V.B.S. 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

V.B.S. PURVANCHAL UNIVERSITY, JAUNPUR

Ordinance governing two-year (four semesters) postgraduate degree program

M. Sc. in Biotechnology (Faculty of Sciences)

Under Choice Based Credit System (CBCS)

w.e.f. 2022-23 (Session)

The following ordinances have been framed governing the admission, course structure, examination and other allied matters relating to the two-year (four semesters) postgraduate degree programme (M.Sc.) in Biotechnology being offered by V.B.S. Purvanchal University.

A. ADMISSION AND EXIT

1. All matters relating to admission to this course shall be dealt with by the Admission Committee constituted for the purpose by the University.
2. The M.Sc. Biotechnology course is open to science graduates (with 3 year undergraduate degree of new or old system) with minimum of 50% of marks, from a recognized University (45% in case of SC/ST). Those who are appearing in final examination of B.Sc. (Biology/Life Sciences/BVSc & AH/MBBS/B.Pharm/Mathematics and related subjects) degree 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 VBS Purvanchal University can be given provisional admission by the Admission Committee in case of delayed results.
3. Admission in M.Sc. Biotechnology course will be based on the entrance test or merit as per the rules of the university.
4. The intake of students in this programme shall be fixed by V.B.S. Purvanchal University. The admission to M.Sc. courses shall be made through a merit based on Written Test conducted by VBS Purvanchal University Combined Admission Test (PUCAT). The reservation norms for admission shall be guided by State Government/ University notification issued from time to time.
5. On selection the candidates shall deposit the fees prescribed for the purpose to get his/her admission confirmed within the time period fixed by the Admission Committee of the Department. If a candidate fails to do so his/her admission shall be automatically cancelled and the seat falling vacant shall be offered to other candidates as per the merit/category. However, matter concerning fees of candidates under SC/ST category would be governed by Govt. Order; as such there is no provision of fee concession/exemption/refund.
6. Admission to M.Sc. course cannot be claimed by any candidate as a matter of right. The Admission Committee shall have power to refuse, reject or cancel any admission if it possesses sufficient reasons to do so.
7. **Student Mentor:** Every student will have a member of faculty of the Department as his/her student advisor. All teachers of the department shall function as Student Mentor (Advisors). The Student Advisor will advise the students in choosing Elective courses and offer all possible student support services

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B. COURSES OF STUDY AND EXAMINATION

1. Postgraduate program (M. Sc. Biotechnology) will be conducted in CBCS (Choice Based Credit System) and semester system
2. There will be 4(four) theory papers of main subject and 1 (one) practical paper (all four credits) in one semester, thus in a semester there will be 20 credits of papers of main subject. 40(forty) in 1(one) year that would be 80(eighty) credits in 2(two) years
3. All four theory papers are compulsory in the first semester.
4. In the second and third semester, the student can choose one paper based on the optional paper (specialization)/elective, according to his interest and on the basis of the resources available in the university /college.
5. All the papers in the fourth semester are optional papers based on specialization from which the student can choose any four theory papers as per his/her interest.
6. In the first year of post-graduation, the student will have to take only 1 minor elective paper from any other faculty (a subject other than the main subject). This paper will be of 4 (four) credits
7. To conduct the M.Sc. (Biotechnology) programme systematically and within a time bound frame, the concerned Department shall draw up an "Academic Calendar" in the beginning of academic session.
8. A candidate admitted to the M.Sc. course shall pursue a regular course of study in all the four semesters of the course and attend a minimum of 75% of the classes held to be eligible to appear in the semester examinations.
9. If a student fails to attend requisite classes in a semester due to illness, he/she may be given relaxation of 15% attendance (10% at the level of Vice-Chancellor and 5% at the level of Head of Department on production of medical certificate.
10. Semester examinations of the M.Sc. course shall be conducted by way of theory papers, practical and industrial training/surveys/research project. Each theory core and elective paper will be of 100 marks out of which 75 marks shall be allocated for semester examination and 25 marks for internal assessment. The pattern of question papers for theory examinations will be as per the University rules
11. Internal assessment is an integral part of the course and is compulsory for all students. Academic performance of students is evaluated by Continuous Internal Assessment (CIA) that includes day to day performance, attendance, home Assignment periodic tests, seminar presentation; subject's quizzes class discussion, etc.
12. The responsibility of evaluating the internal assessment is vested on the teacher(s) who teaches the course.
13. One practical (4 credits) examination shall be conducted which will be assessed jointly by the teachers of the department and the external examiner nominated by the university at the end of each semester out of 100 marks.
14. Ordinarily, the semester examinations shall be held in December and May.
15. Research Project in Post Graduate Program: In the first and second year of post-graduation, the student will have to do a major research project.
16. This research project can also be interdisciplinary / multi-disciplinary. This research

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project can also be in the form of industrial training / internship / survey work etc.

17. The research project will be done under the guidance of a teacher supervisor; co-supervisor can be taken from any industry/company/technical institute/research institute.

18. Undergraduate (including research) and postgraduate students will be required to undertake a research project of four credits (4 hours per week) in each semester.

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 jointly by the supervisor and the external examiner nominated by the university at the end of the year out of 100* marks. Thus there will be a total of 8 credits of this exam. The students have to submit a project report/dissertation/technical report in bound form duly certified by the supervisor. The evaluation of the project/dissertation/technical will be done through presentation and viva voce examination of the student.

20. If a student publishes any of his research papers in this research project in the UGC-CARE listed Journal and published during the program, then he can be given additional marks up to 25 in the evaluation of the research project (out of 100). The maximum received will be 100.

21. Most of the grades will be marked on the marks obtained in the research project and they will also be included in the calculation of CGPA.

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

23. If a student qualifies for the examination on the basis of attendance in the class, but is not able to give the examination due to any reason, then he/she can appear for the qualifying examination in the next time, he will not need to take classes again.

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.

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 Purvanchal University.

26. Papers for theory examination in sealed covers shall be handed over/sent by registered post to the Registrar/Controller of Examination by the Examiners. Controller of Examinations/Technical Cell will ensure the printing of papers and fair conduct of the examinations.

27. The question papers shall be moderated before examination by a committee consisting of the Head and two senior most teachers of the department and the teacher of concerned paper. The Center Superintendent shall ensure implementation of this provision.

28. 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.

29. Practical examinations of semester I, II, III and IV shall be conducted by one internal and one external examiner. Similarly, in the Second and fourth semester project/dissertation/technical report and presentation carrying 100 marks shall also be

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evaluated jointly by external as well as internal examiner(s)..

30. For appearing in semester examinations each student shall have to deposit a prescribed examination fee along with a duly filled examination application form; separate fees will also be charged for back and improvement papers. For SC/ST candidate relaxation in examination fees applicable as per Govt. Order. He/she has been a student of good conduct.

