SYLLABUS

M.Sc. BIOTECHNOLOGY

(Under SFS)

Choice Based Credit System (CBCS)

M.Sc. (PREVIOUS) EXAMINATION, 2017-18

M.Sc. (FINAL) EXAMINATION, 2018-19

JAI NARAIN VYAS UNIVERSITY

JODHPUR

POST-GRADUATE STUDIES IN BIOTECHNOLOGY

POST-GRADUATE STUDIES IN BIOTECHNOLOGY

General Information for Students

Jai Narain Vyas University (erstwhile University of Jodhpur), Jodhpur (established in July, 1962), had been a residential University operating within the Municipal limits of Jodhpur city. As per notification of Govt. of Rajasthan dated September 26th, 2012 all colleges situated in Barmer, Jaisalmer, Jalore and Pali districts shall be affiliated to Jai Narain Vyas University, Jodhpur. The Department of Botany is situated in the New Campus of the University, near the Bhagat-Ki-Kothi Railway Station along Pali Road.

The Department of Botany imparts post-graduate education in the fields of Plant Sciences and allied subjects. This department has made impressive progress in research and teaching activities during the last 50 years. Students and Researchers work for their Ph.D. and D.Sc. degree in the Department of Botany. About eight laboratories are actively engaged in different areas of plant research. The research and development activities attract national and international attention. Research and Development projects are funded by national and international agencies. These include, The European Economic Community, FAO, UNDP/UNIDO, PL480, CSIR, UGC, DST, DBT, DRDO, DOEn, ICAR, ICFRE, CSB, Ministry of Health and State DST. Since 1980 this department has been receiving grants under Special Assistance Program (SAP) of the University Grants Commission of India. UGC Sponsored SAP-DSA Phase III Program has been successfully completed and the Department is upgraded to **Center of Advanced Study.**Since 1980 grants worth Rs. 500 lakhs have been received for development of infrastructure and for implementation of R&D Projects.

In 1983, on the recommendation of the Science Advisory Committee to the Cabinet (SACC), the University Grants Commission of India launched the COSIST (Committee on Strengthening of Infrastructure in Science and Technology). The basic objective of COSIST is to assist selected Science and Technology departments in the Indian Universities; which has already exhibited and achieved high quality performance to attain excellence in the post-graduate education and research. The department of Botany has been selected for implementation of COSIST program by the UGC from April 1999 for raising the standard of post-graduate education and research to international level. The M.Sc. (COSIST) Botany course under the new scheme was started from July 1999. This department is selected by the Department of Science and Technology, Government of India for support under FIST (Funds for Improvement of S & T Infrastructure). FIST program-I was completed successfully and FIST program-II is in operation.

ACADEMIC AND RESEARCH PROGRAMMES IN PLANT SCIENCES

Under the COSIST programme, the Department of Botany offers a two years integrated program leading to Masters (M.Sc.) degree in Botany. From the academic year 2015-16, the Department offers to students Choice Based Credit System (CBCS) with semesterization of the examination pattern under COSIST programme.

Students are admitted on an all India basis. The basic specializations offered are in the areas of Stress Physiology and Biochemistry, Physiology of Plant Growth, Ecology and Environmental Biology, Plant Microbe-Interactions, Mycology and Plant Pathology, Biological Nitrogen Fixation, Molecular characterization of Bacteria/rhizobia, Bacterial genomics, Microbiology, Genetics and Plant Breeding, Plant Resources, Systematics and Biodiversity, Plant Molecular Biology, Biotechnology, Plant Prospecting and Plant genomics. The Department has facilities for advance research in major areas of plant biology leading to Ph.D. and D.Sc. degree.

FACILITIES

The Department possesses modern equipments required for teaching and research. Major equipments available in the department of Botany are:

- Agarose Electrophoresis System(s)
- Chlorophyll Fluorescence Meter
- Cold Room
- Computer Networking System
- Deep Freezers
- Electrophoresis Systems: 1-D and 2-D
- Electroporation cum Protoplast Fusion System
- Fluorescence Microscop

e
- Gel Documentation Systems
- HPLC system
- Humidifiers and Fog Systems
- Ice making machine
- Incubator(s) and Incubator Shaker
- Industrial Oven
- Laminar Air Flow Benches
- Master Thermal Cycler (PCR Machines)
- Microbial storage facility
- Micropropagation/Green House Facilities
- Microscopes with photo-micrographic and image merging facilities
- Microtome
- Millipore Water Purification System
- Nat Steel Autoclave(s)
- Osmometer
- Plant Canopy Analyzer
- Portable Photosynthetic system Li-6400
- Portable Photosynthetic Systems (CID, USA)
- Real Time-PCR
- Spectrofluorimeter-JASCO
- Steady State Porometer
- Submerged Electrophoresis System
- Super Speed Refrigerated Centrifuge
- Ultra Freezers
- UV-VIS-Spectrophotometers
- Slide/Over head Projectors/ Multimedi a System/ Smart Board

In addition, there are other facilities to work with certain instruments available with U.S.I.C. The Departmental library caters to the needs of post-graduate students, research scholars and the faculty members.

GUIDELINES FOR CHOICE BASED CREDIT SYSTEM:

Definitions of Key Words:

1. **Academic Year**: Two consecutive (one odd + one even) semesters constitute one academic year.
2. **Choice Based Credit System (CBCS):** The CBCS provides choice for students to select from the prescribed elective and skill courses. A student need to select **two elective papers** offered by the Department in which he/she is doing core course this shall be part of core programme during third and fourth semester. Each student has to complete **four skill courses**: two within the Department and two from other Department within JNV University or the Universities approved by JNV University
3. **Course**: Usually referred to, as 'papers' is a component of a programme. All courses need not carry the same weight. The courses should define learning objectives and learning outcomes. A course may be designed to comprise lectures/ tutorials/laboratory work/ field work/ project work/ self-study etc. or a combination of some of these.
4. **Credit Based Semester System (CBSS)**: Under the CBSS, the requirement for awarding a degree is prescribed in terms of number of credits to be completed by the students.
5. **Credit Point**: It is the product of grade point and number of credits for a course.
6. **Credit**: A unit by which the course work is measured. It determines the number of hours of instructions required per week. One credit is equivalent to one period of teaching (lecture or tutorial) or two periods of practical work/field work per week.
7. **Cumulative Grade Point Average (CGPA)**: It is a measure of overall cumulative performance of a student over all semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.
8. **Grade Point**: It is a numerical weight allotted to each letter grade on a 10-point scale.
9. **Letter Grade:** It is an index of the performance of students in a said course. Grades are denoted by letters O, A+, A, B+, B, C, P and F.
10. **Programme**: An educational programme leading to award of the Postgraduate Degree in the Core subject in which he/she is admitted.
11. **Semester Grade Point Average (SGPA)**: It is a measure of performance of work done in a semester. It is ratio of total credit points secured by a student in various courses registered in a

semester and the total course credits taken during that semester. It shall be expressed up to two decimal places.

12. **Semester**: Each semester will consist of 15-18 weeks of academic work equivalent to 90 actual teaching days. The odd semester may be scheduled from July to November/ December and even semester from December/January to May.
Odd semester University examination shall be during second/third week of December and even semester University examination shall be during second/third week of May. The Department shall conduct the Practical examinations of odd and evensemesters as per the Panel of Examiners approved by the University. Each Board of examiners shall consist of one external Examiner from other University/Institute and another from the Department.

13. **Transcript or Grade Card or Certificate:** Based on the grades earned, a statement of grades obtained shall be issued to all the registered students after every semester. This statement will display the course details (code, title, number of credits, grade secured) along with SGPA of that semester and CGPA earned till that semester

Fairness in Assessment

Assessment is an integral part of system of education as it is instrumental in identifying and certifying the academic standards accomplished by a student and projecting them far and wide as an objective and impartial indicator of a student's performance. Accordingly the Faculty of Science resolves the following:

a. All internal assessments shall be open assessment system only and that are based on Quizzes, term test and seminar
b. Attendance shall carry the prescribed marks in all papers and Practical examination CCA
c. In each semester three out of four theoretical component University examination shall be undertaken by external examiners from outside the university conducting examination, who may be appointed by the competent authority

Grievances and Redressal Mechanism

a) The students will have the right to make an appeal against any component of evaluation. Such appeal has to be made to the Head/Principal of the College or the Chairperson of the University Department concerned as the case may be clearly stating in writing the reason(s) for the complaint / appeal.

b) The appeal will be assessed by the Chairman and he/she shall place before the **Grievance Redressal Committee (GRC),** Chaired by the Dean, Faculty of Science comprising all HODs of the Faculty and if need be Course Teacher(s) be called for suitable explanation; GRC shall meet at least once in a semester and prior to CCA finalization.

c) The Committee will consider the case and may give a personal hearing to the appellant before deciding the case. The decision of the Committee will be final.

Table 1: Grades and Grade Points

S.No.	Letter Grade	Meaning	Grade Point
1	'O'	Outstanding	10
2	'A+'	Excellent	9
3	'A'	Very Good	8
4	'B+'	Good	7
5	'B'	Above Average	6
6	'C'	Average	5
7	'P'	Pass	4
8	'F'	Fail	0
9	'Ab'	Absent	0

i. A student obtaining Grade F in a paper shall be considered failed and will be required to reappear in the University End Semester examination.

ii. For noncredit courses (Skill Courses) 'Satisfactory' or "Unsatisfactory' shall be indicated instead of the letter grade and this will not be counted for the computation of SGPA/CGPA

Grade Point assignment

= and > 95 % marks Grade Point 10.0
90 to less than 95 % marks Grade Point 9.5
85 to less than 90 % marks Grade Point 9.0
80 to less than 85 % marks Grade Point 8.5
75 to less than 80 % marks Grade Point 8.0
70 to less than 75 % marks Grade Point 7.5
65 to less than 70 % marks Grade Point 7.0
60 to less than 65 % marks Grade Point 6.5
55 to less than 60 % marks Grade Point 6.0
50 to less than 55 % marks Grade Point 5.5
45to less than 50 % marks Grade Point 5.0
40 to less than 45 % marks Grade Point 4.5
35 to less than 40 % marks Grade Point 4.0

Computation of SGPA and CGPA:

i. The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student,

i.e.

SGPA (Si) = Σ (Ci x Gi) / ΣCi

WhereCi is the number of credits of the ith course and Gi is the grade point scored by the student in the ith course.

ii. The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a programme,
i.e.

