Veer Bahadur Singh Purvanchal University, Jaunpur
(A State University- Government of Uttar Pradesh; Accredited A^{+} by NAAC)

Ordinance and Syllabus for

Bachelor of Science (Honours) Biotechnology

(B. Sc. (Hons.) Biotechnology)

Three-years (Six semesters) undergraduate degree programme

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

27/07/24 27.07.24 27.7.2024 27.7.24 27.07.2024

27/7/24

Ordinance governing three-years (Six semesters) undergraduate degree programme

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The following ordinances have been framed governing the admission, course structure, examination and other allied matters relating to the three years (Six semesters) under graduate degree programme B.Sc. (Hons.) Biotechnology is being offered by Veer Bahadur Singh Purvanchal University.

1. ADMISSION AND EXIT

1.1. All matters relating to admission to B.Sc. (Hons.) Biotechnology programme shall be dealt by the Admission Committee constituted by the University.

1.2. The B.Sc. (Hons.) Biotechnology programme is open to candidate passed 10+2 (class XII) Examination or its equivalent from a recognized Board with any of the three subjects of Physics, Chemistry and Biology or any other science subject with 50% or equivalent grade (for SC/ ST candidates passing percentage marks of eligibility will be 45% or equivalent grade).

1.3. In case of candidates who are studying in Board/Schools in any of the foreign countries the eligibility/Qualifying marks will be the same as recognized/equivalent to 10+2 with 50% marks or equivalent grade (for SC/ ST candidates, eligibility will be 45% marks or equivalent grade).

1.4. The candidate who has appeared in the qualifying examination but whose result has so far not been declared can also apply but their eligibility for the entrance test will be purely provisional subject to the condition that they have to produce a passing certificate scoring at least the minimum percentage of marks as prescribed for the qualifying examination on the day and the specified time of counseling.

1.5. Admission in B.Sc. (Hons.) Biotechnology programme will be based on the entrance test or merit of the qualifying examination as per the rules of the university.

1.6. The intake of candidates in B.Sc. (Hons.) Biotechnology programme shall be fixed by Veer Bahadur Singh Purvanchal University. The admission to B.Sc. (Hons.) Biotechnology programme shall be made through a merit based on written test conducted by Veer Bahadur Singh Purvanchal University Combined Admission Test (PUCAT). The reservation norms for admission in B.Sc. (Hons.) Biotechnology programme shall be as per the Uttar Pradesh State Government/ University policy notified from time to time.

1.7. On selection, the candidates shall deposit the fees prescribed for the purpose to get their admission confirmed within the stipulated time period by the Admission Committee of the

Department. If the candidate fails to do so their admission shall be automatically liable to be cancelled and the seat falling vacant shall be offered to other candidates as per the merit/category. There is no provision of fee concession/exemption under any circumstances except the case related to social welfare department, Uttar Pradesh government. Fee refund policy shall be applicable as per the University norms.

1.8. Admission to B. Sc. (Hons.) Biotechnology programme cannot be claimed by any candidate as a matter of right. The Admission Committee B. Sc. (Hons.) Biotechnology programme shall have power to refuse, reject or cancel any admission if it possesses sufficient reasons to do so.

1.9. All the teachers of the department shall function as Student Mentor (Advisors). Every student will be assigned a mentor (advisor) with commencement of the academic session to support the students for their overall development in all possible ways related to their academics/co-curricular/extra-curricular/sports/personality development/soft skill/cultural activity and offer all possible students support services.

2. COURSES OF STUDY AND EXAMINATION

2.1. Undergraduate program B.Sc. (Hons.) Biotechnology programme will be based on CBCS (Choice Based Credit System) and semester system.

2.2. B. Sc. (Hons.) Biotechnology programme- **1st semester**

3 (three) theory papers of major/core courses (4 credits each)	= 12
3 (three) practical papers major/core courses (2 credits each)	= 6
1 minor elective from other faculty (4 credits)	= 4
1 minor vocational skill development course (3 credits)	= 3
1 minor co-curricular course (qualifying)	

1st semester there will be 25 credits.

B. Sc. (Hons.) Biotechnology programme- **2nd semester**

3 (three) theory papers of major/core courses (4 credits each)	= 12
3 (three) practical papers major/core courses (2 credits each)	= 6
1 minor vocational skill development course (3 credits)	= 3
1 minor co-curricular course (qualifying)	

2nd semester there will be 21 credits

Thus, 1st year of B.Sc. will be of 46 credits.

B. Sc. (Hons.) Biotechnology programme- **3rd semester**

3 (three) theory papers of major/core courses (4 credits each)	= 12
3 (three) practical papers major/core courses (2 credits each)	= 6
1 minor elective from other faculty (4 credits)	= 4
1 minor vocational skill development course (3 credits)	= 3

1 minor co-curricular course (qualifying)

3rd semester there will be 25 credits

B. Sc. (Hons.) Biotechnology programme- **4th semester**

3 (three) theory papers of major/core courses (4 credits each)	= 12
3 (three) practical papers major/core courses (2 credits each)	= 6
1 minor vocational skill development course (3 credits)	= 3
1 minor co-curricular course (qualifying)	

4th semester there will be 21 credits.

Thus, 2nd year of B.Sc. will be of 46 credits.

B. Sc. (Hons.) Biotechnology programme- **5th semester**

4 (four) theory papers of major/core courses (4 credits each)	= 16
2 (two) practical papers major/core courses (2 credits each)	= 4
1 minor co-curricular course (qualifying)	

5th semester there will be 20 credits

B. Sc. (Hons.) Biotechnology programme- **6th semester**

4 (four) theory papers of major/core courses (4 credits each)	= 16
2 (two) practical papers major/core courses (2 credits each)	= 4
1 minor co-curricular course (qualifying)	

6th semester there will be 20 credits

Thus, 3rd year of B.Sc. will be of 40 credits.

Hence, three years (6 semesters) B.Sc. (Hons.) Biotechnology programme is of 132 credits.

2.3. All theory major/core courses are compulsory in the first year (1st and 2nd semester) and second year (3rd and 4th semester) of own faculty (Science).

2.4. It will be mandatory for the student to take minor elective course of other faculty (one minor Course/per year) – first year (1st semester) and second year (3rd semester) of undergraduate programmed and fourth year (Bachelor's Degree with research). The university/college may offer the course of the minor elective. Minor elective paper will not be compulsory in third year undergraduate programme (5th and 6th semester).

2.5. Minor elective courses will be opted for amongst the courses conducted in the University/College. The classes for the opted minor course will be held along with the classes of the same course conducted in the faculty and their examination will also be held at the same time.

2.6. In the third year undergraduate programme (5th and 6th semester), the student can choose one course based on the elective course, according to their interest and on the basis of the

resources available in the university /college.

2.7. The student will have to take only 1 minor elective course from any other faculty (a subject other than the own faculty). This course will be of at least 4 (four) or more credits and will not require any pre-requisite.

3. VOCATIONAL/SKILL DEVELOPMENT COURSE

3.1. Every student admitted in undergraduate programme will have to take a skill development course of 3 credits in each semester of the first 2 years (4 semesters) (4 courses of 3 x 4 = 12 credits in total).

4. CO-CURRICULAR COURSES

4.1. It will be mandatory for students admitted in undergraduate programme will have to take one co-curricular/course in each semester of 3 years (6 semesters).

4.2. The student has to pass co-curricular/courses as per the rules prescribed for passing criteria of Veer Bahadur Singh Purvanchal University. Grades based on their marks will be marked on the grade seat of the student, but they will not be included in the calculation of CGPA.

5. RESEARCH PROJECT

5.1. The students has to carry out a research project (qualifying) in 3rd year (5th and 6th semesters).

5.2. This research project can also be in the form of internship/technical report/comprehensive review/online or field surveys work/training in industry or institute.

5.3. This research project may also be intra disciplinary.

5.4. The research project will be done under the direction of a teacher (supervisor), another supervisor can be opted from any industry/company/technical institution/research institute.

5.5. The student will submit a joint dissertation report for the research project carried out in 3rd year (5th and 6th semesters) will be evaluated at the end of the year, which will be assessed jointly out of 100 marks by the respective supervisor and the external examiner nominated by the University or as per the directive of the university.

6. CREDIT AND CREDIT ASSESSMENT

6.1. One credit paper of Theory will consist of one hour/week teaching assignment, i.e. 15 hours of teaching assignments in 15 weeks of a semester.

6.2. One credit paper of Practical/Internship/Field Work etc. will consist of two hours / per week teaching work i.e. 30 hours of practical / internship/field work etc. will be done in 15 weeks of a semester. In computing the workload of the teacher, the workload of 1 hour of theory/practical/internship/field work etc. will be equal to the workload of 2 hours.

6.3. All credit related work will be done through University/State government rule or state level "Academic Bank of Credit".

6.4. A student can take a one-year certificate on earning a minimum of 46 credits, a two-year diploma after earning a minimum of 92 credits, and a three-year bachelor's degree with a minimum of 132 credits.

6.5. After using the credits once, the student will not be able to use the credits for those courses again. For example, if a student obtains a certificate after one year using 46 credits, then their credits will be treated as expenses. If the student wants to take diploma after some years, they will either surrender their original certificate to the University and re-credit the 46 credits into the account or re-credit the new 46 credits and on the basis of which one can take diploma by earning 92 credits (46 + 46) credits in the second year (actual third year). Similar arrangements will be made for the coming years also. If the student studies continuously and does not take the certificate/diploma, then they can take the degree on the basis of 132 credits.

6.6. If a student (fast learner) will get the required credits for the degree in a short time, then there will be a gap facility on getting the minimum credits, but the degree will be available only after completion of three years. During the interval they will be free to any assignment in industry of as per their interest.

6.7. In three years, the student will get a degree in the same faculty in which the student will get at least 60 percent of the total credits of the three main subjects.

6.8. If a qualified student re-credits their credit by taking certificate/diploma and fails in the upcoming examination, then they can get the certificate/diploma again by using the recredited credit.

6.9. The grades based on the marks obtained in the research project will be marked on the grade sheet of the undergraduate programme but they will not be included in the calculation of CGPA.

7. ATTENDANCE AND CREDIT ASSESSMENT

7.1. It will be necessary to take the exam for credit validation. Credits will be incomplete without examination.

7.2. 75 percent attendance will be mandatory as per earlier rules to take the examination.

7.3. A candidate admitted to the B.Sc. (Hons.) Biotechnology programme shall pursue a regular course of study in all the semesters of the programme and attend a minimum of 75% of the classes held to be eligible to appear in the semester examinations.

