FACULTY OF LIFE SCIENCES

Syllabus

For

M.Sc. BOTANY

(CREDIT BASED EVALUATION & GRADING SYSTEM)

(SEMESTER: I - IV)

Examinations: 2019–20

Guru Nanak Dev University
Amritsar

M.Sc. Botany (Semester System)
(Credit Based Evaluation & Grading System)

SCHEME

Note : All Theory Papers having Mid Semester Marks : 20 & End Semester Marks : 80. Total Marks will be 100.

Semester-I

Course No.	C/E/I	Course Title	Credits			Total Credits
			L	T	P	
Core Courses						
BSL401	C	Mathematical Biology	3	-	-	3
BSL402	C	Computer Programming in Botany and Ecology	2	1	-	3
BSL403	C	Phycology	3	-	-	3
BSL404	C	Fungi and Plant Pathology	3	-	-	3
BSL405	C	Metabolic Integration	3	-	-	3
BSL406	C	Genetics and Cytogenetics	3	-	-	3
BSP425	C	Botany Lab I (based on BSL403 and BSL404)	-	-	2	2
BSP426	C	Botany Lab II (based on BSL405 and BSL406)	-	-	2	2
		Total Credits	17	1	4	**22**

Semester-II

Course No.	C/E/I	Course Title	Credits			Total Credits
			L	T	P	
Core Courses						
BSL451	C	Statistical Techniques	3	-	-	3
BSL453	C	Instrumental Methods of Analysis	3	-	-	3
BSL455	C	Bryophytes and Pteridophytes	3	-	-	3
BSL456	C	Advanced Cell Biology	3	-	-	3
BSL457	C	Bioinformatics and PERL Programming	3	-	-	3
BSL458	C	Ecological Biochemistry	3	-	-	3
BSP478	C	Botany Lab III (based on BSL453,BSL457 and BSL458)	-	-	3	3
BSP479	C	Botany Lab IV (based on BSL455 and BSL456)	-	-	2	2
Interdisciplinary/ Optional Courses						
	I	To be offered from outside the department	4	-	-	4
		Total Credits	22	-	5	**27**

NOTE: PSL-053 ID Course Human Rights & Constitutional Duties (Compulsory Paper). Students can opt. this paper in any semester except the 1st Semester. This ID Paper is one of the total ID Papers of this course.

M.Sc. Botany (Semester System)
(Credit Based Evaluation Grading System)

Semester -III

Course No.	C/E/I	Course Title	Credits			Total Credits
			L	T	P	
Core Courses						
BSL501	C	Spermatophytes	3	-	-	3
BSL504	C	Genome Structure, Function and Dynamics	3	-	-	3
ESL506	C	Ecological Modelling	3	-	-	3
BSL507	C	Plant Anatomy	3	-	-	3
BSL508	C	Plant Morphogenesis and Embryology	3	-	-	3
BSL509	C	Plant Molecular Biology and Genetic Engineering	3	-	-	3
BSP528	C	Botany Lab V (based on BSL501 and BSL508)	-	-	2	2
BSP529	C	Botany Lab VI (based on BSL504 and BSL509)	-	-	2	2
BSP530	C	Botany Lab VII (based on BSL507 and ESL506)	-	-	2	2
BSS524	S	Seminar	-	-	-	-
		Total Credits	18	-	6	**24**

M.Sc. Botany (Semester System)
(Credit Based Evaluation Grading System)

Semester-IV

Course No.	C/E/I	Course Title	Credits			Total Credits
			L	T	P	
Core Courses						
BSL551	C	Applied and Industrial Botany	3	-	-	3
BSL553	C	Evolutionary Biology	3	-	-	3
BSL554	C	Population Biology and Biodiversity	3	-	-	3
BSL555	C	Plant Breeding and Intellectual Property Rights	3	-	-	3
BSL557	C	Plant Tissue Culture	2	-	-	2
BSL558	C	Plant Metabolism	3	-	-	3
BSP579	C	Botany Lab VIII (based on BSL551 and BSL557)	-	-	2	2
BSP580	C	Botany Lab IX (based on BSL553 and BSL554)	-	-	2	2
BSP581	C	Botany Lab X (based on BSL555 and BSL558)	-	-	2	2
BSD573	C	Project report/advance practical/Assignment/Review/Status Report	-	-	-	-
BSF574		Field Study	-	-	-	-
Elective Courses (3 Credits)						
	E	Elective Course	3	-	-	3
		Total Credits	20	-	6	26

List of Elective Courses

Course No.	C/E/ I	Course Title	Credits			Total Credits
			L	T	P	
Elective Courses						
BSL582	E	Seed Biotechnology	3	-	-	3
BSL583	E	Human Values and Professional Ethics	3	-	-	3
BSL584	E	Genomics, Transcriptomics and Proteomics	3	-	-	3
BSL585	E	Dynamics of Biogeography	3	-	-	3
BSL587	E	Immunology	3	-	-	3
BSL588	E	Perspectives in Conservation	3	-	-	3
ESL584	E	Solid Waste Management	3	-	-	3
ESL585	E	Bioremediation	3	-	-	3
ESL586	E	Environmental Safety and Management	3	-	-	3
ESL587	E	Waste Stabilization Ponds	3	-	-	3
ESL588	E	Water and Wastewater Analysis	3	-	-	3
ESL589	E	Water Treatment Processes	3	-	-	3

M.Sc. Botany (Semester-I)
(Credit Based Evaluation & Grading System)

BSL401 – Mathematical Biology

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Linear Function:** $y=ax$ and $y=ax+b$, linear relation, linear programming
2. **Power Function:** $y=ax^n$, polynomials, differences, quadratic equation.
3. **Exponential and Logarithmic Functions:** Exponential function $y=aq^x$, logarithmic function, scaling, Weber's law, spirals- spiral of Archimedes and logarithmic spiral.

SECTION-B

4. **Graphical Methods:** Linear, semi logarithmic and double logarithmic plots, triangular charts.
5. **Limits:** Limits of sequences, Fibonacci sequence.
6. **Differentiation and Integration:** Growth rates, instantaneous rate of change, differentiation of some important functions, product rule and quotient rule of differentiation, chain rule of differentiation.

SECTION-C

7. **Integration:** Integrals, definite integral, rules of integration, second derivative, extremes of a function, mean of a continuous function.
8. **Differentiation and Integration of Exponential and Logarithmic Functions:** $d/dx(e^x)$, $d/dx(\ln x)$, integral of $1/x$, properties of $\ln x$**,** inverse function of $\ln x$, logarithms, $a^x = e^{x \ln a}$, introduction to hyperbolic functions.

SECTION-D

9. **Periodic Function:** Cycloid, polar coordinates, sine and cosine, conversion of polar coordinates into rectangular coordinates, trigonometric relations, polar graphs, trigonometric polynomials.
10. **Ordinary Differential Equations:** $y'=ay$, $y'=ay+b$, $y'=ay^2 + by+c$, $dy/dx=k.y/x$.
11. **Fractal Dimension**: Measurement by divider method, applications in biology.

References:

1. Batschelet, E. (1971). Introduction to Mathematics for Life Scientists. Springer-Verlag, Berlin.

M.Sc. Botany (Semester-I)
(Credit Based Evaluation & Grading System)

BSL402 – Computer Programming in Botany and Ecology

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Number Systems:** Binary, octal, hexadecimal and decimal numbers, conversion from one system to another, 1's and 2's complements, binary addition and subtraction, gates, half adder, full adder.
2. **Computer Organization:** Components of digital computers, hardware and software, programming languages, compiler & interpreters.

SECTION-B

3. **Introduction to C Language**: About C language, evolution of C, structure of a C program, compiling a C program, character set, keywords, **Operators:** arithmetic operators, unary operators, relational and logical operators, hierarchy of operators, expressions **Data types**: basic data types, constants and variables in C, type declaration, local and global variables, constraints in C.
4. **Input/Output Functions:** Input function, output functions, formatted I/O, character I/O and string I/O functions.

SECTION-C

5. **Control Statements:** Why control statements, if statement, if-else statement, for statement, while statement, do-while statement, break and continue statements, switch statement, goto statement, ternary operators.

6. **Arrays & String:** Introduction to arrays, advantages of arrays, types of arrays, one, two and three dimensional arrays, array declaration, array initialization, accessing data from array, character arrays, string variables, reading & writing strings, string handling functions, array of strings.

SECTION-D

7. **Functions:** Introduction to functions, library functions vs user-defined functions, advantages of functions, declaring a function, calling a function, passing arguments to a function, passing array to functions, recursion in functions, call by value and call by reference.

8. **Pointers:** Introduction to pointers, pointer variables, declaring pointer variables, assessing values via pointers, pointer to string, passing arguments using pointers.

References:

1. Malvino, A.P., and Leach, Donald P. (1996). Digital Principles and Applications. Tata McGraw-Hill Publishing Company Limited, New Delhi.
2. Sinha, P.K. (1998). Computer Fundamentals. BPB Publications, New Delhi.
3. Salaria, R.S. (1998). Application Programming in C. Khanna Publications, Delhi.
4. Kanetkar, Y. (2004). Let Us C - Fifth Edition. BPB Publications, New Delhi.
5. Balagurusamy, E. (1992). Programming in ANSI C. Tata McGraw-Hill Publishing Company Limited, New Delhi.

M.Sc. Botany (Semester-I)
(Credit Based Evaluation & Grading System)

BSL403 - Phycology

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Range of Thallus Structure:** the range of morphology, unicellular motile forms, unicellular non-motile forms, multicellular flagellated forms, multicellular non-flagellated forms, palmelloid forms, dendroid forms, filamentous forms, heterotrichous forms, siphonous forms, uniaxial forms, multiaxial forms, parenchymatous forms.
2. **Ecology of Algae:** habitats, communities, succession, primary production, phytoplankton, marine epilithic algae, marine and freshwater algae of sediments and sands, soil algae, algal ecology at extreme temperatures, ecology of algae in symbiotic associations.
3. **Water Blooms and Red Tides:** algae forming water blooms in india, algae forming water blooms around the world, red tides, causes of blooms formed, utility of blooms, disadvantages of bloom, methods of controlling blooms.
4. **Algae in water supplies and as Indicators of Water Pollution:** importance and sources of water, causes of varied algal growth in different water bodies, common algae found in water supplies, major problems dueto algal growth in water, algae as indicators of water pollution.

SECTION-B

5. **Control of Algal Nuisance:** reasons to control algae, chemical methods of contolling algae, physical methods of controlling algae, biological methods of controlling algae.
6. **Toxic Algae:** Introduction, major toxic algal groups, algal toxins to human, animals, general symptoms shown by toxic algae, general chemistry of some toxins.
7. **Fossil Algae:**fossil algae, how old are the algal fossils, fossil records of cyanophyceae, rhodophyceae, phaeophyceae, bacillariophyceae, chyrsophyceae, prymnesiophyceae, prymnesiophyceae, dinophyceae, chlorophyceae, utility of algal fossils.
8. **Methods of Algal study:** observing algae in the field, collection of algae, preservation of algae, preparation of herbarium specimens of algae, preparation of temporary mounts of algae, some methods of preparation of permanent algal slides, preparation of some stains and jellies used in studying algae.