31. The students of M.Sc. course shall be examined in the subjects in accordance with course curriculum given at the end of ordinance.

C. RESULTS, PROMOTION AND IMPROVEMENT

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 (including 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.

2. The results of M. Sc. 1st, 2nd and 3rd semester examination shall be declared as pass who scores at least 36% of marks in each paper separately and 40% in aggregate. About 50% of the paper setting would be internal.

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 additional.

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.

5. In order to pass the 2-year M.Sc. (Biotechnology) course, 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 in the following categories. If a student has secured pass marks in aggregate in a semester but has failed in a maximum of two papers a provision is made to grant him a maximum of 3 grace marks.

Passed	:	**40% and above**
Second Division	:	**45% and above but less than 60%**
First Division	:	**60% and above**

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

7. Conversion of Marks into Grades: As per University rules

8. Grade Points: Grade points shall be determined as per the Grade point table as per University Examination rule.

9. CGPA Calculation: As per University Examination rule.

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V.B.S. PURVANCHAL UNIVERSITY, JAUNPUR 222003
Syllabus
Master of Science in Biotechnology (M. Sc. Biotechnology)
Designed as per Syllabus Development Guidelines of
National Education Policy-2020 (NEP-2020)

Year	Semester	Paper Code	Paper Title	Theory/ Practical	Credits
M.Sc. I	I	B100701T	Cell Biology	Theory	4
		B100702T	Genetics	Theory	4
		B100703T	Biochemistry	Theory	4
		B100704T	Biophysics	Theory	4
			Minor (Other Faculty)	Theory*	4
		B100705P	Practical	Practical	4
		B100706R	Industrial Training/Surveys/Research Project	Industrial Training/Surveys/ Research Project	4
					28
M.Sc. I	II				
Core Courses					
		B100807T	Molecular Biology	Theory	4
		B100808T	Microbiology	Theory	4
		B100809T	Recombinant DNA Technology	Theory	4
Elective Courses					
		B100810T	Animal Biotechnology	Theory	4
		B100811T	Plant Biotechnology	Theory	4
Core Courses					
		B100812P	Practical	Practical	4
		B100813R	Industrial Training/Surveys/Research Project	Industrial Training/Surveys/ Research Project	4
					24
* Student must opt for any One of the 2 elective courses					
M. Sc. II	III				
Core Courses					
		B100914T	Immunology	Theory	4
		B100915T	Applied Molecular Biology	Theory	4
		B100916T	Bioinformatics and Biostatistics	Theory	4
Elective Courses					
		B100917T	Industrial Biotechnology	Theory	4
		B100918T	Environmental Biotechnology	Theory	4
Core Courses					
		B100919P	Practical	Practical	4
		B100920R	Industrial Training /Surveys/Research Project	Industrial Training/Surveys/Research	4

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				Project	
					24
Student must opt for any One of the 2 elective courses					
M.Sc. II	**IV**				
Elective Courses					
		B1001021T	Bioentrepreneurship	Theory	4
		B1001022T	Enzymology	Theory	4
		B1001023T	Food Biotechnology	Theory	4
		B1001024T	Intellectual Property Rights, Biosafety and Bioethics	Theory	4
		B1001025T	Microbial Technology	Theory	4
		B1001026T	Molecular Diagnostics	Theory	4
		B1001027T	Molecular Human Genetics	Theory	4
		B1001028T	Nanobiotechnology	Theory	4
Core Course					
		B1001029P	Practical	Practical	4
		B1001030R	Industrial Training /Surveys/Research Project	Industrial Training/Surveys/Research Project	4
					24
Student must opt for any four of the 8 elective courses					
					100

Note: 1. Up to first three semesters the marks allocated for continuous internal assessment (25 marks) will be evaluated on the basis of class attendance and a seminar. The seminar will be an integral part of the sessional and will be evaluated by all the faculty members of the department.
2. The detailed syllabus is given in the following pages. The numbers given in front of each topic/group of topics represent the number of periods (60 minutes each) allocated for teaching that topic(s).

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PROGRAM OUTCOMES (POs)

The program outcomes that a student should be able to demonstrate on completion of a post degree level program 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: Postgraduate students will be able to demonstrate and apply their knowledge of cell biology, biochemistry, molecular biology, Recombinant DNA Technology, Nanobiotechnology to solve the problems related to the field of biotechnology.

PO 2: Design and conduct experiments, as well as to analyze and interpret scientific data and able to carry out independent as well as collaborative research in specialized areas of Biotechnology

PO 3: Develop skills to use modern analytical tools/ software/ equipment and analyse and solve problems in various fields of biotechnology.

PO 4: Write and present technical report, projects in the field of Biotechnology and also understand the importance of professional ethics. Students will be able to understand the issue of plagiarism in research hand importance of copyrights. Students will also gain knowledge about various ethical issues associated with biotechnology.

PO 5: Design and develop sustainable solutions to major biological problems by applying appropriate biotechnology tools., in addition students will be able to implement the scientific skills for development of entrepreneurship

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

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 their knowledge of cell biology, genetics, molecular biology and genetic engineering to solve the problems related to the field of biotechnology

PSO2: gain knowledge about the application of various types of microscope, karyotyping, banding techniques, chromosome painting and FACS.

PSO3: understand the basic concepts of genetics and molecular biology such as inheritance pattern, DNA replication, transcription and translation

PSO4: understand and perform various recent molecular and recombinant DNA technology techniques in early diagnosis and prognosis of human diseases.

PSO5: perform experiments of DNA isolation, agarose gel electrophoresis, gene cloning, transformations, protein expression and purification. This experience would enable them to begin a career in industry that engages in genetic engineering as well as in research laboratories conducting fundamental research.

PSO6: apply at technical positions in different research laboratories, diagnostic centers and industries.

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M. Sc. Biotechnology

After completing the two years degree course in M. Sc. Biotechnology, the students will be able to –

PSO1: demonstrate the concepts in computational Biology. Understand the interrelationship between Biology and Computer

PSO2: acquire knowledge in different domains of biotechnology enabling their application in industry, research and academia.

PSO3: perform and analyse the results of experiments using basic laboratory techniques of cell biology, molecular biology, genetic engineering, biochemistry, immunology, microbiology, bioinformatics, biostatistics, animal and plant biotechnology and Food biotechnology.

PSO4: recognize the foundations of modern biotechnology and explain the principles that form the basis for recombinant technology.

PSO5: develop an ability to properly understand the technical aspects of existing technologies that help in addressing the biological and medical challenges faced by humankind.

PSO 6 : exhibit ability to do research independently as well as in collaboration

PSO 7 : recognize the importance of Bioethics, IPR, and entrepreneurship.