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

7.5. Semester examinations of the B.Sc. (Hons.) Biotechnology programme shall be conducted by way of theory papers, practical and industrial training/surveys/research project. Each theory major/core and elective courses will be of 100 marks out of which 75 marks shall be

allocated for end semester examination and 25 marks for Continuous internal Evaluation. Continuous Internal Evaluation (CIE) is an integral part of the courses and is compulsory for all students. The academic performance of a student is evaluated by assessing day to day performance, attendance, assignments, periodic tests, seminar presentation, subject's quiz, class discussion, etc. There shall be no mid-term examination of CIE will be held rather a teacher assess the student along with the class teaching.

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

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

7.7. 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 they can take the qualifying examination in the next time as per university rules. they won't need to take classes again

8. RESULTS, PROMOTION AND IMPROVEMENT

8.1. If a student wants to leave after passing the first year of graduation by earning a minimum of 46 credits, then he will be awarded a Certificate in Biotechnology

8.2. If a student wants to leave after passing the Second year of graduation by earning a minimum of 92 credits, then he will be awarded a Diploma in Biotechnology

8.3. If a student wants to leave after passing the Third year of graduation by earning a minimum of 132 credits, then he will be awarded a Bachelor of Science (Hons) in Biotechnology

8.4. The declaration of results, promotion, improvement and passing criteria of B.Sc.(Hons.) Biotechnology semester examination shall be declared pass as per the rules of Veer Bahadur Singh Purvanchal University undergraduate programme.

8.5. Those who failed in any course of the semester examination shall not be assigned any rank while declaring the final result of the Bachelor of Science (Hons.) Biotechnology programme.

8.6. If required, before the declaration of result for each semester a moderation committee shall be formed by the Vice chancellor on recommendations of the Convener. The moderation committee shall have the course convener as its convener and the name of the other shall be proposed by the course convener for the approval of the Vice chancellor.

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

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

8.9. Question papers for theory examination in sealed envelope shall be handed over/sent by registered

post to the Registrar/Controller of Examination by the Examiners. Controller of Examinations will ensure the printing of question papers and fair conduct of the examinations.

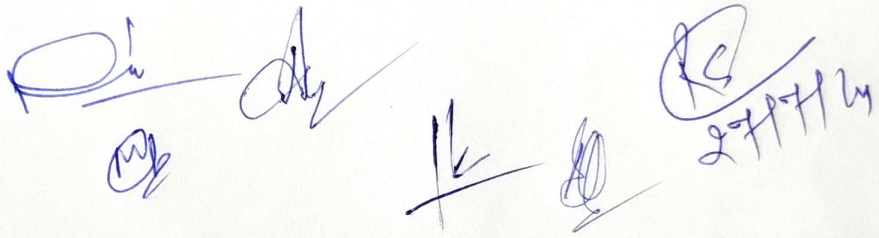
8.10. The Registrar/Controller of the Examinations, with the approval of the Vice-Chancellor shall associate one or two members of the BoS for the moderation of the papers. The moderated papers shall have to be printed by the Registrar/Controller of the Examinations well before commencement of the Examinations.

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

8.12. For appearing in the B.Sc. (Hons.) Biotechnology semester examination each student shall have to deposit a prescribed examination fee along with a copy of online filled examination form for online verification. Separate fees will also be charged for back and improvement papers as per University rules.

8.13. 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.

8.14. Practical examinations of B.Sc. (Hons.) Biotechnology semesters I, II, III, IV, V, and VI will be conducted by one internal and one external examiner nominated by the university.



Veer Bahadur Singh Purvanchal University, Jaunpur 222003

Syllabus

Bachelor of Science (Honours) Biotechnology

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

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

Veer Bahadur Singh Purvanchal University, Jaunpur 222003
Syllabus
Bachelor of Science (Hons.) in Biotechnology
B.Sc. (Hons.) Biotechnology
Designed as per Syllabus Development Guidelines of
National Education Policy-2020 (NEP-2020)

Year	Sem.	Paper Code	Course Type	Paper Title	Theory/ Practical	Credits
B.Sc. I	I	B100101T	Major/core	Biochemistry	Theory	4
		B100101P	Major/core	Biochemistry Lab	Practical	2
		B100102T	Major/core	Cell Biology	Theory	4
		B100102P	Major/core	Cell Biology Lab	Practical	2
		B100103T	Major/core	Genetics	Theory	4
		B100103P	Major/core	Genetics Lab	Practical	2
			Minor (Elective) (Other faculty)	Paper as per the minor elective	Theory	4*
			Minor	(Vocational Skill Development course)	Theory	3
		Z010101T	Minor/Co-Curricular (Qualifying)	Food, Nutrition and Hygiene	Theory	
		* Minor Elective from other faculty.			**Credits (1st Semester)**	25
B.Sc. I	II	B100201T	Major/core	Molecular Biology	Theory	4
		B100201P	Major/core	Molecular Biology Lab	Practical	2
		B100202T	Major/core	Microbiology	Theory	4
		B100202P	Major/core	Microbiology Lab	Practical	2
		B100203T	Major/core	Immunology	Theory	4
		B100203P	Major/core	Immunology Lab	Practical	2
			Minor	(Vocational Skill Development course)	Theory	3
		Z020201	Minor/Co-Curricular (Qualifying)	First Aid and Health	Theory	--
						21
					Credits (1st Year)	**46**

		Paper Code	Course Type	Paper Title	Theory/ Practical	Credits
B.Sc. II	**III**	B100301T	Major/core	Bioinformatics & Biostatistics	Theory	4
		B100301P	Major/core	Bioinformatics & Biostatistics Lab	Practical	2
		B100302T	Major/core	Enzymology	Theory	4
		B100302P	Major/core	Enzymology Lab	Practical	2
		B100303T	Major/core	Industrial Biotechnology	Theory	4
		B100303P	Major/core	Industrial Biotechnology Lab	Practical	2
			Minor (Other Faculty)	Paper as per the minor elective	Theory	4*
			Minor	(Vocational Skill Development course)	Theory	3
		Z030301	Minor) Co-curricular course (Qualifying)	Human Values and Environment studies	Theory	--
		* Minor Elective from other faculty			**Credits (3rd Semester)**	25
B.Sc. II	**IV**	B100401T	Major/core	Bioprocess Technology	Theory	4
		B100401P	Major/core	Bioprocess Technology Lab	Practical	2
		B100402T	Major/core	Environmental Biotechnology	Theory	4
		B100402P	Major/core	Environmental Biotechnology Lab	Practical	2
		B100403T	Major/core	Genetic Engineering	Theory	4
		B100403P	Major/core	Genetic Engineering Lab	Practical	2
			Minor	(Vocational Skill Development course)	Theory	3
		Z040401	Minor) Co-curricular course (Qualifying)	Physical Education and Yoga	Co-curricular course (Qualifying)	--
						21
					Credits (2nd Year)	**46**

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		Paper Code	Course Type	Paper Title	Theory/ Practical	Credits
B.Sc. III	V	B100501T	Major/core	Biochemical Engineering	Theory	4
		B100501P	Major/core	Biochemical Engineering Lab	Practical	2
		B100502T	Major/core	Plant Biotechnology	Theory	4
		B100502P	Major/core	Plant Biotechnology Lab	Practical	2
		B100503T	Major/core	Animal Biotechnology	Theory	4
		Z050501	Minor/Co-curricular course (Qualifying)	Analytic Ability and Digital Awareness	Theory	--
		B100504R	Major/core	Industrial Training/ Surveys/Research Project (Qualifying)	Project	--
		B100505T	Major/ elective*	Basics of Forensic Science	Theory	4
		B100506T	Major/ elective*	Molecular Diagnostics	Theory	4
					Credits (5th Semester)	20
		***Student must opt for any One of the 2 elective courses**				
B.Sc. III	VI	B100601T	Major/core	IPR, Bioethics and Biosafety	Theory	4
		B100601P	Major/core	IPR, Bioethics and Biosafety Lab	Practical	2
		B100602T	Major/core	Entrepreneurship	Theory	4
		B100603T	Major/core	Food Biotechnology	Theory	4
		B100603P	Major/core	Food Biotechnology Lab	Practical	2
		Z060601T	Minor/Co-curricular course (Qualifying)	Communication Skills and Personality Development	Theory	--
		B100604R	Major/core	Industrial Training/ Surveys/Research Project (Qualifying)	Project	--
		B100605T	Major/elective*	Genomics and proteomics	Theory	4
		B100606T	Major/elective*	Animal Physiology	Theory	4
						20
		Student must opt for any One of the 2 elective courses				
					Credits (3rd Year)	**40**
					Total Credits	**132**

Programme Outcomes (POs)	
After completion of the B. Sc. Biotechnology programme, the candidate should be able to:	
PO1	Demonstrate knowledge for in-depth analytical and critical thinking to identify, formulate and slve the issues related to Biotechnology research, Biotechnology Industry, Pharma industry, Medical or hospital related organizations, and Academia.
PO2	Demonstrate skills to use modern analytical tools/software/equipment and analyse and Solve problems in various courses of biotechnology.
PO3	Execute their professional roles in society as biotechnology professionals, employers and employees in various industries, researchers and educators.
PO4	Design, perform experiments, analyse and interpret data for investigating complex problems in biotechnology and related fields.
PO5	Demonstrate learning skills to work as a team in a multidisciplinary environment.
PO6	Design and develop sustainable solutions to major biological problems by applying appropriate biotechnology tools.
PO7	Develop skills, attitude and values required for self-directed, lifelong learning and professional development.
PO8	Acquire knowledge and understanding of norms and ethics in the field of biotechnology.

PROGRAMME SPECIFIC OUT COMES (PSOS)	
CERTIFICATE IN BIOTECHNOLOGY	
First Year	This course introduces the knowledge of cell biology, genetics, molecular biology and genetic engineering. After completion of this certificate 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 centres and industries.
DIPLOMA IN BIOTECHNOLOGY	
	After completion of diploma course, students will be able to:

Second Year	**PSO1:** Familiarize with basic laboratory instruments and understand the principle of measurements using those instruments with experiments in biochemistry. **PSO2**: Understand the significance of Biochemistry and basics of enzymes. **PSO3:** Learn the chemistry, structure and functions of major bio-molecules and metabolism of carbohydrate, protein etc. **PSO4:** Understand different biochemical tools and techniques such as chromatography, electrophoresis, X-ray diffraction, NMR and mass spectrometry. **PSO5:** Perform different experiments based on the techniques such as chromatography, electrophoresis, centrifugation etc. **PSO6:** Understand the different methods of sterilization. **PSO7:** Understand and also able to perform different immunological techniques like agglutination reaction, ABO typing and ELISA.
DEGREE IN BACHELOR OF SCIENCE (HONS.) BIOTECHNOLOGY	
Third Year	After completing the three years degree course in Biotechnology, the students will be able to: **PSO1:** Demonstrate the concepts in computational Biology. Understand the inter-relationship between Biology and Computer **PSO2:** Acquire knowledge in different domains of biotechnology enabling their applications 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. **PSO6:** Exhibit ability to do research independently as well as in collaboration. **PSO7:** Recognize the importance of Bioethics, IPR, and entrepreneurship.