SECTION-C

9. **Chlorophyta** (Chlorella, Ulothrix, Cladophora, Fritschiella, Acetabularia): Nomenclature, genera and species, distinguishing characters, occurrence, cell structure, range in thallus organization, reproduction, economic importance.
10. **Charophyta (Chara, Nitella):** Classification,general characters, occurrence, cell structure, thallus organization, economic importance.

11. Euglenophyta (Euglena): euglenophyceae, phycological position and classification, general characteristics.

12.**Phaeophyta**(Macrocystis, Dictyota): Classification, distinguishing characters, geographical distribution of brown algae in India, thallus organization, cell structure,reproduction, alternation of generations.

13. Bacillariophyta: Classification, general characters, occurrence, pigments, thallus organization, economic importance.

14. Rhodophyta (Bangia, Batrochospermum, Gelidium, Gracilaria): Classification, general characters, occurrence, pigments, food-storage products, range of thallus structure.

SECTION-D

15. Cyanophyta (Chroococcus, Nostoc, Oscillitoria, Rivularia, Scytonema, Spirulina): Classification, general characters, occurrence, pigments, thallus organization, economic importance.

16. Movements and Rhythm in Algae: introduction, types of movements in algae, causes of movements in algae, phototaxis, movements in diatoms, blue-green algae, photokinesis in algae, phototropism in algae, rhythms in algae.

17. Bio fuels from Algae: Biodiesel, ethanol, mass culturing of algae (Raceway ponds, photo bioreactors) in biofuel production, extraction and refinement, algae in global warming-carbon capture by algae.

18. Models (Monod and Droop) of nutrient regulated phytoplankton growth.

Algae and human affairs: Edible algae, algal biofertilizers algal bloom and phycotoxins, seaweeds polysaccharides like agar, carrageenan & alginates.

References:

1. Bold, H.C. and Wynne, M.J. (1985). Introduction to the Algae. Structure and Reproduction, Prentice Hall Inc. Englewood Cliffs, New York.
2. Smith, G.M. (1955). Cryptogamic Botany, McGraw Hill Publication.
3. Smith, G.M. (1955). Cryptogamic Botany. Vol. II, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
4. Ahluwalia, A.S. (Ed.) (2003). Phycology. Daya Publishing House, New Delhi-110035
5. Kumar. H.D. and Singh, H.H. (1971). A Textbook on Algae, East – West Press Pvt. Ltd. New Delhi.
6. Trivedi, P.C. (Ed.) (2001). Algal Biotechnology. Pointer Publishers, Jaipur.
7. Fritsch, F.E. (1979)The structure and reproduction of algae (Vol.I and II). Vikas Publishers House Pvt. Ltd., New Delhi.
8. Smith, J.E. (1988). Biotechnology, 2nd Edition. Edward Arnold London.
9. Anderson, R.A. (2005). Algal Culturing techniques. Physiological society of America. Elseview Academic Press, USA.
10. Sahoo & Qasim S.Z.(Eds), (2002). "Sustainable Aquaculture". APH Publishing Corporation, New Delhi.

M.Sc. Botany (Semester-I)
(Credit Based Evaluation & Grading System)

BSL404 – Fungi and Plant Pathology

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

Kingdom PROTOZOA

1. **Acrasiomycota**: Acrasiomycetes - A general account-Acrasin
2. **Dictyosteliomycota :** Dictyosteliomycetes - *Dictyostelium*
3. **Myxomycota:** Myxomycetes – *Stemonitis*

Kingdom CHROMISTA

4. **Oomycota:** Oomycetes - *Saprolegnia, Pythium* and *Achlya*

SECTION-B

Kingdom FUNGI

5. **Ascomycota:** Ascomycetes , Discomycetes - *Morchella and Tuber*, Pyrenomycetes - *Erysiphe, Claviceps, Xylaria*, *Neurospora*, Hemiascomycetes - *Protomyces* and *Taphrina*
6. **Basidiomycota:** Basidiomycetes - *Agaricus,* Ustomycetes - *Ustilago* Teliomycetes : *Puccinia*
7. **Mitosporic Fungi:** Coelomycetes – *Colletotrichum, Hyphomycetidae: Alternaria, Fusarium, Rhizoctonia,* Agonomycetes: Sclerotium

SECTION-C

8. **Fungi:** General features evolutionary tendency in lower fungi, Sexuality in ascomycetes with special reference to degeneration & modification of sex organ, heterothallism in basidiomycetes, sex hormone in fungi, parasexual cycle.
9. **Plant pathology**
   Pathogenesis, Principles and methods for the prevention and control for plant diseases, toxins and enzymes in plant diseases, defence mechanisms of plants against pathogens, Genetics of plant pathogen interaction.

SECTION-D

10. **Symptomatology, Identification, Etiology and Control Measures** of the following fungal plant diseases:
    Potato wart, damping-off diseases, late blight of potato, white rust of crucifers, downy mildew of bajra, powdery mildew pea, apple scab, ergot of rye and bajra, anthracnose disease of chillies, red rot of sugarcane, tikka disease of groundnuts, blast of rice, false smut of rice, Karnal bunt of wheat, smut/smuts of wheat, barley, oats, bajra and sorghum, rust of wheat.

References:

1. Agrios, G.N. (1997). Plant Pathology. Academic Press, New York.
2. Ainsworth, G.C. Sparrow, F.K., and Sussman A.S. (1973). The Fungi- An Advanced Treatise. Vols. IV A. Academic Press, London.
3. Alexopoulos, C.J., Mims, C.W. and Blackwell, M. (1996). Introductory Mycology. John Wiley and sons, INC, New York.
4. Hawksworth, D.L., Kirk, P.M. Sulton, B.C. and Pegelr, D.N. (1995). Ainsworth and Bisby's Dictionary of Fungi. International Mycological Institute. CAB International.
5. Mehrotra, R.S. (1980). Plant Pathology. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
6. Mehrotra, R.S. and Aneja, K.R. (1990). An Introduction to Mycology. New Age International Publishers, New Delhi.
7. Webster, J. (1980). Introduction to Fungi. Cambridge University Press, Cambridge, London.
8. Vashista, B.R. and Sinha, A.K. (2008) Botany for degree students-Fungi. S. Chand and Company Ltd, New Delhi-pp 1-752.

M.Sc. Botany (Semester-I)
(Credit Based Evaluation & Grading System)

BSL405 - Metabolic Integration

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **RESPONSES AND ADAPTATION OF PLANTS TO ABIOTIC STRESS**
   Plant responses to abiotic stress, Physiological and cellular responses to water deficit, Gene expression and signal transduction in response to dehydration, Freezing and chilling stress, Flooding and oxygen deficit, Oxidative stress, Heat stress, Crosstalk in stress responses

SECTION-B

2. **PLANT GROWTH REGULATOR AND ELICITORS**
   Gibberellins, Abscisic acid, Cytokinins, Auxins , Ethylene, Brassinosteroids, Polyamines Jasmonic acid Salicylic acid , Strigolactones

SECTION-C

3. **SIGNAL PERCEPTION AND TRANSDUCTION**
   Characteristics of signal perception, transduction, and integration in plants, Overview of signal perception at the plasma membrane, Intracellular signal transduction, amplification, and integration via second messengers and MAPK cascades, Ethylene signal transduction ,Cytokinin signal transduction, Integration of auxin signaling and transport, Signal transduction from phytochromes, Gibberellin signal transduction and its integration with phytochrome signaling during seedling development, Integration of light, ABA, and CO2 signals in the regulation of stomatal aperture

SECTION-D

4. **SENESCENCE AND PROGRAMMED CELL DEATH IN PLANTS**
   Types of cell death, PCD during seed development and germination, Cell death during the development of secretory bodies, defensive structures and organ shapes,PCD during reproductive development , Senescence and PCD in the terminal development of leaves and other lateral organs,Pigment metabolism in senescence , Macromolecule breakdown and salvage of nutrients in senescence ,Energy and oxidative metabolism during senescence , Environmental influences on senescence and cell death I: Abiotic interactions, Environmental influences on senescence and cell death II: PCD responses to pathogen attack , Plant hormones in senescence and defense-related PCD

References:

1. Buchann, B.B.,Gruissen, W.,and Jones, R.L(2010). Biochemistry and molecular biology of plants. American society of plant physiologists,Maryland.USA
2. Nobel, P.S. (2009). Physiochemical and Enviornmental Plant Physiology. Academic press, San Diego.U.S.A
3. Scott,P. (2008). Physiology and Behaviour of Plants. John Wiley and Sons Ltd. England.
4. Stewart, S.andGlobig, S. (2011). Plant Physiology. Apple Academic Press Inc., Canada.
5. Taiz, L., and Zeiger, E. (2010). Plant Physiology. Sinauer Associates, Inc., Publishers, Massachusetts.
6. William, G., Hopkins and Norman P.A.,Huner (2008). Plant Physiology. John Wiley& Sons. Inc. USA
7. Salisbury, B., Frank and Ross, W., Cleon (2004). Plants Physiology. Wadsworth ,U.S.A

M.Sc. Botany (Semester-I)
(Credit Based Evaluation & Grading System)

BSL406 Genetics and Cytogenetics

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Introduction:** Growth of Science from Mendel to Genetic Engineering.
2. **Extensions of Mendelian Principles**: Codominiance, incomplete dominance, gene interactions, pleiotropy, genomic imprinting, penetrance and expressivity, phenocopy.
3. **Sex Determination and Sex linkage:** Mechanisms of sex determination, environmental factors and sex-determination, sex-influenced dominance, sex-limited gene expression, sex-linked inheritance, Morgan's discovery of sex-linkage in *Drosophila.*

SECTION-B

4. **Linkage and Crossing Over:** Cytological basis of crossing over, Molecular mechanism of crossing over.Gene Mapping Methods: Linkage maps, two factor crosses, three factor crosses, tetrad analysis, mapping by using somatic cell hybrids.
5. **Extra Chromosomal Inheritance:** Maternal effect, Organelle heredity- chloroplast: variegation in 4'O clock plants, Iojap in Maize, *Chlamydomonas* mutations, Mitochondria: poky in *Neurospora*, Mitochondrial DNA and human diseases, kappa particles in *Paramecium*, infective particles in *Drosophila*.

SECTION-C

6. **Microbial Genetics:**Methods of genetic transfer in bacteria – transformation, conjugation, transduction and sex-duction.
7. **Human Genetics:**Pedigree analysis, karyotypes, genetic disorders.
8. **Quantitative Genetics:**Polygenic inheritance, heritability and its measurements, QTL mapping.

SECTION-D

9. **The Mutability and Repair of DNA:** Nature of mutations, DNA damage from hydrolysis, deamination, alkylation, oxidation and radiation, Repair of DNA damage: base excision repair, recombination repair.
10. **Regularly RNAs:** Regulation by RNAs in bacteria and eukaryotes, synthesis and function of mi RNA molecules, evolution and exploitation of RNA.

