbial Strategies for Crop Improvement, Springer Dordrecht Heidelberg London New York

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3. Bitton G, (2014). Microbiology of Drinking Water Production and Distribution, John Wiley & Sons, Inc., Hoboken, New Jersey
4. Ramalho RS, (1983). Introduction to Wastewater Treatment Processes, Second Edition. Academic Press , Inc. (London) Ltd
5. Muralikrishna I V and Manickam V, (2017). Environmental Management. BS Publications
6. Das S, (2014). Microbial Biodegradation and Bioremediation. First Edition.

Suggested Links

- https://ift.onlinelibrary.wiley.com/doi/full/10.1111/1750-3841.13636
- https://www.nrfhh.com/Comprehensive-strategies-of-Lignocellulolytic-enzyme-production-from-microbes-and,143683,0,2.html
- https://www.britannica.com/technology/wastewater-treatment/Clustered-wastewater-treatment-systems

Programme/Class: M. Sc. Biotechnology (II)	**Year:** Second (2)	**Semester:** Third (III)
Course Code: B100903T	**Course Title: BIOINFORMATICS & BIOSTATISTICS**	
Credits: 4	**Major/Core**	

Course Outcomes (COs)

This course introduces the basic principles of Bioinformatics and after completion of this course, students will be able to:

CO 1: Understand the basic theories and practical of common computational tools
CO 2: Understand databases which facilitate investigation of molecular biology and evolution-related concepts. Critically analyses and interpret results of their studies with the help of bioinformatics tools
CO 3: Understand phylogenetic analysis and Primer designing with bioinformatics tools.
CO 4: Gain broad understanding in statistics; Recognize importance and value of statistical thinking, training, and approach to problem solving, on a diverse variety of disciplines.
CO 5: Critically analyses and interpret results of their study.

Unit	Topics	No. of Lectures (Hr)
I	History, aim of Bioinformatics, Definition and Concepts, Components of Bioinformatics, Basic tools, Scope of Bioinformatics in molecular biology and Computers, Computers in biology and medicine. Role of internet in Bioinformatics.	12
II	NCBI; publicly available tools; resources at EBI; resources on web Biological Data Base: Primary, Secondary and Composite database; Nucleotide sequence databases; Protein sequence databases; Structural sequence databases:	12
III	Sequence analysis; Sequence alignment: Types and methods; Molecular Evolution and phylogenetic trees, Methods for Phylogenetic analysis Construction of Phylogenetic Tree. Primer designing; Role of Bioinformatics in drug discovery and development.	12
IV	Scope of biostatistics, Variables in biology. Collection, classification, tabulations and diagrammatic presentation of statistical data Concepts of statistical population and sample. Measures of central tendencies and Dispersion. Simple measure of	12

	Skewness and kurtosis.	
V	Probability – Definition, simple theorems of probability and simple application of probability. Correlation, correlation coefficient, standard error of estimate and regression, linear regressions, least square method of fitting. Basic idea of significance, testing level of significance, random variations. Chi-square ($\chi 2$) test, ANOVA.	12

Suggested Reading

1. Mount David W. Bioinformatics: Sequence and Genome Analysis. Publisher: Cold Spring Harbor Laboratory Press; Latest Edition
2. Baxevanis Andreas D. Bioinformatics: A Practical Guide to the Analysis of Genes and
3. Proteins, Latest Edition. Publisher: New York, John Wiley & Sons, Inc.
4. Teresa Attwood, Parry-Smith David J. Introduction to Bioinformatics. Publisher: Pearson Education (Singapore) Pte.Ltd., Latest Edition
5. Gibas Cynthia, JambeckPer. Developing Bioinformatics Computer Skills. Publisher: Shroff Publishers and distributors O'Reilly Media, Inc., Latest Edition
6. Biostatistics – Garret
7. Encyclopedia of Biostatistics – Peter Armitage& Theodore Colton
8. Statistics – Schaum's Series Publication.
9. Statistical analysis – A computer oriented approach IInd Ed. Academic Press New York
10. Fundamentals of statistics – D.N. Elhance

Suggested Links

- https://www.swayamprabha.gov.in/index.php/higheredu
- https://swayam.gov.in/nc_details/NPTELh
- ttps://heecontent.upsdc.gov.in/Home.aspx
- https://ocw.mit.edu/ https://vidyamitra.inflibnet.ac.in/index.php/uploaded_content

Programme/Class: M. Sc.-Biotechnology (II)	**Year:** Second (2)	**Semester:** Third (III)
Course Code: B100904T	**Course Title: INDUSTRIAL BIOTECHNOLOGY**	
Credits: 4	**Elective Course 1***	

Course Outcomes (COs)

After completion of the course the student should be able to:

CO 1: Will have to learn about the history of industrial microbiology/biotechnology and screening methods for new metabolites

CO 2: Under this it will have to understand about the development of industrially important new strains through different techniques. It will also emphasis on the selection of substrates for the industrial fermentation

CO 3: Will have to learn about the variety of bioreactors, their working mechanism, immobilization technology and the biosensors and their applications

CO 4: Will have to understand about the transport phenomenon in bioprocessing, mass energy balance, upstream and downstream processing with emphasis to isolation and purification of products

CO 5: Under this it will have to learn about industrial production of distinct types of microbial metabolites viz; alcohols, organic acids, amino acids, antibiotics, vitamins, mushrooms and about the biofertilizers and biopesticide