CGPA = Σ (Ci x Si) / Σ Ci

where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

iii. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

***Illustration* for SGPA**

S.No.	Course	Credit	Grade letter	Grade point	Credit Point (Credit x Grade)
1	Course 1	**4**	**B**	**6**	**4 x 6 =24**
2	Course 2	**4**	**B+**	**7**	**4 X 7 =28**
3	Course 3	**4**	**B**	**6**	**4X 6 = 24**
4	Course 4	**4**	**O**	**10**	**4 X 10 =40**
5	Course 5- Practical I	**4**	**C**	**5**	**4 X 5 =20**

6	Course 6 – Practical II	**4**	**B**	**6**	**4 X 6 = 24**
	Total	**24**			**24+28+24+40+20+24 =160**

Thus, **SGPA =160/24 =6.67**

***Illustration* for CGPA**

	Semester- I	**Semester-II**	**Semester-III**	**Semester-IV**
Credit	**24**	**24**	**24**	**24**
SGPA	**6.67**	**7.25**	**7**	**6.25**

CGPA = (24X6.67+ 24X 7.25 + 24X7 + 24 X 6.25)/ 96

652.08/96 = 6.79

Semester-wise Theory Papers/Practical / Skill component

Type of course	Course code	Title of the Course	Lecture-Tutorial-Practical/Week	No. of credits	Continuous Comprehensive Assessment (CCA)	End-Semester Examination (ESE) [University Examination]	Total
Semester I							
Core course 1	BT 101	Principles of Microbiology	4-0-0	4	30	70	100
Core course 2	BT 102	Cell and Developmental Biology	4-0-0	4	30	70	100
Core course 3	BT 103	Fundamentals of Immunology	4-0-0	4	30	70	100
Core course 4	BT 104	Basic Molecular Biology	4-0-0	4	30	70	100
Core course practical 1	BT 105	Board I consisting of first two theory papers	0-0-8	4	30	70	100
Core course practical 2	BT 106	Board II consisting of second two theory papers	0-0-8	4	30	70	100
SK	Skill course		2-0-2				
Total				24	180	420	600
Semester II							
Core course 5	BT 201	Principles of Biochemistry	4-0-0	4	30	70	100
Core course 6	BT 202	Genetics and Evolution	4-0-0	4	30	70	100
Core course 7	BT 203	Computational Biology and Bioinformatics	4-0-0	4	30	70	100

Core course 8	BT 204	Bioanalytical Techniques	4-0-0	4	30	70	100
Core course practical 3	BT 205	Board I consisting of first two theory papers	0-0-8	4	30	70	100
Core course practical 4	BT 206	Board II consisting of second two theory papers	0-0-8	4	30	70	100
SK	Skill course		2-0-2				
Total				24	180	420	600
Semester III							
Core course 9	BT 301	Genomics and Proteomics	4-0-0	4	30	70	100
Core course 10	BT 302	Genetic Engineering	4-0-0	4	30	70	100
Core course 11	BT 303	Environmental Biotechnology	4-0-0	4	30	70	100
Core course 12	BT 304	IPR, Biosafety and Bioethics	4-0-0	4	30	70	100
Core course practical 5	BT 305	Board I consisting of first two theory papers	0-0-8	4	30	70	100
Core course practical 6	BT 306	Board II consisting of second two theory papers	0-0-8	4	30	70	100
SK	Skill course		2-0-2				
Total				24	180	420	600
Semester IV							
Core course 13	BT 401	Bioprocess Engineering and Technology	4-0-0	4	30	70	100
Core course 14	BT 402	Plant Biotechnology	4-0-0	4	30	70	100
Core course 15	BT 403	Animal Cell Culture and Application	4-0-0	4	30	70	100
Core course 16	BT 404	Dissertation	4-0-0	4	30	70	100
Core course practical 7	BT 405	Board I consisting of first two theory papers	0-0-8	4	30	70	100
Core course practical 7	BT 406	Board II consisting of second two theory papers	0-0-8	4	30	70	100
SK	Skill course		2-0-2				
Total				24	180	420	600

*** The Department shall offer two skill courses per semester from the list of skill courses approved for the Department.**

In view of the course content, the Department of Botany distributed the Periods between Theory/Tutorial/Practical as under per paper

- 4 : 0 : 0 (four lectures only (no tutorial and no practical) per week) – For Theory
- 0 : 0 : 4 (no lecture, no tutorial, and four practical only per week) – For Practical per paper
- 2+0+2 (two lectures, no tutorial and two practical/field experimentations) – For Skill course

The Duration of the Period shall be forty five minutes. In each of these combinations, the first value stands for the same number of lecture instructions per week, whereas the last two values stand for double the number of tutorial / practical instructions per week.

In each practical group the number of students that can be accommodated will be fifteen.

Course Evaluation (Evaluation of the Students)

All courses (Core/ Elective) involve an evaluation system of students that has the following two components:-

(i) **Continuous Comprehensive Assessment (CCA)** accounting for 30% of the final grade that a student gets in a course; and

(ii) **End-Semester Examination (ESE)** accounting for the remaining 70% of the final grade that the student gets in a course.

(i) **Continuous Comprehensive Assessment (CCA)**: This would have the following components:

a. **Quizzes:** Two Quiz examinations of 45 minutes duration each having a maximum of 40 marks shall be arranged for theory paper during the semester course period

b. **Term Test**: One term test shall be arranged for each theory paper prior to End-Semester Examination; examination duration shall be of three hours; maximum marks shall be 70

c. **Seminar**: Each student shall prepare and deliver a seminar per theory paper; maximum marks shall be 15. The seminar shall commence after first quiz examination and shall be completed prior to term test for all the papers.

d. **Classroom Attendance –** Each student will have to attend a minimum of 75% Lectures / Tutorials / Practicals. A student having less than 75% attendance will not be allowed to appear in the End-Semester Examination (ESE). Attendance shall have 15 marks and will be awarded by following the system proposed below:

Those having greater than 75% attendance (for those participating in Co-curricular activities, 25% will be added to per cent attendance) will be awarded CCA marks as follows:-

75% to 80%	=	3 marks
80% to 85%	=	6 marks
85 to 90%	=	9 marks
90% to 95%	=	12 marks
> 95%	=	15 marks

Each student's cumulative attendance shall be displayed in the Department Notice Board every month with a copy to the Dean, Faculty of Science.

e. CCA are based on open evaluation system without any bias to any student

f. Any grievance received in the Department from student shall be placed before the **Grievance Redressal Committee** with adjudicated comments

Each component marks will be added without rounding and the total thus obtained is ratio by a factor of six. This value shall be rounded.

Condonation of Shortage of attendance shall be governed in accordance with the provisions in the Act and Statute of the University vide Ordinance 78 to Ordinance 80 as amended from time to time.

Illustration: Quiz 1 – Marks obtained = 30
Quiz 2 – Marks obtained = 35.5
Term Test Marks obtained = 50.5
Seminar Marks obtained = 14
Attendance Marks obtained = 9
Total =139.00
Conversion = 139/6 = 21.16666
Award = 22.00

Skill Course Evaluation: Based on his/her performance and hands on practice, the respective Department shall declare the result as "Satisfactory" or "Non-Satisfactory"; each student need to get a minimum of three "Satisfactory" declaration for the course completion

In laboratory courses (having only practical (*P*) component), the CCA will be based on students attendance (50%); collection of plant material (25%) and hands on Practical, records, etc. (25%)

For QUIZ (2 quizzes per semester), 40 marks per Quiz and total of 80 marks, 45 minutes duration for each quiz:

Types of question	Number of Questions	Marks per question	Total marks per type
1. Multiple choice	10	1	10
2. Fill in the blanks			
3. Short answer (15 words)	10	2	20
	5	2	10
Total	25		40

For the Term test and ESE:

Part A

Ten short type questions (Definitions, illustrations, functions, short explanations, etc; 25-50 words) for two marks each. 10 × 2= 20 marks; two questions from each Unit; no choice in this part

Part B

Five short answer (250 words) type questions for four marks each. 5 × 4 = 20 marks; one question from each Unit with internal choice

Part C

Five questions of long/explanatory answer (500 words) type, one drawn from each Unit; student need to answer any three; ten marks each; 3 × 10 = 30 marks

20+20+30 = 70 marks

Qualifying for Next semester

1. **A student acquiring minimum of 40% in total of the CCA is eligible to join next semester**.

2. A student who does not pass the examination (CCA+ESE) in any course(s) (or due to some reason as he/she not able to appear in the ESE, other conditions being fulfilled, and so is considered as 'Fail'), shall be permitted to appear in such failed course(s) in the subsequent ESE to be held in the following October / November or April / May, or when the course is offered next, as the case may be.

3. A student who fails in one or more papers in a semester shall get three more chances to complete the same; if he/she fails to complete the same within the prescribed time, i.e. three additional chances for each paper; the student is ineligible for the Postgraduate degree in the Subject in which he/she is admitted, for additional chances examination fee shall be on additive basis.

Improvement Option:

Every student shall have the opportunity to improve Credit thorough University Examination only. Improvement opportunity for each paper is only with two additional chances; improvement examination fee shall be on additive basis; the Credit obtained in improvement examination shall be final. There shall be no improvement opportunity in Practical examinations**.**

Result Declaration:

The ESE (End Semester Examination/University Examination) results shall be declared within twenty days of the last examination. The Theory/ Practical Classes of even semesters shall begin from the next day of ESE; whereas odd semester classes shall commence after summer vacation.

Students Failed in CCA:

Any student declared "Not Eligible" by the Department based on CCA in Semester I, II, III or IV and accordingly did not appear in ESE; can be readmitted as an additional student in that Semester in the **following year only**. Such student need to deposit the annual university fee as prescribed for that academic year.

POST -GRADUTE COURSE: A DESCRIPTION

The academic program at M.Sc. level is through a semester examination scheme. The course work includes lectures, seminars and laboratory works. It shall be compulsory for all students to attend at least one long distance excursion either to a hill station or to seashore or to desert area for field study and for collection of plant materials for class work in addition to 3 to 4 local excursions. For every 15 students or part thereof, one teacher shall accompany the party.

The full course is of FOUR SEMESTERS spread for TWO YEARS duration. A semester-wise list of courses to be offered is given below:

SEMESTER I

BT 101:	Principles of Microbiology
BT 102:	Cell and Developmental Biology
BT 103:	Fundamentals of Immunology
BT 104:	Basic Molecular Biology
BT 105:	Practical Examination I Covering first two theory Papers
BT 106:	Practical Examination II Covering second two theory Papers
SC I	Skill Course(for students of Biotechnology Department only)

SEMESTER II

BT 201:	Principles of Biochemistry
BT 202:	Genetics and Evolution
BT 203:	Computational Biology and Bioinformatics
BT 204:	Bioanalytical techniques
BT 205:	Practical Examination I Covering first two theory Papers
BT 206:	Practical Examination II Covering second two theory Papers
SC II	Skill Course (for students of other Departments)

SEMESTER III

BT 301:	Genomics and Proteomics
BT 302:	Genetic Engineering
BT 303:	Environmental Biotechnology
BT 304:	IPR, Biosafety and Bioethics
BT 305:	Practical Examination I Covering first two theory Papers
BT 306:	Practical Examination II Covering second two theory Papers
SC III	Skill Course (for students of Biotechnology Department only)

SEMESTER IV

BT 401:	Bioprocess Engineering and Technology
BT 402:	Plant Biotechnology

BT 403: Animal Cell Culture and Application
BT 404: Dissertation
BT 405: Practical Examination I Covering first two theory Papers
BT 406: Practical Examination II Covering second two theory Papers
SC IV Skill Course (for students of other Departments)

Skill Courses in Biotechnology

BT-SC-1 BIOFERTILIZERS
BT-SC- 2 BIOREMEDIATION
BT-SC- 3- IMMUNOTECHNOLOGY
BT-SC- 4- INTELLECTUAL PROPERTY RIGHTS
BT-SC- 5- BIOINFORMATICS
BT-SC- 6- MICROPROPAGATION
BT-SC- 7- MOLECULAR TECHNIQUES

ADMISSION

The minimum qualification for admission to M.Sc. Course is B.Sc. (10+2+3) degree with **Botany/ Biotechnology/ Zoology as a major subject with Chemistry as compulsory subject.** The details of eligibility conditions and admission procedure are given in the admission form. The admission will be done on the basis of merit calculated by the aggregate marks obtained at the B.Sc. level including the marks award under the category (a) and (b) mentioned in the admission from [i.e. (a) benefit to the candidates who are resident of Rajasthan, and (b) benefit for candidates of J. N. Vyas University, Jodhpur]. Reservation of Scheduled Caste/Scheduled Tribes/Disabled/OBC and Teacher candidates will be as per university rules. The candidates are required to attend minimum of a 75% of classes in both theory and practical.