Programme/Class: Certificate/B. Sc. (Hons.) (I)	**Year:** First (1)	**Semester:** First (I)
Course Code: B100101T	**Course Title:** Biochemistry	

Course Outcomes (COs)

After successful completion of the course, student will be able to:
CO1: Understand the significance of Biochemistry.
CO2: Learn the chemistry of carbohydrates, lipids, proteins and amino acids.
CO3: Understand the basics of enzymes.
CO4: Understand the metabolism of carbohydrate and proteins.
CO5: Know the chemical structure of nucleotides including their components, describe primary, secondary structure of DNA and RNA

Credits: 4	**Major/Core**

Unit	Topics	No. of Lectures
I	Introduction and history of Biotechnological science with special reference to contribution of Indian scholars in biological sciences A historical prospective.	12
II	Amino acids & Proteins**:** Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape. Different Level of structural organization of proteins, Fibrous and globular proteins. Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides.	12
III	Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines & pyrimidines, Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z– DNA, Denaturation and renaturation of DNA.	12
IV	Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.	12
V	Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors, coenzyme, prosthetic groups, metallozymes, monomeric & oligomeric enzymes, activation energy and transition state, enzyme activity, specific activity, common features of active sites, enzyme specificity.	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– Lubert Stryer. **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.

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

Suggested link

1. https://ocw.mit.edu/courses/findbytopic/#cat=science&subcat=biology&spec=biochemistry
2. https://ocw.mit.edu/courses/find-by-topic/#cat=healthandmedicine&subcat=spectroscopy
3. https://ocw.mit.edu/courses/chemistry/5-07sc-biological-chemistry-i-fall-2013/module-i/session-4/
4. https://ocw.mit.edu/courses/biology/7-016-introductory-biology-fall-2018/lecture-videos/lecture-4-enzymes-and-metabolism/
5. https://ocw.mit.edu/courses/chemistry/5-07sc-biological-chemistry-i-fall-2013/module-i/session-3/
6. https://nptel.ac.in/courses/104/105/104105076/
7. https://nptel.ac.in/courses/102/106/102106087/

Programme/Class: Certificate/ B. Sc. (Hons) (I)	**Year:** First (1)	**Semester:** First (I)
Course Code: B100101P	**Course Title:** Biochemistry Lab	
Credits: 2	**Major/Core**	

	Topics	**No. of Lectures**
1.	Preparation of normal and molar solutions.	60
2.	Preparation of buffers.	
3.	To study activity of any enzyme under optimum conditions.	
4.	To study the effect of pH, temperature on the activity of salivary amylase enzyme.	
5.	Estimation of blood glucose by glucose oxidase method.	
6.	Spectrophotometer/colorimeter (Beer-Lambert's law), estimation of protein by UV-vis Spectrometer (I) Lowry et al. method for estimation of protein (ii) Biuret method for estimation of protein.	
7.	Spectroscopic estimation of DNA (UV).	
8.	Electrophoresis (a) Electrophoresis of red blood cell proteins (b) Electrophoresis of DNA.	
9.	Separation of amino acids by paper chromatography.	
10.	Qualitative tests for carbohydrates, lipids and proteins.	
11.	Estimation of DNA by Diphenylamine and RNA by Orcinol methods.	
12.	Estimation of reducing and total sugar by DNS and H_2SO_4-phenol methods.	
13.	Effect of pH and temperature on enzyme activity.	
14.	Determination of pK_a value of a weak acid by titrating with strong base.	

Programme/Class: Certificate/ B. Sc. (Hons) (I)	**Year:** First (1)	**Semester:** First (I)
Course Code: B100102T	**Course Title**: Cell Biology	
Course Outcomes (COs)		

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

CO1: Learn different areas of cell biology including the structure and functions of cell, its organelles such as mitochondria, nucleus etc.

CO2: Understand the role of cytoskeleton and its remodeling including the diseases associate with improper remodeling.

CO3: Learn how the synthesized proteins are transported to different organelles.

CO4: Understand chemical components of biological membranes and membrane transport.

CO5: Understand molecules that mediate cell adhesion.

Credits: 4 **Major/Core**

Unit	Topics	No. of Lectures
I	Origin of life, History of cell biology, Evolution of the cell: endosymbiotic theory, tree of life, General structure and differences between prokaryotic and eukaryotic cell; Similarities and distinction between plant and animal cells, different kinds of cells in plant and animal tissues.	12
II	Cell: Introduction and classification of organisms by cell structure, cytosol, compartmentalization of eukaryotic cells, Cell Membrane and Permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, membrane as a dynamic entity, cell recognition and membrane transport.	12
III	Membrane Vacuolar system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments, Intermediate filaments. Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions.	12
IV	Lysosomes: Vacuoles and microbodies: Structure and functions Ribosomes: Structures and function, Mitochondria: Structure and function, Chloroplasts: Structure and function, Nucleus: Structure and function, chromosomes and their structure.	12
V	Extracellular Matrix: Composition, molecules that mediate cell adhesion, membrane receptors for extracellular matrix, macromolecules, regulation of receptor expression and function. Signal transduction. Cancer: Carcinogenesis, agents promoting carcinogenesis.	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 NY 10001-2299.
2. Cell and Molecular Biology– G. Karp, **Pub**: John wiley & Sons, Inc. NY.
3. 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.
4. 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.
5. कोशिका विज्ञान एवम अनुवांशिकी पी. के. गुप्ता, रस्तोगी पब्लिकेशन्स.
6. आधुनिक कोशिका विज्ञान, गायत्री स्वरंकार एवम के सी सोनी.

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

Suggested link
1. https://ocw.mit.edu/courses/find-by-topic/#cat=science&subcat=biology&spec=cellbiology 2. https://ocw.mit.edu/courses/find-by-topic/#cat=science&subcat=biology&spec=genetics 3. https://nptel.ac.in/courses/102/103/102103012/ 4. https://nptel.ac.in/courses/102/106/102106025/ 5. https://nptel.ac.in/courses/102/103/102103015/

Programme/Class: Certificate/ B. Sc. (Hons) (I)	**Year:** First (1)	**Semester:** First (I)
Course Code: B100102P	**Course Title:** Cell Biology Lab	
Credits: 2	**Major/Core**	

	Topics	**No. of Lectures**
	1. Introduction to safety measures in Laboratories. 2. Preparation of solutions and buffers. 3. Equipment handling and pipetting. 4. Study of structure of any Prokaryotic and Eukaryotic cell. 5. Microtomy: Fixation, block making, section cutting, double staining of animal tissues like liver, oesophagus, stomach, pancreas, intestine, kidney etc. 6. Cell division in onion root tip/insect (grasshopper) gonads. 7. Vital Staining of Mitochondria with Janus green B. 8. Demonstration of diversity of cell types (Muscle, Neuron). 9. Demonstration of Sex chromatin in buccal smear. 10. Karyotype preparation. 11. Preparation of polytene chromosomes from salivary gland of Chironomous larvae.	60

Programme/Class: Certificate/ B. Sc. (Hons) (I)	**Year:** First (1)	**Semester:** First (I)
Course Code: B100103T	**Course Title:** Genetics	

Course Outcomes (COs)

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

CO1: Describe fundamentals of genetics.

CO2: Understand relationship between phenotype and genotype in human genetic traits.

CO3: Understand Chromosome and genomic organization.

CO4: Describe the basics of genetic mapping.

CO5: Understand how gene expression is regulated.

Credits: 4	**Major/Core**	
Unit	**Topics**	**No. of Lectures**

I	Introduction: Historical developments in the field of genetics. Organisms suitable for genetic experimentation and their genetic significance. Cell Cycle: Mitosis and Meiosis. Mendelian genetics : Mendel's experimental design, monohybrid, di-hybrid and tri hybrid crosses, test and back crosses, Chromosomal theory of inheritance, Allelic interactions: Concept of dominance, recessiveness, incomplete dominance, co-dominance, semi-dominance, pleiotropy, multiple allele, pseudo-allele, essential and lethal genes, penetrance and expressivity	12
II	Non allelic interactions: Interaction producing new phenotype complementary genes, epistasis (dominant & recessive), duplicate genes and inhibitory genes. Chromosome and genomic organization: Eukaryotic nuclear genome nucleotide sequence composition– unique & repetitive DNA, satellite DNA. Centromere and telomere DNA sequences, Genetic Organization of prokaryotic and Eukaryotic genome. Chromosome morphology, one gene one polypeptide hypothesis, concept of cistron, exons, introns, genetic code, gene function.	12
III	Chromosome and gene mutations: Definition and types of mutations, causes of mutations, Ames test for mutagenic agents, screening procedures for isolation of mutants and uses of mutants, Structural and numerical changes in chromosomes, chromosomal aberrations, Sex determination and sex linkage. Environmental factors and sex determination, sex differentiation, Barrbodies, dosage compensation, genetic balance theory. Sex linked inheritance.	12
IV	Genetic linkage, crossing over and chromosome mapping, Extra chromosomal inheritance: Rules of extranuclear inheritance,	12
V	Evolution and population genetics: Inbreeding and out breeding, Hardy Weinberg law (prediction, derivation), allelic and genotype frequencies, changes in allelic frequencies, systems of mating, evolutionary genetics, natural selection.	12

Suggested Reading

1. Hartl, D. L., & Jones, E. W. (1998). *Genetics: Principlesand Analysis*. Sudbury, MA: Jones and Bartlett.
2. Pierce, B. A. (2005). *Genetics: a Conceptual Approach*. New York: W. H. Freeman.
3. Tamarin, R. H., & Leavitt, R. W. (1991). *Principles of Genetics*. Dubuque, IA: Wm. C. Brown.
4. Smith, J. M. (1998). *Evolutionary Genetics*. Oxford: Oxford University Press.
5. Principles of Genetics– Gardner et al.

