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.

SYLLABUS

M.Sc. BOTANY

(SFS)

Under 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 BOTANY

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 this 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 Microscope
- 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/ Multimedia 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	Bot 101	Cell and Molecular Biology of Plants	4-0-0	4	30	70	100
Core course 2	Bot 102	Cytology and Genetics	4-0-0	4	30	70	100
Core course 3	Bot 103	Biology and Diversity of Microbes, Algae and Fungi	4-0-0	4	30	70	100
Core course 4	Bot 104	Biology and Diversity of Archegoniate	4-0-0	4	30	70	100
Core course practical 1	Bot 105	Board I consisting of first two theory papers	0-0-8	4	30	70	100
Core course practical 2	Bot 106	Board II consisting of next two theory papers	0-0-8	4	30	70	100
Skill Course I	As per the list		2-0-2				
Total				24	180	420	600
Semester II							
Core course 5	Bot 201	Taxonomy and Diversity of Seed Plants	4-0-0	4	30	70	100
Core course 6	Bot 202	Plant Development and ReproductiveBiology	4-0-0	4	30	70	100
Core course 7	Bot 203	Plant Resource Utilization	4-0-0	4	30	70	100
Core course 8	Bot 204	Plant physiology	4-0-0	4	30	70	100
Core course practical 3	Bot 205	Board I consisting of first two theory papers	0-0-8	4	30	70	100
Core course practical 4	Bot 206	Board II consisting of next two theory papers	0-0-8	4	30	70	100
Skill course II	As per the list		2-0-2				
Total				24	180	420	600
Semester III							
Core course 9	Bot 301	Plant Ecology	4-0-0	4	30	70	100
Core course 10	Bot 302	Plant Metabolism	4-0-0	4	30	70	100
Discipline Specific Elective 1	One paper from the list of Group I		4-0-0	4	30	70	100
Discipline Specific Elective 2	One paper from the list of GroupII		4-0-0	4	30	70	100

Core course practical 5	Bot 305	Board I consisting of first two theory papers	0-0-8	4	30	70	100
Discipline Specific Elective practical 1	Bot 306	Board II consisting of next two elective theory papers	0-0-8	4	30	70	100
Skill course III	As per the list		2-0-2				
Total				24	180	420	600
Semester IV							
Core course 11	Bot 401	Applied Ecology	4-0-0	4	30	70	100
Core course 12	Bot 402	Biotechnology and Genetic Engineering of Plants	4-0-0	4	30	70	100
Discipline Specific Elective 3	One paper from the list of Group I		4-0-0	4	30	70	100
Discipline Specific Elective 4	One paper from the list of GroupII		4-0-0	4	30	70	100
Core course practical 6	Bot 405	Board I consisting of first two theory papers	0-0-8	4	30	70	100
Discipline Specific Elective practical 2	Bot 406	Board II consisting of next two elective theory papers	0-0-8	4	30	70	100
Skill course IV	As per the list		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.

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	10	2	20
3. Short answer (15 words)	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.

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

Bot 101.	Cell and Molecular Biology of plants
Bot 102.	Cytology and Genetics
Bot 103.	Biology and Diversity of Microbes, Algae and Fungi
Bot 104.	Biology and Diversity of Archegoniate
SC I	Skill course I (for students of Botany Department only)

SEMESTER II

Bot 201.	Taxonomy and Diversity of Seed Plants
Bot 202.	Plant Development and Reproductive Biology
Bot 203.	Plant Resource Utilization and Conservation
Bot 204.	Plant Physiology
SC II	Skill course II (for students of other Departments)

SEMESTER III

Bot 301.	Plant Ecology
Bot 302.	Plant Metabolism
Elective I	Elective paper I
Elective II	Elective paper II
SC III	Skill course III (for students of Botany Department only)

SEMESTER IV

Bot 401.	Applied Ecology
Bot 402.	Biotechnology and Genetic Engineering of Plants
Elective I	Elective paper I
Elective II	Elective paper II
SC IV	Skill course IV (for students of other Departments)

Elective paper group – First – Semester III

Bot 303A. Genomics, Proteomics and Bioinformatics - I
Bot 303B. Plant Molecular Biology and Biotechnology
Bot 303C. Principles of Plant Pathology
Bot 303D. Plant Microbe Interaction (PMIs) - I
Bot 303E. Cytogenetics and Plant Breeding -I
Bot 303F. Industrial Microbiology - I

Elective paper group – Second – Semester III

Bot 304A. Population Biology
Bot 304B. Microbial Ecology-I
Bot 304C. Stress Physiology-I
Bot 304D. Advanced Physiology
Bot 304E. Biosystematics of Plants -I
Bot 304F. Environmental Monitoring, Management and Restoration - I

Elective paper group – First – Semester IV

Bot 403A. Genomics, Proteomics and Bioinformatics - II
Bot 403B. Applied Molecular Biology and Plant Biotechnology
Bot 403C. Plant Diseases and their Management
Bot 403D. Plant Microbe Interaction (PMIs) - II
Bot 403E. Cytogeneticsand Plant Breeding - II
Bot 403F. Industrial Microbiology - II

Elective paper group – Second – Semester IV

Bot 404A. Desert Ecology
Bot 404B. Microbial Ecology-II
Bot 404C. Stress Physiology-II
Bot 404D. Advanced Physiology
Bot 404E. Biosystematics of Plants - II
Bot 404F. Environmental monitoring, management and Restoration-II

Skill Courses in Botany

Bot-SC-1 Intellectual Property Rights
Bot-SC- 2 Agrotechniques for Desert Plants
Bot-SC- 3-Data Analysis and Presentation
Bot-SC- 4-Bioinformatics
Bot-SC- 5-Micropropagation
Bot-SC- 6-Value Addition for Bioresources
Bot-SC- 7-Chromosome Analysis
Bot-SC- 8-Mushroom Cultivation
Bot-SC- 9-Molecular Techniques
Bot-SC- 10-Nutrient Mangement

ADMISSION

The minimum qualification for admission to M.Sc. Course is B.Sc. (10+2+3) degree with Botany as a major 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. In III and IV semester Practical Board II shall have two independent Boards assessing each special paper; the total of both these assessments shall be considered for the Board II.

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

Bot 101- CELL AND MOLECULAR BIOLOGY OF PLANTS

Unit I

Basic concept of Cell and Cell theory: Multicellularity. Composition, structure and function of biomolecules (carbohydrates, lipids, proteins).Chemical foundation: Covalent and non-covalent bonds. Bioenergetics.

Cell wall. Cell membrane: Dynamic structure, compositions, function, biogenesis and structural model.

Plant Vacuoles: Tonoplast membrane, function as storage and transport. Cytoskeleton, organization and role of microtubules, microfilaments and associated motor proteins.

Cell junction and adhesions, Intercellular transport of endogenous macromolecules: Structure and functional significance of plasmodesmata.

Unit II

The nucleus: Nuclear envelope, nuclear pore complex, nucleolus. Mitochondrial and plastid biogenesis and development, concept of endosymbiosis. Organellar genome: organization and function of plastome and chondriome. Cell cycle regulation (Cyclins, CDKs), Senescence and Programmed Cell Death

Unit III

Protein Sorting and Vesicle Traffic; concept of signal peptide, transport of soluble and membrane bound proteins in Endoplasmic Reticulum, ER chaperone proteins and their functions. Targeting to nucleus, mitochondria, chloroplasts, vacuoles and secretory pathway. Replication of genetic material in prokaryotes and eukaryotes: initiation, elongation and termination.

Unit IV

Prokaryotic transcription: Transcription units; RNA polymerase structure and assembly; Promotors; Initiation, elongation and termination.

Eukaryotic transcription: RNA polymerase structure and assembly; eukaryotic promoters and enhancers; transcription factors.

Post transcriptional processing of mRNA: Capping, adenylation and Splicing, RNA editing.

DNA damage and repair.

Unit V

Translation: Translation machinery; Ribosomes: composition and assembly. Genetic code: degeneracy of codons, initiation and termination codons, wobble hypothesis, genetic code in mitochondria; Isoaccepting tRNA

Mechanism of protein synthesis: Translational factors; initiation, elongation and termination

Co- and post-translational modifications: Glycosylation, phosphorylation, ubiquitination, Mechanism of protein degradation

Laboratory Exercises

1. Demonstration of fluorescent microscope and visualization of GFP-proteins
2. Cytochemical staining of cell wall constituents.
3. Fluorescence staining of nuclei with DAPI.
4. Cell wall staining with calcofluor white.
5. Isolation of genomic DNA from plants/bacteria.
6. Amplification of genes using PCR
7. Demonstration of agarose gel electrophoresis.
8. One-dimensional SDS-PAGE protein profiling.
9. Demonstration of Southern/Northern blotting and Western Immunoblotting.
10. Gene tagging and screening
11. Techniques in cell biology: Phase contrast, Fluorescence microscopy, Laser confocal microscopy, electron microscopy (SEM, TEM), LCM (laser capture microdissection), Flow cytometry, FACS.

Suggested readings

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Lodish, H., Berk, A., Zipursky, S. L., Malsudaira, P., Baltimore, D. and Darnell, J. 2000. *Molecular CellBiology* (V Edition). W.H. Freeman and Co., New York, USA.

De, D. N. 2000. *Plant Cell Vacuoles: An Introduction.* CSIRO Publication, Collingwood, Australia.

Glick, B. R. and Thompson, J. E. 1993. *Methods in Plant Molecular Biology and Biotechnology*. CRC Press, Boca Raton, Florida.

Glover, D. M. and Hames, B. D. (eds) 1995. *DNA Cloning 1: A Practical Approach-, Core Techniques*, 2nd edition, PAS, IRL Press at Oxford University Press, Oxford.

Suggested Readings (Laboratory Exercises)

Sambrook, J. and Russell D.W. 2001. Molecular Cloning: A Laboratory Manual. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, New York.

Gunning, B. E. S. and Steer, M. W. 1996. Plant Cell Biology: Structure and Function. Jones and Bartlett Publishers, Boston, Massachusetts.

Hackett, P. B., Fuchs, J. A. and Messing, J. W. 1988. An Introduction to Recombinant DNA Techniques: Basic Experiments in Gene Manipulation. The Benjamin/Cummings Publishing Co., Inc Menlo Park, California.

Hall, J. L. and Moore, A. L. 1983. Isolation of Membranes and Organelles from Plant Cells. Academic Press, London, UK.

Harris, N. and Oparka, K. J., 1994. Plant Cell Biology: A Practical Approach, IRL Press at Oxford University Press, Oxford, U.K.

Klein smith, L. J. and Kish, V. M. 1995. Principles of Cell and Molecular Biology (Edition), Harper Collins College Publishers, New York, USA.

Krishnamurthy, K. V. 2000. Methods in Cell Wall Cytochemistry. CRC Press, Boca Raton, Florida.

Rost, T. et al., 1998. Plant Biology. Wadsworth Publishing Co., California, USA.

Shaw, C. H. (Ed.), 1988. Plant Molecular Biology: A Practical Approach. IRL Press, Oxford.

Wolfe, S. L. 1993. Molecular and Cellular Biology. Wadsworth Publishing Co., California, USA.

Review Journals:

Annual Review of Plant Physiology and Molecular Biology.

Current Advances in Plant Sciences.

Trends in Plant Sciences.

Nature Reviews: Molecular and Cell Biology.

Bot 102: CYTOLOGY AND GENETICS

Unit 1

Genome organization: Chromosome structure and packaging of DNA, Chromosomal banding patterns, karyotype analysis and evolution; specialized types of chromosomes; polytene, lampbrush, B-chromosomes and sex chromosomes, molecular basis of chromosome pairing.

Unit 2

Structural and numerical alterations in chromosomes: breeding behaviour of duplications, deficiency, inversion and translocation heterozygotes. Origin, occurrence, production and meiosis of autopolyploids and allopolyploids. Evolution of major crop plants: *Brassica* and Groundnut.

Unit 3

Mendelian and Non-Mendelian Inheritance (epigenetic and extra neculear), Independent assortment, crossing over, linkage groups and chromosome mapping. Genetic recombination and genetic mapping: Correlation of genetic and physical maps; molecular markers and construction of linkage maps.

Unit 4

Genetics of prokaryotes and eukaryotes: Genetic recombination in bacteria. Molecular mechanism of recombination; Fine structure of prokaryotic and eukaryotic genes. Regulation of gene expression in prokaryote and eukaryotes. Introns and their significance.

Unit 5

Transposons; transposable elements in prokaryotes and eukaryotes.Transfer of whole genome, examples from wheat, *Arachis* and *Brassica.* Genetic basis of inbreeding and heterosis, chromosome microdissection and microcloning, Genetics, evolution and breeding of wheat, rice and cotton.

Laboratory Exercises

1. Preparation of mitotic/meiotic spreads and analysis of various stages of cell division in *Phlox, Allium*, *Aloe*.
2. Preparation of mitotic/meiotic spreads and analysis of various stages of cell division in *Barleria* and *Rhoeo.*
2. Karyotype analysis from given chromosomal complement.
3. Calculation of C.I. value from a given Karyotype.
4. Extraction of genomic DNA from plants by Rapid or CTAB method.
5. Qualitative and quantitative analysis of plant DNA.
6. Basic techniques in plant breeding .
7. Construction of linkage map using available data.

Suggested Readings

Acquaah G (2007). Principles of Plant Genetics and Breeding, Blackwell Publishing Ltd.USA.

Hartl DL and Jones EW (2007). Genetics – Analysis of Genes and Genomes, 7th edition, Jones and Barletta publishers.

Hartwell LH, Hood L, Goldberg ML, Reynolds AE, Silver LM, Veres RC (2006).

Genetics –From Genes to Genomes, 3rd edition, McGraw Hill.

Lewin B (2008). Genes IX, Jones and Barlett Publishers.

Singh RJ (2002). Plant Cytogenetics, 2nd edition, CRC Press.

Strickberger MW (2008). Genetics, 3rd Edition, Pearson (Prentice Hall).

Weising K, Nybom H, Wolff K and Kahl G (2005) DNA Fingerprinting in Plants

Bot 103- BIOLOGY AND DIVERSITY OF MICROBES, ALGAE AND FUNGI

Unit I

Microbes: A brief idea of history of microbiology, Origin and evolution of microorganisms, Biological status of microorganisms, General account of Prion and Viroid. Viruses: morphology, architecture, chemistry, transmission and genetics of viruses.

Unit II

Microbes: A general account of ultrastructure, reproduction and economic importance of Mycoplasma, Phytoplasma, Cynobacteria, Archaeaobacteria, Eubacteria and Actinomycetes.

Unit III

Mycology: General characters and classification of fungi, Phylogeny of fungi. General account of Mastigomycotina, Zygomycotina, Ascomycotina, Basidiomycotina and Deuteromycotina. Economic importance of Fungi.

Unit IV

Phycology: Algae in diversified habitats; thallus organization; cell ultrastructure; reproduction; criteria for classification of algae. Classification and salient features of Protochlorophyta, Chlorophyta and Charophyta.

Unit V

Phycology: Classification and salient features of Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta. Algal blooms, algal biofertilizers; algae as food, feed and uses in industry.

Laboratory Exercises

1. Preparation of basic liquid media (broth) for the routine cultivation of microorganism.
2. Preparation of basic solid media, agar slants for the routine cultivation of microorganisms.
3. Isolation and enumeration of microorganisms from soil by the serial dilution-agar plating method.
4. Staining of bacteria (Gram staining, Negative staining, Acid fast staining).
5. Microscopic preparation and study of cyanobacteria (*Nostoc, Oscillatoria, Lyngbya, Scytonema, Microcystis*).
6. Morphological study of representative members of fungi:
   Peronospora, Sclerospora Albugo, Mucor, Rhizopus Pilobolus, Saccharomyces, Erysiphae, Chaetomium, Morchella, Melampsora, Puccinia, Ustilago, Agaricus, Phellorinia, Podaxis, Ganoderma, Penicillium, Aspergillus, Alternaria Curvularia, Helminthosporium, Drechslera, Fusarium, Trichoderma, Phoma and Colletotrichum.
7. Morphological study of representative members of algae: *Pediastrum, Hydrodictyon, Spirogyra, Ulva, Pithophora, Stigeoclonium, Draparnaldiopsis, Codium, Closterium, Cosmarium, Chara, Ectocarpus, Fucus, Sargassum and Polysiphonia.*

Suggested readings

Alexopoulus, C. J., Mims, C. W. and Blackwell, M. 1996. *Introductory Mycology*. John Wiley & Sons Inc.

Aneja, K.R., Experiments in Microbiology, Plant Pathology and Biotechnology, New Age International Publishers.

Dube, H. S. 2013. An introduction of Fungi. Scientific Publishers. India.

Kumar, H. D. 1988. *Introductory Phycology*. East-West Press Ltd., New Delhi.

Mehrotra, R. S. and Aneja, R. S. 1998. *An Introduction to Mycology*. New Age Intermediate Press.

Morris, I. 1986. *An Introduction to the Algae*. Cambridge University Press, U.K.

Pelczar, M.J., Chau, E.C.G. and Kreig, N.R., Microbiology Concepts and application McGraw Hill.

Prescott, L., Harley, J.P. and Klein, D. A., Microbiology. 6th ed. McGraw Hill.

Round, F. E. 1986. *The Biology of Algae*. Cambridge University Press, Cambridge.

Stainer, R., Ingraham, J.I., Wheelis, M.I., and Painter, P.R., General Mirobiology. The Mc millan Press Ltd.

Tortora, Gerad, J, Funke, B.R. and Case, C.L., Microbiology: An Introduction. Benjamin/ Cummings publishing: Menlo Park, California.

Webster, J. 1985. *Introduction to Fungi*. Cambridge University Press.

Bot 104- BIOLOGY AND DIVERSITY OF ARCHEGONIATE

Unit I

Bryophytes: General introduction and salient features; origin and classification; evolution of sporophytes and gametophytes; alternation of generations of bryophytes.

Unit II

Comparative study of structures, reproduction and life cycles of order Marchantiales, Jungermanniales, Anthocerotales and Sphagnales. Economic and biological importance of bryophytes.

Unit III

Pteridophytes: General introduction; salient features of Psilopsida, Lycopsida, Sphenopsida, Pteropsida; Geological time scale; types and nomenclature of fossils, fossilization

Unit IV

Structure and evolution of stelar system in Pteridophytes. Evolution of sporophytes. Alternation of generation; Apogamy and Apospory; Heterospory and seed habit; economic importance of Pteridophytes.

Unit V

Gymnosperms: General account of distribution of Gymnosperms in India; Classification. General account of structure, reproduction and evolutionary relationship of Cycadales, Coniferales, Ginkgoales, Ephedrales and Gnetales. Economic importance of Gymnosperms.

Laboratory Exercises

Morphological and reproductive study of following members of Bryophytes, Pteridophytes and Gymnosperms:

1. *Marchantia, Dumortiera, Targionia, Reboulia, Asterella, Cythodium, Pellia, Porella, Anthoceros, Notothylus, Sphagnum, Funaria, Polytrichum.*
2. *Psilotum, Lycopodium, Selaginella, Equisetum, Gleichenia, Pteris, Ophioglossum, Isoetes, Osmunda.*
3. *Cycas, Ginkgo, Cedrus, Abies, Picea, Cupressus, Araucaria, Cryptomeria, Taxodium, Podocarpus, Agathis, Taxus, Ephedra* and *Gnetum.*

Suggested Readings

Chopra, R.N. and P. K. Kumra. Biology of Bryophytes. Wiley Eastern Ltd., New Delhi, 1988.

Chopra, R.S. Taxonomy of Indian mosses. CSIR, New Delhi, 1975.

Chopra, R.S. and S.S. Kumar. Mosses of Western Himalayas and Adjacent Plains. Chronica Botanica, New Delhi, 1981.

Dyer, A. F. and J. G. Duckett.(Eds.). The Experimental Biology of Bryophytes. Academic press, London, 1984.

Goffinet, B. and A.J. Shaw. Bryophyte Biology. 2 nd Ed. Cambridge Univ. Press, Cambridge, 2009.

Kashyap, S.R. Liverworts of Western Himalayas and the Punjab Plains. Vols I II. Researchco Publications, New Delhi, 1932

Kumar, S.S. An Approach towards Phylogenetic Classification of Mosses. Jour. Hattori Bot. Lab. Nichinan, Japan, 1984.

Rashid, A. An Introduction to Bryophyta. Ist Ed. Vikas Publishing House Pvt. Ltd., New Delhi, 1998. 9. Richardson, D.H.S. Biology of Mosses. Blackwell Scientific Publications, Oxford, 1981.

Schofield, W.B. Introduction to Bryology. Macmillan Publishing Co., New York., 1983.

Schuster, R.M. (Ed.). New Manual of Bryology. Vols. I & II. Jour. Hattori Bot. Lab.,Nichinan, Japan, 1983-84.

Vashishta, B.R., A.K. Sinha and A. Kumar. Bryophyta. S. Chand & Co. Ltd., New Delhi, 2003.

Watson, E.V. The Structure and Life of Bryophytes. Hutchinson UniversityLibrary, London, 1964. 14. Bierhorst, D.W. Morphology of Vascular Plants. The MacMillan, New York, 1971.

Bold, H.C., C.J. Alexopolous and T. Delevoryas. Morphology of Plants and Fungi.4th Ed. Harper and Row Publishers, Inc., New York, 1980.

Chandra, S. and M. Srivastava (Eds.). Pteridology in the New Millenium. Kluwer Acad. Publishers, Dordrecht / Boston / London, 2003.

Dyer, A.F. The Experimental Biology of Ferns. Academic Press, London, 1979.

Foster, A.S. and E.M. Gifford. Comparative Morphology of Vascular Plants. 2nd Ed. W.H. Freeman and Co., San Francisco, 1974.

Gifford,E.M. and A.S. Foster. Morphology and Evolution of Vascular Plants.3rd Ed. W.H.Freeman & Co., New York, 1989.

Khullar, S.P. An Illustrated fern Flora of West Himalayas . Vols. I & II. International Book Distributors, Dehradun, 2000.

Kubitzki, K. The Families and Genera of Vascular Plants, Vol. I. Pteridophytes and Gymnosperms. Kramer, K.U. and P.S. Green (Ed.) Narosa Publishing House, New Delhi, 1991.

Mehra, P.N. and A.Gupta. Gametophytes of Himalayan Ferns. Publisher: Mehra, P.N., Botany Department, P.U., Chandigarh, 1986.

Parihar, N.S. An Introduction to Embryophyta Vol. II, Pteridophytes. Central Book Depot, Allahabad, 1965.

Raghavan, V. Developmental Biology of Fern Gametophytes (Developmental and Cell Biology Series). Cambridge Univ. Press, Cambridge, 1989.

Ranker, T. and C.H. Haufler (Eds.) The Biology and Evolution of Ferns and Lycophytes. Cambridge Univ. Press, Cambridge, New York, 2008.

Rashid, A. An Introduction to Pteridophyta . Vikas Publishing House Pvt. Ltd., New Delhi, 1999.

Sporne, K.R. The Morphology of Pteridophytes. Hutchinson University Library , London./ B.I. Publications, Bombay / Delhi / Madras, 1982.

Andrews, H.N.Jr. Studies in Paleobotany . John Wiley and Sons, New York, 1961.

Arnold, C.A. An Introduction to Paleobotany. McGraw Hill, New York, 1947.

Bhatnagar, D.W. Morphology of Vascular Plants. The Macmillan and Co., NewYork, 1971.

Bhatnagar, S.P. and A. Moitra. Gymnosperms. New Age International Ltd., New Delhi, 2000.

Bierhorst, D.W. Morphology of Vascular Plants. The Macmillan and Co., New York, 1971.

Chamberlain, C.J. Gymnosperms: Structure and Evolution. University of Chicago Press, Chicago, 1935.

Coulter, J.M. and C.J. Chamberlain. Morphology of Gymnosperms. Univ. of Chicago Press, Chicago, 1917.

Dallimore, W. and A.B. Jackson. A Handbook of Coniferae and Ginkgoaceae . 4 th Ed. Edward Arnold and Co., London, 1966.

Delevoryas, T. Morphology and Evolution of Fossil Plants. Holt, Rinehart and Winston, New York, 1962.

Foster, A.S. and E.M. Gifford. Comparative Morphology of Vascular Plants. 2 nd Ed. W.H. Freeman and Co., San Francisco, 1974.

Sharma, O.P. and S. Dixit. Gymnosperms. Pragati Prakashan, Meerut, 2002.

Sporne, K.R. The Morphology of Gymnosperms. Hutchinson Univ. Library, London, 1974.

SEMESTER II

Bot 201- TAXONOMY AND DIVERSITY OF SEED PLANTS

UNIT I

Plant Taxonomy-principles and significance. Nomenclature: International Code of Botanical Nomenclature (2012)-Taxonomic hierarchy-concept of species, genus, family and other categories; typification, rule of priority, effective and valid publication.

UNIT II

Angiosperm classifications: Phenetic versus phylogenetic systems; cladistics in taxonomy. Classification, relative merits and demerits of major systems of classifications-Bentham and Hooker, Cronquist, Takhtajan,

UNIT III

Plant explorations. Herbarium methodology-collection and preservation of plant specimens. World and Indian herbaria. Plant identification-taxonomic keys; floras and taxonomic journals.

Taxonomic evidence: Morphology, Anatomy, Palynology, Embryology, Cytology, Phytochemistry, Nucleic acid hybridization as a tool in taxonomy; DNA Barcoding. Computer applications and GIS.

UNIT IV

Evolution and differentiation of species: Abrupt and gradual speciation. Isolating mechanism – geographical, ecological, seasonal, temporal, mechanical and ethological.

Principles of phytogeography: Static and dynamic concepts. Continental drift theory and Endemism. Biodiversity hotspots. Invasions and introductions; Local plant diversity and its socio-economic importance.

UNIT V

Salient features, floral diversity, diversity of families and phylogeny of the following orders: Ranales, Centrospermae, Amentiferae, Tubiflorae, Helobieae and Glumiflorae.

Laboratory Exercises

1. Study of about 40 wild taxa representing different families and identification to species level.

2. Study of flora of the University/ college campus.
3. As a part of botanical tour, student should observe and record the flora and vegetation types of the study area and submit a report at the time of practical examination.
4. Part of practical - student should submit 10 herbaria specimens or image softcopies of 10 plants of common wild plant taxa.
5. Construction of taxonomic keys.
6. Demonstration of the utility of secondary metabolites in the taxonomy of some appropriate genera.
7. Comparison of different species of a genus and different genera of a family to calculate similarity coefficients and preparation of dendrograms.
8. Nomenclatural exercise.

Suggested Readings

Angiosperm Phylogeny Group website. 2012. Consult www.apgweb.

Cole, A. J. 1969. Numerical Taxonomy, Academic Press, London.

Davis, P. H. and Heywood, V. A. 1973. Principles of Angiosperms Taxonomy. Robert E. Kreiger Pub. Co-, New York.

Grant, V. 1971. Plant Speciation. Columbia University Press, New York.

Grant, W. F. 1984. Plant Biosystematics. Academic Press, London.

Harrison, H. J. 1971. New Concepts in Flowering Plant Taxonomy. Hieman Educational Books Ltd., London.

Heslop-Harrison, J. 1967. Plant Taxonomy. English Language Book Soc. & Edward Arnold Pub. Ltd., UK.

Heywood, V. H., Brummitt, R. K., Culham, A. and Seberg, O. 2007. Flowering Plant Families of the World. Firefly books Ltd. New York.

Heywood, V. H. and Moore, D. M. 1984. Current Concepts in Plant Taxonomy. Academic Press, London.

Jones, A. D. and Wilkins, A. D. 1971. Variations and Adaptations in Plant Species. Hieman & Co- Educational Books Ltd., London.

Jones, S. B. and Luchsinger, A. E. 1986. Plant Systematics (Ist edition). McGraw-Hill Book Co., New York.

Judd, W. S., Campbell, C. S., Kellogg, E. A., Stevens, P. F. and Donoghue, M. J. 2007. Plant Systematics: A Phylogenetic Approach, 3rd ed. Sinauer.

Lawrence, G. H. M. 1951. Taxonomy of Vascular Plants. McMillan, New York.

Naik, V. N. 1992. Taxonomy of Angiosperms. 2nd Edn. Tata McGraw Hill.

Nordenstam, B., El Gazaly, G. and Kassas, M. 2000. Plant Systematics for 21st Century. Portlant Press Ltd., London.

Pullaiah, T. 2005. Taxonomy of Angiosperms. Regency Publications, New Delhi.

Radford, A. E. 1986. Fundamentals of Plant Systematics. Harper & Row Publications, USA.

Radford. A. E. etal., 1974. Vascular Plant Systematics. Harper & Row, New York.

Ravi Prasad Rao, B. 2009. Plant Name Directory. ABCD, Planographers, Hyderabad.

Simpson, M. G. 2006. Plant Systematics. Elseiver & Academic Press.

Singh, G. 2005. Plant Systematics. Oxford & IBH, New Delhi.

Sivarajan, V. V. 1991. Introduction to Principles of Plant Taxonomy. Oxford & IBH.

Solbrig, O. T. 1970. Principles and Methods of Plant Biosystematics. The MacMillanCo. Collier-Mac Millan Ltd., London.

Solbrig, O. T. and Solbrig, D. J. 1979. Population Biology and Evolution. Addison-Wesley Publicating Co. Inc., USA.

Stace, C. A. 1989. Plant Taxonomy and Biosystematics. Edward Arnold Ltd., London.

Stebbin, G. L. 1974. Flowering Plant- Evolution Above Species Level. Edward Arnold Ltd., London,

Takhtajan, A. L. 1997. Diversity and Classification of Flowering Plants. Columbia University Press, New York.

Woodland, D. W. 1991. Contemporary Plant Systematics. Prentice Hall, New Jersey.

Bot 202-PLANT DEVELOPMENT AND REPRODUCTIVE BIOLOLGY

Unit I

Introduction: Unique features of plant development. Seed germination and seedling development. Concept of stem cells in plants. Shoot apical meristem (SAM) and development of shoot. Cell to cell communication. Regulation of tissue differentiation with special reference to xylem and phloem, secretary ducts and laticifers. Wood development in relation to environmental factors.

Unit II

Differentiation and development of Leaf. Phyllotaxy. Differentiation of epidermis (with special reference to stomata and trichomes) and mesophyll. Programmed cell death, aging and senescence. Root apical meristem (RAM) and development of root(s), lateral roots and root hairs. Hormonal control of root development.

Unit III

Reproduction: Vegetative and sexual reproduction; flower development; genetics of floral organ differentiation; homeotic mutants in *Arabidopsis* and *Antirrhinum*; sex determination in plants. Male gametophyte: microsporogenesis, role of tapetum; pollen development and gene expression; pollen germination, pollen tube growth and guidance; pollen storage; pollen allergy; pollen embryos.

Unit IV

Female gametophyte: Ovule development; megasporogenesis; organization and structure of the embryo sac. Pollination, pollen-pistil interaction, sporophytic and gametophytic self-incompatibility in plants. Double fertilization and *in vitro* fertilization in plants.

Unit V

Endosperm development during early, maturation and desiccation stages; Embryogenesis, Storage proteins of endosperm and embryo; polyembryony; apomixes. Seed development. Fruit development and maturation: biochemistry and molecular biology aspects. Seed dormancy: Importance and types.

Laboratory/Field Exercises

1. Study of living shoot apices by dissections using aquatic plants such as *Ceratophyllum* and *Hydrilla.*
2. Study of cytohistological zonation in the shoot apical meristem (SAM) in sectioned and double-stained permanent slides of a suitable plant such as *Coleus, Kalanchoe*, tobacco. Examination of shoot apices in a monocotyledon in both T.S. and L.S. to show the origin and arrangement of leaf primordia.
3. Study of alternate and distichous, alternate and superposed, opposite and superposed; opposite and decussate leaf arrangement. Examination of rosette plants (*Launaea, Mollugo, Raphanus, Hyoscyamus*, etc.) and induction of bolting under natural conditions as well as by GA treatment.
4. Microscopic examination of vertical sections of leaves such as *Cannabis*, tobacco, *Nerium*, maize and wheat to understand the internal structure of leaf tissues and trichomes, glands, etc. Also study the C3 and C4 leaf anatomy of plants.
5. Study of epidermal peels of leaves such as *Coccinia, Gaillardia, Tradescantia, Notonea*, etc. to study the development and final structure of stomata and prepare stomatal index. Demonstration of the effect of ABA on stomatal closure.
6. Study of whole roots in monocots and dicots. Examination of L.S. of root from a permanent preparation to understand the organization of root apical meristem and its derivatives (use maize, aerial roots of banyan, *Pistia, Jussiaea*, etc.). Origin of lateral roots. Study of leguminous roots with different types of nodules.
7. Study of microsporogenesis and gametogenesis in sections of anthers.
8. Examination of modes of anther dehiscence and collection of pollen grains for microscopic examination (maize, grasses, *Cannabis sativa, Crotolaria, Tradescantia, Brassica, Petunia, Solanum melongena*, etc.).
9. Tests for pollen viability using stains and *in vitro* germination. Pollen germination using hanging drop and sitting drop cultures, suspension culture and surface culture.
10. Estimating percentage and average pollen tube length *in vitro*.
11. Study of nuclear and cellular endosperm through dissections and staining.
12. Isolation of zygotic globular, heart-shaped, torpedo stage and mature embryos from suitable seeds and polyembryony in citrus, jamun (*Syzygium cumini*), etc. by dissections.
13. Study of seed dormancy and methods to break dormancy.

Suggested Readings

Atwell, B. J., Kriedermann, P. E. and Jumbull, C. G. N. (eds) 1999. *Plants in Action: Adaptation in Nature, Performance in Cultivation*, MacMillan Education, Sydney, Australia.

Bewley, J. D. and Black, M. 1994. *Seeds: Physiology of Development and Germination*, Plenum Press, New York.

Bhojwani, S. S. and Bhatnagar, S. P. 2000. *The Embryology of Angiosperms* (4th revised and enlarged edition), Vikas Publishing House, New Delhi.

Burgess, J. 1985. *An Introduction to Plant Cell Development.* Cambridge University Press, Cambridge.
Fageri, K. and Van der Pil, L. 1979. *The Principles of Pollination Ecology*, Pergamon Press, Oxford.
Fahn, A. 1982. *Plant Anatomy* (3rd edition), Pergamon Press, Oxford.
Fosket, D. E. 1994. *Plant Growth and Development. A Molecular Approach.* Academic Press, San Diego.
Howell, S. H. 1998. *Molecular Genetics of Plant Development*. Cambridge University Press, Cambridge.
Leins, P., Tucker, S. C. and Endress, P. K. 1988. *Aspects of Floral Development*. J. Cramer, Germany.
Lyndon, R. F. 1990. *Plant Development. The Cellular Basis*, Unnin Hyman, London.
Murphy, T. M. and Thompson, W. F. 1988. *Molecular Plant Development.* Prentice Hall, New Jersey.
Proctor, M. and Yeo, P. 1973. *The Pollination of Flowers*. William Collins Sons, London.
Raghavan, V. 1997. *Molecular Embryology of Flowering Plants*. Cambridge University Press, Cambridge.
Raghavan, V. 1999. *Developmental Biology of Flowering Plants*. Springer-Verlag, New York.
Raven, P. H., Evert, R. F. and Eichhorn, S. E. 1992. *Biology of Plants* (5th edition), Worth, New York.
Salisbury, F. B. and Ross, C. W. 1992. *Plant Physiology* (4th edition), Wadsworth Publishing, Belmont, California.
Sedgely, M. and Griffin, A. R. 1989. *Sexual Reproduction of Tree Crops.* Academic Press, London.
Shivanna, K. R. and Johri, B. M. 1985. *The Angiosperm Pollen: Structure and Function*. Wiley Eastern Ltd., New York.
Shivanna, K. R. and Rangaswamy, N. S. 1992. *Pollen Biology: A Laboratory Manual*, Springer-Verlag, Berlin.
Shivanna, K. R. and Sawhney, V. K. (eds) 1997. *Pollen Biotechnology for Crop Production and Improvement.* Cambridge University Press, Cambridge.
Steeves, T. A. and Sussex, I. M. 1989. *Patterns in Plant Development* (2nd edition), Cambridge University Press, Cambridge.
The Plant Cell. Special Issue on Reproductive Biology of Plants, Vol. 5(10), 1993. The American Society of Plant Physiologists, Rockville, Maryland, USA.
Waisel, Y., Eshel, A. and Kafkaki, U. (eds) 1997. *Plant Roots: The Hidden Hall* (2nd edition), Marcel Dekker, New York.

Suggested Readings (Laboratory Exercises)

Chopra, V. L. 2001. Plant Breeding: Field Crops. Oxford Pvt. Ltd., New Delhi.
Chopra, V. L. 2001. Plant Breeding: Theory and Practice. Oxford IBH Pvt. Ltd., New Delhi.
Shivanna, K. R. and Rangaswamy, N. S. 1992. Pollen Biology: A Laboratory Mannual. Springer-Verlag, Berlin-Heidelberg (and references therein).

Bot 203- PLANT RESOURCE UTILIZATION AND CONSERVATION

Unit I

Origin of Agriculture and Green Revolution: Primary and secondary centers of diversity of cultivated plants. History of agriculture revolution, Green revolution and new challenges of food security

Unit II

Desert Plant Resources: Important fire-wood and timber yielding plants with special reference to Rajasthan desert. Non-wood forest products (NWFPs) and their uses. Bamboos, Gums, resins, dyes and tannins from natural plant resources and their economic utility.

Unit III

Food, Fiber, Medicinal and Aromatic Plants: Origin, botany, cultivation and utilization of food, forage, fodder and fiber crops of Rajasthan.

Origin, botany, cultivation, chemical constituents and uses of medicinal, aromatic, and vegetable oil-yielding crops of Rajasthan

Unit IV

Biostatistics: Central tendency, dispersion, standard error, coefficient of variation; Probability distributions (normal, binomial of Poission) and Confidence limits. Test of statistical significance (t-test; Chi-square): Analysis of variance- RBD and its application in plant breeding and genetics; Correlation and Regression.

Unit V

Techniques for *In-situ and Ex-situ* Conservations and Institutes: Strategies for – *in-situ*conservation: protected areas in India – biosphere reserves, national parks, sanctuaries, wetlands, mangroves and coral reefs for conservation of wild biodiversity. Strategies for– *ex-situ* conservation: botanical gardens, field gene banks, seed banks, *in vitro* repositories and cryobanks.

General account of the activities of Botanical Survey of India (BSI), National Bureau of Plant Genetic Resources (NBPGR), AYUSH (Ministry of Ayurveda, Yoga and Naturopathy, Unanai, Siddha and Homeopathy) and Indian Spice Board.