TEACHING AND EXAMINATION SCHEME

Per Semester

Course	Periods/Week	Examination hours	CCA	ESE	Total
Theory Papers					
Course I	4	3	30	70	100
Course II	4	3	30	70	100
Course III	4	3	30	70	100
Course IV	4	3	30	70	100
Practical Courses					
Board I	8 per paper	6	30	70	100
Board II	8 per paper	6	30	70	100

Students are required to pass in theory and Practical Board individually in each semester.

UNIVERSITY EXAMINATION

Each course paper shall be of three hours duration.
The model examination schedule for odd semester shall be:

Day	Morning session	Next session
1	Paper I Semester I	Paper I semester II

2	Paper I Semester III	Paper I semester IV
3	Paper II Semester I	Paper II semester II
4	Paper II Semester III	Paper II semester IV
5	Paper III Semester I	Paper III semester II
6	Paper III Semester III	Paper III semester IV
7.	Paper IV Semester I	Paper IV semester II
8	Paper IV Semester III	Paper IV semester IV

The model examination schedule for Even semester shall be:

Day	Morning session	Next session
1	Paper I Semester II	Paper I semester I
2	Paper I Semester IV	Paper I semester III
3	Paper II Semester II	Paper II semester I
4	Paper II Semester IV	Paper II semester III
5	Paper III Semester II	Paper III semester I
6	Paper III Semester IV	Paper III semester III
7.	Paper IV Semester II	Paper IV semester I
8	Paper IV Semester IV	Paper IV semester III

PRACTICALS

The practical examination in M.Sc. (Prev.) and M.Sc. (Final) shall consist of Two Parts- Board I and Board II for all the four semesters

BOARD I: Maximum Marks: 100 (including 30% CCA). It includes course work of two theory papers. Duration: Six hours in a single day.

BOARD II: Maximum Marks: 100 (including 30% CCA). It includes course work of next two theory papers. Duration: Six hours in a single day.

In the fourth Semester, Board II shall also evaluate the dissertation submitted by the student that is the part of Practical examination. Each student shall submit one dissertation allotted by lottery between two special papers.

Note: Number of elective to be taught from each group in a particular year shall be decided by the Department. Elective offered will be announced at the beginning of the academic session. Each student shall be assigned one Elective paper from Group ONE and the second from Group TWO. Elective papers will be allotted on merit-cum-choice basis with equal number of students in each paper.

SEMESTER – I

BT 101: PRINCIPLES OF MICROBIOLOGY

Unit I

History of Microbiology; A general account on ultrastructure, nutrition, reproduction, biology and economic importance of Archaebacteria, Eubacteria and Cyanobacteria. Recent trends in the classification of bacteria.

Genetic recombination in bacteria: Transduction, Conjugation & Transformation

Unit II

Microbial growth: Batch culture, methods of growth estimation, stringent response, death of a bacterial cell, growth as affected by environmental factors like temperature, acidity, alkalinity, water availability and oxygen

Microbial physiology: Photosynthesis; Chemolithotrophy: Hydrogen and iron oxidizing bacteria; Sulfate reduction.

Unit III

General Account of Viruses: Bacterial viruses, life cycle and regulation of λ-Phage; biology of animal viruses-Herpes, Adenovirus, Retrovirus, biology of plant viruses- CaMV, Gemini and TMV.

Host response to infectious diseases – Influenza virus, *Mycobacterium* & *Plasmodium*; Molecular basis of host pathogen interactions in plants – HR & SAR.

Unit IV

Bacterial mutants and mutations: Isolation; Useful phenotypes (auxotrophic, conditional, lethal, resistant); Mutation rate; Types of mutations (base pair changes; frameshift; insertions; deletions; duplication); Mutagenic agents; Mechanisms of mutagenesis; Assay of mutagenic agents (Ames test).

Ecological impacts of microbes: Symbiosis (Nitrogen fixation, Mycorrhizal Symbiosis and ruminant symbiosis), Microbes and Nutrient cycles; Antimicrobial agents: Sulfa drugs, Penicillin and cephalosporin and Mode of action.

Bacterial two component signaling system; Bacterial Quorum sensing and Biofilm production

Unit V

Molecular methods in assessing microbial diversity; Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis(TGGE), Amplified rDNA Restriction Analysis, Terminal Restriction Fragment Length Polymorphism (T-RFLP), 16S rDNA sequencing and Ribosomal Database Project.

Suggested Readings:

1. Buchanan, BB, Gruissem, W & Jones, RL 2002, *Biochemistry & Molecular Biology of Plants*, American Society of Plant Biologist, Rockville, Maryland, USA.
2. Crueger, W & Crueger, A 1990, *Biotechnology: A textbook of Industrial Microbiology*, 2sub edn, Sinaeur Associates.

3. Madigan, MT & Martinko, JM 2006, *Biology of Microorganisms*, 11th edn, Pearson Prentice Hall, USA.
4. Maloy, SR, Cronan, JE Jr., & Freifelder, D 2006, *Microbial Genetics*, Jones Bartlett Publishers, Sudbury, Massachusetts.
5. Pelczar, MJ Jr., Chan, ECS & Kreig, NR 1993, *Microbiology*, 5th edn, Tata McGraw Hill.
6. Reed, G (Ed.) 1987, *Prescott & Dunn's Industrial Microbiology*, 4th edn, CBS Publishers & Distributors, New Delhi.
7. Willey, JM, Sherwood, LM & Woolverton, CJ 2008, *Prescott, Harley and Klein's Microbiology*, 7th edn, McGraw Hill.

BT 102: CELL AND DEVELOPMENTAL BIOLOGY

Unit I

Membrane Structure and Function:Structural models; Composition and dynamics; Transport of ions and macromolecules; Pumps, carriers and channels; Endo- and Exocytosis; Membrane carbohydrates and their significance in cellular recognition.

Unit II

Nucleus – Structure and function of nuclear envelope, lamina and nucleolus; Chromatin organization and packaging; Cell cycle and regulatory mechanisms; Mitochondria and Chloroplast – Origin, structure, function, genome and biogenesis; Male sterility in plants.

Unit III

Structure and function of microbodies, Golgi apparatus, Lysosomes and Endoplasmic Reticulum; Organization and role of microtubules and microfilaments; Actin-binding proteins and their significance; Molecular motors; Intermediate filaments; Cellular junctions and adhesions; Structure and functional significance of plasmodesmata. extra- cellular matrix in plants and animals.

Unit IV

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants;

Gametogenesis, fertilization and early development in Animals: Production of gametes, cell surface molecules in sperm-egg recognition in animals; zygote formation, cleavage, blastula formation, gastrulation and formation of germ layers in animals; embryogenesis

Unit V

Gametogenesis, fertilization and early development in Angiosperms: Production of gamete, Pollination and Self-incompatibility and molecular interactions, fertilization, embryo sac development and double fertilization in plants; seed formation and germination.

Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in *Dictyostelium*; axes and pattern formation in *Drosophila*; organogenesis – vulva formation in *Caenorhabditis elegans*; eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development-larval formation, metamorphosis; environmental regulation of normal development; sex determination.

Suggested Readings:

1. Alberts, B, Bray, D, Lewis, J, Raff, M, Roberts, K & Watson, JD 1999, *Molecular Biology of the Cell*, 3rdedn, Garland Publishing lnc, New York.
2. Gilbert, SF 2013, *Developmental Biology*, 10th edn, Sinauer Associates, Sunderland, MA, USA
3. Geoffrey, M, Cooper & Robert EH 2007, *The Cell: A Molecular Approach*, 4thedn, ASM Press and Sinauer Associates Inc, USA.
4. Gunning, BES & Steer, MW 1995, *Plant Cell Biology: Structure and Function*, Jones and Bartlett Publishers, Boston, Massachusetts, USA.
5. Harris, N &Oparka, KJ 1994, *Plant Cell Biology: A Practical Approach*, IRL Press, Oxford University Press, Oxford, UK.
6. Hardin, J, Bertoni, G & Kleinsmith, LJ 2012, *Becker's-World of Cell*, Pearson Benjamin Cummings, San Francisco, CA, USA
7. Karp G & Vander GP 2005, *Cell and Molecular Biology: Concepts and Experiments*,4thedn, John Wiley & Sons Inc, USA.
8. Kleinsmith, LJ & Kish, VM 1995, *Principles of Cell and Molecular Biology*, Harper Collins College Publishers, New York, USA.
9. Lodish, H, Berk, A, Zipursky, SL, Matsudaira, P, Baltimore, D& Darnell, JE 1999, *Molecular Cell Biology* 4thedn, W.H. Freeman and Company, New York.
10. Slack, JMW 2012, *Essential Developmental Biology*, 3rd edn, Wiley-Blackwell, UK.
11. Wolpert, L & Tickle, C 2010, *Principles of Development*, Oxford University Press, UK.

BT 103: FUNDAMENTALS OF IMMUNOLOGY

Unit I

Components of innate and acquired/adaptive immunity. Haematopoiesis; Organization and structure of organs and cells of the immune system- primary and secondary lymphoid organs, lymphoid cells- B and T cells, Blood cells- granular and agranular cells, Natural killer cells; Nature and biology of antigens – immunogen and hapten.

Unit II

Basics of self –non-self recognition and discrimination; B-cell maturation, activation and differentiation; Immunoglobulins-basic structure, classes and subclasses of immunoglobulins, antigenic determinants; Multigene organization of immunoglobulin genes; Generation of antibody diversity; Major Histocompatibility Complex - MHC types, Immune responsiveness and disease susceptibility, HLA typing.

Unit III

T-cell maturation,activation and differentiation and T-cell receptors, Cell-mediated immune responses. Cytokines-properties and therapeutic uses; Antigen processing and presentation-endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; Antigen-antibody interactions- Precipitation, agglutination and complement mediated immune reactions.