Programme/Class: Bachelor's Degree with Research M. Sc. Biotechnology (I)	Year: First (I)	Semester: First (I)

Subject: Biotechnology

Course Code: B1007011	Course Title: CELL BIOLOGY

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.

Credits: 4	Core Compulsory
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
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:** John wiley& 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.
10. कोशिका विज्ञान एवम अनुवांशिकी, पी के गुप्ता, रस्तोगी पब्लिकेशन्स
11. आधुनिक कोशिका विज्ञान, गायत्री स्वरकार ऐवम के सी सोनी

Suggested link

- https://ocw.mit.edu/courses/find-by-topic/#cat=science&subcat=biology&spec=cellbiology
- https://ocw.mit.edu/courses/find-by-topic/#cat=science&subcat=biology&spec=genetics
- https://nptel.ac.in/courses/102/103/102103012/
- https://nptel.ac.in/courses/102/106/102106025/
- https://nptel.ac.in/courses/102/103/102103015/

Suggested Digital platform/Web link

Suggested Continuous Internal Evaluation (CIE) methods

Continuous Internal Evaluation shall be based on Class test, presentation along with assignment and class interactions. Marks shall be as follows

Total marks: 25

10 marks for Test

10 marks for presentation along with assignment

05 marks for Class interactions

Programme/Class: Bachelor's Degree with Research / M. Sc. Biotechnology (I)	**Year:** First (I)	**Semester:** First (I)
Subject: Biotechnology		
Couse Code: B100702T	**Course Title: GENETICS**	

Course Outcomes (COs)

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

1. Describe fundamental molecular principles of genetics;
2. Describe the basics of genetic mapping;
3. Understand how gene expression is regulated.

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4. Three fundamental aspects in biological phenomenon: a) what to seek; b) how to seek; c) why to seek?

Credits: 4	**Core Compulsory**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Recapitulation of Mendel's Laws of inheritance and gene interaction,Linkage, crossing–over (molecular mechanisms of genetic recombination in pro-and eukaryotes) and gene mapping, Transposable elements. Mutations: types, mechanisms, mapping, mutagens, Ames test for mutagens. Genetic Code: deciphering genetic code; degeneracy, unusual codons in mitochondria and prokaryotes.	12
II	Concept of a gene in pre-DNA era; mapping of genes in bacterial and phage chromosomes by classical genetic crosses; fine structure analysis of a gene; genetic complementation and other genetic crosses using phenotypic markers; phenotype to genotype connectivity prior to DNA-based understanding of gene.	12
III	Meiotic crosses, tetrad analyses, non-Mendelian and Mendelian ratios, gene conversion, models of genetic recombination, yeast mating type switch; dominant and recessive genes/mutations, suppressor or modifier screens, complementation groups, transposon mutagenesis, synthetic lethality, genetic epistasis.	12
IV	Monohybrid &dihybrid crosses, back-crosses, test-crosses, analyses of autosomal and sex linkages, screening of mutations based on phenotypes and mapping the same, hypomorphy, genetic mosaics, genetic epistasis in context of developmental mechanism.	12
V	Introduction to the elements of population genetics: genetic variation, genetic drift, neutral evolution; mutation selection, balancing selection, Fishers theorem, Hardy-Weinberg equilibrium, linkage disequilibrium; in-breeding depression & mating systems; population bottlenecks, migrations, Bayesian statistics; adaptive landscape, spatial variation & 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.

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8. Genetics: Principles and Analysis – Hartl and Jones.
9. Principles of Genetics – Gardner et al.
10. Principles of Genetics – Snustand et al.

Suggested Continuous Internal Evaluation (CIE) methods

Continuous Internal Evaluation shall be based on Class test, presentation along with assignment and class interactions. Marks shall be as follows
Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: Bachelor's Degree with Research / M. Sc. Biotechnology (I)	**Year:** First (1)	**Semester:** First (I)
Subject: Biotechnology		
Couse Code: B100703T	**Course Title: BIOCHEMISTRY**	

Course Outcomes (COs)

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, 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.

Credits: 4	**Core Compulsory**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
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,	12

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	secondary pathways of glucose oxidation Pentose phosphate pathway (Non-oxidative & Oxidative) reaction. Glucuronic acid pathway & TCA. Glyoxylate cycle, regulation of carbohydrates metabolism.	
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.
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.)

Suggested Continuous Internal Evaluation (CIE) methods

Continuous Internal Evaluation shall be based on Class test, presentation along with assignment and class interactions. Marks shall be as follows

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: Bachelor's Degree with Research / M. Sc. Biotechnology (I)	**Year:** First (I)	**Semester:** First (I)

Subject: Biotechnology

Couse Code: B100704T	**Course Title: BIOPHYSICS**

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.

Credits: 4	**Core Compulsory**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
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

Suggested Reading

1. Biophysical Chemistry vol. I, II & III (1997) Cantor and Schimmel**Pub**: W.H. Freeman & Com.
2. 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
3. Biochemistry – G. Zubay., **Pub**: Wm. C. Brown Pub
4. Biochemistry – D. Voet and J.G. Voet**Pub:** John Willy & Sons.
5. Physical Biochemistry D. Friefelder**Pub:** W.H. Freeman & Com.
6. Biochemistry – LubertStryer. **Pub:** W.H. Freeman & Com., NY.
7. Principles of Biochemistry –Lehninger, Nelson & Cox. **Pub**: Macmillan Pub.

8. 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.
9. Practical Biochemistry–K.Wilson&J.Walker.**Pub**:CambridgeUniv.Press, (U.K.)
10. Practical Biochemistry – David Plummer. **Pub**: Tata McGraw Hill

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/

Suggested Continuous Internal Evaluation (CIE) methods

Continuous Internal Evaluation shall be based on Class test, presentation along with assignment and class interactions. Marks shall be as follows.

