Starex University, Gurugram

Choice Based Credit System (CBCS)

M.Sc. (BOTANY)

(2021-23)

Scheme & Syllabus

M.Sc. (BOTANY)

(w.e.f. 2021-23)

PREAMBLE

The University Grants Commission (UGC) has initiated several measures to bring equity, efficiency and excellence in the Higher Education System of country. The important measures taken to enhance academic standards and quality in higher education include innovation and improvements in curriculum, teaching-learning process, examination and evaluation systems, besides governance and other matters. The UGC has formulated various regulations and guidelines from time to time to improve the higher education system and maintain minimum standards and quality across the Higher Educational Institutions (HEIs) in India. The academic reforms recommended by the UGC in the recent past have led to overall improvement in the higher education system. However, due to lot of diversity in the system of higher education, there are multiple approaches followed by universities towards examination, evaluation and grading system. While the HEIs must have the flexibility and freedom in designing the examination and evaluation methods that best fits the curriculum, syllabi and teaching–learning methods, there is a need to devise a sensible system for awarding the grades based on the performance of students.

Presently the performance of the students is reported using the conventional system of marks secured in the examinations or grades or both. The conversion from marks to letter grades and the letter grades used vary widely across the HEIs in the country. This creates difficulty for the academia and the employers to understand and infer the performance of the students graduating from different universities and colleges based on grades. The grading system is considered to be better than the conventional marks system and hence it has been followed in the top institutions in India and abroad. So it is desirable to introduce uniform grading system. This will facilitate student mobility across institutions within and across countries and also enable potential employers to assess the performance of students. To bring in the desired uniformity, in grading system and method for computing the cumulative grade point average (CGPA) based on the performance of students in the examinations, the UGC has formulated these guidelines.

CHOICE BASED CREDIT SYSTEM (CBCS)

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Therefore, it is necessary to introduce uniform grading system in the entire higher education in India. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations, the UGC has formulated the guidelines to be followed.

Outline of Choice Based Credit System:

1. **Core Course**: A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

2. **Elective Course**: Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

Discipline Centric Elective (DCE) Course: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective. The University/Institute may also offer discipline related Elective courses of interdisciplinary nature (to be offered by main discipline/subject of study).

Dissertation/Project: An elective course designed to acquire special/advanced knowledge, such as supplement study/support study to a project work, and a candidate studies such a course on his own with an advisory support by a teacher/faculty member is called dissertation/project.

Generic Elective (GE) Course: An elective course chosen generally from an unrelated discipline/subject, with an intention to seek exposure is called a Generic Elective. P.S.: A core course offered in a discipline/subject may be treated as an

elective by other discipline/subject and vice versa and such electives may also be referred to as Generic Elective.

3. **Skill Enhancement Elective (SEE) Course:-** SEEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.

Project work/Dissertation is considered as a special course involving application of knowledge in solving / analyzing /exploring a real life situation / difficult problem. A Project/Dissertation work would be of 24 and 16 credits for Major and Minor projects, respectively. A Project/Dissertation work may be given in lieu of a discipline centric elective paper.

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 courses (core, elective or minor or soft skill courses).

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/ outreach activities/ project work/ vocational training/viva/ seminars/ term papers/assignments/ presentations/ 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 or diploma or certificate 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 hour of teaching (lecture or tutorial) or two hours 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 a Degree, Diploma or Certificate.

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 December and even semester from January to May/June.

13. Transcript and Detailed Grade

Certificate/Statement (DGS): Based on the earned credit points, a detailed grade Certificate/Statement (DGS) shall be issued to all the registered students after every semester. The grade Certificate/Statement will display the course details (Course Code, its nomenclature, total credit points and letter grade) along with SGPA of that semester and CGPA in the final semester.

19. Grading Method

The grading method for evaluating students' performance involves award, of grade according to the range of total marks in the course. The grade will be awarded based on marks out of 100, as depicted below:

Formula for Computation of SGPA & CGPA

Range of Percentage of Marks	**Letter Grade**	**Grade Points**	**Range of Grade Points**	**Classification**
90 and above	O (Outstanding)	10	9-10	Outstanding
80 & above but less than 90	A+ (Excellent)	9	8 < 9	Excellent
70 & above but less than 80	A (Very Good)	8	7 < 8	1st Div. with Distinction
60 & above but less than 70	B+ (Good)	7	6 < 7	1st Division
50 & above but less than 60	B (Above Average)	6	5 < 6	2nd Division
Above 40 but less than 50	C (Pass-Average)	5	Above 4 < 5	3rd Division
35 To 40	P (Pass)	4	3.5 To 4	Pass
Below minimum pass marks	F (Fail)	0	-	-

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

$$SGPA\ (Si) = \sum (Ci \times Gi) / \sum Ci$$

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.

$$CGPA = \sum (Si \times Si) / \sum Ci$$

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 worked up to 2 decimal points and mentioned in the DGS and transcripts.

iv). Formula for calculation of aggregate pass percentage CGPA x 10

Example

Course	**Credit**	**Grade Letter**	**Grade Point Block**	**Range of Grade Points(Actual Grade Value as per marks obtd.**	**Earned Credit Points (Credit ×Actual Grade Value)**
Course 1	3	O	10	9.2	3×9.2=27.6
Course 2	3	A+	9	8.2	3×8.2=24.6
Course 3	4	A	8	7	4×7=28
Course 4	3	B+	7	6.7	3×6.7=20.1
Course 5	3	B	6	5.6	3×5.6=16.8
Course 6	4	C	5	4.7	4×4.7=18.8
	20				135.9

Thus, **SGPA** = 135.9/20 = 6.79

Similarly, suppose SGPA for 2^{nd}, 3^{rd} , and 4^{th} semester are 7.85, 5.6 and 6.0 with credits 22, 24 and 22 respectively than for a two year programme, the CGPA will be computed as follows

CGPA= 20 × 6.79 + 22× 7.85 + 24 × 5.6 + 22 × 6.0/88 = 6.53

Formula for calculating percentage of marks

CGPA × 10 e.g. 6.53 × 10 = 65.3

SCHEME/ NOMENCLATURE/ CREDITS FOR M. Sc. BOTANY

SEMESTER-I

Paper/ Course Code	Nomenclature of Paper/Course	Course Type	Theory	Internal	Total	Credits
1	MICROBIAL DIVERSITY	CC	75	25	100	4
2	PLANT DIVERSITY	CC	75	25	100	4
3	CELL BIOLOGY	CC	75	25	100	4
4	FUNDAMENTALS OF BIOCHEMISTRY	CC	75	25	100	4
5	PRINCIPLES OF MICROBIOLOGY	GEC*	75	25	100	4
5	INTRODUCTION TO BIOTECHNOLOGY	GEC*	75	25	100	4
6	PRACTICAL- I	CC	75	25	100	4
TOTAL						**24**
* ANY ONE TO BE CHOSEN BY STUDENTS						

SEMESTER-II

Paper/ Course Code	Nomenclature of Paper/Course	Course Type	Theory	Internal	Total	Credits
7	PLANT SYSTEMATICS	CC	75	25	100	4
8	PLANT TISSUE CULTURE	CC	75	25	100	4
9	MOLECULAR BIOLOGY	CC	75	25	100	4
10	PLANT BIOTECHNOLOGY	GEC*	75	25	100	4
10	TOOLS AND TECHNIQUES	GEC*	75	25	100	4
11	AGRICULTURAL & SOIL MICROBIOLOGY	DCEC*	75	25	100	4
11	PLANT PATHOLOGY	DCEC*	75	25	100	4
12	PRACTICAL- II	CC	75	25	100	4
13	SEMINAR	CC			50	2
TOTAL						**26**
* ANY ONE TO BE CHOSEN BY STUDENTS						

SEMESTER-III

Paper/ Course Code	Nomenclature of Paper/Course	Course Type	Theory	Internal	Total	Credits
14	GENETICS	CC	75	25	100	4
15	PLANT PHYSIOLOGY	CC	75	25	100	4
16	PRINCIPLES OF ECOLOGY	CC	75	25	100	4
17	DEVELOPMENTAL AND REPRODUCTIVE BIOLOGY	GEC*	75	25	100	4
17	BIOINFORMATICS AND BIOSTATISTICS	GEC*	75	25	100	4
18	IMMUNOLOGY	DCEC*	75	25	100	4
18	PLANTS FOR HUMAN WELFARE	DCEC*	75	25	100	4
19	PRACTICAL- III	CC	75	25	100	4
20	NTCC	CC				2
TOTAL						**26**
* ANY ONE TO BE CHOSEN BY STUDENTS						