Unit	Topics	No. of Lectures (Hr)
I	History-Introduction, scope and relation with other sciences. Screening for new metabolites: primary and secondary products.	12
II	Development of new strains through, mutations, recombination, and other recent genetic/ biochemical methods. Substrates for fermentation: Nature, types and availability. Fermentation: different types and systems for optimization of productivity.	12
III	Design and working of a typical bioreactor including stirred tank, bubble column, air lift, packed bed, fluidized bed, trickle bed, ideal reactor, plug flow etc. Bioreactor for immobilized cells/enzyme system, Biosensors and their applications	12
IV	Transport phenomenon in bioprocessing: introduction, oxygen requirements in industrial processing, oxygen supply and transfer rate, KLa values, factors affecting KLa values, non-Newtonian Fluids, heat transfer correlations. Mass and energy balance. Scale up, automation and use of computers in fermentation. Downstream processes for product recovery: isolation purification and concentration through physical / chemical means.	12
V	Production of alcohols (Ethanol), organic acids (citric and acetic), amino acids (Lysine & glutamic acid), solvent (glycerol & butanol), nucleotides. Production of biologically active compounds: antibiotics (penicillins), vitamins (B-12, riboflavine), enzymes (amylase, protease). Production of microbial food and single cell proteins. Mushroom: Production, Nutritive and Medicinal value. Microorganisms as biofertilizers & biopesticides.	12

Suggested Reading

1. Biotechnology – A text book of Industrial Microbiology – Crueger&Crueger, Pub: Panima Publishing Corp., New Delhi.
2. Microbial Biotechnology – Fundamental & Applied Microbiology – Glazier &Nikaido.**Pub**: Freeman & Comp., NY
3. Industrial Microbiology: An introduction (2001) Waites& others. **Pub**: Blackwell Science
4. Manual of Industrial Microbiology & Biotechnology– Demain&Davies ,**Pub**: ASM Press, Washington DC.
5. Principles of Fermentation Technology - Stanbury PF & Whitaker **Pub**: (Pergamon press Oxford), Aditya Book Pvt. Ltd, N. Delhi.
6. Process Biotechnology Fundamental – S.N. Muckhopadhyay, **Pub**: Viva Books Pvt Ltd
7. Bioprocess Engineering – Wolf R. Vieth., **Pub**: John Willey Inc.
8. Biochemical engineering fundamentals by Baily JE and Ollis DF, **Pub**: Mcgrawhill Book co. New York Bioprocess Engineering by Pauline M Doran.

Programme/Class: M. Sc. Biotechnology (II)	**Year: Second (2)**	**Semester:** Third (III)
Course Code: B100905T	**Course Title: APPLIED MOLECULAR BIOLOGY**	
Credits: 4	**Elective Course 2***	
Course Outcomes (COs)		

After completion of the course the student should be able to:

CO 1: Understand the different strategies of human genome analysis, Introduction to Basic concepts of Human Genome

CO 2: Understand the applications and methods of recent techniques of human molecular biology.

CO 3: Understand the basic inheritance patterns and non-mendelian inheritance patterns and able to prepare human pedigree and different techniques of genetic disorder diagnosis

CO 4: Understand about monogenic disorders of different systems.

CO 5: Differentiate monogenic and complex traits, chromosomal disorders and triplet repeat syndromes.

Unit	Topics	No. of Lectures (Hr)
I	History, organization and goals of human genome project, Mapping strategies, organization of human genome Mitochondrial genome, Gross base composition of nuclear genome, Gene density, CpG islands, RNA-encoding genes, Functionally identical/similar genes, Diversity in size and organization of genes, and comparison with genomes of others organisms. (Drosophila, Yeast)	12
II	Embryonic stem cell, neural and hematopoetic stem cells, Gene Therapy: current status, problems and future prospects.	12
III	DNA fingerprinting: applications and limitations, forensic applications, Micro-arrays , Introduction to CRISPRCas9 technology and Applications	12
IV	Viral, Physical and chemical gene delivery methods for animals and plants: Viral vectors and vector less or direct DNA transfer, particle bombardment, electroporation, microinjection & chemical methods, agrobacterium infection, creation of animal models of human diseases, Transgenesis, Transgenic animal and Plants	12
V	Proteome and proteomics, Pharmacogenomics: Exemplify specific cases that highlight potential use of individual-specific genomic features that impact disease relevance and treatment modalities. Gene- environment interaction; gene- diet interaction (folate cycle and one carbon cycle), Bioactive components of food(folate and B12); nutraceuticals, effective gene expression; epigenetic process	12

Suggested Reading

1. Griffith AJF, Doeblay J, Peichel C, Wassarman DA. (2020) Introduction to genetic analysis 12th Edition. WH Freeman & Co., New York.
2. Strachan T, Read AP (2018). Human Molecular Genetics 5th Edition. Garland Science, Taylor & Francis Group New York
3. Eberhard P.(2017). Color Atlas of Genetics 5th edition. Thieme Publishing Group.
4. Cohn R, Scherer S, Hamosh A (2023). Thompson and Thompson Genetics and Genomics Medicine 9th edition. Elsevier.
5. Gibson G, Muse SV (2009). A primer of genome science 3rd edition OUP USA.
6. Pasternak JJ (2005) an Introduction to Human Molecular Genetics 2nd Edition. Fitzgerald Science Press, Bathesda, Maryland.
7. Turnpenney P, Ellard S, Cleaver R (2020). Emery's Elements of Medical Genetics 16th edition. Elsevier.
8. Wilson GN (2000). Genetics -a short course. Wiley Blackwell
9. Rusko I Downes CS (1994) Genes in Medicine 4th edition. Springer.
10. Singh BD(2011) Biotechnology (Hindi). Kalyani Publishers, India.
11. Singh BD(2020) Biotechnology-Expanding Horizons. Kalyani Publishers, India.