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: Bachelor's Degree with Research / M. Sc. Biotechnology (I)	**Year:** First (I)	**Semester:** First (I)

Subject: Biotechnology

Couse 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)**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Suggested Continuous Internal Evaluation (CIE) methods
Continuous Internal Evaluation shall be based on Class test, presentation along with assignment and class interactions. Marks shall be as follows
Total marks: 25
10 marks for Test
10 marks for presentation along with assignment

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05 marks for Class interactions		
Programme/Class: Bachelor's Degree with Research / M. Sc. Biotechnology (I)	**Year:** First (I)	**Semester:** First (I)
Subject: Biotechnology		
Couse Code: B100705P	**Course Title: Practical**	
Credits: 4	**Core Compulsory**	
Maximum Marks: 100	**Minimum Passing Marks:** As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-8		

Topics	No. of Lectures
CELL BIOLOGY LAB 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** 1. Study of mitosis (smear and squash method, root tip of onion). 2. Study of meiosis (pollen grain), Maize, Rat testis. 3. Genetics problems: (i) Mendel's law (ii) Gene mapping (iii) Transposable elements. 4. Ames test for mutagenesis. 5. Genetic experiment – Drosophila model **BIOCHEMISTRY LAB** 1. Determination of pK_a value of a weak acid by titrating with strong base. 2. Estimation of DNA by Diphenylamine and RNA by Orcinol methods. 3. Estimation of reducing and total sugar by DNS and H_2SO_4-phenol methods. 4. Determination of R_f values of amino acids by TLC using ninhydrin. 5. Enzyme production and its activity measurement. 6. Effect of pH and temperature on enzyme activity. 7. Titration of ascorbic acids using 2, 6 dichloropheno-endophenol dye. 8. Determination of acid value of fats. **BIOPHYSICS LAB**	120

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1. Introduction to Biotechnology laboratory, Instruments, and general laboratory safety rules. 2. Pipetting Techniques, Calculations/Dilutions/ Conversion/ Solutions. 3. Introduction to Basic principles and handling of: Balances 4. Introduction to Basic principles and handling of pH meter 5. Introduction to Basic principles and handling of Centrifuges 6. Introduction to Basic principles and handling of Colorimeter 7. 8. Introduction to Basic principles and handling of Spectrophotometer 9. Estimation of Protein by UV-Vis Spectrometer 10. Lowry et al. method for estimation of protein (ii)Biuret method for estimation of protein 11. Estimation of DNA by spectrophotometer 12. 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:** First (I)
Subject: Biotechnology		
Couse Code: B100706R	**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	**Core Compulsory**	
Maximum Marks: 100*	**Minimum Passing Marks:** As per University norms	
*** 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 jointly by the supervisor and the external examiner nominated by the university at the end of the year out of 100* marks**		
Programme/Class: Bachelor's Degree with Research / M. Sc. Biotechnology (I)	**Year:** First (1)	**Semester: Second (II)**
Subject: Biotechnology		
Couse Code: B100807T	**Course Title: MOLECULAR BIOLOGY**	
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		

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CO 3 Post translation and transcriptional mechanism
CO4 Gene expression in prokaryotes using Lap operon and in Eukaryotes by Trp operon
CO5 Cell cycle and its regulation

Credits: 4	**Core Compulsory**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
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. 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.

Suggested Continuous Internal Evaluation (CIE) methods

Continuous Internal Evaluation shall be based on Class test, presentation along with assignment and class interactions. Marks shall be as follows

Total marks: 25

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10 marks for Test 10 marks for presentation along with assignment 05 marks for Class interactions		
Programme/Class: Bachelor's Degree with Research / M. Sc. Biotechnology (I)	**Year:** First (I)	**Semester:** Second (II)
Subject: Biotechnology		
Couse Code: B100808T	**Course Title: MICROBIOLOGY**	
Course Outcomes (COs)		
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.		
Credits: 4	**Core Compulsory**	
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0		

Unit	Topics	No. of Lectures
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	12

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	protozoa; extremophiles and unculturable microbes.	
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.

Suggested Continuous Internal Evaluation (CIE) methods

Continuous Internal Evaluation shall be based on Class test, presentation along with assignment and class interactions. Marks shall be as follows

Total marks: 25

10 marks for Test

10 marks for presentation along with assignment

05 marks for Class interactions

Programme/Class: Bachelor's Degree with Research / M. Sc. Biotechnology (I)	**Year:** First (I)	**Semester:**Second (II)

Subject: Biotechnology

Couse Code: B100809T	**Course Title: RECOMBINANT DNA TECHNOLOGY**

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: Understandmethods 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: Uunderstanding the techniques for DNA- protein and protein- protein interaction and application of Recombinant DNA techniques in different fields of Biotechnology

Credits: 4	**Core Compulsory**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

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Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0		
Unit	**Topics**	**No. of Lectures**
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: Immunocoprecipitation, Yeast Two-Hybrid System; DNA-Protein interaction: Gel Shift Assay, Foot-printing.	12

Suggested Reading

1. DNA Science: A first course in Recombinant DNA Technology – David-A. Micklos&Creg. A. Freyer. **Pub:** Cold Spring harbor laboratory press, NY
2. DNA Cloning: a Practical Approach, D.M. Glover and B.D. Hames, **Pub:** IRL Press, Oxford.
3. Molecular Cloning: A laboratory Manual Vol. 1-3, - J. Sambrook&Russel. **Pub:** Cold Spring Harbor Laboratory Press, NY.
4. Molecular Biotechnology,– S.B. Primrose, **Pub:** Blackwell Scientific Publishers, Oxford
5. Principals of Gene Manipulation – S. Primrose, R. Twyman& Bob Old **Pub:** Blackwell Scientific Publishers, Oxford
6. Essential Molecular Biology: A practical Approach, Vol. 1,2 – T.A. Brown.
7. Gene Cloning: An Introduction – T.A. Brown. John Wiley & Sons, Ltd

Other ccourse books published in Hindi must be prescribed by the University/College

Suggested link

https://youtu.be/Yh9w_fyvpUk
https://youtu.be/fTFoqDn5E1w
https://youtu.be/HmzyI73ZW0U
https://youtu.be/LB99cFUl18U
https://youtu.be/EtgdrrI-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

Suggested Continuous Internal Evaluation (CIE) methods

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Continuous Internal Evaluation shall be based on Class test, presentation along with assignment and class interactions. Marks shall be as follows.
Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme Class: Bachelor's Degree with Research / M. Sc. Biotechnology (I)	**Year:** First (I)	**Semester:** Second (II)

Subject: Biotechnology

Couse Code: B100810T	**Course Title: Animal Biotechnology**

Course Outcomes (COs)

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

CO 1 Get proper knowledge about the history and Scope of Animal Tissue Culture, Culture Media, Simulating natural conditions for growth of animal cells.
CO 2 characterization of cultured cells
CO3 learn about transfection of animal cell lines, Selectable makers
CO 4 Commercial applications of cell culture
CO 5 Animal improvement techniques

Credits: 4	**Elective**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Equipment and materials for animal cell culture technology Physiochemical properties of media, balanced salt solution, complete media and serum. Serum free media. Sterile handlingarea. Sterilization of different materials used in animal cell culture.Aseptic concepts.	12
II	Biology and characterization of cultured cells Basic techniques of mammalian cell culture invitro; disaggregation of the tissue primary culture, cell separation.-5 Cell lines (finite and continuous) selection and routine maintenanceCell cloning, selection and quantitation. Measurement of viability and cytotoxicity. Cryopreservation and germplasm conservation	12
III	Manipulation of cells- cell transfection (electroporation and chemical methods) and transduction Synchronization of cell cultures, production of secondary metabolites, biotransformation, scaling up of animal cell culture	12
IV	Commercial applications of cell culture: tissue culture as a screening system, diagnostic tests, mass production of biologically important compounds (e.g. vaccines), harvesting of products, purification, assays and tissue Engineering	12