SEMESTER-IV

Paper/ Course Code	Nomenclature of Paper/Course	Course Type	Theory	Internal	Total	Credits
21	GENOMICS AND PROTEOMICS	DCEC*	75	25	100	4
22	PLANT BREEDING AND CYTOGENETICS	DCEC*	75	25	100	4
23	**PROJECT**				400	16
TOTAL						**26**

OR

Paper/ Course Code	Nomenclature of Paper/Course	Course Type	Theory	Internal	Total	Credits
21	DESSERTATION	SEEC*			600	24

CC	Core Course
DCEC	Discipline Centric Elective Course
GEC	Generic Elective Course
SEEC	Skill Enhancement Elective Course
*****	Choose any one in given semester

Semester	Credits: Core Courses	Elective Courses: DCEC	Elective Courses: GEC	Total Credits	Total marks
I	20		4	24	600
II	16	4+2	4	26	650
III	16	4+2	4	26	650
IV	16(SEEC)	8		24	600
Total	68	20	12	100	2500

SEMESTER-I

Core Course: I
MICROBIAL DIVERSITY

Paper Code: Time Allowed: 3 Hours

Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION A

Discovery of microorganisms, Spontaneous Generation Controversy, Germ theory of disease. Prokaryotic vs. Eukaryotic Organisation.

Whittaker's five-kingdom concept. Three-domain concept of Carl Woese. Characters used in microbial taxonomy (morphological, physiological, ecological, genetics protein content, nucleic acid sequence and base composition).

SECTION B

Eubacteria, Archaebacteria, Cyanobacteria–General comparison, Morphology and structure of a typical Bacterium (Eubacterium). Gram staining (Gram- positive and Gram negative Bacteria) with reference to cell wall, Capsular, Endosperm and Flagellar staining techniques. Different types of nutrition in Bacteria. Reproduction, in Bacteria including Transformation, Transduction, Conjugation (Genetical details should be avoided).

SECTION C

General structure of Viruses, Detailed structure plant virus (TMV) & Bacteriophages, Replication of viruses, Transmission of viruses.

Classification & nomenclature of Viruses, Importance of Viruses (as Disease causing agents and use in Biotechnology). Viroids and Pirons: their nature & importance.

General characteristics of Fungi; Range of thallus organization and Reproduction. Classification according to Alexopolous and Blackwell. Important genera of Fungi (Yeast, ,

Rhizopus, Aspergillus, Penicillium, Altenaria, Ustilago, Puccinia); Economic Importance of Fungi.

SECTION D

Algae in diversified habitats (terrestrial, freshwater, marine); thallus organization; cell ultra structure; reproduction (vegetative, asexual and sexual). Classification of algae; criteria for classification; pigments, reserve food and flagella.

Salient features of Protochlorophyta, Chlorophyta, Charophyta, Xanthophyta, Bacillariophyta, Phaeophyta and Rhodophyta. Algal blooms; algal biofertilizers; Economic importance of algae as food, feed, in medicine and industry.

Suggested readings:

1. Atlas RM (1997). Principles of Microbiology, Wm C Brown Publishers, USA.
2. Brock TD (1961). Milestones in Microbiology, Infinity Books.
3. Madigan MT, Martinko JM, Parker J (2015). Brock Biology of Microorganisms, 14th edition, Pearson Education Ltd, Prentice-Hall, Englewood Cliffs, NJ, Inc USA.
4. Pelczar MJ, Chan ECS, Kreig NR (1993). Microbiology: Concepts and Application, 5th edition, Tata McGraw Hill, New Delhi.
5. Stanier RY, Ingraham JL, Wheelis ML, Painter PR (1976). General Microbiology, 4th edition, MacMillan, New Jersey, USA.
6. Alexopolus CJ, Mims CW, Blackwell M (2002). Introductory Mycology, 4th edition, Wiley India Pvt. Ltd, India.
7. Barsanti L, Gualtieri P (2005). Algae, Anatomy, Biochemistry & Biotechnology, CRC press, Taylor & Francis, Florida, USA.
8. Carlile MS, Watkinson SC, and G. Gooday (2001). The Fungi, 2nd edition, Academic Press, New York.
9. Graham LE, Graham JM, Wilcox LW (2009). Algae, 2nd edition, Benjamin Cummings, San Francisco.

Core Course: II
PLANT DIVERSITY

Paper Code: Time Allowed: 3 Hours

Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION A

Bryophyta: Morphology, structure, reproduction and life history; distribution; economic and ecological importance. Classification of bryophytes; general account of Marchantiales, Jungermaniales, Anthoceratales, Sphagnales, Funariales and Polytrichales

SECTION B

Pteridophyta: General characteristics, morphology, anatomy, reproduction and classification of Pteridophytes. Evolution of stele and stelar system; hetrospory and origin of seed habit; general account of fossil pteridophyta; introduction to Psilopsida, Lycopsida, Sphenopsida and Pteropsida.

SECTION C

Introduction to gymnosperms, general characters, life cycle, diversity and origin and classification of gymnosperms. Evolution of gymnosperms. Distribution of gymnosperms in India. Economic and ecological importance of gymnosperms. Comparative account of the morphology, anatomy and reproduction in the following orders: Cycadales, Ginkgoales, Coniferales, Ephedrales, Welwitschiales and Gnetales.

SECTION D

Paleobotany: fossils, types of rocks, types of fossils and fossilization. Techniques for study of fossils. Notable paleobotanists of India. General account of the few fossil gymnosperm families (Lyginopteridaceae, Medullosaceae, Glossopteridaceae and Caytoniaceae) and orders (Cycadeoidales, Pentoxylales and Cordaitales).

SUGGESTED READINGS

1. Puri, P. 1980. **Bryophytes**. Atma Ram & Sons, New Delhi.
2. Sporne, K.R. 1991. **The Morphology of Pteridophytes**. B.I. Publ. Pvt. Ltd.
3. Parihar, N.S. 1991. **Bryophytes**. Central Book Depot, Allahabad.
4. Parihar, N.S. 1996. **The Biology and Morphology of Pteridophytes**.

Core Course: III
CELL BIOLOGY

Paper Code: Time Allowed: 3 Hours

Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION A

Overview of prokaryotic and eukaryotic cells, Nuclear Envelope- structure of nuclear pore complex, nuclear lamina, Transport across Nuclear Envelope, Chromatin: molecular organization, Nucleolus and rRNA Processing.
Protein Sorting and Transport: The Endoplasmic reticulum, The Golgi Apparatus, Mechanism of Vesicular Transport, Lysosomes.

SECTION B

Mitochondria, Chloroplasts and Peroxisomes: Structural organization, Function, Marker enzymes, Mitochondrial biogenesis, Protein import in mitochondria, Semiautonomous nature of mitochondria and chloroplast, chloroplast DNA, Peroxisomes' assembly
Cytoskeleton and Cell Movement: Structure and organization of actin filaments; actin, myosin and cell movement; intermediate filaments; microtubules.

SECTION C

The Plasma Membrane: Structure, Transport of small molecules, Endocytosis
Cell Wall, the Extracellular Matrix and Cell Interactions
Bacterial and Eukaryotic Cell Wall; the extracellular matrix and cell matrix interactions; cell-cell interactions. Cell Signaling, Signaling molecules and their receptor; functions of cell surface receptors; Intracellular signal transduction pathway; signaling networks.

SECTION D

The Cell Cycle: Eukaryotic Cell Cycle, Regulation of Cell cycle progression, Events of Mitotic Phase, Meiosis and Fertilization.
Cell Death and Cell Renewal: Programmed Cell Death, Stem Cells and Maintenance of adult tissues, Embryonic Stem Cells and Therapeutic cloning.

Cancer: Development and Causes of Cancer, Tumor Viruses, Oncogenes, Tumor Suppressor genes, Cancer Treatment- molecular approach.

SUGGESTED BOOKS

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.

2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.

3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.