References:

1. Brown, T.A. (1999). Genomes. BIOS Scientific Publishers limited, UK.
2. Gardener, E.J., Simsons, M.J., and Sinustad, D.P. (1991). Principles of Genetics. John Wiley Sons Inc., New York.
3. Griffiths, A.J.F., Miller, J.H., Suzuki, D.T., Lewontin, R.C., and Gelbart, W.M. (1993). An Introduction to Genetic Analysis. Freeman and Comapany, USA.
4. Hawley R.S. and Walker, M. Y. (2003) Advanced Genetics analysis-Finding meaning in Genome. Blackwell Publishing, USA.
5. Klug W. S. and Cummings, M. R. (1997). Concepts of Genetics. Printice Hall International, Inc.
6. Lewin, B. (2000). Gene VII. OxfordUniversity Press, New York.

M.Sc. Botany (Semester-II)
(Credit Based Evaluation & Grading System)

BSL451 - Statistical Techniques

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Statistical Methods:** Basic principles of statistical techniques with numericals for analysis of ecological data. Measures of central tendency and dispersal; sampling distribution; confidence interval; errors; levels of significance.
2. **Central Tendency:** Arithmatic mean, geometric mean, harmonic mean, median, mode.
3. **Dispersion:** Range, quartile deviation, mean deviation, variance, standard deviation, standard error, coefficient of variation.

SECTION-B

4. **Skewness, Moments and Kurtosis:** Measures of skewness, moments about mean, measures of kurtosis.
5. **Probability:** Events, concept of probability, conditional probabilities, multiplication rule, permutations and combinations.
6. **Probability Distributions:** Binomial, Poisson and Normal distributions
7. **Normal Distribution:** Mathematical equation for normal curve, confidence limits, hypothesis testing, null hypothesis, comparing the mean of a sample with a known standard, comparing the means of two samples, Student's *t*-test.

SECTION-C

8. **Binomial Distribution:** Comparison of percentage with a known standard, comparison of two percentages.
9. **Poisson Distribution:** Comparing two Poisson distributions.
10. **Chi square Distribution:** Goodness of fit.
11. **Regression and Correlation:** Computation of correlation coefficient and regression equation.
12. **Partial Correlation and Multiple Regression:** Partial correlation, multiple regression with two independent variables**.**

SECTION-D

13. **Elements of Path and Principal Component Analysis**.
14. **Analysis of Variance:** F-test, one way analysis of variance, multivariate statistics
15. **Non-Parametric and Distribution –Free Tests:** Wilcoxon's signed rank sum test for single sample Wilcoxon's signed rank sum test for two samples, rank correlation coefficient.
16. **Time Series Analysis:** Seasonal, cyclic and irregular variations, trend analysis, Index numbers and their classification.

References:

1. Bailey, N.T.J. (1995). Statistical Methods in Biology. Cambridge University Press, Cambridge.
2. Ludwig, J. and Reynolds, J.F. (1988). Statistical Ecology. John Wiley & Sons, New York.
3. Sokal, R.R. and Rohlf, F.J. (1995). Biometry. W.H. Freeman & Co. San Francisco.

M.Sc. Botany (Semester-II)
(Credit Based Evaluation & Grading System)

BSL453 - Instrumental Methods of Analysis

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Principles of Analytical Methods:** Chromatography, GLC, HPLC, GC-MS, LC-MS, Atomic Absorption, Spectrophotometry and Flame Photometry.
2. **Histochemical and Immunotechniques:** Antibody generation, detection of molecules using ELISA, RIA, western blot, immunoprecipitation, flow cytometry and immunofluorescence microscopy, detection of molecules in living cells, *in situ*localization by techniques such as FISH and GISH.

SECTION-B

3. **Biophysical Methods: a**nalysis of biomolecules using UV/visible, fluorescence, UV, circular dichroism, NMR and ESR spectroscopy, molecular structure determination using X- ray fluorescence and X-ray diffraction and NMR; Molecular analysis using light scattering surface plasma resonance methods.

SECTION-C

4. **Microscopic Techniques:** Visualization of cellular and sub cellular components by light microscopy, resolving power of different microscopes, microscopy of living cells, scanning and transmission microscopes, different fixation and stating techniques for EM, freeze-etch and freeze fracture methods for EM image processing methods in microscopy.

SECTION-D

5. **Radiolabeling Techniques:** Detection and measurement of radioisotopes normally used in biology; incorporation of radioisotopes in biological tissues and cells, molecular imaging of radioactive material, safety guidelines.

References:

1. Brown TA (2010) Gene cloning and DNA analysis, An Introduction, 6th Edition, Blackwell Scientific Publication, Oxford, UK
2. Goldsby RA, Kindt TJ and Osborne BA (2000) Immunology, 4th Edition, WH Freeman and Company, NY
3. Kostic, T., Butaye, P., Schrenzel, J. (2009). Introduction to Microarray Based Detection Methods. In: Detection of Highly Dangerous Pathogens: Microarray Methods for the Detection of BSL 3 and BSL 4 Agents. Edited by TanjaKostic, Patrick Butaye, and Jacques Schrenzel.Wiley-VCH Verlag GmbH & Co. KGaA.
4. Sheehan, D. (2000). Physical Biochemistry: Principles and Applications, John Wiley

M.Sc. Botany (Semester-II)
(Credit Based Evaluation & Grading System)

BSL455 - Bryophytes and Pteridophytes

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. Origin of land habit, Bryophytes- the first land plants, the fossil evidence, adaptive characters for land habit.
2. Organographic development in vascular plants – telome theory, significance and shortcomings, homologous and antithetic theories of origin of sporophyte, Pteridophytes- the first vascular plants, monophyletic vs polyphyletic origin.

SECTION-B

3. Classificatiuon of Bryophytes, comparative account of morphology, life cycle and affinities of Marchantiales, Jungermanniales, Anthocerotales, Sphagnales, Andreales, Bryales and Polytrichales, experimental studies and economic importance.

SECTION-C

4. Salient features of pteridophytic life cycle with reference to phylogenetic status of major plant groups, classical and modern classification of pteridophytes, occurrence, comparative organography, systematics, reproduction and life cycle in various divisions, classes and orders evolutionary relations.

SECTION-D

5. Evolutionary trends in pteridophytes, prothallial evolution, organization and evolution of sorus in ferns, role of polyploidy and hybridization in speciation in ferns, apomictic life cycle, apogamy, apospory, heterospory and development of seed habit.

References:

1. Bierhorst, D.W. (1971). Morphology of Vascular Plants. The MacMillan Press, London.
2. Bower F.O. (1928). The Ferns, Vols. I – III. Cambridge University Press, Cambridge.
3. Bower, F.O. (1908). The Origin of Land Flora. The MacMillan Press, London.
4. Campbell, D.R. (1985). The Evolution of Land Plants (Embryophyta) Reprinted Central Book Depot, Allahabad.
5. Forster, A.S. & Gifford, E.M. (1959). Comparative Morphology of Vascular Plants. W.H. Freeman & Company.
6. Goebel, K. (1969). Organography of Plants. Hafner Publishing Company, New York.

7. Kumar, B.K. Kazami, F.O. Kaur, S. and Chandra, S. (1962). Ferns of India, Today's and Tomorrow's Printers and Publishers, New Delhi.
8. Parihar, N.S. (1987). The Biology and Morphology of Pteridophytes, Central Book Distributors, Allahabad.
9. Rashid, A. (1991). An Introduction to Pteridophytes. Vikas Publishing House Pvt. Ltd. New Delhi.
10. Schofield, W.B. (1985). Introduction to Bryology, MacMillan Publishing Company, New York.
11. Sinnott, E.W. (1960). Plant Morphogenesis. McGraw Hill Book Company Inc. New York, Toronto london.
12. Smith, G.M. (1955). Cryptogamic Botany. Vol. II, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
13. Sporne, K.R. (1962). Morphology of Pteridophytes, BI Publications, New Delhi.
14. Stewart, W.N. (1983). Palaeobotany and Evolution of Plants. Cambridge University Press, London.
15. Taylor, T.N. (1981). Palaeobotany. An Introduction to Fossil Plant Biology, McGraw Hill Book Company, New York.

M.Sc. Botany (Semester-II)
(Credit Based Evaluation & Grading System)

BSL456 - Advanced Cell Biology

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Origin and Evolution of Cells:** First cell, evolution of metabolism, Present day Prokaryotes, Eukaryotic Cells, Development of multicellular organisms.

2. **Cells as Experimental Models:** *Escherichia coli, Saccharomyces cerevisiae, Dictyosteliun discoideum, Caenorhabditis elegans, Drosophila melanogaster, Arabidopsis thaliana*

3. **Techniques in Molecular Cell Biology:** Microscopy-light, phase-contrast, fluorescence, confocal, scanning electron microscopy. Use of radioisotopes, cell culture, fractionation of cells contents

SECTION-B

4. **Oxidative Metabolism in Mitochondira:** Electron transport chain, Chemiosmotic coupling, role of mitochondria in the formation of ATP.
5. **Phototrophic Energy Metabolism:** Light Harvesting, NADPH synthesis, ATP synthesis.

SECTION-C

6. **Cell signaling:** Hormones and their receptors, cell surface receptor, signaling through G-protein coupled receptors, signal transduction pathways, second messengers, regulation of signaling pathways, bacterial and plant two-component signaling systems.

7. **Cellular communication:** General principles of cell communication, cell adhesion and roles of different adhesion molecules, gap junctions, extracellular matrix, integrins, neurotransmission and its regulation.

SECTION-D

8. **Regulators of Cell Cycle Progression:** Regulation and control of cell cycle, MPF, families of cyclins and cyclin dependent kinases, Growth factors, cell cycle inhibitors.

9. **Cancer:** Genetic rearrangements in progenitor cells, oncogenes, tumor suppressor genes, cancer and the cell cycle, virus-induced cancer, metastasis, interaction of cancer cells with normal cells, apoptosis, therapeutic interventions of uncontrolled cell growth.

References:

1. Pollard, T.D. and Ernshaw, W.C. (2002). Cell Biology. Elsevier Science (USA)
2. Becker, W.M., Kleinsmith, L.J. and Hardin, J. (2000). The World of the Cell. The Benjamin/Cummings Publishing Company.
3. Cooper, G.M. (2000). The Cell – A Molecular Approach. ASM Press, Washington, D.C.
4. Karp, G. (1999). Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons Inc., New York.
5. Smith, C.A. and Wood, E.J. (1993). Cell Biology: Molecular and Cell Biochemistry. Chapman & Hall, London
6. Purves, W.K., Oriam, G.H., Hellen, H.C., Sadana, D. (1998). Life. The Science of Biology. W.H. Freeman and Company, Utah.
7. Sadava, D.E. (1993). Cell Biology: Organelle Structure and Function. Jones and Barlett Publishers, Boston, London.