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V	Animal reproductive biotechnology: cryopreservation of sperms and ova of livestock; artificial insemination; super ovulation, embryo recovery and *in vitro* fertilization; culture of embryos; cryopreservation of embryos; embryo transfer technology; transgenic manipulation of animal embryos; applications of transgenic animal technology; animal cloning - basic concept, cloning for conservation for conservation endangered species;	**12**

Suggested Reading

1. Culture of Animal Cells, R. I Freshney, **Pub:** Wiley-Liss. John W. & Sons.
2. Animal Cell Culture-Practical Approach. Ed. John R. W. Masters,**Pub:** OXFORD
3. Animal Cell Culture Techniques Ed. Martin Clynes. **Pub:** Springer
4. B.Hafez, E.S.E Hafez, Reproduction in Farm Animals, 7th Edition, Wiley- Blackwell, 2000.
5. 5. Louis-Marie Houdebine, Transgenic Animals: Generation and Use, 1st Edition, CRC Press, 1997

Suggested Continuous Internal Evaluation (CIE) methods

Continuous Internal Evaluation shall be based on Class test, presentation along with assignment and class interactions. Marks shall be as follows.
Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: Bachelor's Degree with Research / M. Sc. Biotechnology (I)	**Year:** First (I)	**Semester:** Second (II)

Subject: Biotechnology

Couse Code: B100811T	**Course Title: Plant Biotechnology**

Course Outcomes (COs)

Students should be able to gain the
1. Fundamental knowledge in plant Cell culture technique and their applications.
2. Fundamental knowledge in Plant Cell Culture technique.
3. Knowledge of Transgenic and Genetic transformation of plants.
4. Knowledge of Application of plant transformation for productivity
5. Information regarding Plant secondary metabolites

Credits: 4	**Elective**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Introduction to the techniques of plant tissue culture. Concept of cellular	12

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	totipotency, Laboratory requirement and basic aseptic techniques, Plant Culture media: composition and preparation	
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 Gametoclonal 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 manipulation of alkaloids and industrial enzymes (Shikimate and PHA pathway), biodegradable plastics, therapeutic proteins, Edible vaccines, purification strategies. Green house Technology. Biotic and Abiotic stress.	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.

Suggested Continuous Internal Evaluation (CIE) methods

Continuous Internal Evaluation shall be based on Class test, presentation along with assignment and class interactions. Marks shall be as follows.

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: Bachelor's Degree with Research / M. Sc. Biotechnology (I)	**Year:** First (I)	**Semester:** Second (II)
Subject: Biotechnology		
Couse Code: B100812P	**Course Title: Practical**	
Credits: 4	**Core Compulsory**	
Maximum Marks: 100	**Minimum Passing Marks:** As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-8		

	Topics	No. of Lectures
	MOLECULAR BIOLOGY LAB	120

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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 (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

RECOMBINANT DNA TECHNOLOGY 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.
5. Restriction digestion.

ANIMAL BIOTECHNOLOGY LAB

1. Laboratory Safety and To Study various parts of compound Microscope
2. To prepare and study temporary or permanent slides of mitosis,
3. meiosis, stem and root cells/sections and differentiate the plant cells and animal cells
4. To study the effect of salinity on biological membranes of cells
5. To prepare the blood smear slides, visualization and cell count of the
6. components of blood using light microscopy
7. Introduction to ATC, Fluid Transfer using aseptic technique,
8. Preparation of stock media from powder and filter sterilization

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

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medium for shoot regeneration. 4. Isolation of plant genomic DNA by modified CTAB method 5. To perform DNA fingerprinting by random amplification of polymorphic 6. DNA (RAPD) technique by PCR	

Programme/Class: Bachelor's Degree with Research M. Sc. Biotechnology (I)	**Year:** First (1)	**Semester:** Second (II)

Subject: Biotechnology

Couse Code: B100813 R	**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	**Core Compulsory**
Maximum Marks: 100*	**Minimum Passing Marks:** As per University norms

*** 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 jointly by the supervisor and the external examiner nominated by the university at the end of the year out of 100* marks**

Programme/Class: M. Sc. Biotechnology (II)	**Year:** Second(2)	**Semester: Third** (III)

Subject: Biotechnology

Couse Code: B100914T	**Course Title: IMMUNOLOGY**

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.

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Credits: 4	Core Compulsory
Maximum Marks: 100 (75(UE)+25(CIE))	Minimum Passing Marks: As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
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

3. Immunology– R.A. Goldsby, T.J. Kindt, B. A Osborne, & Janis Kuby**Pub**: W.H. Freeman & Comp.
4. Immunology – I. Roitt, J. Brostoff, D. Male, **Pub**: Mosby Year Book Europe Ltd.
5. Cellular & Molecular Immunology– A.K. Abbas, Andrew H. Lichtman, J.S. Pober. **Pub:** W.B. Saunders Comp., A Harcourt Health Science Company, NY

Other ccourse books published in Hindi must be prescribed by the University/College

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

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment

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05 marks for Class interactions		
Programme/Class: M. Sc. Biotechnology (II)	**Year:** Second (2)	**Semester:** Third (III)
Subject: Biotechnology		
Couse Code: B100915T	**Course Title: APPLIED MOLECULAR BIOLOGY**	

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.

CO5: Differentiate monogenic and complex traits, chromosomal disorders and triplet repeat syndromes.

Credits: 4	**Core Compulsory**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
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 vectorless 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	12

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	carbon cycle), Bioactive components of food(folate and B12); nutraceuticals, effective gene expression; epigenetic process	

Suggested Reading

1. Human Molecular Genetics– Tom Stratchen& Andrew P. Read. **Pub:** John Wiley & Sons.
2. An introduction to Genetic Analysis– Griffith, Miller, Suzuki, Lewontin, Gelbard. **Pub**: W.H. Freeman Co.
3. Genomes 2 – T.A. Brown, **Pub**: Wiley-Liss. John W. & Sons.
4. Colour Atlas of Genetics (2001): EberhardPassarge**Pub** : Thieme
5. Genetics in Medicine (6^{th}Edn. or Later): EberhardPassarge**Pub**: saunders)
6. A primer of geneme science: Greg Gilson, Spencer V Muse **Pub**: Sinanur Associates Inc. Pvt. Ltd., Sunderland Massachussetts 01375)
7. Instant Notes: Developmental Biology – RM Twyman**Pub**: Viva Books Pvt. Ltd. India
8. Principles of Development: 2^{nd} or later Ed., Lewis Wolpert et al. **Pub**: Oxford Univ. Press
9. Genes In Medicine (1996) – J. Rusko and C.S. Downes. **Pub**: Chapman & Hall, London,
10. Human Molecular Genetics– Tom Stratchen& Andrew P. Read. **Pub:** John Wiley Sons Clinical Genetics – A short course (2000) – G. N. Wilson. **Pub**: Wiley-Liss. John W. & Sons.
11. An Introduction To Genetic Analysis Griffith, Miller, Suzuki Lewontich and Gelbard. **Pub**: W H Freeman & Com.
12. Emery's Elements of Medical Genetics (1998) – R.F. Mueller, I.D. Young, **Pub**: Churchill Livingston Pub. NY. Medical Genetics – L.B. Jonde, J.C. Cary and R.L.Whitel, **Pub**: Mosby pub. NY
13. An Introduction to Human Molecular Genetics (1999) – J.J. Pasternak, **Pub**: Fitzgerald Science Press, Bathesda, Maryland.