Laboratory Exercises

1. To locate the centers of origin of agriculture in the given map
2. To locate the primary and secondary centers of origin in the given map
3. Quantification of starch in food and forage crops (wheat, rice, maize, potato, sweet potato, sorghum, bajra, gram & guar bean)
4. Micro-chemical test for fats & oils
5. Morpho-anatomical features of plant fibers (cotton, jute, coir & silk cotton)
6. Quantification of acid, iodine and saponification values in vegetable oils (mustard, groundnut, soybean, coconut, sunflower & castor)
7. Micro-chemical test for gums (guar &kumbhatia), tannins (*Acacia, Terminalia, Cassia*& tea leaves) and dyes (*Butea*& henna powder)
8. Impurity test for natural products (honey, saffron & mustard oil)
9. Distribution pattern of a biological character in a population
10. Measurement of central tendency (mean, variance & standard deviation)
11. Regression and confidence limits
12. Analysis of variance (RBD, split & strip)
13. Estimation of pcv, gcv, heritability and genetic advance using RBD analysis
14. Students t-test for comparison of means
15. Correlation and testing deviation of correlation coefficient
16. To locate the various national parks, sanctuaries, biosphere reserves, wetlands, /mangroves and coral reefs in the given Indian map.
17. **Specimen identifications:**
    Food crops: Wheat, Maize Potato, Chickpea, Sugarcane &Sweet potato
    Forage/Fodder crops: Sorghum, Bajra, Gram &Guar bean
    Fiber crops: Cotton, Jute, Coir &Silk cotton
    Medicinal plants:*Papaver, Catharanthus, Adhatoda, Allium, Rauvolfia, Withania, Phyllanthus&Aloe*
    Aromatic plants:*Mentha, Rosa, Majorana, Jasminum, Cymbopogon&Pandanus*
    Non-wood forest products: Silk, Honey comb, Bidi, Flute, Hand fan& Kraft paper

Scientific visits*

The students should be taken to one of the following:

i. A protected area (biosphere reserve, national park, or a sanctuary)
ii. A wet land
iii. A mangrove
iv. National Bureau of Plant Genetic Resources, New Delhi – 110012 or one of its field stations
v. Headquarters of the Botanical Survey of India or one of its Regional Circles
vi. A recognized botanical garden or a museum (such as those at the Forest Research Institute, Dehradun; National Botanical Research Institute, Lucknow; Tropical Botanical Garden and Research Institute, Trivandrum), which has rich collection of plant products.

* Note: The students are expected to prepare a brief illustrated narrative of the Scientific Visits. After evaluation, the grades awarded to the students by the teachers should be added to the final assessment of the practical examination.

Suggested Readings

Anonymous 1997. National Gene Bank: Indian Heritage on Plant Genetic Resources (Booklet). National Bureau of Plant Genetic Resources, New Delhi.

Arora, R.K. and Nayar, E.R. 1984. Wild Relatives of Crop Plants in India. NBPGR Science Monograph No. 7.

Baker, H.G. 1978. Plants and Civilization (3rd ed.). C.A. Wadsworth, Belmont.

Bole, P.V. and Vaghani, Y. 1986.Field Guide to Common Indian Trees. Oxford University Press, Mumbai.

Chandel, K.P.S., Shukla, G. and Sharma, N. 1996. Biodiversity of Medicinal and Aromatic Plants in India: Conservation and Utilization. National Bureau of Plant Genetic Resources, New Delhi.

Chrispeels, M.J. and Sadava, D. 1977. Plants, Food and People. W.H. Freeman and Co., San Francisco.

Conway, G. 1999. The Doubly Green Revolution: Food for All in the 21st Century, Penguin Books.
Conway, G. and Barbier, E. 1990. After the Green Revolution, Earthscan Press, London.
Conway, G. and Barbier, E. 1994.Plant, Genes and Agriculture, Jones and Bartlett Publishers, Boston.
Council of Scientific& Industrial Research (1948-2005). The Wealth of India.A Dictionary of Indian Raw Materials and Industrial Products, New Delhi. Raw Materials I-XII, Revised Vol. I-III (1985-1992) Supplement (2000).
Cristi, B.R. (ed.) 1999. Handbook of Plant Sciences and Agriculture, Vol. I. In-situ Conservation, CRC Press, Boca Raton, Florida, USA.
Cronquist, A. 1981.An Integrated System of Classification of Flowering Plants. Columbia University Press, New York, USA.
Directory of Indian Wetlands, 1993. WWF INDIA, New Delhi and AWS, Kuala Lumpur.
Dodds, J.H. 1991. In vitro method for Conservation of Plant Genetic Resources. Springer
Falk, D.A., Olwell, M. and Millan, C. 1996.Restoring Diversity, Island Press, Columbia, USA.
FAO/IBPGR 1989.Technical Guidelines for the Safe Movement of Germplasm.FAO/IBPGR, Rome.
Frankel, O.H., Brown, A.H.D. and Burdon, J.J. 1995. The Conservation of Plant Diversity, Cambridge University Press, Cambridge, U.K.
Gadgil, M. and Guha, R. 1996. Ecology and Equity: Use and Abuse of Nature in Contemporary India. Penguin, New Delhi.
Gaston, K.J. (ed). Biodiversity: A Biology of Numbers and Differences, Blackwell Science Ltd., Oxford, U.K.
Gomez, A. Kwanchai and Gomez, A. Arturo. 1984. Statistical Procedures for Agricultural Research (second Edition), John Wiley & Sons, New York
Guerrant, E.O., Havens, K. and Maunder, M. 2004. Ex situ Plant Conservation.Island Press.
Hamilton, A. 2013. Plant Conservation: An Ecosystem Approach. Routedge.
Henry, R.J. 2010.Plant Resources for Food, Fuel and Conservation.Earthscan.
Heywood, V. (ed) 1995. Global Biodiversity Assessment. United Nations Environment Programme. Cambridge University Press, Cambridge, U.K.
Heywood, V.H. and Wyse Jackon, P.S. (eds) 1991. Tropical Botanical Gardens: Their Role in Conservation and Development. Academic Press, San Diego.
Kochar, S.L. 1998. Economic Botany of the Tropics, 2nd edition, Macmillan India Ltd., Delhi.
Kohli, R., Arya, K.S., Singh, P.H. and Dhillon, H.S. 1994. Tree Directory of Chandigarh, Lovedale Educational, New Delhi.
Kothari, A. 1997.Understanding Biodiversity: Life Sustainability and Equity, Orient Longman.
Mishra, B.N. and Mishra M.K. 1989.Introductory Practical Biostatistics.NayaPrakash Publication, Calcutta.
Nair, M.N.B. et al. (eds) 1998. Sustainable Management of Non-wood Forest Products. Faculty of Forestry, University Putra Malaysia, 434004 PM Sardong, Selanger, Malaysia.
Panse, V.G. and Sukhatme, P.V. 1989. Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research, New Delhi.
Paroda, R.S. and Arora, R.K. 1991. Plant Genetic Resources Conservation and Management. IPGRI (Publication), South Asia Office, C/o NBPGR, Pusa Campus, New Delhi.
Pimentel, D. and Hall, C.W. (eds) 1989. Food and Natural Resources, Academic Press, London-New York.
Pinstrup-Anderson, P. et al. 1999. World Food Prospects: Critical Issues for the Early 21st Century. International Food Policy Research Institute, Washington, D.C., USA.
Plant Wealth of India 1997.Special Issue of Proceedings Indian National Science Academy B-63.
Plucknett, D.L., Smith, N.J.H., William, J.T. and MurliAnnishetty, N. 1987.Gene Banks and Worlds Food. Princeton University Press, Princeton, New Jersey, USA.
Quinn, P. Gerry and Keough, J. Michael. 2002. Experimental Design and Data Analysis for Biologists. Cambridge University Press Cambridge, UK .
Rao, Sundar P.S.S. and Richard, J. 2011.Introduction to Biostatistics and Research Methods.(4th Ed), PHI Learning Pvt. Ltd., New Delhi.
Reed, B.M. 2008. Plant Cryopreservation – A Practical Guide.Springer.
Rodgers, N.A. and Panwar, H.S. 1988. Planning a Wildlife Protected Area Network in India. Vol. I.The Report.Wildlife Institute of India, Dehradun.
Sahni, K.C. 2000. The Book of Indian Trees, 2nd edition. Oxford University Press, Mumbai.
Schery, R.W. 1972. Plants for Man, 2nd ed. Englewood Cliffs, New Jersey Prentice Hall.
Sharma, O.P. 1996. Hill's Economic Botany (Late Dr. A.F. Hill, adapted by O.P. Sharma). Tata McGraw Hill Co. Ltd., New Delhi.
Sofo, A. 2011. Biodiversity (Ed), InTech Publisher, DOI: 10.5772/1836
Swaminathan, M.S. and Kocchar, S.L. (eds) 1989. Plants and Society. Macmillan Publication Ltd., London.
Thakur, R.S., Puri, H.S. and Husain, A. 1989.Major Medicinal Plants of India.Central Institute of Medicinal and Aromatic Plants, CSIR, Lucknow.

Thomas, P. 2000. Trees: Their National History. Cambridge University Press, Cambridge, U.K.
Wagner, H., Hikino, H. and Famswarth, N. 1989. Economic and Medicinal Plant Research, Vols. 1-3, Academic Press, London.
Walter, K.S. and Gillett, H.J. 1998. IUCN Red List of Threatened Plants. IUCN, the World Conservation Union. IUCN, Gland, Switzerland and Cambridge, UK.
Williams, Brain. 1993. Biostatistics- Concepts and Applications for Biologist. Chapman & Hall, London

Bot 204 - PLANT PHYSIOLOGY

UNIT I

Membrane transport and Translocation of water and solutes: Mechanism of water transport through xylem, stomatal regulation , nutrient deficiency, root microbe interactions in facilitating nutrient uptake, phloem loading and unloading, passive and active solute transport, Protein transporters.

UNIT II

Photosynthesis: Photosynthetic apparatus, photosynthetic pigments and light harvesting complexes, photooxidation of water, mechanisms of electron and proton transport, carbon assimilation the Calvin cycle, photo respiration and its significance, the C4 cycle, the CAM pathway. Light regulation of C3 and C4 cycle enzymes.

UNIT III

Signal transduction: Overview, receptors, signaling molecules, G-proteins, phospholipids signaling, role of cyclic nucleotides, calcium-calmodulin cascade, and phosphatases, specific signaling mechanisms, e.g. two-component sensor-regulator system in bacteria and plants. Sensory photo receptors.

UNIT IV

Plant growth regulators: Physiological effects and general mechanism of action of plant hormones. Brief account on brassinosteroids, polyamines, Jasmonic acid, salicylic acid and nitric oxide (NO). Photoperiodism and its significance, endogenous clock and its regulation. Vernalization.

UNIT V

Stress physiology- Plant responses to biotic and abiotic stress, general mechanisms of abiotic stress tolerance, drought and salinity stress, freezing and heat stress, oxidative stress and antioxidants system in plants.

Laboratory Exercises

1. Extraction of chloroplast pigments from leaves and preparation of the absorption spectrum of chlorophylls and carotenoids.
2. To determine the chlorophyll a/chlorophyll b ratio in C3 and C4 plants.
3. Desalting of proteins by gel filtration chromatography employing Sephadex G25.
4. SDS PAGE for soluble proteins extracted from the given plant materials and comparison of their profile by staining with Coomassie Brilliant Blue or silver nitrate.
5. Isolation of intact chloroplasts and estimation of chloroplast proteins by spot protein assay.
6. To demonstrate photophosphorylation in intact chloroplasts, resolve the phosphoproteins by SDS PAGE and perform autoradiography.
7. Radioisotope methodology, autoradiography, instrumentation (GM counter and Scintillation counter) and principles involved.

Suggested Readings

Ahmad, P. and Wani, M.R. 2014. Physiological Mechanisms and Adaptation Strategies in Plants Under Changing Environment (eds). Springer New York
Buchanan, B. B., Gruissem, W. and Jones, R. L. 2000. Biochemistry and Molecular Biology of Plants. American Society of Plant Physiologists. Maryland, USA.
Dennis, D. T., Turpin, D. H., Lefebvre, D. D. and Layzell, D. B. (eds) 1997. Plant Metabolism (2nd edition). Longman, Essex, England.
Galston, A. W. 1989. Life Processes in Plants. Scientific American Library, Springer Verlag, New York, USA.
Hooykaas, P. J. J., Hall, M. A. and Libbenga, K. R. (eds) 1999. Biochemistry and Molecular Biology of Plant Hormones. Elsevier, Amsterdam, The Netherlands.

Hopkins, W. G. 1995. Introduction to Plant Physiology. John Wiley & Sons, Inc., New York, USA.
Hopkins, W.G. and Huner, N.P.A . 2009. Introduction to Plant Physiology (4th Edition). John Wiley & Sons, Inc. New York, USA
Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell, J. 2000. Molecular Cell Biology (4th edition). W.H. Freeman and Company, New York, USA.
Moore, T. C. 1989. Biochemistry and Physiology of Plant Hormones (2nd edition). Springer Verlag, New York, USA.
Nobel, P. S. 1999. Physiochemical and Environmental Plant Physiology (2nd edition). Academic Press, San Diego, USA.
Ricardo, A. 2012. Plant Responses to Drought Stress - From Morphological to Molecular Features (ed). Springer
Salisbury, F. B. and Ross, C. W. 1992. Plant Physiology (4th edition). Wadsworth Publishing Co., California, USA.
Singhal, G. S., Renger, G., Sopory, S. K., Irrgang, K. D. and Govindjee. 1999. Concepts in Photobiology: Photosynthesis and Photomorphogenesis. Narosa Publishing House. New Delhi.
Taiz, L. and Zeiger, E. 1998. Plant Physiology (2nd edition). Sinauer Associates, Inc., Publishers, Massachusetts, USA.
Tripathi, B.N. and , Müller, M.2015.Stress Responses in Plants: Mechanisms of Toxicity and Tolerance(eds). Springer
Thomas, B. and Vince Prue, D. 1997. Photoperiodism in Plants (2nd edition). Academic Press, San Diego, USA.
Westhoff, P. 1998. Molecular Plant Development: from Gene to Plant. Oxford University Press, Oxford, UK.

SUGGESTED READINGS (FOR LABORATORY EXERCISES)

Bajracharya, D. 1999. Experiments in Plant Physiology: A Laboratory 'Manual. Narosa Publishing House, New Delhi.
Cooper, T. G. 1977. Tools in Biochemistry. John Wiley, New York, USA.
Copeland, R. A. 1996. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis. VCH Publishers, New York.
Dennison, C. 1999. A Guide to Protein Isolation. Kluwer Academic Publishers, Dordrecht, The Netherland.
Devi, P. 2000. Principles and Methods of Plant Molecular Biology, Biochemistry and Genetics. Agrobios, Jodhpur, India.
Dryer, R. L. and Lata, G. F. 1989. Experimental Biochemistry. Oxford University Press, New York.
Harborne, T. C. 1981. Phytochernical Methods: A Guide to Modern Techniques of Plant Analysis. Chapman & Hall, London.
Harries, B. D. (Ed.) 1998. Gel Electrophoresis of Proteins: A Practical Approach, 3rd edition. PAS, Oxford University Press, Oxford, U.K.
Moore, T. C. 1974. Research Experiences in Plant Physiology: A Laboratory Manual. Springer Verlag, Berlin.
Ninfa, A. J. and Ballou, D. P. 1998. Fundamental Laboratory Approaches for Biochemistry and Biotechnology. Fitzgerald Science Press, Inc., Maryland, USA.
Plummer, D. T. 1988. An Introduction to Practical Biochemistry. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
Scott, R. P. W. 1995. Techniques and Practice of Chromatography. Marcel Dekker, Inc., New York.
Wilson, K. and Goulding, K. H. (eds.), 1986. A Biologists Guide to Principles and Techniques of Practical Biochemistry. Edward Arnold, London, UK.
Wilson, K. and Walker, J. 1994. Practical Biochemistry: Principles and Techniques, 4th edition. Cambridge University Press, Cambridge, UK.

SEMESTER III

Bot 301- PLANT ECOLOGY

Unit I

Climate and Vegetation: Introduction to concepts developments in ecology. Atmosphere, Hydrosphere and Biosphere – Life zones. Major biomes of the world; Vegetation types of the world and India.

Unit II

Plant Community and Population Biology: Concepts of community, analytical and synthetic characters, community coefficients, interspecific associations, Concept of habitat; species coexistence and niche.

Population Biology: Concepts and Growth models

Unit III

Ecosystem: Structure and function. Energy dynamics – energy flow models and efficiencies.

Mineral cycles: C, N, P and S mineral cycles, pathways, processes and budgets in terrestrial and aquatic systems. Global biogeochemical cycles of C, N, P and S.

Unit IV

Productivity and Plant Succession: Productivity: definition, types. Primary productivity – measurements, global pattern and controlling factors.

Succession (Ecosystem development): Concept, kinds, mechanisms and models, changes in ecosystem properties during succession.

Unit V

Environmental Pollution and Standard Parameters: Air, water and soil pollution – definition, kinds, sources, quality parameters, effects on plants and ecosystem. Methods/techniques used in Phytoremediation/ Bioremediation. Environment Impact Assessment and its model formats.

Laboratory/field exercises

1. To calculate mean, variance, standard deviation, standard error, coefficient of variation and to use t-test for comparing two means related to ecological data.
2. To prepare ombrothermic diagram for different sites on the basis of given data and to comment on climate.
3. To compute phenothermal indices for some desert plants
4. To find out the relationship between two ecological variables using correlation and regression analysis.
5. To determine minimum size and number of quadrates required for reliable estimate of biomass in a natural field.
6. To find out association between important species using chi-square test.
7. To compare protected and gochar land vegetation using similarity indices.
8. To analyze plant communities using Bra-Curtis/Twin span ordination method.
9. To determine diversity indices (concentration of dominance, Shannon-Wiener, species richness, equitability and β diversity) for protected and gochar land vegetation.
10. To estimate IVI of the species in protected and gochar land vegetation
11. To determine productivity in terrestrial (CO_2 Analyzer) and aquatic (Light and dark bottle method) systems.

Suggested Readings

Barbour, M. G., Burk, J. H. and Pitts, W. D. 1987. *Terrestrial Plant Ecology*. Bejamin/Cummings Publication Company, California.

Begon, M., Harper, J. L. and Townsend, C. R. 1996. *Ecology*. Blackwell Science, Cambridge, U.S.A.

Brady, N. C. 1990. *The Nature and Properties of Soils*. Macmillan.

Cadish, G. and Giller,K. E. 1997. *Driven by Nature, Plant Litter Quality and Decomposition*, CAB International Wallingford, U.K.

Chapman, B. and Bilharz, S. 1997. *Sustainability Indicators*. John Wiley & Sons, New York.

Heywood, V. H. and Watson, R. T. 1995. *Global Biodiversity Assessment.* Cambridge University Press.

Hill, M. K. 1997. *Understanding Environmental Pollution.* Cambridge University Press.

Koromondy, E. J. 1996. *Concepts of Ecology*. Prentice-Hall of India Pvt. Ltd., New Delhi.

Ludwig, J. and Reynolds, J.F. 1988. *Statistical Ecology*. John Wiley & Sons.

Mason, C. F. 1991. *Biology of Freshwater Pollution*. Longman.

Muller-Dombois, D. and Ellenberg, H. 1974. *Aims and Methods of Vegetation Ecology*, Wiley, New York.

Odum, E. P. 1971. *Fundamentals of Ecology*, Saunders, Philadelphia.

Odum, E. P. 1983. *Basic Ecology*, Saunders, Philadelphia.

Smith, R. L. 1996. *Ecology and Field Biology*. Harper Collins, New York.

Treshow, M. 1985. *Air Pollution and Plant Life*. Wiley Interscience.

SUGGESTED READINGS (FOR LABORATORY EXERCISES)

APHA-Standard Methods for the Examination of Water and Waste Water. American Public Health Association, Washington, D.C.
Krebs, C. J. 1989. Ecological Methodology. Harper and Row, New York, USA.
Ludwig, J. A. and Reynolds, J. F. 1988. Statistical Ecology. Wiley, New York.
Magurran, A. E. 1988. Ecological Density and its Measurement. Chapman & Hall, London.
Misra, R. 1968. Ecology Work Book. Oxford & IBH, New Delhi.
Moore, P. W. and Chapman, S. B. 1986. Methods in Plant Ecology. Blackwell Scientific Publications.
Muller-Domois, D. and Ellenberg, H. 1974. Aims and Methods of Vegetaion Ecology. Wiley, New York.
Pielou, E. C. 1984. The Interpretation of Ecological Data. Wiley, New York.
Smith, R. L. 1996. Ecology and Field Biology. Harper Collins, New York.
Sokal, R. R. and Rohlf, F. J. 1995. *Biometry*. W.H. Freeman & Co., San Francisco.

Bot 302-PLANT METABOLISM

UNIT I

Metabolic processes and Fundamentals of enzymology: Anabolic and catabolic processes, General aspects of enzymes, allosteric mechanism, regulatory and active sites, isozymes.

UNIT II

Biosynthesis of starch and sucrose, Biosynthesis and degradation of fatty acids, Metabolism of plant hormones, Major pathways of biosynthesis of hormones and secondary metabolites

UNIT III

Respiration: Overview of plant respiration, glycolysis, the TCA cycle, electron transport and ATP synthesis, pentose phosphate pathway, glyoxylate cycle, alternative oxidase system.

UNIT IV

Nitrogen metabolism: Overview of biological nitrogen fixation, Nitrogenase, Mechanism of nitrate uptake and reduction, ammonia assimilation, GS-GOGAT system, amino acids synthesis, Nucleotide synthesis, Protein degradation.

UNIT V

Sulphur metabolism and bio analytical techniques: sulfate uptake, transport and assimilation, metabolic control of sulfate uptake and assimilation in plants. Concepts and applications of spectroscopy, visible and UV spectroscopy. Principles and applications of centrifugation, low speed, high speed, cooling and ultracentrifugation.

Laboratory Exercises

1. Effect of time and enzyme concentration on the rate of reaction of enzyme (e.g. acid phosphatase, nitrate reductase).
2. Demonstration of the substrate inducibility of the enzyme nitrate reductase.
3. Extraction of seed proteins depending upon the solubility.
4. Desalting of proteins by gel filtration chromatography employing Sephadex G25.
5. Preparation of the standard curve of protein (BSA) and estimation of the protein content in extracts of plant material by Lowry's or Bradford's method.
6. Separation of isozymes of esterases, peroxidases by native polyacrylamide gel electrophoresis.
7. Principles of colorimetry, spectrophotometry and fluorimetry.
8. Effect of substrate concentration on activity of any enzyme and determination of its Km value.

Suggested Readings

Barker A.V.and Pilbeam D.J. 2007. *Handbook of Plant Nutrition* (eds.). Taylor & Francis
Buchanan, B. B., Gruissem, W. and Jones, R. L. 2000. *Biochemistry and Molecular Biology of Plants*. American Society of Plant Physiologists. Maryland, USA.
Dennis, D. T., Turpin, D. H., Lefebvre, D. D. and Layzell, D. B. (eds) 1997. *Plant Metabolism* (2nd edition). Longman, Essex, England.
Galston, A. W. 1989. *LifeProcesses in Plants.* Scientific American Library, Springer-Verlag, New York, USA.
Hooykaas, P. J. J., Hall, M. A. and Libbenga, K. R. (eds) 1999. *Biochemistry and Molecular Biology of Plant Hormones*. Elsevier, Amsterdam, The Netherlands.

Hopkins, W. G. 1995. *Introduction to Plant Physiology*. John Wiley & Sons, Inc., New York, USA.
Hopkins, W.G. and Huner, N.P.A . 2009. *Introduction to Plant Physiology* (4th Edition). John Wiley & Sons, Inc. New York, USA
Lodish, H., Berk, A., Zipursky, S.L., Matsudaira, P., Baltimore, D. and Darnell, J. 2000. *Molecular Cell Biology* (4th edition). W.H. Freeman and Company, New York, USA.
Moore, T. C. 1989. *Biochemistry and Physiology of Plant Hormones* (2nd edition). Springer-Verlag, New York, USA.
Morison, J.I.L.and Morecroft , M.D. 2006. *Plant Growth and Climate Change* (eds). Blackwell Publishing Ltd, Oxford, UK
Nobel, P. S. 1999. *Physiochemical and Environmental Plant Physiology* (2nd edition). Academic Press, San Diego, USA.
Pessarakli, M.2014. *Handbook of Plant Crop Physiology* (ed.). CRC Press
Salisbury, F. B. and Ross, C. W. 1992. *Plant Physiology* (4th edition). Wadsworth Publishing Co., California, USA.
Singhal, G. S., Renger, G., Sopory, S. K., Irrgang, K. D. and Govindjee. 1999. *Concepts in Photobiology: Photosynthesis and Photomorphogenesis.* Narosa Publishing House. New Delhi.
Taiz, L. and Zeiger, E. 1998. *Plant Physiology* (2nd edition). Sinauer Associates, Inc., Publishers, Massachusetts, USA.
Thomas, B. and Vince-Prue, D. 1997. *Photoperiodism in Plants* (2nd edition). Academic Press, San Diego, USA.
Westhoff, P. 1998. *Molecular Plant Development: from Gene to Plant.* Oxford University Press, Oxford, UK.

Suggested Readings (Laboratory Exercises)

Bajracharya, D. 1999. *Experiments in Plant Physiology: A Laboratory Manual*. Narosa Publishing House, New Delhi.
Cooper, T. G. 1977. Tools in Biochemistry. John Wiley, New York, USA.
Copeland, R. A. 1996. Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis. VCH Publishers, New York.
Dennison, C. 1999. A Guide to Protein Isolation. Kluwer Academic Publishers, Dordrecht, The Netherland.
Devi, P. 2000. Principles and Methods of Plant Molecular Biology, Biochemistry and Genetics. Agrobios, Jodhpur, India.
Dryer, R. L. and Lata, G. F. 1989. Experimental Biochemistry. Oxford University Press, New York.
Harborne, T. C. 1981. Phytochernical Methods: A Guide to Modern Techniques of Plant Analysis. Chapman & Hall, London.
Harries, B. D. (Ed.) 1998. Gel Electrophoresis of Proteins: A Practical Approach, 3rd edition. PAS, Oxford University Press, Oxford, U.K.
Maathuis, F. J.M 2013.Plant Mineral Nutrients :Methods and Protocols (ed.). Springer
Moore, T. C. 1974. Research Experiences in Plant Physiology: A Laboratory Manual. Springer-Verlag, Berlin.
Ninfa, A. J. and Ballou, D. P. 1998. Fundamental Laboratory Approaches for Biochemistry and Biotechnology. Fitzgerald Science Press, Inc., Maryland, USA.
Pansu M. and Gautheyrou J. 2006 . Handbook of Soil Analysis - Mineralogical, Organic and Inorganic Methods. Springer
Plummer, D. T. 1988. An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd., New Delhi.
Samuelson, J.C. 2013 .Enzyme Engineering: Methods and Protocols (ed) .Springer, New York
Scott, R. P. W. 1995. Techniques and Practice of Chromatography. Marcel Dekker, Inc., New York.
Wilson, K. and Goulding, K. H. (eds.), 1986. A Biologists Guide to Principles and Techniques of Practical Biochemistry. Edward Arnold, London, UK.
Wilson, K. and Walker, J. 1994. Practical Biochemistry: Principles and Techniques, 4th edition. Cambridge University Press, Cambridge, UK.

Bot 303 A- GENOMICS, PROTEOMICS AND BIOINFORMATICS -I

Unit I

Genomics: Introduction, Structural, functional and comparative genomics. Introduction to Sequencing strategies, High throughput sequencing; Next generation sequencing (NGS) platforms. Genome sequence analysis, annotation and gene prediction.

Unit II

Mapping of genes; Genetic and Physical mapping: restriction hybridization analysis, FISH and related techniques, Chromosome walking and jumping. Major Genome sequencing projects: Arabidopsis, RNB-GEBA, Model Legumes.

Unit III

Functional genomics: Approaches to analyze differential gene expression: Transcriptomics, Serial Analysis of Gene Expression (SAGE), microarray and its applications. Validation of transcriptome and microarray data: Quantitative Real Time PCR.

Unit IV

Comparative Genomics: Concept, approaches and applications. Synteny; Gene search and comparison tools.Comparative genomics of model plants and related crop species. Application of genomics for crop improvement.

Bioinformatics: Introduction and applications. Major gene and protein sequence/structure databases: Genbank EMBL, DDBJ, ENTREZ, UniProt, PDB, Literature database- PubMED, Rice and Arabidopsis databases: RGAP/RAP-DB, TAIR. Searching database and locating genes, Storage, Retrieval and analysis of sequences.

Unit V

Editing/refinement of sequences. Alignment of gene/protein sequences: Local and Global. Multiple sequence alignments, Sequence similarity search. Generating phylogenetic trees based on DNA sequence and evolutionary relationship.

Selected Model Organismal Genomes and Databases; Gene Ontology (GO) Database; IMG Resource for Comparative Analysis and Annotation; GOLD: Data resource for genomic and matagenomic projects, Phytozome.

Laboratory Exercises

1. Demonstration of PCR and Real time PCR.
2. Qualitative and quantitative analysis of nucleic acids using agarose gel electrophoresis and Nanodrop spectrophotometer.
3. Searching and retrieval of gene/protein sequences.
4. Assembly of sequences using GENETOOL software.
5. Multiple Sequence alignment using ClustalW
6. Similarity searching using BLAST (n and p-blast).
7. Use of SILVA or RDP vs Clustal software for 16S rRNA alignment
8. Phylogenetic tree construction using MEGA.
9. Genome Annotation using RAST
10. Multiple genome alignments using MAUVE
11. Estimating average nucleotide identity between two genomic datasets
12. *In silico* DNA-DNA hybridization using GGDC (Genome-to-Genome Distance Calculator)
13. Submission of nucleotide sequences at NCBI-GenBank using Sequin

Suggested Readings

Gustafson, J. P. 2000. *Genomes.* Kluwer Academic Plenum Publishers, New York, USA.

Brown, T. A. 1999. *Genomes*. John Wiley & Sons (Asia) Pvt. Ltd., Singapore.

Primrose, S. B. 1995. *Principles of Genome Analysis.* Blackwell Science Ltd., Oxford, UK.

Singer, M. and Berg, P. 1991. *Genes and Genomes: A Changing Perspective.* UniversityScience Books, CA, USA.

Attwood, T.K. and Parry-Smith, D.J. 2004. *Introduction to Bioinformatics*. Pearson Education(Singapore) Pvt. Ltd.

David, E. (Ed.) 2007. *PlantBioinformatics: Methods and Protocol*. Humana Press, New Jersey, USA.

Suggested Readings (Laboratory Exercises)

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.

Glover, D. M. and Harnes, B. D. (eds) 1995. *DNA Cloning: A Practical Approach. Core Techniques*, 2nd edition, PAS, IRL Press at Oxford University Press, Oxford.

Peter, C. and Rolf, B. 2000. *Computational Molecular Biology: An Introduction.* John Willey & Sons Ltd.

Journals/Research papers

1. Nature reviews
2. BMC Genomics
3. Genome
4. Journal of Genetics & Genomics
5. DNA Research
6. Genomics Proteomics & Bioinformatics
7. Bioinformatics
8. Journal of Bioinformatics and Computational Biology

The Arabidopsis Genome Initiative (2000) Analysis of the genome sequence of the flowering plant *Arabidopsis thaliana.* Nature 408:796–815

Tamura K, Stecher G, Peterson D, Filipski A, and Kumar S (2013) MEGA6: Molecular Evolutionary Genetics Analysis Version 6.0. Molecular Biology and Evolution 30: 2725-2729.

Aziz RK, Bartels D, Best AA, DeJongh M, Disz T, et al. (2008) The RAST Server: rapid annotations using subsystems technology. BMC Genomics. 8;9:75.

Darling AC, Mau B, Blattner FR, Perna NT. (2004) Mauve: multiple alignment of conserved genomic sequence with rearrangements.Genome Res.;14(7):1394-403.

Meier-Kolthoff, J.P., Auch, A.F., Klenk, H.-P., Göker, M. Genome sequence-based species delimitation with confidence intervals and improved distance functions. BMC Bioinformatics 14:60, 2013

Goris J, Konstantinidis KT, Klappenbach JA, Coenye T, Vandamme P, Tiedje JM. (2007) DNA-DNA hybridization values and their relationship to whole-genome sequence similarities. Int J Syst Evol Microbiol.;57(Pt 1):81-91.

Bot 303 B- PLANT MOLECULAR BIOLOGY AND BIOTECHNOLOGY

Unit I

Molecular genetics: Central dogma of molecular biology, Classical and molecular genetics, forward and reverse genetics, Classical and molecular gene concept, process molecular gene concept

Unit II

Analysis of gene expression regulation: various means of transcript and translation product analysis, localization and identification of control sequences of gene expression.

Unit III

Transcriptomics and metabolomics: techniques and applications. Site directed mutagenesis: technique and applications. Transcript and proteome analysis of plants of arid regions: prospects and limitations.

Unit IV

Multilocus and locus specific DNA markers, applications of DNA profiling, Molecular marker based genetic analysis of plants of arid environment.

Unit V

Somatic cell genetics of plants of arid regions, molecular biology of somatic embryogenesis and organogenesis. Genetic fidelity analysis of *in vitro* regenerated plants by DNA markers.

Laboratory Exercises

1. Genomic DNA, Protein and RNA extraction from plants of arid environment.
2. Qualitative and quantitative analysis of DNA, RNA and Protein
3. Molecular analysis of somatic embryogenesis and organogenesis
4. Genetic diversity analysis of plants of arid environment
5. Genetic fidelity analysis of *in vitro* regenerated plants
6. Gene analysis by RT-PCR
7. *Agrobacterium*-mediated plant genetic transformation of tomato.
8. Bioinformatics exercises:

(a) Labeling and scoring of molecular markers and phylogenetic tree preparation through NTYSIS software, and analysis of genetic diversity relationship.

(b) Database searching and sequence retrieval of nucleic acids and proteins.

(c) BLAST (n and p-blast).
(d) Primer designing.
(e) Multiple sequence alignment using ClustalW.
(f) Protein structural modeling.

Suggested Readings

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.

Brown, T.A. 1999. *Genomes*. John Wiley & Sons (Asia) Pvt. Ltd., Singapore.

Brown,T. A. *Gene Cloning and Data Analysis an Introduction*, Blackwell Publishing

Gustafson, J.P. 2000. *Genomes*. Kluwer Academic Plenum Publishers, New York, USA.

Hartl, D. L. and Jones, E. W. 1988. *Genetics: Principles and Analysis* (4th edition). Jones & Bartlett Publishers, Massachusetts, USA.

Henry, R.J. 1997. *Practical Applications of Plant Molecular Biology*. Chapman & Hall, London, UK.

Jolles, O. and Jornvall, H. (eds) 2000. *Proteomics in Functional Genomics*. Birkhauser Verlag, Basel, Switzerland.

Kayser,O. and Quax,W. (eds) 2007.Medicinal Plant Biotechnology From Basic Research to Industrial Applications. Wiley-VCH Verlag.

Old, R.W. and Primrose, S.B. 1989. *Principles of Gene Manipulation.* Blackwell Scientific Publications, Oxford, UK.

Primrose, S.B. 1995. *Principles of Genome Analysis and Genomics.* Blackwell Science Ltd., Oxford, UK.

Raghavan, V. 1986. *Embryogenesis in Angiosperms*: *A Developmental and Experimental Study*. Cambridge University Press, New York, USA.

Raghavan, V. 1997. *Molecular Biology of Flowering Plants*. Cambridge University Press, New York, USA.

Russel, P. J. 1998. *Genetics* (5th edition). The Benjamin/Cummings Publishing Company Inc., USA.

Snustad, D. P. and Simmnns, M. J. 2000. *Principles of Genetics* (2nd edition). John Wiley & Sons Inc., USA.

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

Suggested Readings (Laboratory Exercises)

Butenko, R.G. 2000. Plant Cell Culture. University Press of Pacific.

Collin, H.A. and Edwards, S. 1998. Plant Cell Culture. Bios Scientific Publishers, Oxford, UK.

Dixon, R.A. (ed.) 1987. Plant Cell Culture: A Practical Approach. IRL Press, Oxford.

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.

Hall, R.D. (ed) 1999. Plant Cell Culture Protocols. Humana Press, Inc., New Jersey, USA.

Sambrook, J, Fritsch, E.F. and Maniatis, T. (1989) Molecular Cloning: a laboratory manual. 2nd ed. N.Y. Cold Spring Harbor Laboratory, Cold Spring Harbor Laboratory press.

Shaw, C.H. (ed) 1988. Plant Molecular Biology: A Practical Approach. IRL Press, Oxford.

Smith, R.H. 2000. Plant Tissue Culture: Techniques and Experiments. Academic Press, New York.

Bot 303 C - PRINCIPLES OF PLANT PATHOLOGY

Unit I

Terminology of plant pathology, General symptoms of plant diseases, Components of plant disease, Disease diagnosis. Host parasite interaction (Genetics and Molecular basis) and Pathogenesis.

Unit II

Role of enzymes and toxins in plant diseases, Effects of infection on the host, Plant defense against pathogens, Plant disease epidemiology and Plant disease forecasting.

Unit III

Principles of plant protection, Management of plant diseases (Physical, Chemical and Biological management, biocides, microbial pesticide), Induced resistance in Plants, Breeding for disease resistance, Transgenic plants for disease resistance.

Unit IV

Principles and methods of seed health testing, Seed borne pathogenic microorganisms, important disease caused by seed borne pathogen. Morphology and anatomy of seed in relation of infection, Mechanism of seed infection and Factors affecting seed infection.

Unit V

Seed deterioration, mycotoxins, detection of mycotoxins, management of mycotoxin contaminant seeds, principles of seed borne disease controls, seed treatments (physical, chemical and biological methods), Quarantine for seed, seed laws and Seed certification.

Laboratory Exercises

1. Studies of some local Bacterial, Fungal, Nematode, Phytoplasma and Viral diseases.
2. Field visit for demonstration of diseases on wild and crop plants.
3. Isolation of fungal and bacterial pathogens from leaves.
4. Isolation of fungal and bacterial pathogens from stem, fruits and other aerial plant parts.
5. Isolation of seed borne mycoflora by standard blotter method.
6. Isolation of Seed borne mycoflora using potato dextrose agar plate method.
7. Location of infection in seed through hand section and microtome section.
8. Detection of aflatoxin contamination in stored seed samples by UV fluorescence light.
9. General study of Pesticides and their application.
10. Symptomology of some diseased specimens: White rust, downy mildew, powdery mildew, rust, smut, ergot, leaf spot, red rot, wilt, bacterial canker, bacterial blight, angular leaf spot , mosaic, little leaf, phyllody.