Unit IV

Active and passive immunization; Live, killed, attenuated, sub unit vaccines.; Vaccine technology- Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines; Antibody engineering- Hybridoma Technology, chimeric and humanized

monoclonal antibodies. Catalytic antibody- Abzyme; Immunotechniques: Chromatin immunoprecipitation, ELISA, RIA, immunofluorescence, FACS and ELISPOT assay

Unit V

Hypersensitivity – Type I-IV, mechanisms and diseases; Autoimmune disorders- Types and causes; Transplantation – Immunological basis of graft rejection; Clinical transplantation and immunosuppressive therapy; Tumor immunology –Tumor antigens; Immune response to tumors and tumor evasion of the immune system, Cancer immunotherapy.

Suggested Readings:

1. Abul K. Abbas & Andrew H 2014, *Basic Immunology: Functions and Disorders of the Immune System*, 4th edn, Saunders Elseviers Pubs. Philadelphia, PA
2. Brostoff, J, Seaddin, JK, Male, D & Roitt, IM 2002, *Clinical Immunology*, 6th Edn, Gower Medical Publishing.
3. Decker, J & Reischl, U 2004, *Molecular Diagnosis of infectious diseases*, Humana Press.
4. Goldsby, RA, Kindt, TJ, Osborne, BA & Kuby 2002, *Immunology*, 6th edn W.H. Freeman & Co. NY.
5. Lydyard, P M, Whelan, A & Fanger Michael W 2002, *Instant notes in Immunology*, Viva Books New Delhi
6. Paul 1999, *Fundamental of Immunology*, 4th edn, Lippencott Raven, USA.
7. Rao, CV 2011, *Immunology-A Text Book* 5th edn, Narosa Publication House, New Delhi.
8. Sinha, JK & Bhattacharya, SA 2006, *Text Book of Immunology*, 2006 Academic Publishers, Kolkata.

BT 104: BASIC MOLECULAR BIOLOGY

Unit I

Prokaryotic and Eukaryotic genome structure and organization, Levels of eukaryotic chromatin organization – Nucleosome, Solenoid & higher- order chromatin structure; Regulation of chromatin structure- nucleosome remodeling.

Unit II

DNA Replication; Repair & Recombination***:*** DNA Replication- initiation, elongation and termination in prokaryotes and eukaryotes, Enzymes and accessory proteins; DNA repair-enzymes; Photoreactivation; Nucleotide excision repair; Mismatch correction; SOS repair; Non-homologous end joining; Recombination: Homologous .

Unit III

Prokaryotic & Eukaryotic Transcription***:*** Prokaryotic Transcription; Prokaryotic Promoters; Mechanism- Initiation, Elongation and Termination-Rho-dependent and independent; Prokaryotic gene expression with reference to inducible and repressible operons.

Eukaryotic transcription and regulation-Initiation, Elongation and Termination; RNA polymerase structure; RNA polymerase I, II, III and IV / V (Plant specific); Eukaryotic promoters ; Transcription factors; Transcriptional and post-transcriptional gene silencing-RNA interference and CRISPR

Unit IV

Post Transcriptional Modifications*:* Processing of mRNA, tRNA, rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; Splicing; RNA editing; Nuclear export of mRNA; mRNA stability.

Translation & Transport: Translation machinery; Ribosomes; Features of genetic code; Prokaryotic and eukaryotic translation, Mechanism of initiation, elongation and termination.

Unit V

Oncogenes and Tumor suppressor genes*:* Viral and cellular oncogenes; Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins; Activation of oncogenes and dominant negative effect; Suppression of tumor suppressor genes.

Suggested Readings:

1. Alberts, B, Johnson,A , Lewis, J, Raff, M, Roberts, K & Walter, P 2007, *Molecular Biology of the Cell*, 5th edn, Garland Science, New York.
2. Pierce, BA 2013 , *Genetics: A Conceptual Approach* ,5th edn ,W.H. Freeman and Company ,NY.
3. Krebs,JE, Goldstein,ES & Kilpatrick,ST 2014, *Lewin's Gene XI*, Jones and Bartlett Publishers, Sudbury, Massachusetts.
4. Lodish, H, Berk, A, Zipursky, SL, Matsudaira ,P, Baltimore, D & Darnell, J 2000, *Molecular Cell Biology*, 4th edn , W.H. Freeman and Co., New York.
5. Snustad, DP & Simmons, MJ 2009, *Principles of Genetics*,4th edn, John Wiley & Sons Inc., USA.
6. Watson, JD ,Baker, TA, Bell, SP, Gann, A, Levine, M & Losick, R 2013, *Molecular Biology of the Gene*,7th edn, Pearson Education, Inc.
7. Watson, JD, Hopkins, NH, Roberts, JW ,Steitz, JA & Weiner, AM 1987, *Molecular Biology of the Gene*, 6th edn ,The Benjamin/ Cummings Publ. Co. Inc, California.

BT 105: PRACTICALS EXCERCISES

1. Compound Microscope
2. Centrifuge
3. Conjugation
4. Aids Virus
5. Quorum Sensing
6. Ames Test
7. N2 Fixation
8. Preparation of culture media for the growth of bacteria and fungi (Nutrient Agar, LB agar, EMB agar, Mckonkey agar and PDA)
9. Separation and identification of microorganisms by streaking and spread plate method.
10. Separation of microorganisms from water and soil by serial dilution method.
11. Study of antibiotic sensitivity of microorganisms by Kirby- Bauer method.
12. Study the effect of temperature, pH, carbon and nitrogen on growth kinetics of bacteria.
13. Staining (Gram's staining and acid fast staining) and enumeration (Haemocytometer) of microorganisms.

14. Determination of thermal death point and thermal death time of microorganisms.
15. Study of various stages of Mitosis from onion root tip.
16. Study of various stages of Meiosis from *Phlox*/*Aloe vera* flower bud.
17. Fluid Mosaic Model Of Plasma Membrane
18. Receptor Mediated Endocytosis
19. Microtubule
20. *C.elegans* As Experimental Organism
21. Cell Cycle And Its Regulation
22. Double Fertilization

BT 106: PRACTICALS EXCERCISES

1. Thymus- As Organ Of Immune System
2. Mhc-T Cell Interaction
3. Superantigen
4. Monoclonal Antibody
5. FACs
6. Plant Based Vaccine
7. Autoimmune Disorder
8. Extraction and visualization of genomic DNA from plants by CTAB method.
9. Extraction and visualization of DNA from blood cells.
10. Extraction and visualization of RNA from plants.
11. Qualitative estimation of carbohydrates & proteins.
12. Quantitative estimation of reducing sugar & total soluble sugar
13. Quantitative estimation of proteins by Bradford's method.
14. Quantitative estimation of DNA by DPA reagent method.
15. Quantitative estimation of RNA by Orcinol method.
16. Separation of amino acids, sugars & plant pigments by TLC
17. Separation of biomolecules by gel permeation chromatography.
18. Study of the effect of various parameters (substrate concentration, enzyme concentration, temperature and pH) on enzyme (peroxidase/ alkaline phosphatase) activity.
19. Quantitatve estimation of Vitamin C from lemon fruits
20. Prepartion of blood smear for identification of leucocytes by Giemsa stain.
21. Separation of leucocytes by dextran method.
22. Performing Immunodiagnostic test to detect diseases- typhoid and malaria.
23. Performing antibody titre by ELISA method.
24. Analysis of antigen- antibody interaction by double diffusion.
25. Analysis of antigen- antibody interaction by Immuno-electrophoresis.

SEMESTER II

BT 201: PRINCIPLES OF BIOCHEMISTRY

Unit I

Chemical basis of life, Water – properties, pH, buffers, covalent and non covalent interactions, Concept of free energy, standard free energy, determination of ΔG for a reaction. Relationship between equilibrium constant and standard free energy change. Redox potentials. High energy phosphate compounds – introduction, phosphate group transfer, free energy of hydrolysis of ATP and sugar phosphates.

Structure and function of Saccharides, Lipids , Amino acids, Nucleic acids and Vitamins

Unit II

Emergent properties of biomolecules in water, Macromolecules; Molecular assemblies; Peptides and covalent structure of proteins; Elucidation of primary and higher order structures; Conformations of proteins (Ramachandran plot, secondary structure, domains, motif and folds). Structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin and ATPase.

Unit III

Enzyme: Historical perspective, general characteristics and structure, nomenclature, IUB enzyme classification, Concept of ES complex, active site, specificity, Michaelis-Menten equation. Different plots for the determination of Km & Vmax and their physiological significances. Collision & transition state theories. Classification of multi substrate reactions. Ping Pong, random & ordered Bi-Bi mechanisms. Enzyme inhibition, reversible inhibitions and their kinetics. Allosteric enzymes.

Unit IV

Primary Metabolic pathways: Glycolysis, Gluconeogenesis, Pentose Phosphate Pathway, Metabolism of Glycogen, Cori cycle, Citric acid cycle, Fatty acid oxidation, Amino acid oxidation, Urea cycle and its regulation..

Unit V

Substrate level phosphorylation,Oxidative Phosphorylation and Photophosphorylation (cyclic and noncyclic), Photorespiration , Carbohydrate biosynthesis in plants, Lipid biosynthesis, Biosynthesis of amino acids, Integration and hormonal regulation of metabolism. Inborn Errors of Metabolism

SUGGESTED READINGS

1 Berg JM, Tymoczko JL & Stryer L 2002, *Biochemistry*, W.H. Freeman and Company.
2 Buchanan, B, Gruissem, BW & Jones, RL 2002, *Biochemistry and Molecular Biology of Plants*. ASPB, Maryland, USA.
3 Cooper, TG 1977, *Tools of Biochemistry*, John Wiley and Sons, New York. USA.
4 Cox, MM & Nelson,DL 2012, *Lehninger Principles of Biochemistry*. W. H. Freeman,

New York, USA.
5 Freifelder D., Physical Biochemistry, 1982, *Application to Biochemistry and Molecular Biology*, W.H. Freeman & Company, San Fransisco, USA.
6 Rao, CNR 2001, *Understanding Chemistry*, Universities Press, Hyderabad. India.
7 Segel IH 1976, *Biochemical Calculations*, John Wiley and sons Inc. New York. USA.
8 Voet D, Pratt CW & Voet JG 2013, *Principles of Biochemistry*, John Wiley and Sons, New York. USA.
9 Zubay, G 2014, Biochemistry, Addison Wesley, Menlo Park, USA.

BT 202: GENETICS AND EVOLUTION

Unit I

Mendelian Genetics: Introduction to genetics; Background and history; Patterns of single gene inheritance-autosomal recessive; Autosomal dominant; X linked inheritance. Role of genetics in medicine; Human pedigrees;
Complicating factors - incomplete penetrance; variable expression; Multiple alleles; Co-dominance; Sex influenced expression

Unit II

Non-Mendelian inheritance patterns: Mitochondrial inheritance; Polygenic inheritance - genetic and environmental variation; Heritability; Analysis of quantitative and qualitative traits.
Developmental genetics: Genes in early development; maternal effect genes; Pattern formation genes; Homeotic genes; Signaling and adhesion molecules.

Unit III

Cytogenetics: Cell division and errors in cell division; Non disjunction; Structural and numerical chromosomal abnormalities – deletion; duplication; translocation; Sex determination; Role of Y chromosome; Genetic recombination; Disorders of sex chromosomes and autosomes.
Molecular cytogenetics - Fluorescence Insitu Hybridization (FISH);Comparative Genomic Hybridization (CGH).