Suggested Continuous Internal Evaluation (CIE) methods

Continuous Internal Evaluation shall be based on Class test, presentation along with assignment and class interactions. Marks shall be as follows.
Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: : M. Sc. Biotechnology (II)	**Year:** Second (2)	**Semester:** Third (III)

Subject: Biotechnology

Couse Code: B100916T	**Course Title: BIOINFORMATICS & BIOSTATISTICS**

Course Outcomes (COs)

(SECTION A): BIOINFORMATICS
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 analyse and interpret results of their studies with the help of bioinformatics tools
CO 3: Understand phylogenetic analysis and Primer designing with bioinformatics tools.

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(SECTION B): BIOSTATISTICS

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

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 analyse and interpret results of their study.

Credits: 4	**Core Compulsory**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	History, aims of Bioinformatics, Definition and Concepts, Components of Bioinformatics, Basic tools, Scope of Bioinformatics in molecular biology and Computers, Introduction, classification and generation of computers, components of a computer system, input andoutput devices. 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; phylogenetic analysis.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 ofSkewness and kurtosis.	12
V	Probability – Definition, simple theorems of probability and simple application of probability.Correlation, correlation coefficient, standard error of estimate and regression, linear regressions, leastsquare 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.

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9. Statistical analysis – A computer oriented approach IInd Ed. Academic Press New York
10. Fundamentals of statistics – D.N. Elhance

Suggested Continuous Internal Evaluation (CIE) methods

Continuous Internal Evaluation shall be based on Class test, presentation along with assignment and class interactions. Marks shall be as follows.
Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: M. Sc. Biotechnology (II)	**Year:** Second (2)	**Semester:** Third (III)
Subject: Biotechnology		
Couse Code: B100917T	**Course Title: INDUSTRIAL BIOTECHNOLOGY**	

Course Outcomes (COs)

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 biopesticides.

Credits: 4	**Elective**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
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

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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.

Suggested Continuous Internal Evaluation (CIE) methods

Continuous Internal Evaluation shall be based on Class test, presentation along with assignment and class interactions. Marks shall be as follows.

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: : M. Sc. Biotechnology (II)	**Year:** Second (2)	**Semester:** Third (III)
Subject: Biotechnology		
Couse Code: B100918T	**Course Title: ENVIRONMENTAL**	

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	BIOTECHNOLOGY

Course Outcomes (COs)

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.

Credits: 4	**Elective**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
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 Continuous Internal Evaluation (CIE) methods

Continuous Internal Evaluation shall be based on Class test, presentation along with assignment and class interactions. Marks shall be as follows
Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Further Suggestions: None

Programme/Class: M. Sc. Biotechnology (II)	**Year:** Second (2)	**Semester:** Third (III)

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Subject: Biotechnology	
Couse Code: B100919P	Course Title: Practical
Credits: 4	Core Course
Maximum Marks: 100	Minimum Passing Marks: As per University norms
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-8	

Topics	No. of Lectures
IMMUNOLOGY & IMMUNOTECHNOLOGY LAB 1. Blood film preparation & Identification of cells 2. ABO blood grouping. 3. Immunization 4. Antigen-Antibody reaction, precipitation. 5. ELISA 6. Immunoelectrophoresis. **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 5. Fluorescent (Q-banding) **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, Swissprot/ TrEMBL, UniProt. 3. Similarity searches using tools like BLAST and interpretation of results. 4. Multiple sequence alignment using ClustalW and interpretation of results. 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. 4. Measure of skewness and kurtosis 5. Probability **INDUSTRIAL BIOTECHNOLOGY LAB**	120

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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)

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.

Programme/Class: M. Sc. Biotechnology (II)	**Year:** Second (2)	**Semester:** Third (III)
Subject: Biotechnology		
Couse Code: B100920R	**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	**Core Compulsory**	
Maximum Marks: 100*	**Minimum Passing Marks:** As per University norms	
*** 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 jointly by the supervisor and the external examiner nominated by the university at the end of the year out of 100* marks**		

Programme/Class: M. Sc. Biotechnology (II)	**Year:** Second (2)	**Semester: Fourth** (IV)

Subject: Biotechnology	
Couse Code: B1001021T	**Course Title: BIO-ENTREPRENEURSHIP**

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.

Credits: 4	**Elective**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
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.

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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.

Suggested Continuous Internal Evaluation (CIE) methods

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: M. Sc. Biotechnology (II)	**Year:** Second (2)	**Semester:** Fourth(IV)

Subject: Biotechnology

Couse Code: B10010022T	**Course Title: Enzymology**

Course Outcomes (COs)

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 andmetallozyme and important applications of industrial enzymes and acquaintance with immobilized systems.

Credits: 4	**Elective**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
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,	12

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	ribonucleaseandlysozyme. Oligomeric enzyme: lactate dehydrogenase, lactose synthase, tryptophan synthase, pyruvate dehydrogenase.	
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
5. Gary Walsh, (2014), Proteins: Biochemistry and Biotechnology, John Wiley & Sons Ltd.

Suggested Continuous Internal Evaluation (CIE) methods

Continuous Internal Evaluation shall be based on Class test, presentation along with assignment and class interactions. Marks shall be as follows

Total marks: 25

10 marks for Test

10 marks for presentation along with assignment

05 marks for Class interactions

Programme/Class: M. Sc. Biotechnology (II)	**Year:** Second (2)	**Semester:** Fourth (IV)

Subject: Biotechnology

Couse Code: B10010231	**Course Title: FOOD BIOTECHNOLOGY**

Course Outcomes (COs)

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.

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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.

Credits: 4	**Elective**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
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.
5. Advances in Agriculture Microbiology by SubbaRao, NS, Oxford & IBH Pub.
7. Molecular plant pathology by M. Dickinson, Bios Scientific Publishers, New York.