Suggested Links/Websites

- https://www.swayamprabha.gov.in/index.php/higheredu
- https://swayam.gov.in/nc_details/NPTEL
- https://heecontent.upsdc.gov.in/Home.aspx https://ocw.mit.edu/
- https://vidyamitra.inflibnet.ac.in/index.php/uploaded_content
- Further Suggestions: None

Programme/Class: M. Sc.-Biotechnology (II)	**Year: Second** (2)	**Semester:** Third (III)
Course Code: B100906P	**Course Title: PRACTICAL**	
Credits: 4	**Major/Core**	

Topics	**No. of Lectures (Hr)**
GENETIC ENGINEERING LAB 1. Preparation of bacterial growth medium (L.B., 2XYT) 2. Preparation of competent bacterial cell. 3. Transformation of *E. coli* Cells (color selection of transformants – with or without inserts) X – gal and IPTG. Mini plasmid DNA preparation (this DNA can be digested and religated) 4. Concentration estimation by agarose gel electrophoresis. Restriction digestion. **ENVIRONMENTAL BIOTECHNOLOGY LAB** 1. Color determination of water sample by Platinum-Cobalt method. 2. Determination of transparency and turbidity of water sample. 3. Calculation of total solids and total dissolved solids in water sample. 4. Determination of dissolved oxygen (DO) by Winkler's method and free CO_2 in water sample. 5. Determination of BOD and COD of water sample. 6. Determination of microphytes and estimation of chlorophyll a and b in macrophytes. Biomass, moisture, ash and organic matter estimation of macrophytes. 7. Determination of porosity, density and pH and color of the soil sample. Coliform test to check the microbiological quality of water. **BIOSTATISTICS & BIOINFORMATICS LAB** **Bioinformatics** 1. An introduction to Computers, MS-Word, MS Excel, MS Power Point. 2. Sequence information resource: Using NCBI, EMBL, Genbank, Entrez, Swissport/ TrEMBL, UniProt. 3. Similarity searches using tools like BLAST and interpretation of results. 4. Phylogenetic analysis. 5. Use of various primer designing tools. 6. Use of different protein structure prediction databases (PDB, SCOP, CATH etc.). **Biostatistics** 1. Exercise to data entry, edit, copy, move etc. . using MS EXCEL spreadsheet 2. Computations analysis of biological data by Mean, Median, Mode, S.D., Correlation, regression Analysis, Chi square test, Student test, ANOVA 3. Designing of bar diagram, pi chart, histogram, scatter plots, in EXCEL for presentation of data.	120

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4. Measure of skewness and kurtosis 5. Probability **INDUSTRIAL BIOTECHNOLOGY LAB** 1. Isolation and screening of bacteria/fungi & industrial importance (e.g. Protease or amylase) from soil 2. Production and estimation of citric acid. 3. UV survival curve and isolation of mutants. 4. Demonstration of replica plating techniques. 5. Demonstration of surface and submerged fermentations. 6. Study of design and working of a typical fermenter (lab scale) 7. Production of cellulose & ligninase from white rot fungi – *Pleurotus.* 8. Production and assay of alcohol by yeast cells (free immobilized and packed bed bioreactor) **APPLIED MOLECULAR BIOLOGY LAB** 1. Demonstration of PCR and analysis of abnormalities. 2. Native and SDS-PAGE 3. Karyotyping of abnormal individual. 4. G-banding of human chromosomes Fluorescent (Q-banding)	

Programme/Class: M. Sc.-Biotechnology (II)	**Year:** Second (2)	**Semester:** Fourth (IV)
Course Code: B1001001T	**Course Title: BIO-ENTREPRENEURSHIP**	
Credits: 4	**Major Elective Course 1#**	

Course Outcomes (COs)

On completion of this course, students should be able to:

CO 1: Gain entrepreneurial skills, understand the various operations involved in venture creation,

CO 2: Identify scope for entrepreneurship in biosciences and utilize the schemes promoted through knowledge centers and various agencies

CO 3 : The knowledge pertaining to management should also help students to be able to build up a strong network within the industry

Unit	Topics	No. of Lectures (Hr)
I	Introduction and scope in Bio-entrepreneurship, Types of bio-industries and competitive dynamics between the sub-industries of the bio-sector(*e.g.* pharmaceuticals *vs.* Industrial biotech)	12
II	Strategy and operations of bio-sector firms: Factors shaping opportunities for innovation and entrepreneurship in bio-sectors, and the business implications of those opportunities, Alternatives faced by emerging bio-firms and the relevant tools for strategic decision, Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make In India), strategic dimensions of patenting & commercialization strategies.	12
III	Negotiating the road from lab to the market (strategies and processes of negotiation with financiers, government and regulatory authorities), Pricing strategy, Challenges in marketing in bio business (market conditions & segments; developing distribution channels, the nature, analysis and management of customer needs), Basic contract principles, different types of agreement and contract terms typically found in joint venture and development agreements, Dispute resolution skills.	12
IV	Business plan preparation including statutory and legal requirements, Business feasibility study, financial management issues of procurement of capital and management of costs, Collaborations & partnership, Information technology.	12
V	Technology – assessment, development &upgradation, Managing technology transfer, Quality control & transfer of foreign technologies, Knowledge centers and Technology transfer agencies, Understanding of regulatory compliances and procedures (CDSCO, NBA, GCP, GLA, GMP).	12

Suggested Reading

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
3. Onetti, A., &Zucchella, A. Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge. Routledge.
4. Jordan, J. F. (2014). Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press.
5. Desai, V. (2009). The Dynamics of Entrepreneurial Development and Management. New Delhi: Himalaya Pub. House.