Unit IV

Emergence of evolutionary thoughts: Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection.
Origin of cells and unicellular evolution: Origin of basic biological molecules and polymers; Concept of Oparin and Haldane; Experiment of Miller; The first cell; Evolution of prokaryotes; Origin of eukaryotic cells.
Molecular Evolution: Concepts of neutral evolution, molecular divergence and molecular clocks; Origin of new genes and proteins; Gene duplication and divergence.

Unit V

Genetic variation: Agents of genetic polymorphism; genome polymorphism; uses of polymorphism and molecular markers.
Population genetics and evolution: Phenotype; Genotype; Gene frequency; Hardy-Weinberg law; Factors distinguishing Hardy-Weinberg equilibrium; Mutation selection; Migration; Gene flow; Gene drive, Genetic drift.

Suggested Readings:

1. Atherly, AG, Girton, JR & McDonald, JF 1999, *The Science of Genetics*, Saunders, College Publishing, Fort Worth, USA.
2. Ayala, FJ & Avise, JC 2014, *Essential Readings in Evolutionary Biology*, Johns Hopkins University Press, Baltimore, Maryland.
3. Brooker, RJ 2009, *Genetics: Analysis and principles* 3rdedn, The McGraw-Hill Companies Inc., New York, USA.
4. Chahal, G S & Gosal, SS 2002, *Principles and Procedures of Plant Breeding: Biotechnological and Conventional approaches*. Alpha Science International Ltd., Oxford, UK.
5. Chaudhary, HK 1983, *Elementary principles of plant Breeding*, Oxford IBH Publishing, New Delhi.
6. Futuyma, DJ 2013, Evolution, 3rd edn., Sinauer Associates Inc, Sunderland, MA, USA
7. Futuyma, DJ & Futuyma, 1997, Evolutionary Biology, 3rd edn, Sinauer Associates Inc, Sunderland, MA, USA
8. Gardner, EJ 2004, *Principles of genetics*, 2nd edn, John Wiley and sons, New York, USA
9. Gupta, PK 2010, *Cytology, Genetics, Evolution and plant Breeding*, 2nd edn, Rastogi Publications, Meerut.
10. Hartl, DL & Jones, EW 1998, *Genetics: Principles and Analysis*, 4th edn, Jones and Bartlett Publishers, Boston, Massachusetts, USA.
11. Pierce, BA 2005, *Genetics: A conceptual Approach*, 2ndedn, WH freeman & Company, New York, USA.
12. Snustad, DP & Simmons, MJ 2012, *Principles of Genetics*, 6th edn, John Wiley & Sons Inc, Hoboken, NJ, USA.
13. Ridley, M 2003, Evolution, 3rd edn, Blackwell Publishing, Hoboken, NJ, USA
14. Singh, BD 2007, Fundamentals *of Genetics*, Kalyani Publishers, Ludhiana.
15. Tamarin, RH 2001, *Principles of Genetics*, 7th edn, The McGraw-Hill Companies Inc., New York, USA.
16. Verma, PS & Agarwal VK 2004, *Cell Biology, Genetics, Molecular Biology, Evolution & Ecology*, S. Chand & Company Ltd.

BT 203: COMPUTATIONAL BIOLOGY AND BIOINFORMATICS

Unit I

Biostatistics- definition and scope. Collection of data- Population and sampling, Graphical and diagrammatic representation of data - scale diagram, histograms, pie diagrams, frequency polygon and frequency curves. Measures of central tendency - arithmetic mean, median, and mode. Measure of dispersion - standard deviation.

Unit II

Hypothesis: principle and evaluation of hypothesis, null and alternate hypothesis. Test for significance: chi-square test, student t-test (single sample mean and two sample mean), F-test. Analysis of variance (ANOVA): assumptions, techniques of analysis of variance, analysis of variance in one-way techniques.

Unit III

Principles of bioinformatics, Databases introduction, Biological databases: EMBL, GenBank, DDBJ, TrEMBL, SWISS-PROT, PIR; primary and secondary composite databases; SCOP, CATH, Overview of web servers: NCBI, EBI, PDRB; Search engines: Pub Med, ENTREZ, Expasy and SRS. Biological softwares

Unit IV

Computation Biology: Analysis of nucleic acid and protein sequences, sequence comparison algorithms, sequence scoring schemes. Sequence and Genome analysis: Local alignment, global alignment, FASTA, BLAST (Blast P, Blast N, Blast X) and similarity searching scores and their statistical interpretation.

Unit V

Sequence analysis, Genome annotation, Computational evolutionary biology, Analysis of gene expression, Analysis of regulation, Analysis of protein expression, Analysis of mutations, Comparative genomics, Modeling biological systems, High-throughput image analysis, Prediction of protein structure, Molecular Interaction and Docking algorithms. Role of bioinformatics in genome analysis and cloud computing.

Suggested Readings:

1. Baxevanis, AD & Ouellette BFF 2004,. *Bioinformatics-A practical guide to the analysis of genes and proteins*, Wiley Publishers
2. Bergeron, B 2002, *Bioinformatics Computing*. Pearson Education, US.
3. Bhat, B R, Srivenkatramana, T & Madhav Rao K S 2011, *Statistics. A Beginners Text. Vol. I*. New Age International (p) Ltd, New Delhi.
4. Bliss, CJK 1967, *Statistics in Biology. Vol*. I McGraw hill. New York, USA
5. Campbell, RC 1974, *Statistics for Biologists*. Cambridge University, Press, Cambridge,UK.
6. Daniel, WW 1995, *Biostatistics-A foundation for Health Science*, John Wiley, New York, USA.
7. Gupta, SC & Kapoor, VK 2014, *Fundamentals of Mathematical Statistics*. Sulthan Chand & sons. New Delhi.
8. Mount, DW 2004, *Bioinformatics: Sequence and Genome Analysis*, Cold Spring Harbor Laboratory.
9. Orengo, CA & Thornton, JM 2003, *Bioinformatics: Genes, Proteins and Computers*. Taylor and Francis, US.
10. Rashidi, H & Buchler, LK 2005, *Bioinformatics Basics: Application in Biological Science and Medicine*. CRC Press, USA.
11. Rastogi, VB 2011, *Fundamentals of Biostatistics*, Ane Books Pvt. Ltd. New Delhi, India.
12. Simpson, RJ 2013, *Proteins and Proteomics*: *A Lab Manual*. Cold Spring Harbor, US.
13. Sward law, AC 1985, *Practical Statistics for Exponents Biologists*, John Wiley and Sons, New York, USA.

BT 204: BIOANALYTICAL TECHNIQUES

Unit I

Chromatography techniques: TLC, gel permeation, ion exchange and affinity chromatography, HPLC.

Spectroscopy technique: UV-visible spectroscopy. Theory and application of circular dichroism, fluorescence, NMR, ESR and plasma emission spectroscopy.

Unit II

Electrophoretic techniques: theory and application of polyacrylamide and agarose gel electrophoresis, capillary electrophoresis, 2-D electrophoresis, pulsed field gel electrophoresis.

Unit III

Radioactivity: radioactive and stable isotopes, pattern and rate of radioactive decay, measurement of radioactivity- Geiger-Muller counter, solid and liquid scintillation counters (Basic principle, instrumentation and technique). Autoradiography and radioimmunoassay.

Unit IV

Centrifugation: basic principles, types of centrifuge - microcentrifuge, ultracentrifuge and density gradient centrifugation, applications (isolation of cell components), determination of molecular weight by sedimentation velocity and sedimentation equilibrium methods

Unit V

Microscope and its modifications – Light, phase contrast and interference, Fluorescence, Confocal, Electron (TEM and SEM)

Advanced techniques: protein crystallization- theory and methods. X- ray crystallography, API-electrospray, mass spectrometry.

***Suggested Readings*:**

1. Campbell, AM & Heyer, LJ 2007, *Discovering Genomics, Proteomics and Bioinformatics,* 2nd edn, Benjamin Cummings.
2. Freifelder, D 1982, *Physical Biochemistry- Application to Biochemistry and Molecular Biology*, 2nd edn, W.H. Freemen and Company, San Fransisco.
3. Gibas, C & Jambeck, P 2001, *Developing Bioinformatics Computer Skills,* O'Reilly, Sebastopol.
4. Holme, D & Peck, H 1998, *Analytical Biochemistry,* 3rd edn, Longman.
5. Scopes, R 1994, *Protein Purification - Principles & Practices*, 3rd edn, Springer Verlag.
6. Wilson, K & Walker, J 2000, *Principles and Techniques of Practical Biochemistry*, 5th edn, Cambridge University Press.

BT 205: PRACTICALS EXCERCISES

1. Structure of DNA
2. DNA Replication
3. Eukaryotic Transcription
4. Eukaryotic Promoter
5. Structure Of Eukaryotic Chromosome

6. Lac Operon
7. Ribosome
8. Ramachandran Plot
9. ATPase Pump
10. Non Compititive Inhibition
11. Cori Cycle
12. Feed-back Inhibition
13. Photorespiration
14. Phenylketonuria
15. Introduction to NCBI, NCBI data bases, BLAST, BLASTn, BLASTp, PSI-BLAST,
16. Biological databases: EMBL, Gene-Bank, DDBJ, TrEMBL, SWISS-PROT, PIR; primary and secondary composite databases; SCOP, CATH
17. Sequence manipulation Suite, Sequence alignment.
18. Primer designing through bioinformatics tools- Primer3.
19. Phylogenetic Analysis through PHYLIP/CULTA-W
20. Protein structure Analysis, Docking, Ligplot interactions.
21. Protein Modeling
22. Electrophoresis for native and denatured proteins (SDS PAGE)
23. HPLC- Handling and basic exercise
24. Identification of bio molecules on the basis of maximum absorption spectrum.
25. Statistical analysis-Mean, mode, Median, Standard Deviation and Chi-Square Test
26. Validating ratio using chi square test.
27. Assessment of mode of inheritance on the basis of pedigree chart
28. Preparation of genetic maps based on data from recombination
29. Preparation of genetic map in bacteria using data obtained from interrupted mating
30. Preparation of genetic map in bacteria on the basis of transformation and generalized transduction.

BT 206: PRACTICALS EXCERCISES

1. Co Dominance
2. Translocation
3. Miller's Experiment
4. RFLP
5. NMR Spectroscopy
6. X-RAY Crystallography
7. Electron Microscope
8. Sequence Alignment
9. Comparative Genomics
10. Swiss-Prot
11. Phylogenetic Tree
12. SCOP
13. Chi- Square Test
14. Histogram
15. Correlation and regression
16. Phase Contrast Microscope
17. Density Gradient Centrifugation
18. RIA
19. TLC and HPTLC
20. Darwin

21. FISH
22. Genomic Imprinting

SEMESTER III

BT 301: GENOMICS AND PROTEOMICS

Unit I

Introduction to Genomics- Structural, Functional, Comparative and evolutionary genomics. DNA sequencing-principles and translation to large scale projects; Deep sequencing, High throughput Sequencing;Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR.