M.Sc. Botany (Semester-II)
(Credit Based Evaluation & Grading System)

BSL457 – Bioinformatics and PERL Programming

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Network:** Introduction, objectives, applications, types of network, components of network, elementary idea of OSI model, network topologies; star, ring, bus, hybrid, tree.
2. **Internet:** development, management, services available, various applications of Internet
3. **Overview of Bioinformatics:** Introduction, bioinformatics and the internet, useful bioinformatics sites on the WWW.

SECTION-B

4. **Introduction to PERL:** Scalar variables, strings and numbers, Assignment statements, Arrays, Hashes, Operators, Input from file, Standard Input, Conditional and logical operators, loops, I/O, Input from file named in command line, Regular expression, Pattern matching, Meta symbols, Pattern modifiers, Subroutines.
5. **Applications of PERL in Bioinformatics:** Storing DNA sequence, DNA to RNA transcription, Finding motifs, Counting nucleotides, Generating random numbers, simulating DNA mutation, generating random DNA, Analyzing DNA.

SECTION-C

6. **Biological Databases:** Introduction, classification of databases on the basis of type of molecule, nucleic acid, protein sequence and structure databases, classification of databases on the basis of source and type of information.
7. **Data Mining Methods for Sequence Analysis:** Data retrieval with Entrez and DBGET/ Link DB and SRS (Sequence retrieval system).
8. **Analysis of Data:** sequence similarity search, amino acid substitution matrices, web-based tools for sequence searches (FASTA and BLAST), motif analysis.

SECTION-D

9. **Sequence Alignment**: Multiple sequence alignment and family relationships, phylogenetics.
10. **Structural Bioinformatics:** Obtaining, viewing and analyzing structural data, structural alignment, classification of known three dimensional structure : CATH and SCOP, structure **prediction by comparative modeling.**
11. **Applications of Bioinformatics.**

References:

1. Baxevains, A.D. and Ouellete, B.F.F. (2001). Bioinformatics: A practical guide to the analysis of genes and proteins. John Wiley and Sons, NewYork.
2. Crumlish, C. (1996). The ABC's of the Internet. BPB Publications, New Delhi.
3. Foy, B.D. Phoenix, T and Schwartz, R. L. (2005). Learning Perl, 4th Edition. O' Rilley.
4. Misenere, S. and Krawetz, S.A. (2001). Bioinformatics: Methods and Protocols. Humana Press, Totowa, New Jersey.
5. Mount, D.W. (2001). Bioinformatics: Sequence and genome analysis. Cold spring Leubn Laboratory press, NewYork.
6. Rastogi, S.C., Mendiratta, N. and Rastogi, P. (2004). Bioinformatics - Methods and Application. Genomics, Proteomics and Drug Discovery. Prentice - Hall of India Pvt Ltd. New Delhi.
7. Sensen, C.W. (Ed.) (2002). Essentials of Genomics and Bioinformatics Wiley-VCH, Verlag GmbH Winheim.
8. Tanen, Baun A.S. (1998). Computer Networks. 3rd Edition. Prentice Hall of India, Delhi.
9. Tisdall, J. (2001). Beginning Perl for Bioinformatics. O' Rilley.
10. Westhead, D.R., Parish , J.H. (2003). Instant Notes : Bioinformatics. Viva Books Private Ltd., New Delhi. 19

M.Sc. Botany (Semester-II)
(Credit Based Evaluation & Grading System)

BSL458 - Ecological Biochemistry

Credits 2-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. Biochemical adaptation of Plants to Environment: Adaptation to climate: photosynthesis in tropical plants, adaptation to freezing, flooding, drought; Adaptation to soil: selenium toxicity, heavy metal toxicity, adaptation to salinity; Detoxification mechanisms: detoxification of phenols, systemic fungicides, herbicides.

2. Biochemistry of Plant Pollination: Role of flower colour: colour preferences of pollinators, chemical basis of flower colour, evolution of flower colour, honey guides; Role of flower scent: types of scent, insect pheromones and flower scents, Role of nectar and pollen: sugars of nectar, amino acids of nectar, lipids in nectar, nectar toxins, extrafloral nectaries, nutritive value of pollen.

SECTION-B

3. Plant Toxins and Their effects on Animals: Different classes of plant toxins: nitrogen-based toxins, non-nitrogenous toxins, fate in animals; Cyanogenic glycosides: occurrence of cyanogenic glycosides in plants, polymorphism of cyanogenesis, other protective roles of cyanogens; Cardiac glycosides; Pyrrolizidine alkaloids; Utilization of plant toxins by animals.

4. Hormonal Interactions Between Plants and Animals: Plant oestrogens, insect moulting hormones in plants, the fruit fly-cactus interaction, insect juvenile hormones in plants, pheromones

SECTION-C

5. Insect Feeding Preferences: Biochemical basis of plant selection by insects: coevolutionary aspects, plant chemicals as defense agents, insect feeding requirements; Secondary compounds as feeding attractants: the silkworm-mulberry interaction, glucosinolates as feeding attractants in the Cruciferae, other feeding attractants; secondary compounds as feeding deterrents: the winter moth amd oak leaf tannins, the Colorado beetle and Solanum alkaloids, other feeding deterrents.

6. Feeding Preferences of Vertebrates: Domestic animals: responses to individual chemicals, responses to chemicals present in plants, feeding prefernces; wild animals, man: the choice of plant foods, the chemistry of flavours, sweetness, flavour potentiators and modifiers.

SECTION-D

7. Animal Pheromones and Defence Substances: Insect pheromones: sex, trail, alarm pheromones; Mammalian pheromones, Defence substances: terpenoids, alkaloids, phenols and quinones.

8. Biochemical Interactions Between Higher Plants: Allelopathy, biochemistry of host-parasite interactions.

9. Higher Plant-Lower Plant Interactions: Biochemical basis of disease resistance: pre-infectional compounds, post inflectional compounds: post inhibitins, phytoalexins; phytotoxins: the pathotoxin concept, pyridine-based pathotoxins, macromolecular toxins.

Reference:

1. Harborne, J.B. (1992). Ecological Biochemistry. Academic Press Ltd., London.

M.Sc. Botany (Semester-III)
(Credit Based Evaluation & Grading System)

BSL501 – Spermatophytes

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. Classification of gymnosperms and their distribution in time and space with particular reference to Indian members. Classification of rocks according to chronostratigraphy, lithology and biostratigraphy. Important geological formations in India. A general account of structure reproduction and evolutionary relationships of progymnosperms, Cyacadofilicales, Cycadeoidales, Glossopteridales, Pentoxylales, Cycadales, Cordaitales, Coniferales Ginkgoales, Taxales, Ephedrales, Welwitschiales, Gnetales.

SECTION-B

2. Origin and evolution of gymnosperms, tendencies in organographic and organ evolution: male and female sporophylls, cones, ovules, seeds and archegonia, pollination mechanisms; chromosome numbers and karyotypes.
3. Historical perspective of plant classification, comparative study of phylogenetic systems after Engler and Prantl, Bessey, Hutchinson, Cronquist, Takhtajan, Dahlgren and Thorne and Stebbins, treatment of Ranales, Apetalae, Centrospermae, Tubiflorae and Helobiales in the above mentioned systems of classification.

SECTION-C

4. Historical perspective and main provisions of the International Code of Botanical Nomenclature. Elementary study of Latin language in light of the provisions of the code. Etymology, connotation and grammatical structure of generic names and epithets for species, sub divisions of genera and infraspecific categories.
5. Principles and methods of taxonomy: Taxonomic evidence and choice of characters, alpha versus omega taxonomy, role of anatomy, palynology, embryology, cytology and phytochemistry in plant classification. Floral anatomy in relation to morphological nature of floral parts, phylogenetic considerations.

SECTION-D

6. Phenetic method in plant taxonomy; patterns and causes of variation, inter- and intra-population variations, numerical methods in plant taxonomy, statistical analysis in deriving taxonomic relationships, figurative representation of taxonomic affinities, cladistics, indices of taxonomic diversity.
7. Biosystematic methods in taxonomy, transplant experiments, non hierarchical and hierarchical categories, study of agamic, hybrid and polyploid complexes.

8. Taxonomic tools: herbaria; floras; serology; electrophoresis; nucleic acid hybridization; computers, computer-aided keys for identification of taxa, role of GIS

References:

1. Arnold, C.A. (1947) An Introduction to Palaeobotany. McGraw Hill Book Company, New York.
2. Bhatnagar, S.P., and Moitra, A. (1996). Gymnosperms. New age International, Private Limited.
3. Biswas, C., and Johri, B.M. (1997). Gymnosperms. Narosa Publishing House, New Delhi.
4. Brown, H.P. (1989). An Elementary Manual of Indian Tree Technology, Dehradun.
5. Chamberlain C.J. (1935) Gymnosperms: Structure and Evolution CBS Publishers and Distributors, N. Delhi.
6. Cole, A.J. 1969. Numerical Taxonomy,Academic Press, London
7. Coulter, J.M., and Chamberlain, C.J. (1917) Morphology of Gymnosperms (Reprinted) Central Book Dept. Allahabad.
8. Cutter, E.G. (1971). Plant Anatomy: Experiment and Interpretation. Part II. Organs. Edward Arnold, London.
9. Davis P.H. and Heywood, V.H. (1973). Principles of Angiosperms Taxonomy. Robert E. Kreiger Pub. Co., New York.
10. Esau, K. (1977). Anatomy of Seed Plants, 2nd edition. John Wiley and Sons, New York. Fahn, A. 1974. Plant Anatomy, 2nd edition. Pergamon Press, Oxford.
11. Grant W.E. (Ed.) (1984) Plant Biosystematics Academic Press, Toronto.
12. Haywood, V.H., and Moore, D.M. (1984). Current Concepts in Plant Taxonomy. Academic Press, London.
13. Heslop- Harrison, J. 1967. Plant Taxonomy. English Language Book Society & Edward Arnold Pub. Ltd., U.K.
14. Jeffery, C (1982) An Introduction to Plant Taxonomy, Cambridge University Press, Cambridge.
15. Jones, S.B. and Luchsinger, A.E. (1986), Plant Systematics. McGraw Hill Book Company, New York.
16. Krishnan, M.S. (1982). Geology of India and Burma. CBS Publishers and Distributors, New Delhi.
17. Lawrence, D.H. (1969). Taxonomy of Vascular Plants. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
18. Nair, P.K.K. (1970). Pollen Morphology of Angiosperms, Vikas Publishing House, New Delhi.
19. Radford, A.E. (1986). Fundamentals of Plant Systematics. Harper & Row Publicatons, USA.
20. Raghvan, V. (2000). Developmental Biology of Flowering Plants. Springer-Verlag, New York.
21. Saklani, P.S. (1991). Elementary Geology. Today's & Tomorrow's Printers and Publishers, New Delhi.
22. Singh, H. (1978). Embryology of Gymnosperms. Encyclopaedia of Plant Anatomy X. Gebruder Bortraeger, Berlin.
23. Solbrig O.T., and Solbrig D.J. (1979). Population Biology and Evolution. Addison – Wesley Publishing Co. Inc., USA.