4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

Core Course: IV
FUNDAMENTALS OF BIOCHEMISTRY

Paper Code: Time Allowed: 3 Hours

Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

Chemical basis of life; Composition of living matter; Water – properties, pH, ionization and hydrophobicity; Emergent properties of biomolecules in water; Biomolecular hierarchy; Macromolecules; Molecular assemblies; Structure-function relationships Amino acids – structure and functional group properties; Peptides and covalent structure of proteins; Elucidation of primary and higher order structures; Evolution of protein structure; Structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin etc.; Tools to characterize expressed proteins. 17 hours

Section-B

Enzyme catalysis – general principles of catalysis; Quantitation of enzyme activity and efficiency; Enzyme characterization and Michaelis-Menten kinetics; Relevance of enzymes in metabolic regulation, activation, inhibition and covalent modification; Single substrate enzymes, Sugars - mono, di, and polysaccharides; Suitability in the context of their different functions- cellular structure, energy storage, signaling; Glycosylation of other biomolecules - glycoproteins and glycolipids; Lipids - structure and properties of important members of storage and membrane lipids; lipoproteins. 12 hours

Section-C

Biomembrane organization - sidedness and function; Membrane bound proteins - structure, properties and function; Transport phenomena Nucleosides, nucleotides, nucleic acids - structure, diversity and function; sequencing; Brief overview of central dogma. 12 hours

Section-D

Bioenergetics-basic principles; Equilibria and concept of free energy; Coupled processes; Glycolytic pathway; Kreb's cycle; Oxidative phosphorylation; Photosynthesis; Elucidation of metabolic pathways; Logic and integration of central metabolism; entry/ exit of various biomolecules from central pathways; Principles of metabolic regulation; Regulatory steps; Signals and second messengers 19 hours

Suggested readings:

1. V. Voet and J. G. Voet, Biochemistry, 3rd edition, John Wiley, New York, 2004.
2. A.L. Lehninger, Principles of Biochemistry, 4th edition, W.H Freeman and Company, 2004.
3. L. Stryer, Biochemistry, 5th edition, W.H. Freeman and Company, 2002.
4. A. C. Deb, Fundamentals of Biochemistry

GENERIC ELECTIVE COURSE: I
PRINCIPLES OF MICROBIOLOGY

Paper Code: Time Allowed: 3 Hours

Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION-A

History of development of Microbiology in 20^{th} century; The spontaneous generation controversy; Germ theory of disease; Microbes and fermentation; Physical and chemical methods of sterilization; Microscopy - light, confocal and electron.

SECTION-B

Binomial Nomenclature; Haeckel's three kingdom classification; Basic principles and techniques used in bacterial classification; Use of DNA and r-RNA sequencing in classification of microorganisms; Woese's three kingdom classification system and its utility - archaea, eubacteria, eukarya; Organization of prokaryotic and eukaryotic cell in detail; Different groups of acellular microorganisms - viruses, viriods and prions.

SECTION-C

General features of microorganisms - Bacteria, Algae, Fungi and Protozoa; Classification of bacteria; Bacterial growth and metabolism; Microbes in different environment; Microbes in extreme environment - special features of the thermophilic, methanogenic and halophilicarchaea; Photosynthetic bacteria, Cyanobacteria; Microbes in other extreme conditions - deep ocean and space.

SECTION-D

Scope of Microbiology; Biogeochemical cycles; Microbial interactions - mutualism, symbiosis, commensalisms, predation, parasitism, amensalism, competition;

Bioluminescence; Biodegradation; Biofilms; Cleaning oil spills; Microbes in composting; Biocontrol agents; Bioremediation; Bioleaching; SCP; Microbial enzymes and fermented foods; Human, animals and plant diseases and their causative agents; Aeromicrobiology.

Suggested readings:

1. Atlas RM (1997). Principles of obiology, Wm C Brown Publishers, USA.
2. Brock TD (1961). Milestones in Microbiology, Infinity Books.
3. Madigan MT, Martinko JM, Parker J (2015). Brock Biology of Microorganisms, 14th edition, Pearson Education Ltd, Prentice-Hall, Englewood Cliffs, NJ, Inc USA.
4. Pelczar MJ, Chan ECS, Kreig NR (1993). Microbiology: Concepts and Application, 5th edition, Tata McGraw Hill, New Delhi.
5. Stanier RY, Ingraham JL, Wheelis ML, Painter PR (1976). General Microbiology, 4th edition, MacMillan, New Jersey, USA.

GENERIC ELECTIVE COURSE: II
INTRODUCTION TO BIOTECHNOLOGY

Paper Code: Time Allowed: 3 Hours

Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION-A

Biotechnology: An overview-definition, Scope and importance of biotechnology, Concepts of recombinant DNA technology and Gene Cloning. Nano Science & Technology: An Overview, Insights and intervention into the Nano world.

SECTION-B

Microbial Biotechnology: A brief account of microbes in industry and agriculture, Metabolic engineering for over production of metabolites.

Plant Biotechnology: Introduction to plant tissue culture and its applications, Gene transfer methods in plants, Transgenic plants (A brief introduction), Chloroplast and mitochondria engineering.

SECTION-C

Animal Biotechnology: In-vitro fertilization and embryo transfer in humans and livestock, Transfection techniques and transgenic animals, Animal Cloning.

Medical Biotechnology: (A brief account) Biotechnology in medicine, Vaccines, Molecular diagnostics, Forensic, Gene therapy, Nano Medicine & Drug Delivery Cell & Tissue Engineering, Stem Cell therapy.

SECTION-D

Environmental Biotechnology: (A brief account) Role of biotechnology in pollution control, Sewage treatment, Energy management, Bioremediation, Restoration of degraded lands and Conservation of biodiversity. 14 hours

Suggested Readings:

1. Nelson DL and Cox MM (2013), Lehninger Principles of Biochemistr, 6th Edition Freeman and Company, New York

2. Pelczar, M.J. et. al (2001), Microbiology- Concepts and Applications, International Ed. McGraw Hill Publication, New York

3. Stanbury, P.F., Hall, S., Whitaker, A. (1998), Principles of Fermentation Technology, 2 ndedn. Butterworth-Heinemann Ltd

4. Plant Biotechnology – The genetic manipulation of plants (2003) by Slater A., Scott N. and Fowler M., Oxford University Press.

5. Animal Cell Culture Methods In: Methods in Cell Biology, Vol. 57, Ed. Jenni P Mather and David Barnes, Academic Press.

6. Genome-3 (2007) T.A Brown. Garland science, Taylor & Francis, NewYork.

7. Diagnostic and Therapeutic Antibodies (Methods in Molecular Medicine by Andrew J.T. George (Editor), Catherine E. Urch (Editor) Publisher: Humana Press; edition (2000).

8. Ajayan, P., Schadler, L.S. & Braun, P.V., 2003. Nanocomposite Science and Technology. Wiley-VCH Verlag.

SEMESTER-1
CC-PRACTICAL-1

Paper Code: Time Allowed: 6 Hours
Max. Marks: 100 Credits: 4
Minimum 20 experiments are to be conducted as per the availability and circumstances

MICROBIAL DIVERSITY

1. Viruses: Diagrammatic representation and ultrastructure of some typical viruses like TMV, Bacteriophage, Cyanophage. EM photographs of RNA and DNA Viruses. Viral diseases of plants and animals (Specimens, Diagrams only).
2. Bacteria: General morophology (permanent slides and live materials) e. g.
   I. Coccoid
   II. Rod – shaped (Bacillus etc)
   III. Vibrio
   IV. Spirillum
3. Algae: Thallus range with class representatives (*Volvox, Cladophora, Oedogonium, Vaucheria, Spirogyra*)
4. Fungi: Thallus range with class representatives *(Puccinia, Aspergillus, Penicillium, Mucor, Ustilago, Alternaria*).

CRYPTOGAMMIC BOTANY

1. Comparative study of anatomy of vegetative and reproductive parts of *Cycas, Pinus,Ginkgo, Cedrus, Aracaria, Cryptomeria, Ephedra, Gnetum* and *Taxus.*

2. Morphological study of representative members of Bryophytes and Pteridophytes.

Bryophytes: *Marchantia, Anthoceros, Funaria, Polytrichum, Pellia, Porella, Sphagnum*.

Pteridophytes: *Lycopodium, Selaginella, Psilotum, Equisetum, Adiantum, Marsilea, Azolla, Pteris, Ophioglossum, Dryopteris, Nephrolepis*.

3. To study permanent slides of Bryophytes, Gymnosperms and Pteridophytes.
4. Collection and submission of locally available Cryptogammic plant species.

CELL BIOLOGY

1. Separation of nucleic acid bases by paper chromatography.
2. Microscopy- Theoretical knowledge of Light and Electron microscope.
3. Study of the following techniques through electron / photo micrographs: Fluorescence microscopy, autoradiography, positive staining, negative staining, freeze fracture, freeze etching,
shadow casting.
4. Study of structure of cell organelles through electron micrographs.