Unit II

Nature of genome in prokaryotes and eukaryotes; Importance of genome projects- human genome project; *Haemophilus influenzae* genome; *Caenorhabditis elegans* genome; genomics of cattle; Plant genomes; Indian initiatives in genome sequencing.

Unit III

Proteome: definitions and conceptualization; Protein structure; Post-translational modifications (PTM) -phosphorylation, glycosylation, ubiquitination, additional modifications; Mass spectrometric characterization of PTM –Identification of phosphorylated , glycosylated proteins and other PTM.

Unit IV

Proteomics: Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Peptide fingerprinting; MALDI-TOF; Differential display proteomics; Protein-protein interactions.

Unit V

Functional genomics and proteomics: Microarrays ; Protein and peptide microarray-based technology; PCR-directed protein *in situ* arrays; Concept of Transcriptomics, Metabolomics, Epigenomics and Metagenomics.

***Suggested Readings*:**

1. Campbell, AM & Heyer, LJ 2007, *Discovering Genomics, Proteomics and Bioinformatics*,2nd edn, Benjamin Cummings Publ. Co., San Francisco, California, USA.
2. Gibson ,G & Muse, SV 2004 , *A Primer of Genome Science*,2nd edn, Sinauer Associates, USA.
3. Glick, BR & Pasternak, JJ 1998 , *Molecular Biotechnology*, 3rd edn, ASM Press, USA.
4. Primrose, S & Twyman R 2006, *Principles of Gene Manipulation and Genomics*, 7th edn, Blackwell Publ. Co., London.
5. Sambrook, J, Fritsch, EF & Maniatis, T 1989,*Molecular Cloning-A Lab Manual*, Cold Spring Harbor Laboratory Press, New York.
6. Veenstra ,TD & Yates, JR 2006, *Proteomics for Biological Discovery*, Wiley-Liss

BT 302: GENETIC ENGINEERING

Unit I

General introduction and tools of genetic engineering: restriction enzyme, homing enzyme, DNA ligase, polynucleotide kinase, alkaline phosphatase, DNA polymerase, terminal transferase, Reverse transcriptase.

Cohesive and blunt end ligation: Linkers, Adaptors, Homopolymer tailing; Genome editing and

Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes.

Unit II

Cloning vector- Plasmid (pBR322 and pUC19), cosmid, lambda phage, shuttle vector, gateway vector, BACs and YAC. Animal virus derived vectors- SV40, vaccinia and retroviral vectors. *Agrobacterium* as vector- binary and co-integrative vector. Expression vectors- pMal, GST, pET-based vectors.

Choice of hosts, Methods for transferring recombinant DNA to host cells (Transformation and Transfection).

Unit III

Screening and selection for transformants- Hybridization techniques (Northern, Southern and Colony hybridization, Fluorescence *in situ* hybridization).

Construction of libraries- Isolation of mRNA and total RNA, cDNA and genomic libraries.

Analysis of DNA-Protein Interactions- Yeast- two hybrid system, S1 Mapping, DNaseI footprinting, DNA methylation and Methyl interference assay.

Unit IV

Expression of foreign gene in *E.coli*, Baculovirus, mammalian cell and plant. Principles in maximizing gene expression: Codon optimization, codon biasing, phage display.

Gene Therapy- gene augmentation, gene editing, gene knockout technology. Somatic and germ-line therapy- *in vivo* and *ex vivo* therapy.

Mutagenesis: PCR based mutagenesis, site - directed mutagenesis and cassette mutagenesis.

Unit V

PCR- Primer design, fidelity of thermo-stable enzymes, proof reading enzymes. Types of PCR- LA- PCR, nested, RT - PCR, real time PCR.

PCR in gene recombination: Deletion, recombination, addition. PCR in molecular diagnostics and detection of diseases; Handling biohazardous materials.

Suggested Readings:

1. Brown, TA 2010, *Gene Cloning and DNA Analysis: An Introduction*, 6th edn, Wiley-Blackwell publishing, UK.
2. Dale, JW, Schantz, M & Plant, N 2011, *From genes to genomes:Concepts and Applications of DNA Technology*, 3rd edn, Wiley-Blackwell publishing, UK
3. Glick, BR & Pasternak JJ 1998, *Molecular Biotechnology*, 2nd edn, ASM Press, Washington DC.
4. Gupta, PK 2012, *Biotechnology and Genomics*, 1st edn, Rastogi publications, Meerut.
5. Joshi, P 2007,*Genetic engineering and its applications*, 2nd edn, Agrobios- India, Jodhpur.
6. Primrose, S & Twyman R, 2001, *Principles of Gene Manipulation and Genomics*, 6th edn, Blackwell Science, USA.

7. Sambrook, J, Fritsch, EF & Maniatis, T 1989, *Molecular Cloning-A Lab Manual*, 2nd edn, Cold Spring Harbor Laboratory Press, New York.
8. Sandhya Mitra 2000, *Genetic engineering- principles and practice*. Macmillan India Limited, New Delhi.
9. Satyanarayana, U 2005, *Biotechnology*, 1st edn, Books and Allied Publishers, Kolkata.
10. Singh, BD 2003, *Biotechnology- An Expanding Horizon*, 2nd edn. Kalyani Publishers.

BT 303: ENVIRONMENTAL BIOTECHNOLOGY

Unit I

Environmental pollutions: Basic concepts and types (air, water, soil). Types of pollutants (inorganic and organic); impact of pollutants on ecosystem. Methods to measures the pollutants.

Global warming and Climate change: introduction and current perspectives. Concept of anthropocene. Xenobiotics: Persistence and biomagnification of xenobiotic molecules.

Unit II

Concept of clean and green technology. Bioremediation: *in situ* and *ex situ* bioremediation; Evaluating Bioremediation: Bioremediation of volatile organic compounds (VOCs).

Biodegradation of agricultural chemicals; Factors affecting process of biodegradation; Methods in determining biodegradability. Contaminant availability for biodegradation.

Unit III

Basic aspects of solid waste management, Aerobic and anaerobic treatments of solid wastes; Comparison of aerobic and anaerobic methods; Composting; Vermiculture; Biogas generation; Treatment of hazardous wastes and effluent treatment.

Unit IV

GM microorganisms and their impact on environment. Oil recovery bacteria; hydrocarbon transforming bacteria; Phosphate solubilization; Biofertilizers; Biological control of insect pests; Role of biopesticides/ insecticides, Biocontrol of plant pathogens.

Unit V

Need for management of resources; Role of biotechnology in the management of bioresources. Reclamation of wasteland, integrated waste management. Organic farming: Basic concepts and utilities in dry land farming.

Suggested Readings:

1. Alexander, M 1999, *Biodegradation and Bioremediation*,2nd edn, Academic Press.
2. Mukerji, KG, Chamola, BP & Upadhyay, R K 1999, *Biotechnological Approaches in Biocontrol of Plant Pathogens*, Kluwer Academic/Plenum Publishers, Harbound.
3. Prasad, MNV & Strzalka, K 2002, *Physiology and Biochemistry of Metal Toxicity and Tolerance in Plants*, Kluwer Academic Publishers, Dordrecht, Harbound.
4. Rittman, B & Perry L McCarty 2000, *Environmental Biotechnology: Principles and Applications*, 2nd edn, McGraw-Hill, NewYork.

5. Wainwright, M 1999, *An Introduction to Environmental Biotechnology*, Kluwer Academic Publishers, Boston.

BT 304: IPR, BIOSAFETY AND BIOETHICS

Unit I

Introduction to Intellectual Property**:** Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indicators- importance of IPR – patentable and non patentables – patenting life – legal protection of biotechnological inventions. – World intellectual property rights organization (WIPO).

Unit II

Agreements and Treaties**:** History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970,2005 & recent amendments/decisions, TIFAC and its role in India.

Unit III

Biosafety: Introduction; biosafety issues in biotechnology-historical background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels, Biomedical waste management.

Biosafety guidelines and regulations (National and International) – operation of biosafety guidelines and regulations of Government of India;

Unit IV

Roles of Institutional Biosafety Committee **:** RCGM, GEAC, Definition of GMOs; applications of GMO in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol, Biopiracy.

Unit V

Bioethics: Introduction to ethics/bioethics – framework for ethical decision making; biotechnology and ethics –benefits and risks of genetic engineering – ethical aspects of genetic testing – ethical aspects relating to use of genetic information – genetic engineering and biowarfare; Ethical implications of cloning: Reproductive cloning , therapeutic cloning ; Ethical, legal and socioeconomic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research and GMO's.

Suggested Readings:

1. BAREACT, Indian Patent Act 1970 Acts & Rules, Universal Law Publishing Co. Pvt. Ltd.
2. Cibelli, J, Wilmut, IS, Jaenisch, R, Gurdon, J, Lanza, R, Michael, W & Campbell, KHS 2013, *Principles of Cloning*, Academic Press, SanDiego, Gurdon.
3. http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section3.html
4. http://www.cbd.int/biosafety/background.html
5. Kankanala, KC 2007, *Genetic Patent Law & Strategy*, Manupatra Information Solution Pvt. Ltd.,.Noida, India.

6. Martin, MW & Schinzinger, R 1989, *Ethics in engineering*, Tata McGraw-Hill, New Delhi.
7. Sadhasivam, SK & Jaabir, M 2008, *IPR, Biosafety and Biotechnology Management*, Jasen Publications, Tiruchirapalli, India.

BT 305: PRACTICALS EXCERCISES

1. Plasmid DNA isolation from bacteria.
2. Quantitative estimation of plasmid isolated from bacteria.
3. Restriction and digestion of lambda phage DNA (kit based)
4. DNA ligation of restricted lambda DNA (kit based)
5. Purification of DNA from electrophoresed gel.
6. Preparation of competent cells of bacteria (kit based)
7. Transformation of *E. coli* cells with standard plasmids (kit based)
8. Calculation of transformation efficiency in bacteria.
9. Amplification of nucleic acid through polymerase chain reaction (demonstration).
10. Construction of restriction map of the plasmid pBR322.
11. Isolation of the gene (neomycin phosphotransferase) from the plasmid pUC7 KAPA (kit based)
12. Cloning of the Bam HI fragment containing the neomycin phosphotransferase gene into the Bam HI site of pUC19 B/W screening (kit based)
13. DNA sequencing from the given data / photograph by Sanger's / Maxam Gilbert's method.
14. Determination of the effect of different concentrations of agarose on banding pattern of DNA.
15. DNA Fingerprinting
16. Human Genome Project
17. Central Dogma Of Life
18. α- Helix
19. 2-D PAGE
20. Microarray
21. DNA Ligation
22. A. Kornberg
23. Cosmid
24. Southern Blotting
25. C-DNA Library
26. Gene Knockout Technology
27. PCR
28. Microinjection

BT 306: PRACTICALS EXCERCISES

1. Quantification of filterable solid wastes.
2. Water quality assessment for polluted waterbodies:
   a. Physical- colour, pH and conductivity.

b. Chemical- nitrate, chloride, Dissolved oxygen, Chemical oxygen demand and alkalinity.