Suggested Continuous Internal Evaluation (CIE) methods

Continuous Internal Evaluation shall be based on Class test, presentation along with assignment and class interactions. Marks shall be as follows

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment

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05 marks for Class interactions

Programme/Class: M. Sc. Biotechnology (II)	**Year:** Second (2)	**Semester:** Fourth (IV)
Subject: Biotechnology		
Couse Code: B1001024T	**Course Title: Intellectual Property Rights, Bioethics And Biosafety**	

Course Outcomes (COs)

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

1. Understand the rationale for and against IPR and especially patents; and patent regulations
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;
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;
4. Understand ethical aspects related to biological, biomedical, health care and biotechnology research.

Credits: 4	**Elective**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
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 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	12
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 -	12

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	backward and forward IP: benefit/credit sharing among parties/community, commercial (financial) and non-commercial incentives.	
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.

Suggested Continuous Internal Evaluation (CIE) methods

Continuous Internal Evaluation shall be based on Class test, presentation along with assignment and class interactions. Marks shall be as follows

Total marks: 25

10 marks for Test

10 marks for presentation along with assignment

05 marks for Class interactions

Programme/Class: M. Sc. Biotechnology (II)	**Year:** Second (2)	**Semester:** Fourth (IV)

Subject: Biotechnology

Couse Code: B1001025T	**Course Title: MICROBIAL TECHNOLOGY**

Course Outcomes (COs)

CO 1: Will have to learn about the microbial genetics, genetic transfers, genetic amplification and

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microbial gene expressions.
CO 2: Under this it will have to understand about the nature of polysaccacharides , microbial transformation of steroids and about the immobilization technology.
CO 3: Will have to learn about the bioprocess technology and production of distinct types of microbial metabolites such as: alcohols, organic acids, amino acids, antibiotics, vitamins.
CO 4: Will have to emphasis on the laboratory fermentation methods, strain improvement and about the development of microbial inoculums.
CO 5: Under this it will have to learn about the role of microbes in the field of agribiotechnology with reference to biofertilizers, inoculant manufacturing and diagnostic clinical microbiology.

Credits: 4	**Elective**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Microbial genetics: Replication, regulation of bacterial gene expression, mutations, genetic transfer, role of bacteria in cancer, DNA amplification using PCR– manipulation of gene expression in prokaryotes , increasing protein production – expression and application in E. coil.	12
II	Nature of microbial polysaccharides, mechanism of synthesis; microbial transformation of steroids and sterols: screening for microbial products; microorganism for waste treatment; Immobilization of microalgae for pollutant removal.	12
III	Bioprocess technology, beer brewing, cheese manufacture, mold–modified foods, Wine, Vinegar, The fermentation process, procedure and equipments. Microbial production of amino acids, antibiotics, microbial enzymes, organic acids;	12
IV	Methods for laboratory fermentations, isolation of fermentation products, immobilized microbial cells and fine chemicals. Strain improvement, culture preservation and inoculum development. Microbial culture selection, fermented foods, probiotics.	12
V	Microbes in agribiotechnology (livestock and transgenic plants); Introduction to bio-insecticides, candidate microbiology insecticides; biofertilizers, inoculant manufacture; diagnostic clinical microbiology (emerging and re-emerging infectious diseases, microscopy, culture & sensitivity); microbes in production of alternative energy.	12

Suggested Reading

1. General Microbiology, Stainer RY, Ingraham JL, Wheelis ML. & Painter PR. The Macmillan Press Ltd., (2000).
2. Microbiology-Principles and exploration, Black JG, Prentice Hall, (1999).
3. Microbial Biotechnology, Glazer AN, Nikaido H, WH Freeman and Company, (1995).
4. Biochemical Engineering Fundamentals (2nd ed), JE Baily & DF Ollis, McGraw Hill Book Co. New York. 1986
5. Bioprocess Technology: Fundamentals and Applications, KTH, Stockholm. 2000

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6. Bioprocess Engineering: Basic Concepts (2nded), ML Shuler, & F Kargi, Prentice Hall, Engelwood Cliffs, 2003
7. Principles of Fermentation Technology (2nd edition), PF Stanbury, A Whittaker and SJ Hall, Pergamon Press, Oxford, 1995

Suggested Continuous Internal Evaluation (CIE) methods

Continuous Internal Evaluation shall be based on Class test, presentation along with assignment and class interactions. Marks shall be as follows
Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: M. Sc. Biotechnology (II)	**Year:** Second(2)	**Semester:** Fourth (IV)
Subject: Biotechnology		
Couse Code: B10010026T	**Course Title: MOLECULAR DIAGNOSTICS**	

Course Outcomes (COs)

Students should be able to
CO 1understands various facets of molecular procedures and basics of genomics, proteomics and metabolomics.
CO 2 understand different methods of early diagnosis and prognosis of human diseases
CO 3 understand Role of disease biomarkers in Disease diagnosis
CO 4 understands various facets of molecular procedures and basics of genomics, proteomics and metabolomics that could be employed in early diagnosis and prognosis of human diseases.
CO 5 understand next-generation sequencing of clinical isolates

Credits: 4	**Elective**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Introduction to Molecular Diagnostics: Historical perspective of clinical diagnosis and molecular diagnostics; 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	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-Hippel Lindau disease: recent acquisition in growing number of familial cancer syndromes	12
V	Detection of recognized genetic aberrations in clinical samples from cancer patients; types of cancer-causing alterations revealed by next-generation sequencing of clinical isolates; predictive biomarkers for personalized onco-therapy of human diseases such as chronic myeloid leukemia, colon, breast, lung cancer and melanoma as well as matching targeted therapies with patients and preventing toxicity of standard systemic therapies.	12

Suggested Reading

1. WB. Coleman and G J. Tsongalis, (2006) Molecular Diagnosis for the Clinical Laboratories, 2nd Edition, Human Press.
2. Iankowski and Polak, (1996) Clinical Gene Analysis and Manipulation: Tools, Techniques and Trouble Shooting, 1st Edition, Cambridge University press.
3. Molecular Cloning: A laboratory Manual Vol. 1-3, - J. Sambrook&Russel. **Pub:** Cold Spring Harbor Laboratory Press, NY.
4. Darby &Hewiston, (2006). In Situ Hybridization Protocols, (3rd edition), Human press.
5. Sharpe & Carter, (2006). Genetic Testing, Care, Consent & Liability, Wiley-Liss.