Suggested Readings

Agrios, G.N. 1997. Plant Pathology. Academic Press, London.

Albajes, R., Gullino, M.L., Van Lenteren, J.C. and Elad, Y. 2000. Integrated Pest and Disease management in Greenhouse Crops. Kiuwel Academic Publishers.

Mehrotra, R.S. 1993. Plant Pathology, Tata McGraw Hill.

Rangaswamy, G. and Mahadevan, A. 1999. Disease of crop plants in India. Prentice Hall of India, New Delhi.

Trivedi, P.C. 1998. Nematode disease in Plants CBS Publisher & Distributors, New Delhi.

Roger, H. 2001. Mathew's Plant Virology , Academic Press, NY.

Strange, R.N. 2003. Plant resistance mechanism (SAR, ISR) –Introduction to plant Pathology, John Wiley & Sons, USA.

Singh, R.S. 1998. Plant disease. Oxford and IBH Publication Co. Pvt. Ltd.

Singh, R.S. 2005. Introduction to Principles of Plant Pathology. Oxford & IBH Publication Co. Pvt. Ltd.

Sharma, P.D. 2006. Plant Pathology. Narosa Publishing House, India

Pandey, B.P. 1997. Plant Pathology, Pathogen and Plant Disease. S. Chand and Company Ltd.

Agarwal, V.K. and Sissclair, J.B. 1993. Principles of Seed Pathology. Vol. I & II CBS Publishers and Distributors, India

Neergaard, P. 1997. Seed pathology, Vol. I & II. The Macmillan Press.Ltd, London.

Suryanarayana, D. 1978. Seed pathology. Vikas Publishing House, Pvt, Ltd.

Bot 303 D-PLANT MICROBE-INTERACTIONS (PMIs)-I

Unit I

Biology of plant-microbe interactions. Rhizosphere; rhizodeposition. Concepts of competition, commensalisms, mutualism and parasitisms. Evolution of parasitism, symbiosis, susceptibility and resistance. Endosymbiosis; Gene for gene concept; r-gene and avr gene.

Unit II

Positive and negative interactions: The effect of microbes on plant physiology and metabolism (Photosynthesis, respiration and the translocation of water and nutrients); Interaction of Nematodes, Bacteria and Viruses with plants

Unit III

Mycorrhizal and other types of symbiosis: Ecto and Endomycorrhiza; Plant nutrient transporters for AM fungi (AM inducible Ammonium transporters); Mechanism of P mobilization and uptake by Mycorrhiza. Introduction to mycorrhizal genome.

Unit IV

Legume-rhizobia symbiosis, Actinorhizal plants and *Frankia*, Plant- Signaling mechanisms in RN symbiosis; Plant and bacterial factors in establishing RN symbiosis. *Sym* genes; regulation of Nitrogenase. Host inducible regulation. Mechanism of auto-regulation.

Unit V

Fungi as endophytes; Products/secondary metabolites in response to fungal endophytes; Bacterial endophytes in cereals/grasses and their significance (*Herbaspirillum*, *Gluconacetobacter*, *Azorcus*, *Burkholderia*). Known examples of bacterial endophytes in sugar cane, sugar beet, *Poplar*, *Pinus* etc.

Laboratory Exercises

1. Preparation of culture media (TY, YEMA, LB)
2. Isolation of bacteria from various sources (root nodules, roots and stems and phyllosphere).
3. Methods of culturing bacteria
4. Purification of bacterial isolates
5. Motility test of bacteria by hanging drop method
6. Preservation of bacterial cultures (short term and long term)
7. Phenotypic characterization of bacterial isolates
    (i) Intrinsic antibiotic resistance (IAR) pattern
    (ii) NaCl tolerance
    (iii) Acid alkali production
    (iv) High temperature tolerance
    (v) Carbon utilization profile
8. Biochemical characterization of bacterial isolates
    (i) Nitrate reductase activity
    (ii) Catalase activity
    (iii) Oxidase activity
    (iv) Ammonia production
    (v) Citrate Utilization
9. Extraction and identification of Mycorrhizal spores from rhizosphere soil.
10. Staining of roots for assessment of Mycorrhizal colonization.
11. Mass multiplication of monospecific culture of AM fungi.

Suggested Readings

Bergey's Manual of Systematic Bacteriology. Second Edition. Volume Two (The Proteobacteria).Springer.

Nitrogen fixing Actinorhizial symbioses edited by Katharina Pawlowsky and William E Newton; Springer Nitrogen Fixation: Origins, Applications and Research Progresses, Volume 6 (2008)

Boyd, R. F. 1984. *General Microbiology*. Times Mirror Publishers, New Delhi.

Chandra, S. and Kehri, H. K. 2006.*Biotechnology of VA Mycorrhizae*: *Indian Scenario*. New India Publishing Agency, New Delhi.

Dilworth, M. J., James, E. K., Sprent, J. I. and Newton, W. E. 2008.*Nitrogen-fixing Leguminous Symbioses*. Springer.

Pawlowski, K. and Newton, W. E. 2008.*Nitrogen-fixing Actinorhizal Symbioses.* Springer.

Pelczar, M. J., Chau, E. C. G. and Krieg, N. R. 1993.*Microbiology concepts and application.* McGraw Hill, New Delhi.

Power, C. B. and Daginawala, H. F. 1992.*General Microbiology*. Himalaya Pub. House, New Delhi.

Prescott, S. C. and Dunn, C. G. 1993.*Industrial Microbiology*. McGraw Hill Pub., New Delhi.
Salle, A. J. 2004. *Fundamental & Principles of Bacteriology*. Tata McGraw Hill Pub., New Delhi.
Smith, S. E. and Read, D. J. 1997. *Mycorrhizal Symbiosis*, Third Edition. Academic Press, London.
Somasegaran, P. and Hoben, H. J. 1994.*Handbook of Rhizobia* (*Methods in Legume-Rhizobium Technology*).Springer-Verlag.
Sprent, J. I. 2001. *Nodulation in legumes.*Kew Publishing.
Stéphane, D., Georges, S. D. and André, F. J. 2005.*In Vitro Culture of Mycorrhizas.*Springer.
Tiwari, M. and Sati, S. C. 2008.*The Mycorrhizae: Diversity Ecology & Applications*. Daya Publisher, New Delhi.
Vincent, J. M. 1970. *A manual for the practical study of the root nodule bacteria*. Blackwell Scientific Publications.

Bot 303E- CYTOGENETICS AND PLANT BREEDING -I

Unit I

Structure and function of chromosomes. - nucleosome morphology and higher level organization, chemical composition, telomeres, centromeres and kinetochores, nucleolar organizers, chromomeres, euchromatin and heterochromatin, unique and repetitive DNA, chromosome structure throughout the cell cycle, banded, lampbrush, polytene, B chromosomes.

Unit II

Molecular mechanism of crossing over, chromosomal evidence of crossing over, genetic factors which affect the frequency of crossing over, genetic control of meiosis.

Unit III

Variations in chromosome structure: The origin and adaptive significance (and use in plant breeding where appropriate) of duplications, deletions, inversions, and translocations, isochromosomes, ring chromosomes, centric fusions and fissions.

UnitIV

Aneuploidy and euploidy in plants, their origins, cytogenetic effects, use in crop breeding, and adaptive significance, chromosome diminution and elimination.

Unit V

Mutation – Classification, mechanism, repair, role in cytogenetic analysis and evolution, role of cytogenetics in evolution and improvement of crops.

Laboratory Exercises

1. Preparation of important stains
2. Microscopy; Preparation of slides
3. Fixing of the materials for mitotic and meiotic analyses
4. Demonstration of crossing over/chiasmata
5. Karyotype analysis
6. Chromosomal aberration
7. Chromosome banding
8. Photomicrography and image analysis.

Suggested Readings

Acquaah G (2007). Principles of Plant Genetics and Breeding, Blackwell Publishing Ltd., USA.
Gupta, R.K. 1999. Cytogenetics. Rastogi Publishers, Meerut.
Prasad, G. 1998. Introduction to Cytogenetics. Kalyani Publishers, New Delhi.
Simmonds (1995). Evolution of Crop Plants (2nd Edition) Longman.
Sinha, U. and Sinha S. 1998. Cytogenetics, Plant Breeding and Evolution. Vikas Publishing House Pvt. Ltd., New Delhi.
Strickberger (2008). Genetics, 3rd Edition, Pearson (Prentice Hall).1. FISH for rDNA
Swaminathan, M.S., Gupta, P.K. and Sinha, U.1974. Cytogenetics of Crop Plants. Mac Millan India Ltd., New Delhi.
Swanson, C.P., Merz, T. and Young, J. 1973. Cytogenetics. Prentice Hall of India Private Limited, New Delhi.

Bot 303F- INDUSTRIAL MICROBIOLOGY I

Unit I

Definition, scope and historical development of Industrial microbiology. Fermentors: (Bioreactor) construction, Type, operation and basic functions.

Unit II

Development of Industrial fermentation process: Screening–Primary and Secondary.FermentationProducts, Stock Cultures, Fermentation media, Biological waste treatment.

Unit III

Dairy Microbiology: Milk (composition and constituents), Processing and Pathogens, Pasteurization and grading of milk. Diary product: Cheese, Yogurt, Cream and Buttermilk

Unit IV

Food Microbiology: Fermented vegetables: Sauerkraut and Kumis. Food borne illness, microbial spoilage and food preservation.

Unit V

Industrial production: Alcohol, Beer, Wine, Vinegar, Citric acid, Vitamins, enzymes and steroids,

Laboratory Exercises

1. Preparation of culture media.
2. Culturing of microorganisms and cultural characteristics of bacteria.
3. Study of some important industrially important genera of fungi.
4. Enzymatic test of Milk by Methyl Blue Reductase Test.
5. Metabolism of microorganisms–carbohydrate fermentation, hydrolysis of starch, urea and gelatin.
6. Microbiological analysis of food product.
7. Presumptive test of coliform group of bacteria.

Suggested Readings

Casida,L.E. *Industrial Microbiology*. John Wiley and sons. Chum. *Microbiology*. John Wiley &Sons.
Corum ,C.J. Development of Industrial Microbiology. American Institute of Bio.Science.
Dube,.C., and Maheshwari D.K. , A Text Book of Microbiology , S. Chand and co. Ltd
Dube R. C.and Maheshwari D.K. , Practical Microbiology , S. Chand and co. Ltd
Kaushik,P. *Microbiology*. Emkay Pub., NewDelhi.
Pelczer, M.J., Chau, E.C.G. and Krieg, N.R. *Microbiology Concepts and application.*McGraHill.
Power,C.B. and Daginawala, H.F.*General Microbiology*. Himalaya Pub. House.
Prescott,S.C.andDunn,C.G.*IndustrialMicrobiology*.McGrawHill Pub.
Robert F. Boyd. *General Microbiology*. TimesMirror Publishers.
Salle, A .J .*Fundamental & Principles of Bacteriology*. Tata McGraw Hill.
Sivakumar P.K. , Joe M .M, Sukesh K , An Introduction to Industrial Microbiology, Pub.: S. Chand & Co. Ltd
Spencer ,J.E.T.andSpencer,D.M.*YeastTechnology*.Springer-Verlag.
Staubury,P.F.and Whiterker, A.*PrinciplesofFermentationTechnology*.PergamonPress.
Thoma,R.W.*IndustrialMicrobiology*.Hutchinson&Ross.
Tortora,G.J.,Funke,B.R. andCasechristive:*Microbiology*.BengaminPublishingCo.
Cappuccino, J and Sherman, N. Microbiology: A Laboratory manual. Pearson publication.

Bot 304 A- POPULATION BIOLOGY

Unit I

Population and Models: Concept in population biology, Darwin theories of Evolution: Population grown models. Density – independent, density – dependent.

Unit II

Population Genetics: Gene frequencies: Hardy Weinburg principle; Genetic variations of population: Polygenetic inheritance; Quantitative genetics and heritability. Human population: Growth, Environment and Development.

Unit III

Demography: Plant demography and population dynamics. Life tables and their components; Regulation of plant population; Interaction in mixture of species.

Unit IV

Competition and Allelopathy: Competition: components, characters favouring success, models. Allelopathy: mode of release, allelochemicals and their role in natural ecosystems

Unit V

Evolutionary Ecology and Threatened plants: Coexistence and niche; Evolution of mutualism – Basic models; Basic concepts of Evolutionary ecology. Threatened/Endangered/Critically endangered plants of Rajasthan desert and their conservation strategies.

Laboratory/field exercises

1. Measurement of growth for fitting the growth curve and estimating specific growth rate:
    a. Soil fungi
    b. For any two wild weedy annual species
2. Rate of seedling natality and mortality for two weedy dicots.
3. Dominance, diversity and evenness measurements of desert vegetation.
4. Preparation of population growth curve
5. Measurement of niche width for trees/shrubs/annuals.
6. Gene frequency for a character in tree/shrub seedlings.
7. Estimation of inheritance using ANOVA (RBD) tool.
8. Measurement of gochar land carrying capacity for farm animals
9. Qualitative test for allelopathic organic acids in soil

Suggested Readings

Barbour, M.G. Burk, J.H. and Pitts, W.D. 1987. *Terrestrial Plant Ecology*, Benjamin/Cummings Publication Company, California.

Begon, M. Harper, J.L. and Townsend, C.R. 1996. *Ecology*/Blackwell Science, Cambridge, U.S.A.

Britton, N.F. 2003. *Essential Mathematical Biology* Springer International Edition, 335 pp.

Brooker, R.J. 1999. *Genetics – Analysis and Principles*. Benjamin/Cummings an imprint of Addison Westoy Longman, Inc.

Donovan, T.M. and Weldon, C.W. 2002. *Spreadsheet Exercises in Ecology and Evolution.* Sinauar Associates Inc. Publ. Sunderland, Massachusetts, USA, 556 pp.

Freysen, A.H.J. and Woldendrop, J. 1978. *Structure and Functioning of Plant Populations* (eds.), North Holland Publ. Co., Amsterdam.

Harper, J.L. 1977. Population Biology of Plants. Academic Press, London and New York.

Hastings, A. 1997. Population Biology: Concepts and Models. Springer Publication.

Krebs, C.J. 1989. Ecological Methodology. Harper and Row, New York, USA.

Ludwig, J.A. and Raynolds, J.F. 1988. Statistical Ecology, Wiley, New York.

Neel, D. 2004. Introduction to Population Biology, Cambridge University Press, 393 pp.

Turchin, P. 2003. Complex Population Dynamics: A Theoretical/Empirical Synthesis, Princeton University Press

Bot 304 B- MICROBIAL ECOLOGY - I

Unit I

Introduction and historical background: Historical overview, relation of microbial ecology with general ecology.

Characteristics of microbial life: Structure and evolution of cell shape, metabolic diversity in microbes, growth, reproduction and development.

Unit II

Classification and taxonomy of microbes: Species concept, three domains of life, Bacterial, Archaeal and Eukaryal biodiversity.

Unit III

Microbial genome diversity: Structure, diversity, stability of microbial communities. Species diversity indices, genetic/molecular diversity indices.

Genetic exchange in microbial communities, the breadth and significance of LGT on the process of evolution of microorganisms.

Unit IV

Microorganisms in diverse habitats: Abiotic limitations to microbial growth, starvation strategies and environmental determinants of microbial growth.

Microorganisms in atmo-ecosphere, hydro-ecosphere and freshwater habitats.

Unit V

Microbial populations and communities: Population interactions: Interactions among single and diverse microbial populations. Populations within biofilms; biofilm lifestyle and quorum sensing, neutralism, commensalism, synergism, mutualism, competition, amensalism, parasitism, predation.

Laboratory Exercises

1. Study of a cross section of natural environment using Winogradsky column.
2. Study of multiplication of desired microorganism with the help of enrichment technique.
3. Selection of microorganisms which secrete metabolites.
4. Study of various techniques related to isolation and observation of microorganisms
    a. Micrometry
    b. Dilution series
    c. Surface plate method
    d. Agar stake method
    e. Streak feeding
    f. Overlay method
    g. Filter disc method
    h. Hanging drop method
    i. Staining techniques

Suggested Readings

Atlas, R. M. and Bartha. 1998. *Microbial Ecology: Fundamentals and Applications*. The Benjamin/Cummings Science Publishing.

Coleman, D. C., Crossley, D.A. and Paul, F. H. 2004. Fundamentals of Soil Ecology. Academic Press.

McArthur, J.V. 2006. Microbial Ecology: An Evolutionary Approach. Academic Press.

Loutit, M. W., and Miles, J. A. R. 2011. Microbial Ecology. Springer, London.

Cheeke, T. E., David C. C. and Diana H. W. 2012. Microbial Ecology in Sustainable Agroecosystems. CRC Press.

Bot 304 C- STRESS PHYSIOLOGY-I

UNIT I

Plant response to abiotic stresses: Types of stresses, include temperature, water deficit, high irradiation, fluoride and CO_2.Early adaptive response to water deficit; Structure and processes affected by desiccation.

UNIT II

Plant responses to salinity and heavy metal stresses: Ionic and osmotic sensing signaling mechanism (SOS salt overlay pathways). Salinity tolerance determinants (effectors and regulatory molecules).Molecular mechanisms of tolerating heavy metal stress.

UNIT III

Abiotic and biotic stress signaling in plants; Stress sensor, role of MAP Kinases, and Calcium calmodulin in stress sensing. ABA dependent and ABA independent pathways.

UNIT IV

Oxidative stress and anti-oxidant system in plants. Reactive oxygen species (ROS) under stress, ROS production in different organelles,ROS scavenging antioxidant defense mechanism:ROS scavenging enzymatic antioxidants,Non-enzymatic antioxidants; Haliwal Asada pathway.

UNIT V

Biotic stress signaling (plant defense): Role of Jasmonic acid, salicylic acid, ethylene and nitric oxide signaling in plant defense. Systemic acquired resistance.

Laboratory Exercises

1. Find out the ascorbic content in temperature (low and high) and salt stressed samples.
2. Effect of stress on the activity of following scavenging enzymes:
    a. Superoxide dismutase,
    b. Catalase
    c. Peroxidase
    d. Ascorbate peroxidase
3. Estimate anthocyanin content in stressed samples.
4. Effect of stress on membrane damage in relation to lipid peroxidation.
5. Effect of stress on membrane damage in relation to membrane stability index .
6. Effect of water stress and Hyperthermia on the activity of nitrate reductase.

Suggested Readings

Ahmad, P. 2014. *Physiological Mechanisms and Oxidative Damage to Plants: Antioxidant Networks and Signaling*. Elsevier Science

Ahmad, P. and Wani, M.R. 2014. *Physiological Mechanisms and Adaptation Strategies in Plants Under Changing Environment*(eds). Springer New York.

Alscher, R. G. and Cumming, J. R. 1990. *Stress Responses in Plants: Adaptation and Acclimation Mechanisms* (eds.). New York Wiley-Liss, Inc.

Aroca , R. 2012. *Plant Responses to Drought Stress From Morphological to Molecular Features* (ed). Springer-Verlag Berlin Heidelberg

Ashraf, M., Ozturk ,M. and Athar, H.R. 2009. *Salinity and Water Stress: Improving Crop Efficiency* (eds) .Springer

Basra, A. S. 2001. *Crop Responses and Adaptations to Temperature Stress* (ed.). Food Products Press, New York.

Basra, A. S. and Bastra, R. K. 1997. *Mechanisms of Environmental Stress in Plants* (ed.). Amsterdam: The Netherlands, Harwood Academic Publishers.

Belhassen, E. 1997. *Drought Tolerance in Higher Plants: Genetical, Physiological and Molecular Biological Analysis* (ed.). Kluwer Academic Publishers, Dordrecht.

Buchanan, B. B., Gruissem, W. and Jones, R. L. 2000. *Biochemistry and molecular biology of plants*. American Society of Plant Physiologists, Maryland, USA.

Cherry, J. H. 1994. *Biochemical and cellular mechanisms of stress tolerance in plants* (ed.). Springer-Verlag, Berlin.

Chopra, V. L., Singh, R. B. and Varma, A. 1998. *Crop productivity and substantiality and shaping the future. Proceedings of Second International Crop Science Congress* (ed.). Oxford and IBH Publishing Company, New Delhi.

Dhaliwal, G. S. and Arora, R. 1999. *Environmental Stress in Crop Plants* (ed.). Commonwealth Publishers, New Delhi.

Gupta, D. and Sandalio, L.M.2011. *Metal Toxicity in Plants: Perception, Signaling and Remediation*(eds). Springer.

Grillo, S. and Leone, A. 1997. *Physical Stresses in Plants: Genes and Their Products for Their Tolerance.* Springer-Verlag, Berlin.
Hedden,P. and Thomas ,S.G. 2006. *Plant Hormone Signaling*. Blackwell Publishing Ltd.Oxford, UK
Hopkins, W.G. and Huner, N.P.A . 2009. *Introduction to Plant Physiology* (4th Edition). John Wiley & Sons, Inc. New York, USA
Jenks, M.A. and Hasegawa, P.A. 2005. *Plant Abiotic Stress*(eds). Blackwell Publishing Ltd ,Oxford ,UK
Lerner, H. R. 1998. *Plant Responses to Environmental Stresses* (from Phytohormones to Genome Reorganization). Mercel Dekker, Inc.
Levitt, J. 1980. *Responses of plants to environmental stress. Vol. 1. Chilling and temperature stress*. Academic Press, New York, USA.
Luttge, U., Beck, E. and Bartels, D. 2011. *Plant Desiccation Tolerance (Ecological Studies);* (eds.). Springer
Morison, J.I.L.and Morecroft, M.D. 2006. *Plant Growth and Climate Change* (eds). Blackwell Publishing Ltd, Oxford, UK
Pessarakli, M. 1994. *Handbook of Plant Crop Stress* (ed.) Marcel Dekker, Inc., New York.
Ricardo, A. 2012. *Plant Responses to Drought Stress - From Morphological to Molecular Features* (ed). Springer
Scandolios, J. 1997. *Oxidative stress and the molecular biology of antioxidant defenses* (ed.). New York: Cold Spring Harbor Laboratory Press.
Taiz, L. and Ziegler, E. 2003. *Plant Physiology* (3rd edition), Panima Publishing Corporation, New Delhi.
Tuteja, N. and Gill, S.S. 2014 .*Climate Change and Plant Abiotic Stress Tolerance* (eds.). Wiley-VCH Weinheim, Germany.
Tripathi, B.N. and , Müller, M.2015.*Stress Responses in Plants: Mechanisms of Toxicity and Tolerance* (eds). Springer.

Bot 304 E - BIOSYSTEMATICS OF PLANTS -I

Unit I

Plant systematics: The Components of systematics, Major objectives of systematics; Relevance to society and science. Taxonomic History: Natural systems to cladistics: Natural systems; Phyletic systems; Phenetics; Cladistics.

Unit II

Plant identification. Botanical Nomenclature: Kinds of names; International Code of Botanical Nomenclature, Names according to rank; Citation of authors; Priority; Type method; Naming a new species; Legitimacy; Synonyms.

Unit III

Classification: The components of classification; Characters and their states; Sources of characters; Evaluation of characters. A critical study of principles, outline and Phylogeny: Arthur Cronquist (1988), Armen Takhajan (2009), RMT Dahlgren (1980), Robert F. Thorne (1968),

Unit IV

Systematic evidence: Morphology, Anatomy and ultrastructure; Embryology; Palynology; Cytology; Phytochemistry. Numerical taxonomy.

Unit V

Introduction to the angiosperms: General characteristics; Evolutionary history; Basal angiosperms and Magnoliids, Basal monocots; Petaloid monocots.

Laboratory/Field Exercises

1. Live plants/ Herbarium specimens of the following families will be provided in the class for description and identification (classification based on APG II, 2003):
    - Basal Angiosperm and Magnoliids: Nymphaeaceae, Magnoliaceae
    - Basal Monocots: Araceae, Alismataceae
    - Petaloid monocots: Liliaceae, Smilacaceae, Alliaceae, Orchidaceae
2. Writing exercise

3. Nomenclature exercise
4. Classification exercise

Suggested Readings

Scott-Ram, N.R. 1990. Transformed Cladistics, Taxonomy and Evolution .Cambridge University Press.
Winston J.E. 1999.Describing Species: Practical Taxonomic Procedure for Biologist. Columbia University Press.
Cronquist, A. 1981. An integrated system of classification of flowering plants. Columbia University Press, New York.
Angiosperm Phylogeny Group 2003. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. Botanical Journal of the Linnaean Society 141: 399-436.
Simpson, M.G. 2006. Plant Systematics. Elsevier, Amsterdam.
Judd, W.S., C.S. Campbell, E.A. Kellogg, P.F.Stevens and M.J. Donoghue 2002. Plant Systematics: A phylogenetic Approach. Sinauer Associates, Inc., Massachusetts.
Gurcharan Singh, 2010. Plant Systematics: An Integrative Approach. Science Publishers, Enfield, NH, USA

Bot 304 F- ENVIRONMENTAL MONITORING, MANAGEMENT AND RESTORATION - I

Unit I

Pollution: Definition, kinds, sources, quality parameters; Air, Water, Soil, Radioactive, Noise, Thermal pollution, effects on plants, animals and buildings; control of pollution; indoor air pollution.

Unit II

Management: Introduction and scope of basic concepts of sustainable development: Definition, concepts, capitals, currencies, problems and integration. Indicators for Sustainable Development.

Unit III

Biodiversity: Meanings, levels, estimates, importance and role in ecosystem functioning. Threats to biodiversity, major causes of extinction, vulnerability of species to extinction, IUCN threat categories, Red data book.

Unit IV

Waste management: Solid Waste; Sources and management; Composting and methane production; Hazardous waste; Disposal and management of radioactive waste.

Unit V

Ecology of Disturbed Ecosystems; Wastelands – Description, classification. Disturbance and its impact on the structure and functioning of terrestrial and aquatic ecosystems. Environmental impacts of mining and industrialization.

Laboratory/Field Exercises

1. Determination of phenol contents of the given plant samples growing in polluted and seemingly non-polluted environments.
2. Determination of chlorophyll ‘a’, ‘b’ and total chlorophyll contents of the given plant samples growing in polluted and seemingly non-polluted environments.
3. Determination of soluble protein contents of the given plant samples growing in polluted and seemingly non-polluted environments.
4. Determination of carbohydrate contents of the given plant samples growing in polluted and seemingly non-polluted environment.
5. Determination of the proline contents of plants growing in polluted and seemingly non-polluted environments.
6. Determination of the activity of acid phosphatase enzyme in the given plant samples growing in polluted and seemingly non-polluted environments.
7. Determination of the activity of peroxidase enzyme in the given plant samples growing in polluted and seemingly non-polluted environments.
8. Determination of the activity of polyphenol oxidase enzyme in the given plant samples growing in polluted and seemingly non-polluted environments.

Suggested Readings

Bradshaw, A.D. and Chadwick, M.J. 1980. *The Restoration of Land*. Blackwell Scientific Publications, Oxford.
Singh, A. and Ward, O.P. (Eds.). *Applied Bioremediation and Phytoremediation.* Springer. 2004.
Abrol, I.P. and Dhruva Narayan, V.V. (Eds.). *Technologies for Wasteland Development.* ICAR, New Delhi. 1998.
Murlikrishan, K.V.S.G. *Air pollution and control.* Published by Kaushal & Co, New Delhi
Bell, L.H. and Bell, D.H. 1993 Industrial Noise Control: Fundamentals and Applications, Second Edition, Marcel Dekker, New York
Masters, M., Gilbert, and Ela P. Wendell. 2007. *Introduction to Environmental Engineering and Science.* Prentice Hall; 3 edition

SEMESTER IV

Bot 401-APPLIED ECOLOGY

Unit I

Soils: Characters, formation, classification and major soil types of the world and India. Soil quality assessment and factors affecting soil quality.

Unit II

Mineralization: Litter fall and decomposition – litter quality, climatic factors, soil microorganisms affecting mineralization. Nutrient synchronization and biological management of soil fertility.

Unit III

Biodiversity: Concept and levels; biodiversity role in ecosystem functions and stability; speciation and extinction; IUCN categories of threat; distribution and global patterns; terrestrial biodiversity hot spots. Biodiversity status in India.

Unit IV

Ecosystem Stability and Management Concept of ecosystem resistance and resilience; natural and anthropogenic ecological perturbations and their impact on plants and ecosystems. Ecosystem restoration. Ecology of plant invasion.

Concepts of sustainable development. Sustainability indicators.

Unit V

Global Warming and Climatic Changes: Climatic changes: Greenhouse gases; CO_2, CH_4, N_2O, CFCs – sources, trends and role; ozone layer and hole; consequences of climatic change – CO_2 fertilization; global warming, sea level rise and UV radiation.

Concepts of Industrial Ecology.

Laboratory/Field Exercises

1. To determine organic carbon content in protected and gochar land soils.
2. To determine nitrogen in protected and gochar land soils.
3. To determine EC and pH in protected and gochar land soils.
4. To determine available phosphorus in protected and gochar land soils.
5. To estimate chlorophyll contents of plants growing in polluted and non-polluted areas.
6. To estimate rate of soil respiration by alkali absorption method.
7. To estimate percent loss of litter using litterbag method.
8. To study environmental impact of a given developmental activity using checklist as an EIA method.

Suggested Readings

Ali, M. 2012. Diversity of Ecosystems (Eds.), In Tech Publisher. DOI: 10.5772/2276
APHA-Standard Methods for the Examination of Water and Waste Water. American Public Health Association, Washington, D.C.
Barbour, M.G., Burk, J.H. and Pitts, W.D. 1987. Terrestrial Plant Ecology. Bejamin/Cummings Publication Company, California.
Begon, M., Harper, J.L. and Townsend, C.R. 1996. Ecology. Blackwell Science, Cambridge, U.S.A.
Brady, N.C. 1990. The Nature and Properties of Soils. Macmillan.
Cadish, G. and Giller, K.E. 1997. Driven by Nature, Plant Litter Quality and Decomposition, CAB International Wallingford, U.K.

Chapman, B. and Bilharz, S. 1997. Sustainability Indicators. John Wiley & Sons, New York.
Eisner, T. and Meinwald, J. 1995. Chemical Ecology: The Chemistry of Biotic Interaction. National Academies Press
Heywood, V.H. and Watson, R.T. 1995. Global Biodiversity Assessment. Cambridge University Press.
Hill, M.K. 1997. Understanding Environmental Pollution. Cambridge University Press.
Koromondy, E.J. 1996. Concepts of Ecology. Prentice-Hall of India Pvt. Ltd., New Delhi.
Krebs, C.J. 1989. Ecological Methodology. Harper and Row, New York, USA.
Ludwig, J. and Reynolds, J.F. 1988. Statistical Ecology, John Wiley & Sons.
Ludwig, J.A. and Reynolds, J.F. 1988. Statistical Ecology, Wiley, New York.
Magurran, A.E. 1988. Ecological Density and its Measurement. Chapman & Hall, London.
Mason, C.F. 1991. Biology of Freshwater Pollution. Longman.
Misra, R. 1968. Ecology Work Book. Oxford & IBH, New Delhi.
Moore, P.W. and Chapman, S.B. 1986. Methods in Plant Ecology. Blackwell Scientific Publications.
Muller-Dombois, D. and Ellenberg, H. 1974. Aims and Methods of Vegetation Ecology, Wiley, New York.
Muller-Domois, D. and Ellenberg, H. 1974. Aims and Methods of Vegetaion Ecology, Wiley, New York.
Odum, E.P. 1971. Fundamentals of Ecology, Saunders, Philadelphia.
Odum, E.P. 1983. Basic Ecology, Saunders, Philadelphia.
Pielou, E.C. 1984. The Interpretation of Ecological Data. Wiley, New York.
Smith, R.L. 1996. Ecology and Field Biology. Harper Collins, New York.
Smith, R.L. 1996. Ecology and Field Biology. Harper Collins, New York.
Sokal, R.R. and Rohlf, F. J. 1995. Biometry. W.H. Freeman & Co., San Fransisco.
Treshow, M. 1985. Air Pollution and Plant Life. Wiley Interscience.

Bot 402-BIOTECHNOLOGY AND GENETIC ENGINEERING OF PLANTS

Unit I

Biotechnology: Basic concepts, principles and scope. Concepts of cellular differentiation and totipotency. Historical development of plant cell, tissue and organ culture. Fundamental aspects of somatic embryogenesis, organogenesis and androgenesis; mechanism, techniques and utility.

Unit II

Somatic hybridization: Protoplast isolation, fusion, culture, hybrid selection, regeneration. Possibilities, achievements and limitations of protoplast research. Various means of Micropropagation.

Unit III

Applications of plant tissue culture: production of hybrids, somaclones and artificial seed, production of secondary metabolites/natural products, cryopreservation and germplasm storage.IPR, possible ecological risk and ethical concern.

Unit IV

Recombinant DNA technology: Gene cloning principles and techniques; vectors and PCR.DNA synthesis and sequencing. DNA fingerprinting, Genetic engineering of plants; aims and strategies for development of transgenics.

Unit V

Genomics and proteomics: molecular markers, functional genomics, microarrays, protein profiling and its significance. Bioinformatics.

Laboratory Exercises

1. Preparation of various types of culture media.
2. Micropropagation of plants of arid environment.
3. Induction of callus for cellular differentiation of plants of arid environment.
4. Demonstration of androgenesis.
5. Isolation of protoplast
6. Demonstration of protoplast fusion
7. Extraction and purification of DNA and proteins.
8. Qualitative and quantitative analysis of proteins and DNA.
9. Analysis of Plant Genomic DNA using molecular markers
10. Exercises on Bioinformatics

Suggested readings

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.

Brown, T. A. 1999. *Genomes*. John Wiley & Sons (Asia) Pvt. Ltd., Singapore.

Callow, J. A., Ford-Lloyd, B. V. and Newbury, H. J. 1997. *Biotechnology and Plant Genetic Resources: Conservation and Use.* CAB International, Oxon, UK.

Chrispeels, M. J. and Sadava, D. E. 2002. *Plants, Genes and Agriculture.* Jones & Bartlett Publishers, Boston, USA.

Collins, H. A. and Edwards, S. 1998. *Plant Cell Culture*. Bios Scientific Publishers, Oxford, UK.

Glazer, A. N. and Nikaido, H. 1995. *Microbial Biotechnology*, W.H. Freeman & Company, New York, USA.

Gustafson, J. P. 2000. *Genomes.* Kluwer Academic Plenum Publishers, New York, USA.

Henry, R. J. 1997. *Practical Applications of Plant Molecular Biology*. Chapman & Hall, London, UK.

Jain, S. M., Sopory, S. K. and Veilleux, R. E. 1996. *In Vitro Haploid Production in Higher Plants*, Vols. 1-5, *Fundamental Aspects and Methods.* Kluwer Academic Publishers, Dordrecht, The Netherlands.

Jolles, O. and Jornvall, H. (eds) 2000. *Proteomics in Functional Genomics*. Birkhauser Verlag, Basel, Switzerland.

Kartha, K. K. 1985. *Cryopreservation of Plant Cells and Organs.* CRC Press, Boca Raton, Florida, USA.

Old, R. W. and Primrose, S. B. 1989. *Principles of Gene Manipulation.* Blackwell Scientific Publications, Oxford, UK.

Primrose, S. B. 1995. *Principles of Genome Analysis.* Blackwell Science Ltd., Oxford, UK.

Raghavan, V. 1986. *Embryogenesis in Angiosperms*: *A Developmental and Experimental Study*. Cambridge University Press, New York, USA.

Raghavan, V. 1997. *Molecular Biology of Flowering Plants.* Cambridge University Press, New York, USA.

Shantharam, S. and Montgomery, J.F. 1999. *Biotechnology, Biosafety, and Biodiversity*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.

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

Suggested Readings (Laboratory Exercises)

Butenko, R. G. 2000. *Plant Cell Culture*. University Press of Pacific.

Collin, H. A. and Edwards, S. 1998. *Plant Cell Culture.* Bios Scientific Publishers, Oxford, UK.

Dixon, R. A. (ed.) 1987. *Plant Cell Culture: A Practical Approach*. IRL Press, Oxford.

Gelvin, S.B. and Schilperoort, R.A. (eds) 1994. *Plant Molecular Biology Manual*, 2nd edition, Kluwer Academic Publishers, Dordrecht, The Netherlands.

George, E. F. 1993. *Plant Propagation by Tissue Culture, Part 1. The Technology*, 2nd edition, Exegetics Ltd., Edington, UK.

George, E. F. 1993. *Plant Propagation by Tissue Culture, Part 2. In Practice*, 2nd edition, Exegetics Ltd., Edington, UK.

Glick, B. R. and Thompson, J.E. 1993. *Methods in Plant Molecular Biology and Biotechnology*. CRC Press, Boca Raton, Florida.

Glover, D. M. and Harnes, B. D. (eds) 1995. *DNA Cloning: A Practical Approach. Core Techniques*, 2nd edition, PAS, IRL Press at Oxford University Press, Oxford.

Hackett, P. B., Fuchs, J. A. and Messing, J. W. 1988. *An Introduction to Recombinant DNA Techniques: Basic Experiments in Gene Manipulation.* The Benjamin/Cummings Publishing Co., Inc Menlo Park, California.

Hall, R. D. (ed.) 1999. *Plant Cell Culture Protocols*. Humana Press, Inc., New Jersey, USA.

Shaw, C. H. (ed.) 1988. *Plant Molecular Biology: A Practical Approach*. IRL Press, Oxford.

Smith, R. H. 2000. *Plant Tissue Culture: Techniques and Experiments*. Academic Press, New York.

Suggested Journals

Plant Cell Tissue and Organ Culture
In Vitro Cellular and Development Biology-Plant
Indian Journal of Biotechnology (NISCAIR-CSIR, India)

Plant Tissue Culture Historical Development and Applied Aspects (2012). Resonance (IASC Bangalore, India) 17(8):759-767.
Genomics
Proteomics
Genomics, proteomics and bioinformatics

Bot 403 A- GENOMICS, PROTEOMICS AND BIOINFORMATICS -II

Unit I

Proteomics: Introduction. Top-down and bottom-up proteomics. Shotgun proteomics. Global protein expression profiling and proteome mining: basic methods and tools. Gel-based proteomics: 2-DE workflow and data analysis, Protein identification techniques: Mass spectrometry: MALDI-TOF, sample preparation, in-gel and in-solution digestion, Peptide mass fingerprinting and MS/MS.

Unit II

Quantitative proteomic analysis, DIGE, MUDPIT, ICAT, ITRAQ. Validation of proteomic data: Western Immunoblotting, ELISA, Protein-protein interaction studies: yeast two-hybrid assay

Unit III

Approaches to determine Protein function. Protein chips and microarrays: Introduction and applications. Emerging trends in proteomics. Proteomics in India.