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Programme/Class: M. Sc.-Biotechnology (II)	**Year: Second** (2)	**Semester: Fourth** (IV)
Course Code: B1001002T	**Course Title: MEDICAL BIOTECHNOLOGY**	
Credits: 4	**Major Elective Course 2#**	

Course Outcomes (COs)

After completion of this course successfully, the students will be able to:

CO 1: To interpret certain molecular reasons behind the certain hereditary diseases

CO 2: To explain the available molecular, genomic, proteomic and metabolomics diagnostic procedures available for various diseases

CO 3: The vaccines available for different diseases and their method of preparation

CO 4: Able to explain the problems associated with the vaccine development for the infections without vaccines at present

CO 5: This course structure would expose students to gain expertise in the area of translational immunology including diagnosis, vaccinology, biologics which forms the major component of modern medicine and have enormous industrial scope

Unit	Topics	No. of Lectures (Hr)
I	Introduction to Medical Biotechnology: Historical perspective of Medical Biotechnology; Significance, Scope, Rise of diagnostic industry in Indian and global scenario. Nucleic acid based diagnosis: Extraction of Nucleic acids: sample collection, methods of extraction from various diagnostic materials, assessment of quality, storage: Nucleic acid hybridization: Blotting Techniques and their interpretations: Southern and Northern Blotting methods and applications in clinical diagnosis	12
II	Polymerase Chain Reaction: Principle, components, optimization and analysis of PCR products: PCR based methods for mutation detection and gene expression: real Time PCR: Electrophoresis: PAGE and Capillary Electrophoresis: Application of electrophoresis I DNA Diagnosis-SSCP, RFLP and DNA sequencing in the clinical diagnostics.	12
III	Definition and Role of disease biomarkers in Disease diagnosis. Different methods and approaches in the identification of disease markers, predictive value, diagnostic value, emerging blood markers for sepsis, tumour& cancer markers, markers in inflammation and diagnosis of cytoskeletal disorders.	12
IV	Detection of inherited diseases : Exemplified by two inherited diseases for which molecular diagnosis has provided a dramatic improvement of quality of medical care: Fragile X Syndrome: Paradigm of new mutational mechanism of unstable triplet repeats, von-HippelLindau disease: recent acquisition in growing number of familial cancer syndromes	12
V	Success stories in vaccinology *e.g.* Hepatitis, Polio, Small pox, DPT, COVID-19. Drug development and detection; Environmental monitoring; Examples of various diseases (Cancer, HIV/AIDS, Tuberculosis, Malaria, Dengue, Chikungunya).	12

Suggested Reading

1. Glick, B. R., Pasternak, J. J., & Patten, C. L. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA. Washington, DC: ASM Press.

2. Coleman, W. B., &Tsongalis, G. J. (2010). Molecular Diagnostics: for the Clinical Laboratorian. Totowa, NJ: Humana Press.
3. Campbell, A. M., &Heyer, L. J. (2006). Discovering Genomics, Proteomics, and Bioinformatics. San Francisco: Benjamin Cummings.
4. Coleman, W. B., &Tsongalis, G. J. (2007). Molecular Diagnostics: for the Clinical Laboratorian 2nd edition . Totowa, NJ: Humana Totowa Press.
5. Pamela Greenwell, Michelle McCulley, (2008), Molecular Therapeutics: 21st century Medicine, 1st Edition, Springer.
6. Punt J, Stranford SA, Jones PP Owen JA. (2019) Kuby Immunology, 8th Edition. WH Freeman & Co., New York.
7. Delves PJ, Martin SJ, Burton DR, Roitt IM, (2017). Roitt's Essential Immunology 13th edition John Wiley & Sons, Ltd, UK
8. Murphy K, Weaver C, Berg L(2022). Janeway' Immunobiology 10th Edition. W. W. Norton & Company, New York.

Suggested link/Websites

- https://www.youtube.com/watch?v=hYl9xtEUC-o https://www.youtube.com/watch?v=n5m_qOy14VQ
- https://www.youtube.com/watch?v=1Ez-M4_QGjg https://www.youtube.com/watch?v=GEzswmEsuy4
- https://www.youtube.com/watch?v=Wo71e6H2_tI https://www.youtube.com/watch?v=Ek3EBMccyfQ
- https://www.youtube.com/watch?v=KSqS38U4lgg
- https://www.swayamprabha.gov.in/index.php/higheredu https://swayam.gov.in/nc_details/NPTEL
- https://heecontent.upsdc.gov.in/Home.aspx https://ocw.mit.edu/
- https://vidyamitra.inflibnet.ac.in/index.php/uploaded_content

Programme/Class: M. Sc.-Biotechnology (II)	**Year: Second** (2)	**Semester:** Fourth (IV)
Course Code: B1001003T	**Course Title: FOOD BIOTECHNOLOGY**	
Credits: 4	**Major Elective Course 3#**	

Course Outcomes (COs)

After successful completion of this course, students are expected to

CO 1: Under this part of the syllabus will have to learn about the chemistry, water activity and bioavailability of vitamins and minerals

CO 2: Under this it will have to understand about the microbial spoilages of food and factors influencing the spoilage of meat, poultry and Seafood; milk and dairy products; fruits and vegetables etc

CO 3: Will have to learn about the variety of methods used for the preservation (physical, chemical and biological) of the food and food stuffs

CO 4: Will have to understand about the detailed knowledge of fermented foods including dairy, meat, fish, vegetables and fermented beverages

CO 5: Under this it will have to learn about the broader study of probiotics, prebiotics, indicator microorganisms, adulterations and food standards in India

Unit	Topics	No. of Lectures (Hr)
I	Food chemistry- definition, scope and importance; water in food, water activity and shelf life of food; chemistry and stability of water and fat soluble vitamins; minerals and their bioavailability, Food enrichment and fortification.	12
II	Microbial spoilage of food and factors affecting them, Spoilage of various kinds of foods: Meat, Poultry, and Seafood; Milk and Dairy Products; Fruits and Vegetables; Nuts, Seeds, and Cereals. An overview of food borne microorganisms, Food poisoning: Botulinism, Staphylococcal toxicity and Mycotoxins.	12
III	Physical Methods of Food Preservation, Chemical Preservatives and Natural Antimicrobial Compounds, Biological Control of Foodborne Bacteria.	12
IV	Fermented Dairy Products, Fermented Vegetables, Fermented Meat, Poultry, and Fish Products, Cocoa and Coffee, Beer, Wine, Vinegar. Traditional fermented foods of India and other Asian countries - fermented foods based on milk, meat, and vegetables; fermented beverages.	12
V	Probiotics and Prebiotics, Indicator Microorganisms as an indicator of good quality, Food adulteration and prevailing food standards in India (*fssai*, Agmark and BIS), Hazard Analysis and Critical Control Point System.	12