Programme/Class: Certificate/ B. Sc.(Hons) (I)	**Year:** First (1)	**Semester:** First (I)
Course Code: B100103P	**Course Title:** Genetics Lab	
Credits: 2	**Major/Core**	

	Topics	**No. of Lectures**

	1. Genetics problems based on: (i) Mendel's law (ii) Gene mapping and (iii) Transposable elements. 2. Ames test for mutagenesis. 3. Genetic experiment– Drosophila model 4. Pedigree charts of some common characters like blood group, color blindness. 5. Study of polyploidy in onion root tip by colchicine treatment.	60

Programme/Class: Certificate/ B. Sc. (Hons.) (I)	**Year:** First (1)	**Semester:** First (I)
Course Code:	**Course Title:** Minor Elective (Other faculty)	
Credits: 4	**Major/Core**	

Programme/Class: Certificate/ B. Sc. (Hons.) (I)	**Year:** First (I)	**Semester:** First (I)
Course Code:	**Course Title:** Vocational Skill Development	
Credits: 3	**Major/Core**	

Programme/Class: Certificate/ B. Sc. (Hons.) (I)	**Year:** First (I)	**Semester: First** (I)
Course Code: Z010101T	**Course Title:** Co-Curricular: Food, Nutrition and Hygiene	
Credits: As per University norms	**Major/Core**	

Programme/Class: Certificate/ B. Sc. (Hons) (I)	**Year:** First(1)	**Semester:** Second (II)
Course Code: B100201T	**Course Title:** Molecular Biology	

Course Outcomes (COs)

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

CO1: acquainted with the structure of various types of DNA and RNA as well as their organization as genetic material in various living organisms.

CO2: understand DNA replication mechanisms in prokaryotes and eukaryotes, enzymes and proteins involved in replication.

CO3: learn the fundamental principles of transcription in prokaryotes and eukaryotes, including the RNA polymerases and general transcription factors involved.

CO4: able to distinguish between the process in prokaryotes versus eukaryotes.

Credits:4	**Major/Core**	
Unit	**Topics**	**No. of Lectures**

I	Nucleic Acids convey Genetic Information: DNA as the carrier of genetic information, Key experiments establishing-The Central Dogma, DNA Double helix, Genetic code, Direction of Protein Synthesis DNA as genetic Material.	12
II	Structure of DNA, Replication of DNA in prokaryotes and eukaryotes: Semi-conservative nature of DNA replication, Bi-directional replication, DNA polymerases, The replication complex: Pre-primming proteins, primosome, replisome, Rolling circle replication, Unique aspects of eukaryotic chromosome replication, Fidelity of replication.	12
III	DNA damage and repair: causes and types of DNA damage, mechanism of DNA repair: Photo reactivation, base excision repair, nucleotide excision repair, mismatch repair, translesion synthesis, recombinational repair, non-homologous end joining. Homologous recombination: models and mechanism.	12
IV	RNA structure and types of RNA, Transcription in prokaryotes: Prokaryotic RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNAsplicingandprocessing:processingofpre-mRNA:5'capformation, polyadenylation, splicing, rRNA and tRNA splicing.	12
V	Regulation of gene expression in prokaryotes: Operon concept (inducible and repressible system), Genetic code and its characteristics, Prokaryotic and eukaryotic translation: ribosome structure and assembly, Charging of tRNA, aminoacyl tRNA synthetases, Mechanism of initiation, elongation and termination of polypeptides, Posttranslational modifications of proteins.	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 NY 10001-2299
2. Cell and Molecular Biology– G. Karp, Pub: John wiley & Sons, Inc. NY.
3. 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.
4. 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.
5. Cell and Molecular Biology– P. K. Gupta **Pub**: Rastogi Publication India.

Programme/Class: Certificate	**Year:** First (1)	**Semester:** Second (II)
Course Code:B100201P	**Course Title:** Molecular Biology Lab	
Credits: 2	**Major/Core**	

	Topics	No. of Lectures
	1. Estimation of DNA by Di-Phenylamine/C-TAB method. 2. Estimation of RNA by Orcinol method. 3. Study of conjugation in *E. coli* 4. Study of transduction in *E. coli*	60

Programme/Class: Certificate/ B. Sc. (Hons) (I)	**Year:** First (1)	**Semester:** Second (II)
Course Code: B100202T	**Course Title:** Microbiology	

Course Outcomes (COs)

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

CO1: Understanding the basics of microbiology and microbial classification.

CO2: To culture different bacteria and know how to preserve them.

CO3: Acquaintance with culturing of viruses and viral pathogenesis.

CO4: Critical understanding of general characteristics and classification of algae, fungi and protozoa.

CO5: Retrieve and use cotemporary information related to microbial world

Credits: 4	**Major/Core**

nit	**Topics**	**No. of Lectures**
I	Fundamentals, History and Evolution of Microbiology. Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria.	12
II	Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg., Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.	12
III	Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation. Control of Microorganisms: By physical, chemical and Chemotherapeutic Agents	12
IV	Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria. Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways. Genetic recombination in bacteria: Transformation, Transduction and Conjugation.	12
V	Water Microbiology: Bacterial pollutants of water, coli forms and non coli forms. Sewage composition and its disposal. Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major food born infections and intoxications, Preservation of various types of foods. Fermented Foods. Introduction to microbial ecology.	12

Suggested Reading

1. PelczarMiJ., Chan, E. C. S., Krieg, NR, (2009). Microbiology, McGraw-Hill publisher.
2. Willey, J. SherwoodL,WoolvertonC,(2016),PrescottMicrobiology.10thEdition, McGraw Hill Publisher, Columbus, OH.
3. Ananth anarayan and Paniker (2017)A textbookofMicrobiology,:10th Edition. Orient Blacks wan Publisher, Delhi
4. Dubey R. C. and D. K. Maheshwari (2004).ATextbookofmicrobiology,1st Edition; S. Chand and Company Ltd.
5. General Microbiology by Stanier, R. Y, J. L. Ingrahm, M. L. Wheelis & P. R. Painter.

Programme/Class: Certificate	**Year:** First(1)	**Semester:** Second (II)
Course Code: B100202P	**Course Title:** Microbiology Lab	
Credits: 2	**Major/Core**	

	Topics	**No. of Lectures**
	1. Sterilization, disinfection, safety in microbiology laboratory 2. Preparation of media for growth of various micro organisms 3. Identification and culturing of various microorganisms 4. Staining and enumeration of microorganisms 5. Growth curve, measure of bacterial population by turbidometry and studying the effect of temperature, pH, carbon and nitrogen sources 6. Determination of bacterial cell size by micrometry. 7. Enumeration of microorganism-total & viable count. 8. Isolation of enzyme producing microorganisms	60

Programme/Class: Certificate/ B. Sc.(Hons) (I)	**Year:** First(1)	**Semester:** Second (II)
Course Code:B100203T	**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-

CO1: Understand the basic principles of immune system
CO2: Understand the nature of antigen and antibodies, and antigen
CO3: Understand the basic techniques to identify antigens.
CO4: Understand the basis of allergy and allergic diseases
CO5: Understand the importance of vaccines

Credits:4	**Major/Core**	
Unit	**Topics**	**No. of Lectures**
I	Immune Response- An overview, components of mammalian immune system, molecular structure of Immunoglobulins or Antibodies, Humoral & Cellular immune responses, T lymphocytes & immune response (cytotoxic T-cell, helper T-cell, suppressor T-cells), T-cell receptors, genome rearrangements during B-lymphocyte differentiation, Antibody affinity maturation class switching, assembly of T-cell receptor genes by Somatic recombination.	12
II	Basic immunology: Historical perspectives, Cells and organs of the Immune system	12
III	Regulation of immunoglobulin gene expression- clonal selection theory, allotypes & idiotypes, allelic exclusion, immunologic memory, heavy chain gene transcription, genetic basis of antibody diversity, hypotheses (germ line & somatic mutation), antibody diversity.	12

IV	Major Histocompatibility complexes – class I & class II MHC antigens, antigen processing. Immunity to infection–immunity to different organisms, pathogen defense strategies, avoidance of recognition. Autoimmune diseases, Immunodeficiency-AIDS.	12
V	Vaccines & Vaccination– adjuvants, cytokines, DNA vaccines, recombinant vaccines, bacterial vaccines, viral vaccines, vaccines to other infectious agents, passive & active immunization. Introduction to immunodiagnostics–RIA, ELISA.	12

Suggested Reading

1. Kindt T. J., Golds by RA and Osborne BA (2007). Kuby Immunology. W. H. Freeman and Co., New York, 6th Ed.
2. Abbas A. K, Lichtman A. Hand Pillai S. (2011). Cellular and Molecular Immunology. Elsevier, USA, 7th Ed.
1. Coico R. and Sunshine G. (2009.) Immunology: A Short Course. Wiley– Liss, 6th Ed.
2. Delves PJ, Martin SJ, Burton DR and Roitt IM (2011) Roitt's Essential Immunology. Wiley-Blackwell, 12th Ed.

Programme/Class: Certificate/ B. Sc. (Hons) (I)	**Year:** First (1)	**Semester:** Second (II)
Course Code: B100203P	**Course Title:** Immunology Lab	
Credits:2	**Major/Core**	

	Topics	**No. of Lectures**
	1.Differential leucocytes count 2.Total leucocytes count 3.Total RBC count 4.Haemagglutination assay 5.Haemagglutination inhibition assay 6.Separation of serum from blood 7.Double immunodiffusion test using specific antibody and antigen. 8.ELISA.	60

Programme/Class: Certificate/ B. Sc. (Hons.) (I)	**Year:** First (I)	**Semester:** Second (II)
Course Code:	**Course Title:** Vocational Skill Development course	
Credits: 3	**Major/Core**	
Maximum Marks: As per University norms	**Minimum Passing Marks:** As per University norms	

Programme/Class: Certificate/ B. Sc. (Hons.) (I)	**Year:** First (I)	**Semester:** Second (II)
Course Code: Z020201	**Course Title:** Co-Curricular: First Aid and Health	
Credits:	**Minor/Core** Qualifying	

Programme/Class: Diploma/ B. Sc. Hons) (II)	**Year:** Second (II)	**Semester:** Third (III)
Course Code: B100301T	**Course Title:** Bioinformatics & Biostatistics	

Course Outcomes (COs)

After completion of the course, students will be able t:-

CO1: learn the need of statistical approach, identify the different axiomatic approach.
CO2: learn to study the variability of observation.
CO3: know effective use of Office package–word, excel, ppt and publisher etc
CO4: understand simple calculation using excel
CO5: understand the basic theories and practicals of common computational tools and databases which facilitate investigation of molecular biology and evolution-related concepts.
CO6: critically analyse and interpret results of their studies with the help of bioinformatical and biostatistical tools.