3. Quantification of inorganic ions (sodium, potassium and calcium) in water sample using flame photometer.
4. Designing of bioreactor prototype.
5. Study the cell death and cytotoxicity by staining methods
6. Study the synthesis of alcohol by molasses.
7. Study the cell immobilization and the growth of immobilized cell.
8. Simple staining, differential staining.
9. Differentiation of the viable and nonviable cell by staining methods.
10. Study the pure and mixed cell culture of plant/animal/microbial cell by staining method.
11. GATT
12. Patent
13. Biosafety Levels
14. Indian Patent Act 1970, 1989, 2005: Important cases.
15. Process of patenting in India; Filing of patent.
16. Manufacturing unit's safety assessments

SEMESTER IV

BT 401: BIOPROCESS ENGINEERING AND TECHNOLOGY

Unit I

Introduction to bioprocess engineering and technology, Material balance in biological systems, energy balance in biological system, kinetics of cell growth and death. Batch, fed-batch and continuous cultures (definition and kinetics). Product formation kinetics, heat transfer and mass transfer. Measurement and control of bioprocess parameter: Feedback control, controller characteristics. Cell as a factory, Cell cytotoxicity.

Unit II

Concepts of basic mode of fermentation processes**:** Bioreactor designs; Types of fermenters; Concepts of basic modes of fermentation - Batch, fed batch and continuous; Conventional fermentation v/s biotransformation; Solid substrate, surface and submerged fermentation; Fermentation economics; Fermentation media. Upstream processing: Media formulation; Sterilization. Measurement and control of bioprocess parameters.

Unit III

Downstream processing**:** Bioseparation - filtration, centrifugation, sedimentation, flocculation; Cell disruption; Liquid-liquid extraction; Purification by chromatographic techniques; Reverse osmosis and ultra filtration; Drying; Crystallization; Storage and packaging.

Unit IV

Applications of enzymes in food processing: Mechanism of enzyme function and reactions in process techniques; Enzymatic bioconversions e.g. starch and sugar conversion processes; High-Fructose Corn Syrup; Interesterified fat; Hydrolyzed protein etc. and their downstream processing.

Unit V

Applications of Microbes in food processing and Pharmaceutical products**:** Food ingredients and additives prepared by fermentation and their purification; Microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; Biofuels. Bacteriocins from lactic acid bacteria – Microbial products - Antibiotics (penicillin, streptomycin, tetracycline), vitamins, pre- and probiotics; Biotech industries in India.

Suggested Readings:

1. Demain, AL & Davies, J 2010, *Manual of Industrial Microbiology and Biotechnology*, ASM press, Washington DC, USA.
2. El-Mansi, M & Bryce, C 2002, *Fermentation Microbiology and Biotechnology*. Taylor and Francis Ltd., London (Replika Press Pvt. Ltd., Kundli, Haryana), India.
3. Nakra, BC & Chaudhry, KK 2004, *Instrumentation, measurement and analysis.* Tata McGraw Hill Publishing Co. Ltd., New Delhi, India.
4. Paul, JK 1983, *Genetic Engineering Applications for Industry*, Noyer Corporation, New Jersey, US.
5. Prescott and Reed, DG 1983, *Industrial Microbiology*, AVI Publishing Company Inc. Conneticut USA.
6. Rehm, HJ & Reed, G 1983, *Biotechnology, VI-VIII*, Verlag Chemie,Weinheim, Germany.
7. Stanbury, PF & Whitaker, A 1984, *Principles of Fermentation technology*, Pergamon Press, Oxford, UK.

BT 402: PLANT BIOTECHNOLOGY

Unit I

Plant Tissue Culture: General Introduction; Concept of Totipotency, Historical Background; Concept of asepsis and methods of sterilization. Laboratory planning and design, Basic tools and techniques of *in vitro* culture, Explant selection and surface sterilisation, Composition and preparation of tissue culture media.

Unit II

Micropropagation : Pathways (Axillary bud proliferation, adventitious shoot bud differentiation, callus organogenesis and somatic embryogenesis), meristem tip culture and production of virus - free plants-Thermotherapy, chemotherapy, virus indexing , Applications and limitations.

Anther, pollen and ovule culture for haploid production, *in vitro* fertilization and ovary culture; Somaclonal Variations-Isolation of somaclonal variants, molecular basis, Applications and Limitations.

Unit III

Germplasm conservation and cryopreservation: Importance, methods of conservation: *In situ* and *ex situ* conservation; *In vitro* conservation, cryopreservation technique – importance of cryopreservation, pretreatment, freezing methods, cryoprotectants, vitrification.

Protoplast Culture: Isolation, purification and regeneration of protoplast; Testing of viability of isolated protoplast; Somatic hybridization and methods of protoplast fusion; Selection of hybrids, Practical applications of somatic hybridization (hybrids/cybrids).

Unit IV

Plant Transformation Technology : Features of Ti and Ri plasmid; The basis of tumour formation, mechanisms of DNA transfer , role of virulence genes; Vectors engineered from Ti plasmid; Use of 35S and other promoters; Methods of nuclear transformation , Direct DNA transfer : particle bombardment , electroporation , microinjection; Transgene stability and gene silencing.

Unit V

Application of plant transformation for productivity and performance: herbicide resistance , insect resistance with special reference to Bt genes, virus resistance, Use of antisense technology to prevent post-harvest losses and prolonging shelf-life of fruits and flowers, Production of vaccines/ plantibodies in GM plants, Terminator gene technology, Transplastomics , cis-genics, Application of genome editing.

Suggested Readings:

1. Barbara, MR 2007, *Plant Cryopreservation: A Practical Guide*. Springer Verlag, Berlin, Heidelberg.
2. Bhojwani, SS & Razdan, MK 1996, *Plant Tissue Culture : Theory and Practice (revised edition)*, Elsevier Science ,Netherlands.
3. Davey, Michael ,R & Anthony, P 2010, *Plant Cell Culture: Essential Methods*, Wiley-Blackwell Ltd.
4. De, KK 1992, *An Introduction to Plant Tissue Culture*, New Central Book Agency, Kolkatta.
5. Endress, R 1994, *Plant Cell Biotechnology* ,Springer –Verlag ,Berlin ,Heidelberg.
6. Pauline, MD 1997, *Hairy Roots: Culture and Applications*, Harwood Academic Publishers.
7. Purohit,SD 2013, *Introduction to Plant Cell, Tissue and Organ Culture*, PHI Learning Private Limited, Delhi.
8. Razdan, MK 2003, *An Introduction to Plant Tissue Culture*, Oxford & IBH Publ. Ltd., New Delhi.
9. Slater,A, Scott, N & Fowler, M 2003, *Plant Biotechnology: The Genetic Manipulation of Plants*, Oxford University Press, UK.
10. Thorpe, TA & Edward CY (eds) 2011, *Plant Embryo Culture: Methods and Protocols*, Springer Verlag, Berlin, Heidelberg.
11. Vasil, IK & Thorpe, TA (eds) 2005, *Plant Cell and Tissue Culture*, Springer India Pvt. Limited, New Delhi.

BT 403: ANIMAL CELL CULTURE AND APPLICATIONS

Unit I

Structure and organization of animal cell. Equipments and materials for animal cell culture technology. Balance salt solution and simple growth medium. Role of carbon dioxide, serum and other supplements in medium. Serum - free defined media and their application.

Concept of stem cell, totipotency, pluripotency and induced pluripotency. Epigenetics and stem cell.

Unit II

Biology of cultured cells: the culture environment, cell adhesion, cell proliferation . Primary culture: primary explant, isolation of the tissue. Cell line: nomenclature, subculture and

propagation, immortalization of cell lines, cell line designations. Maintenance of cell culture: cell morphology, replacement of medium, surface area, holding medium and use of antibiotics. Methods for measurement of growth: cell quantification, biochemical determinations, viability assay.

Unit III

Cell characterization: requirement and methods. Cell cloning: monolayer cloning, suspension cloning and isolation of clones.

Organotypic culture: introduction, types- organ and histotypic culture, applications.

Scaling-up of animal cell culture: scale- up in suspension and scale- up in monolayer.

Unit IV

Cell transformation: introduction, properties and causative factors-genetic instability, immortalization, aberrant growth control and tumorigenicity.

Three dimensional culture: introduction, multicellular tumour spheroids (MCTS) monoculture .

Tissue engineering: introduction and examples (skin, urothelium and peripheral nerve implants).

Safety measures, hazards and ethics of animal cell culture.

Unit V

Applications of animal cell culture: Cell culture based vaccines, Production of special secondary metabolites/ products (insulin, somatotropin, interferon, tPA, factor VIII etc.), Growth factors for promoting proliferation of animal cells (EGF, FGF, PDGF, IL-1, IL-2, NGF, erythropoietin), Transgenic animals: importance and applications.

Suggested Readings:

1.Ranga, M.M. Animal Biotechnology. Agrobios, India.
2.Satyanarayana, U., Biotechnology. Books and Allied (P) Ltd.
3.Butler M., Animal Cell Biotechnology-Principles and Practices.
4.Freshney, R. I. Culture of Animal Cells: A Manual of Basic Techniques. Wiley-Liss
5.John R W Masters., Animal Cell Culture – Practical Approach, Oxford Univ Press.
6.Jennie P. and David Barnes., Methods in Cell Biology, Volume 57, Animal Cell Culture Methods Academic Press.

BT404: DISSERTATION

ACADEMIC REGULATIONS

1. For the Dissertation, the student shall carry out a **minimum two days a week** of research work in a research laboratory of any Institute/Organisation/University.

2. After the completion of the work, the student shall **submit 2 copies** of the Dissertation report (type written and hard bound) on or before the prescribed date.

3. The Dissertation report shall bear a **certificate** from the supervisor certifying that :

   (i) The work has been undertaken and completed under his/her supervision and guidance and meets the requirements of the course;

   (ii) The Dissertation is a bonafide record of the original work carried out by the candidate and the Dissertation work has not formed the basis of award of any other degree of this or any other University;

4. **CCA (Maximum 30)** shall be awarded on the basis of attendance (50%) and hands on experimentation (50%) by the supervisor

5. **External evaluation** (**Maximum 70**) for the Dissertation report shall be awarded on the basis of Dissertation report, presentation and viva-voce by a board consisting of internal examiner (Mentor), external examiner and the HOD. The senior member shall be the chairperson of the board.

6. The Board shall be furnishing clear statement of reasons for failure and suggestions for improvement for any student who fails in dissertation. The candidate shall revise and resubmit the Dissertation report after incorporating suggestions made by the board and such a student will have to reappear during the subsequent semester assessment.

BT 405: PRACTICALS EXCERCISES

1. Trickling Filter
2. Fermenter
3. Effluent Treatment
4. Flocculation
5. Reverse Osmosis
6. Ultrafiltration
7. Vermiculture
8. Bio- Leaching
9. Biofertilizer
10. Geneticallay Modified Orgaanism
11. Bioweapons
12. Probiotics
13. Bacteriocins
14. Alcoholic Beverages
15. Downstream Processing
16. High Fructose Corn Syrup
17. VAM
18. Preparation of stock solutions of MS medium.
19. Preparation of MS medium from stock solutions.
20. Harvesting, preparation, surface sterilization and inoculation of different explants.
21. Effect of auxins and cytokinins on callus growth and organogenesis.
22. Effect of auxins and cytokinins on shoot multiplication.
23. Experiments on multiple shoot induction from mature nodal shoot segments.