Permanent slide preparation:

5. Cytochemical staining of DNA-Feulgen.
6. Cytochemical staining of DNA and RNA- Methyl Green Pyronin (MGP).
7. Cytochemical staining of Polysaccharides-Periodic Acid Schiff's (PAS).
8. Cytochemical staining of Total proteins- Bromophenol blue.
9. Cytochemical staining of Histones -Fast Green.

SEMESTER-II

Core Course: V
PLANT SYSTEMATICS AND EVOLUTION

Paper Code: Time Allowed: 3 Hours

Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION A

Evolutionary Biology: Origin of life (including aspects of prebiotic environment and molecular evolution); Concept of evolution; Theories of organic evolution; Mechanisms of speciation. Hardyweinberg genetic equilibrium, genetic polymorphism and selection, origin and evolution of economically important crops (Wheat, Rice and cotton)

SECTION B

Principles of taxonomy, characters considered before plant identification; identification keys, computer aided identification, floral formula and floral diagram. Salient features of the International Code of Botanical Nomenclature (ICBN); some important rules of nomenclature; brief idea about phylocode as a new system of nomenclature

SECTION C

Systems of angiosperm classification: Phenetic versus phylogenetic systems; cladistics in taxonomy; Relative merits and demerits of major systems of classification. Taxonomic evidence: Morphology, anatomy, palynology, embryology, cytology; Modern trends in plant taxonomy: Numerical taxonomy, Chemotaxonomy, molecular taxonomy.

SECTION D

Herbarium and botanical garden: purpose of modern herbarium, techniques of herbarium preparation, description of flowering plants in different types of herbaria, major Indian herbaria and botanical gardens, importance of herbarium and botanical gardens in botanical research; Relevance of taxonomy to conservation, sustainable utilization of Bioresources and ecosystem research.

Suggested Books

- Davis, P.H. and Heywood, V.M. 1973. **Principles of Angiosperm Taxonomy**. Robert E. Kereiger Publ. New York.
- Grant, W.F. 1984. **Plant Biosystematics**. Academic Press, London.
- Heywood, V.H. and Moore, D.M. 1984. **Current Concepts in Plant Taxonomy**. Academic Press. London.
- Radford, A.E. 1986. **Fundamentals of Plant Systematics**, Harper & Row Publ. USA.
- Stace, C.A. 1989. **Plant Taxonomy and Biosystematics** (2nd ed.) Edward Arnold Ltd. London.
- Takhtajan, A.L. 1997. **Diversity and Classification of Flowering Plants**. Columbia Univ. Press, New York.
- Nordenstam, B., El Gazaly, G. and Kassas, M. 2000. **Plant Systematics for 21st Century**. Portland Press Ltd. London
- Singh, G. 2005. **Plant Systematics: Theory and Practices** (2nd Ed.) Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi
- Sambamurty, A.V.S.S. 2005. **Taxonomy of Angiosperms**. I.K. International Pvt. Ltd., New Delhi.
- Naik, V.N. 2006. **Taxonomy of Angiosperms**. Tata McGraw Hill Education Pvt. Ltd. New Delhi.
- Sharma, O.P. 2009. **Plant Taxonomy**. Tata McGraw Hill Education Pvt. Ltd. New Delhi.
- Verma, B.K. 2011. **Introduction to Taxonomy of Angiosperms**. PHI Learning Pvt. Ltd. New Delhi.

Core Course: VI
PLANT TISSUE CULTURE

Paper Code: Time Allowed: 3 Hours
Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION A

Plant Tissue Culture: General introduction, History and Scope and basic concepts ,laboratory Organization; media preparation and sterilization techniques, Nutrition of plant tissues-Growth limiting Factor, Concept of cellular differentiation and totipotency, Types of culture, Embryo and Endosperm culture, Induction and maintence of Callus and suspension Cultures

SECTION B

Fundamental aspect of Morphogenesis, Study of differentiation through Organogenesis and Embryogenesis, Somatic embryogenesis, Zygotic vs. Somatic embryogenesis, micropropagation advances and encapsulation of somatic embryo & shoot tip for artificial seeds and its applications, In vitro production of haploids, techniques and utility, Haploid for breeding and selection of mutants

SECTION C

Protoplast isolation, fusion, culture, hybrid selection and regeneration possibilities with special reference to crop plants, Limitations of protoplast research, Somatic hybridization and selection mechanism for hybrids and cybrids, cell line selection through callus/ suspension culture for the production of stress resistant plants, their application in crop improvement

SECTION D

Somaclonal & gametoclonal variations, Large scale clonally propagation of plants, Cryopreservation and germplasm storage, embryo/endosperm culture, Applications of plant tissue culture in Forestry, Ornamental Plants, Disease free plants and in the production of secondary metabolites/natural products.

Suggested Books

1. Bajaj, Y.P.S. 1986. Biotechnology in agriculture and forestry Vol.2 Crops.Springer Verlag

2. Dodds.J.H and L.W. Roberth.1985. Experiments in plant tissue culture. Cambridge University Press.

3. Vasil,I.K and T.A.Thorpe.1994. Plant Cell and Tissue Culture. Kluwer Academic Press.

4. Owen and Pen, 1996? Transgenic plants-a production system for industrial and pharmaceutical proteins, Wiley.

Core Course: VII
MOLECULAR BIOLOGY

Paper Code: Time Allowed: 3 Hours
Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.
2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION A

Key experiments establishing-The Central Dogma and DNA as genetic material, DNA Structure: Miescher to Watson and Crick, Salient features of double helix, Types of DNA, denaturation and renaturation. RNA Structure
Organelle DNA -- mitochondria and chloroplast DNA.
The Nucleosome Chromatin structure- Euchromatin, Heterochromatin. Regulation of Chromatin Structure and Nucleosome Assembly.

SECTION B

Chemistry of DNA replication, general principles - bidirectional replication, Semi-conservative, Semi discontinuous, RNA priming, Various models of DNA replication including rolling circle, D-loop (mitochondrial), Θ (theta) mode of replication. Replicating the 5'end of linear chromosome, Enzyme involved in DNA replication – DNA polymerases, DNA ligase, Primase, Telomerase and other accessory proteins

SECTION C

RNA Polymerase and the transcription unit, Transcription in Prokaryotes & Eukaryotes, ribosome structure and assembly, various steps in protein synthesis. Charging of tRNA, aminoacyl tRNA synthetases. Proteins involved in initiation, elongation and termination of polypeptides. Fidelity of translation. Inhibitors of protein synthesis.

SECTION D

Transcription Regulation in Prokaryotes: Principles of transcriptional regulation, regulation at initiation with examples from *lac* and *trp* operons

Transcription Regulation in Eukaryotes: Conserved mechanism of regulation, Eukaryotic activators, Signal integration, combinatorial control, transcriptional repressors, signal transduction and control of transcriptional regulator, Gene Silencing

SUGGESTED BOOKS

1. Lewin, B. 2000. **Genes VII**, Oxford University Press, USA.
2. DeRobertis, E.D.P. and De Robertis, E.M.F. 2001. **Cell and Molecular Biology**, Lippineott Williams & Wilkins, Bombay.
3. Sharma, A.K. and Sharma, A. 1980. **Chromosome Techniques**. Theory and Practice, Butterworth.
4. Stebbins, J.L. **Chromosomal Evolution in Higher Plants**, Edward Arnold Publ., London.

5. Roy, S.C. and Kumar, K.D.C. 1977. **Cell Biology**, New Central Book Agency, Calcutta.
6. Wolfe, S.L. 1993. **Molecular and Cellular Biology**, Wordsworth Publ. Co., California, USA.

GENERIC ELECTIVE COURSE: I
PLANT BIOTECHNOLOGY

Paper Code: Time Allowed: 3 Hours
Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION A

Tools of Genetic engineering - Enzymes, Cloning vectors (Plasmids, Bacteriophages, Cosmids, Phagemids, Shuttle vectors, transposons vectors, artificial chromosomes as vector and eukaryotic vectors) Constriction of genomic library , and cDNA library, Staggered cleavage, addition of oligopolymer tailing ,blunt end ligation, Polymerase Chain Reaction (PCR) Principals, technique and modifications, Gene cloning Vs PCR, application , Applications of PCR.