Credits: 4	**Major/Core**	
Unit	**Topics**	**No. of Lectures**
I	History of Bioinformatics. Sequence Information Sources, EMBL, GENBANK, Entrez, Unigene, Understanding the structure of each source and using it on the web. Components of a computer system, Input and output devices. Computers in biology and medicine.	12
II	General Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL), Protein databases (Primary, Composite, and Secondary). Specialized Genome databases: (SGD, TIGR, and ACeDB).Structure databases (CATH, SCOP, and PDBsum) File Format (Genbank, DDBJ, FASTA, PDB, SwissProt).	12
III	Local alignment and Global alignment (algorithm and example), Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal W algorithm). Introduction to BLAST, Using it on the web, Interpreting results, Phylogenetic Analysis.	12
IV	Primary and Secondary data, Classification and Graphical representation of Statistical data. Measures of central tendency and Dispersion. Measures of Skewness and Kurtosis.	12
V	Definition of probability, Theorems on total and compound probability Elementary ideas of Binomial, Poisson and Normal distributions. Problems on test of significance, t-test, Chi-square test. Correlation and Regression	12

Suggested Reading

1. Biostatistics– Garret
2. Encyclopedia of Biostatistics– Peter Armitage & Theodore Colton
3. Statistics–Schaum's Series Publication.
4. Statisticalanalysis–AcomputerorientedapproachIIndEd. AcademicPressNew York
5. Fundamentals of statistics– D. N. Elhance
6. Statistical methods for research workers– Central publisher Ludhiana.
7. Bioinformatics: A practical guide to the analysis of genes &Proteins– Ed. Andreas,
8. Computer–Schaum Series Publication.

Suggested link

1. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-092-bioinformatics-and-proteomics-january-iap-2005/lecture-notes/
2. https://ocw.mit.edu/courses/biology/7-91j-foundations-of-computational-and-systems-biology-spring-2014/
3. https://ocw.mit.edu/courses/biology/7-91j-foundations-of-computational-and-systems-biology-spring-2014/lecture-slides/

Programme/Class: Diploma/B. Sc. (Hons) (II)	**Year :**Second (II)	**Semester:** Third(III)
Course Code:B100301P	**Course Title:** Bioinformatics & Biostatistics Lab	
Credits: 2	**Major/Core**	

Topics	No. of Lectures(hr)
1. Sequence information resource, Understanding and use of various web resources: EMBL, Genbank, Entrez, Unigene, 2. Protein information resource (PIR) 3. Understanding and using: PDB, Swissprot, TREMBL 4. Using various BLAST and interpretation of results. 5. Retrieval of information from nucleotide databases. 6. Sequence alignment using BLAST. **Practicals:** 1.Based on graphical Representation 2.Based on measures of Central Tendency &Dispersion 3.Based on Distributions Binomial Poisson Normal 4.Based on t, f, z and Chi-square	60

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Programme/Class: Diploma/ B. Sc. (Hons) (II)	**Year:** Second (II)	**Semester:** Third (III)
Course Code: B100302T	**Course Title:** Enzymology	

Course Outcomes (COs)

After Completion of the course the students will be able to know:

CO1: the general aspects of enzymes

CO2: enzyme classification

CO3: mechanism of enzyme action

CO4: enzyme-Enzyme interaction

CO5: application of Immobilized and soluble enzyme in industry

Credits:4	**Major/Core**

Unit	Topics	No. of Lectures
I	Brief description of general aspects of enzymes, enzyme techniques, kinetics, mechanism of enzyme action-enzyme specificity active sites, mechanism at active sites, covalent catalysis, acid base catalysis, proximity and orientation effects, zymogen, multi enzyme complexes, enzyme technology.	12
II	Isolation, crystallization and purification of enzymes, test of homogeneity of enzyme preparation, methods of enzyme analysis. Enzyme classification (rationale, overview and specific examples) Zymogens and their activation (Proteases and Prothrombin). Enzyme substrate complex: concept of E-S complex, binding sites, active site, specificity, Kinetics of enzyme activity, Michaelis-Menten equation and its derivation, Different plots for the determination of Km and Vmax and their physiological significance, factors affecting initial rate, E, S, temp. & pH. Collision and transition state theories, Significance of activation energy and free energy.	12
III	Two substrate reactions (Random, ordered and ping-pong mechanism) Enzyme inhibition types of inhibition, determination of Ki, suicide inhibitor. Mechanism of enzyme action: General mechanistic principle, factors associated with catalytic efficiency: proximity, orientation, distortion of strain, acid-base, nucleophilic and covalent catalysis. chemical modification of active site groups, specific examples-: chymotrypsin, Iysozyme, GPDH, aldolase, RNase, Carboxypeptidase and alcohol dehydrogenase. Enzyme regulation: Product inhibition, feed backcontrol, covalent modification.	12
IV	Allosteric enzymes with special reference to aspartate transcarbomylase and phosphofructokinase. Qualitative description of concerted and sequential models. Negative cooperativity and half site reactivity. Enzyme - Enzyme interaction, Protein ligand binding, measurements analysis of binding isotherm, cooperativity, Hill and scatchard plots, kinetics of allosteric enzymes.	12
V	Enzyme Technology: Methods for large scale production of enzymes. Immobilized enzyme and their comparison with soluble enzymes, Methods for immobilization of enzymes. Immobilized enzyme reactors. Application of Immobilized and soluble enzyme in health and industry. Application to fundamental studies of biochemistry.	12

Suggested Reading

1. Biochemistry, Lubert Stryer, 6th Edition, WH Freeman, 2006.
2. Harper's illustrated Biochemistry by Robert K. Murray, David AB ender, Kathleen
3. M. Botham, Peter J. Kennelly, Victor W. Rodwell, P. Anthony Weil. 28th Edition, McGraw Hill, 2009.
4. Biochemistry, Donald Voet and Judith Voet, 2nd Edition, Publisher: John Wiley and Sons, 1995.
5. Biochemistry by Mary K. Campbell & Shawn O. Farrell, 5th Edition, Cenage Learning, 2005.
6. Fundamentals of Enzymology Nicholas Price and Lewis Stevens Oxford University
7. Press1999
8. FundamentalsofEnzymeKineticsAthelCornish-BowdenPortlandPress2004 Practical Enzymology Hans Bisswanger Wiley–VCH 2004
9. TheOrganicChemistryofEnzyme-catalyzedReactionsRichardB.Silverman Academic Press 2002

Programme/Class: Diploma/ B. Sc. (Hons) (II)	**Year:** Second (II)	**Semester:** Third (III)
Course Code: B100302P	**Course Title:** Enzymology Lab	
Credits: 2	**Major/Core**	

	Topics	**No. of Lectures**
	1. Demonstration of aseptic technique: Work place for aseptic handling; packing glassware (flasks, test tubes, pipettes, petridishes) for sterilization; aseptic transfer of liquids (pipetting from flask to test tube). 2. Determination of activities of digestive enzymes viz. Amylase, Pepsin, Trypsin, Lipase etc. 3. Study of effect on activity of any enzyme of various factors like pH, Temperature, Activator, Inhibitor 4. Routine human blood tests like RBC, WBC, DWBC, Hb content, blood 5. sugar.	60

Programme/Class: Diploma/B. Sc. (Hons) (II)	**Year:** Second (II)	**Semester:** Third (III)
Course Code: B100303T	**Course Title:** Industrial Biotechnology	

Course Outcomes(COs)

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

CO1: understand the industrial bioprocess & lab design
CO2: understand the development of new strains
CO3: assess the composition of fermentation media
CO4: understand the fundamentals of economics of industrial bioprocesses
CO5: understand the Industrial production of alcohol, Antibiotics etc.

Credits: 4	**Major/Core**	
Unit	**Topics**	**No. of Lectures**

I	Introduction, history and scope of industrially important microorganisms. Biology of industrial Microorganisms: Cell growth, Microbial growth kinetics, factors affecting growth, Basic nutrition, Primary metabolism, Secondary Metabolism, Regulation of Metabolism.	12
II	Screening for new metabolites: primary and secondary products. Introduction to Industrial Bioprocess & Lab Design, Isolation, preservation and maintenance of industrial microorganisms, Development of new strains through, mutations, recombination, and other recent genetic/biochemical methods.	12
III	Fermentation Media: Media composition, Media sterilization, Contamination, Inoculum media, Media economics, Screening for Fermentation media. Substrates for fermentation: Nature, types and availability.	12
IV	Design and working of a typical bio reactor. Introduction to Economics of a fermentation process, determination of cost and its recovery, cost cutting strategies, cell and enzyme immobilization, biological waste treatment, hygiene and safety in fermentation industries. Product value Assessment and competence improvement.	12
V	Industrial production of- alcohol (ethanol), acids (acetic gluconic and citric), Antibiotics (penicillin) amino acids (glutamic acid and lysine), Single cell protein.	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**: (Pergamonpress Oxford), Aditya Book Pvt. Ltd, N. Delhi.
6. Process Biotechnology Fundamental– S. N. Muckhopadhyay, **Pub**: Viva Books Pvt. Ltd.
7. Bioprocess Engineering– Wolf R. Vieth., **Pub**: John Willey Inc.
8. Biochemical engineering fundamentals by Baily JE and Ollis DF, **Pub**: Mcgrawhill Book co. New York Bioprocess Engineering by Pauline M Doran.

Programme/Class: Diploma/ B. Sc. (Hons) (II)	**Year:** Second (II)	**Semester: Third** (III)
Course Code: B100303P	**Course Title:** Industrial Biotechnology Lab	
Credits: 2	**Major/Core**	

	Topics	No. of Lectures

	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.	60

Programme/Class: Diploma/ B. Sc. (Hons.) (II)	**Year:** Second(II)	**Semester:** Third (III)
Course Code:	**Course Title:** Minor Elective (Other faculty)	
Credits:4	**Major/Core**	
Programme/Class: Diploma/ B. Sc. (Hons.) (II)	**Year:** Second (II)	**Semester:** Third (III)
Course Code:	**Course Title:** Vocational Skill Development course	
Credits: 3	**Major/Core**	
Maximum Marks: As per University norms	**Minimum Passing Marks:** As per University norms	

Programme/Class: Diploma/ B. Sc. (Hons.)(II)	**Year:** Second (II)	**Semester:** Third (III)
Course Code: Z030301	**Course Title:** Co-Curricular: Human Values and Environment studies	
Credits: As per University norms	Minor/Qualifying	

Programme/Class: Diploma/ B. Sc. (Hons) (II)	**Year:** Second (II)	**Semester:** Fourth (IV)
Course Code: B100401T	**Course Title:** Bioprocess Technology	

Course Outcomes (COs)

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

CO1: understand Range of bioprocess technology

CO2: understand the Basic principle components of fermentation technology.

CO3: understand the Principles of upstream and downstream processing..

CO4: understand the oxygen requirement in bioprocess.