24. Solbrig, O.T. (1970). Principles and methods of plant Biosystematics. MacMillan Company, Collier MacMillan Limited, London.
25. Sporne, K.R. (1965). The Morphology of Gymnosperms, B.I. Publications, New Delhi.
26. Stace, C.A. (1980). Plant Taxonomy and Biosystematics, Arnold Publications limited, London.
27. Takhtajan, A.L. (1997). Diversity and Classification of Flowering Plants. Columbia University Press, New York.
28. Trotter, H. (1982). The Common Commercial Timbers of India and their Uses (Reprint). Govt. of India Press, Nasik.

M.Sc. Botany (Semester-III)
(Credit Based Evaluation & Grading System)

BSL504 - Genome Structure, Function and Dynamics

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Genetic Fine Structure:** Classical versus molecular concepts of the gene, cis-trans test, limitation of cis-trans test, introns and their significance.
2. **Organization of genes and chromosomes:** Structure of chromatin and chromosomes, unique and repetitive DNA, heterochromatin, euchromatin, banding patterns.

SECTION-B

3. **DNA Replication, Repair anSd Recombination:** Unit of replication, enzymes involved, replication origin and replication fork, fidelity of replication, extrachromosomal replicons, DNA damage and repair mechanisms.
4. **RNA Synthesis and Processing:** Transcription factors and machinery, formation of initiation complex, transcription activators and repressors, RNA polymerases, capping, elongation and termination, RNA processing, RNA editing, splicing, polyadenylation, structure and function of different types of RNA, RNA transport.

SECTION-C

5. **Protein Synthesis and Processing:** Ribosome, formation of initiation complex, initiation factors and their regulation, elongation and elongation factors, termination, genetic code, aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase, translational proofreading, translational inhibitors, post- translational modification of proteins.
6. **Control of Gene Expression at Transcription and Translation Level:** Regulation of phages, viruses, prokaryotic and eukaryotic gene expression, role of chromatin in regulating gene expression and gene silencing.

SECTION-D

7. **Transposable Genetic Elements:** Transposable elements in prokaryotes and eukaryotes, significance of transposable elements.
8. **Quantitative and Molecular Aspects of Evolution:** Populations, gene pool, gene frequency; Hardy-Weinberg law; concepts and rate of change in gene frequency through natural selection, migration and random genetic drift; adaptive radiation and modifications; isolating mechanisms; speciation; convergent evolution; sexual selection; co-evolution, molecular divergence and molecular clocks; molecular tools in phylogeny, origin of new genes and proteins; gene duplication and divergence.

References:

1. Brown, T.A. (1999). Genomes. BIOS Scientific Publishers limited, UK.
2. Gardener, E.J., Simsons, M.J., and Sinustad, D.P. (1991). Principles of Genetics. John Wiley Sons Inc., New York.
3. Griffiths, A.J.F., Miller, J.H., Suzuki, D.T., Lewontin, R.C., and Gelbart, W.M. (1993). An Introduction to Genetic Analysis. Freeman and Comapany, USA.
4. Hawley R.S. and Walker, M. Y. (2003) Advanced Genetics analysis-Finding meaning in Genome. Blackwell Publishing, USA.
5. Klug W. S. and Cummings, M. R. (1997). Concepts of Genetics. Printice Hall International, Inc.
6. Lewin, B. (2000). Gene VII. Oxford University Press, New York.
7. Schulz-Schaeffer, J. (1980). Cytogenetics of Plants Animals and Human. Spinger-Verlag, New York.
8. Smith, J. M. (1998). Evolutionary Genetics. Oxford University Press, New York.
9. Snustad, D. P., Simmons, M. J. and Jenkins, J. B. (1997). Principles of Genetics, John Wiley and Sons, Inc., New York, Sixth edition.
10. Strickberger, M.W. (2001). Genetics. Prentice-Hall, Inc., Englewood Cliffs, N. Jersey.

M.Sc. Botany (Semester-III)
(Credit Based Evaluation & Grading System)

ESL506 - Ecological Modeling

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Exponential Population Growth:** Finite rate of increase, population doubling time, life tables, life expectancy, net reproduction rate, generation time, intrinsic rate of natural increase, stable age distribution.
2. **Matrix Model for Population Growth:** Matrix operations, addition, subtraction, multiplication, inversion, latent roots of a matrix, Leslies matrix model for population growth in unlimited environment, finite rate of increase with stable age distribution.

SECTION-B

3. **Logistic Population Growth:** Differential and matrix models for population growth in limited environment.
4. **Dispersal:** Empirical models, random walk model.
5. **Dispersion:** Poisson, random, uniform and aggregate patterns, Morisita's index of aggregation.

SECTION-C

6. **Interaction Between Two Species:** Competition – Differential equations, Leslie-Gower Model, Lotka-Volterra model for predator – prey interaction, Leslie model, deterministic models for simple and general epidemics.
7. **Association Analysis and Community Classification:** Chisquare, Cole's measures and point correlation coefficient for association, information analysis, ordination, continuum concept.

SECTION-D

8. **Species Diversity:** Species area relationships, species abundance relationships – Log normal distribution, information measures of diversity. Brillouin's measure, Shannon-Wiener measure, Simpson's measure. Extinction and formation of single populations, McArthur – Wilson theory of biogeography.
9. **Production and Energy Flow:** Production efficiency. Bertalanffy's growth equation, measurement of production in plants, litter decomposition – differential equations, Gompertz curve – differential equations, Energy flow. Ecological energetic.

10. **Applied Ecology:** Lake classification, Industrial water management, Water quality indices, Technological disasters.

References:

1. Barbour, M.G., Burk, J.H. and Pitts, W.D. (1987). Terrestrial Plant Ecology. Benjamin/Cummings Publication Company, California.
2. Batschelet, E. (1971). Introduction to Mathematics for Life Scientists. Springer-Verlag, Berlin.
3. Begon, M., Harper, J.L. and Townsend, C.R. (1996). Ecology. Blackwell Science, Cambridge.
4. Chapman, J.L. and Reiss, M.J. (1988). Ecology: Principles and Applications. Cambridge University Press, Cambridge.
5. Curran, P.J. (1988). Principles of Remote Sensing. E.L.B.S., Longman Scientific and Technical, Harlow.
6. Heywood, V.H. and Watson, R.T. (1995). Global Biodiversity Assessment. Cambridge University Press, Cambridge.
7. Kormondy, E.J. (1996). Concepts of Ecology. Prentice-Hall of India Pvt. Ltd., New Delhi.
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9. Ludwig, J. and Reynolds, J.F. (1988). Statistical Ecology. John Wiley & Sons, New York.
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12. Moldan, B. and Billharz, S. (1997). Sustainability Indicators. John Wiley & Sons, New York.
13. Moore, P .W and Chapman, S.B. (1986). Methods in Plant Ecology. Blackwell Scientific Publications, Cambridge.
14. Muller-Dombois, D. and Ellenberq, H. (1974). Aims and Methods of Vegetation Ecology, Wiley, New York.
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16. Odum, E.P. (1971). Fundamentals of Ecology. Saunders, Philadelphia..
17. Odum, E.P. (1983). Basic Ecology. Saunders, Philadelphia
18. Pielou, E.C. (1984). The Interpretation of Ecological Data. Wiley, New York.
19. Poole, R.W. (1974). An Introduction to Quantitative Ecology. McGraw Hill Book Co., New York.
20. Sabbins Jr, F.F. (1986) Remote Sensing: Principles and Intrepretation. WH Freeman & Co., New York.
21. Smith, R.L. (1996). Ecology and Field Biology. Harper Collins, New York.
22. Sokal, R.R. and Rohlf, F.J. (1995). Biometry. W.H. Freeman & Co. San Francisco.

M.Sc. Botany (Semester-III)
(Credit Based Evaluation & Grading System)

BSL507 - Plant Anatomy

3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Cells and Tissues:** Plant cell structure, cell inclusions including cystoliths, phytoliths, their distribution in plant groups and plant body, role in taxonomy, the cell and tissue systems, apoplast and symplast, permanent and meristematic tissues, histology, organization and differentiation into permanent tissues.
2. **The Stem, Root and Leaf:** primary structure and basic vasculature, types of stele, dicots vs monocots, ontogenetic development of stem, root and leaf, anatomy of leaf abscission.
3. **Secondary growth in stem and roots**: the origin of vascular cambium and its activity, anatomy of secondary xylem, anomalous secondary growth, polycyclic vasculature, types and ultrastructure of tracheids, vessels and wood rays , longitudinal parenchyma and its arrangement ,growth rings, grain and texture , knots, formation of resin cavities and tyloses, anatomy and chemistry of lignification.

SECTION-B

4. **The cork cambium**: origin and function, the role of pericycle, phellogen, phellem, phelloderm, anatomy and chemistry of suberization, distribution of sclerenchyma in leaf, stem and root, polyderm, commercial cork, protective tissues in monocots, wound cork, lenticels, distribution in plant body and plant groups, development and structure, duration and role.
5. **Nodal Anatomy:** types of nodes in dicots and monocots, leaf trace, cauline and common bundles, the node-internode transition, formation of leaf and branch traces, leaf gaps and branch gaps.

SECTION-C

6. **Floral Anatomy:** ontogeny and anatomy of the flower, floral axis and the whorls, vascularization of the flower, vestigial vascular bundles, stamen, phylogeny, structure and tissue differentiation, phylogeny of carpel, the leaf origin of carpel, evidences from anatomy of essential and accessory whorls.
7. **Fruit and Seed Anatomy**: Fruit types, gross and ultrastructural surface features of fruits and seeds, histology and the pericarp in dehiscent and indehiscent fruits, role in taxonomy, internal anatomy of dicot and monocot seeds, organ and cellular anatomy of typical monocot and dicot seeds, structural adaptations of fruits and seeds for various modes of dispersal.

8. **Secretary ducts and Laticifers**: inner secretary structures, resin ducts in primary and secondary body, development of ducts, laticifers, types, metabolic sources and chemistry of latex, origin of rubber.

SECTION-D

9. **Functional and Ecological Anatomy**: Anatomy of stem and root in relation to habit and growth form, aerial and buttress roots, haustoria and other special structures of epiphytes, parasites, mycorhizas and nitrogen fixers. Leaf anatomy in relation to photosynthesis and transpiration, anatomical modification of xerophytes and hydrophytes.

10. Applied anatomy: physical and anatomical features of common hard and soft woods of India, importance of density and weight in commercial utilization of woods, keys for identification of common Indian woods and their economic importance, techniques and methods in wood technology, methods of wood hardening, growth rings and dendrochronology and its practical uses, anatomical sources and histology of common plant fibres, masceration and staining, identification.