Suggested Reading

1. Food Microbiology Fundamentals and Frontiers by Doyle, MP, Beuchat, LR & Montville, TJ ASM Press
2. Food Microbiology by Adams AR, & Moss MO Third edition, Royal Society of Chemistry publishing .
3. Food Microbiology By Frazier, WC, and Westhoff, DC. Fourth edition, MacGraw Hills publication
4. Plant Pathology by Agrios GN. Fifth edition, Elsevier Academic press.
5. Agriculture Microbiology by Rangaswami, G, and Bagyaraj, DJ, edition 2nd, Prentice Hall of India Pvt. Ltd., New Delhi.
6. 5. Advances in Agriculture Microbiology by SubbaRao, NS, Oxford & IBH Pub.
7. Molecular plant pathology by M. Dickinson, Bios Scientific Publishers, New York.

Programme/Class: M. Sc.-Biotechnology (II)	**Year:** Second (2)	**Semester:** Fourth (IV)
Course Code: B1001004T	**Course Title: INTELLECTUAL PROPERTY RIGHTS, BIOETHICS AND BIOSAFETY**	
Credits: 4	**Major Elective Course 4#**	

Course Outcomes (COs)

On completion of this course, students should be able to:

CO 1: Understand the rationale for and against IPR and especially patents; and patent regulations

CO 2: Understand different types of intellectual property rights in general and protection of products derived from biotechnology research and issues related to application and obtaining patents

CO 3: Gain knowledge of biosafety and risk assessment of products derived from recombinant DNA research and environmental release of genetically modified organisms, national and international regulations

CO 4: Understand ethical aspects related to biological, biomedical, health care and biotechnology research

Unit	Topics	No. of Lectures (Hr)
I	Intellectual Property Rights: Introduction to intellectual property; types of IP: patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications, protection of new GMOs; International framework for the protection of IP; IP as a factor in R&D; IPs of relevance to biotechnology and few case studies; introduction to history of GATT, WTO, WIPO and TRIPS. Basics of patents.	12
II	Basics of patents: types of patents; Indian Patent Act 1970; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT)and implications; procedure for filing a PCT application; role of a Country Patent	12
	Office; filing of a patent application; precautions before patenting-disclosure/non-disclosure - patent application- forms and guidelines including those of National Bio-diversity Authority (NBA) and other regulatory bodies, fee structure, time frames; types of patent applications: provisional and complete specifications; PCT and conventional patent applications; international patenting-requirement, procedures and costs; financial assistance for patenting	
III	Introduction to existing schemes; publication of patents-gazette of India, status in Europe and US; patent infringement- meaning, scope, litigation, case studies and examples; commercialization of patented innovations; licensing – outright sale, licensing, royalty; patenting by research students and scientists-university/organizational rules in India and abroad, collaborative research - backward and forward IP; benefit/credit sharing among parties/community, Commercial (financial) and non-commercial incentives.	12
IV	**Biosafety:** Introduction; historical background; introduction to biological safety cabinets; primary containment for biohazards; biosafety levels; GRAS organisms, biosafety levels of specific microorganisms; recommended biosafety levels for infectious agents and infected animals; definition of GMOs & LMOs	12
V	**Bio-ethics:** Introduction, ethical conflicts in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy, transplantation. Bioethics in research – cloning and stem cell research, Human and animal experimentation, animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk, labeling and public opinion. Sharing benefits and protecting future generations - Protection of environment and biodiversity – biopiracy.	12

Suggested Reading

1. Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy. New Delhi: Tata McGraw-Hill Pub.
2. National IPR Policy, Department of Industrial Policy & Promotion, Ministry of Commerce, GoI
3. Complete Reference to Intellectual Property Rights Laws. (2007). Snow White Publication Oct.
4. Kuhse, H. (2010). Bioethics: an Anthology. Malden, MA: Blackwell.
5. Recombinant DNA Safety Guidelines, 1990 Department of Biotechnology, Ministry of Science and Technology, Govt. of India. Retrieved from http://www.envfor.nic.in/ divisions/csurv/geac/annex-5.pdf
6. Wolt, J. D., Keese, P., Raybould, A., Fitzpatrick, J. W., Burachik, M., Gray, A., Wu, F. (2009). Problem Formulation in the Environmental Risk Assessment for Genetically Modified Plants.

Programme/Class: M. Sc.-Biotechnology (II)	**Year: Second** (2)	**Semester: Fourth** (IV)
Course Code: B1001005T	**Course Title: AGRICULTURAL BIOTECHNOLOGY**	
Credits: 4	**Major Elective Course 5#**	

Course Outcomes (COs)

After successful completion of this course, students are expected to:

CO 1: Understand advantages and limitations of plant breeding selection programmes

CO 2: Understand role of diversity analysis in plants

CO 3: Analyze development of gene based markers

CO 4: Describe the current hypotheses on how plants and microbes interact

CO 5: Formulate scientific questions about how plants and pathogens interact to result in disease or resistance