CO5: understand the Microbial production alcohol

Credits: 4 **Major/Core**

Unit	Topics	No .of Lectures
I	Introduction to bioprocess technology. Range of bioprocess Technology and its chronological development.	12
II	Basic principle components of fermentation technology. Types of microbial culture and its growth kinetics– Batch, Fed batch and Continuous culture.	12
III	Design of bioprocess vessels- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Mechanically and non-mechanically agitated reactors and their application. Principles of upstream and downstream processing.	12

IV	Mass Transfer and Downstream Processing: Fluids and its properties, Non-Newtonian fluids, introduction to transport phenomena, Gas– liquid mass transfer, mass transfer resistances, and determination of oxygen transfer coefficient;	12
V	Recovery and purification of products from fermentation broth, Main Unit Operations in downstream processing, Membrane separation (microfiltration and ultrafiltration), Disruption of microbial cells.	12

Suggested Reading

1. 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.
ProcessBiotechnologyFundamental–S.N.Muckhopadhyay,**Pub**:VivaBooksPvtLtd
6. Bioprocess Engineering– Wolf R. Vieth., **Pub**: John Willey Inc.

Programme/Class: Diploma/B. Sc. (Hons) (II)	**Year:** Second (II)	**Semester:** Fourth (IV)
Course Code: B100401P	**Course Title:** Bioprocess Technology Lab	
Credits: 2	**Major/Core**	

	Topics	**No. of Lectures**
	1. Isolation and screening of bacteria/fungi & industrial importance from soil 2. Demonstration of replicaplating techniques. 3. Demonstration of surface and submerged fermentations. 4. Study of design and working of a typical fermenter (lab scale)	60

Programme/Class: Diploma/B. Sc. (Hons) (II)	**Year:** Second (II)	**Semester:** Fourth (IV)
Course Code: B100402T	**Course Title:** Environmental Biotechnology	
Course Outcomes (COs)		

After Completion of the course the students will be able to:
CO1: learn fundamentals of Environmental Biotechnology.
CO2: understand the importance of clean (pollution free) environment
CO3: Understand Treatment of municipal waste and Industrial effluents.
CO4: Understand the role of symbiotic and a symbiotic nitrogen fixing bacteria.
CO5: Understand biotechnological solutions to address environmental issues including pollution, mineral resource winning, renewable energy and water recycling.

Credits:4	**Major/Core**	
Unit	**Topics**	**No. of Lectures**
I	Conventional fuels and their environmental impact – Firewood, Plant, Animal, Water, Coal and Gas. Modern fuels and their environmental impact– Methanogenic bacteria, Biogas, Microbial hydrogen Production, Conversion of sugar to alcohol Gasohol	12
II	Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes. Phyto-remediation. Degradation of pesticides and other toxic chemicals by micro-organisms- degradation aromatic and chlorinated hydrocarbons and petroleum products.	12
III	Treatment of municipal solid waste and Industrial effluents. Sewage treatment and biofertilizers**:** Treatment of municipal waste and Industrial effluents.	12
IV	Bio-fertilizers: Role of symbiotic and a symbiotic nitrogen fixing bacteria in the enrichment of soil. Algal and fungal biofertilizers (VAM)Bio-fertilizers: Role of symbiotic and a symbiotic nitrogen fixing bacteria in the enrichment of soil. Fungal and cynobacterial biofertilizers.	12
V	Bioleaching, Enrichment of ores by microorganisms (Gold, Copper and Uranium). Environmental significance of genetically modified microbes in environmental cleanup, Zoo-remediation.	12

Suggested Reading

1. Fundamentals of Ecology– Odum, **Pub**: Nataraj Publication.
2. Ecology: Principal & Application–Chapman, **Pub**: Cambridge Univ. Press.
3. Encyclopedia of Environment & Pollution-**Pub**: Jaico Publication House.
4. Plant Ecology- Ambastand Ambast., **Pub**: CBS Publication.
5. Environment & Pollution- Ambastand Ambast., **Pub**: CBS Publication.

Programme/Class: Diploma/B. Sc. (Hons) (II)	**Year: Second** (II)	**Semester: Fourth (IV)**
Course Code: B100402P	**Course Title:** Environmental Biotechnology Lab	
Credits: 2	**Major/Core**	

	Topics	**No. of Lectures**

	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.	60

Programme/Class: Diploma/B. Sc. (Hons) (II)	**Year:** Second (II)	**Semester:** Fourth (IV)
Course Code: B100403T	**Course Title:** Genetic Engineering	

Course Outcomes (COs)

After Completion of the course the students will be able to

CO1: gain knowledge on the foundation of genetic engineering and their applications in biological research as well as in biotechnology industries.

CO2: understand gene concept, plasmids, and wide range of techniques, especially modern molecular tools in diagnosis.

CO3: acquainted with various techniques of genetic engineering and their applications in biological research, diagnostics as well as in biotechnology industries.

CO4: understand the basic principles of PCR

CO5: understand the Strategies for gene transfer to plant cells

Credits:4 **Major/Core**

Unit	Topics	No. of Lectures
I	Molecular tools and applications -Restriction and modification system (restriction enzymes, ligases, polymerases, alkaline phosphatase), restriction mapping. Cloning vectors: Episomes, Plasmids and other cloning vectors (Bacteriophage- derived vectors, artificial chromosomes),	12
II	DNA delivery methods: Transformation, Microinjection, Electroporation, Biolistics. Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR.	12
III	Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, DNA fingerprinting, Applications of Genetic Engineering Genetic engineering in medical, agriculture and environment.	12
IV	Random and site-directed mutagenesis: Primer extension and PCR based Methods of site directed mutagenesis, Random mutagenesis.	12
V	Genetic engineering in plants: Use of *Agrobacterium tumefaciens* and *A. rhizogenes*, Ti plasmids, Strategies for gene transfer to plant cells, Direct DNA transfer to plants, Gene targeting in plants, Use of plant viruses as Episomal expression vectors.	12

Suggested Reading

1. DNA Cloning: a Practical Approach, D.M. Glover and B.D. Hames, **Pub:** IRL Press, Oxford.
2. Molecular Cloning: A laboratory Manual Vol. 1-3, - J. Sambrook & Russel. **Pub:** Cold Spring Harbor Laboratory Press, NY.
3. Molecular Biotechnology– S.B. Primrose, **Pub:** Blackwell Scientific Publishers, Oxford
4. Principals of Gene Manipulation– S. Primrose, R. Twyman & Bob Old **Pub:** Blackwell Scientific Publishers, Oxford.
5. Essential Molecular Biology: A practical Approach, Vol.1, 2– T.A. Brown.
6. Molecular Biology: A Project Approach– Susan J. Karcher.
7. Gene Cloning: An Introduction– T.A. Brown.

Programme/Class: Diploma/B. Sc. (Hons) (II)	**Year:** Second (II)	**Semester:** Fourth (IV)
Course Code: B100403P	**Course Title:** Genetic Engineering Lab	
Credits:2	**Major/Core**	

Unit	Topics	No. of Lectures
	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 re-ligated) 4. Concentration estimation by agarose gel electrophoresis, Restriction digestion.	60

Programme/Class: Diploma/B. Sc. (Hons.)(II)	**Year:** Second(II)	**Semester:** Fourth (IV)
Course Code:	**Course Title:** Vocational Skill Development course	
Credits: 3	**Major/Core**	

Programme/Class: Diploma/B. Sc. (Hons.) (II)	**Year:** Second (II)	**Semester:** Fourth (IV)
Course Code: Z040401	**Course Title:** Co-Curricular: Physical Education and Yoga	
Credits: As per University norms	Minor / Qualifying	

Programme/Class: B.Sc. (Hons) (III)	**Year:** Third (III)	**Semester:** Fifth (V)
Course Code: B100501T	**Course Title:** Biochemical Engineering	

Course Outcomes (COs)

After Completion of the course the students will be able to

CO1: understand fundamentals of Microbial Growth Kinetics
CO2: understand Basic concepts of bioreactors.
CO3: understand Kinetics and Engineering of Sterilization
CO4: understand Mass Transfer and Downstream Processing
CO5: understand Recovery and purification of products.

Credits: 4	Major/Core	
Unit	**Topics**	**No. of Lectures**
I	Microbial Growth Kinetics: Thermodynamic principles, Stationary cell growth, Growth yield, Specific growth rate, Product yield, Saturation constant, Biomass energetics, Yield equations based on YG, YO2, YATP, Maintenance energy, Growth kinetics of batch, fed-batch, plug flow and continuous culture, High cell density cultures; Types of fermentation depending upon the product formation, Product synthesis kinetics, Growth and non-growth associated product synthesis.	12
II	Bioreactors and Scale up: Basic concepts of bioreactors, parameters of biochemical process, packed bed, fedbatch, bubble column, fluidized bed, trickle bed, CSTR, plug flow reactors, Innovative bioreactors, Reactor Dynamics and reactors with non-ideal characteristics; Translation of laboratory, pilot and plant scale data, Criteria for translation between two scale of operation, Scale-up practices; Manual and automatic control system, on-line and off-line analytical instruments.	12
III	Kinetics and Engineering of Sterilization: Kinetics of media sterilization, design of batch sterilization process, D-time, Z-value and F-value, calculation of Del-factor and holding time, Richards rapid method for design of sterilization cycles, Design of continuous sterilization, Air sterilization-design of air filters, Effect of air velocity and bed depth on filtration.	12
IV	Mass Transfer and Downstream Processing: Fluids and its properties, Non-Newtonian fluids, introduction to transport phenomena, Gas–liquid mass transfer, mass transfer resistances and determination of oxygen transfer coefficient;	12
V	Recovery and purification of products from fermentation broth, Main Unit Operations in downstream processing, Membrane separation (microfiltration and ultrafiltration), Disruption of microbial cells.	12

Suggested Reading

1. Biochemical Engineering: Aibaand Hemphery.
2. Biochemical Engineering Fundamentals: J.E. Bailey and D.F. Ollis.
3. Principles of Microbes and Cell Cultivation: S. John Pirt.
4. Bioprocess Engineering Principles: Pauline M. Doran.
5. Principles of fermentation technology: P.F. Stanbury and A. Whitekar.