References

1. Brown, H.P. 1989. An Elementary Manual on Indian Wood Technology. R. P.S Publishers.
2. Cutter, E.G., 1969, Part 1 Cells and Tissues, Edward Arnold, London.
3. Cutter, E.G., 1971, Plant anatomy: Experiment and Interpretation, Part II, Organs Edward Arnold, London.
4. Eames A. J and Mac Daniels L. H (1947) An introduction to plant anatomy Tata Mc Graw Hill publishing company Ltd. Bombay, New Delhi.
5. Esau, K., 1977, Anatomy of Seed Plants, 3rd Edition. John Wiley and Sons, New York.
6. Fahn, A (1982). Plant Anatomy Pergaman Press Ltd. Headington Hill Hall, Oxford OX3-OBW, England.
7. Hartman, H.T. and Kestler, D.E., 1976. Propagation: Principles and practices, 3rd Edition, Prentice Hall of India Pvt.Ltd., New Delhi.
8. Mauseth, J.D., 1998, Plant Anatomy. The Benjamin Cumming Publishing Company Inc. Menlo Park, California, USA.
9. Trotter, H. 1982. The Common Commercial Timbers of India and their uses. Controller of Publications Delhi.
10. David F. Cutler, Ted Botha, Dennis Wm. Stevenson Plant Anatomy: An Applied Approach March 2008, Wiley-Blackwell
11. Richard Crang; Andrey Vassilyev; Michelle Salodyna; Plant Anatomy McGraw-hill Companies . 2003.
12. James D. Mauseth. Plant Anatomy Edition 8 Benjamin/Cummings Publishing Company, 1988. 560 pages
13. Pratibha saxena and susheela M. Das. A textbook of plant anatomy. Wisdom Press, 2012, v, 338 p,

M.Sc. Botany (Semester-III)
(Credit Based Evaluation & Grading System)

BSL508 - Plant Morphogenesis and Embryology

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Correlation, Polarity and Differentiation:** Physiological and genetic correlations. Polarity as expressed in external and internal structures, polarity in isolated cells, polarity in plasmodia and coenocytes. Growth and differentiation, differentiation as expressed in structure, external and internal differentiation, differentiation during ontogeny, differentiation in relation to environment, physiological differentiation, differentiation without growth.
2. **Introduction to Morphogenetic Factors**: light, water, temperature, physical factors like tension, compression, balancing and swaying, ultrasonics, gravity, bioelectical effects, genetic factors, chemical factors.

SECTION-B

3. **Microsporogenesis:** Historical perspective of the development of our knowledge of embryology.
   Structure and function of walls layers, ultra – structural changes in tapetum and meiocytes during microsporogenesis, role of callose, role of tapetum in pollen development, anther culture and haploid plants. Pollen mitosis, division of generative cell, cell heterogeneity in sperms, pollen fertility and sterility, pollen storage, viability and germination.
4. **Megasporogenesis:** Subcellular profiles of archesporial and megaspore mother cells, megaspore tetrad, dyad and coenomegaspore (Polarity of nuclei) determination of functional megaspore/ dyad. Ovules: Ontogeny; types of evolution, reduction, nutrition, post pollination changes, ovule culture.

SECTION-C

5. **Embryo Sac Types:** Ultrastructure of components, synergid and antipodal haustoria, nutrition of embryo sac.
6. **Pollination** Ultrastructural and histochemical details of style and stigma, self and interspecific incompatibility, significance of pollen-pistil interaction, role of pollen pistil interaction, role of pollen wall proteins and stigma surface proteins, barriers to fertilization, methods of over coming incompatibilities, intra-ovarian pollination, in-vitro pollination.

SECTION-D

7. **Fertilization:** Heterospermy, differential behaviour of male gametes, discharge and movement of sperms, syngamy and triple fusion, post fertilization, metabolic and structural changes in embryo sac.
8. **Embryo:** Polarization of zygote, embryogenic types, histology and organogenesis of dicot embryos, organless (undifferentiated) embryos, delayed differentiation of embryo, structure, cytology and function of suspensor, physiological and morphogenetical relationship of endosperm and embryo, embryo culture for rescue of hybrid embryo. Polyembryony: Types, genetic and somatic, pollen embryos.

References:

1. Atwell, B.J. Kriederusann, P.E. and Jumbull, C.G.N. (Eds.) 1999. Plant in action: Adaptation in nature, Performance in cultivation, MacMillan Education, Sydney.
2. Beck, C.B. 2005. An Introduction to Plant Structure and Development: Plant Anatomy for the Twenty-First Century. Cambridge University Press.
3. Bewley,J.D. and Black, M. 1994. Seeds: Physiology of Development and Germination, Plenum Press, New York.
4. Bhojwani, S.S. and Bhatnagar, S.P. 1975. The Embryology of Angiosperms. Vikas Publishing House, Delhi.
5. Eames, A.J. 1961. Morphology of the Angilosperms. Tata McGraw Hill Publishing Co., Bombay.
6. Fosket, D.E. 1994. Plant Growth and Development – A Molecular approach, Academic Press, Oxford.
7. Lyndon, R.F. 1990. Plant Development – The Cellular basis, Unnin Hyman, London.
8. Maheshwari, P. 1950. An Introduction to the Embryology of Angiosperms. Tata McGraw Hill Publishing Co. Bombay – New Delhi.
9. Raghavan, V. 1999. Developmental Biology of Flowering Plants, SpringerVerlag, New York.
10. Sinnot, E.W. 1960. Plant Morphogenesis, McGraw Hill Book Company, New York.
11. Steeve, T.A. and Sussex, I.M. 1989. Patterns in Plant Development (2nd Ed.), Cambridge University Press, Cambridge.
12. Bhojwani, S.S. and Bhatnagar, S.P. 2003. The Embryology of Angiosperms. Vikas Publishing House Pvt. Ltd., Delhi.
13. Maheshwari, P. 1980, An Introduction to the Embryology of Angiosperms. Tata McGraw Hill Publishing Company Ltd., Bombay – New Delhi.
14. Eames, A.J. 1961 Morphology of the Angiosperms. Tata McGraw Hill Publishing Co. Ltd. Bombay.
15. Johri. B.M. 1980. The Embryology of Angiosperms. McGraw Hill Publishing Co. Ltd. Bombay.

M.Sc. Botany (Semester-III)
(Credit Based Evaluation & Grading System)

BSL509 - Plant Molecular Biology and Genetic Engineering

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. Isolation and purification of RNA, DNA (genomic and plasmid) and proteins, different separation methods; analysis of RNA, DNA and proteins by one and two dimensional gel electrophoresis, isoelectric focusing gels.
2. Cloning vehicles-plasmids (Natural plasmids, pBR322 pUC118 and pUC119), bacteriophages, phagmids, viruses, cosmids, BAC and YAC vectors.

SECTION-B

3. Recombinant DNA technology: Use of restriction endonucleases, DNA ligases.
4. Agarose gel electrophoresis, Southern/Northern/ Western blotting. RFLP, RAPD and AFLP techniques.
5. Molecular cloning of DNA or RNA fragments in bacterial and eukaryotic systems. Generation of genomic and cDNA libraries.

SECTION-C

6. Expression of recombinant proteins using bacterial, animal and plant vectors.
7. In vitro mutagenesis and deletion techniques, gene knock out in bacterial and eukaryotic organisms.
8. Protein sequencing methods, detection of post-translation modification of proteins.

SECTION-D

9. DNA sequencing methods, strategies for genome sequencing. Isolation of specific nucleic acid sequences. Genomics and its application to health and agriculture, including gene therapy.
10. Methods for analysis of gene expression at RNA and protein level, large scale expression analysis, such as micro array based techniques.

References:

1. Draper, J.R., Scott, P., Armitage, R. Walden (1988). Plant Genetic Transformation and Gene Expression – A Laboratory Manual. Blackwell Scientific Publications, Oxford.
2. Grierson, D., and Covey, S.N. (1984). Plant Molecular Biology, Black Publishers, New York
3. Gupta, P.K. (1990). An Introduction to Biotechnology, Rastogi Publications, Meerut.
4. Kung, Shain – Dow and Arntzen, C.J. (1989). Plant Biotechnology, Butterworths, London.
5. Old, R.W., and Primrose, S.B. (1991). Principles of Gene Manipulation: An Introduction to Genetic Engineering. Blackwell Scientific Publications, Oxford.
6. Reinert, J., and Bajaj, Y.P.S. (1977). Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture. Springer Verlag, Berlin.
7. Shaw C.H. (1988). Plant Molecular Biology – A Practical Approach. IRL Press Oxford.
8. Mount, D.W. (2001). Bioinformatics: Sequence and Genome Analysis, Cold Spring Harbour Laboratory Press. New York.
9. Hartl, D. L. and Ruvolo, M. (2012). Genetics, Analysis of Genes and Genomes. 8th Edition. Jones and Bartlet, Ontario.

M.Sc. Botany (Semester-IV)
(Credit Based Evaluation & Grading System)

BSL551 – Applied and Industrial Botany

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Physical characteristics of Indian woods**: Methods of seasoning and chemical treatment of specialized use, fire proofing of the wood. Industrial manufacturing of packing material and plywood and the classifications of plywoods according to their use. Some important commercial woods:*Dalbergia* spp., *Shorea robusta*, *Tectona grandis, Cedrus deodara*, Bamboo-the 'green gold' of India
2. **Manufacturing of paper and board from raw plant material**: Manufacturing of crude and high quality paper, recycled paper.

SECTION-B

3. **Extraction of sugar from sugar cane .** Flow diagram of the process with a critical study of the steps involved, problems faced by the sugar industry in India. Bye-products of sugar industry, distillation of alcohol and other products with special reference to distilleries in Punjab.
4. **The rubber plants of India,** extraction of raw rubber and its chemical processing for the manufacturing of finished rubber.
5. **Fibres:** Classification of fibres, physical and chemical processes involved in the manufacuring of fibres from different types of fibre yielding plants.

SECTION-C

6. **Vegetable oils and fats** :Sources and methods of extractions of vegetable oils and fats and their utilization
7. **Gums and resins** :Sources of gums and resins and their classifications according to their chemical nature. Extraction of the raw resin and down the line processing for terpentine and other products.
8. **Essential oil** : Essential oil yielding plants of India, their use in perfumery.
9. **Natural dyes** Sources of natural dyes in India and their extraction methods, merits and limitations of plant based dyes.

SECTION-D

10. **An introduction to pharmaceutical industry in India**, extraction of antibiotics from microorganisms. Medicines extracted from higher plants, Industrial manufacturing of quinine, the concept of nutraceuticals, their availability, uses & problems.
11. **Agro industries in India with particular reference to Punjab**. The manufacturing and packing of milk and milk products, pickles, jams, jellies, juices, pastes, sauces etc. Problems of storage and marketing .

References:

1. Kochhar S. L. (1998). Economic Botany in the Tropics. MacMillan India limited, Delhi.
2. Pandey B P (1984). Economic Botany (3rd Ed.). S. Chand & Company Ltd.New Delhi.
3. Trotter H (1982). The Common Commercial Timbers of India And TheirUses. The Controller of Publications, Delhi.
4. Brown H P (1989). An Elementary Manual on Indian Wood Technology (Reprinted). International Book Distributors, Dehra Dun, India.
5. Shankar Gopal Joshi (2000). Medicinal Plants. Oxford & IBH Publishing Co.Pvt. Ltd. New Delhi.
6. Ambasta S P (1994). The Useful Plants of India. (3rd Ed.). Publications & Information Directorate, New Delhi.