Suggested Continuous Internal Evaluation (CIE) methods

Continuous Internal Evaluation shall be based on Class test, presentation along with assignment and class interactions. Marks shall be as follows

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: M. Sc. Biotechnology (II)	**Year:** Second (2)	**Semester:** Fourth (IV)
Subject: Biotechnology		
Couse Code: B1001027T	**Course Title: HUMAN MOLECULAR GENETICS**	

Course Outcomes (COs)

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On completing this course, students should be able to:
CO1: Elicit and document a family history and pedigree
CO2: Understand the role of genetics in cancer
CO3: Understand the role of genetics as the underlying cause of various disorders of the human body
CO4: Have an appreciation of molecular and cytogenetic testing utilized in clinical genetics
CO5: Understand the role of prenatal screening and testing in pregnancy management and care and the options available when fetal abnormality is detected

Credits: 4	**Elective**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
I	Origin of medical genetics, major developments and its impact on clinical practice; Patterns of inheritance, Pedigree analysis and monogenic traits: autosomal, sex-linked and sex – influenced traits: mitochondrial inheritance, Complications to the basic pedigree patterns: non-penetrance, pleiotropy, late onset, anticipation, genomic imprinting Classical and non-classical; Clinical cytogenetics: Principles and mechanisms of chromosome abnormalities; Numerical Chromosome Aberrations, Structural Chromosomal Aberrations; Common autosomal and the sex Chromosomes abnormalities; Cancer genetics: common cancers and diagnostics;	12
II	Monogenic disorders- cystic fibrosis; Disorders of haematological system- Thalassemia, sickle cell disease; Muscular dystrophy- Duchenne muscular dystrophy, Bakers muscular dystrophy; Biochemical basis of Genetic diseases: Inborn errors of metabolism- Phenylketonuria; Alkeptonuria; X-linked disorder: Color blindness; Hemophilia, Glucose 6-phosphate dehydrogenase deficiency; Mitochondrial Diseases–Leber Hereditary optic neuropathy(LHON);	12
III	Common disorders of neurological system- Charcot-Marie tooth syndrome, Alzheimers' disease; Syndromes due to triplet repeat expansion-Huntington's chorea, fragile X syndrome; Susceptibility and Complex traits: polygenic and multifactorial- diabetes mellitus; Psychaitric disease-Schizophrenia; Genomic Imprinting defects, molecular characterization, mechanisms of phenotypic expression of the Prader-Willi Syndrome (PWS), Angelman Syndrome(AS); Congenital anomalies of development– dysmorphology and teratogenesis.	12
IV	Cytogenetic testing- Karyotype, human karyotype, banding and nomenclature; Molecular-cytogenetic testing-FISH; Testing for single gene disorders-common molecular techniques for known and unknown mutations; Inherited variation and Polymorphism, RFLP.	12
V	Genetic counseling and principles in practice – case studies and risk assessment; Genetic screening, carrier testing, newborn screening; antenatal screening, population screening; Prenatal diagnosis- different techniques for prenatal diagnosis; invasive methods and non-invasive methods of prenatal testing; Pre-implantation genetic screening-methods of pre-implantation and preconception	12

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	genetic diagnosis.	

Suggested Reading

1. Pastemak, 2005, An Introduction to Molecular Human Genetics, 2nd Edition, Fritzgarald
2. Mange and Mange, 1999, Basic Human Genetics, 2nd Edition, Sinauer Assoc
3. Lewis, 2007, Human Genetics, 7th Edition, WCB & McGraw
4. Vogel and Motulsky, 1997, Human Genetics, 3rd Edition, Springer Verlag
5. Strachen and Read, 2004, Human Molecular Genetics, 3rd Edition, Garland Sci. Publishing
6. Maroni, 2001, Molecular and Genetic Analysis of Human Traits, 1st Edition, Wiley-Blackwell
1. Howley and Mori, 1999, The Human Genome, Academic Press.
7. Haines & Pericak, (2006). Approaches to Gene Mapping in Complex Human Diseases. Wiley.

Suggested Continuous Internal Evaluation (CIE) methods

Continuous Internal Evaluation shall be based on Class test, presentation along with assignment and class interactions. Marks shall be as follows
Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: M. Sc. Biotechnology (II)	**Year:** Second (2)	**Semester:** Fourth (IV)
Subject: Biotechnology		
Couse Code: B1001028T	**Course Title: NANOBIOTECHNOLOGY**	

Course Outcomes (COs)

After completion of the course the students will be able to:
1. Understand a broad outline of Nanoscience and Nanotechnology.
2. Understand the basics of Nanobiotechnology
3. Explain the interaction between biomolecules and nanoparticle surface and its applications.
4. Optimize the synthesis of Biocompatibility of Nanomaterials
5. Identify the risk assessments involved bionanomaterials

Credits: 4	**Elective**
Maximum Marks: 100 (75(UE)+25(CIE))	**Minimum Passing Marks:** As per University norms

Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 4-0-0

Unit	Topics	No. of Lectures
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

Suggested Reading

1. Jain K.K, Nanobiotechnology in Molecular Diagnostics – Current Techniques andApplications, 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 Continuous Internal Evaluation (CIE) methods

Continuous Internal Evaluation shall be based on Class test, presentation along with assignment and class interactions. Marks shall be as follows

Total marks: 25
10 marks for Test
10 marks for presentation along with assignment
05 marks for Class interactions

Programme/Class: M. Sc. Biotechnology (II)	**Year:** Second (2)	**Semester:** Fourth (IV)
Subject: Biotechnology		
Couse Code: B1001029P	**Course Title: Practical**	
Credits: 4	**Core Course**	
Maximum Marks: 100	**Minimum Passing Marks:** As per University norms	
Total Number of Lectures-Tutorials-Practical (in hours per week)L-T-P: 0-0-8		
Topics		**No. of Lectures**

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120

BIO-ENTREPRENEURSHIP 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

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).

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
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
5. Case Studies of patents, trademarks, copyright.

MICROBIAL TECHNOLOGY 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.

MOLECULAR DIAGNOSTICS LAB

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1. Metaphase chromosome preparations
2. Survey based analysis of Diagnostic industry in India and world.
3. Nucleic acid based diagnosis: Extraction of Nucleic Extraction of Nucleic acids: sample collection, methods of extraction from various diagnostic materials.
4. PCR-RFLP of MTHFR gene
5. Characterization of Proteins by SDS-PAGE

HUMAN MOLECULAR GENETICS LAB

1. Preparation of Pedigree chart of some human genetic disorders.
2. Study of Sex-chromatin from buccal smear and hair root cells.
3. Karyotyping with G- banded metaphase chromosomes.
4. Karyotyping for some available human genetic anomalies.
5. Mutation screening by PCR- RFLP.
6. PCR-based detection of allelic inheritance of a DNA marker.

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)
Subject: Biotechnology		
Couse Code: B1001030R	**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	**Core Compulsory**	
Maximum Marks: 100*	**Minimum Passing Marks:** As per University norms	
*** 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 jointly by the supervisor and the external examiner nominated by the university at the end of the year out of 100* marks**		