Programme/Class: B.Sc. (Hons) (III)	**Year:** Third (III)	**Semester:** Fifth (V)
Course Code: B100501P	**Course Title:** Biochemical Engineering Lab	
Credits: 2	**Major/Core**	

	Topics	No. of Lectures
	1. Microbial Growth kinetics- Determination of specific growth rate (max), saturation constant (KS) and 2. Growth yield (YX/S) for *Saccharomyces cerevisiaein* batch culture. 3. Determination of KLa by sulphite oxidation method. 4. Determination of thermal death rate constant and decimal reduction time for E. coli. 5. Disruption of microbial cells (Baker's yeast) for the release of the intracellular protein. 6. Bio-transformation of sucrose into high fructose syrup by Immobilized cell of *Saccharomyces cerevisiae.*	60

Programme/Class: B.Sc. (Hons) (III)	**Year: Third** (III)	**Semester:** Fifth (V)
Course Code: B100502T	**Course Title:** Plant Biotechnology	

Course Outcomes (COs)

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

CO1: have astrong foundation of basics of Plant Biotechnology.
CO2: understand Embryo, Callus, Organs, Cell and Protoplast culture.
CO3: be acquainted with the *In vitro* haploid production.
CO4: understand the principles, practices and applications of, transgenic plant generation, plant tissue culture, plant genomics, and genetic transformation.
CO5: gain knowledge about Plant Growth Promoting Bacteria

Credits: 4	**Major/Core**	
Unit	**Topics**	**No. of Lectures**
I	Introduction to Embryo, Callus, Organs, Cell and Protoplast culture. Micropopagation: advantages and disadvantages of micropropagation, Axillary bud proliferation, Meristem and shoot tip culture, organogenesis and embryogenesis.	12
II	*In vitro* haploid production, Anther culture, significance and use of haploids, Ploidy level and chromosome doubling, diplodization, Gynogenic haploids, factors effecting gynogenesis, chromosome elimination techniques for production of haploids in cereals.	12
III	Protoplast isolation, viability and fusion methods, protoplast development, regeneration frequency.	12
IV	Somatic hybridization, identification and selection of hybrid cells. Cybrids, potential of somatic hybridization and limitations. Somaclonal variation and its applications.	12
V	Plant Growth Promoting bacteria: direct and indirect methods for plant growth promotion.	12

Suggested Reading

1. An Introduction to Plant Tissue Culture: MK Razdan., Pub: Oxford (India).
2. Plant Tissue Culture HDK umar, Pub: Agro Bios. India.
3. Plant Tissue Culture: Kalyan Kumar De: Pub: The New Central Book Agency, Calcutta, India.
4. Fundamentals of Plant Biotechnology– Amla Batra, Pub: Capital Publishing Co.

Programme/Class: B.Sc. (Hons) (III)	**Year:** Third (III)	**Semester:** Fifth (V)
Course Code: B100502P	**Course Title:** Plant Biotechnology Lab	
Credits: 2	**Major/Core**	

	Topics	**No. of Lectures**
	1. Preparation of stock solutions of MS (Murashige & Skoog, 1962) basal medium. 2. To prepare MS media with different concentration of 6-Benzylaminopurine (BAP) for regeneration from leaf of Tobacco. 3. Surface sterilization and inoculation of tobacco leaf explants on MS medium for shoot regeneration. 4. Isolation of plant genomic DNA by modified CTAB method.	60

Programme/Class: B.Sc. (Hons) (III)	**Year:** Third (III)	**Semester:** Fifth (V)
Course Code:B100503T	**Course Title:** Animal Biotechnology	

Course Outcomes (COs)

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

CO1: understand the principles, practices and application of animal biotechnology in Transgenesis, Tissue Engineering, and biopharmaceuticals.
CO2: understand applications of stem cells and tissues engineering.
CO3: learn different gene delivery methods to deliver foreign gene in plants and animals
CO4: know about different products of transgenic animals.
CO5: understand the principles of gene therapy.

Credits: 4	**Major/Core**	
Unit	**Topics**	**No. of Lectures**
I	Gene transfer methods in Animals: Microinjection, Embryonic Stem cell, Viral mediated gene transfer.	12
II	Introduction to transgenesis. Transgenic Animals: Mice, Cow, Pig, Sheep, Goat, Bird, Insect. Animal diseases: Foot and mouth disease, Coccidiosis, Trypanosomiasis and role of biotechnology in disease control.	12
III	Animal propagation– Artificial insemination, Animal Clones. Conservation Biology: Embryo transfer techniques.	12
IV	Introduction to Stem Cell Technology and its applications.	12

V	Genetic modification in Medicine: gene therapy, types of gene therapy, vectors in gene therapy, molecular engineering, human genetic engineering, problems & ethics.	12

Suggested Reading

1. Culture of Animal Cells, R. Ifreshney, **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.

Programme/Class: B.Sc. (Hons.) (III)	**Year:** Third (III)	**Semester:** Fifth (V)
Course Code: Z050501	**Course Title:** Co-Curricular: Analytic Ability and Digital Awareness	
Credits: As per University norms	Minor / Qualifying	
Maximum Marks: As per University norms	**Minimum Passing Marks:** As per University norms	

Programme/Class: B. Sc. (Hons.) (III)	**Year:** Third (III)	**Semester:** Fifth (V)
Course Code: B100504R	**Course Title:** Industrial Training/Surveys/Research Project	
Credits: As per University norms	**Major/Core** Qualifying	
Maximum Marks: As per University norms	**Minimum Passing Marks:** As per University norms	

Programme/Class: B. Sc. (Hons) III)	**Year:** Third (III)	**Semester:** Fifth (V)
Course Code: B100505T	**Course Title:** Basics of Forensic Science	

Course Outcomes (COs)

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

CO1: The significance of forensic science to human society.
CO2: The fundamental principles and functions of forensic science.
CO3: The divisions in a forensic science laboratory.
CO4: The application of DNA profiling in forensic.
CO5: The significance of criminal profiling to mitigate crime.

Credits: 4 **Elective**

Unit	Topics	No. of Lectures
I	Introduction and principles of forensic science, forensic science laboratory and its organization and service, tools and techniques in forensic science, branches of forensic science, causes of crime, role of modusoperandiin criminal investigation.	12
II	Classification of injuries and their medico-legal aspects, method of assessing various types of deaths.	12

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III	Classification of fire arms and explosives, introduction to internal, External and terminal ballistics. Chemical evidence for explosives. General and individual characteristics of hand writing, examination and comparison of hand writings and analysis of ink various samples.	12
IV	Role of the toxicologist, significance of toxicological findings, Fundamental principles of fingerprinting, classification of fingerprints, development of finger print as science for personal identification.	12
V	Principle of DNA fingerprinting, application of DNA profiling in forensic science, Investigation Tools, eDiscovery, Evidence Preservation, Search and Seizure of Computers, Introduction to Cyber security.	12

Suggested Reading

1. B.B. Nandaand R.K. Tiwari, Forensic Sciencein India: A Vision for the Twenty First Century, Select Publishers, New Delhi (2001).
2. M.K. Bhasinand S. Nath, Role of Forensic Science in the New Millennium, University of Delhi, Delhi (2002).
3. S.H. James and J.J. Nordby, Forensic Science: An Introduction to Scientific and Investigative Techniques, 2nd Edition, CRC Press, Boca Raton (2005).
4. W.G. Eckert and R.K. Wright in Introduction to Forensic Sciences, 2nd Edition, W.G. Eckert (ED.), CRC Press, Boca Raton (1997).
5. R. Saferstein, Criminalistics, 8th Edition, Prentice Hall, New Jersey (2004).
6. W.J. Tilstone, M.L. Hastrup and C. Hald, Fisher's Techniques of Crime Scene Investigation, CRC Press, Boca Raton (2013).

Programme/Class: B.Sc. (Hons) (III)	**Year:** Third (III)	**Semester:** Fifth (V)
Course Code: B100506T	**Course Title:** Molecular Diagnostics	

Course Outcomes (COs)

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

CO1: The significance of Enzyme Immunoassays.
CO2: The fundamental principles of RFLP, RAPD.
CO3: The Laboratory tests in chemotherapy.
CO4: The applications. Immunodiagnostic tests.
CO5: The basics of Electron microscopy.

Credits: 4 | **Major/Core**

Unit	Topics	No. of Lectures
I	Enzyme Immunoassays: Comparison of enzymes available for enzyme immunoassays, conjugation of enzymes, immunoblotting. histochemical techniques. Use of polyclonal or monoclonal antibodies in enzymes immunoassays. Applications of enzyme immunoassays in disease diagnosis.	12
II	Applications of PCR, RFLP, RAPD, Nuclear hybridization methods, Single nucleotide polymorphism and plasmid finger printing in clinical microbiology	12
III	Laboratory tests in chemotherapy: Susceptibility tests: Micro-dilution and macro-dilution broth procedures.	12

IV	Automation in microbial diagnosis, standardization of antigen and specific antibodies, Concepts and methods in idiotypes. Anti idiotypes and molecular mimicry and receptors. Epitope design and applications. Immunodiagnostic tests. Immunoflorescence. Radioimmunoassay.	12
V	GLC, HPLC, Electron microscopy, flow cytometry and cell sorting.	12

Suggested Reading

1. Practical Biochemistry, Principles and Techniques, Keith Wilson and John Walker.
2. Advanced Instrumentation, Data Interpretation, and Control of Biotechnological Processes, J.F. VanImpe, Kluwer Academic.
3. Ananthanarayan R and Paniker CKJ. (2005).Text book of Microbiology. 7th edition (edited by Paniker CKJ). University Press Publication.
4. Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's Medical Microbiology. 24th edition. McGraw Hill Publication.

Programme/Class: B.Sc. (Hons) (III)	**Year:** Third (III)	**Semester**: Sixth (VI)
Course Code: B100601T	**Course Title:** IPR, Bioethics and Biosafety	

Course Outcomes (COs)

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

CO1: develop an understanding of concept of Intellectual Property and its types.
CO2: have broad knowledge on of various types of IPRs, its protection and infringement.
CO3: demonstrate the understanding of International treaties and case studies.
CO4: have knowledge of Biosafety, GMOs and various Institutional committees.
CO5: demonstrate a clear understanding of Bioethics and its legal implications.