M.Sc. Botany (Semester-IV)
(Credit Based Evaluation & Grading System)

BSL553 - Evolutionary Biology

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. Historical perspective of evolutionary biology, fundamental concepts in cosmology and geology, origin of life and evolutionary changes in the early life forms. origin of unicellular and multicelluar organism and major groups of plants, animals, human evolution. Pre-Darwinian and Darwinian theories of organic evolution.
2. Paleontology, geological time table, eras, the evolutionary synthesis, periods and epochs, major evolutionary events in the geological time scale.

SECTION-B

3. The environmental context, dynamics of the geological and climatic changes, response of biotas, Pleistocene glaciations, the fossil evidence, carbon and oxygen dating.
4. The taxonomic and biological concept of species, barriers to gene flow, pre-zygotic and post-zygotic, the genetics of reproductive isolation, the role of hybridization, the deviant forms, the hybrid. agamic and polyploid complexes.

SECTION-C

5. Allopatric speciation, evidences and genetic models, the role of genetic drift, peripetric speciation,. Role of dispersal and distribution, disjunct distributions, dispersalism versus extensionism, pattern of geographic variation, the theory of island biogeography.
6. Sympatric speciation: concepts of genetic variation, population as the unit of evolutionary change, mechanisms of genic and genotypic diversity, the role of genetic drift and gene flow in evolution, models of genetic drift, extinction and recolonalization, mutualism and coevolution.

SECTION-D

7. Molecular and genomic evolution, aims and methods of study, phylogenetic insights, evolution of DNA sequences, molecular phylogenetics, divergence and molecular clocks, evolution of novel genes and proteins, gene duplication and divergence, genome and chromosomal evolution in prokaryotes and eukaryotes.

References:

1. Graur Dan and Li Wen-Hsiuung. Fundamentals of Molecular Evolution (Second edition). Sinauer Publications.
2. Avers Charlotte J. Process & Pattern in Evolution. Oxford Publications.
3. Douglas J. Futuyma. Evolutionary Biology (Third Edition) Sinauer Publications.
4. Minkoff, J.C. 1983. Evolutionary Biology. Addision Wesley Publishing Company.
5. Dobzhansky, T. 1972. Evolutionary Biology . Appleton – Century – Crofts , Educational Division/ Meredith Corpoartion, New York. Ayala, F.J. & Valentine , J.W. !979. Evolving the theory of organic evolution. The Benjamin cumming Publishing Company, Melno Park, California. Lull, R.S. 1976. Organic Evolution. Light and Life Publishers, New Delhi
6. Smith, J.M. 1998. Evolutionary Genetics . Oxford University Press.
7. Stebbins, G.L. 1973. Prentice Hall of India Pvt. Ltd.

M.Sc. Botany (Semester-IV)
(Credit Based Evaluation & Grading System)

BSL554 - Population Biology and Biodiversity

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. Concept of population biology, behaviour and properties of population, life equation and key factor analysis. Principles of demography, mathematical techniques and models for the projection of population growth.
2. Genetic structure of population, the concept of gene pool, effect of mating systems on the population structure, models of study, ideal population, Hardy-Weinberg law, effect of selection, the basic selection model.

SECTION-B

3. Fundamental theorem of natural selection, models of selection, multiple alleles, other types of selection, multi-locus selection; genetic drift, effective population size, Founders effect and bottleneck effects, inbreeding coefficient; inbreeding and selection.
4. Mutation as a factor in change of allele frequencies, mutation-selection balance, mutation in a finite population, effect of migration on allele frequencies, genetic variations, point and chromosomal mutations, genetic polymorphism, speciation as genetic phenomenon.

SECTION-C

5. Gene flow and population structure, general model, Wahlund's effect, estimation of genetic distance, F coefficient, other differentiation measures, sex differences in gene flow, genetic drift
6. Ecological causes and background rates of plant extinctions, mass extinctions in the geological past. A study of anthropogenic factors in the loss of biodiversity, historical phases and recent escalations.
7. Biodiversity, concept, definition and scope, its relation to biogeography, genetic, specific and ecosystem diversity with particular reference to India. Levels of species diversity (alpha, beta & gamma) and indices of their measurement, species-area relationships and models.

SECTION-D

8. Ecological and practical uses of biodiversity; distribution and conservation status of plants with particular reference to economically important species, red data book categories, strategies and practices for *in situ* and *ex situ* conservation of biodiversity, role of botanical gardens.

9. Recent concerns for biodiversity beginning with Rio summit, National and International conventions and regulations on biodiversity with detailed study of CBD, major agencies involved and their activity profiles.

References:

1. Boughey, A.S. (1973). Ecology of Population (2nd Ed.). The Macmillon Company Ltd., New York.
2. McNaughton, S.J. & Wolf, L.L. (1973). General Ecology (Ist Ed.). Holt, Rinehart & Winston Inc. New York.
3. Dawson P.S. & King C.E. (Eds.) (1971). Readings in Population Biology. Prentice-Hall Inc. Englewood Cliffs, New Jersey.
4. Benton, A.H. & Werner(Jr.). W.E. (1974). Field Biology and Ecology (3rd Ed.) MacGraw Hill-Book Company, New York.

M.Sc. Botany (Semester-IV)
(Credit Based Evaluation & Grading System)

BSL555 - Plant Breeding and Intellectual Property Rights

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Origin of Agriculture, World Centres of Primary Diversity of Domesticated Plants:** Centres of origin of crop species and routes of their spread under cultivation, secondary centres of origin. Plant introduction and domestication, history, nature and objections of plant breeding.
2. **Breeding Systems of Crop Species:** Breeding in plants, including marker– assisted selection, Systems of mating in sexually reproducing species and their genetic consequences, breeding methods for self and cross pollinated crops, pure line, pedigree and mass selection, male sterility and self incompatibility.

SECTION-B

3. **Inbreeding Depression and Hybrid Vigour (Heterosis):** Hybridization in self and cross pollinated crops, genetic and physiological basis of heterosis, hybrid varieties, multiline synthetic and composite varieties, role of interspecific and intergeneric hybrids, barriers and techniques for production of distant hybrids.
4. **Breeding for Disease Resistance:** Classification of resistance, responses of the host to pathogens, variability systems of pathogenic fungi, breeding disease resistant varieties.

SECTION-C

5. **Mutations and Polyploidy Types:** causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function, germinal verses somatic mutants, insertional mutagenesis, protocols of point mutations and polyploidy in plant breeding, inheritance in polyploids, Structural and numerical alterations of chromosomes: Deletion, duplication, inversion, translocation, ploidy and their genetic implications.
6. **Seed Biotechnology:** Seed quality concept and general principles of seed production, synthetic seeds. Modern techniques in variety identification: Various biochemical methods

like electrophoresis, DNA, profiling techniques. Use of machine vision. Applications of variety identifications and future trends.

SECTION-D

7. **Intellectual Property Rights:** concept and administration, national and international laws and conventions related to intellectual property rights with particular reference to CITES, Dunkel's proposals, WIPO, GATT, TRIPS etc. publications on IPR, trade secrecy and material transfer agreements, biosafety and product labelling considerations.
8. The national and international patenting syatem, procedures to apply and secure patents, formats of application and background information, patenting of plant materials and breeders's rights, role of TIFAC and IP management division of CSIR, Patent facilitation centres.

References:

1. Conway, G. (1999). The Doubly Green Revolution: Food for All in the *21st Century*. Penguin Books.
2. Conway, G., and Barbier, E. (1990). After the Green Revolution. Earthscan Press, London.
3. Cristi, B.R. (ed.) (1999). CRC Handbook of Plant Sciences and Agriculture. Vol. I. *In-situ* Conservation. CRC Press, Boca Raton, Florida.
4. Haye, H.K., Immer, F.R., and Smith, D.C. (1955). Methods of Plant Breeding. McGraw Hill Book Co., New York.
5. Khush G.S. (1973). Cytogenetics of Aneuploids. Academic Press, New York.
6. Kohli, R., Arya, K.S., Singh, P,H., and Dhillon, H.S. (1994). Tree Directory of Chandigarh. Lovedale Educational, New Delhi.
7. Simmonds, N.W. (1979) Principles of Crop Improvement. Longman, London.
8. Singh B.D.(2005), Plant Breeding- Principles and Methods, Kalyani Publishers, Ludhiana.
9. Swaminathan, M.S., and Kochhar, S.l. (Eds) (1989). Plants and Society. Macmillan Publication Ltd., London.
10. Agarwal, K.C. (2000) Biodiversity. Agrobios, Jodhpur (India).
11. Kumar,U. and Asija, M.J (2002). Biodiversity, Principles and Conservation. Agrobios, Jodhpur (India).
12. TIFAC: Doc:023(2007). Some Questions and Answers on Patents, Designs, Copyrights Trademarks, IC Layout Designs, Geographical Indications, Protection of New Plant Varieties. Patent Facilitating Centre (PFC) Technology Information, Forecasting and Assessment Council (TIFAC). Department of Science and Technology (DST), New Delhi. Pp 1-38.

Internet Sources:

www.indianpatents.org.in,
www.tifac.org.in.

M.Sc. Botany (Semester-IV)
(Credit Based Evaluation & Grading System)

BSL557 – Plant Tissue Culture

Credits 2-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20

End Semester Marks : 80

Mid Semester Examination: 20% weightage

End Semester Examination: 80% weightage

Instructions for the Paper Setters:

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. Basic techniques of plant tissue culture, culture media, tissue and organ culture, cell culture, growth, differentiation and organogenesis in cell and organ culture.
2. Protoplast isolation, culture, somatic hybridization, selection systems for somatic hybrids, cell modification by DNA uptake, chloroplast uptake and genetic complementation.
3. Haploid production and its significance, anther and microspore cultures, monoploid production through chromosome elimination, production of triploids through endosperm culture.

SECTION-B

4. Cytogenetics and differentiation in cell and tissue culture, plant regeneration from callus, shoot apex culture and anthers.
5. Micropropagation : Stages, somatic embryogenesis,usefulness, hardening of micropropagated plantlets, advantages and disadvantages, application of the technique in crop improvement.
6. Somaclonal variations and isolation of useful mutants at cellular level, disease resistance, herbicide resistance and salt tolerance. Transgenic plants, molecular approaches to diagnosis and strain identification.

SECTION-C

7. Production of pathogen free plants through tissue culture.
8. Production of artificial seeds, their use and application.
9. Techniques for the production of transgenic plants : concept, vectorless transgenosis, gene targeting tools, crop improvement through transgenics, benefits and risk of producing transgenic plants, commercialization of transgenics.
10. In vitro cell culture and secondary metabolites production techniques.

SECTION-D

11. Cryobiology of plant cell cultures and establishment of plant banks, freeze preservation technology, factors influencing revival of frozen cells and future prospects.
12. Terminator technology, apprehensions and challenges.
13. Role of plant tissue culture and biotechnology in agriculture, medicine and human welfare, prospects of genetic engineering of plants.