Unit	Topics	No. of Lectures (Hr)
I	Introduction to geographical diversity, center of origin and diversity of plant species, gene pools (primary, secondary and tertiary); Germplasm characterization using morphological and molecular markers; Diversity analysis - Hierarchical and nonhierarchical cluster analysis, Phylogenetic analysis - maximum parsimony, distance methods, maximum likelihood; algorithms for forming clusters/ dendrograms, clustering softwares (MEGA, Phylip. NTSYS etc.); Molecular markers in Plant variety protection, IPR issues, hybrid purity testing, clonal fidelity testing and transgenic testing	12
II	Introduction to genetic mapping; Construction of genetic linkage maps, Linkage mapping software packages and interfaces; Types of populations - F2 populations, RILs (recombinant inbred lines), Backcross lines, NILS (Near Isogenic Lines), HIF (Heterogeneous Inbred Families), AILs (Advanced Intercross Lines), Biparental mapping vs Multi-parent mapping, NAM (Nested Association mapping), MAGIC (Multi-parent advanced generation inter-cross).	12
III	Linked markers vs gene based markers; Development of gene based markers – SNPs, InDels; Advances in SSR genotyping – capillary system and chip based; DARTseq, SNP genotyping – Real Time PCR based methods, Illumina's Golden Gate Technology, Fluidigm; GBS (genotyping by sequencing).	12
IV	Introduction to molecular-plant microbe interaction. Molecular basis of host-pathogen interactions - pathogen virulence, regulation of infection genetics of virulence - pathogenicity genes in plant pathogens, toxins-mode of action Host plant resistance - vertical and horizontal resistance, non-host resistance-recognition system, elicitors - endogenous and exogenous elicitors, general and race-specific elicitors - chemical nature of elicitors systemic acquired resistance, signal molecules, quorum sensing.	12

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V	Genetics of disease resistance - Gene-for-gene theory, avirulence (avr) genes, characteristics of avrgene - coded proteins, hrpgenes, protein-for-protein, Resistance (R) genes of plants, R-gene expression and transcription profiling, mapping and cloning of resistance genes, structure and classes of resistance genes, genomic organization of resistance genes. Development of disease resistance in plants using genetic engineering approaches; fungal resistance- bacterial resistance- Virus resistance- biosafety issues related to GM crops.	12

Suggested Reading

1. Henry R. J., (2005), Plant Genotyping: the DNA Fingerprinting of Plants. CABI, New Delhi.
2. Patterson, (1998), Molecular Dissection of Complex Traits, CRC Publications, Washington.
3. D.J. Somers, (2009), Plant Genomics – Methods and Protocols, Humana Press, Business Media.
6. C. Kole, A.G. Abott, (2008), Principles and Practices of Plant Genomics, Science Publishers.
7. R.K. Varshney, R. Tuberosa, (2008). Genomics Assisted Crop Improvement, Springer.
8. K. Meksem, G Kahl, (2005). The Handbook of Plant Genome Mapping: Genetic and Physical Mapping, Wiley-Blackwell.
9. Clement, S. L. and Quissenberry, S. S. (1998). Global Plant Genetic Resources for Insect-Resistant Crops. CRC Press, London.
10. Datta, S.K. and Muthukrishnan, S. (1999). Pathogenesis - Related Proteins in Plants, CRC Press, Florida, USA.
11. Goodman, R.N., Kiraly, Z. and Wood, K.R. (1986). The Biochemistry and Physiology of Plant Diseases. University of Missouri Press, Columbia, MO, USA.
12. Gurr, S.J. McPherson, M.J. and Bowles, D.J. (1992). Molecular Plant Pathology: a Practical Approach. Vol. II. IRL Press, Oxford, England.

Programme/Class: M. Sc.-Biotechnology (II)	**Year:** Second(2)	**Semester:** Fourth (IV)
Course Code: B1001006T	**Course Title: SYSTEMS BIOLOGY**	
Credits: 4	**Major Elective Course 6#**	

Course Outcomes (COs)

On successful completion of this course, student will be able:

CO 1: Understand the basic concepts of Graph and networks
CO 2: Understand the basic concepts of systems biology
CO 3: Explain the various types of biological networks and their interaction
CO 4: Explain the various types of biological databases used for molecular interaction network
CO 5: construct and analyze biological networks
CO 6: Simulate the constructed networks and able to explain the output of the network

Unit	Topics	No. of Lectures (Hr)
I	Graph Theory; Euler and Hamiltonian path/circuits; Cliques; bipartite networks; directed and undirected graphs/networks with examples, Models of networks: Random network model, Real-world networks; Scale-free nature of a network; robustness and fragile nature of scale-free network; modularity, heterogeneity and randomness of networks; Characteristics properties of network node, modules, bottlenecks, etc.	12

II	Introduction to Systems Biology, Microarray – definition, Applications of Micro Arrays in systems biology. Self-organizing maps and Connectivity maps - definition and its uses; Types of data used in modeling; Lethality-centrality rule; spatiotemporal aspect; hubs, Dichotomy of hubs: Date and party hubs; local and global hubs and their molecular characteristics;	12
III	Networks and Pathways – Types and methods. Gene networks, Protein-protein interaction networks, metabolic and signalling networks. Host-pathogen interaction networks, bipartite and bridge networks. Disease-disease networks including human-disease network. Comparative analysis of Biological Networks.	12
IV	Different biological databases and their usage- databases STRING, KEGG, DAVID, BioGRID, ArrayExpress, EMP, MetaCyc, AraCycetc; Expression databases and various databases related to systems biology; BioMaze- representing and analyzing biochemical networks;	12
V	Biological network editor tools vizCellDesigner, Newt editor, yED Graph, Hipathia, Metabolizer and workbench interfacing stimulator, Cytoscape and plugins. Multiomics data (Genomics, Transcriptomics, Proteomics and Metabolomics) integration networkviz Mergeomics, OmicsNet, MiBiOmics and PaintOmics, Simulation of Simulation of pathways: Whole cell- Principle and levels of simulation – Virtual Erythrocytes. Pathological analysis. Flux Balance Analysis. Signalling & Experimental methods in systems biology- slow and auto–regulation and identification, data Vs meta data.	12