Unit IV

Cell, tissue and organelle proteomics: Cell Wall/ Extracellular matrix/Apoplast proteomics/Secretomics, Nuclear proteomics, Plasma membrane/tonoplast proteomics. Application of proteomics in crop improvement

Unit V

Proteome Informatics: Protein Identification by database searching. *In silico* characterization of proteins for subcellular localization, domain and motif analysis, KEGG An integrated database resource; Metabolic Pathways databases (METACYC). Structural bioinformatics: From sequence to structure: prediction of protein secondary and tertiary structure, homology modeling, tools for structure prediction, validation and visualization.

Laboratory Exercises

1. Gel-based Protein profiling.
2. Demonstration of 2-DE and Western immunoblotting.
3. Protein domain analysis.
4. Homology modeling for protein 3-D structure determination.
5. WebMGA for Protein function annotation by COG database
6. Identifying metabolic pathways using KAAS (KEGG Automatic Annotation Server)
7. WebMGA for tRNA prediction using tRNAscan-SE program

Suggested Readings

Lieber, D.C. 2006. *Introduction to Proteomics: Tools for New Biology*. Humana Press, NJ.

Pennington, S.R., Dunn, MJ (Eds.) 2002. *Proteomics: From Protein Sequence to Function.*BIOS Scientific Publishers, United Kingdom.

Jolles, O. and Jornvall, H. (eds) 2000. *Proteomics in Functional Genomics*. Birkhauser Verlag, Basel, Switzerland.

Attwood, T.K. and Parry-Smith, D.J. 2004. *Introduction to Bioinformatics*, Pearson Education(Singapore) Pvt. Ltd.

David, E. (Ed.) 2007. *Plant Bioinformatics: Methods and Protocols*. Humana Press,New Jersey, USA.

Mount, D.W. *Bioinformatics: Sequence and Genome Analysis.* Cold Spring HarborLaboratory, USA.

Suggested Readings (Laboratory Exercises)

Harlow and Lane D. (Eds.) 1988. *Antibodies – A Laboratory Manual*; Cold Spring HarborLaboratory, USA.

Sambrook, J. and Russell, D.W. 2001. *Molecular Cloning – A Laboratory Manual,Vols I – III*, Cold Spring Harbor Laboratory, USA.

Peter, C. and Rolf, B. 2000. *Computational Molecular Biology: An Introduction.* John Willey & Sons Ltd.

S. Wu, Z. Zhu, L. Fu, B. Niu and W. Li, "WebMGA: a Customizable Web Server for Fast Metagenomic Sequence Analysis", BMC Genomics 2011, 12:444.

Moriya, Y., Itoh, M., Okuda, S., Yoshizawa, A., and Kanehisa, M.; KAAS: an automatic genome annotation and pathway reconstruction server. Nucleic Acids Res. 35, W182-W185 (2007).

Journals:

Journal of proteome research
Molecular cell proteomics
Journal of proteomics
Genomics Proteomics & Bioinformatics
Bioinformatics
Journal of Bioinformatics and Computational Biology

Bot 403 B- APPLIED MOLECULAR BIOLOGY AND PLANT BIOTECHNOLOGY

Unit I

Applications of plant biotechnology and genetic engineering: Plant cell culture and somatic cell genetics as non-conventional methods of plant improvement.

Unit II

Plants as bioreactors. Secondary plant products from cultured cells and their industrial application. Future prospects for genetically modified crops

Unit III

IPR .Plant breeder's and farmer's rights. Development of biotechnology in India.

Unit IV

TransplastomicCisgenesis and Cisgeneicplants .Terminator and Traitor technology. Biosensor technology: principles and applications. Application of Gene driving/genome editing.

Unit V

Biotechnology as related to society: ethics, environmental safety, biodiversity and genetic resources. Safety measures, risk assessment and good laboratory practices. Guidelines, ethics and safety for upcoming technologies.

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. Study of parameters of tissue growth in culture (i) Fresh weight, (ii) Dry weight, (iii) Cell number, (iv) Protein contents, and (v) Carbohydrate contents.
4. Differentiation of tissue through organogenesis/somatic embryogenesis. Microscopic studies and photomicrography
5. Experiments on rejuvenation and multiple shoot induction from mature nodal shoot segments of trees/horticultural/floricultural crops.
6. Encapsulation of somatic embryos/buds using alginate.
7. Isolation of protoplasts from leaf/suspension culture. Purification of protoplasts. Culture of protoplast.
8. Experiments on fusion of plant protoplasts using polyethylene glycol (PEG) electro fusion of plant protoplast.
9. Experiments on root induction from cultured shoots.
10. Biosafety measures/IPR/patents.

Suggested Readings

Weaver, R. F. and Hedrick, P. W. 1992. *Genetics* (2nded.). Dubuque, IA: Wm. C. Brown Publishers.
Pauline, M. D. 1997. *Hairy Roots: Culture and Applications.* Harwood Academic Publishers.
Peter, C. and Rolf, B. 2000.*Computational Molecular Biology: An Introduction.* John Willey & Sons Ltd.
Brown, T.A. 1999. *Genomes.* John Wiley & Sons (Asia) Pvt. Ltd., Singapore.
Phillips, R. L. and Vasil, I. K. 1994. *DNA- Based Markers in Plants.* Kluwer Academic Publishers.
Schena, M. 1996. *DNA microassays (A Practical Approach).*Oxford University Press.

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

Bot 403 C - PLANT DISEASES AND THEIR MANAGEMENT

Unit I

Non- infectious disease: Black heart of Potato, Khaira disease of Rice,

Viroid and Viral disease: Potato spindle tuber, Tobacco Mosaic, Yellow vein mosaic of Bhindi, Leaf curl of Papaya.

Phytoplasma disease: Little leaf of Brinjal, Witches broom of legumes.

Unit II

Bacterial disease: Citrus canker, Angular leaf spot of cotton, Tundu disease of wheat, Bacterial wilt of Cucurbit and Crown gall of fruits plants.

Unit III

Fungal disease: Wart disease of potato, Damping off of chilli, Late blight of potato, Downy mildew & Green ear disease of bajra and Powdery mildew of cereals.

Unit IV

Fungal disease: Ergot of Bajra, Smut of Bajra, Rust of Wheat, Early blight of Potato, Tikka disease of Groundnut, Blast of Rice, Red rot of Sugarcane, Wilt of cotton and Blight of Gram.

Unit V

Nematode disease: Ear cockle of Wheat, Molya disease of Barley and Root Knot disease of vegetables.

Laboratory Exercises

1. Demonstration of Koch's postulates for pathogenic microbes.
2. Isolation and Purification of plant pathogenic viruses.
3. Detection of plant viruses from infected leaf tissue using ELISA and Western Blot.
4. Isolation of Male, Female, II stage larva and eggs of Nematode for disease cycle study.
5. Microscopic study of pathogenic fungi: *Mucor, Rhizopus, Chaetomium, Penicillium, Aspergillus, Alternaria Curvularia, Helminthosporium, Drechslera, Fusarium, Phoma, Colletotrichum.*
6. Microscopic study of pathogenic bacteria: *Agrobacterium, Xanthomonas and Pseudomonas.*
7. Microscopic study of biocontrol agents: *Trichoderma, Gliocladium,Metarrhizium, Paeciliomyces, Beavaria, Streptomyces* and *Bacillus thuringiensis.*
8. In vitro study of effect of different fungicide on growth of pathogenic microbes.
9. In vitro study of effect of different biocide on growth of pathogenic microbes.
10. Antagonistic effect of biocontrol agents on pathogenic microbes.

Suggested Readings

Agarwal, V.K. and Sissclair, J.B. 1993. Principles of Seed Pathology. Vol. I & II CBS Publishers and Distributors, India

Agrios, G.N. 1997. Plant Pathology. Academic Press, London.

Albajes, R., Gullino, M.L., Van Lenteren, J.C. and Elad, Y. 2000. Integrated Pest and Disease management in Greenhouse Crops. Kiuwel Academic Publishers.

Mehrotra, R.S. 1993. Plant Pathology, Tata McGraw Hill.

Neergaard, P. 1997. Seed pathology, Vol. I & II. The Macmillan Press.Ltd, London.

Pandey, B.P. 1997. Plant Pathology, Pathogen and Plant Disease. S. Chand and Company Ltd.

Rangaswamy, G. and Mahadevan, A. 1999. Disease of crop plants in India. Prentice Hall of India, New Delhi.

Roger, H. 2001. Mathew's Plant Virology, Academic Press, NY.

Sharma, P.D. 2006. Plant Pathology. Narosa Publishing House, India

Singh, R.S. 1998. Plant disease. Oxford and IBH Publication Co. Pvt. Ltd.

Singh, R.S. 2005. Introduction to Principles of Plant Pathology. Oxford & IBH Publication Co. Pvt. Ltd.

Strange, R.N. 2003. Plant resistance mechanism (SAR, ISR) –Introduction to plant Pathology, John Wiley & Sons, USA.

Suryanarayana, D. 1978. Seed pathology. Vikas Publishing House, Pvt. Ltd.

Trivedi, P.C. 1998. Nematode disease in Plants. CBS Publisher & Distributors, New Delhi.

Bot 403 D- PLANT MICROBE-INTERACTIONS (PMIs)-II

Unit I

Molecular basis of pathogenesis, *Agrobacterium* and *Pseudomonas*;Plant immunity and Systemic acquired resistance. Hypersensitive reactions and PCD in plant pathogen interaction. Bacterial quorum sensing and biofilms.

Unit II

History and basic procedure of diagnosis of diseases; disease development; effect of pathogen on plant physiology; genetics of plant diseases; control of plant diseases; major plant diseases caused by bacteria, virus and fungus. Plant- virus/viroid/phytoplasma interactions. Multitrophic interactions (pathogens, insects, nematodes, endophytes, parasitic plants). Biocontrol of diseases.

Unit III

Plant growth promoting rhizobacteria (PGPR), Mechanisms of PGPR. Bioremediation, Heavy metal resistance genes in bacteria; Genome of PGPR; genes related to production of siderophore, ACC-deaminase, Phytohormones; Bacteria as bio-control agent. Consortium of Agriculturally important microbes.

Unit IV

Genomics of model legumes and microsymbionts:Model *Rhizobium*, *Bradyrhizobium*, *Ensifer* and *Burkholderia*. Brief account of model legumes (*Lotus japonicus*, *Medicago truncatula*, *Glycine max*). Comparative genomics of rhizobia.

Unit V

Community and genome based views of plant–associated bacterial interactions. Metagenomics; Bacterial secretary systems- Type- I, II, III, IV, V, VI and VII and their role in symbiosis, pathogenesis and defense.

Laboratory Exercises

1. Metabolism of microorganisms-hydrolysis of starch, urea and gelatin
2. Demonstration of phosphate solubilization by bacterial isolates using PVK medium
3. Study of types of root nodules/morphology/anatomical preparation showing infection zone etc.
4. Preparation of bacterial cell templates for amplification of DNA/genes through PCR
5. Amplification of 16S rRNA gene of bacterial isolates using PCR
6. Assessing genetic diversity in bacterial isolates by primer based amplification through PCR or performing amplified rDNA restriction analysis (ARDRA)
7. Tagging of root nodule bacteria with GUS gene and screening of GUS transconjugants
8. In-vitro inoculation studies using GUS tagged RNB strains
9. Performing GUS histochemical staining for localization of GUS tagged bacteria within root nodule
10. Preparation of basic solid media, agar slant for cultivation of pathogenic microorganism.
11. Isolation of fungal and bacterial pathogens from leaves.
12. Isolation of fungal and bacterial pathogen from stems fruits and other aerial plant parts.
13. Microscopic preparation and study of pathogenic microbes.
14. Detection of plant viruses from infected leaf tissue using ELISA and Western Blot.
15. Demonstration of Koch's postulates for pathogenic microbes.
16. Screening for antagonism.

Suggested Readings

Bergey's Manual of Systematic Bacteriology. Second Edition. Volume Two (The Proteobacteria).Springer.
Boyd, R. F. 1984. *General Microbiology.* Times Mirror Publishers, New Delhi.
Chandra, S. and Kehri, H. K. 2006.*Biotechnology of VA Mycorrhizae*: *Indian Scenario*. New India Publishing Agency, New Delhi.

Dilworth, M. J., James, E. K., Sprent, J. I. and Newton, W. E. 2008.*Nitrogen-fixing Leguminous Symbioses*. Springer.
Pawlowski, K. and Newton, W. E. 2008.*Nitrogen-fixing Actinorhizal Symbioses.* Springer.
Pelczar, M. J., Chau, E. C. G. and Krieg, N. R. 1993.*Microbiology concepts and application.* McGraw Hill, New Delhi.
Power, C. B. and Daginawala, H. F. 1992.*General Microbiology*. Himalaya Pub. House, New Delhi.
Prescott, S. C. and Dunn, C. G. 1993.*Industrial Microbiology*. McGraw Hill Pub., New Delhi.
Salle, A. J. 2004. *Fundamental & Principles of Bacteriology*. Tata McGraw Hill Pub., New Delhi.
Smith, S. E. and Read, D. J. 1997. *Mycorrhizal Symbiosis*, Third Edition. Academic Press, London.
Somasegaran, P. and Hoben, H. J. 1994.*Handbook of Rhizobia* (*Methods in Legume-Rhizobium Technology*).Springer-Verlag.
Sprent, J. I. 2001. *Nodulation in legumes.*Kew Publishing.
Stéphane, D., Georges, S. D. and André, F. J. 2005.*In Vitro Culture of Mycorrhizas*.Springer.
Tiwari, M. and Sati, S. C. 2008.*The Mycorrhizae: Diversity Ecology & Applications*. Daya Publisher, New Delhi.
Vincent, J. M. 1970. *A manual for the practical study of the root nodule bacteria*. Blackwell Scientific Publications.
Nitrogen Fixation in Agriculture, Forestry, Ecology and the Environment edited by Dietrich Werner and William E. Newton. Springer Nitrogen Fixation: Origins, Applications and Research Progresses, Volume 4 (2005)

Bot 403E- CYTOGENETICS AND PLANT BREEDING -II

Unit I

Natural breeding systems in plants and their application in plant breeding. Selection and breeding strategies for self-pollinated, cross-pollinated and clonally propagated crop plants.

Unit II

Genetics, evolution and breeding of major crop plants – Wheat, Rice, Brassica and Groundnut; Plant breeding work done in India on these crops.

Unit III

Origin and history of crop plants: Plant domestication - morphological, agronomic and genetic features accompanying domestication of plants. Genetic basis of inbreeding and heterosis, exploitation of hybrid vigor, Male sterility and its application on crop improvement.

Unit IV

Mutation breeding, use of polyploidy and distant hybridization in plant breeding. Mechanisms and genetic bases of resistance/tolerance to biotic and abiotic stresses in plants, breeding for resistance/tolerance.

Unit V

Release and registration of new varieties, quality seed - classes, production practices and maintenance of pure seed, seed purity standards, UPOV convention and convention on biodiversity.

Practical Exercises

1. Floral biology in self and cross pollinating crop species
2. Selfing and crossing techniques in major field crops
3. Determination of extent of outcrossing
4. Male sterility - detection & maintenance;
5. Self incompatibility and techniques of maintenance and overcoming sporophytic and gametophytic incompatibility
6. Screening for quality traits; resistance/tolerance to biotic & abiotic stresses
7. Demonstration of quality seed production through nucleus and breeders seed production techniques.

Suggested Readings

Acquaah G (2007). Principles of Plant Genetics and Breeding, Blackwell Publishing Ltd. USA.
Allard RW (1999). Principles of Plant Breeding (2nd Edition), John Wiley and Sons, ISBN 0471023094, 9780471023098.
Allard, R.W. 1960. Principles of Plant Breeding. John Wiley & Sons, New York.

Fehr, W.R. 1987. Principles of Cultivar Development (2 Volumes). Mac Millan Publishing Co., New York.
Hays, H.K., Immer, F.R. and Smith, D.C. 1955. Methods of Plant Breeding. McGraw Hill Book Company, Inc., New York.
Lewin B (2008). Genes IX, Jones and Barlett Publishers, ISBN-10: 0763740632.
Poehlman, J.M. 1986, Breeding Field Crops. AVI Publishing Company, Connecticut.
Simmonds (1995). Evolution of Crop Plants (2nd Edition) Longman.
Singh, B.D. 2000. Plant Breeding-Principles and Methods. Kalyani Publsihers, New Delhi.

Bot 403 F- INDUSTRIAL MICROBIOLOGY II

Unit I

Antibiotics: Classification, mode of action, commercial production: Penicillinandstreptomycin. Production of vaccines.

Unit II

Nitrogen fixing Biofertilizers: *Rhizobium, Azospirillum,* and *Azatobactor*. Plant growth promoting *Rhizobacteria,* Blue green algae. Phosphate mobilizing Biofertilizers. Industrial Production of Biofertilizer.

Unit III

Biopesticides and Bioherbicides, Plant incorporated protectants (PIPs). Biofuel: Biogas production. Role of EPA (Environmental Protection Agency

Unit IV

Biofilm, Biochip, Biosensor, Biosurfactants, Biosorption, Bioremediation and Bioleaching.

Unit V

Textile microbiology: (Cotton and wool). Petroleum microbiology and Leather Microbiology.

Laboratory Exercises

1. Effect of various factors on the growth of microorganisms (pH, Temp,UV light)
2. Cultivation of Nitrogen fixing Biofertilizers: *Rhizobium, Azospirillum, Azatobacter*.
3. Oligodynamic action of heavy metals.
4. Antibiotic sensitivity test by agar disc diffusion and
5. Antibiotic sensitivity test by tube dilution methods.
6. Isolation &identification of Mycorrhizal fungi from Rhizosphere soil.
7. Production of penicillin
8. Production of citric acid.
9. Isolation and characterization of bacteria from hydrocarbon contaminated soils.

Suggested readings

Casida,L.E. *Industrial Microbiology*. John Wiley and sons. Chum. *Microbiology*. John Wiley &Sons.
Corum ,C.J. Development of Industrial Microbiology. American Institute of Bio.Science.
Dube .C., and Maheshwari D.K. , A Text Book of Microbiology , S. Chand and co. Ltd
Dube R. C.,and Maheshwari D.K. , Practical Microbiology , S. Chand and co. Ltd
Kaushik,P. Microbiology. Emkay Pub., NewDelhi.
Pelczer, M.J., Chau, E.C.G. and Krieg, N.R. Microbiology Concepts and application.McGraHill.
Power,C.B. and Daginawala, H.F.General Microbiology. Himalaya Pub. House.
Prescott,S.C.andDunn,C.G.IndustrialMicrobiology.McGrawHill Pub.
Robert F. Boyd. General Microbiology.Times Mirror Publishers.
Salle, A .J .Fundamental & Principles of Bacteriology. Tata McGRaw Hill.
Sivakumar P.K. , Joe M .M, Sukesh K , An Introduction to Industrial Microbioloy, Pub.: S. Chand and co. Ltd
Spencer ,J.E.T.andSpencer,D.M.YeastTechnology.Springer-Verlag.
Staubury,P.F.and Whiterker, A.PrinciplesofFermentationTechnology.PergamonPress.
Thoma,R.W.IndustrialMicrobiology.Hutchinson&Ross.

Tortora,G.J.,Funke,B.R. andCasechristive:Microbiology.BengaminPublishingCo.
Cappuccino, J and Sherman, N. Microbiology: A Laboratory manual. Pearson publication.

Bot 404 A- DESERT ECOLOGY

Unit I

Sand dunes and their management: Sand dunes: classification, stabilization and management, wind breaks and shelter belts, afforestation and desert control measures.

Unit II

Drought and Indira Gandhi Canal: Drought: definition, types, implication and management techniques; Indira Gandhi Canal: History, ecological implications and its present status

Unit III

Saline habitats and Wastelands: Inland Saline: Habitat and vegetation characteristics, germination, growth and survival adaptations. Wasteland development: definition, nature and characteristics of wasteland. Wastelands in Rajasthan.

Unit IV

Wetlands and Desert Resources: Wetlands: Introduction, characteristics, distribution in world, wetlands in India and their importance. Thar Desert Resources: Forest, energy, minerals, livestocks and rangeland conditions, Ecology of grazing lands and impact of over-grazing,

Unit V

Desert vegetation and Adaptations: Origin, characters and Geomorphology of Thar desert; Vegetation and floral composition of the Rajasthan desert; Adaptations of plants matching the desert environment; Effect of biotic factors on desert vegetation

Laboratory/field exercises

1. Seed to seedling character relationships.
2. Stomata size, opening rhymes and density in two well adapted desert plants.
3. Measurement of water loss by quick weighing method
4. Measurement of relative water content in desert plants.
5. Measurement of succulence in desert halophytic plants
6. Measurement of soil salinity in Thar desert
7. Quantification of ions (Na^+ and Cl^-) concentrations in halophytes
8. Quantification of proline concentrations in plants of desert/haloxeric environment
9. Quantification of soluble salts (Na^+ and Cl^-) in desert soils.

Suggested Readings

Faroda, A.S. and Singh, M. 1998. *Fifty years of Arid Zone Research in India* (eds.) CAZRI, Jodhpur, 476 pp.
Pachausri, R.K. and Qureshy, L.F. 1997. *Population, Environment and Development* (eds.) TERI, New Delhi.
Rice, E.L. 1984. *Allelopathy* (2nd Edition), Academic Press, New York.
Sen, D.N. 1982. *Environment and Plant Life in Indian Desert*. Geobios International, Jodhpur.
Sen, D.N. 2003. *Ecology and Vegetation of Indian Desert* (eds.) Agro Botanical Publishers, India 340 pp.
Singh, R.P. and Singh S. 2001. *Sustainable Development of the Indian Arid Zone – A Research Perspective* (eds.), Scientific Publishers, Jodhpur.

Bot 404 B- MICROBIAL ECOLOGY - II

Unit I

Microbial communities in extreme environments and their functions: Adaptation and response to stimuli. Measurement of microbial metabolism: Heterotrophic potential, productivity and decomposition.

Unit II

Development and dynamics of microbial communities. Population selection within communities (r and k strategies). Succession within microbial communities (during degradation of organic matter, nutrient cycling, and in biofilms)

Unit III

Detection of microbial populations: Phenotypic detection, lipid profile analysis, molecular detection. Detection of non culturable bacteria. Determination of microbial numbers (direct count and viable count procedures) and biomass (biochemical assays and physiological approaches).

Unit IV

Association of microbes with other organisms: Interactions of microorganisms with plants and animals, microbial contribution to animal nutrition, gut micorbiome and its importance, predation of microorganisms by animals, cultivation of microorganisms for food and food processing, commensal and mutualistic intestinal symbionts, digestion within rumen, mutualistic association of invertebrates with photosynthetic, chemolithotropic and methanotropic microorganisms.

Unit V

Microbial role in nutrient cycling and remediation of pollutants: Carbon cycle, Nitrogen cycle, Sulfur cycle and Phosphorus cycle.

Biodeterioration and its control. Microbial interaction with xenobiotic and inorganic pollutants, persistence and biomagnification of xenobiotic molecules.

Biodegradability: Biodegradation and heterotrophic production in aquatic environments. Biodegradability and ecological side effect testing, testing for biodegradability and biomagnifications.

Bioremediation: Approaches to bioremediation.

Laboratory Exercises

1. Enumeration of the nutrient requirements of microorganisms
2. Isolation of microorganism with specific capabilities or those adapted to specific habitats
    a. Isolation of temperature resistant microorganisms
    b. Isolation of anaerobes
    c. Isolation of extremely halophilic bacteria
    d. Isolation of cellulolytic microorganisms
    e. Isolation of chitin decomposing bacteria
    f. Enrichment of methane utilizing bacteria
    g. Isolation of phosphatase active microorganisms
    h. Enrichment and isolation of photosynthetic bacteria
    i. Enrichment for nitrifying bacteria
    j. Isolation and culture of blue green algae
3. Study of enzyme activities of microorganisms
    a. Dehydrogenase
    b. Urease
    c. B-glucosidase
    d. Acid and alkaline phosphatase

Suggested Readings

Aronson, S. 1970. *Experimental microbial ecology*. Academic Press.

Burlage, Robert S. 1998. *Techniques in Microbial Ecology*. Oxford University Press.

Atlas, R. M. and Bartha. 1998. *Microbial Ecology: Fundamentals and Applications*. The Benjamin/Cummings Science Publishing.

Bernhard, S. 2000. *Advances in Microbial Ecology*. Springer.

Singer, S. 2001. *Experiments in Applied Microbiology*. Academic Press.

Kirchman, D.L. 2012. *Processes in microbial ecology*. Oxford University Press.

Bot 404 C- STRESS PHYSIOLOGY-II

Unit I

Photo-inhibition:Photoinhibition of Photosystem under environmental stresses.Photoprotection and repair mechanism of photosystem I in plants. Stomatal regulation under stress .

Unit II

Strategies and Mechanisms of stress tolerance: Biochemical and molecular basis of water deficit and salt tolerance in plants. Molecular mechanism of salinity tolerance; Strategies to improve crop plants for stress tolerance (water deficit, salinity and low and high temperature stress) using transgenic plants

Unit III

Stress Proteins: Genes regulated by environmental stress. Structure and functions of some important stress proteins (HSPs, ANPs, PR proteins, LEA proteins, aquaporines, osmotin, systemines, defensins, ubiquitins).

Unit IV

Stress induced genes**:** Expression of Stress Signaling Pathway Genes under Drought, Salinity and temperature stresses . Expression of Cell Expansion Genes under Drought. Improve crop plants for biotic (pathogen: Bacterial, Fungal) stress tolerance using transgenic plants.

Unit V

Plant growth regulators and stress: Role of PGRs in mitigation of stress. Role of ABA, Ethylene, Salicylic acid and Jasmonic acid.

Laboratory Exercises

1. Estimate free amino acids content in the given sample.
2. Estimate proline content in given water stressed samples.
3. Estimate glycine betaine content in salt stressed samples.
4. Estimate total phenol content in salt stressed samples.
5. Find out the soluble sugars in temperature (low and high) and salt stressed samples.
6. Find out the concentration of polyamines in the given stressed samples.
7. Visualization of stress proteins by SDS-gel electrophoresis.

Suggested Readings

Ahmad , P ., Azooz M.M.and Prasad M.N.V. 2013. *Salt Stress in Plants: Signalling, Omics and Adaptations* (eds). Springer

Alscher, R. G. and Cumming, J. R. 1990. *Stress Responses in Plants: Adaptation and Acclimation Mechanisms* (eds.). New York Wiley-Liss, Inc.

Aroca, R. 2012. Plant Responses to Drought Stress From Morphological to Molecular Features. (ed) Springer-Verlag Berlin Heidelberg.

Basra, A. S. 2001. *Crop Responses and Adaptations to Temperature Stress* (ed.). Food Products Press, New York.

Basra, A. S. and Bastra, R. K. 1997. *Mechanisms of Environmental Stress in Plants* (ed.). Amsterdam: The Netherlands, Harwood Academic Publishers.

Belhassen, E. 1997. *Drought Tolerance in Higher Plants: Genetical, Physiological and Molecular Biological Analysis* (ed.). Kluwer Academic Publishers, Dordrecht.

Buchanan, B. B., Gruissem, W. and Jones, R. L. 2000. *Biochemistry and molecular biology of plants*. American Society of Plant Physiologists, Maryland, USA.

Cherry, J. H. 1994. Biochemical and cellular mechanisms of stress tolerance in plants (ed.). Springer-Verlag, Berlin.

Dhaliwal, G. S. and Arora, R. 1999. *Environmental Stress in Crop Plants* (ed.). Commonwealth Publishers, New Delhi.

Grillo, S. and Leone, A. 1997. Physical Stresses in Plants: Genes and Their Products for Their Tolerance. Springer-Verlag, Berlin.

Hedden, P. and Thomas S.G. 2006. *Plant Hormone Signaling*. Blackwell Publishing Ltd .Oxford, UK

Hir,t H. 2009. *Plant Stress Biology: From Genomics to Systems Biology* (ed), Wiley-VCH Verlag Weinheim, Germany

Jenks, M.A. and. Wood A.J. 2009.*Genes for Plant Abiotic Stress Tolerance*. John Wiley & Sons.

Khan, M .N. and Mobin M. 2014. Nitric Oxide in Plants: Metabolism and Role in Stress Physiology(eds) Springer

Lerner, H. R. 1998. *Plant Responses to Environmental Stresses (from Phytohormones to Genome Reorganization*). Mercel Dekker, Inc.

Levitt, J. 1980. *Responses of plants to environmental stress. Vol. 1. Chilling and temperature stress*. Academic Press, New York, USA.
Pandey, G.K. 2015. *Elucidation of Abiotic Stress Signaling in Plants: A Functional Genomic Perspective.* Springer
Pessarakli, M.2014. *Handbook of Plant Crop Stress* (ed.). CRC Press
Rout, G. R. and Das, A. B. 2013. *Molecular Stress Physiology of Plants* (eds.) Springer .
Samuelson, J.C. 2013 .*Enzyme Engineering: Methods and Protocols* (ed) .Springer ,New York
Sarwat, M., Ahmad, A. and Abdin, M.Z . 2013.*Stress Signaling in Plants: Genomics and Proteomics Perspective*. Vol. 1 . Springer
Taiz, L. and Ziegler, E. 2003. *Plant Physiology* (3rd edition), Panima Publishing Corporation, New Delhi.
Tuteja, N. and Gill, S.S. 2014 .*Climate Change and Plant Abiotic Stress Tolerance* (eds.). Wiley-VCH Verlag Weinheim, Germany.
Yoshioka, K.and Shinozaki, K. 2009. *Signal Crosstalk in Plant Stress Responses* (eds). Willey-Blackwell.

Bot 404 E- BIOSYSTEMATICS OF PLANTS -II

Unit I

Taxonomy in the service of Man and Conservation: Introduction, field inventorisation, collection, preparation, preservation, documentation and handling of Herbarium.

Unit II

Molecular Systematics: Plant genomes: nuclear, mitochondrial, chloroplast; Molecular markers; Generating molecular data: restriction site mapping, gene sequencing;

Unit III

Phylogenetics: The nature of phylogeny; How we depict phylogeny?; The importance of homology, Polarizing characters of homology; Rooting Trees; The problem of homoplasy.

Analysis of molecular data: alignment of sequences, methods of phylogeny reconstruction.

Unit IV

Biosystematics: Aims and procedures of Investigation. A case study of Clausen et al and Turresson experiments. Numerical Taxonomy, role of biosystematics in evolution

Unit V

Introduction to the angiosperms: General characteristics; Evolutionary history; Commelinids; Basal eudicots and Caryophyllids; Rosids; Asterids.

Laboratory Exercises

1. Live plants/ Herbarium specimens of the following families will be provided in the class for description and identification (classification based on APG II, 2003):
    - Commelinids: Arecaceae, Poaceae, Cyperaceae
    - Basal Eudicots and Caryophyllids: Ranunculaceae, Caryophyllaceae
    - Rosids: Euphorbiaceae, Rosaceae, Fabaceae, Cucurbitaceae
    - Asterids: Solanaceae, Lamiaceae, Apiaceae, Asteraceae
2. Cladogram construction and analysis
3. Techniques in molecular systematic
4. Computer Exercises: Finding DNA Sequences in GenBank; aligning the sequences, and making phylogenetic trees

Suggested Readings

Angiosperm Phylogeny Group 2003. An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: APG II. Botanical Journal of the Linnaean Society 141: 399-436.
Crawford, D.J. 2003. Plant Molecular Systematics. Cambridge University Press, Cambridge, UK.
Gurcharan Singh, 2010. Plant Systematics: An Integrative Approach. Science Publishers, Enfield, NH, USA

Judd, W.S., C.S. Campbell, E.A. Kellogg, P.F.Stevens and M.J. Donoghue 2002. Plant Systematics: A phylogenetic Approach. Sinauer Associates, Inc., Massachusetts.
Nei, M. and S. Kumar 2000. Molecular Evolution and Phylogenetics. Oxford University Press, New York.
Radford, A. E., W.C. Dickison, J.R. Massey and C.R. Bell 1974. Vascular Plant
Semple, C. and Steel M.A. 2003. Phylogenetics. Oxford University Press, Oxford.38
Simpson, M.G. 2006. Plant Systematics. Elsevier, Amsterdam.
Stuessy, T.F. 2009. Plant Taxonomy: The systematic Evaluation of Comparative Data. Columbia University Press, New York.
Systematics. Harper and Row, New York.
Harris, J.G. and Harris, M.W. 2001. Plant identification terminology: An illustrated Glossory. Spring Lake Pub.
Crank, Q.C.B., Bateman, R. M. And Hawkins, J. A. 2002. Developmental genetics and Plant Evolution. Taylor and Francis Inc. USA and Canada
Soltis, P.S., Soltis, D.E. and Doyle, J. J. 1992. Molecular Systematics of Plants. Chapman and Hall
Hollingsworth, P.M., Bateman, R.M. and Gornall, R.J. 2002. Molecular systematic and Plant Evolution. Taylor and Francis, London and Newyork.
Besse, P. 2014. Molecular Plant Taxonomy: Method and Protocols. Humana Press.
Scott-Ram, N.R. 1990. Transformed Cladistics, Taxonomy and Evolution .Cambridge University Press.
Winston J.E. 1999.Describing Species: Practical Taxonomic Procedure for Biologist. Columbia University Press.

Bot 404 F- ENVIRONMENTAL MONITORING, MANAGEMENT AND RESTORATION - II

Unit I

Global Warming: Green house effect and global warming; ozone depletion; UV- B radiations; acid rain. Environmental monitoring; Biomonitoring; Bioindicators.

Unit II

Management: Survey and classification of natural resources; conservation; management of resources: Management and utilization of inland freshwater resources; management of forest resources. Non-conventional sources of energy; Biomass as a source of energy.

Unit III

Biodiversity: Strategies for biodiversity conservation, principles of biodiversity conservation *in-situ* and *ex*-situ conservation strategies, theory of reserve design; Biosphere reserves. Mega diversity zones and Hot spots, concepts, distribution and importance. Threatened plants of India

Unit IV

Management: Industrial ecology- concepts and principles, importance and recycling of resources in industrial production. Environmental Biotechnology – Scope and applications; Concept of cleaner technology

Unit V

Restoration: Aims and strategies of restoration; physical, chemical, biological and biotechnological tools of restoration. Phytoremediation of disturbed ecosystems; Acceleration of ecological succession, reintroduction of biota.

Laboratory/Field Exercises

1. To calculate the dust capturing capacity of the leaves provided to you.
2. To calculate the percentage of the injured area in the leaves provided to you.
3. Study the effect of different lead and cadmium concentrations on the germination of seeds
4. Determination of the Dissolved Oxygen content in water bodies.
5. Determination of the hardness of in water bodies.
6. Determination of the alkalinity in water bodies.
7. Determination of the acidity in water bodies.
8. Determination of the residual chlorine in water bodies.
9. Determination of the organic carbon contents in water bodies.
10. Determination of the contents of calcium carbonate in water bodies.
11. Field survey of important plants of the region for biodiversity assessment.

Suggested Readings

Bradshaw, A.D. and Chadwick, M.J. 1980. *The Restoration of Land.* Blackwell Scientific Publications, Oxford.
Singh, A. and Ward, O.P. (Eds.). *Applied Bioremediation and Phytoremediation.* Springer. 2004.
Abrol, I.P. and Dhruva Narayan, V.V. (Eds.). *Technologies for Wasteland Development*. ICAR, New Delhi. 1998.
Owen, S.O. and Chiras, D.D. 1990. *Natural Resource Conservation: An Ecological Approach.*Macmillan USA; 5th edition.
url: *www.**iucn**.org* for Global Biodiversity.

Skill Courses in Botany

Bot-SC-1- 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.

Bot-SC- 2- AGROTECHNIQUES FOR DESERT PLANTS

1. Introduction and WHO guidelines on Good Agricultural and Collection Practices (GACPs)
2. Propagation material(s) and techniques
3. Seed biology and germination behaviour
4. Nursery and field techniques of important desert medicinal plants
5. Harvest management
6. Storage techniques
7. Disease management

Laboratory/Field Exercises

1. Morphological features of desert plant seeds
2. To estimate viability and germination behavior of medicinal plant germplasms
3. Techniques for raising of nursery and transplanting in field conditions
4. To demonstrate techniques for storage of germplasm
5. To evaluate important symptoms of disease causing pathogens.

Suggested Readings

Agro-techniques of selected medicinal plants, Vol. I, Department of AYUSH, New Delhi, 2008

Chadha, K.L. and Gupta, R. Advances in Horticulture, Vol. 11, Medicinal and Aromatic Plants, Malhotra Publishing House, New Delhi, 1995.
50 Years of Crop Research in India, ICAR, New Delhi, 1996.
Prospects of Medicinal Plants, NBPGR, New Delhi, 1998.
The Wealth of India. A Dictionary of Indian Raw Materials and Industrial Products, New Delhi. Raw Materials I-XII, Revised Vol. I-III (1985-1992) Supplement (2000), CSIR, New Delhi.

Bot-SC- 3- DATA ANALYSIS AND PRESENTATION

1. Sampling techniques
2. Central tendency – Mean, Median, Mode, Variance, Normalized Variance, Standard Error, Coefficient of Variance
3. Analysis of Variance
4. Correlation
5. Regression
6. Tables and Graphs
7. Preparation of Power Point Presentation

Laboratory/Field Exercises

1. Basic operations in MS-Excel
2. Computation of Central tendency quantifiers in MS-Excel
3. Computational techniques for ANOVAin MS-Excel
4. Computational techniques for Correlation in MS-Excel
5. Computational techniques for regression in MS-Excel
6. Techniques for table preparation in MS-Excel
7. Hands on exercises for Power point presentation

Suggested Readings

Gomez, A. Kwanchai and Gomez, A. Arturo. 1984. Statistical Procedures for Agricultural Research (second Edition) , John Wiley & Sons, New York
Mishra, B.N. and Mishra M.K. 1989.Introductory Practical Biostatistics.NayaPrakash Publication, Calcutta.
Panse, V.G. and Sukhatme, P.V. 1989. Statistical Methods for Agricultural Workers. Indian Council of Agricultural Research, New Delhi.
Quinn, P. Gerry and Keough, J. Michael. 2002. *Experimental Design and Data Analysis for Biologists.* Cambridge University Press Cambridge, UK .
Rao, Sundar P.S.S. and Richard, J. 2011.*Introduction to Biostatistics and Research Methods.*(4th Ed), PHI Learning Pvt. Ltd., New Delhi.
Williams, Brain. 1993. Biostatistics- Concepts and Applications for Biologist. Chapman & Hall, London

Bot-SC- 4-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

Bot-SC- 5-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.