SECTION B

DNA synthesis and gene sequencing, Aims, strategies for the development of transgenic - Transformation vectors, Promoters from heterologous sources and its utility, Terminators, Markers and Reporter genes, *Agrobacterium* mediated gene transfer, Molecular genetics of T- DNA transfer from *Agrobacterium* to plants, Direct gene transfer methods, Comparison of vector – mediated & vector free methods, Gene tagging in transgenic plants, Uses of transgenes for herbicide Salinity and drought tolerance

SECTION C

Chloroplast and Mitochondrial Transformation, Mechanism and Genetics of nitrogen fixation, *nif* & *nod* gene cluster, Fermentation Technology, Genetic improvement of industrial microbes & N2 fixer, Biofertilizer, Nutritional quality improvement - Golden rice and other development

SECTION D

Molecular markers for introgression of useful traits in plants, Genomics and Proteomics: Genome project, Microarray, protein profiling and its significance, Applications of G.E. to Health, Industry & Agriculture, including gene therapy, IPR and regulatory requirements

Suggested Books

1. Foster and Twell. (1997).Plant gene isolation: Principles and Practice
2. Owen and Pen (1997.Transgenic plants :(a production system for industrial and pharmaceutical proteins)
3. Kung and Wu (1993).Transgenic Plants: Vols 1&2
4. Potrykus and Spangenberg 1995.Gene Transfer to Plants
5. Brown.T.A. 1995. Gene Cloning an Introduction. (3rd edition). Chapman Hall, 2-6 Bundary Row, U.K.
6. Rissler and Mellon 1996.Ecological risks of transgenic crops
7. Old and Primrose (1984).Principles of gene manipulation. Blackwell

GENERIC ELECTIVE COURSE: II
TOOLS AND TECHNIQUES

Paper Code: Time Allowed: 3 Hours
Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION A

Microscopy: Principles and applications of light, phase contrast, fluorescence microscopes, scanning and transmission electron microscopes. Fixation and staining; cytophotometry and flow cytometry.

SECTION B

Chromatography: Principles and applications of gel filtration, ion-exchange, affinity, thin layer, gas chromatography and high pressure liquid chromatography (HPLC). Electrophoresis and centrifugation: Principles and applications of agarose and polyacrylamide gel electrophoresis; ultracentrifugation (velocity and buoyant density).

SECTION C

Molecular biology techniques: southern, northern and western blotting techniques, polymerase chain reaction (PCR), ELISA. Methods for measuring nucleic acid and protein interactions; DNA fingerprinting; Molecular markers (RFLP, AFLP, RAPD).

SECTION D

Spectroscopy: Fluorescence, UV, visible, NMR and ESR spectroscopy; X-ray diffraction. Tracer Biology: Principles and applications of tracer techniques in biology; radioactive isotopes and half-life of isotopes; autoradiography.

Suggested Books

1. Freifelder D. (1982), Physical Biochemistry- Application to Biochemistry and Molecular Biology, 2nd Edition, W.H. Freemen and Company, San Fransisco.

2. Rietdorf, J. (2010) Microscopy Techniques, Springer, Berlin

3. Walker J. and Wilson K (2010), Principles and Techniques-Practical Biochemistry, 7 th Edition, Cambridge University Press, London.

4. Robyt, J.F. and White, B.J. (1987) Biochemical Techniques: Theory and Practice, Waveland Press

5. Skoog, D.A.; Crouch, S.R. and Holler, F.J. (2006) Principles of Instrumental Analysis, 6thEdn. Brooks/Cole, USA

6. Slater R.J. (1990), Radioisotopes in Biology-A Practical Approach, Oxford University Press, New York.

7. Boyer, R.F. (2006) Modern Experimental Biochemistry, Pearson, New Delhi.

DISCIPLINE SPECIFIC ELECTIVE COURSE: I
SOIL AND AGRICULTURAL MICROBIOLOGY

Paper Code: Time Allowed: 3 Hours
Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION-A

History of Development of soil microbiology; Soil microbiota and their interactions; Unculturable soil microbiota; Soil microbial ecology; Microorganisms in soil fertility; Influence of soil and environmental factors on microflora; Microbial population in manure and composts; Soil amendments and microbial dynamics.

SECTION -B

Microorganisms in biogeochemical cycles; Microbial transformations of carbon, nitrogen, phosphorus, sulphur, iron and manganese; Biodegradation of pesticides and other organic wastes; Production of biogas; Production of manure using organic waste; Methods to improve soil structure and soil health by microorganisms.

SECTION-C

Interrelationships between plants and microorganisms – Rhizosphere (Quantitative and qualitative studies – R:S ratio), Rhizoplane, spermosphere, phyllosphere microorganisms; Nitrogen fixation by soil bacteria - symbiotic, non-symbiotic, associative symbiotic and endophytic organisms, process of nitrogen fixation; Molecular biology of Nitrogen fixation; PGPR (plant growth promoting rhizobacteria), siderophore producers and biocontrol agents.

SECTION-D

Biofertilizers – Mycorrhizal inoculants, Mass cultivation of microbial inoculants; Green manuring; Microbial products and plant health; Microbial Pesticides: development and their significance.

Suggested readings:

1. Alexander M (1985). Introduction to Soil Microbiology, 3rd edition, Wiley Eastern, New Delhi.

2. Atlas RM, Bartha R (1998). Microbial Ecology: Fundamentals and Applications, 4th editions, Benjamin Cummings, San Francisco.

3. Paul EA (2007). Soil Microbiology, Ecology and Biochemistry, 3rd edition, Academic

Press, New York, USA.

4. Sylvia D, Fuhrmann J, Hartel P, Zuberer D (2005). Principles and Applications of Soil Microbiology, 2nd edition, Pearson Education, USA.

5. van Elsas JD, Trevors JT, Wellington EMH (1997). Modern Soil Microbiology. Marcel Dekker, New York, USA.

DISCIPLINE SPECIFIC ELECTIVE COURSE: II
PLANT PATHOLOGY

Paper Code: Time Allowed: 3 Hours
Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section-A

Introduction and history of plant pathology; Definitions and concepts of plant diseases; Biotic and abiotic factors responsible for plant diseases; Interaction of microorganisms with plants and their effect on plant growth.

Section-B

Growth, reproduction, survival and dispersal of important plant pathogens; Production of various enzymes, toxins and other metabolites by pathogens for causing disease; Role of environment and host nutrition on disease development; Diseases of some important cereals, vegetables and crops - Crown gall, downy mildew; Symptoms of important viral diseases and their control.

Section-C

Host parasite interactions - recognition and infection, symptomatology, disease development-role of enzymes, toxins, growth regulators; defense strategies, oxidative burst; Phenolics, phytoalexins, PR proteins, elicitors and their effects on host plants.

Section-D

Plant disease resistance – Pathogen Associated Molecular patterns, Pattern Recognition Receptors, PTI, Effectors, ETI, 'R' genes; Mechanism of genetic variation in pathogens; Disease control in plants - physical, chemical methods; Use of biocontrol agents - bacteria and fungi; Molecular markers for disease resistance in plants; Transgenic approach for plant protection - applications and constraints.

Suggested Readings

1. Agrios GN (2005). Plant Pathology, 5th edition, Academic Press, New York.
2. Dickinson M (2003). Molecular Plant Pathology, BIOS Scientific Publishers, London.
3. Mukerji KG, Garg KL (1988). Biocontrol of Plant Diseases (Vol. I) CRC Press, Inc., Boca Raton, Florida, USA.
4. Sigee DC (1993). Bacterial Plant Pathology, Cell and Molecular aspects, Cambridge University Press, UK.
5. Upadhyay RK, Mukherjee KG (1997). Toxins in Plant Disease Development and Evolving Biotechnology. Oxford & IBH.

SEMESTER-2
CC-PRACTICAL-2

Paper Code: Time Allowed: 6 Hours
Max. Marks: 100 Credits: 4

PLANT SYSTEMATICS

1. Description of a specimen from representative, locally available families such as Apiaceae, Asclepiadaceae, Asteraceae, Apocynaceae, Brassicaceae, Chenopodiaceae, Convolvulaceae, Cryophyllaceae, Cucurbitaceae, Euphorbiaceae, Fabaceae, Lamiaceae, Liliaceae, Malvaceae, Myrtaceae, Poaceae, Ranunculaceae, Rosaceae, Rubiaceae, Solanaceae, Verbenaceae etc.
2. Location of key characters and use of keys at family level
3. Description of various species of a genus, location of key characters and preparation of keys at generic level.
4. Preparation of herbarium of locally available wild plants.
5. Training in using floras and herbarium for identification of specimens described in class.
6. Field trips / excursion, compilation of field notes and preparation of herbarium specimens of wild plants.