Suggested Reading

1. Systems Biology: Definitions and perspectives by L.AlberghinaH.V.westerhoff, 2005, Springer.
2. An Introduction to Systems Biology: Design Principles of Biological Circuits by Uri Alon Published byChapman& Hall/CRC Mathematical and Computational Biology
3. Analysis of Biological Networks Edited by Björn H. Junker and Falk Schreiber Published by Wiley.
4. Network Sciences by Albert-LászlóBarabásihttps://barabasi.com/ Published by Cambridge University Press.
5. Choi. S. Introduction to Systems Biology. Humana Press, 2010
6. Metagenomics of the Human Body. Editor: Karen E. Nelson. Publisher: Springer; 1st Edition. Edition (November 17, 2010)
7. Mass Spectrometry: Principles and Applications by Edmond de Hoffmann, Vincent Stroobant. Publisher: Wiley-Interscience; 3 edition (November 20, 2007).
8. Computational systems biology by A.Kriete, R.Eils, 2005, Academic press.
9. Mathematical Modelling in Systems Biology – An Introduction by Brian Ingalls, MIT Press, Cambridge, London 2013 Edition
10. Systems Biology in practice: Concepts, Implementation and applications by E.KlippR.Herwig, A.Kowlad, C.Wierling and H.Lehrach, 2005, Wiley InterScience.
11. Systems Biology and Synthetic Biology by Pengcheng Fu, Sven Panke, 2009, Wiley InterScience.
12. https://epgp.inflibnet.ac.in/Home/ViewSubject?catid=t5vt4STquHRj94mcOBMr5g
13. https://youtu.be/92SSSReMd9M

Programme/Class: M. Sc.-Biotechnology (II)	**Year: Second** (2)	**Semester:** Fourth (IV)
Course Code: B1001007T	**Course Title: BIOPROCESS ENGINEERING**	
Credits: 4	**Major Elective Course 7#**	

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Course Outcomes (COs)

On successful completion of this course, student will be able:

CO 1: Discuss the industrial important microorganisms and their growth conditions as well as applications

CO 2: Develop and design new bioreactors and methods to isolate and characterize the processed products

CO 3: Explain the differences between the batch Vs continuous bioreactors, advantages and disadvantages in using them

CO 4: Explain the bacterial strain improvement towards usage for different industrial purposes

CO 5: Implement the experimental procedures for the expression and purification of certain biomolecules at the bulk level

Unit	Topics	No. of Lectures (Hr)
I	Isolation, screening and maintenance of industrially important microbes; microbial Growth and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms); unstructured models of microbial growth; structured models of microbial growth; strain improvement for increased yield and other desirable characteristics. Growth kinetics of batch, fed-batch, plug flow and continuous culture, High cell density cultures; Types of fermentation depending upon the product formation, Product synthesis kinetics, Growth and non-growth associated product synthesis.	12
II	Bioreactor design and analysis; Batch and continuous fermenters; modifying batch and continuous reactors: chemostat with recycle, multistage chemostat systems, fed-batch operations; conventional fermentation v/s biotransformation; immobilized cell systems; large scale animal and plant cell cultivation; fermentation economics; upstream processing: media formulation and optimization; sterilization; aeration, agitation and heat transfer in bioprocess; scale up and scale down; measurement and control of bioprocess parameters.	12
III	Kinetics and Engineering of Sterilization: Kinetics of media sterilization, design of batch sterilization process, D-time, Z-value and F-value, calculation of Del-factor and holding time, Richards rapid method for design of sterilization cycles, Design of continuous sterilization, Air sterilization-design of air filters, Effect of air velocity and bed depth on filtration.	12
IV	Mass Transfer and Downstream Processing: Fluids and its properties, Non-Newtonian fluids, introduction to transport phenomena, Gas–liquid mass transfer, mass transfer resistances, and determination of oxygen transfer coefficient;	12
V	Recovery and purification of products from fermentation broth, Main Unit Operations in downstream processing, Membrane separation (microfiltration and ultrafiltration), Disruption of microbial cells.	12

Suggested Reading

1. Shuler, M. L., & Kargi, F. (2002). Bioprocess Engineering: Basic Concepts. Upper Saddle River, NJ: Prentice Hall.
2. Stanbury, P. F., & Whitaker, A. (2010). Principles of Fermentation Technology. Oxford: Pergamon Press.

3. Blanch, H. W., & Clark, D. S. (1997). Biochemical Engineering. New York: M. Dekker.
4. Bailey, J. E., & Ollis, D. F. (1986). Biochemical Engineering Fundamentals. New York: McGraw-Hill.
5. Biochemical Engineering: Aiba and Hemphery
6. Principles of Microbes and Cell Cultivation: S. John Pirt
7. Bioprocess Engineering Principles: Pauline M. Dora
8. Principles of fermentation technology: P.F. Stanbury and A. Whitekar

Programme/Class: M. Sc.-Biotechnology (II)	**Year: Second** (2)	**Semester: Fourth** (IV)
Course Code: B10010008T	**Course Title: NANOBIOTECHNOLOGY**	
Credits: 4	**Major Elective Course 8#**	

Course Outcomes (COs)

After completion of the course the students will be able to:

CO 1: Understand a broad outline of Nanoscience and Nanotechnology
CO 2: Understand the basics of Nanobiotechnology
CO 3: Explain the interaction between biomolecules and nanoparticle surface and its applications
CO 4: Optimize the synthesis of Biocompatibility of Nanomaterials
CO 5: Identify the risk assessments involved bionanomaterials

Unit	Topics	No. of Lectures (Hr)
I	Introduction to Nanobiotechnology; Concepts, historical perspective; Different formats of nanomaterials and applications;	12
II	Cellular Nanostructures; Bio-inspired Nanostructures, Synthesis and Characterization of different nanomaterials.	12
III	Nanoparticles, different types of nanoparticles, nanoparticles for drug delivery, concepts, optimization of nanoparticle properties for suitability of administration through various routes of delivery, advantages, strategies for cellular internalization and circulation, strategies for enhanced permeation through various anatomical barriers.	12
IV	Nanoparticles for diagnostics and imaging (theranostics); concepts of smart stimuli responsive nanoparticles, implications in cancer therapy, Nanodevices for biosensor development.	12
V	Introduction to Safety of nanomaterials, Basics of nanotoxicity, Models and assays for Nanotoxicity assessment; Fate of nanomaterials in different stratas of environment; Ecotoxicity models and assays; Life Cycle Assessment, Containment.	12

27/7/24.