Bot-SC- 6- VALUE ADDITION FOR BIORESOURCES

1. Introduction and bioresource profile
2. Need for identifying real/true value of the bio-resources
3. Wild and domestic bioresources
4. Thar desert resources with special reference to forest, energy (solar and wind) and minerals
5. Energy and petro plants
6. Air-layering technique
7. Concept of Harvest Index
8. Economics (Benefit: Cost ratio)

Laboratory/Field Exercises

1. Methods for bio-resources valuation
2. General idea for desert bioresources with special reference to solar and wind energy plantation
3. Identification of petro plants of desert
4. To perform air layering experiment
5. To calculate Harvest Index
6. To calculate economics of desert plants

Suggested Readings

Agro-techniques of selected medicinal plants, Vol. I, Department of AYUSH, New Delhi, 2008
Handbook of Horticulture, ICAR, 2001
50 Years of Crop Research in India, ICAR, New Delhi, 1996.
Prospects of Medicinal Plants, NBPGR, New Delhi, 1998.

The Wealth of India. A Dictionary of Indian Raw Materials and Industrial Products, New Delhi. Raw Materials I-XII, Revised Vol. I-III (1985-1992) Supplement (2000), CSIR, New Delhi.
Recent Progress in Medicinal Plants,Volume 9 : Plant Bioactives in Traditional Medicine, (eds.) D.K. Majumdar, J.N. Govil, V.K. Singh & R.K. Sharma, Studium Press, LLC, USA, 2005

Bot-SC- 7 –CHROMOSOME ANALYSIS

1. Survey and collection of germplasm
2. Propagation/Maintenance of plant materials
3. Collection and preservation of plant samples
4. Preparation of solutions for chromosome staining
5. Preparation of meiotic and mitotic spreads
6. Observation of various stages for cell division
7. Data analysis

Laboratory Exercises

1. Counting the Number of chromosomes & Observing somatic chromosomes in root tips
2. Analyzing size and morphology of chromosome
3. Observing somatic chromosome in young leaves
4. Gametic chromosome observation in young flower
5. Gametic or meiotic chromosome observation in young frond of fern during sporogenesis
6. Preparation of solutions

Suggested Readings

Setterfield, G., Schreiber, R., and Woodard, J., *Stain Technology*, **29**, 113 (1954).
Pathways, Mechanisms, and Rates of Polyploid Formation in Flowering Plants Justin Ramsey and Douglas W. Schemske *Annual Review of Ecology and Systematics*Vol. 29 (1998), pp467-501
Grubb, Chandra. "Practical Cytology." *Proceedings of the Royal Society of Medicine* 61.5 (1968): 537. Print.
.Grubb, C. (1968). Practical Cytology. *Proceedings of the Royal Society of Medicine*, *61*(5), 537.

Bot-SC- 8- MUSHROOM CULTIVATION

1. General Introduction of mushroom.
2. Taxonomy and Biology of Mushroom.
3. Neutraceutical (nutritional) values of mushroom.
4. Pharmaceutical (medicinal) values of mushroom.
5. Mushroom laboratory/ farm design.
6. Mushroom production technology.
7. Spawn production technology.
8. Compost (natural and synthetic).
9. Management of mushroom disease.
10. Post harvest technology of mushroom.
11. Economics of mushroom cultivation.
12. Mushroom producers, Exporters, consultants, literature and sources of inputs.

Laboratory Exercises

1. Survey and collection of local edible mushrooms.
2. Visit to mushroom cultivation Laboratory.
3. General studies on laboratory rules, equipments, tools and Precaution.
4. Principles and demonstration of Laboratory Instruments.
5. Preparation of culture media.
6. Isolation and culture of Spawn (mushroom seed/spore)
7. Preparation of composting.
8. Cultivation of white button mushroom.
9. Post harvest technique.
10. Preservation of mushroom.

Suggested Reading

Bahl, N. 1984. Handbook on mushroom, Oxford and IBH, New Delhi
Chandra, K. L. and Sharma, S. R. 1995. Mushroom, Advances in horticulture, Volume XIII Malhotra Publishing House, New Delhi, India
Kannaiyan, S. and Ramasamy, K. 1980. A handbook of edible mushroom. Today and tomorrows printers and publishers New Delhi
Kapoor, J. N. 1989. Mushroom cultivation, ICAR Publishers, Coimbatore
Purkayastha, R.P. and Chandra, A. 1985. Manual of Indian edible mushrooms.Today and Tomorrows printers and publishers, New Delhi
Saini, L.C. and Prashar, R.D. 1992 Khumb Utpadan. HAU Publication Hissar
Sharma, S.R. and Mehta, K.B. 1991. Bibliography of mushroom Research of India. NCMRT Publication, Solan
Singh, H. 1991. Mushroom- The art of cultivation. Sterling Publishers Pvt. Ltd. New Delhi
Singh, R.P. 1986 Bulletins of Successful mushroom production. GB pant University, Pantnagar.
Tewari, S.C. and Kapoor, P. 1988. Mushroom Cultivation: An Economics analysis. Oxford and IBH New Delhi
Journals: Indian Journal of mushroom and Mushroom research (for update information)

Bot-SC- 9- 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, ion-exchange and affinity chromatography.
6. Quantitative and Qualitative analysis of Proteins: Dye-binding methods, native and denaturing SDS-PAGE, 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.

Bot-SC- 10-NUTRIENT MANAGEMENT

1. Soil Analysis: Physical, chemical and Biological properties of soil
2. Nutritional requirement of Plant: Macro and micro nutrients
3. Forms and Sources of nutrients in Soils
4. Uptake ,transport and roles of nutrients in plants

5. Symptoms of Deficiency and Excess of nutrients in plants
6. Tissue Testing for nutrient status in plants , recommendation of Fertilizers
7. Types of nutrient media
8. Soil preparation, Soil amendments, bed preparation, transplantation techniques
9. Soil less culture: hydroponic, Nutrient Film Technique (NFT), cocopeat and Airoponics
10. Greenhouse Technology: Importance, types and operation techniques

Laboratory/Field Exercises

1. Assessment of Deficiency and Excess of nutrients on the basis of Visual Symptoms .
2. Soil Analysis(Physical): moisture, temperature and soil texture.
3. Soil analysis (chemical): EC and pH, carbon, phosphorus,.
4. Biological properties: microbial diversity of soil analysis.
5. Tissue Tests for nutrients: (N.P, K & Na)
6. Estimation of photosynthetic pigments in plant leaves.
7. Assay of nitrate reductase activity from plant tissues.
8. Techniques for Soil less culture: hydroponic and Airoponics.

SUGGESTED READINGS

Ahmad P. and Wani M.R. 2014. Physiological Mechanisms and Adaptation Strategies in Plants Under Changing Environment(eds). Springer New York

BassiriRad H.2005. *Nutrient Acquisition by Plants - An Ecological Perspective*. Springer .

Barker A.V.and Pilbeam D.J. 2007. Handbook of Plant Nutrition (eds.). Taylor & Francis

Hopkins W.G. and Norman P. A. Huner N.P.A . 2009. Introduction to Plant Physiology (4th Edition) John Wiley & Sons, Inc. New York, USA

Konrad M. and Ernest A. K.2001. *Principles of Plant Nutrition* (eds.). Springer

Maathuis, F. J.M 2013.Plant Mineral Nutrients :Methods and Protocols (ed.). Springer

Pansu M. and Gautheyrou J. 2006 .*Handbook of Soil Analysis - Mineralogical, Organic and Inorganic Methods.* Springer

Pessarakli, M.2014. *Handbook of Plant Crop Physiology* (ed.). CRC Press

Resh M. H .2012. *Hydroponic Food Production: A Definitive Guidebook for the Advanced Home Gardener and the Commercial Hydroponic Grower (7th edition).*CRC Press Taylor & Francis Group

Taiz, L. and Ziegler, E. 2003. Plant Physiology (3rd edition), Panima Publishing Corporation,New Delhi.

SYLLABUS

CHEMISTRY

Under Choice Based Credit System (CBCS)

M.Sc. (FINAL) EXAMINATION- 2019

JAI NARAIN VYAS UNIVERSITY

JODHPUR

M.Sc. Chemistry

(CBCS)

Second Year (2018-19)

(Two Semesters each of 15 weeks)

III SEMESTER:

1. THEORY PAPERS	Pds/Wk	No. of Credits	CCA	ESE	Total
CH 301 Group Theory & Inorganic Spectroscopy	6	4	30	70	100
CH 302 Application of Spectroscopy	6	4	30	70	100
Elective Paper I (303A-I/303B-I/303C-I/303D-I)	6	4	30	70	100
Elective Paper II (304A-II/304B-II/304C-II/304D-II)	6	4	30	70	100
Grand Total				Marks	400

A student will opt for any one of the four elective groups.

Elective Group A **C. No 303A-I /304A-II**

Elective Group B **C. No 303B-I /304B-II**

Elective Group C **C. No 303C-I/304C-II**

Elective Group D **C. No 303D-I/304D-II**

PRACTICALS:

Practicals **24 pds./week** **375 pds./semester**

There will be 4 Labs. Namely Lab. 1, Lab. 2, Lab. 3 and Lab.4. Students will be divided into four groups. Each group of students will work for 7 weeks for two Lab Courses in one semester.

CH -305 : **Lab. Course 1 (Inorganic)**

CH -306 : **Lab. Course 2 (Analytical)**

CH -307 : **Lab. Course 3 (Organic)**

CH -308: **Lab. Course 4 (Physical)**

PRACTICALS EXAMINATION SCHEME

Lab Course	**Pds/Wk**	**No. of Credits**	**CCA**	**ESE**	**Total**
Lab Course 1 / Lab Course 3	**24**	**4**	**30**	**70**	**100**
Lab Course 2 / Lab Course 4	**24**	**4**	**30**	**70**	**100**
Grand Total				**Marks**	**200**
Total marks of III Semester					**600**

IV SEMESTER:

1. THEORY PAPERS	Pds/Wk	No. of Credits	CCA	ESE	Total
CH 401 Solid State Chemistry	6	4	30	70	100
CH 402 Bio Chemistry	6	4	30	70	100
Elective Paper I (403A-III/403B-III/403C-III/403D-III)	6	4	30	70	100
Elective Paper II (404A-IV/404B-IV/404C-IV/404D-IV)	6	4	30	70	100
Grand Total				Marks	400

(A student who had opted group in III Semester will continue with the same group in the IV Semester.)

There will be 4 Labs. Namely Lab. 1, Lab. 2, Lab. 3 and Lab.4. Students will be divided into four groups. Each group of students will work for 7 weeks for two Lab Courses in one semester.

CH -405 :	**Lab. Course 1 (Inorganic)**
CH -406 :	**Lab. Course 2 (Analytical)**
CH -407 :	**Lab. Course 3 (Organic)**
CH -408:	**Lab. Course 4 (Physical)**

Lab. Course	Pds/Wk	No. of Credits	CCA	ESE	Total
Lab Course 1 / Lab Course 3	**24**	**4**	**30**	**70**	**100**
Lab Course 2 / Lab Course 4	**24**	**4**	**30**	**70**	**100**
Total				**Marks**	**200**
Total marks of IV Semester					**600**

SK-CH for III Semester 4pd/week (For students of Chemistry Department only)

SK-CH for IV Semester 4pd/week (For students of Other Department only)

M.Sc Chemistry

II YEAR-2019

SEMESTER III

There will be two compulsory papers and two elective papers.

A student has to take any one of the four elective groups. (The group a student chooses this Semester, they would have to continue with the same group in the IV Semester.)

LIST OF TWO COMPULSORY PAPERS:

Compulsory Paper-I

CH 301 GROUP THEORY & INORGANIC SPECTROSCOPY

Compulsory Paper-II

CH-302 APPLICATIONS OF SPECTROSCOPY

List of Elective Groups in M.Sc. III Semster:

GROUP A

CH 303A-I: ORGANOTRANSITION METAL CHEMISTRY.

CH 304A-II: NANOMATERIALS AND NANOTECHNOLOGY

GROUP B

CH 303B-I: PHOTOCHEMISTRY

CH 304B-II: ORGANIC SYNTEHSIS-I

GROUP C

CH 303C-I: BIOINORGANIC AND SUPRAMOLECULAR CHEMISTRY

CH 304C-II: HETEROCYCLIC CHEMISTRY

GROUP D

CH 303D-I: NUCLEAR AND RADIOCHEMISTRY

CH 304D-II: MEDICINAL & PHARMACEUTICAL CHEMISTRY

Compulsory Paper-I

CH-301: GROUP THEORY & INORGANIC SPECTROSCOPY

Unit I

Molecular Symmetry and Group theory (A) : Symmetry elements and operation. Symmetry classification of group, relation between orders of a finite group and its sub groups. Conjugacy relation and classes. Schonfiles symbols, representation of groups by matrices (representation for the Cn,Cnv, Cnh, Dnh etc. groups to be worked out explicitly). Characters of representations.

Unit II

Molecular symmetry and group theory (B) : The great orthogonality theorm and its importance, character tables and their use in spectroscopy. Irreducible representations unit vector transformation, reducible representations.

Unit III

Vibrational Spectroscopy: Symmetry and shapes of AB_2 $AB_3$$AB_4$ AB_5& AB_6 mode of bonding of ambidentate ligands, ethylenediamine and di ketonato complexes, applications of Resonance . Raman Spectroscopy particularly for the study of activesites of metalloproteins.

Electron Spin Resonance Spectroscopy: Hyperfine coupling, spin polarization for atoms and transition metal ion, spen-orbit- coupling and significance of g-tensors, Applications to transition metal complexes (having one unpaired electron) including biological systems and to inorganic free radicals such as PH_4 , F_2 and [BH_3].

Unit IV

Nuclear Magnetic Resonance of Paramagnetic substances in solution. The contact and pseudo contact shifts, factors affecting nuclear relaxation, some applications including biochemical systems, an overview of NMR of metal nuclides with emphasis on195pt and 119sn NMR.

Unit V

Mossbauer Spectroscopy: Basic principles, spectral display applications of the technique of the studies of (1) bonding and structures of Fe^{2+} and Fe^{3+} compounds including those of intermediate spin, (2) Sn^{2+} and Sn^{4+} compounds nature of M-L bond, coordination number, structure and (3) detection of oxidation state and in equivalent MB atoms.

Books Suggested:

1. Chemical Applications of Group Theory. F.A. Cotton
2. Physical Methods in Chemistry, R.S.Drago, Saunders College.
3. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V.Parish, Ellis Harwood.
4. Structural Methods in Inorganic Chemistry, E.A.V. Ebsworth, D.W.H. Rankin and S. Cradock, ELBS.
5. Infrared and Raman Spectra: Inorganic and Coordination Compounds, K. Nakamoto, Wiley.
6. Progress in Inorganic Chemistry vol., 8 ed., F.A. Cotton, vol., 15, ed. S.J. Lippard, Wiley.

Compulsory Paper-II

CH-302: APPLICATIONS OF SPECTROSCOPY

UNIT I

Ultraviolet and Visible Spectroscopy

Various electronic transitions (185-800 nm), Instrumentation, Beer-Lambert law, effect of solvent on electronic transitions, ultraviolet bands for carbonyl compounds, unsaturated carbonyl compounds, dienes, conjugated polyenes. Fieser-Woodward rules for conjugated dienes and carbonyl compounds, ultraviolet spectra of aromatic and heterocyclic compounds. Steric effect in biphenyls.

UNIT II

Infrared Spectroscopy

General introduction, Instrumentation and sample handling, Characteristic vibrational frequencies of alkanes, alkenes, alkynes, aromatic compounds, alcohols, ethers, phenols and amines. Detailed study of vibrational frequencies of carbonyl compounds (ketones, aldehydes, esters, amides, acids, anhydrides, lactones, lactames and conjugated carbonyl compounds). Effect of hydrogen bonding and solvent effect on vibrational frequencies, overtones, combination bands and Fermi resonance. FT IR. IR, of gaseous, solids and polymeric materials..

Optical Rotatory Dispersion (ORD) and Circular Dichroism (CD): Definition, deduction of absolute configuration, octant rule for ketones.

UNIT III

Nuclear Magnetic Resonance Spectroscopy

General introduction and definition, chemical shift, spin-spin interaction, shielding mechanism, mechanism of measurement, chemical shift values and correlation for protons bonded to carbon (aliphatic, olefinic, aldehydic and aromatic) and other nuclei (alcohols, phenols, enols, carboxylic acids, amines & amides), chemical exchange, effect of deuteration, complex spin-spin interaction between two, three, four and five nuclei (first order spectra), virtual coupling. Stereochemistry, hindered rotation, Karplus curve-variation of coupling constant with dihedral angle. Simplification

of complex spectra-nuclear magnetic double resonance, contact shift reagents, solvent effects. Fourier transform technique, nuclear Overhauser effect (NOE). Resonance of other nuclei-F, P.

UNIT IV

Carbon-13 NMR Spectroscopy

General considerations, chemical shift (aliphatic, olefinic, alkyne, aromatic, heteroaromatic and carbonyl carbon), coupling constants.

Two dimension NMR spectroscopy – COSY, NOESY, DEPT, INEPT, APT and INADEQUATE techniques. Instrumentation of H^1 and C^{13} NMR and sample handling.

UNIT V

Mass Spectrometry

Introduction, ion production – El, Cl, FD and FAB, factors affecting fragmentative, ion analysis, Instrumentation and sample handling. Mass spectral framentation of organic compounds, common functional groups, molecular ion peak, metastable peak, McLafferty rearrangement. Nitrogen rule. High resolution mass spectrometery. Examples of mass spectral fragmentation of organic compounds with respect to their structure determination.

Books Suggested:

1. NMR, NQR, EPR and Mossbauer Spectroscopy in Inorganic Chemistry, R.V. Parish, Ellis Horwood.
2. Practical NMR Spectroscopy, M.L. Martin, J.J. Delpeuch and G.J. Martin, Heyden.
7. Spectrometric Identification of Organic Compounds, R.M. Silverstein, G.C. Bassler and T.C. Morrill, John Wiley.
3. Introduction to NMR Spectyroscopy, R.J. Abraham, J. Fisher and P. Loftus, Wiley.
4. Application of Spectroscopy of Organic Compounds, J.R. dyer, Prentice Hall.
5. Spectroscopic Methods in Organic Chemistry, D.H. Williams, I. Fleming, Tata McGraw-Hill.
6. Spectroscopy, P. S. Kalsi New Age Publishers

Group A

Elective Paper-I

CH-303A-I: ORGANOTRANSITION METAL CHEMISTRY

UNIT I

Organotransition metal compounds : Definition, Classification and nomenclature of organotransition metal compounds. Comparison of bonding between metal carbonyls and Organotransition metal compounds. Organometallic compounds of inner transition elements

UNIT II

Alkyls and Aryls of Transition Metals: Types, methods of synthesis, thermal stability and decomposition pathways.

UNIT III

Transition Metal π-Complexes

Transition metal π-complexes with unsaturated organic molecules, alkenes, cyclopentadienyls and arenas, methods of synthesis, properties, nature of bonding and structural features.

UNIT IV

Homogeneous Catalysis

Homogeneous catalytic hydrogenation of Alkenes, Zeigler Natta polymerization of olefins, Isomerisation of Alkenes, Hydroformylation, Dimerisation and polymerization of Alkenes and Alkynes.

UNIT V

Organocopper in Organic Synthesis : Conjugated additions, halogen substitution, alkylation of epoxides, alkylation of allylacetates, ketones from acid chlorides.

Books Suggested:

1. Principles and Application of Organotransition Metal Chemistry, J.P. Collman, L.S. Hegsdus, J.R. Norton and R.G. Finke, University Science Books.
2. The Organomettalic Chemistry of the Transition Metals, R.H. Crabtree, John, Wiley.
3. Metallo-organic Chemistry, A.J. pearson, Wiley.
4. Organometallic Chemistry, R.C. Mehrotra and A. Singh, New Age International.

Group A

Elective Paper-II

CH-304A-II: NANOSCIENCE & NANOTECHNOLOGY

Unit I

Introduction and Preparation: Introduction to Nano Scale and Nanomaterials, Unique properties of Nanomaterials; Optical, Magnetic, electrical, thermal and chemical properties of Nanomaterials. Bonding, self-assembly, catalysis.

Synthesis of nanomaterial: Chemical Approaches: Chemical reduction; sonochemical synthesis; Sol-Gel Synthesis; Self assembly. Physical Approaches: Aerosol spray; Chemical vapour deposition(CVD) and lithography.

Unit II

Nanostructured materials: Classification of nano materials based on dimension and configuration, Nanorods, Nanotubes and Nonofibres, wells & wires. Semiconductors quantum dots.

Inorganic nano materials: Metal/Oxide nanoparticles (NPs).

Organic nano materials- Polymer NPs

Carbon nano materials: Graphenes, Fullerenes, Carbon Nano tubes (CNTs)- Single walled carbon nanotubes (SWNTs), Multiwalled Carbon nanotubes (MWNTs)

Unit III

Characterization techniques for Nanomaterials-I:

Electron Microscopy: Scanning electron microscopy (SEM), Transmission electron microscopy (TEM), Scanning Probe Microscopy- Atomic force Microscopy (AFM)

Unit IV

Characterization techniques for Nanomaterials-II

Particle size Analyser (Dynamic light scattering), X-ray Differaction (XRD), Auger Emission Spectroscopy, Electron Spectroscopy for Chemical analysis (ESCA)

Unit V

Application of Nanomaterials and Nanotechnology:

Impact of Nanotechnology in various fields. Pharmaceutical-Advance durg delivery system, Medical & Health diagnosis through biosensors. Environment-water purification and air pollution control. Consumer goods-cosmetics and sports goods, Defence- Light Military platform and soldier protection.

Books Recommended:

1. Essentials in Nanoscience and Nanotechnology, N. Kumar & S. Kumbhat, John Wiley 2016
2. Charles P.Poole, Jr. and Frank J.Owens ;Introduction to Nanotechnology, , Wiley, 2003
3. G. Cao, Nanostructures and Nanomaterials: Synthesis, Properties and Applications, ICP, London, 2004.
4. C.M. Niemeyer and C.A. Mirkin, Nanobiotechnology, Concepts, Applications and perspectives, WILEY-VCH, Verlag Gmb H&Co, 2004.
5. G.M.Chow and K.E.Gonslaves ;Nanotechnology - Molecularly Designed Materials, (American chemical society)
6. K.P.Jain,Physics of semiconductor Nanostructures: Narosa Publishers, 1997
7. S.P. Gaponenko, Optical Properties of semiconductor nanocrystals, Cambridge University Press, 1980.
8. G. Cao, Nanostructures & Nanomaterials: Synthesis, Properties & Applications, Imperial College Press, 2004.
9. T.Pradeep, “Nano: The essentials, Tata Mc Graw Hill, New Delhi, 2007.
10. Willard, “Instrumental Methods of Analysis”, 2000.

Group B

Elective Paper-I

CH-303B-I: PHOTOCHEMISTRY

UNIT I

Solar radiation spectrum, Insolation;Photochemical Reactions: Interaction of electromagnetic radiations with matter, types of excitations, fate of excited molecules, quantum yield, transfer of excitation; Properties of excited states: Structure, dipole moment, acid-base strengths, Reactivity; Bimolecular deactivation-quenching. Determination of Reaction Mechanism: Classification,, rate constants and life time of reactive energy states- determination of rate constants of reaction, Effect of light intensity on the rate of photochemical reactions, Types of photochemical reaction- photo-dissociation, gas-phase photolysis.

UNIT II

Photochemistry of Alkenes and Carbony1 Compounds: Intramolecular reactions of the olefinic bond – geometrical isomerism,cyclisation reactions, rearrangement 1,4- and 1,5- dienes; Intramolecular reactions of carbony1 compounds – saturated, cyclic and acylic, β,γ – unsaturated and α,β-unsaturated compounds, Cyclohexadienones; Intermolecular cyloaddition reactions – dimerisations and oxetane formation.

UNIT III

Photochemistry of Aromatic Compounds : Isomerisations, additions and Substitutions; Miscellaneous Photochemical Reactions; Photo-Fires reaction of anilides, Photo- Fries rearrangement, Barton reaction, Singlet molecular oxygen Reactions;Photochemical formation of smog, Photo degradation of polymers, Photochemistry of vision.

UNIT IV

Excited states of metal complexes: Excited states of metal complexes: Comparison with organic compounds, electronically excited states of metal complexes, charges transfer spectra, charge transfer excitations; Ligand field photochemistry: Photosubstitutuion, Photoreduction, lability and Selectivity, Zero vibrational levels of ground state and excited state, energy content of excited state, zero-zero spectroscopic energy, development of the equations for redox potentials of the excited states;Redox reactions by excited metal complexes: Redox reactions of metal complexes in excited states, excited electron transfer using examples [$Ru(bpy)]^{2+}$ complexes and $[Fe(bpy)_3]^{3+}$ complex , role of spin-orbit coupling, life times of excited states in these complexes; Metal complex sensitizers: Metal complex sensitizer, electron relay, metal colloid systems, semiconductor supported metal or oxide systems, water photolysis, nitrogen fixation and carbon dioxide reduction.

UNIT V

Photochemistry and electricity generation; solar energy conversion and storage; Concepts of solar power, maximum current, open-circuit potential, short-circuit current, i-v characteristics, Energy conversion efficiency, Thermodynamic efficiency limit, Quantum efficiency, Maximum power, Fill factor. Solar power storage;Basic principles, fabrication, characteristics, application and latest status of various solar power techniques like Solar steam generator (solar concentrating solar power), Solar chimney or solar cells, Organic/Polymer solar cells, Nanocrystal solar cells, Multijunction photovoltaic cells, Photoeletrochemical cells, Photogalvanic cells, Point-contact solar cells, Porous Nanaoparticulate PEC, Perovskite Solar Cell.

Books Suggested:

1. Fundamentals of Photochemistry, K.K. Rohtagi-Mukherji, Wiley-Easter.
2. Molecular Photochemistry, N.J. Turro, W.A. Benjamin.
3. Introductory Photochemistry, A. Cox and T. Camp, McGraw-Hill.
4. Photochemistry, R.P. Kundall and A.Gilbert, Thomson Nelson.
5. Organic Photochemistry, J.Coxon and B. Halton, Cambridge University Press.
6. Solar Energy Hand Book, J.F. Kreider and F. Krejth, MacGraw Hill Book Co. 1981.

7. Solar Energy Conversion, R.C. Neville, Elsevier.

8. Alternative Energy Systems, B.K. Hodge, Wiley.

9. Advanced Energy Systems, Second Edition, Nicolai V. Khartchenko; Vadym M. Kharchenko, Taylor & Francis.

10. Non- Conventional Energy Resources, D.S. Chauhan, New Age International

11. Concepts of Inorganic Photochemistry, A.W. Adamson and P.D. Fleischauer, Wiley

12. Inorganic Photochemistry, J.Chem.Educ.vol. 60 No. 10, 1983.

13. Progress in Inorganic Chemistry, Vol. 30ed. S.J. Lippard. Wiley.

14. Photochemistry of Coordination Compounds, V. Balzari and V. Carassiti, Academic Press.

15. Elements in Inorganic Photochemistry, G.J. Ferraudi, Wiley..

Group B

Elective Paper-II

CH-304B-II: ORGANIC SYNTHESIS I

UNIT I

Organometallic Reagents

Principle, preparations, properties and applications of the following in organic synthesis with mechanistic details.

Group I and II metal organic compounds- Li, Mg, Hg, Cd, and Zn compounds.

Transition metals- Cu, Pd, Ni, Fe, Co, and Ti compounds.

Other elements- Si and B compounds.

UNIT II

Oxidation

Introduction, Different oxidative processes.
Hydrocarbons- alkenes, aromatic rings, saturated C-H groups (activated and unactivated).
Alcohols, diols, aldehydes, ketones, ketals and carboxylic acids.
Amines, hydrazines, and sulphides.
Oxidations with ruthenium tetraoxide, iodobenzene diacetate and thallium (III) nitrate.

UNIT III

Reduction

Introduction. Different reductive processes.
Hydrocarbons – alkanes, alkenes, alkynes and aromatic rings.
Carbonyl compounds – aldehydes, ketones, acids and their derivatives
Epoxides.
Nitro, nitroso, azo and oxime groups.
Hydrogenolysis.

UNIT IV

Rearrangements

General mechanistic considerations – nature of migration, migratory aptitude, memory effects.A detailed study of the following rearrangements:

Pinacol-pinacolone, Wagner-Meerwein, Demjanov, Benzil-Benzilic acid, Favorskii, Arndt-Eistert synthesis, Neber, Beckmann, Hofmann, Curtius, Schmidt, Baeyer-Villiger, Shapiro reaction.

UNIT V

Metallocenes, Nonbenzenoid Aromatics and Polycyclic Aromatic Compounds.

General considerations, synthesis and reactions of some representative compounds.

Books Suggested:

1. Modern Synthetic Reactions, H.O. House, W.A. Benjamin.
2. Somer Modern Methods of Organic Synthesis, W. Carruthers, Cambridge Univ. Press.
3. Advanced Organic Chemistry, Reactions Mechanisms and Structure, J. March, John Wiley.
4. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional.
5. Advanced Organic Chemistry Part B. F.A. Carey and R.J. Sundberg, Plenum Press.
6. Rodd's Chemistry of Carbon Compounds, Ed. S. Coffey, Elsevier.

Group C

Elective Paper-I

CH-303C-I: BIOINORGANIC AND SUPRAMOLECULAR CHEMISTRY

UNIT I

Metal storage Transport: Iron storage and Transport;

Oxygen carriers: Hb, Mb , ferritin and transferitin;

Bio-mineralization;

Iron Transport in Microbs: siderophores.

Calcium in Biology: Storage and Transport of Calcium & calcium in Muscle contraction, transport and regulation, intramoleculer process, extracellular binding protein, Ca^{2+} ATP ase structure, Ca^{2+} ATP ase reaction cycle, intracellular Ca^{+2} transport.

UNIT II

Metalloenzyms: Zinc enzymes- carboxy peptidase and carbonic anhydrase. Iron enzymes- Reactivity and structure of catalase, peroxidase and cytochrome P450. Copper enzymes- Reactivity and structure of superoxide dimutase (SOD).

Co enzyme vitamin B_{12} – Names of different forms, biochemical function of cobalamin, Vitamin $B_{12,}$ special characteristics of B_{12} co-enzyme.

UNIT III

Metals and chelates in medicine, metal deficiency and disease, toxic effect of metals, metal used for diagnosis and chemotherapy with particular reference to anticancer drugs.

UNIT IV

Supramoleculer chemistry: Concepts and language moleculer recognization, Principal of molecular receptors designs for different types of molecules, design and synthesis of co- receptor molecules and multiple recognition.

UNIT V

Supramolecular reactions and catalysis, supramolecular assemblies, Molecular and supramolecular devices, molecular and supra molecular photonic , electronic and ionic devices. supramolecular photochemistry

Books suggested:

2. Principles of Bioinorganic chemistry, SJ Lippard and J.M. Berg, University science books.

3. Bioinorganic chemistry, I Bertini, H.B. Garg, S.J. Lippard and J.S. Valentine, University science books.

4. Inorganic Biochemistry, Vol I and II Ed. G.S. Eichhorn, Elsevier progress in inorganic chemistry Vol. 18 and 38 ed. J.J. Lippard, Wiley.

5. Supra molecular chemistry, J.M. Lehn, VCH.

6. Bioinorganic chemistry, A K. Das Books and allied (P) Ltd.

7. Bioinorganic and supra molecular chemistry, Ajay kumar bhagi, G.R. Chatwal Himalaya publishing house.

Group C

Elective Paper-II

CH-304C-II: HETEROCYCLIC CHEMISTRY

UNIT I

Nomenclature of heterocycles: Systemic nomenclature of monocyclic, fused & bridge heterocycles.

Three Membered Heterocyclic Compounds With One Hetero Atom:

Aziridines, Oxiranes and Thiiranes

UNIT II

Four Membered Heterocyclic Compounds with One Hetero Atom:

Azitines & Azitidines; Oxitanes, Thietanes

Bicyclic Ring Systems Derived from Pyrrole, Furan and Thiophene:

Benzopyrroles, benzofurans and benzothiophenes

UNIT III

Five Membered Heterocyclic Compounds with One Hetero Atom:

Tautomerism

Pyrroles, Furans and Thiophenes

Five Membered Heterocyclic Compounds with Two Hetero Atoms:

Pyrazoles, Imidazoles, Oxazoles and Thiazoles

UNIT IV

Six Membered Heterocyclic Compounds With One Hetero Atom:

Pyridines, Pyrylium salts and α- and γ-Pyrones

Six Membered Heterocyclic Compounds with Two Hetero Atoms:

Pyrazines, Pyridazines and Pyrimidines,

Cinnolines and Phthalazines

UNIT V

Seven Membered Heterocyclic Compounds with Two Hetero Atoms:

Azepines, Oxepins and Thiepins

Bicyclic Ring Systems Derived from Pyridine:

Quinoline and Isoquinolune

Books Suggested:

1. Heterocyclic Chemistry Vol. 1-3, R.R. Gupta, M. Kumar and V. Gupta, Springer Verlag.
2. The Chemistry of Hetrocycles, T. Eicher and S. Hauptmann, Thieme.
3. Heterocyclic Chemistry, J.A. Joule, K. Mills and G.F. Smith, Chapman and Hall.
4. Heterocyclic Chemistry, T.L., Gilchrist, Longman Scientific Techinal.
5. Contemporary Heterocyclic Chemistry, G.R. Newkome and W.W. Paudler, Wiley-Inter Science.
6. An Introduction to the Heterocyclic Compounds, R.M. Acheson, John Wiley.
7. Comprehensive Heterocyclic Chemistry, A.R. Katritzky and C.W. Rees, eds. Pergamon Press.

Group D

Elective Paper-I

CH-303D-I: NUCLEAR AND RADIOCHEMISTRY

UNIT I

Stability of the nucleus, Mass Energy relationship for nuclear reactions, Properties of nucleus, Nuclear Models (The shell model, the liquid drop model, the fermi gas model, the collective model and the optical model).

Nuclear reactions, Energetics of nuclear reactions, fission and fusion reactions, spallation, fragmentation, stripping and pick up reactions, photonuclear and thermonuclear reactions.

UNIT II

Interaction of radiation with matter, passage of neutrons through matter, interaction of radiation with matter; measurement of radiations. Radiolysis of water, counting techniques (GM Ionisation, proportional and scintillation counter), counting statistics.

UNIT III

Applications of radioactivity, Activation Analysis, isotopic dilution analysis, radiometric titrations, application in chemical investigations and synthesis in physiochemical analysis, in age determination and in prospecting of natural reasources. Medical agricultural and industrial applications, source of electivity. Radiation hazards and protection.

UNIT IV

Nuclear reactors: Basic features, materials and design of nuclear power reactors, Conversion and Breeding, safety features of reactors, Health Physics: Radiation unit (exposure unit), External and doses from various sources of radiations, allowed limit of intake (ALI)

UNIT V

Applications of radioisotopes in biology & molecular biology: biodistribution, metallic & biochemical pathways for protein synthesis, purine nucleotide synthesis, role of methionine in research, radioligand assay, autoradiography, primer extension, Nick translation , hybridization, nucleic acid sequencing.

Books Recommended:

1. Essentials of Nuclear Chemistry, H.J. Arnikar.
2. Introduction to Nuclear Science, M.W. Sarton, East West Edition.
3. Theory of Nuclear Structure, M.K. Pal, East West Edition.
4. Principles of Radiochemistry, G.W.A. Newton and V.J. Robinson, Macmilan Education Ltd.
5. Nuclear Chemistry, A. Vertes and I. Kiss.
6. Fundamental of radiation Chemistry, A. Mojumdar, J. David, Morrisey, G. T. Seaborg
7. Fundamentals of Analytical Chemistry, D.A. Skoog, D.M. West and F.J.Holler. Publ. W B Saunders.

Group D

Elective Paper-II

CH-304D-II: MEDICINAL AND PHARMACEUTICAL CHEMISTRY

UNIT I

Drug design & Pharmacodynamics

Procedure followed in drug design, Concepts of lead compound and lead modification, concepts of pro drugs & soft drugs, structure-activity relationship(SAR), Theories of drug activity : occupancy theory, rate theory, induced fit theory .

An Introduction of pharmacodynamics, Mechanism of drug action, elementary treatment of enzyme stimulation, enzyme inhibition, sulphonamides , drug metabolism

UNIT II

Antineoplastic agents :

Inroduction, cancer chemotherapy, role of alkylating agents and antimetabolites in treatment of cancer.Mention of carcinolytic antibiotics and mitotic inhibitors.

Synthesis of cyclophosphamide , Uracil and mustards .

UNIT III

Cardiovascular Drugs :

Intoduction , Cardiovascular diseases, drug inhibitors of peripheral sympathetic function , Synthesis of amylnitrite, sorbitrate, Methyldopa and atenolol.

UNIT IV

Drugs: Psychotic and Antipsychotic –

Inroduction, CNS depressants, general anaesthetics, mode of action of; hypnotics, sedatives, anti-anxiety drugs. Anti depressants, stereochemical aspects of psychotropic drugs. Synthesis of diazepam, alprazolam and barbiturates..

UNIT V

Antibiotics :

Cell wall biosynthesis , inhibitors , β-lactam rings , antibiotics inhibiting protein synthesis , synthesis of penicillin –G , penicillin – V, Chloramphenicol and Tetracyclin.

Books Suggested:

1. Introduction to Medicinal Chemistry, A. Gringuage, Wiley-VCH.
2. Wilson and Gisvold's Text Book of Organic Medicinal and Pharmaceutical Chemistry, Ed. Robert F. Dorge.
3. An Introduction to Drug Design, S.S. Pandeya and J.R. Dimmock, New Age International.
4. Burger's Medicinal Chemistry and Drug Discovery, Vol-1 (Chapter-9 and Ch-14), Ed. M.E. Wolff, John Wiley.
5. Goodman and Gilman's Pharmacological Basis of Therapeutics, McGraw-Hill.
6. The Organic Chemistry of Drug Design and Drug Action, R.B. Silverman, Academic Press.
7. Strategies for Organic Drug Synthesis and Design, D. Lednicer, John Wiley.

M Sc II YEAR-2017

SEMESTER-IV

There will be two compulsory papers and two elective papers.

(A student who had opted group in III Semester will continue with the same group in the IV Semester.)