PLANT TISSUE CULTURE

1. Preparation of germination medium
2. Inoculation of seeds on germination medium
3. Determination of fresh and dry weight of *in vitro* seedling
4. Preparation of culture medium (MS/B5 medium)
5. Culture of explants on MS medium
6. Establishment and maintenance of callus & suspension culture
7. Organogenesis and Somatic embryogenesis using appropriate explants
8. Multiple shoots induction & calli regeneration
9. Raising of haploids by tissue culture
10. Protoplast isolation from various tissues and testing their viability
11. Demonstration of fusion technique

MOLECULAR BIOLOGY

1. Histochemical localization of nucleus and nucleolus.
2. Isolation quantification of RNA.
3. Isolation quantification of DNA.
4. Isolation quantification of Proteins.
5. To study chromosomal banding pattern.
6. To determine the Tm of given sample of RNA and DNA.
7. Separation of proteins through electrophoresis

PLANT BIOTECHNOLOGY

1. Growth characteristics of bacteria using planting & turbidimetric methods.
2. Isolation of plasmids from bacteria by alkaline lysis and its quantification Spectrophotometrically
3. Co-cultivation of plant material with *Agrobacterium* and study GUS activity Histochemically.
4. Isolation of DNA from suitable plant material.
5. Spectrophotometer demonstration of DNA/RNA.
6. Study of PCR

TOOLS AND TECHNIQUES

1. Demonstration of working of different types of microscopes.
2. Demonstration of Chromatography i.e. TLC, HPLC, GC.
3. To demonstrate the separation of proteins with the help of electrophoresis.
4. To study various molecular biology techniques i.e. PCR, ELISA.
5. To demonstrate the use of spectrophotometer.
6. Purification of protein by column chromatography.
8. Visit of various laboratories in the university, preparation and submission of report.
9. Principles of Calorimetry, Spectrophotometry and Fluorimetry.

SOIL & AGRICULTURAL MICROBIOLOGY

1. Determination of soil microbial population
2. Isolation of different bacterial and fungal organisms important in recycling of C, N, P, S in soil
3. Soil microbial biomass
4. Decomposition studies in soil, Soil enzymes
5. Measurement of important soil microbial processes such as ammonification, nitrification, N_2 fixation, S oxidation, P solubilization and mineralization of other micro nutrients
6. Study of rhizosphere microflora effect on plant growth.

PLANT PATHOLOGY

To study the symptoms and diagnostic features of causal organisms of the following plant diseases:

1. Downy mildew of grapes
2. Karnal bunt of wheat
3. Smut of bajra
4. Late and early blight of potato
5. Yellow vein mosaic of Bhindi
6. Tikka disease of groundnut
7. Bacterial blight of paddy
8. Black rust of wheat

SEMESTER-III

Core course-VIII

GENETICS

Paper Code: Time Allowed: 3 Hours
Max. Marks:75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

Section A

Mendel's laws and their chromosomal basis; extension of Mendel's principles: allelic variation and gene function- incomplete dominance and co-dominance, allelic series, testing gene mutations for allelism; gene action- from genotype to phenotype– penetrance and expressivity, gene interaction, epistasis, pleiotropy. Fine structure of Gene.

Section B

Methods of gene mapping: 3- point test cross in Drosophila, pattern of inheritance by pedigree analysis and gene mapping. Gene mutation, types of gene mutations, methods for detection of induced mutations; P- element insertional mutagenesis in Drosophila; DNA damage, repair and recombination.

Section C

Regulation of Gene Expression:Regulation of gene activity in lac and trp operons of E. coli.;General introduction to gene regulation in eukaryotes at transcriptional and posttranscriptional levels; Chromatin organization and gene expression, transcription factors, enhancers and silencers, non-coding genes.

Section D

Mechanisms of sex determination and Dosage Compensation: Human,DrosophilaandC. elegans. Genetic analysis of complex traits - complex pattern of inheritance, quantitative traits, threshold traits. Chromosome banding, karyotype and nomenclature of metaphase chromosome; chromosomal anomalies in malignancy (chronic myeloid leukemia, Burkitt's lymphoma, retinoblastoma and Wilms' tumor); oncogenes and tumor suppressor genes-genetic pathways to cancer.

Suggested Books:

1. Principles of Genetics, Snustad and Simmons, John Wiley & Sons, USA [Latest edition] .

2. Modern Genetic Analysis: Integrating Genes and Genomes, Griffiths, J.F., Gilbert, M., Lewontin, C. and Miller, W. H. Freeman and Company, New York, USA[Latest edition] .

3. Genetics, J. Russell, Benjamin-Cummings Publishing Company, San Francisco, California, USA [Latest edition] .

Core Course: IX
PLANT PHYSIOLOGY

Paper Code: Time Allowed: 3 Hours
Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION A

Water: Structure, properties and movement, osmosensors. Water absorption and conduction. Loss of water from plants, stomatal physiology. Beneficial nutrient elements, their functions and deficiency symptoms. Toxic effects of minerals. Antagonistic and synergistic relationship amongst ions. Nutrient uptake by roots. Root microbe interactions for nutrient uptake. Comparison of xylem and phloem transport, molecular mechanism of phloem loading and unloading, passive or active solute transport.

SECTION B

Signal transduction: Overview, receptors and G-proteins, phospholipid signaling, role of cyclic nucleotides, Ca+2 - calmodulin cascade. Regulation of signaling pathways. Diversity in protein kinases and phosphatases, specific signaling mechanisms-two component system in plants.Physiology of flowering: History, discovery, properties and molecular structure of phytochromes and cryptochromes. Photoperiodism, photoinduction and endogenous rhythms.

SECTION C

Promoters and inhibitors of plant growth. Structure, bioassay, transport, storage, physiological role and mechanism of action of auxins, gibberellins and cytokinins. Peptide hormones in plants. Structure and function of ABA, ethylene, ascorbic acid, brassinosteoids, polyamines (putrescine, spermidine, spermine and cadavarin), jasmonic acid and salicylic acid.

SECTION D

Stress physiology: Type of stresses. Plant responses and mechanism of tolerance of biotic and abiotic stress. Water, temperature, salt, heavy metal and oxidative stress. Effect of air pollutants SO2 and O3 and elevated CO2 on plants. Hypersensitive reaction and systemic acquired resistance. Role of phytoalexins and phenyl propanoid pathway in plants. Secondary plant metabolites: role of terpenes, phenols and nitrogenous compounds, allelopathy.

PLANT PHYSIOLOGY

1. Demonstration of stomatal activity from suitable plant material.

2. To study plant responses to red and far-red light.

3. Bioassay of auxin, cytokinin and gibberellins.

4. Effect of plant hormones on growth.

5. To study the effect of plant hormones on enzymatic activity.

6. To study the effect of salt and water stress on seed germination and plant growth in terms of metabolites.

Suggested Books:

1. Brett, C.T. and Waldron, K.K. 1996. Physiology and Biochemistry of Plant Cell Walls, Chapman and Hall London.
2. Conn, E.E. and Stumpf P.K. et al., 1999. Biochemistry. John Wiley and Sons. New Delhi.
3. Daphne. J. Osborne, Micheal. B. Jackson. 1989. Cell separation in plants physiology, Biochemistry and Molecular Biology. Springer – Verlag. Berlin.
4. David T. Dennis and David H. Trurpin (Eds.) 1993. Plant Physiology, Biochemistry and Molecular Biology. Longmann Scientific and Technical, Singapore.

Core Course: X
PRINCIPLES OF ECOLOGY

Paper Code: Time Allowed: 3 Hours

Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION A

Environment – the concept and limits; Law of tolerance and Law of Limiting factors, abiotic factors, biotic interactions, biogeographical distributions – ecological equivalents, Phylogeography, The biosphere, biomes and ecological zones, Bioindicators and biomarkers, Environmental pollution and mitigation strategies.

SECTION B

Characteristics of population, population size and exponential growth, limits of population growth, population dynamics, life history pattern, fertility rate and age structure, population growth (density dependent and density independent). Metapopulation dynamics, Competition and coexistence, intra-specific interactions, inter specific interactions, scramble and contest competition model, symbiosis, pre-predator interactions.

SECTION C

Nature of ecosystem, production, food webs, energy flow through ecosystem, biogeochemical cycles, resilience of ecosystem, ecosystem management. Case studies of climax and disturbed ecosystems. Ecological factors and plant adaptation. Concepts of ecosystem restoration and applications. Biodiversity – assessment, conservation and management, Biodiversity acts and conventions.