Suggested Reading

1. Jain K.K, Nanobiotechnology in Molecular Diagnostics – Current Techniques and Applications, Taylor and Francis Publications 2006.
2. Nanobiotechnology: Concepts, Applications and Perspectives (2004), Christof M.Niemeyer (Editor), Chad A. Mirkin (Editor), Wiley VCH.
3. Nanobiotechnology - II more concepts and applications. (2007) - Chad A Mirkin and Christof M. Niemeyer (Eds), Wiley VCH.
4. Nanotechnology in Biology and Medicine: Methods, Devices, and Applications.

Suggested Links/Websites

- https://www.swayamprabha.gov.in/index.php/higheredu https://swayam.gov.in/nc_details/NPTEL
- https://heecontent.upsdc.gov.in/Home.aspx
- https://ocw.mit.edu/ https://vidyamitra.inflibnet.ac.in/index.php/uploaded_content

Programme/Class: M. Sc.-Biotechnology (II)	**Year:** Second (2)	**Semester:** Fourth (IV)
Course Code: B10010009P	**Course Title: PRACTICAL**	
Credits: 4	**Major/Core**	

Topics	**No. of Lectures**
BIOENTREPRENEURSHIP LAB 1. Role-Play — Businesses Around Me 2. Role-play — Qualities of Entrepreneur 3. Outdoor Interaction: Interviewing Employees and Entrepreneurs 4. Pair-work—Identifying and Solving Problems 5. Group Activity: Ideas 6. Outdoor Interviews and Presentation: Real Customer Survey 7. Group Exercise: Business Plan Pitching **MEDICAL BIOTECHNOLOGY LAB** 1. PCR and ELISA based detection of plant diseases 2. Detection of genetic mutation using PCR 3. Metabolite profile for biomarker detection in body fluids/tissues under various metabolic disorders by making use of any biochemical methods. 4. Lecture-demonstration of success stories of vaccines. 5. Lecture-demonstration of any two inherited diseases for which molecular diagnosis has provided a dramatic improvement of quality of medical care: take through web-tutorial using online content. **FOOD BIOTECHNOLOGY LAB** 1. Fruit Processing : fruit squash 2. Fruit processing: jelly, jam, marmalade 3. Vegetable processing: pickles, juices, dehydrated vegetables 4. Analysis of milk (liquid) 5. Analysis of wheat flour 6. Analysis of tea 7. Detection of Food adulteration **INTELLECTUAL PROPERTY RIGHTS, BIOETHICS AND BIOSAFETY LAB** 1. The designing and use of the Bioethics Consultation Form	120

2. Handling of biological safety cabinets; primary containment for biohazards 3. Filling of Patents(Demo) 4. Group Activity: Ideas, discussion about national international patenting-requirement, procedures Case Studies of patents, trademarks, copyright **AGRICULTURAL BIOTECHNOLOGY** 1. Genome databases – rice; Retrieving marker information 2. Molecular markers - Germplasm characterization using molecular markers 3. Mapping populations - Linkage map construction - QTL mapping 4. Principle of Association mapping – GWAS **SYSTEMS BIOLOGY LAB** 1. Handling different biological databases: KEGG, BioGRID, ArrayExpress 2. Functional enrichment analysis of interested gene list through DAVID 3. Protein-protein interaction network construction using STRING database 4. Analysis and visualization of biological networks using Cytoscape 5. Extracting disease-associated genes and variants through DisGeNET **BIOPROCESS ENGINEERING LAB** 1. Isolation and characterization of industrially important microorganisms for 2. (Organic acid /antibiotic / enzymes / amino acid) 3. Improvement of strain of isolated industrially important microorganism for increase yield by mutation. 4. Laboratory scale media optimization, production and extraction of the following: Organic acid / Antibiotic / Enzyme / Wine / Biosurfactant / Polysaccharide 5. Cell disruption for intracellular enzymes by various extraction methods. 6. Enzymatic clarification of fruit juices. 7. Culturing of Chlorella / Spirulina 8. Liquefaction and saccharification of corn or molasses. 9. Biomedical applications of microbial products 10. Microbial enhanced oil recovery. **NANOBIOTECHNOLOGY LAB** 1. Synthesis of biodegradable micelles and inverse micelles. 2. Synthesis of metal nanoparticles by chemical route or by biogenic methods. 3. Synthesis and characterization of polymeric nanoparticles. 4. Synthesis and characterization of lipid-based nanoparticles. 5. Optical properties of metal nanoparticles by using UV-Vis spectroscopy. 6. Demonstration and Image processing of EM micrograph.	

Programme/Class: M. Sc.-Biotechnology (II)	**Year:** Second (2)	**Semester:** Fourth (IV)
Course Code: B1001010R	**Course Title: INDUSTRIAL TRAINING/SURVEYS/RESEARCH PROJECT**	
This research project can be interdisciplinary / multi-disciplinary. This research project can also be in the form of industrial training / internship / survey work etc.		
Credits: 4	**Major/Core (Project)**	