List of two compulsory papers:

Compulsory Paper-I

CH-401: SOLID STATE CHEMISTRY

Compulsory Paper-II

CH-402: BIO-CHEMISTRY

List of Elective Groups in M.Sc. IV Semester:

GROUP- A

CH 403A-III: INDUSTRIAL CHEMISTRY

CH 404A-IV: POLYMERS

GROUP- B

CH 403B-III: ORGANIC SYNTHESIS II

CH 404B-IV: ADVANCED ELECTROCHEMISTRY AND APPLICATIONS

GROUP- C

CH 403C-III: CHEMISTRY OF NATURAL PRODUCTS

CH 404C-IV: ENVIRONMENTAL CHEMISTRY

GROUP- D

CH 403D-III: PHYSICAL ORGANIC CHEMISTRY

CH 404D-IV: CHEMISTRY OF MATERIALS

Compulsory Paper I

CH-401: SOLID STATE CHEMISTRY

UNIT I

Solid State Reactions and Non-Stoichiometry

Crystalline solid, Solid State Reactions - General principles and Experimental procedures, Wagner's theory in reference to MgO and Al_2O_3, Enhancement of reactivity of solids, Co-precipitation as a precursor to solid state reaction, Kinetics of solid state reaction

Non-Stoichiometry – Introduction, Classification – Small and Large deviations from stoichiometry, Superlattice ordering of defects

UNIT II

Crystal Defects

Perfect crystal and Crystal Defect, Thermodynamic requirement of defect, Intrinsic and Extrinsic defects, Point defects - Schottky, Frenkel, Interstitial atom, Substitutional impurity atom and Color Centre, Line defect – Dislocation (edge and screw), Plane defects - Lineage boundary, Grain Boundary, Stacking fault, Thermodynamics of Schottky and Frenkel defect

UNIT III

Electronic Structure of Solids

Introduction to Free electron theory of Metals, Formation of Energy bands, Valence and Conduction bands, Kronig-Penny Model, Band theory of solids, Brillouin zone, Motion of electrons in a band – velocity and effective mass of an electron, f_k factor, Distinction between metal, semiconductor and insulator on the basis of Band theory

Electrically conducting solids – Conjugated systems, Charge-transfer complexes

UNIT IV

Semiconductors and Properties of Solids

Intrinsic and Extrinsic semiconductors, p-type and n-type semiconductors, Dependence of conductivity of n-type and p-type semiconductors on temperature, p-n Junction

Optical Properties – Photoconduction and Photoelectric effect

Magnetic Properties: Classification of materials – para-, dia-, ferro-, and antiferromagnet, Effect of temperature on magnetic susceptibility of para-, dia-, ferro-, antiferromagnetic substances, Magnetic Hysteresis

UNIT V

Superconductor

Superconductivity, Factors affecting superconductivity, Isotope effect, Meissner Effect, Magnetic effects – Type I and Type II superconductors, Persistent current, BCS theory of superconductivity, Cooper pair, Occurrence of superconductivity– conventional, organic and high temperature superconductors, Fullerene as superconductor

Books Suggested:

1. Solid State Chemistry and its Applications, A.R. West, Plenum
2. Principles of Solid State, H.V. Keer, Wiley Eastern
3. Solid State Chemistry, D.K. Chakrabarty, New Age International
4. Fundamentals of Solid State Physics, B.S. Saxena, R.C. Gupta and P.N. Saxena
5. Solid State Physics, A. J. Dekkar, Macmillan

Compulsory Paper II

CH-402: BIO-CHEMISTRY

UNIT I

Metal ions in Biological Systems: Role of metal ions in biological processes.

Dioxygen Uptake: Structure and function of haemoglobin, myoglobin, hemocyanins and hemerythrin, model system and synthetic complexes of iron and Copper. Electron Transfer in Biology: Structure and function of metalloproteins, Cytochromes and iron-sulphur proteins, synthetic models, peroxidases and catalases.

Nitrogenases: Biological nitrogen fixation, molyhydenum nitrogenases, model systems

UNIT II

Enzymes: Introduction and historical perspective, chemical and biological catalysis, remarkable properties of enzymes like catalytic power, binding energy specificity and regulation. Kinetics of enzyme action that is activation energy, Michaelis- Menten equation, Lineweaver Burk plot & factors effecting enzyme activity. Nomenclature and classification. Fischer's lock and key and Koshland's induced fit hypothesis. Types of inhibition, concept and identification of active site by the use of inhibitors and affinity labeling. Transition state theory, acid-base catalysis and covalent catalysis.

UNIT III

Co-Enzyme Chemistry: Cofactors as derived from vitamins, coenzyme, prosthetic groups, apoenzymes. Structure and biological functions of coenzyme A, thiamine pyrophosphate, pyridoxal phosphate, NAD+, NADP+, FMN, FAD, lipoic acid, vitamin B12, Mechanism of reaction catalysed by the above cofactors. Large-scale production and purification of enzymes, techniques.

UNIT IV

Bio-energetic and Bio-polymer Interactions: Standard free energy change in biochemical reactions, exergonic, endergonic. Hydrolysis of ATP, synthesis of ATP from ADP.

Forces involved in biopolymer interactions. Electrostatic charges and molecular expansion, hydrophobic forces, dispersion force interactions. Multiple equilibria and various types of binding processes in biological systems. Hydrogen ion titration curves.

UNIT V

Diffraction Methods and Statistical Mechanics in Biopolymers: Evaluation of size, shape, molecular weight by various experimental techniques. Light scattering,X-ray scattering, X-ray diffraction and photo correlation spectroscopy ORD. Chain configuration of macromolecules and calculation of average dimensions. Polypeptide and protein structures, introduction to protein folding.

Books Suggested:

1. The Inorganic Chemistry of Biological Processes, M.N.Hughes Wiles (1972).
2. Bioinorganic Chemistry-An Introduction, Enchiroochiai.
3. Principles of Bioinorganic Chemistry, S.J. Lippard and J.M.Berg, University Science Books.
4. Bioinorganic Chemistry, I Bertini, H.B. Gray, S.J.Lipard and J.S. Valentine, University Science Books.
5. Bioorganic Chemistry: A Chemical Approach to Enzyme Action, Hermann Dugas and C.Penny, Springer-Verlag.
6. Understanding Enzymes, Trevor Palmer, Prentice Hall.
7. Enzyme Chemistry:Impact and Applications, Ed. Collin J. Suckling, Chapman and Hall.
8. Enzyme Mechanisms Ed. M.I.Page and A.Williams, Royal Society of Chemistry.
9. Fundamentals of Enzymology, N.C. Price and L. Stevens, Oxford University Press.
10. Immobilized Enzymes: An Introduction and Applications in Biotechnology, Michael D. Tevan, John Wiley.
11. Enzymatic Reaction Mechanisms, C.Walsh, W.H. freeman.
12. Enzynie Structure and Mechanism, A Fersht, W.H. Freeman.
13. Biochemistry: The Chemical Reactions of Living Cells, D.E.Metzler, Academic Press.
14. Principles of Biochemistry, A.L.Lehninger, Worth Publishers.
15. Biochemistry, L. Strver, W.H.Freeman
16. Biochemistry, J.David Rawn, Neil Patterson.
17. Biochemistry, Voet and Voet, John Wiley.
18. Outlines of Biochemistry, E.E.Conn and P.K.Stumpf, Johh Wiley.
19. Bioorganic Chemistry: A Chemical Approach to Enzyme Achon. H. Dugas and C.Penny, Springer-Verlag.
20. Macromolecules: Structure and Function, F.World, Prentice Hall.

Group A

Elective Paper-I

CH-403A-III: INDUSTRIAL CHEMISTRY

UNIT I

Chemistry of colors

Introduction, Classification of dyes, according to chemical constitution and according to application. General ideas about the synthesis of different dye intermediate and synthetic dyes i.e. direct and reactive dyes , azoic colours, acid and basic dyes, newer cationic dyes for acrylics, Disperse dye, mordent and sulphur dyes. Pigment and fluorescence brightners. Colour fastness against light, washing, perspiration, rubbing etc. and its evaluation. Methods of colour measurements.

UNIT II

Industrial/ Commercial polymers and their compounding ingredients:

General characteristics of Fibers, Plastic, Rubbers and Adhesives-

Structure, properties and preparation of Polyamides, Polystyrene, Polychloride, Polymethylmethacrylate, Polymethacrylate, ABS, Epoxide, IR, SBR, NBR & IIR

Compounding Ingredients: Extenders, Fillers, plasticisers, stabilizers, anti oxidant and anti ozonants, Flame retardants, mould release agents, Sulphur valcanisation.

UNIT III

Ores and Minerals

Inorganic materials of industrial importance, their availability, forms and structure-

Bauxite, clay, mica, zeolites, copper pyrites, zinc blend, dolomite and coal.

UNIT IV

Characteristic Features of surfactants: Conditions under which interfacial phenomena and surfactants become significant. General structural features and behaviour of surfactants : General use of charge types, general effect of nature of hydrophobic group.

UNIT V

Micelle Critical micelle concentration (cmc), factors affecting the value of cmc in aqueous medium.factors determining the extent of Solubilization, effect of Solubilization. Formation of emulsions, factors determining emulsion stability, Mechanism of the cleaning process.

Books Recommended:

1. Hall, A.J.(8^{TH} ed.): The Standard Hand Book of Textiles, Butter-Worth, London.
2. Clark, W.: An Introduction to Textiles Printing, A Practical Manual for use in Laboratories College and School of Arts, Bottorworth, London.
3. Shinai, V.A.: technology OF textile processing, Sevak publication, Bombay, Vols. I to IX
4. Chakravarty, R.R. : Glimpses of Textile Technology, Caxton Press, Delhi.
5. Peters, R.H.: Textile Chemistry, Elsevier, Amsterdam, Vol. I to Vol. II
6. Surfactants and Interfacial Phenomenon. Milton J. Rosen, Johan-Wiley, 1978.
7. Textbook of Polymer Science, F.W. Billmeyer Jr. Wiley.
8. Polymer Science, V.R. Gowariker, N.V. Viswanathan and J. Screedhar, Wiley-Eastern.

Group A

Elective Paper-II

CH-404A-IV: POLYMERS

UNIT I

Basics:

Importance of polymers. Basic concepts: Monomers, repeat units, degree of polymerization. Linear, branched and network polymers.

Classification of polymers.

Polymerization: condensation, addition, radical chain-ionic and co-ordination and co-polymerization. Polymerization conditions and polymer reactions. Polymerization in homogeneous and heterogeneous systems.

UNIT II

Polymer Characterization

Polydispersion-average molecular weight concept. Number, weight and viscocity average molecular weights. Polydispersity and molecular weight distribution. The practical significance of molecular weight. Measurement of molecular weights End-group analysis and ultracentrifugation methods.

Analysis and testing of polymers-chemical analysis of polymers, Microscopy.

Thermal techniques: thermo gravimetric analysis, differential thermal analysis, and physical testing-tensile strength, impact. Tear resistance. Hardness and abrasion resistance.

UNIT III

Structure and Properties

Morphology and order in crystalline polymers-configurations of polymer chains. Crystal structures of polymers. Morphology of crystalline polymers, strain-induced morphology, crystallization and melting. Polymer structure and physical properties-crystalline melting point Tm-melting points of

homogeneous series, effect of chain flexibility and other steric factors, entropy and heat of fusion. The glass transition temperature, Tg-Relationship between Tm and Tg, effects of molecular weight, diluents, chemical structure, chain topology, branching and cross linking. Property requirements and polymer utilization.

UNIT IV

Polymer Processing

Plastics, elastomers and fibres. Compounding. Processing techniques: Calendering, die casting, rotational casting, film casting, injection moulding, blow moulding, extrusion moulding, thermoforming, foaming, reinforcing and fibre spining.

UNIT V

Properties of Commercial Polymers

Polyethylene, polyvinyl chloride, polyamides, polyesters, phenolic resins, epoxy resins and silicone polymers. Functional polymers – Fire retarding polymers and electrically conducting polymers. Biomedical polymers – contact lens, dental polymers, artificial heart, kidney, skin and blood cells.

Books Suggested:

1. Textbook of Polymer Science, F.W. Billmeyer Jr. Wiley.
2. Polymer Science, V.R. Gowariker, N.V. Viswanathan and J. Screedhar, Wiley-Eastern.
3. Functional Monomers and Polymers, K. Takemoto, Y. Inaki and RM. Ottanbrite.
4. Contemporary Polymer Chemistry, H.R. Alcock and F.W. Lambe, Prentice Hall.
5. Physics and Chemistry of Polymers, J.M.G. Gowie, Blackie Academic and Professional.
6. J.M.G. Gowie, Blackie Academic and Professional.

Group B

Elective Paper-I

CH-403B-III: ORGANIC SYNTHESIS II

UNIT I

Disconnection Approach

An introduction to synthons and synthetic equivalents, disconnection approach, functional group inter-conversions, the importance of the order of events in organic synthesis, one group C-X and two group C-X disconnections, chemoselectivity, reversal of polarity, cyclisation reactions, amine synthesis.

UNIT II

Protecting Groups, & Heterocyclic Compounds

Principle of protection of alcohol, amine, carbonyl and carboxyl groups.

Heterocyclic Compounds

IUPAC of Heterocyclic compounds, saturated heterocyclic compounds containing mono-hetero atom (O, S, N), synthesis of 3-, 4-, 5- and 6-membered rings, aromatic heterocyclic compounds in organic synthesis.

UNIT III

One Group C-C Disconnections

Alcohols and carbonyl compounds, regioselectivity. Alkene synthesis, use of acetylenes and aliphatic nitro compounds in organic synthesis.

UNIT IV

Two Group C-C Disconnections

Diels-Alder reaction, 1,3-difunctionalised compounds, α,β-unsaturated carbonyl compounds, control in carbonyl condensations, 1,5-difunctionalised compounds. Micheal addition and Robinson annelation.

UNIT V

Synthesis of Some Complex Molecules

Application of the above in the synthesis of following compounds:

Camphor, Longifoline, Cortisone, Reserpine, vitamin D, Juvabione, Aphidicolin and Fredericamycin A.

Books Suggested:

1. Designing Organic Synthesis, S. Warren, Wiley.
2. Organic Synthesis- Concept, Methods and Starting Materials, J. Fuhrhop and G. Penzillin, Verlage VCH.
3. Some Modern Methods of Organic Synthesis. W. Carruthers, Cambridge Univ. Press.
4. Modern Synthetic Reactions, H.O. House, W.A. Benjamin.
5. Advanced Organic Chemistry: Reactions, Mechanisms and Structure, J. March, Wiley.
6. Principles of Organic Synthesis, R. Norman and J.M. Coxon, Blackie Academic & Professional.
7. Advanced Organic Chemistry Part B, F. A. Carey and R.J. Sundberg, Plenum Press.

Group B

Elective Paper-II

CH-404B-IV: ADVANCED ELECTROCHEMISTRY AND APPLICATIONS

UNIT I

Electrochemical Energy Storage

Properties of Electrochemical energy stores: measure of battery performance, charging and discharging of batteries, storage density, energy density, Classical Batteries: (i) Lead Acid (ii) Nickel- Cadmium (iii) Zinc- Manganese dioxide

Modern Batteries: (i) Zinc Air (ii) Nickel- Metal Hydride (iii) Lithium battery

Future electricity stores: storage in (i) hydrogen (ii) alkali metals (iii) non aqueous solution

UNIT II

Electrochemical Energy Generators

Fuel cells: Hydrogen –Oxygen Cell, Hydrogen –Air Cell, Hydrocarbon –Air Cell, Alkaline Fuel Cell, Phosphoric Acid Fuel Cell, Direct NaOH Fuel Cell, and Application of Fuel Cell. Comparisons of batteries, fuel cells and super capacitors, electrochemical processes of particular relevance to energy conversion.

UNIT III

Corrosion and Passivity

Electrochemical mechanism of corrosion of metals, thermodynamics and stability of metals, theories of corrosion, forms of corrosion, corrosion current and corrosion potential- Evans diagrams. Measurement of corrosion rate: Non electro chemical method and electrochemical method. corrosion monitoring and prevention methods,(i) by addition of substrates to the electrolyte environment (ii) by charging corroding method from external source, anodic protection ,(iii)by alternation in the medium,(IV) by alternation in the metal and design consideration, organic inhibitors, Green inhibitors. Passivation: structure of passivation films, mechanism of passivation, spontaneous passivation,.

UNIT IV

Kinetics of Electrode process and their nature

Kinetically and mass transport controlled electrochemical processes, Mass transport by migration, convection and diffusion. , essential of electrode reaction,. Current density, over potential, Tafel equation, Buttler- Volmer equation, Potentiostatic and galvanostatic methods including chronoamperometry, chronopotentiometry.

UNIT-V

Electro- organic synthesis

Types of electro-organic reactions, constant current and constant potential, electrolysis, cell design, effect of variable, nature of medium, nature of electrode materials, overvoltage, application of sewage waste water treatment, electrochemical incineration of human waste in combined space, electro-organic synthesis of novel drugs.

Books Recommended:

1. Modern electrochemistry, Vol. l, IIA, Vol. II B, JOM Brockris and A.K.N. Raddy, Plenum publication, New York.
2. Electrochemical methods by Allen J. Bard and Larry R.Faulkner, John Wiley.
3. Techniques of Electro-organic synthesis part I, II and III by N.L. Weinberg, john wiley.
4. Corrosion and Corrosion Engineering chemistry by M.G. Fontana, N.D. Green, McGraw-Hill, New York.
5. Electro chemistry by Carl H. Hamann, Andrew Hamett and Wolf Vielstich. Joh
6. M. G. Fontana “Corrosion Engineering”, Mc Graw Hill, New York, 1997
7. .”Corrosion Metal Environment Reactions” eds. L L. Shreir, R. A. Jerman, G. T. Burstein, Butterwirths, London, 1994
8. . D. Gabe “Principles of Metal Surface Treatment and Protection”, Merlin Books, London, 1993
9. Corrosion Inhibitors, Principles & Applications, V.S. Sastry, John Wiley & Sons.
10. Electrochemistry for clean environment by Bockrish
11. Electrochemistry by D R crow
12. Organic electrochemistry by M.M.Baizer

Group C

Elective Paper-I

CH-403C-III: CHEMISTRY OF NATURAL PRODUCTS

UNIT I

Terpenoids and Carotenoids

Classification, nomenclature, occurrence, isolation, general methods of structure determination, isoprene rule, biosynthesis.

Structure determination, synthesis of the following representative molecules: Citral, Geraniol, β - Terpeneol, Zingiberene, Phytol, Abietic acid and β-Carotene.

UNIT II

Alkaloids

Definition, nomenclature and physiological action, occurrence, isolation, general methods of structure elucidation, degradation, classification based on nitrogen heterocyclic ring, role of alkaloids in plants, biosynthesis.

Structure, synthesis of the following:Ephedrine, (+)-Cocaine(concine), Nicotine, Quinine and Morphine.

UNIT III

Steroids

Occurrence, nomenclature, basic skeleton, Diel's hydrocarbon, Stereochemistry biosynthesis. Isolation, structure determination of Cholesterol and Bile acids.

UNIT IV

Plant Pigments

Occurrence, nomenclature and general methods of structure determination. Isolation structure and synthesis of Apigenin, Luteolin,Quercetin, Myrcetin, Vitexin, Diadzein, Butein, Aureusin, Cyanidin, Hirsutidin.

Biosynthesis of flavonoids : Acetate pathway and Shikimic acid pathway.

UNIT V

Porphyrins

Structure of Haemoglobin and Chlorophyll.

Prostaglandins

Occurrence, nomenclature, classification, physiological effects. Synthesis of PGE_2 and PGF_{20}

Pyrethroids and Rotenones

Structure and reactions.

Books Suggested:

1. Natural Products: Chemistry and Biological Significance, J. Mann, R.S. Davidson, J.B. Hobbs, D.V. Banthrope and J.B. Harborne, Longman, Essex.
2. Organic Chemistry, Vol. 2 I.L. Finar, ELBS.
3. Stereoselective Synthesis: A Practical Approach, M. Nogradi, VCH.
4. Rodd's Chemistry of Carbon Compounds, Ed. S. Coffey, Elsevier.
5. Chemistry, Biological and Pharmacological Properties of Medicinal Plants from the Americas, Ed. Kurt Hostettmann, M.P. Gupta and A. Marston, Harwood Academic Publishers.
6. Introduction to Flavonoids, B.A. Bohm, Hardwood Academic Publishers.
7. New Trends in Natural Product Chemistry, Atta-ur-Rahman and M.I. Choudhary, Harwood Academic Publishers.
8. Insecticides of Natural Origin, Sukh Dev, Harwood Academic Publishers.

Group C

Elective Paper-II

CH-404C-IV: ENVIRONMENTAL CHEMISTRY

UNIT I

Environment; An Introduction, Atmosphere & Air Pollution

Concept & scope of Environmental chemistry; Environmental segments; Environmental Pollution; Classification of pollutants; Bio-geological cycles in the environment: Hydrological cycle, C, N, O, S and P cycles in the environment; Bio-distribution of elements;

Structure and Composition of Atmosphere; Particles, Ions & Radicals in the atmosphere; Major sources of Air Pollutants.

Pollution by C, CO, NO_X, SO_X, HC, Acid Rain, Smog, Particulates; Green House effect/Global Warming, Ozone Layer; Effects & Control of Air Pollutants; Air quality standards; Sampling, Monitoring.

UNIT II

Hydrosphere & Water Pollution

Aquatic environment, Chemical composition of water bodies; Lakes, Streams, Rivers.
Classification of water pollution; Pollution by Pesticides, Polymers, Detergents, Agriculture and Sewage wastes; Purification and Treatment of water;

UNIT III

Lithosphere: Soil Pollution

Introduction: Soil formation, composition & classification; Acid-Base and Ion-exchange reactions in Soil; Macro- and Micronutrients, Soil Profile; Soil fertility and Productivity, Soil erosion, Soil Analysis (Moisture, Nitrogen & pH).
Soil Pollution: Sources & Classification, Effects of Pesticides, Fertilizers & Sediments, Control of soil pollution.

UNIT IV

Industrial Pollution & Toxicology

Classification, Nature and treatment of Industrial Effluents, Industrial Effluents from Distillery, Textile, Cement, Electroplating, Paper & pulp, Dairy & Detergent, Fertilizers, Tanning, .

Toxic Chemicals in the Environment, Biochemical Effects of Ozone, PAN, Carcinogens, Cyanides, Pesticides, Natural & Man-made Disasters.

Solutions to Environmental Problems; Preventive Environmental Management, Better Industrial Processes.

UNIT V

Green Chemistry

Principles and Goals of Green Chemistry, Green chemicals, reagents, catalysts, and solvents. Examples of green synthesis / reactions, Microwave assisted synthesis.

Books Recommended/Suggested

1. Environmental Chemistry: Edited by J. O'M. Bockris, Plenum Press.
2. Environmental Chemistry: S.E. Manahen, Lewis Publications.
3. Environmental Chemistry: H. Kaur, Pragati Prakashan.
4. Environmental Chemistry: AK Day, New Age Int. Publishers.
5. Environmental Chemistry: SM Khopkar, Wiley Estern.
6. Physico-chemical Examination of Water, Sewage & Industrial Effluents: K. Manivasakam.
7. An introduction to Green Chemistry, V Kumar, Vishal Publ..

Group D

Elective Paper-I

CH-403D-III: PHYSICAL ORGANIC CHEMISTRY

UNIT I

Principles of Reactivity

Mechanistic significance of entropy, enthalpy and Gibb's free energy. Arrhenius equation. Transition state theory. Uses of activation parameters, Hammond's postulate.Potential energy surface model. Reactivity and selectivity principles.

UNIT II

Kinetic Isotope Effect and Structural Effects:

Theory of isotope effects. Primary and secondary kinetic isotope effects. Heavy atom isotope effects. Tunneling effect. Solvent effects.

Linear free energy relationships (LFER) The Hammett equation, substituent constants, theories of substituent effects. Interpreation of σ-values. Reaction constant ρ. Deviations from Hammett equation. Dual-parameter correlations, inductive substituent constant. The Taft model, σ 1- and σ R-scales.

UNIT III

Solvation and Solvent Effects

Qualitative understanding of solvent-solute effects on reactivity. Thermodynamic measure of solvation. Effects of solvation on reaction rates and equilibria. Various empirical indexes of solvation based on physical properties, solvent-sensitive reaction rates, spectroscopic properties and scales for specific solvation.

UNIT IV

Steric and Conformational Properties

Various type of steric strain and their influence on reactivity. Steric acceleration. Molecular measurements of steric effects upon rates. Steric LFER. Conformational barrier to bond rotation, Rotation around partial double bonds. Winstein-Holness and Curtin-Hammett principle.

UNIT V

Nucleophilic and Electrophilic Reactivity

Structural and electronic effects on SN1 and SN2 reactivity. Solvent effects. Kinetic isotope effects. Intramolecular assisgtance. Electron trlansfer nature of SN2 reaction. SRN1 mechanism.

Electrophilic reactivity, general mechanism. Kinetic of SE2-Ar reaction. Structural effects on rates and selectivity.

Books Suggested:

1. Molecular Mechanics, U. Burkert and N.L. Allinger, ACS Monograph 177,1982.
2. Organic Chemists' Book of Orbitals. L. Salem and W.L. Jorgenses, Academic Press.
3. Mechanism and Theory in Organic Chemistry, T.H. Lowry and K.C. Richardson, Harper and Row.
4. Introduction to Theoretical Organic Chemistry and Molecular, Modeling, W.B. Smith, VCH, Weinheim.
5. Physical Organic Chemistry, N.S. Isaacs, ELBS/Longman.
6. Supramolecular Chemistry, Concepts and Perspectives, J.M. Lehn, VCH.
7. The Physical Basis of Organic Chemistry, H. Maskill, Oxford University Press.

Group D

Elective Paper-II

CH-404D-IV: CHEMISTRY OF MATERIALS

UNIT I

Multiphase Materials

Classification and properties of materials, Types of phase diagrams, Isomorphous, Eutectic, Peritectic, Monotectic and Eutectiod systems, Calculation of phase amounts from a phase diagram, Phase rule, Ferrous alloys Fe-C phase diagram, Non Ferro alloys, Phase diagrams of brass and tin bronze.

UNIT II

Ceramic Materials

Raw materials of glass, Cement and Ceramics, Refractories, Characterization, Properties and Applications, Abrasives, kinds and uses, Powder metallurgy, Manufacturing process, Properties and Applications, Advantages and Limitations**.**

UNIT III

Composite Materials

Traditional composites, concrete, Asphalt and Wood, Synthetic composites, dispersion reinforced, Particle reinforced, Laminated and fiber reinforced composites, applications of composites.

UNIT IV

Polymeric and advanced materials : Brief idea of following :Insulating material, Semiconductors, Superconductors, Fullerenes, Optical fibers, Organic electronic material.

UNIT V

Environmental effects of Materials : Corrosion mechanisms of dry and wet corrosion, Galvanic and concentration cell corrosion, Pitting and stress corrosion, Corrosion control methods, Types, preparation and uses of adhesives, Types and Application of paints and Pigments.

Books Suggested:

1. Solid State Physics, N.W. Ashcroft and N.D. Mermin, Saunders College.
2. Material Science and Engineering, An Introduction, W.D. Callister, Wiley.
3. Principles of the Solid State, H.V. Keer, Wiley Eastern.
4. Materials Science, J.C. Anderson, K.D. Leaver, J.M. Alexander and R.D. Rawlings, ELBS.
5. Thermotropic Liquid Crystals, Ed., G.W. Gray, John Wiley.
6. Handbook of Liquid Crystals, Kelker and Hatz, Chemie Verlag.

LABORATORY COURSES

III & IV Semester(2016-17)

LABORATORY COURSE 1

CH-305/405: INORGANIC LAB

I. Preparation of some Inorganic coordination compounds/ Complexes.

II. Analysis the given mixture for four rare elements.

III. Estimation of three constituent in the given sample of alloy / Coin (Two gravimetrically and one volumetrically**).**

IV. Spectrophotometry

a. Iron- phenanthroline complex: Job's Method of continuous variations.

b. Find out the stability constant of metal complexes by Bjerrum's Method.

V. Complexometry

a. Estimate Zn in given tablet/ sample complexometrically using xylenol orange as an indicator.

b. Estimate Ni in given sample complexometrically using mureoxide as an indicator.

LABORATORY COURSE 2

CH-306/406: ANALYTICAL LAB

I. pH metry:

1. To determine the dissociation constants of dibasic and tribasic acids.

2. Titration of mixture of acids (HCl + CH_3 COOH) against strong base.

II. Spectrophotometry:

1. Determination of P_{ka} of an indicator (e.g. methyl red) in (a) aqueous and (b) micellor media.

2. Determination of stoichiometry and stability constant of inorganic (e.g. Iron– salicylic acid) and organic (e.g. Amine – Iodine).

3. To determine the concentration of chromium and Complexes a binary mixture.

III. Polarography:

1. To study oxygen wave by polorography.

2. To characterize and determine Pb^{2+}. Cd^{2+} and Zn^{2+} , ions by polarography/ cyclic voltammetry

IV Fluorometry

1. Determination of strength of Vitamin B (Riboflavin) and Aluminium.

V. Nephelometry

1. Determination of sulphate content in water sample.

2. Determination of phosphate content in water sample.

VI. Flame photometry

1. Estimation of Mg, K and Ca.

2. Estimation in a mixture (Na and K; K and Ca).

VII. Water and Waste Water examination:

1. DO and BOD determination.

2. COD estimation.

3. Fluoride and nitrate determination.

VIII. Cement Analysis

IX. Chromatography: Column

Books Suggested:

1. Systematic Qualitative Organic analysis by H. Middleton.
2. Qualitative and Quantitative hand book of Organic analysis by H. Clark
3. Vogel's Text book of practical Organic Chemistry by Vogel

LABORATORY COURSE 3

CH-307/407: ORGANIC LAB

I. Qualitative Analysis

Separation, purification and identification of three components of a mixture of organic compounds (three solids or two liquids and one solid, two solids and one liquid).

II. Multi-step Synthesis of Organic Compounds

Benzophenone → Benzpinacol → Benzpinacolone

→ Benzophenone → Benzophenone oxime → Benzanilide

Benzoin → Benzil → Benzilic acid

Skraup synthesis: Preparation of quinoline from aniline.

Synthesis using microwaves

To carry out oxidation of alcohols and oxime by PCC.

Synthesis using phase transfer catalyst

Alkylation of diethyl malonate or ethyl acetoacetate with an alkyl halide.

III. Extraction of Organic Compounds from Natural Sources

1. Isolation of caffeine from tea leaves.
2. Isolation of casein from milk (the students are required to try some typical colour reactions of proteins).
3. Isolation of lactose from milk (purity of sugar should be checked by TLC and PC and $R_f$value reported).
4. Isolation of piperine from black pepper.
5. Isolation of lycopene from tomatoes.

6. Isolation of -cartoene from carrots.

7. Isolation of eugenol from cloves.

IV. Paper Chromatography / TLC

Separation and identification of the sugars present in the given mixture of glucose, fructose and sucrose by paper chromatography and determination of Rf values.

V. Spectroscopy

Identification of organic compounds by the analysis of their spectral data (UV, IR, PMR, MS).

Spectrophotometric (UV/VIS) Estimations

2. Amino acids
3. Proteins
4. Carbohydrates
5. Ascorbic acid
6. Aspirin
7. Caffiene

Books Suggested:

1. Systematic Qualitative Organic analysis by H. Middleton.
2. Qualitative and Quantitative hand book of Organic analysis by H. Clark
3. Vogel's Text book of practical Organic Chemistry by Vogel
4. Practical Organic Chemistry by N.K. Vishnoi.

LABORATORY COURSE 4

CH-308/408: PHYSICAL LAB

I. Chemical Kinetics

(i) To investigate the kinetics of the reaction between I^- and persulphate ion

(a) Order of the reaction

(b) Energy of activation of the reaction.

(c) Effect of ionic strength on rate.

(ii) To find out the order of the reaction of saponification of ester using unequal concentrations of reactants.

II. Chemical kinetics

(i) To investigate the kinetics of the reaction between ceric ammonium sulfate and glycollic acid.

(a) Order with respect to ceric ion.

(b) Order with respect to glycollic acid.

(c) Energy of activation of the reaction.

(d) Effect of ionic strength on rate.

(e) To study the reaction between cericammonium nitrate and primary alcohol.

II. Thermodynamics

(i) Determination of partial molar volume of solute (e.g.,KCl) and solvent in a binary mixture.

(ii) Determination of the temperature dependence of the solubility of a compound in two solvents having similar intermolecular interactions (benzoic acid in water and in DMSO-water mixture) and calculate the partial molar heat of solution.

III. Phase Equilibrium

(i) To find out the equilibrium constant for the triiodide formation:

(ii) To find the formula of complex cuprammonium ion by distribution method.

IV. Conductometry

(i) To find out the equivalent conductance of strong electrolytes at different dilutions and to verify Debye Huckel Onsagar equation.

(ii) To determine the equivalent conductance of a weak electrolyte at infinite dilution.

(iii) To determine the dissociation constant of acetic acid/Oxalic acid and verify the Ostwald's dilution law.

(iv) To determine the degree of hydrolysis and hydrolysis constant of ammonium chloride at room temperature.

(v) To determine the activity coefficient of zinc ions in the solution of 0.002 M $ZnSO_4$ using Debye-Huckel's Limiting Law.

(vi) Determination of the velocity constant, order of the reaction and energy of activation for saponification of ethyl acetate by NaOH conductometrically.

(vii) To determine the solubility and solubility product of sparingly soluble salt ($PbSO_4$, $BaSO_4$)

V. Potentiometry/pH metry

(i) To determine the dissociation constants of weak acids (oxalic, tartaric, phosphoric) using pH meter.

(ii) To determine the temperature dependence of emf of a cell.

(iii) To determine the degree of hydrolysis of aniline hydrochloride for three different solutions at room temperature and hence calculate the hydrolysis constant of the salt and dissociation constant of the base.

(iv) To study the acid-base titration in a non-aqueous media using a pH meter.

(v) To find out thermodynamic constants ΔG, ΔS and ΔH for the reaction by emf measurements.

$$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$$

Books suggested:

1. Practical Physical Chemistry, A.M. James and F.E. Prichard, Longman.
2. Findley's Practical Physical Chemistry, B.P. Levitt, Longman.
3. Experimental Physical Chemistry, R.C. Das and B. Behera, Tata McGraw Hill.
4. Advanced Practical Physical Chemistry, J.B. Yadav, Goel Publishing House.
5. Advanced Experimental Chemistry, vol.1 – Physical J.N. Gurtu and R. Kapoor, S. Chand & Co.

SYLLABUS

MATHEMATICS

M.A./M.Sc. (Final) (Annual Scheme)
Examination - 2017

(For Regular and Private Students)

JAI NARAIN VYAS UNIVERSITY
JODHPUR

N O T F I C A T I O N

In Compliance of decision of the Hon'ble High Court all students are required to fulfil the 75% attendance rule in each subject and there must be 75% attendance of the student before he / she could be permitted to appear in the Examination.

REGISTRAR
(Academic)

FACULTY OF THE DEPARTMENT AND THEIR RESEARCH/TEACHING INTEREST

Sr. No.	Name/Designation	Academic Qualification	Field of Specialization
	Professor		
01.	Dr. Chena Ram **(Head)**	M.Sc., Ph.D.	Special Functions, Fractional Calculus, Statistical Distributions.
02.	Dr. R.K.Yadav	M.Sc., Ph.D.	Special Functions, Integral Transforms, Fractional Calculus, Complex Analysis.
03.	Dr. Jeta Ram	M.Sc., Ph.D.	Integral Transform, Fractional Calculus, Special Functions
	Associate Professor		
04.	Dr. R.K.Gupta	M.Sc., Ph.D.	Special Functions, Fractional Calculus, Integral Transforms
05.	Dr. Vijay Mehta	M.Sc., Ph.D.	Fluid Dynamics and M.H.D.
06.	Dr. Aiyub Khan	M.Sc., Ph.D.	Computational Fluid Dynamics
	Assistant Professor		
07.	Dr. Ramdayal Pankaj	M.Sc. Ph.D.	Applied Mathematics
08.	Mr. Madan lal	M.Sc.	
09.	Dr. Meena Kumari Gurjar	M.Sc. Ph.D.	Special Functions, Fractional Calculus and Operation Research

MASTER OF SCIENCE

General Information for Students

The examination for the degree of Master of Science will consist of two examinations: (i) The Previous Examination, and (ii) The Final Examination.

The subject of examination shall be one of the following:

Mathematics, Statistics, Physics, Electronics, Chemistry, Zoology, Geology, Botany and Home Science.

The examination will be through theory papers/practical. Pass marks for the previous and final examination are 36% of the aggregate marks in all the theory papers and practical and not less than 25% marks in an individual theory paper. A candidate is required to pass in the written and the practical examinations separately.

Successful candidates will be placed in the following division on the basis of the total marks obtained in previous and final examinations taken together.

First division 60%; Second division 48% and Third division 36%. No student will be permitted to register himself/herself simultaneously for more than one post-graduate course.

ATTENDANCE

1. For all regular candidates in the faculties of Arts, Education and Social Sciences, Science, Law and Commerce the minimum attendance requirement should be that a candidate should have attended at least 75% of the lectures delivered and tutorials held taken together from the date of her/his admission.
2. The shortage of attendance up to the limits specified below may be condoned.
   (i) Up to 3% of the total (a) Lectures delivered and tutorials held (taken together), and (b) Practical or Practical and Sessionals subject-wise condonable by the Dean/Director/Principal on the recommendation of the Department concerned.
   (ii) Up to 6% including (i) above by the Syndicate on the recommendation of the Dean/Director/Principal.
   (iii) Up to 5% attendance in all subjects/papers/practical and sessionals (taken together) by the Vice-Chancellor in special cases, on the recommendation of the Dean/Director/Principal.
3. The N.C.C. cadets sent out to parades and camps and such students who are deputed by the University to take part in games, athletics or cultural activities may, for purpose of attendance, be treated as present for the days of their absence in connection with the aforesaid activities and that period shall be added to their total attendance subject to the maximum of 20 days.
4. Advantage of fraction while calculating the attendance, shall be given to the candidate.

EXAMINATION AND TEACHING SCHEME
M.A./ M.Sc. (Final) Mathematics

Nomenclature/Paper	Periods/week	Exam Hours	Max.Marks
M.Sc. (Final)			
I Complex Analysis and Topology	6	3	100
II Differential Geometry and Tensor Analysis	6	3	100
III Functional Analysis	6	3	100
IV and V (i) to (x)* *Electives	6 (each)	3	100 (each)

***Elective (Optional) Paper IV and V of M.Sc. (Final) Mathematics.**

Elective paper have been divided into two groups A and B and a student has to opt one paper from each of the following groups (A and B):

GROUP A	GROUP B
1. Magnetofluid Dynamics	1. Generalized Functions
2. Linear Operators in Hilbert Space	2. Fundamental of Operations Research
3. Laminar Viscous Flow Theory	3. Integral Equations and Boundary Value Problems
4. Theory of Lie Algebras	4. Advanced Numerical Analysis
5. Biomathematics	5. Probability and Statistical Distributions

Not more than 33% of the total admitted students of M.A./M.Sc. (Final) Mathematics will be allowed in any elective paper.