SECTION D

Sustainable Development, Natural resource management in changing environment, Molecular ecology and applications in conservation biology, Global climatic patterns and variations over time, climate change and global warming, coping with environmental variations. Environmental Impacts and their assessment.

Suggested Books:

1. Odum, E.P. (2011). Fundamental of Ecology. 5th Edition. Saunders. ISBN 9780030584145. 613 pages.

2. Real, L.A. and Brown, J.H. (Eds.) (1991). Foundations of Ecology: Classic Papers with Commentaries. The University of Chicago Press. ISBN-10 0-226-70594-3. 904 pages.

3. Chapman, J.L. and Reiss, M.J. (2003). Ecology: Principles and Applications. Second Edition. Cambridge University Press, UK. ISBN 0 521 58802 2. 335 pages.

4. Singh, J.S., Singh, S.P. and Gupta, S.R. (2006). Ecology, Environment & Resource Conservation. Anamaya Publishers. ISBN 978 8188342556. 688 pages.

GENERIC ELECTIVE COURSE: I
DEVELOPMENTAL AND REPRODUCTIVE BIOLOGY

Paper Code: Time Allowed: 3 Hours

Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION A

Key concepts in growth and development, plant growth vs animal growth, Positive and negative regulatory networks; coordination of growth, isotropic and anisotropic growth, polarity, proliferation and termination of growth, Growth and development of three dimensional structures, developmental plasticity, Meristems: Different types, RAM, SAM, Cell fate determination, lineage decisions, developmental patterning

SECTION B

Differentiation of cells: stomata, trichomes, tracheary elements etc.; Development of organs: organ identity, key regulatory mechanisms in development of size and shape of specific organs such as leaf, stem, shoot etc., Development and evolution of form and its diversity, Plant architecture: growth of main stem and lateral organs, branching pattern and apical dominance, root and shoot architecture, phyllotaxy, determinate and indeterminate growth.

SECTION C

Transition to flowering; formation of inflorescence and floral meristems, maintenance of domains; floral homeotic mutations in Arabidopsis, Antirrhinum and Petunia, Regulation of anther and ovuledevelopment, microsporogenesis andmicrogametogenesis, megasporogenesis andmegagametogenesis, domains of pollen wall, pollen embryogenesis.

SECTION D

Progamic phase, in vitro pollen germination, pollen tube growth and guidance, double fertilization, self-incompatibility mechanisms, incongruity. Polarity during embryogenesis, pattern mutants, invitro fertilization, endosperm development, apomixis, polyembryony, somatic embryogenesis.

Suggested Books:

1. Bhojwani, S.S., and Razdan, M.K. (1996). Plant Tissue Culture: Theory and Practice, Elsevier

2. Beck, C.B. (2010). An Introduction to Plant Structure and Development, II edition

3. Pua, E-C. and Davey, M.R. (2010). Plant Developmental Biology-Biotechnological perspectives

4. Fosket, D.E. (1994). Plant, Growth and Development: A Molecular Approach, Academic Press.

5. Hopkins, W.G. (2006). The Green World: Plant Development, Chelsea House Publication

6. Howell, S.H. (1998). Molecular Genetics of Plant Development, Cambridge University Press.

7. Leyser, O. and Day, S. (2003). Mechanism of Plant Development, Blackwell Press, 241p.

8. Raghavan, V. (1997). Molecular Embryology of Flowering Plants. Cambridge. University Press.

9. Raghavan, V. (2000). Developmental Biology of Flowering Plants, Springer, Netherlands

10. Shivanna, K.R. (2003). Pollen Biology and Biotechnology, Science Publishers.

11. Shivanna, K.R. and Rangaswamy, N.S. (1992). Pollen Biology: A Laboratory Manual, springer Verlag

12. Whitelam, G.C. and Halliday, K.J. (2007). Light and plant development; Blackwell Publishing; 325p; ISBN : 978-1-4051-4538-1

13. Wolpert, L., Jessell, T., Meyerowitz, E., Robertson, E. and Smith, J. (2007). Principles of Development; Oxford, Oxford University Press.

GENERIC ELECTIVE COURSE: II
BIOINFORMATICS AND BIOSTATISTICS

Paper Code: Time Allowed: 3 Hours

Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION-A (Biostatistics)

Basic definitions and applications, Data collection and representation. Measure of central tendencies (Mean, Median and Mode) and dispersal; measure of variability (standard deviation, standard error, range, mean deviation, coefficient of variation); probability distributions (Binomial, Poisson and Normal), sampling distribution ,Difference between parametric and nonparametric statistics, confidence interval, errors, levels of significance 3. Regression and correlation, t-test, analysis of variance, chi-square test, Basic introduction to Multivariate statistics.

SECTION-B (Biological databases)

Brief on programming languages commonly used in Biological Sciences, Database-introduction, Primary, Secondary and Tertiary databases; Type and kind of databases; Literature search (PUBMED and MEDLINE). ,Nucleic acid (GenBank, EMBL etc.); Structural databases- PDB, PDBsum, NDB, CATH, SCOP etc. Motifs and Pattern Databases-PROSITE, Pfam, iPfam etc. ,Protein databases (SWISS PROT, UNIPROT etc.); Structural databases- PDB, PDBsum, NDB, CATH, SCOP etc; Motifs and Pattern Databases-PROSITE, Pfam, etc. , Sequence retrieval (SRS, Entrez) and Data submission.

SECTION-C (Sequence analysis)

Sequence alignment- introduction and concepts, Local and Global alignment concepts. Similarity and Percent identity score (open, extended gap penalty). Multiple sequence alignment (MSA) - introduction and concepts. Types of multiple sequence alignment techniques. Description of major softwares (MSA, CLUSTAL variants (X, W2, OMEGA), PILEUP, T-Coffee, PROS, CONS). ,Database Scanning and Sequence similarity searches. Algorithm of FASTA. Description of BLAST algorithm. Various BLAST programs (BLASTP, BLASTN, BLASTX, PHIBLAST, PSIBLAST etc). Protein Structure:

Classification, Structure Analysis, Secondary structure predictions, Comparative/Homology modeling, Modeling using Swiss Model Server.

SECTION-D (Genome analysis)

Introduction to genomes, sequencing techniques. Sequencing of whole genomes. Next Gen Sequencing (NGS); Assembling of genomes from short reads ,Concept of Metagenomics;Types of repeats and repeat finding techniques; Structure of genes; Prediction of gene in prokaryotic and eukaryotic genomes (GENESCAN, GeneMark, GeneSeqer etc.); Promoter prediction in E. coli and in eukaryotes , Description of major gene prediction methods

PRACTICALS:

1. Sequence (DNA & Protein) alignments

2. Genome sequence studies

3. Designing ideal primers for amplification of genetic material

4. Deciphering 3-D structure of proteins

5. Designing inhibitors of enzymes

Suggested Books:

1. Understanding Bioinformatics by Marketa Zvelebil and Jeremy Baum (2007) Publisher: Garland Science; 1 st edition ISBN-10: 0815340249, ISBN-13: 978-0815340249

2. Essential Bioinformatics by Jin Xiong (2006) Publisher: Cambridge University Press; 1st edition ISBN-10: 0521600820, ISBN-13: 978-0521600828

3. Bioinformatics: Sequence and Genome Analysis by David W. Mount (2004). Publisher: Cold Spring Harbor Laboratory Press; 2 nd edition ISBN-10: 0879697121 ISBN-13: 978-0879697129

4. An Introduction to Bioinformatics Algorithms (Computational Molecular Biology) by Neil C. Jones and Pavel A. Pevzner (2004) Publisher: The MIT Press; 1 st edition ISBN-10: 0262101068, ISBN- 13: 978-0262101066

5. Bioinformatics: A Biologist's Guide to Biocomputing and the Internet by Stuart M. Brown (2000). Publisher: Eaton Publishing Company/Biotechniques Books ISBN-10: 188129918X, ISBN- 13: 978-1881299189

DISCIPLINE SPECIFIC ELECTIVE COURSE: I
IMMUNOLOGY

Paper Code: Time Allowed: 3 Hours

Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION-A

Overview of Immune System, Historical perspective of Immunology, Early theories of Immunology, Innate and adaptive immune system, Cells and molecules involved in innate and adaptive immunity, Effector mechanisms in immunity, B and T cell epitopes, Structure and function of antibody molecules, Generation of antibody diversity.

SECTION-B

Antigens: Antigenicity and immunogenicity, Factors influencing immunogenecity, antigenantibody interaction, Endogenous and exogenous pathway of antigen processing and presentation, Monoclonal antibodies.