Credits: 4 **Major/Core**

Unit	Topics	No. of Lectures
I	Introduction of Intellectual properties and rights conferred. Integration of Intellectual Property, Bioethics and Biosafety for biological and applied sciences in research and academia.	12
II	Introduction to Indian Patent Law. World Trade Organization and its related intellectual property provisions. Intellectual/Industrial property and its legal protection in research, design and development. Patenting in Biotechnology, economic, ethical and depository considerations.	12
III	International Agreements and Treaties: International IP treaties (Madrid Agreement, Trademark law treaty, Patent Law treaty etc.) WIPO, EPC, WTO, and TRIPS. International agreements relevant to biotechnology associated IP.	12
IV	Bioethics: Necessity of Bioethics, different paradigms of Bioethics– National &International. Ethical issues against the molecular technologies.	12
V	Biosafety: Introduction to biosafety cabinets and health hazards concerning biotechnology. Introduction to the concept of containment level. and Good Laboratory Practices (GLP) and Good Manufacturing Practices (GMP).	12

Suggested Reading

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

Programme/Class: B.Sc. (Hons) III)	**Year:** Third (III)	**Semester:** Sixth (VI)
Course Code: B100601P	**Course Title**: IPR, Bioethics and Biosafety Lab	
Credits: 2	**Major/Core**	

	Topics	**No. of Lectures**
	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.	60

Programme/Class: B.Sc. (Hons) (III)	**Year:** Third (III)	**Semester:** Sixth (VI)
Course Code: B100602T	**Course Title:** Entrepreneurship	

Course Outcomes(COs)

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

CO1: understand the scope, importance of biotechnology and allied fields.

CO2: role of entrepreneurship in economic development of industry.

CO3: learnt to do Market survey and assessment.

CO4: preparation of Business Plan; learn Forms of business organization/ownership.

CO5: case study of any top three Biotechnology Companies (startup, various stages in establishment, etc.)

Credits: 4	Major/Core	
Unit	**Topics**	**No. of Lectures**
I	Introduction to Biotechnology & Applications: Biotechnology– definition, history, thrust areas of biotechnology; Elements of Bio-Process Engineering; Biotech Industries; Basic concepts of GLP, GMP and FDA; Scope and Importance of Biotechnology and allied fields.	12
II	Definition of Bioentrepreneurship, traits of an entrepreneur; Copyright, Patents, trademark, plant breeders and farmers' rights, biodiversity related issues; Biopiracy, International and Indian business policies with the focus on Bio and Pharmaceutical products.	12
III	Entrepreneurship: Selection of a product, line, design and development processes, economics on material and energy requirement, stock theproduct and release the same for making etc. The basic regulations of excise: Demand for a given product, feasibility of its production under given constraints of raw material, energy input, financial situations export potential etc.	12
IV	Introduction; Entrepreneur and Entrepreneurship; Role of entrepreneurship in economic development; Entrepreneurial competencies and motivation; Institutional Interface for Small Scale Industry/Enterprises.	12
V	Opportunity Scanning and Identification; Creativity and product development process; Market survey and assessment; choice of technology and selection of site Financing new/small enterprises; Techno Economic Feasibility Assessment; Preparation of Business Plan; Forms of business organization/ownership. Case study of any top three Biotechnology Companies (startup, various stages in establishment, etc.)	12

Suggested Reading

1. G.G. Meredith, R.E. Nelson and P.A. Neek, The Practice of Entrepreneurship, ILO, 1982.

2. Dr. Vasant Desai, Management of Small Scale Enterprises, Himalaya Publishing House, 2004.

3. Patzelt, Holger, Brenner, Thomas (Eds.). Handbook of Bioentrepreneurship. Springer, 2008.

4. A Handbook for New Entrepreneurs, Entrepreneurship Development Institute of India, Ahmedabad, 1988.

5. Bruce R Barringer and R Duane Ireland, Entrepreneurship: Successfully Launching New Ventures, 3rd ed., Pearson Edu., 2013. 6. Lee, James W., 2013.

6. Advanced Biofuels and Bioproducts. Springer New York, 7. C.T. Hou, Jei-Fu Shaw, 2008. Biocatalysis and Bioenergy Wiley.

Programme/Class: B.Sc. (Hons) (III)	**Year:** Third (III)	**Semester:** Sixth (VI)
Course Code: B100603T	**Course Title:** Food Biotechnology	

Course Outcomes(COs)

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

CO1: learn the mechanisms of preservation method applied to different food products.

CO2: understand different bioprocesses involved in food production.

CO3: gain knowledge of different streams of agriculture having biotechnological interventions.

CO4: apply knowledge and analyze the problems associated with food and agricultural biotechnology.

CO5: apply these methodologies and techniques for developing modified crops and agricultural products

Credits:4	**Major/Core**

Unit	Topics	No. of Lectures
I	Historical Background, Composition of Food, Improvement of food resources through Biotechnology (e.g. Golden Rice, Flavor savor tomato), Traditional fermented foods (meat, fish, bread, sauerkraut, tea).	12
II	Food Fermentations: Fermented milk, Cheese, Butter, Yoghurt. Alcoholic beverages (Beer, Wine, distilled beverages), Pickles, Soy products.	12
III	Value addition products: High Fructose Corn Syrup, Invert Sugars, Edible fungus: Mushrooms. Concept of pre and Probiotics. Food preservation and storage.	12
IV	Growth of microorganisms in food: Intrinsic and extrinsic factors. Food Spoilage (microbial and non-microbial), Control mechanisms of food spoilage: Physical and Chemical.	12
V	Food and water borne diseases: Gastroenteritis, Diarrhea, Salmonellosis, Typhoid, Cholera, Polio, Hepatitis, Food borne intoxications: Staphylococcal, Bacillus, Clostridium etc. Detection of food-borne pathogens.	12

Suggested Reading

1. Plant Biotechnology- Adrian Slater, Nigel W. Scott and Mark R. Fowler (Text Book).
2. Biotechnology- Expanding Horizons by B.D. Singh.
3. Food Microbiology: Fundamentals and frontiers- M.P. Doyle.
4. Agricultural Biotechnology by Arie Altman.
5. Modern Food Micro Biology James M. Jay.

Programme/Class: B. Sc. (Hons) (III)	**Year:** Third (III)	**Semester:** Sixth (VI)
Course Code: B100603P	**Course Title:** Food Biotechnology Lab	
Credits: 2	**Major/Core**	

	Topics	**No. of Lectures**
	1. Estimation of total plate countinany food sample. 2. Detection of *Salmonella*, *E. coli* in food material. 3. MBRT test of milk samples. 4. Malt preparation for beer making. 5. Cheese making (Non-ripened cheese). 6. Sauerkraut production. 7. Acetic acid/vinegar production and estimation of the product. 8. Toxin detection in the food materials. 9. Effect of internal factors on microbial growth in food i.e. pH, temperature, water activity.	60

Programme/Class: B.Sc. (Hons.) (III)	**Year:** Third (III)	**Semester:** Sixth (VI)
Course Code: Z060601T	**Course Title:** Co-Curricular: Communication Skills and Personality Development	
Credits: As per University norms	Minor / Qualifying	

Programme/Class: B.Sc. (Hons.) (III)	**Year:** Third (III)	**Semester:** Sixth (VI)
Course Code: B100604R	**Course Title:** Industrial Training/Surveys/Research Project	
Credits: As per University norms	**Major/Core** / Qualifying	
Maximum Marks: As per University norms	**Minimum Passing Marks:** As per University norms	

Programme/Class: B.Sc. (Hons) (III)	**Year:** Third (III)	**Semester:** Sixth (VI)
Course Code: B100605T	**Course Title:** Genomics and proteomics	

Course Outcomes (COs)

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

CO1: Students will have a thorough understanding of various genomic technologies such as whole genome mapping & sequencing, comparative genomics.

CO2: know the vast amount of genome information in publically available databases and how to access and best utilize for practical purposes.

CO3: analyze the gene expression datasets to derive the biologically meaning information.

CO4: apply the knowledge of function genomics in public health.

Credits : 4	**Elective**	
Unit	**Topics**	**No. of Lectures**

I	Introduction to Genomics, DNA sequencing methods: manual & automated: Maxam& Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Computer tools for sequencing projects: Genome sequence assembly software.	12
II	Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.	12
III	Introduction to protein structure, Chemical properties of proteins. Physical interactions that determine the property of proteins. Short-range interactions, electrostatic forces, vander waal interactions, hydrogen bonds, Hydrophobic interactions.	12
IV	Introduction to Proteomics, Analysis of proteomes. 2D-PAGE. Sample preparation, solubilization, reduction, resolution. Reproducibility of 2D-PAGE.	12
V	Mass spectrometry based methods for protein identification. Denovo sequencing using mass spectrometric data.	12

Suggested Reading

1. Discovering Genomics, proteomics & bioinformatics. Second edition by A Malcolm Campbell, Davidson College; Laurie J. Heyer Davidson College; With Foreword by Francis S. Collins.
2. Molecular Biology of the Gene (1987) Watson J.D., Hopking N., Robast J. and Steiz, J.
3. Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins (Third edition) Andreas D. Baxevanis & B. F. Francis Ouellette.

Programme/Class: B.Sc. (Hons) (III)	**Year:** Third (III)	**Semester:** Sixth (VI)
Course Code: B100606T	**Course Title:** Animal Physiology	

Course Outcomes (COs)

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

CO1: Understand the Mechanism of digestion & absorption.
CO2: Understand the Composition of blood and functions of heart.
CO3: understand the mechanism of muscle contraction.
CO4: understand the Nervous and endocrine coordination mechanism.
CO5: understand the functions of Different endocrine glands.

Credits: 4 **Major/Core**

Unit	Topics	No. of Lectures
I	Digestive system: Mechanism of digestion & absorption of carbohydrates, Proteins, Lipids and nucleic acids. Composition of bile, Saliva, Pancreatic, gastric and intestinal juice. Respiratory system: Exchange of gases, Transport of O_2 and CO_2, Oxygen dissociation curve, Chloride shift.	12
II	Circulatory system: Composition of blood, Plasma proteins & their role, bloodcells, Haematopoiesis, Mechanism of coagulation of blood.	12

	Mechanism of working of heart: Cardiac output, cardiac cycle, Origin & conduction of heart beat.	
III	Muscular system: physiology and osmoregulation, Structure of cardiac, smooth & skeletal muscle, threshold stimulus, All or None principle, single muscle twitch, muscle tone, isotonic and isometric contraction, Physical, chemical & electrical events of mechanism of muscle contraction. Functions of nephron and Mechanism of urine formation.	12
IV	Nervous and endocrine coordination mechanism of generation & propagation of nerve impulse, structure of synapse, synaptic conduction, saltatory conduction, Neurotransmitters.	12
V	Mechanism of action of hormones (insulin and steroids) Different endocrine glands– Hypothalamus, pituitary, pineal, thymus, thyroid, parathyroid and adrenals, hypo & hyper-secretions.	12

Suggested Reading

1. "Animal Physiology" by N. Arumugam and A. Mariakuttikan.
2. "Essentials of Animal Physiology" by S. C. Rastogi.
3. Ganong's Review of Medical Physiology, Kim E. Barrett, Susan M. Barman. Heddwen L. Brooks, Jason X. J. Yuan.
4. "Principles of Animal Physiology" by Moyes/Schulte.
5. "Animal Physiology" by Schmidt-Nielsen.