Selection of these elective papers will be strictly on merit, obtained in M.A./M.Sc. (Previous) Mathematics Examinations.

M.A./M.Sc.(Final) Mathematics

Examination 2017

Note: Each theory paper is divided in three parts i.e. Section – A, Section – B and Section – C

Section A: Will consist of 10 compulsory questions. There will be two questions from each unit and answer of each question shall be limited up to 30 words. Each question will carry 2.

Section B: Will consist of 10 questions. Two questions from each unit will be set and students will answer one question from each Unit. Answer of each question shall be limited up to 250 words. Each question will carry 7.

Section – C: Will consist of total 05 questions one from each unit. Students will answer any 03 questions and answer of each question shall be limited up to 500 words. Each question will carry 15.

Paper – I

COMPLEX ANALYSIS AND TOPOLOGY

Duration of Paper : 3 Hours **Max. Marks : 100**

Unit 1 : Conformal transformations, bilinear transformation, cross ratios and some special transformations. Taylor's and Laurent's theorem, Poles and Singularities. Theory of residues. Contour integration.

Unit 2 : Principle of maximum and minimum modulus; principle of argument, Schwarz's lemma, Rouche's theorem, Fundamental theorem of Algebra; Meromorphic function, Mittag-Leffler's theorem, Analytic continuation, definition and illustrations.

Unit 3 : Harmonic Functions: Definition, Basic Properties, Maximum Principle (First Version), and (second Version), Minimum Principle, Harmonic functions on a disc, Harnack's inequqality and theorem, subharmonic and superharmonic functions and maximum principle (3^{rd} and 4^{th} versions).

Univalent Functions: Definition and examples, Theorems on univalent functions, Bieberbach Conjecture.

Unit 4 : Definition of topological spaces by using open sets, Characterization in terms of closed sets and interior closure and neighborhood operators, Frontier of a set, Sub-space. Bases and sub-bases, dense subsets. Connected spaces.

Unit 5 : Continuous functions, closed and open functions. Homomorphism, First and Second axioms of countability. Separable spaces. Lindeloff spaces. T_0, T_1 and T_2 spaces. Regular and normal spaces.

The **Books Recommended** will be as follows:

1. Shanti Narayan: Theory of Functions of Complex Variable; S. Chand & Co., New Delhi.
2. Mathews, J.H.: Howell, R.W. Complex analysis, Jones and Bartlet, India (2011).
3. Chouhan, J.P. Complex Analysis, (2006), Kedar Nath Ram Nath.
4. H.K. Pathak: Complex Analysis; Shiksha Sahitya, Prakashan, Meerut (2011).
5. B.D. Gupta: Topology; Kedar Nath Ram Nath; Delhi; Meerut.
6. Colin Adams and Robert Franzosa: Introduction to Topology; Dorling Kindersley India Pvt. Ltd., Pearson Prentice Hall (2009), Delhi.

Paper – II

Differential Geometry and Tensor Analysis

Duration of Paper : 3 Hours **Max.Marks: 100**

Unit 1: Curves in Space: Definition of unit tangent vector, tangent line, Normal line and Normal plane. Contact of a curve and a surface. Equation of osculating plane. Fundamental unit vectors, equations of fundamental planes. Curvature, Torsion and skew curvature vectors. Serret-Frenet formulae and their applications.

Unit 2: Definition and properties of the osculating circle and osculating spheres. Bertrand curves and their properties. Involute and evolute of space curves. Envelope of family of surfaces. Ruled surfaces: Definition and properties of developable and skew surfaces.

Unit 3: Parametric representation of a surface. First and Second fundamental forms and magnitudes of various surfaces. Orthogonal trajectories. Definition and Differential equation of lines of curvature (Excluding theorms). Definition and equation of curvature and torsion of asymptotic lines. Beltrami-Enneper Theorem. Fundamental equations of Surface Theory: Gauss equations, Gauss Characteristic equations, Weingarten equations and Mainardi-Codazai equations.

Unit 4 : Geodesics: General differential equation of various standard surfaces. Notations and definitions of contravariant and covariant tensors of first and second order. Mixed tensors, higher order tensors. Contraction and Quotient law for tensors. Symmetric and skew symmetric tensors. Metric [Fundamental] tensor, conjugate metric tensors. Definitions and properties of first and second kind of Christoffel's symbols.

Unit 5 : Laws of transformation of Christoffel's symbols. Covariant derivatives of contravariant and covariant tensors of first and second orders. Laws of covariant differentiation. Ricci's Theorem. Definition and properties of Riemann-Christoffel's tensor. Definition and properties of covariant curvature tensor. Contraction of Riemann-Christoffel Tensor-Ricci tensor.

BOOKS RECOMMENDED:

Bansal, J.l. and Sharma, P.R.: Differential Geometry: Jaipur Publishing House (2004).

Thorpe, J.A.: Introduction to Differential Geometry, Springer-verlag.

Slemberg, S.: Lectures on Differential Geometry, P.H.I. (1964).

Docarmo, M.: Differential Geometry of Curves and surfaces, P.H.I. (1976).

Bansal, J.L.: Tensor Analysis, Jaipur Publishing House, (2004).

Gupta, P.P. and Malik, G.S.: Three Dimensional Differential Geometry, Pragati Prakashan, Meerut.

PAPER – III
FUNCTIONAL ANALYSIS

Duration of Paper : 3 Hours **Max. Marks : 100**

Unit 1: Metric Spaces: Definition and Examples of Metric Spaces, Open and Closed Sets, Neighbourhoods Interior, Limit and isolated points, subspace of a metric space, product spaces. Completeness: Convergent sequences, complete spaces, Dense Sets and Separable spaces, Baire's Category theorem. Compactness: Compact Spaces and Sets, Sequential compactness, Heine-Borel theorem, Equivalence of compactness and sequential compactness, continuous mappings.

Unit 2: Normed spaces and their properties. Banach Spaces. Quotient spaces of Banach Space, Finite dimensional normed spaces and subspaces, Linear operators, Linear Operators and functionals on finite dimensional spaces, Normed Spaces of Operators – Dual space: Space B (x,y), Completeness theorem.

Unit 3: Fundamental Theorems for Normed and Banach Spaces: Zorn's lemma, Hahn-Banach theorem, Hahn-Banach theorem for complex vector spaces and normed spaces, Reflexive operator, Definitions of strong and weak convergences, Lemma for weak convergence, Lemma for weak convergence for the space l^p, strong and weak convergence theorem, Open mapping theorem, Closed graph theorem, Convergence of sequences of operators and functionals.

Unit 4: Inner spaces; Hilbert Spaces: Definitions of Inner Product space, Orthogonality, Euclidean Space R^n, unitary space C^n, Space L^2 [a,b], Hilbert sequence space l^2, space l^p and space C[a,b]; Properties of inner product spaces, Orthonormal sets and sequences, Representation of functionals on Hilbert spaces, Hilbert-Adjoint operator.

Unit 5: Spectral theory of Linear Operators in Normed spaces and of Bounded Self-Adjoint Linear Operators: Definitions: Eigenvalues, Eigevectors, eigenspaces, spectrum and, resolvent set of a matrix; Theorems: Eigenvalues of an operator, closed spectrum theorem, representation theorem. Hilbert – Adjoint operator, Eigenvalue and eigenvector theorem, Norm Theorem, Theorem on product of positive operators, monotone sequence, positive square root, projection, product of projections.

BOOKS RECOMMENDED

1. Kreyszig, E. Introductory Functional Analysis with Applications, John Wiley & Sons (1978).
2.Somasundaram, D.A. First Course in Functional Analysis, Narosa Publishing House, Delhi (2006).
3.Taylor, A.E. Introduction to Functional; Analysis, John Wiley & Sons (1958).
4.Choudhary, B. and Nanda, S. Functional Analysis with Applications, Wiley Eastern Limited, Delhi (1989).
5.Rudin, W. Functional Analysis, Tata McGraw-Hill Publ. Co. Ltd., Delhi (1977).
6.Jain, P.K. and Ahmad, Khalil, Metric Spaces, Narosa Publishing House (1996).
7.Copson, E.T. Metric Spaces, Universal Book Stal, Delhi (1989).
8.Berberian, S. Introduction to Hilbert Space, Oxford University Press, Oxford (1961).
9.Edwards, R.E. Functional Analysis Theory and Applications, Dover Publications, Inc. (1995).

PAPER – IV
GROUP – A
1. MAGNETO FLUID DYNAMICS

Duration of Paper : 3 Hours **Max. Marks : 100**

Unit 1: Fundamental Equations of MFD:

(i) Electromagnetic field equations: Charge conservation equation. Maxwell's equations, constitutive equations, Generalized Ohm's law.

(ii) Fluid dynamics field equations: Equation of State, Equations of motion, Equation of energy.

(iii) MFD approximations, Magnetic field equation, Magnetic Reynolds number, MFD equations for special cases. Alfven's theorem, Magnetic energy, Electromagnetic stresses, force-free magnetic fields.

Unit 2: Basic equations for MHD flow, MHD boundary conditions, MHD flow between parallel plates. Hartmann flow. Hydromagnetic Couette flow (Velocity and temperature distributions). MHD flow in a tube of rectangular cross-section, MHD pipe flow.

Unit 3: MHD flow in an annular channel, MHD flow between two rotating coaxial cylinders, MHD boundary layer approximations. Two dimensional MHD boundary layer equations for flow over a plane surface for fluids of large electrical conductivity. MHD boundary lawyer flow past a semi infinite rigid flat plate in an aligned and Transverse magnetic field. Two-dimensional thermal boundary layer equations for flow over a plane surface, Heat transfer in MHD boundary layer flow past a flat plate in an aligned magnetic field.

Unit 4: MHD waves, waves in an infinite fluid of infinite electrical conductivity, Alfven waves. MHD waves in a compressible fluid. Reflection and Refraction of Alfven waves, MHD waves in the presence of dissipative effects. Hydromagnetic shock waves, stationary plane shock waves in the absence of a magnetic field, plane hydromagnetic shock waves, plane shock waves advancing into a stationary gas.

Unit 5: Motion of a charged particle in uniform static electric and magnetic fields. Magnetic moment, Particle drifts in an inhomogeneous magnetic field. Drifts produced by a field of force. MHF Applications. Astrophysical and geophysical applications, MFD ejectors, MFD accelerators, MFD Lubrication, MFD thin Airfoil, MFD Power generation.

BOOKS RECOMMENDED

Bansal, J.L.: Magnetofluiddynamics of Viscous fluids, Jaipur Publishing House, Jaipur, India

Farraro, V.C.A. and Plumpton, C.: Magnetofluidmecbanics Jeffereys, A.; Magnetohydrodynamics

Cowing, T.G.: Magnetohydrodynamics

Cramer, K.R. and Pai S.I.: Magnetofluiddynamics for Engineers and Physicists, Scripta Publishing Company, Washington, D.C., 1973.

Pai, S.I.: Magneto Geodynamics & Plasma Dynamics, Springer-Verlag, New York, 1962.

Shereliff, J.A.: Magnetohydrodynamics, Pergamon Press, London, 1965.

Charlton, P.: Text Book on Fluid Dynamics, CBS Publications, Delhi, 1985.

Rathy, R.K.: An Introduction to fluid dynamics Oxford & IBH Publishing Company, New Delhi, 1976.

GROUP – A
2. LINEAR OPERATIONS IN HILBERT SPACE

Duration of Paper : 3 Hours **Max. Marks : 100**

Unit 1: Linear spaces. The scalar product, Hilbert space, Linear manifolds and subspaces. The distance from a point to a subspace, Projection of a vector on a subspace. Orthogonalization of a sequence of vectors Complete orthonormal systems. The space L^2 and complete orthonormal system in $\boldsymbol{L}_1^2$.

Unit 2: Linear functionals. The theories of F Riesz. A criterion for the closure in H of given system of vectors. A Lemma concerning convex functionals Bounded linear operators. Bilinear functions. The general form of a Bilinear functional adjoint operators. Weak convergence in H weak compactness.

Unit 3: A criterion for the boundedness of an operator, Linear operators in a separable space. Complete continuous operators. A criterion for complete continuity of an operator. Sequence of bounded Linear Operators. Definition of a projection operator. Properties of projection operators. Operations involving projection operators, Monotone sequences of projection operators.

Unit 4: The aperture of two linear manifolds. Unitary operators Isometric operators. The Fourier-Plan-Cherel operator. Closed operators. The general definition of an adjoint operator. Eigen vectors. Invariant subspaces and reducibility of linear operators. Symmetric operators. Isometric and unitary operators.

Unit 5: The concept of the spectrum. The resolvent conjugation operators. The graph of an operator. Matrix representation of unbounded symmetric operators. The operation of multiplication by the independent variable

BOOKS RECOMMENDED

Akhiezer, N.I. and Glazman, I.M.: Theory of Linear Operation in Hilberts Space.

Translated from the Russian by Merlyind Nestell, Vingar Pub. Co., New York.

GROUP - A

3. LAMINAR VISCOUS FLOW THEORY

Duration of Paper : 3 Hours **Max. Marks : 100**

Unit 1: Fluid, Continuum hypothesis. Constitutive equation for Newtonian fluids, Navier-stoke's equations for viscous compressible flow. Vorticity and Circulation, Equation to energy. Some exact Solutions; Flow between two concentric rotating cylinders, stagnation in two dimensional flow. Flow due to a plane wall suddenly set in motion (Stoke's first problem). Flow due to an oscillating plane wall (Stoke's first problem).

Unit 2: Temperature distributions in Couette flow, Plane Poissuille flow and Haigen-Poissuille flow in a circular pipe. Theory of very slow motion: Stoke's equation of very slow motion. Stoke's flow past a sphere, stoke's stream function. Oseen equations. Lubrication theory.

Unit 3: Laminar Boundary layers. Two dimensional incompressible boundary layer equations. The boundary layer on a flat plate (Blasuis-Topfer-solution). Similar Solutions of boundary layer equations. Wedge flow, Flow in a convergent channel. Flow in the wake of flat plate. Two dimensional Plane jet flow. Prandtl-Mises transformation and its application to plane jet flow.

Unit 4: Boundary layer separation. Boundary layer on a symmetrically placed cylinder (Blasius series solution) Gortler new series method. Axially symmetrical boundary layer. Mangler's transformation. Three dimensional boundary layers; boundary layer on yawed cylinder. Non-steady boundary layer formation (i) after impulsive start of motion (two dimensional case) and (ii) in accelerated motion.

Unit 5: Karman momentum and kinetic energy integral equations. The Von karman and K Pohlhausen's approximate method for boundary layer over a flat plate.

Thermal boundary layers in two dimensional incompressible flow, Crocco's integrals. Forced convection in a laminar boundary layer on a flat plate. Free convection from a heated vertical plate.

BOOKS RECOMMENDED

Schliching H.: Boundary Layer Theory, McGraw Hill.

Pai, S.I.: Viscous Flow Theory, Vol.I, Laminar Flow, D.Van Nostrand Company, New York, 1956.

Bamal, J.L.: Viscous Fluid Dynamics, Oxford and IBH, 2004.

GROUP - A

4. THEORY OF LIE ALGEBRAS

Duration of Paper : 3 Hours **Max.Marks: 100**

Unit 1: Resume of Lie Theory: Local Lie groups. Examples. Local Transformation Group, Examples of Local Transformation group, Examples Representations and Realizations of Lie Algebras.

Unit 2: Representation of Lie Algebras, Realizations of Representations. Representations of $L(O_3)$ G(a,b), the angular momentum operators. Realization of G (a,b) in one and two variables.

Unit 3: Lie theory and Bessel Functions: The representations $Q(w,m_0)$. Recursion relations for the Matrix Elements. Realizations of (w,mo) in two variables, Weisner's Method for Bessel Functions. The reat Euclidean group E3.

Unit 4: Unitary Representations of Lie Groups. Induced Representations of E. The Unitary Representations (p) of E3. The Matrix Elements of (p). The Infinitensimal operators of (p).

Unit 5: Lie Theory and Confluent Hypergeometric Functions: The Representations of $\mathrm{R}\,(w.m.\mu) \uparrow w\mu : w_1\mu \uparrow w_1\mu x \uparrow w_2\mu_2 (\lambda.e)x(\lambda',e')I(\lambda',e)(\lambda e)x(\lambda',e'),(e)x((\lambda.e.)$. Differential Equations for the Matrix Elements.

BOOKS RECOMMENDED

Text Books: Willard Miller, Jr. Lie, Theory and Special Functions, Chapter I to 4, - Academic Press, New York and London, 1968.

Group – A

5. BIOMATHEMATICS

Duration of Paper : 03 Hours Max. Marks: 100

Unit 1: Population growth, single spair time depend models, application to mathematical opidemiology, age structured models.

Unit 2: Two and more spair model, Lotka-Voltarra equations, Pary predator models, Equil-solutions.

Unit 3: Biofluid dynamics, Blood flow in large and small blood vessels. Flow in capillaries, Application of Poinsots law, Sedimentation of red blood cells.

Unit 4: Diffusion problem in biology, Diffusion through membrane, transcapillan exchange. Solutions in simple cases.

Unit 5: Engymes Kinetics, Mendalh's mental theory, Equilibrium solutions.

REFERENCE BOOKS:

Rubinov, S.L. : Introduction to Mathematical Biology.
Kapoor, J.N.: Mathematical Models in Biology and Medicines.
Murry, R.D.: Population Dynamics
Saxena, V.P.: Introduction to Biomaths, Wiley-Eastern.

PAPER - V

GROUP – B

1. GENERALIZED FUNCTIONS

Duration of Paper : 3 Hours **Max. Marks : 100**

Unit 1: Definition and simple properties of generalized functions, Functional and generalized functions.

Unit 2: Differentiation and integration of generalized functions, Regularization of functions of algebraic singularities.

Unit 3: Associated functions, Convolution of generalized functions, Elementary solutions of differential equations with constant coefficient.

Unit 4: Fourier Transforms of generalized functions. Fourier transform of test function, Fourier transforms of generalized functions of one and several variables. Fourier transform and differential equations.

Unit 5: Particular type of generalized functions: Generalized functions concentrated on smooth monifolds of lower dimension. Generalized functions associated with Quadratic form. Homogeneous functions Arbitrary functions raised to a power.

BOOKS RECOMMENDED

Gellifand, I.M. and Shilvo, G.C.: Generalized functions, Vol. I. Acad. Press. 1964.

Fredman, A.: Generalized Functions and Partial Differential Equations,

Prentice Hall. Inc., Englewood Cliffs, N.J., U.S.A., 1963.

GROUP – B

2. FUNDAMENTAL OF OPERATIONS RESEARCH

Duration of Paper : 3 Hours **Max. Marks : 100**

Unit 1: Basic concepts of probability. Conditional probability, Bayes' theorem; Basic concepts of Poisson, exponential distributions, Definition, scope and objectives of O.R., Different types of O.R. Models, basic ideas of convex sets. Linear programming problems-Simplex Method, two phase method, Duality.

Unit 2: Transportation and assignment problems. Theory of games: Competitive strategies, minimax and maximin criteria, two person zero-sum games with and without saddle point, dominance, fundamental theorem of game.

Unit 3: Inventories: Single item deterministic inventory models with finite and infinite rates of replenishment, economic lot-size model with known demand and its extension allowing backlogging of demand concept of price break, simple probabilistic models.

Unit 4: Replacement problems: Replacement of item that deteriorate, replacement of items that fail completely, group replacement policty, individual replacement policy, mortality tables, staffing problems.

Unit 5: Queing theory-Ques with Poisson input and exponential service time, the queue length, waiting time and busy period in steady state case, model with service in phase, multiserver queueing models.

BOOKS RECOMMENDED

Kanti Swaroop, Gupta, Man Mohan: Operations Research, Sultan Chand and Sons.

Goel and Mittal: Operations Research, Pragati Prakashan

Mittal, K.V.: Optimizadon Methods in O.R. and S. Analysis

Sharma, S.D.: Operations Research

Loomba, N.P.: Linear Programming

Satty, T.L.: Mathematical Methods of Operations Research.

GROUP – B

3. INTEGRAL EQUATIONS AND BOUNDARY VALUE PROBLEMS

Duration of Paper : 3 Hours **Max. Marks : 100**

Unit 1: General concepts of integral equation. Linear integral equations of the first and second kind of Fredholm and Volterra types. Solution by successive substitution and successive approximations. Solution of integral equation by Resolvent Kernel.

Unit 2: Singular Integral equation. Solution of Abel's integral equation. General form of Abel Singular integral equation. Weakly Singular Kernel. Hilbert – Schmidt theory by symmetric kernels. Riesz – Fischer theorem. Hilbert – Schmidt theorem. Hilbert's theorem..

Unit 3: Schmidt's solution of the non-homogeneous fredholm integral equation of second kind. Homogeneous Fredholm integral equations. Eigen values and Eigen functions. Fredholm integral equations with degenerate kernels.

Unit 4: Classical Fredholm theory and Boundary Value Problems: Fredholm's equation as limit of a finite system of linear equations. Fredholm's two fundamental relations. Hadamard's theorem. Fredholm Fundamental theorems.

Green's function for Ordinary differential equation. Application of Integral transform in Boundary Value Problems. Applications of Integral Equation.

Unit 5: Integral transform method: Some special types of integral equations. Application of Laplace Transform to determine the solution of Volterra integral equation with convolution type kernels. Application of Fourier transform to determine the solutions of singular integral equations. Integro-differential equation.

Books Recommended:

W.V.Lovaitt: Linear Integral Equation, Dover Publications, 1950.

Krasnov, Kiselev and MakrankoL Problem and Exercises in Integral Equations, Translated by G. Yankovsky, Mir Publishers, Moscow, 1971.

Mikhlim, S.G.: Integral Equations, Pergamon, Oxford, 1957

Triconi, F.D.: Integral Equations, Interscience, New York, 1957.

Pundir, S.K. and Pundir, R. Integral equations and Boundary Value Problems, Pragati Prakashan, Meerut (U.P.)

Chandramouli, A.B.: Integral Equations with Boundary Value Problems, Shiksha Sahitya Prakashan, Meerut (U.P.)

GROUP – B

4. ADVANCED NUMERICAL ANALYSIS

Duration of Paper : 3 Hours **Max. Marks : 100**

Unit 1 : Solution of Algebraic and Transcendental Equations: Newton-Raphson method for real multiple roots, for complex roots and for system of non-linear equations; Synthetic Division, Birge-Vieta, Bairstow and Graefre's root squaring methods for polynomial equations.

Unit 2 : Solution of simultaneous Linear Equations and Eigen Value Problems: Direct methods: Gauss-elimination, Gauss-Jordan, Cholesky and Partition method. Iterative Methods: Jacobi iteration, Gauss-seidel iteration and Successive Relaxation method.

Eigen value Problems: power method, Jacobi Method and Givin's Method for finding Eigen values of a matrix.

Unit 3 : Curve fitting and Function Approximation: Least square Method, Fitting a straight line, Second Degree Polynomials, Exponential Curves. And Logarithmic Curves. Uniform minimax polynomial approximation, Chebyshev approximations, Chebyshev Expansion, Chebyshev Polynomials. Economization of Power Series.

Unit 4 : Solution of Boundary Value Problem: Finite Difference method. Finite Difference scheme for Linear and Non-Linear Boundary Value Problems. Shooting method. Numerical Solution of boundary value problems of the type $y'' = f(x\,y')$, $y'' = f(x, y, y')$ and $y'' = f(x, y)$.

Unit 5 : Numerical Solution of Partial Differential Equations: Finite difference Approximation to partial derivatives. Solution of Laplace and poisson equations, Solution of one and two-dimensional heat and wave equation by the method of separation of variables. Derivation of Crank-Nicolson method for Parabolic Partial Differential Equation

Books Recommended:

Jain, M.K.,Iyenger, SRK, Jain R.K.:: Numerical Methods for Scientists & Engineering Computations, Wiley Eastern Ltd.,

Jain, M.K. : Numerical Solution of Differential Equations, New Age International.

Shastry, S.S.: Introductory Methods of Numerical Analysis, Prentice Hall India Pvt., Ltd.,

Grewal, B.S. : Numerical Methods in Engineering & Science, Khanna Publishers.
Collatz, L.: Numerical Solution of Differential Equations, Tata McGraw-Hill.
D.S. Chouhan: Numerical Methods, JPH.

GROUP – B

5. PROBABILITY AND STATISTICAL DISTRIBUTIONS
(Only for Non-Statistics students of B.Sc.Final)

Duration of Paper : 3 Hours **Max.Marks: 100**

Unit 1: Probability, Random Variables & their probability distribution: Probability: Random Experiment, Statistical Regularity, Algebra of events. Classical, relative frequency and axiomatic approaches of probability. Additive law and Bool's inequalities. Conditional probability. Stochastic independence of events. Multiplicative law of probability and Baye's Theorem.
Random Variable (R.V.): Discrete RV. Probability mass function (p.m.f.). continuous r.v. probability density functions (p.d.f). Cumulative distribution function (c.d.f). and its properties. Two dimensional Random Variable. Joint, marginal and conditional, p.m.f., p.d.f. and c.d.f. Independence of random variable.

Unit 2: Expectation of Random Variable and function of r.v. Theorems on Expectation and inequalities, Moments: Factorial moments, Moments about a point A, Raw moments and Central moments. Measurers of Central tendency, Measures of Dispersion, Measures of Skewness and Kurtosis. Moment generating function (m.g.f.), Cumalant generating function (c.g.f.) and characteristic function (c.f.) of random variables. Product moments and Joint m.g.f. of random variables. Convergence of sequence of random variables; Convergence in law (or in distribution), convergence in probability. Convergence in rth moment.

Unit 3: Discrete Distribution. Discrete Uniform distribution. Bernoulli distribution Binomial distribution. Hypergeometric distribution. Poisson distribution. Geometrical distribution. Negative Binomial Distribution,the Power series distribution. The properties and interrelation of these distribution.

Unit 4:Continuous distributions: Continuous uniform distribution, exponential distribution, Gamma distribution, Beta I and II kind distributions, Cauchy distribution, Normal distribution and Double exponential distribution.
Probability distribution of functions of random variables: Moment generating, cumulative distribution and transformation techniques to find distribution of function of random variables.

Unit 5: Truncated distributions, Compound (or composite) distributions and Sampling distributions:
Truncated distribution: Definition of Truncated distribution, Truncated Binomial, Poisson and Normal distributions.
Compound distributions: Definition, practical situation and applications of compound distributions.
Sampling distributions: Random sample, parameter and statistic, standard error, Sampling Distribution of sample mean $\bar{x}$ and variance s^2 from normal population. Chi-square, t and F distributions.
Methods of estimation of parameters: Method of Maximum Likelihood, Method of Moments and Method of Least squares.

BOOKS RECOMMENDED

01. Mathematical Statistics By Parimal Mukhopadhyay (Books and Allied (P.) Ltd.,
02. An Introduction to Probability and Statistics By Vijay K. Rophtgi & A.K. Mod. Ehsanes Saleh.
03. Fundamental of Mathematical Statistics By S.C.Gupta and V.K. Kapoor
(Sultan Chand & Sons).

SYLLABUS

CHEMISTRY

Under Choice Based Credit System (CBCS)

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

JAI NARAIN VYAS UNIVERSITY

JODHPUR

INTRODUCTION

Jai Narain Vyas University, Jodhpur was established in July 1962. It is a regional University now and operates in the limits of Jodhpur, Jalore, Barmer, Pali and Jaiselmer districts. The Department of Chemistry is located in the New Campus of the University, near the Bhagat-ki Kothi Railway Station, Pali Road. (The Department runs post graduate course in chemistry and has various research laboratories). More than 700 candidates have been awarded with degree of Ph.D. and three candidates have been awarded D.Sc. degree. About 1700 research papers from various faculty members and research scholars have been published in the International and National Scientific Journals. The Department have received research projects from different agencies like U.G.C., C.S.I.R., D.S.T., D.B.T., I.C.A.R., DRDO, DAE etc from time to time. In 1983, U.G.C. has formulated a programme under which certain departments, selected on the basis of their

achievements in the field of teaching and research, they were provided with infrastructure for raising the standard of their post-graduate education and research to international level. The programme was formulated as Committee on Strengthening of Infrastructure of Science and Technology (COSIST) of U.G.C.

The Department is one of the three departments of chemistry in the country, which were selected for this programme. M.Sc. was awarded under COSIST programme from 1985 to 2003, there after department was identified by the UGC under SAP (Special Assistance Programme) in 2010 for research support to the department. Thereafter DST awarded II level FIST programme to the department in 2010.

Awards

Apart from the university gold medal for securing highest marks in M.Sc/B.Sc., following awards have been instituted in the Department of Chemistry for the meritorious students:

1. Professor R.C. Kapoor Gold Medal for securing highest marks in M.Sc. (Chemistry)
2. Professor J.P. Saxena Award for excellence in Organic Chemistry
3. Sushila Bhandari Ugam Kanwar Bhandari Memorial Abhay-II Award for excellence in Physical Chemistry
4. Dr. Kamla Tandon Memorial Award for excellence in Inorganic Chemistry.
5. B.M.Gang Memorial Award for excellence in Analytical Chemistry

Academic and Research Programme

Under Special Assistance Program (SAP), Department of Chemistry offers a two year (4 semesters) integrated programme leading to the Master's degree in Chemistry in two sections of 40 students each. Syllabus is designed to cover all four branches of chemistry viz. Inorganic Chemistry, Organic Chemistry, Physical Chemistry and Analytical Chemistry. IInd and IVth semester offers a choice of eight electives each to strengthen diverse field of interdisciplinary nature.

Department of Chemistry has advanced facilities for research in major areas of Chemistry leading to Ph.D.. The major research interests of the faculty members includes: Nanotechnology, Biosensors; Electrochemistry & Electroanalytical Chemistry, Chemical Dynamics & Reaction Mechanism; Mineral Beneficiation; Oil & Fats; Natural Products; Synthetic Heterocyclics; Chemical Spectroscopy; Synthetic & Structural Organo & Organometallic Chemistry; Effluent Treatment; Environmental Chemistry; Synthetic Organic Chemistry; Photochemistry; Solar Energy Conversion & Storage; Co-ordination Chemistry; Green Chemistry and Applied Chemistry.

ADDMISSION

The minimum qualification for admission to M.Sc. course is B.Sc. (10+2+3) degree with Chemistry as a major subject. The details of the eligibility conditions and admission procedures are given in the admission forms. The admission would be done on the basis of merit as per university rules. Reservation for SC, ST and OBC would also be done as per J.N.V. University, Jodhpur rules. Candidates are required to attend minimum 75% of the classes in theory and practicals both.

FACILITIES

The Department of Chemistry possesses several sophisticated, advanced and modern equipments required for teaching and research. The specialized instruments includes Electrochemical Analysers, Surface plasmon Resonance Spectrometer, Fluorescence Spectrophotometer, FTIR, UV-VIS spectrophotometers, Stoped-flow spectrophotometers, HPLC, Low temperature thermostats, Flame photometers, Ion meters, Centrifuge and computers for networking. In addition, certain facilities related to equipments are also available with USIC in the Faculty of Science.

FACULTY MEMBERS

PROFESSOR & HEAD

Dr. Seema Acharya	Florescence Studies
Ph.D.	

PROFESSOR

Prof. P.K. Sharma(M)	Analytical Electrochemistry
Ph.D.	Environmental Chemistry
Prof. (Mrs.) Sunita Kumbhat	Biosensors, Electrochemistry & Electro analytical
Ph.D.	Chemistry Environmental Chemistry
Dr. (Miss) Seema Kothari	Reactions Kinetics, Correlation Analysis
Ph.D.	
Dr. P.K. Sharma (B)	Electro-chemistry, Chemical Kinetics &
Ph.D.	Correction Analysis.
Dr. Kailash Daga	Co- ordination Chemistry
Ph.D.	
Dr. (Mrs.) Vinita Sharma	Organic Chemistry Reaction Mechanism

Ph.D.	
Dr. (Mrs.) S. Loonker	Polymers, Environmental and applied Chemistry
Ph.D.	
Dr. (Miss) S. Sharma	Co-ordination Chemistry ,
Ph.D.	Environmental Chemistry
Dr. (Mrs.) V. Choudhary	Co-ordination Chemistry ,
Ph.D.	Environmental Chemistry
Dr. (Mrs.) S. Gaur	Co-ordination Chemistry
Ph.D.	
Dr. V. Gupta	Applied Chemistry;
Ph.D.	Effluent Treatment Studies
Dr. A.V. Singh	Physical Chemistry, Mineral beneficiation and
Ph.D.	Environmental Chemistry
Dr. (Mrs.) P. Mishra	Organic Reaction Mechanism
Ph.D.	
Dr. K.R. Genwa	Solar energy conversion technologies

Ph.D.	
Dr. R.C. Meena	Photochemistry (Solar energy
Ph.D.	Conversion technologies)
Dr. A. Arora	Natural products, Oils and fats
Ph.D.	

ASSOCIATE PROFESSORS

Dr. J.S. Rathore	Analytical Chemistry
Ph.D.	Environmental Chemistry
Dr. Rajendra Mathur	Polymer Science
Ph.D.	
Dr. P. Koli	Organic Chemistry and Solar Energy Conversion
Ph.D.	and storage

ASSISTANT PROFESSOR

Dr. S.L. Meena	Photo Electrochemistry, Corrosion & its prevention
Ph.D.	
Dr. Jaishree Rathore	Organic Chemistry
Ph.D.	
Ms. Meenakshi Jonwal	Inorganic Chemistry

M.Sc.	
Dr. Anita Meena	Physical Chemistry
Ph.D.	
Dr. Priyanka Purohit	Chemical Kinetics
Ph.D.	
Dr. Rajni Bais	Analytical Electrochemistry
Ph.D.	
Dr. Sangeeta Parihar	Environmental Chemistry
Ph.D.	
Dr. Om Prakash	Chemical Kinetics
Ph.D.	
Sh. R.L. Saini	Organic Chemistry
M.Sc.	
Dr. Anurag Choudhary	Chemical Kinetics
Ph.D.	
Dr. Seema Parveen	Organic and Phytochemistry
Ph.D.	

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 the 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 Departments 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 weightage. 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 even semesters 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, seminar
b. Attendance shall carry the prescribed marks in all papers and Practical examination internal assessment
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

$$\textbf{SGPA } (Si) = \Sigma(Ci \times Gi) / \Sigma Ci$$

Where Ci 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	CH 101	Inorganic Chemistry	6-0-0	4	30	70	100
Core course 2	CH 102	Organic Chemistry	6-0-0	4	30	70	100
Core course 3	CH 103	Physical Chemistry	6-0-0	4	30	70	100
Core course 4	CH 104	Instrumental Methods of Analysis	6-0-0	4	30	70	100
Core course practical 1	CH 105	Inorganic Lab	0-0-12	4	30	70	100
Core course practical 2	CH 106	Physical Lab	0-0-12	4	30	70	100

Skill Course I	As per the list		2-0-2				
Total				24	180	420	600
Semester II							
Core course 5	CH 201	Inorganic Chemistry	6-0-0	4	30	70	100
Core course 6	CH 202	Organic Chemistry	6-0-0	4	30	70	100
Core course 7	CH 203	Physical Chemistry	6-0-0	4	30	70	100
Core course 8	CH 204	Analytical Chemistry	6-0-0	4	30	70	100
Core course practical 3	CH 205	Organic Lab	0-0-12	4	30	70	100
Core course practical 4	CH 206	Analytical Lab	0-0-12	4	30	70	100
Skill course II	As per the list		2-0-2	2-0-2			
Total				24	180	420	600
Semester III							
Core course 9	CH 301	Group Theory & Inorganic Spectroscopy	6-0-0	4	30	70	100
Core course 10	CH 302	Application of Spectroscopy	6-0-0	4	30	70	100
Discipline Specific Elective 1	(303A-I/303B-I/303C-I/303D-I)		6-0-0	6-0-0	30	70	100
Discipline	(304A-II/304B-II/304C-		6-0-0	6-0-0	30	70	100

Specific Elective 2	II/304D-II)						
Core course practical 5	CH 305/307	Lab. Course1/3	0-0-24	4	30	70	100
Core course practical 6	CH 306/308	Lab. Course2/4	0-0-24	4	30	70	100
Skill course III	As per the list		2-0-2	2-0-2			
Total				24	180	420	600
Semester IV							
Core course 11	CH 401	Solid State Chemistry	6-0-0	4	30	70	100
Core course 12	CH 402	Bio Chemistry	6-0-0	4	30	70	100
Discipline Specific Elective 3	403A-III/403B-III/403C-III/403D-III		6-0-0	4	30	70	100
Discipline Specific Elective 4	404A-IV/404B-IV/404C-IV/404D-IV		6-0-0	4	30	70	100
Core course practical 7	CH 405/407	Lab. Course1/3	0-0-24	4	30	70	100
Core course practical 8	CH 406/408	Lab. Course2/4	0-0-24	4	30	70	100
Skill course IV	As per the list		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 Chemistry distributed the Periods between Theory/Tutorial/Practical as under per paper

- 4 : 0 : 0 (four lectures only (no tutorial and no practical)) – For Theory
- 0 : 0 : 5 (no lecture, no tutorial, and practical)-For practical
- 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 is 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.

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%); hands on Practical and sessional (50%).

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	10	2	20
3. Short answer (15 words)	5	2	10
Total	25		40

For the Term test and ESE:

Part A

Ten short type questions (Definitions, illustrations, functions, short explanations, etc ;) 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 (400 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. 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.