SECTION- C

Major Histocompatibility Complex: Structure and function, Humoral and cell mediated immune responses, Primary and Secondary immune modulation, Complement System: Components and pathways of complement activation.

SECTION- D

Inflammation, Hypersensivity: Gell and Coomb's classification and brief description of various types of hypersensivities, Autoimmunity, Vaccines: Various types of vaccines.

Suggested Books:

1. Kuby. Immunology, W.H. Freeman, USA.

2. W. Paul. Fundamentals of Immunology.

3. Totora et al. Microbiology.

DISCIPLINE SPECIFIC ELECTIVE COURSE: II
PLANTS FOR HUMAN WELFARE

Paper Code: Time Allowed: 3 Hours

Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION A

A general overview of economically important plants and their role in human welfare as food, oil, drugs, nutraceuticals, beverages, fibre, timber, biofuels, ornamental and as environment protection through carbon sequestration. **Food crops:** Cereals; Origin, cultivation and food values of important crops e.g.,wheat, rice, maize, grain legumes (Pulses), studies pertaining to their improvement through breeding and genetic engineering. **Sugars:** morphology, processing of sugarcane and improvement in productivity, byproducts and their management for generation of ethanols and electricity. Sources of alternate source of sugars. **Spices and condiments:** important spices, structure and their economic values. **Alcoholic and non-alcoholic beverages:** Tea, coffee, types, processing, uses and improvement.

SECTION B

- **Medicinal and nutraceuticals:** Traditional plants as source of drugs used against several serious diseases such as cancer, diabetes, malaria, dengue, psoriasis,etc. Plant secondary metabolites; classification, roles in human welfare with reference to case studies; knowledge of extraction, isolation and characterization of bioactive metabolites; elicitation of secondary metabolites from anticancerous plants such as Podopyllum, Taxus, Cathranthus, Psoralia, Nardostachys, Piper; antimalarial plants e.g., Artemisia, Spilanthes, Holarrhena, etc, and antidiabetics such as Stevia, Gymnema, Momordica, Azadirachta,etc: Edible vaccines **Nutraceuticals and functional foods:** Important plants such as Aloe vera, Moringa, piper spp. Aspargus, Withania, Ginseng, Plantago, Amaranthus, Mentha, blue berries, nuts, etc. yielding antioxidants and nutraceutical compounds. **Nutritionally rich GM plants** such as golden rice, Tomato, etc.

SECTION C

Edible and non-edible oils: Classification of oils, Oil yielding plants, processing and purification of different edible oils such as mustard, olive, sunflower oil, safflower peanut oil; transgenic approaches and constraints for improvement in different oils. **Non-edible oils:** such as Jojoba (Simmondsia chinensis), Sesamum indicum oil, Linseed oil, Eucalyptus oil, Citrus oil, etc. **Essential oils:** Lavender oil, rosemary oil, almond oil, clove oil cinnamomum oil, etc. **Plant-based biofuels** e.g., Difference between first and 2nd generation biofuels, Jatropha, Pongamia, Zea mayze, Madhuca, etc. Extraction and economic viability; application as alternate source of diesels.

SECTION D

Plants as a source of timber: e.g., Tectona grandis, Salix sp., Dalberia sisso (sheesham) and fuel wood, type and resources. **Fibre yielding plants:** Cotton (Gossypium sp.), Jute (Corchorus sp.), sun-hemp (Crotalaria sp.) with special reference to current advances pertaining to their improvement through breeding and genetic transformation e.g., Bt cotton. **Plants used for Horticulture, floriculture & ornamental values:** Brief introduction of different type of horticultural and ornamental plants (carnation, anthurium, orchids,etc.) and their commercial aspects; recent development of novel varieties through grafting, breeding and genetic transformation for pigment modification.

SEMESTER-III

NTCC

Research Seminar

Max. Marks:50 Credits: 2

1. The students will choose a topic from their syllabus and do research on it, so as to write a review article that can be published.

2. The mentor of the student and the student will also look into any small experiment if can be done and a research paper can be published.

3. Presentation of the article as a seminar will be the final step in completion of the course.

SEMESTER-IV

This semester has two modules and the students will have to choose any one.

Module 1: Dissertation for 6 months in different lab /institution /organisation. The students will submit a dissertation report (5 copies) in the University and will defend the work done during the dissertation. Marks will be alloted based on the work, its presentation and questions asnwered.

Module 2: Two papers on fish and fisheries will have to cleared and a small project on the same must be done.

DISCIPLINE SPECIFIC ELECTIVE COURSE: I
GENOMICS AND PROTEOMICS

Paper Code: Time Allowed: 3 Hours

Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION A

Genome sequencing strategies and programs, new technologies for high throughput sequencing, methods for sequence alignment and gene annotation, Approaches to analyze differential expression of genes - ESTs, SAGE, microarrays and their applications.

SECTION B

Concept of forward and reverse genetics as applied to designing genome wide screens for deciphering gene function. Gene tagging, gene and promoter trapping, knockout and knock-down mutants. Dynamic modulation of protein structure and function. Introduction to comparative genomics of model plants and related crop species.

SECTION C

Introduction to RNAi and gene silencing. Genome imprinting, small RNAs and their biogenesis, role of small RNAs in heterochromatin formation and gene silencing, genomic tools to study methylome, histone modifications and chromatin structure.

SECTION D

Analysis of proteins by different biophysical and biochemical methods (CD, circular dichroism, NMR, nuclear magnetic resonance, UV visible and fluorescent spectroscopy. Proteomics-what, why and tools of proteome analysis. Mass spectrometry based protein identification like PMF- protein mass fingerprinting and tandem MS/LCMS. Protein identification and analysis on protein related databases like ExPASy server. Gel based proteome analysis including sample extraction, lysis, resolution on 2D-PAGE, Image analysis including data acquisition, gel matching, master gel, and data analysis.

Suggested Books:

1. Brown, T.A. (2017). Genomes 4 . CRC Press.

2. Armstrong, L. (2013). Epigenetics. CRC Press.

3. Dale, J.W., Schantz, M.V. and Plant, N. (2011). From Genes to Genomes: Concepts and Applications of DNA Technology. Third edition. John Wiley & Sons, UK.

4. Green, M.R. and Sambrook, J. (2012) Molecular Cloning: A Laboratory Manual. Fourth edition. CSHL Press, USA.

5. Leibler, D.C. (2006). Introduction to Proteomics: tools for the new biology, Humana Press.

6. Walker, J.M. (2005). The Proteomics Protocols Handbook, Humana Press, Totowa, New Jersey, USA.

DISCIPLINE SPECIFIC ELECTIVE COURSE: II
PLANT BREEDING AND CYTOGENETICS

Paper Code: Time Allowed: 3 Hours

Max. Marks: 75 Credits: 4

Note for Examiners and Students:

1. The question paper will consist of four sections A, B, C & D. Examiner will set nine questions in all, selecting two questions from section A, B, C, and D of 15 marks each and may contain more than one part. Question 1 will be of 15 marks and consists of short answer type questions of 2 to 3 marks each covering the entire syllabus.

2. The candidate will be required to attempt five questions in all i.e. selecting one question from each section including the compulsory question. The duration of the examination will be 3 hours.

SECTION A

Chromatin organization and replication: Chemical constituents- DNA and histones, nucleosome and higher order organization, DNA packaging and genetic activity, nucleosome assembly and deassembly, Cytogenetics of haploids: Haploidy/monopolidy, meiosis and breeding behaviour of haploids, uses of haploids in plant breeding and genetic studies

SECTION B

Aneu- and euploids: Induction and characterization of monosomics, trisomics and nullisomics, aneupolid gene mapping, inheritance pattern in autopolyploids, status of allopolyploids in plant evolution, Chromosome banding patterns: Linear differentiation of chromosome segments, types of chromosome banding, uses of chromosome banding in cytogenetics

SECTION C

Organization of eukaryotic genetic material: Nuclear DNA and C-value paradox, DNA content and adaptability, repetitive DNA, split genes, overlapping genes, Plant breeding and crop improvement: Objectives and scope of plant breeding, hybridization in self- and cross-pollinated crops, genetic basis of inbreeding depression and heterosis, breeding for disease and insect resistance, transgenes and transgenic plants

SECTION D

Alien gene transfer through chromosome: Transfer of gene through individual chromosome, characterization and utility of alien addition and substitution lines, Physical and genetic mapping using molecular markers.