24. Differentiation of tissues through organogenesis/ somatic embryogenesis.
25. Experiments on in vitro and ex vitro rooting.
26. Establishment of suspension culture.
27. Preparation of synthetic seeds.
28. Demonstration of anther culture of Datura.
29. Preparation of tissue culture media and concept of sterilization in animal cell culture.

BT 406: PRACTICALS EXCERCISES

1. Cryopreservation
2. Media preparation for animal cell cultures
3. *Agrobacterium tumefaciens*
4. Electroporation
5. Gene Silencing
6. Primary Culture
7. Cell Cytotoxicity
8. Batch Culture
9. Continuous Culture
10. Serum Free Media
11. Growth Kinetics
12. Vaccine
13. Gene Therapy
14. Stem cells, preservation and utilization
15. Project Evaluation seminar

Skill Courses:

BT-SC-1: BIOFERTILIZERS

General account about the microbes used as biofertilizer – Rhizobium , Azospirillum, Azotobacter, Cyanobacteria , Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

Practicals

1. Isolation, identification, mass multiplication, of Rhizobium , Azospirillum, Azotobacter, Cyanobacteria and VAM .

Suggested Readings

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & Co, New Delhi.
2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.
3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology. Emkay Publication, New Delhi.
4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.
5. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.
6. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming Akta Prakashan, Nadiad.

BT-SC-2: BIOREMEDIATION

Principles and degradation of common pesticides, organic and inorganic pollutants.Bioremediation of soil, water, contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes.

Practicals

Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.

REFERENCE BOOKS:

1. Principle of Environmental Science, William P. Conningham and Mary Ann Conningham (2003) Tata McGraw-Hill publishing company. Tokyo
2. Environmental Biotechnology, Hans – Joachim Jordening, Josefwinter (2005) New Delhi
3. Environmental Biology. P.D.Sharma (1994) Rastogi publications New Delhi
4. Environmental Biotechnology and cleaner bioprocesses, Eugenia J. Olugin (2000) Taylor and Francis India
5. Environmental Biotechnology, K. C. Agarwal (2005) Nidhi publishers, New Delhi
6. Biotechnology, Satyanarayana. U, (2005):, Books and Allied (p) Ltd

BT-SC-3: IMMUNOTECHNOLOGY:

History of Immunology, Edward Jenner, Eli Metchnikoff, Louis Pasteur, Robert Koch; Innate immunity – barriers; acquired immunity-cells involved; humoral and cellular immunity; lymphoid organs-primary & secondary – Hamatopoiesis; immunogens and antigens – characteristics of ideal antigens; classes of antigens, cross reactivity, haptens and adjuvants

Principles, methodology and application of LTT, Hybridomatechnology and antibody engineering, ELISA; ELISPOT; RIST; RAST and Immunoblotting; FACSCAN, Immunoflourescence and RIA; Immunoinformatics and vaccine designing: Cloning strategies for vaccine production. T cell cloning and stem cell technology.

Immunology Practicals

1. Purification of Immunoglobulin from serum
2. Antigen preparation
3. Isolation and Enumeration of B & T Lymphocytes
4. Generation of antibody in mouse
5. Agglutination reaction
6. Single and Double immunodiffusion
7. Conjugation of antibodies with Enzyme
8. ELISA : i) Capture ELISA ii) Direct ELISA
9. Western blot

Suggested Readings

1. Benjamin E. Coico and G. Ssunskine (2000) Immunology a short course, IV edn. Wiley – Liss Publication, NY
2. Kuby. J (1997) Immunology, III edn. WH Freeman & Co. NY
3. Goldsby R.A. Kindt T.I. and Osborne B.A. (2000) Kuby Immunology IV edn. WH Freeman & Co. NY.
4. Janeway C.A. Travers P. Wolport M and Capra J.D (1999) Immunology IV edn. Current ?Biology, NY
5. Roitt, I (2000), Essential Immunology, IV edn. Blackwell Sci. NY
6. Brown, F, Chanock, R.M., Lerner R.A. (Editiors) (1986) Vaccines 86; New approaches to Immunization
7. Fathman, C.G. Fitch F.W. (1982) Isolation, Characterization and utilization of TIymphocytes clones, Academic Press, London

8. Goding, J.W. (1998) Monoclonal antibodies: Principles and practice, Academic Press, London
9. Roitt, Male and Brostoff (1998) Immunology 4th edn. Pub. Mochy, New York pp 28.14
10. Springer T.A. (Editor) (1985) Hybrodoma technology in Biosciences and Medicine, Plenum Press, New York.

BT-SC 4: INTELLECTUAL PROPERTY RIGHTS

1. Introduction, Historical perspectives and Forms of IPR.
2. Concept related to Patent: Requirements, procedure, duration.
3. Revocation of patent, Infringement and Litigation with case studies on patent.
4. Fundamentals of Copy Rights, Trade Marks and Industrial Designs.
5. Basics of Geographical Indications; Trade Secrets and Traditional Knowledge.
6. Protection of Plant Varieties (Plant Breeders Rights and Farmer's Right).
7. IPR and Biodiversity (CBD; Protection in biotechnology, protection of other biological materials).
8. Introduction to the leading International Agreements concerning Intellectual Property Rights: WTO
(GATT, TRIPS), WIPO, Madrid Protocol, Berne Convention, Paris Convention.
9. Indian Legislations for the protection of various types of Intellectual Properties.
10. Management and Valuation of Intellectual Property.

Suggested Readings:

Acharya, NK. 2001. Text book on Intellectual Property Rights. Asia Law House.
Arthur RP and Micheal HD. 2000. Intellectual Property: Patents, Trademarks and Copyright in a nutshell.
West Group Publishers.
Das, HK. 2010. Text book of Biotechnology 4th edition. Willey India.
Erbisch FH & Maredia K.1998. Intellectual Property Rights in Agricultural Biotechnology. CABI.
Ganguli P. 2001. Intellectual Property Rights: Unleashing Knowledge Economy. McGraw-Hill.
Intellectual Property Rights: Key to New Wealth Generation. 2001. NRDC & Aesthetic Technologies.
Saha R. (Ed.). 2006. Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies. Daya Publ. House.
Singh, BD. 2010. Biotechnology: Expanding horizons. Kalyani Publishers.
Wadhera BL. 2007. Law Relating to Intellectual Properety. Universal Law Publishing.
Wattal, J. 1997. Intellectual Property Right. Oxford Publication House.

BT-SC-5: BIOINFORMATICS

1. Introduction to Bioinformatics and its applications
2. Bioinformatics databases
3. Database searching
4. Sequence Alignments and Visualization
5. Structural Bioinformatics
6. Genomics: Genome Annotation, Genome Assembly, Structural and Functional Genomics.
7. Comparative Genomics
8. Metabolomics
9. Chemoinformatics
10. Molecular phylogeny and evolution

11. Biodiversity informatics

Laboratory Exercises

1. Demonstration of Molecular Biology Laboratory equipments
2. Demonstration of various Next-generation sequencing technologies
3. Introduction of National Center for Biotechnology Information (NCBI) and biological databases
4. Analysis of sequences using BIOEDIT software.
5. Assembly of sequences using GENETOOL software
6. Similarity search using the Blast and interpretation of the results.
7. Multiple Sequence alignment using ClustalW
8. Phylogenetic analysis using MEGA.
9. Submission of nucleotide sequences at NCBI-GenBank using Sequin

BT-SC 6: MICROPROPAGATION

1. Basic layout of Mircropropagation laboratory and Green House
2. Basic Concepts of Micropropagation
3. Tools and Techniques of Micropropagation: LAFB, Autoclave, Filter Sterilization
4. Medium composition and Preparation
5. Basic concept of Aseptic Culture establishment
6. Hardening and Acclimatization

Laboratory Exercises

1. Selection of explants, surface sterilization and inoculation to initiate cultures of tobacco/cereals/legumes.
2. Studies on effects of plant growth regulators on cell, tissue and organ culture.
3. Experiments on rejuvenation and multiple shoot induction from mature nodal shoot segments of
trees/horticultural/floricultural crops.
4. Encapsulation of somatic embryos/buds using alginate.
5. Experiments on root induction from cultured shoots.

Suggested Reading

Bhojwani, S. S. 1990. *Plant Tissue Culture: Applications and Limitations.* Elsevier Science Publishers, New
York, USA.

Bhojwani, S. S. and Razdan, M. K. 1996. *Plant Tissue Culture: Theory and Practice* (a revised edition).
Elsevier Science Publishers, New York, USA.

Vasil, I. K. and Thorpe, T. A. 1994. *Plant Cell and Tissue Culture*. Kluwer Academic Publishers, The
Netherlands

Woung-Young, S. and Bhojwani, S. S. 1999. *Morphogenesis in Tissue Cultures* (ed.). Kluwer Academic
Publishers.

BT-SC-7: MOLECULAR TECHNIQUES

1. Methods of isolation and purification of nucleic acids.
2. Quantitative and Qualitative analysis of nucleic acid: Principle and applications of electrophoresis.
3. Nucleic acid hybridization, PCR and Quantitative RT-PCR.
4. Principle and methods of Recombinant DNA technology and Genetic Engineering.

5. Methods of isolation and purification of proteins. Protein purification techniques: size-exclusion, ionexchange
and affinity chromatography.
6. Quantitative and Qualitative analysis of Proteins: Dye-binding methods, native and denaturing SDSPAGE,
Western immunoblotting, ELISA.
7. Tools and techniques used in proteomics: 2-DE, Mass spectrometry, peptide mass fingerprinting.
8. Recombinant protein expression and purification from *E.coli*.
9. Recombinant protein expression and purification from plants.
10. Molecular characterization of transgenic plants.

LABORATORY EXERCISES

1. Preparation of different reagents, buffers and media.
2. Isolation of genomic DNA from plants.
3. Isolation of proteins from plants.
4. Demonstration of DNA/RNA and protein quantitation using Nanodrop.
5. Agarose gel electrophoresis and Gel documentation.
6. Demonstration of PCR, RT-PCR and Southern/Northern Blotting
7. One-dimensional SDS-PAGE protein profiling
8. Demonstration of 2-DE and Western immunoblotting

SUGGESTED READINGS

Sambrook, J. and Russell, D.W. 2001. *Molecular Cloning – A Laboratory Manual, Vols I – III*, Cold Spring
Harbor Laboratory, USA.
Gelvin, S.B. and Schilperoort, R.A. (eds) 1994. *Plant Molecular Biology Manual*, 2nd edition, Kluwer Academic
Publishers, Dordrecht, The Netherlands.
Glick, B. R. and Thompson, J.E. 1993. *Methods in Plant Molecular Biology and Biotechnology*. CRC Press, Boca
Raton, Florida.