Skill Based Course in Chemistry

S.No.	Course No.	Name of Course
A	SK-CH-1	Water Analysis
B	SK-CH-2	Food Adulteration and Testing
C	SK-CH-3	Application of solar Energy
D	SK-CH-4	Ores and building material
E	SK-CH-5	Polymer Technology
D	SK-CH-6	Conservation and Management of cultural Heritage

M.Sc. Chemistry

(Under CBCS)

First Year (2017-18)

(Two Semesters each of 15 weeks)

TEACHING AND EXAMINATION SCHEME:

I SEMESTER

1.	THEORY PAPERS (Four Papers)	Periods/ Wk	No. of Credits	CCA	ESE	Total
CH-101	Inorganic Chemistry	6	4	30	70	100
CH-102	Organic Chemistry	6	4	30	70	100
CH-103	Physical Chemistry	6	4	30	70	100
CH-104	Instrumental Methods of Analysis	6	4	30	70	100
	Grand Total					**400marks**

2. PRACTICALS EXAMINATIONS:

Lab Course	Periods/Wk	No. of Credits	CCA	ESE	Total
CH-105 Inorganic Lab	12	4	30	70	100
CH-106 Physical Lab	12	4	30	70	100
Total					**200**
Total marks of I Semester					**600**

II SEMESTER

1.	THEORY PAPERS (Four Papers)	Periods/ Wk	No. of Credits	CCA	ESE	Total
CH-201	Inorganic Chemistry	6	4	30	70	100
CH-202	Organic Chemistry	6	4	30	70	100
CH-203	Physical Chemistry	6	4	30	70	100
CH-204	Analytical Chemistry	6	4	30	70	100
	Grand Total					**400marks**

2. PRACTICALS EXAMINATIONS:

Lab Course	Periods/Wk	No. of Credits	CCA	ESE	Total
CH- 205 Organic Lab	**12**	**4**	**30**	**70**	**100**
CH- 206 Analytical Lab	**12**	**4**	**30**	**70**	**100**
Total					**200**
Total marks of II Semester					**600**
Total marks of M. Sc. I Year					**1200**

3.SKILL BASED COURSE

SK-CH for I Semester	**4pd/wk**	(For students of Chemistry Department only)
SK-CH for II Semester	**4pd/wk**	(For students of Other Department only)

M.Sc Chemistry

I YEAR-2018

SEMESTER – I

CH- 101: INORGANIC CHEMISTRY

Unit I

Stereochemistry and bonding in compounds of main group elements: Walsh diagram of tri atomic molecules, d π -p π bonds and synergic bonding, equivalent and in equivalent hybridization and Bent-rule. Energetics of hybridization Simple reactions of covalently bonded molecules, atomic inversion. Berry pseudo rotation and Nucleophilic displacement, Free radical reactions. Applications of valance shell election pair repulsion(VSEPR) theory in structure elucidation.

Unit II

Metal Ligand Bonding :Limitations of crystal field theory, Jahn Tellor theorem. And distortion of molecules. molecular orbital theory of hetero triatomic molecules viz . BeH_2, CO_2, NO_2 , H_2O, Coulson diagrams of tri atomic molecules CO_2 , NO_2 , H_2O. Molecular orbital theory(MOT): octahedral, tetrahedral and square planer complexes, π - bonding and molecular orbital theory, Comparison with CFT.

Unit III

Metal Ligand Equilibrium in solution : stepwise and overall formation constant and their interaction, trends in stepwise constants, factors affecting the stability of metal complexes with reference to the nature of metal ion and ligand, Chelate effect and its thermodynamic origin, determination of binary formation constants by pH metry and spectrophotometry.

Unit IV

Correlation diagrams of Transition Metal Complexes:Types of transitions, selection rules for electronic transition, Spectroscopic ,ground States, correlation diagrams, Orgel and Tanabe

sugano diagrams for d_1 to d_9 states in Transitions metal complexes. Calculations of Dq. B and β parameters.

Unit V

Electronic spectra and Magnetic properties of transitions metal

Complexes, Spectroscopic methods of assignment of absolute configuration in optically active, metal chelates and their stereo chemical information, Charge transfer spectra, Anomalous magnetic moments, magnetic exchange coupling and spin crossover.

Books Suggested:

1. Advanced Inorganic Chemistry, F.A. Cotton and Wilkinson, John Wiley.
2. Inorganic Chemistry, J.E. Huhey, Harpes & Row.
3. Chemistry of the Elements, N.N. greenwood and A.Earnshow, Pergamon.
4. Inorganic Electronic Spectroscopy, A.B.P. lever, Elsevier.
5. Magnetochemistry, R.L.Carlin, Springer Verlag.
6. Comprehensive Coordination Chemistry eds., G. Wilkinson, R.D. Gillars and LA McCleverty, Pergamon.

CH -102: ORGANIC CHEMISTRY

UNIT I

Nature of Bonding in Organic Molecules

Delocalized chemical bonding-conjugation, cross conjugation, reasonance hyperconjugation, bonding in fullerenes, tautromerism.

Aromaticity in benzenoid and non-benzenoid compounds, alternant and non-alternant hydrocarbvonds, Huckel's rule, energy level of π-molecular orbitals, annulenes aromaticity, homo-aromaticity, PMO (approach).

Bonds weaker than covalent- addition compounds, crown ether complexes, cryptands inclusion compounds, cyclodextrins, catenanes and rotaxanes.

UNIT II

Stereochemistry I

Conformational analysis of cycloalkanes, decalins, effect of conformation on reactivity conformation of sugars, steric strain due to unavoidable crowding. Stereochemistry of the compounds containing nitrogen, sulphur and phosphorus.

UNIT III

Stereochemistry II

Elements of symmetry, chirality, molecules with more than one chiral center, threo and erythro isomers, methods of resolution, optical purity, enantiotopic and diastereotopic atoms, groups and faces, stereospecific and stereoselective synthesis. Asymmetric synthesis. Optical activity in the absence of chiral crbon (biphenyls, allenes and spiranes), chirality due to helical shape.

UNIT IV

Reaction Mechanism: Structure and Reactivity

Types of mechanisms, types of reactions, thermodynamic and kinetic requirements, Kinetic and thermodynamic control. Hammond's postulate, Curtin-Hammett principle, Potential energy diagrams, transition states and intermediates, methods of determining mechanism isotope effects. Hard and Soft acids and bases.

Generation, structure, stability and reactivity of carbocations, carbanions free radicals, carbenes and nitrenes.

Effect of structure on reactivity – resonance and field effects, steric effect, quantitative treatment. The Hammett equation and linear free energy relationship. substituent and reaction constants. Taft equation.

UNIT V

Pericyclic Reactions

Molecular orbital symmetry, Frontier orbitals of ethylene, 1,3- butadiene, 1,3,5-hexatriene and allyl system. Classification of pericyclic reactions. Woodward – Hoffmann correlation diagrams, FMO and PMO approach. Electrocyclic reactions – conrotatory and disrotatory motions, 4n, 4n+2 systems, 2+2 addition of ketenes, 1,3 dipolar cycloadditions and cheleotropic reactions.

Sigmatropic rearrangements – suprafacial and antrafacial shifts of H, sigmatropic shifts involving carbon moieties, 3,3- and 5,5- sigmatropic

rearrangements. Claisen, Cope and aza-Cope rearrangements. Fluxional tautomerism. Ene reaction.

Books Suggested:

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.

2. Advanced Organic Chemistry, F.A. Carey and R.J.Sundberg, Plenum.

3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.

4. Structure and Mechanism in Organic Chemistry, C.K.Ingold, Cornell University Press.

5. Organic Chemistry, R.T. Morrison and R.N.Boyd, Prentice-Hall

6. Modern Organic Reactions, H.O. House, Benjamin.

7. Principles of Organic Synthesis, R.O.C. Norman and J.M. Coxon, Blackie Academic & Professional.

8. Pericyclic Reactions, S.M.Mukherji, Macmillan, India.

9. Reaction Mechanism in Organic Chemistry S.M.Mukherji and S.P. Singh, Macmillan.

10. Stereochemistry Organic Compounds, D.N.asipuri, New Age International.

11. Stereochemistry of Organic Compounds, P.S.Kalsi, New Age Internationa.

12. Pericyclic Reactions by Jagdama Singh.

CH-103: PHYSICAL CHEMISTRY

UNIT I

Chemical Kinetics-I

Chemical Dynamics: Ionic reactions, kinetic salt effects, steady state kinetics, kinetic and thermodynamic control of reactions.

Dynamic chain (hydrogen-bromine reaction, pyrolysis of acetaldehyde). photochemical (hydrogen-bromine and hydrogen-chlorine reactions) .

UNIT II

Chemical Kinetics-II

Homogeneous and heterogeneous catalysis, kinetics of enzyme reactions, general features of fast reactions, study of fast reactions by flow method, relaxation method, and flash photolysis method.

Dynamics of complex Reactions, Collision and Transition state, Theories of Rate Constant, dynamics of unimolecular reaction, Lindemann and Hinshelweed theories of unimolelcular reactions.

UNIT III

Adsorption

Surface tension, capillary action, pressure difference across curved surface (Laplace equation), vapour pressure of droplets (Kelvin equation) Gibbs adsorption isotherm, estimation of surface area (BET equation), surface films on liquids Electro-kinetic phenomenon and quantitative treatment of Zeeta potential.

Micelles: Surface active agents, classification of surface active agents, micellization, types of ionic micelles present in colloidal electrolytes, solubilization of surfactant solutions, critical micellar concentration (CMC), factors affecting the CMC of surfactants,

UNIT IV

Macromolecules

Polymer – definition, types of polymers,, kinetics of polymerization, mechanism of polymerisation.

Molecular mass, number and mass average molecular mass, molecular mass determination (osmometry, viscometry, diffusion and light scattering methods), sedimention, calculation of average dimensions of various chain structures.

UNIT V

Electrochemistry

Electrochemistry of solutions. Debye-Huckel – Onsagar treatment and its extension, Debye-Huckel-Jerrum mode, ion - solvent interactions, Born model.

Thermodynamics of electrified interface; Derivation of electrocapillary Lippmann equation (surface excess), Structure of electrified interfaces. Helmholtz, Guoy-Chapman and Stern models.

Books Suggested :

1. Physical Chemistry, P.W. Atkins, ELBS.
2. Chemical Kinetics, K.J.Laidler, Megraw-Hill
3. Kinetics and Mechanism of Chemical Transformation, J.Rajaraman and J.Kuriacose, McMillan.
4. Micelles, Theoretical and Applied Aspects, V.Moroi, Plenum.
5. Modern Electrochemistry Vol. I and Vol. II, J.O.M. Bockris and A.K.N.Reddy, Plenum.
6. Introduction to Polymer Science, V.R.Gowarkar, N.V.Vishwananathan and J.Sridhar, Wiley Eastern.

CH- 104: INSTRUMENTAL METHODS OF ANALYSIS

UNIT I

Instrumental analytical methods: Types and range of determination.

Accuracy and minimization of errors

Precision and its determination (Standared deviation, R.S.D, C.V). confidence limit and confidence, level significance and tapes of "t" test in analytical chemistry.

Analysis of variance (ANOVA), Correlation coefficient and liniar regression.

Numericals based on above concepts

Unit II

Atomic spectral analytical techniques :

Atomic absorption Spectrophotometry : Theory with chemical and spectral interferances , Instrumentation and application.

Emission spectroscopy : Principle and application of Flame photometry; ICPAES- Salient features and application on multielement determination

UNIT III

U-V Visible Spectrophotometry;

Colorimetric estimation of metal ion with specific reagents Iron with 8-Hydroxyquinoline, Lead with Dithizone, Technique of dual wavelength and derivative spectroscopy and their applications.

Fluorescence Photometry: Theory with partial energy diagram, instrumentation and applications.

UNIT IV

Chromatography – I

Introduction, Classification and terms related to chromatography.

Basic principles, factors affecting column efficiency

Gas chromatography (GC)

Principle, layout of instrument with columns, detectors (TCD,FID, and Electron Capture) and applications.

Techniques of TLC and its applications

UNIT V

Chromatography-II

High performance liquid chromatography (HPLC)

Principle, layout of instrument with columns detectors (UV-Visible, RI and electro chemical) and applications.

Super Critical Fluid chromatography: Principle and applications

Books:

1. Instrumental Analysis: Skoog, Hollar and Crouch, Cengage learning.
2. Vogel's Textbook of Quantitative Chemical Analysis, G.H.Jeffery, J.Bassett, J. Mendham and R.C. Denney, Publ ELBS, Longman, UK
3. Analytical Chemistry, G.D. Christian, John Willy & Sons.
4. Basic Concepts of Analytical Chemistry, S. M. Khopkar, Wiely Eastern.
5. Fundamentals of Analytical Chemistry, D.A. Skoog, D.M. West and F.J.Holler. Publ. W B Saunders.

Laboratory Course- I-Semester

CH -105: Inorganic Chemistry

Qualitative Analysis

Eight component mixture including two less common metal ions (TI, Mo, W, Ti, Zr, Th, V, U in cationic/anionic forms) and insoluble – oxides, sulphates and halides.

Quantitative Analysis

Separation and estimation of metal ions in a binary mixture Cu-Ni, Ni-Zn, Cu-Ag etc. involving volumetric and gravimetric methods.

Chromatography

Separation of cations and anions by

(a) Paper Chromatography: Separation of chloride, bromide and iodide

(b) Column Chromatography – separation of Cu, Ni, Co by Ion exchange.

Preparations

Preparation of selected inorganic compounds and their studies by I.R., electronic Mossbauer, E.S.R. and magnetic susceptibility measurements. Handling of air and moisture sensitive compounds.

(1) $VO(acac)_2$

(2) Cis-$K[Cr(C_2O_4)_2(H_2O)_2]$

(3) $Na[NH_3)_2(SCN)_4]$

(4) $Mn(acac)_3$

(5) $K_3[Fe(C_2O_4)_3]$

(6) Prussian Blue, Turnubull's Blue

(7) $[Co(NH_3)_6][Co(NO_2)_6]$

(8) Cis-$[Co(trine)(NO_2)_2]Cl.H_2O$

(9) $Hg[Co(SCN)_4]$

(10) $\{Co(Py)_2Cl_2]$

(11) $[Ni(NH_3)_6]Cl_2$

(12) Ni $(dmg)_2$

(13) $[Cu(NH_3)_4]SO_4.H_2O$

CH - 106: Physical Chemistry

Surface Tension

(i) To determine the parachor of carbon and hydrogen atoms by drop weight method.

(ii) To determine the relative efficiencies of different detergents by surface tension measurements.

Chemical Kinetics

(i) To compare the strengths of HCl and H_2SO_4 by studying the kinetics of hydrolysis of an ester.

(ii) Determination of the effect of

(a) Change of temperature

(b) Change of concentration of reactant and catalyst.

(c) Ionic strength of the media on the velocity constant of acid hydrolysis of an ester

(iii) To study the effect of acid strength on the reaction of acetone and iodine.

Adsorption

(i) To study surface tension-concentration relationship for solutions (Gibbs equation) and hence determine the limiting cross-sectional area of molecule.

(ii) To study the adsorption of acetic acid/oxalic acid by activated charcoal and verification of Freundlich and Langmuir's isotherms.

Book Suggested:

1. Vogel's Textbook of Quantitative Analysis, revised, J.Bassett, R.C. Denney, GH.H. Jeffery and J. mENDHAM, elbs.
2. Synthesis and Characterization of Inorganic Compounds, W.L.Jolly, Prentice Hall.
3. Practical Physical Chemistry, A.M.James and F.E. Prichard, Longman.
4. Findley's Practical Physical Chemistry, B.P.Levitt, Longman.

5. Experimental Physical Chemistry, R.C.Das and B.Behera, Tata McGraw Hill.

6. Advanced Practical Physical Chemistry, J.B.Yadav, Goel Publishing House.

7. Advanced Experimental Chemistry, Vol. I Physical, J.N.Gurtu and R.Kapoor, S.Chand & Co.

Marking Scheme for M.Sc. I Semester Practicals

Inorganic CH-105 Lab Course

1.	Gravimetric	20 Marks
2.	Inorganic Mixture Eight component	30 Marks
3.	Inorganic Preparation	10 Marks
4.	Viva-voce	10 Marks

Total 70 Marks

Physical CH-106 Lab Course

1.	Major Experiment	35 Marks
2.	Minor Experiment	25 Marks
3.	Viva-Voce	10 Marks

Total 70 Marks

M.Sc Chemistry

SEMESTER-II

CH -201: INORGANIC CHEMISTRY

UNIT I

Reaction mechanism of Transitions metal complexes: Energy profile of a reaction (transition state or activated complex), Nucleophilic and Electrophilic Substitution, factors responsible for including SN_1 and SN_2 reaction, Lability and inertness of octahedral complexes acc to VBT and CFT. Acid hydrolysis, factor affecting acid hydrolysis, Base hydrolysis, Conjugate base mechanism (SN_1 CB), Evidences in favour of conjugate base mechanism, anation reactions, Substitution reaction without metal-ligand bond cleavage (Special reference to Co(III) complexes).

UNIT II

Substitution in square planer complexes: Trans-effect, mechanism of substitution reaction, polarization theory and π bonding theory. Redox reaction : electron transfer reaction, mechanism of 1e-transfer reaction, outer sphere reaction, Inner sphere reaction, bridge intermediate mechanism.

UNIT III

Metal π-complexes: Metal carbonyls, structure and bonding in metal carbonyls, vibrational spectra of metal carbonyls for bonding and structure elucidation. Preparation, bonding, structure and important reactions of transition metal nitrosyls.

UNIT IV

Boranes : Structure and bonding in diborane, preparations of higher boranes, Lipscomb's concept of bonding elements in higher boranes. Preparation, properties and structure of borazines.

UNIT V

Metal clusters: Metal carbonyl and halide type clusters, compounds with metal-metal multiple bonds, Metalloboranes, Carboranes, Silicates: types and Uses

Books Suggested:

1. F.A. Cotton and Wilkinson: Advanced Inorganic Chemistry, John Wiley.
2. J.E. Huhey: Inorganic Chemistry, Harper and Row.
3. N.N.Green Wood and A. Eafnshow: Chemisry of the element, Pergamon.
4. A.B.P. Lever: Inorganic Electronic Spectroscopy, Elsevier
5. R.L.Carlin: Magnetochemistry, Verlag.
6. G. Wilkinson, R.D. Gillars and J.A. MCeLEVERTY: Comprehensive Coordination Chemistry eds. Pergamon.
7. F. Basolo and R.G. Pearson: Mechanism of Inorganic Reaction, Wiley Eastern

CH- 202: ORGANIC CHEMISTRY

UNIT I

Aliphatic Nucleophilic Substitution

The SN_2, SN_1, mixed SN_1 and SN_2 and SET mechanisms.

The neighbouring group mechanism, neighbouring group participation by π and σ bonds, anchimeric assistance.

Classical and nonclassical carbocations, phenonium ions, norbornyl system, common carbocation rearrangements. Application of NMR spectroscopy in the detection of carbocations.

The S_Ni mechanism.

Nucleophilic substitution at an allylic, aliphatic trigonal and a vinylic carbon.

Reactivity effects of substrate structure, attacking nucleophile, leaving group and reaction medium, phase transfer catalysis and ultrasound, ambident nucleophile, regioselectivity.

Aliphatic Electrophilic Substitution

Bimolecular mechanisms- S_E2 and SE^i. The S_E1 mechanism, electrophilic substitution accompanied by double shifts. Effect of substrates, leaving group and the solvent polarity on the reactivity.

UNIT II

Aromatic Electrophilic Substitution

The arenium ion mechanism, orientation and reactivity, energy profile diagrams. The ortho/para ratio, ipso attack, orientation in other ring systems. Quantitative treatment of reactivity in substrates and electrophiles. Diazonium coupling, Vilsmeir reaction, Gattermann-Koch reaction.

Aromatic Nucleophilic Substitution

The S_NAr S_N1, benzyne and $S_{RN}1$ mechanisms. Reactivity – effect of substrate structure, leaving group and attacking nucleophile. The von Ritcher, Sommelet-Hauser, and Smiles rearrangements.

UNIT III

Free Radical Reactions

Types of free radical reactions, free radical substitution mechanism, mechanism at an aromatic substrate, neighbouring group assistance.

Reactivity for aliphatic and aromatic substrates at a bridgehead. Reactivity in the attacking radicals. The effect of solvents on reactivity.

Allylic halogenation (NBS), oxidation of aldehydes to carboxylic acids, auto-oxidation, coupling of alkynes and arylation of aromatic compounds by diazonium salts, Sandmeyer reaction. Free radical rearrangement. Hunsdiecker reaction.

UNIT IV

Addition to Carbon-Carbon Multiple Bouds

Mechanistic and sterochemical aspects of addition reactions involving electrophiles, nucleophiles and free radicals, regio- and chemoselectivity, orientation and reactivity. Addition to cyclopropane ring. Hydrogenation of double and triple bonds, hydrogenation of aromatic rings. Hydroboration. Michael reaction. Sharpless asymmetric epoxidatio.

Addition to Carbon-Hetero Multiple Bonds

Mechanism of metal hydride reduction of saturated and unsaturated carbonyl compounds, acids, esters and nitriles. Addition of Grignard reagents, Organozinc and Organolithium reagents to carbonyl and unsaturated carbonyl compounds. Wittig reaction.

Meehanism of condensation reactions involving enolates – Aldol, Knoevenagel, Claisen, Mannich, Benzoin, Perkin and Stobbe reactions.

Hydrolysis of esters and amides, ammonolysis of esters.

UNIT V

Elimination Reactions

The E2, E1 and E1cB mechanisms and their spectrum, Orientation of the double bond. Reactivity – effects of substrate structures, attacking base, the leaving group and the medium.

Mechanism and orientation in pyrolytic elimination.

Books Suggested:

1. Advanced Organic Chemistry-Reactions, Mechanism and Structure, Jerry March, John Wiley.
2. Advanced Organic Chemistry, F.A. Carey and R.J.Sundberg, Plenum.
3. A Guide Book to Mechanism in Organic Chemistry, Peter Sykes, Longman.
4. Structure and Mechanism in Organic Chemistry, C.K.Ingold, Cornell University Press.
5. Organic Chemistry, R.T. Morrison and R.N.Boyd, Prentice-Hall
6. Modern Organic Reactions, H.O. House, Benjamin.
7. Principles of Organic Synthesis, R.O.C. Norman and J.M.Coxon, Blackie Academic & Professional.
8. Pericyclic Reactions, S.M. Mukherji, Macmillan, India.
9. Stereochemistry of Organic Compounds, D. Nasipuri, New Age International.

CH- 203: PHYSICAL CHEMISTRY

UNIT- I

Quantum Chemistry I

Introduction to Exact Quantum Mechanical Results: The Schrodinger's wave equation and its Hamiltonian operator form, postulates of quantum mechanics, operators. Discussion of solutions of the Schrodinger's wave equation to some model systems viz; particle in one dimensional box, particle in three dimensional box, the linear harmonic oscillator, the Hydrogen atom.

UNIT- II

Quantum Chemistry II

Concepts of spatial quantization and spinning electron hypothesis, Quantum numbers, Russell-Saunders terms and coupling schemes (L-S and j-j Coupling), spectral terms for p^n and d^n configurations, Magnetic effects: Normal and anomalous Zeeman effects.

UNIT - III

Classical Thermodynamics:

Partial molal properties; free energy – chemical potential, Gibbs – Duhem equation, physical significance of chemical potential, variation of chemical potential with temperature and pressure, chemical potential for ideal gas and mixture of ideal gases, Thermodynamic derivation of law of mass action.

Concept of fugacity, Change in fugacity with temperature and pressure, physical significance of fugacity, fugacity of a gas in a mixture of real gases, determination of fugacity (graphical method).

UNIT - IV

Statistical Thermodynamics I

Concepts of phase space, microstate and macrostate, ensemble, canonical, grand canonical and microcanonical ensembles, ensembles averaging, Maxwell-Boltzmann distribution law using Lagrange's method of undetermined multipliers.

Bose-Einstein statistics, Fermi-Dirac statistics and Maxwell-Boltzman statistics

UNIT – V

Statistical Thermodynamics II

Partition functions – translational, rotational, vibrational and electronic partition functions, calculation of thermodynamic properties in terms of partition functions- Energy, specific heat at constant volume and constant pressure, entropy, work function, pressure and Gibb's free energy.

Books Suggested:

1. Physical Chemistry, P.W. Atkins, ELBS.
2. Introduction to Quantium Chemistry, A.K. Chandra, Tata McGraw Hill.
3. Quantum Chemistry, Ira N. Levine, Prentice Hall.
4. Coulson's Valence, R. McWeeny, ELBS.
5. Theoretical Chemistry, S. Glasston, Princeton, London.
6. Fundamentals of Chemical GThermodynamics, E.N.Yeremin, Mir Publishers.

CH- 204: ANALYTICAL CHEMISTRY

Unit I

Basic components of analytical instruments, Operational Amplifiers (for current, potential, resistance/conducatnce), Analog &digital signals, basic digital circuit components, DAC & ADC.Automation in analysis: Automatic & Automated instruments, process control analyzer, continuous analyzer & discrete analyzer, Flow injection analysis, Microprocessor controlled smart instruments

Unit II

Thermal Analysis: Introduction to thermal Analysis**,** Thermogravemetric Analysis(TGA); Basic Instrumentation, methodology and applications.Differential Techniques: Principal Instrumentation and applications of differential thermal analysis (DTA) and differential scanning calorimetry (DSC).

Unit III

Electrochemistry

Electrochemical Cell, Ion Selective Electrodes: Types (Glass membrane, Precipitate, Solid State, Liquid-Liquid, Enzyme), Mechanism of membrane response, Advantages and limitations of ISEs. Introduction to sensors and biosensors, Design & working of Glucose Amperometric sensor.

Unit IV

Electroanalytical Methods

dc Polarography: theoretical principle, Ilkowic equation, Half wave potential and their significance. Different wave form & Current-Voltage Curves, Cyclic Voltammetry: Theoretical Principles, Randle-Sevick Equation, Determination of Heterogenous Rate Constant (K_s), Criteria of reversibility by CV.

Unit V:

Voltammetry

Theoretical Principle, Methodology and applications of Pulse Voltammetry, Differential Pulse Voltammetry, Square Wave Voltammetry, Stripping Voltammetry (Anodic, Cathodic and Adsorptive Stripping techniques). Voltammetry in Inorganic & Organic Analysis

Books Suggested:

1. Instrumental Methods of Analysis, H.H. Willard, L.L. Merritt, J.A. Dean and F.A. Settle, CBS Publ. Delhi.
2. Principles of Instrumental Analysis, D.A. Skoog and J.L. Loary, Publ. W B Saunders
3. Instrumental Methods of Analysis, Strobel
4. Vogel's Textbook of Quantitative Chemical Analysis, G.H.Jeffery, J.Bassett, J. Mendham and R.C. Denney, Publ ELBS, Longman, UK

LABORATORY COURSE: II-SEMESTER

CH-205: ORGANIC CHEMISTRY

Qualitative Analysis

Separation, purification and identification of compounds of binary mixture (one liquid and one solid), chemical tests, Interpretation of IR Spectra of simple compounds.

Two Step Organic Synthesis

Acetylation: Acetylation of glucose and hydroquinone.

Oxidation: Adipic acid by chromic acid oxidation of cyclohexanol.

Cannizzaro reaction: 4-Chlorobenzaldehyde as substrate.

Aromatic electrophilic substitutions: Synthesis of p-nitroaniline and p-bromoaniline.

Quantitative Analysis

Determination of the percentage or number of hydroxyl group in an organic compound by acetylation method.

Estimation of amines/phenols using bromate bromide solution/or acetylation method.

Determination of Iodine and Saponification values of an oil sample.

Determination of DO, COD and BOD of water sample.

CH- 206: ANALYTICAL CHEMISTRY

Conductometry:

(1) Estimation of Oxalic acid by Conductometric Titration in following solutions
   (a) A solution of pure oxalic acid
   (b) A solution of oxalic acid and HCl

(2) To titrate a given mixture of sulphuric acid, acetic acid and Copper Sulphate conductometrically.

Environmental Analysis:

(1) Determination of carbon dioxide, carbon monoxide, oxygen and nitrogen in air sample using Orsat apparatus.

(2) Determination of NO_x by 49pectrophotometry in environmental samples.

Electrophoresis:

(1) To study the separation of amino acids in a mixture by electrophoresis.

(2) To Determine isoelectric point of glutamic acid by paper electrophoresis.

TLC :

(1) Separation of dyes by TLC

(2) Separation of pharmaceutical Samples by TLC

(3) Study of reaction monitoring by TLC

Books Suggested:

1. Vogel's Textbook of Quantitative Chemical Analysis, G.H.Jeffery, J.Bassett, J. Mendham and R.C. Denney, Publ ELBS, Longman, UK
2. Handbook of Organic Analysis – Qualitative and Quantitative, H. Clark, Adward Arnold.
3. Vogel's Textbook of Practical Organic Chemistry, John Wiley. Experiments and Techniques in Organic Chemistry, D. Pasto, C.Johnson and M.Miller, Prentice Hall
4. Macroscale and Microscale Organic Experiments, K.L. Williamson, D.C. Heath.
5. Systematic Qualitative Organic Analysis, H. Middleton, Adward Arnold.
6. Instrumental Methods of Analysis, H.H. Willard, L.L. Merritt, J.A. Dean and F.A. Settle, CBS Publ. Delhi.

7. Principles of Instrumental Analysis, D.A. Skoog and J.L. Loary, Publ. W B Saunders

8. Instrumental Methods of Analysis, Strobel

Marking Scheme for M.Sc. II Semester Practicals

Organic CH-205 Lab Course

1.	Qualitative Analysis	25 Marks
2.	Two step organic synthesis	20 Marks
3.	Quantitative Analysis	15 Marks
4.	Viva-voce	10 Marks
	Total	70 Marks

Analytical CH-206 Lab Course

1.	Conductometry	25 Marks
2.	Environmental Analysis/Electrophoresis	15 Marks
3.	TLC---A	10 Marks
	TLC---B	10 Marks
4.	Viva-Voce	10 Marks
	Total	70 Marks

SKILL BASED COURSE

SK-CH-1 Water Analysis

Introduction, water sources (ground water, surface water, municipal water supplies)

Characteristics of water, water standards, simple water analysis technique: for

a] physical parameter

B] Chemical parameter

Color, odour, turbidity, hardness (Ca^{+2}/Mg^{+2}) TDS, pH, alkalinity, conductivity, dissolve oxygen(DO), chloride, sulphate, nitrate, fluoride, biological oxygen demand(BOD) and chemical oxygen demand(COD) some important water analysis equipment/instruments. Interpretation of water quality parameter.

LABORATORY

Experiments

1- To find out the Colour, Turbidity and Odour of a given sample of water.
2- To determine the pH value of a given sample of water.
3- To determine the Electrical conductivity value of a given sample of water.
4- To determine the carbonate, bicarbonate and hydroxide alkalinity of a given sample of water.
5- To find out the concentration of chlorides in the given sample of water.
6- To estimate the hardness of the given sample of water by standard EDTA method.
7- To find out the amount of water sterilizing powder(Bleaching powder) required by Horrock's test and modified Horrock's test.
8- To determine the residual chlorine in a given sample of water.
9- To determine the residual chlorine in a water sample volumetrically

10- To determine the amount of dissolve oxygen (DO) in the given sample of water by Winkler method.

11- To determine 5 day BOD of the given sample of effluent.

12- To determine the quality of alum required to coagulate a given sample of water by jar test.

13- To determine the amount of chemical oxygen demand (COD) in the given sample of water

14- To determine the Antimicrobial Activity of water /bacteriological examination of water.

Books Recommended:

1. Industrial Chemistry (Including Chemical Engineering) : B.K. Sharma: Goyal Publishing House

2. Engineering Chemistry by Jain & Jain, Goyal Publishing House

3. Water Pollution by B.K. Sharma.

SK-CH-2 FOOD ADULTERATION AND TESTING

Introduction to food adulteration,

Adulterants: types, sources and their impact on health.

Criteria of adulterated food.

Detection methods of food adulterants.

Awareness towards food adulteration.

The Prevention of Food Adulteration Act & Rules

Practical

Detection of adulterants in

1. Milk and milk products

2. Oils and fats

3. Sweetening agents

4. Food grains

5. Spices

Books Recommended:

1. A Textbook Of Foods,Nutrition And Dietetics 2009 M Raheena Begum

2. Textbook of Food Science & Technology: Unique Book For B.SC., M.SC., Home Science, Food Science & Technology, Horticulture, Agriculture,2006. Avantina Sharma .

3. A First Course in Food Analysis .1999. A.Y. Sathay

4. FSSAI manual.

SK-CH-3 APPLICATION OF SOLAR ENERGY

Theory

Sunlight, spectral composition of surface illumination, solar intensity and solar irradiancy, photo chemistry and electricity generation, solar energy conversion and storage, energy conversion efficiency;

Fabrication, basic principles, characteristics and applications of various solar power devices like photo-electrochemical cells, photo galvanic cells and photovoltaic cells.

Practical

Study of photo galvanic cells; Study, fabrications and characteristics of solar power devices like solar charger, solar calculator, solar heater, solar cap, solar power desalination unit and solar power fountain.

Books Recommended:

1. Organic Photochemistry, J.Coxon and B. Halton, Cambridge University Press.
2. Solar Energy Hand Book, J.F. Kreider and F. Krejth, MacGraw Hill Book Co. 1981.
3. Solar Energy Conversion, R.C. Neville, Elsevier.
4. Alternative Energy Systems, B.K. Hodge, Wiley.
5. Advanced Energy Systems, Second Edition, Nicolai V. Khartchenko; Vadym M. Kharchenko, Taylor & Francis.
6. Non- Conventional Energy Resources, D.S. Chauhan, New Age International

SK-CH-4 ORES AND BUILDING MATERIAL

Theory:

Ceramics- general properties and classification

Cement-classification,composition,basic constituents and their significance.manufacturing of Portland cement by rotary kiln method,setting and hardening of cement.

Lime- manufacture of lime,setting and hardening and lime mortar.

Plaster of paris-manufacture,setting and hardening of plaster of paris.

Ore- definition ,basics of ores.

Ore and building material

Practical

1.determination of % of Cu in Cu ore.

2. estimation of calcium in lime stone.

3.determine the % of iron in the given iron ore.

4.determine the amount of chromium in the chromite ore.

5.analysis of cement.

List of books for Ores and Building Materials

Books Recommended:

1. Building Materials: S. K. Duggal
2. Industrial Chemistry: B K Sharma
3. Material Chemistry: S S Dara & S S Umare
4. Engineering Chemistry: Dr. Sunita Rattan
5. Engineering Chemistry: Jain & Jain
6. Experiments and Calculations in Engineering Chemistry: S S Dara
7. Laboratory Manual on Engineering Chemistry: S K Bhasin & Sudha Rani

SK-CH-5 POLYMER TECHNOLOGY

Polymer: Classification, introduction to concept of Average Molecular Mass, polydispersity, amorphous and crystalline state. Introductory rheology, polymer degradation, diffusion and mechanical properties.

Polymer Processing:

Mixing: Introduction, material flow to the mixture, feeding, incorporation, dispersion, distribution and plasticization.

Extrusion: Basic principles of extrusion, types of extruders; ram type and screw type.

Calendering: Types of calender rolls, roll positioning and adjustments. Calendering Operations, sheeting, fractioning, coating, profiling and embossing.

Moulding: Types; Compression, transfer, injection and blow moulding of low viscosity materials: casting.

Polymer testing and characterization: Introduction to thermal techniques; TGA, DTA.

Introduction to Chemical Characterization: Identification of materials by thermal, elemental, solubility and color tests.

Practical

1. Synthesis of PMMA, PS, PAN

2. Determination of free phenol and free formaldehyde in one stage synthesis of PF resin.

3. Identification of polymers by color test:

    i. Thermoplastics: PE, PS, PVC.

    ii Thermosetting: PF, UF, MF, Epoxy resin.

4. Determination of moisture content.

5. Determination of ash content.

6. Determination of Bulk Density.

7. Determination of percentage DOP absorption.

Books Recommended:

1. Polymer Science- V R Gowarikear, N V Vishwanathan and J Sridhar

2. Polymer Science & Technology: J R Fried

3. Science & Technology of Polymers-Plastics and Rubber: P Ghosh

4. Rubber Technology: M Morton

SK-CH-6 Conservation and Management of cultural Heritage

Course Objectives: The primary objective is to build awareness and competence in the country on the recent developments in Heritage and historical aspects of conservation and Protecting and save our culture and civilization.

Course Contents / Syllabus:

Heritage and their types, Heritage and historical aspects of corrosion in India. Ethics of conservation, restoration and preservation and its history. Importance of knowledge of archaeology, chemistry, geology, art and architecture for conservation of heritage monuments. Guiding principles for conservation / preservation of monuments as per international conventions. Distribution of monuments in different geographical / seismic zones and their conservation problem. Stone, Building materials and their classifications, degradation equation. Causes of Decay of Heritage structure and Antiquities. Electrochemical basis of corrosion of cultural heritage, management of heritage site, economic value of cultural heritage, methods and technique in conservation treatment, An overview on analytical methods and approach to the conservation process, requirement of analytical methodology applied to Archaeometric and conservation research of cultural Goods , Metals and non-metals, Alloys, Acids, bases and salts ,pH, ionic and non-ionic solutions ,Solubility, solvents and insolubility ,Micro-climate

ESTABLISHMENT OF LABORATORY (NECESSARY INSTRUMENTS, TOOLS, EQUIPMENTS AND CHEMICALS) AND FIELD STUDY TOUR/VISIT.

PRACTICAL:

1. Preparation of conservation notes (history, architecture, building materials, problems, remedial measures to be adopted)

2. Macroscopic analysis by visual examination or the aid of a hand lens to record the texture, colour, shine, transparency, type of fracture.

3. Physical tests to determine hardness, cohesion, density, porosity, permeability, effect of heat.

4. Laboratory procedures and determination of pH, etc

5. Practical training in -(i) Testing and chemical analysis of heritage building materials in the field study visit/ tour and in -situ treatment .

6. Treatment and cleaning of metal antiquities
7. Cleaning and treatment of stones, marble, etc
8. Special form of examination to determine structure using high powered equipment such as x-rays crystallography.

Books:

1. History of Indian Archaeology: The Beginning to 1947 by Dilip K . Chakrabarti **,**Munshiram Manoharlal Publishers (1 May 1995)
2. An Introduction to Archaeological Chemistry by By T. Douglas Price, James H. Burton ,Springer Science
3. Electrochemical Methods in Archaeometry, Conservation and Restoration **by Antonio Doménech-Carbó,** María Teresa, Virginia **Costa**, Spirnger.
4. Chemical Methods of Rock Analysis (Third Edition) *by D. Hutchison and P.G. Jeffrey* Pergamon press New York.
5. Petrology Igneous, Sedimentary, and Metamorphic by Ernest G. Ehlers, Harvey Blatt, W. H. Freeman& Company, USA.
6. Protection, Conservation and Preservation of Indian Monuments *by* S.L. Nagar, Aryan Books International, Ansari Road Delhi (November 30, 1993)
7. Conservation of Cultural Property in India by O.P. Agrawal, Publisher: Agam Kala Prakashan.
8. The Conservation of Antiquities and Works of Art: Treatment, Repair and Restoration by H. J. Plenderleith, A. E. A. Werner, Oxford University Press; 2nd edition (March 9, 1972).
9. Conservation science: Heritage Materials by Eric May and Mark Jones, RSC Publication Cambridge U.K.