References:

1. Ammirato, P.V., D.A. Evans, N.D. Sharp and Y.P.S. Bajaj (1990). Hand Book of Plant Cell Culture, Vols. 1 – 5. McGraw Hill Publishing Company, New York.
2. Bhojwani, S.S. and M.K. Razdan (1983), Plant Tissue Culture. Theory Practice Elsevier science publications Amsterdam.
3. Draper J.R. Scott, P. Armitage, R. Walden, (1988). Plant Genetic Transformation and Gene Expression – A Laboratory Manual. Blackwell Scientific Publications, Oxford.
4. Grierson, D. and Covey, S.N. (1984). Plant Molecular Biology, Black Publishers, New York
5. Gupta P.K., (1990), An Introduction to Biotechnology, Rastogi Publications, Meerut.
6. Kung, Shain – Dow and Arntzen, C.J. (1989). Plant Biotechnology, ButterWorths, London.
7. Old, R.W. and Primrose S.B. (1991). Principles of Gene Manipulation: An Introduction to Genetic Engineering, Blackwell Scientific Publications, Oxford.
8. Reinert, J. and Bajaj, Y.P.S. (1977). Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture, Springer Verlang, Berlin.
9. Shaw C.H. (1988), Plant Molecular Biology – A Practical Approach IRL Press Oxford.

M.Sc. Botany (Semester-IV)
(Credit Based Evaluation & Grading System)

BSL558 – Plant Metabolism

Credits: 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Nitrogen Metabolism**: Introduction, Overview of nitrogen in the biosphere and in plants, overview of nitrogen fixation, enzymology of nitrogen fixation, symbiotic nitrogen fixation, ammonia uptake and transport, overview of nitrate and nitrite reduction, interaction between nitrate assimilation and carbon metabolism,

SECTION-B

2. **Sulphur Metabolism**: Overview of sulfate assimilation, sulfur chemistry and function, sulfur uptake and transport, the reductive sulfate assimilation pathway, synthesis and function of glutathione and its derivatives.

SECTION-C

3. **Lipid Metabolism**: Biosynthesis of fats, fatty acids and glycerol, condensation of fatty acids and glycerol; Fat oxidation - hydrolysis of triglycerides by lipase; metabolism of glycerol; Oxidation of Fatty Acids – β-oxidation, α- oxidation, ω- oxidation; conversion of fat into carbohydrates (glyoxylate cycle).

SECTION-D

4. **Carbohydrate Metabolism**: Classification of carbohydrates, common carbohydrates found in plants. Breakdown and synthesis of sucrose, starch and cellulose.
5. **Secondary Metabolites and Plant Defence**: Role of secondary metabolites in plants, biosynthetic pathways and functions of terpenes, phenolic compounds and nitrogen containing compounds; induced plant defences against insect herbivores, plant defences against pathogens.

References:

1. Buchanan, B.B., Gruissem, W., and Jones, R.L. (2000). Biochemistry and Molecular Biology of Plants.American Society of Plant Physiologists, Maryland.
2. Hopkins, W.G. (2012). Introduction to Plant Physiology. John Wiley & Sons, Inc., New York
3. Nobel, P.S. (2009). Physiochemical and Environmental Plant Physiology. Academic Press, San Diego.
4. Salisbury, F.B., and Ross, C.W. (2010). Plant Physiology, Wadsworth Publishing Co., California.
5. Scott, P. (2008). Physiology and Behaviour of Plants.John Wiley and Sons Ltd. England.
6. Stewart, S. and Globig, S. (2011). Plant Physiology. Apple Academic Press Inc., Canada
8. Taiz, L., and Zeiger, E. (2010). Plant Physiology.Sinauer Associates, Inc., Publishers.
9. Jain, V. K. (2013). Fundamentals of plant physiology, 15th edition. S. Chand publishers.

M.Sc. Botany (Semester System)
(Credit Based Evaluation & Grading System)

BSL582 - Seed Biotechnology
(Elective Paper)

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Seed Enhancements: -** Seed hydration –prehydration priming and solid matrix priming, preplant germination, factors affecting priming.
2. **Commercial Seed Treatment Technology:** Introduction, Biological seed treatments against diseases or pests, Pelleting, coating or other techniques to alter physical characteristics, future directions.

SECTION-B

3. **Synthetic Seed Biotechnology:** Introduction, culture procedure, drying, storage, encapsulation, germination etc. Advantages and Disadvantages of artificial seeds, future prospects.
4. **Loss Reduction Biotechnology of Seeds:** Introduction, Causes and magnitude of seed crop losses, loss reduction measures.

SECTION-C

5. **Modern Techniques in Variety Identification:** Various biochemical methods like electrophoresis, DNA profiling techniques. Use of machine vision. Applications of variety identifications and future trends.

SECTION-D

6. **Molecular Farming Using Seeds as Hosts:** Seed storage proteins, strategies for protein targeting, examples of recombinant proteins produced in seeds. Advantages and prospects of seed based molecular farming.
7. **The Seed Production Industry:-** Functions of the seed industry. Growth and Development of the seed industry- Indian as well as international. Indian seed exports and imports. Genetically Modified Organisms (GMOs) in seed industry.

References:

1. Desai, B.B., Kotecha, P.M. Salunkhe, D. K. (1997). Seeds Handbook. Biology, Production, Processing, and Storage. Marcel Dekker, Inc; New York. pp. 1-627.
2. Black, M and Beewley, J.D. (2000). Seed Technology and its Biological Basis. Sheffield Academic Press, CRC Press, Boca Raton, U.S.A., pp. 1-419.
3. Black M, Bradford K J and Vazquez- Romos J. (2000) (Editors) Seed Biology - Advances and Applications Proceedings of the sixth International Workshop on seeds, Merida, Mexico, 1999. CABI Publishing, Oxon pp. 1-508.
4. Basra A S (1995) (Ed.) Seed Quality Basic Mechanisms and Agricultural Implications. Variety identification: Modern Technologies and Applications (Robert J. Cook). Food Product Press, New York.pp. 279-318.
5. Copeland L O, McDonald M B (1995). Principles of Seed Science and Technology. (3rd Edition) Chapman and Hall, New York
6. Kelly A F and George RAT (1998) (Editors). Encyclopedia of Seed Production of World Crops. Cultivars identification: Review of new methods (R J Cooke and J C Reeves). John Wiley and Sons, New York, pp. 88-111.

M.Sc. Botany (Semester System)
(Credit Based Evaluation & Grading System)

BSL583 - Human Values and Professional Ethics
(Elective Paper)

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A
INTRODUCTION TO VALUE EDUCATION

1. Understanding Value Education
2. Self-exploration as the Process for Value Education
3. The Program to Fulfil Basic Human Aspirations
4. The Basic Human Aspirations - Continuous Happiness and Prosperity

SECTION-B
UNDERSTANDING THE HARMONY AT VARIOUS LEVELS

5. Understanding the Human Being as Co-existence of Self ('I') and Body
6. Harmony in the Self ('I') - Understanding Myself
7. Harmony with the Body - Understanding Sanyama (Self regulation) and Svasthya (Health)

SECTION-C

8. Harmony in the Family - Understanding Values in Human Relationships
9. Harmony in the Society - From Family Order to World Family Order
10. Harmony in Nature - Understanding the Interconnectedness and Mutual Fulfilment
11. Harmony in Existence - Understanding Existence as Co-existence

SECTION-D
IMPLICATIONS OF THE RIGHT UNDERSTANDING

12. Providing the Basis for Universal Human Values and Ethical Human Conduct
13. Basis for the Holistic Alternative towards Universal Human Order
14. Professional Ethics in the Light of Right Understanding
15. Vision for Holistic Technologies, Production Systems and Management Models
16. Journey towards the Holistic Alternative - The Road Ahead

References:

1. Gaur, R.R., Sanghal, R. and Bagaria, G.P. (2010), A Foundation Course in Human Values and Professional Ethics. Excel Books, New Delhi
2. Seebauer, E.G. and Berry, R.L. (2000). Fundamentals of Ethics for Scientists and Engineers. Oxford University Press.
3. Tripathy, A.N.(2003), Human Values, New Age International Publishers.
4. www.universalhumanvalues.info

M.Sc. Botany (Semester System)
(Credit Based Evaluation & Grading System)

BSL584 - Genomics, Transcriptomics and Proteomics
(Elective Paper)

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Defining Genome and Genomics,** sequencing complete genomes, genomic databases.
2. **Physical Mapping of DNA**, Restriction site mapping, hybridization mapping.
3. Finding genes in genomes of (bacterial genome and higher eukaryotic genomes), detecting non-coding RNA genes

SECTION-B

4. **Genomic Variation:** Can genome diversity affect global warming, human SNPs and their relation to diseases and therapies, ethical consequences of genomic variations.
5. **Defining Transcriptome and Transcriptomics**, methods for large scale analysis of gene expression.
6. **Microarrays:** Introduction; properties and processing of array data, Microarray standards and databases.

SECTION-C

7. **Defining Proteome and Proteomics:** amino acid residue conservation, substitution matrices.
8. **Protein Analysis:** major proteomic approaches, data processing, major protein identification programs.

SECTION-D

9. **Conceptional Models of Proteins Structure**, obtaining viewing and analyzing structural data, structural alignment.
10. **Classification of Proteins** of known 3-D structure. CATH and SCOP. Protein structure prediction.

References:

1. Zimmermann, K. (2003). An Introduction to Protein Informatics. Kluwer Academic Publishers. The Netherland.
2. Christine, O., David, J. and Thornton, J. (2003). Bioinformatics: Genes, Proteins and Computers. 1st Edition. Bios Scientific Publishers. Oxford, United Kingdom.
3. Setubal and Meidanis. (2008). Introduction to Computional Molecular Biology. 1st Edition. Krishna Offset, New Delhi.
4. Baxevanis, A.D. and Onellette, B.F.F. (2005). Bioinforamtics: A Practical Guide to the Analysis of Genes and Proteins.3rd Edition. John Willey, Hoboken, New Jersey.
5. Cambell, A.M. (2003). Discovering Genomics, Proteomics and Bioinformatics. Banjamin Cummings Publishers. San Franciso.

M.Sc. Botany (Semester System)
(Credit Based Evaluation & Grading System)

BSL585 - Dynamics of Biogeography

(Elective Paper)

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**
Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Biogeography and its History:** Basic principles, its relationship to physiography and other modern sciences, biology, geography, biodiversity, and landscape ecology, age of exploration, biogeography of 18th , 19th and 20th centuries, biogeographic distribution of globe., vegetation types and classification of floristic regions.
2. **Geological History of the Earth:** The geological time scale, Wegner's theory of continental drift, tectonic history of the planet, patterns of continents, Gondwanaland, Laurasia, assembly and breakup of Pangaea, Development of marine basins and island chains, Epeiric, Mediterranean and Red seas, glaciations and biogeographic dynamics of the Pleistocene.

SECTION-B

3. **Ecological Biogeography: habitats, environment and niches,** Climate and life, physical setting of the planet, climatic zones of the world and life, solar energy and temperature regimes, winds and rainfall, soils and successions, formation of major soil types, Topography and Life, Aquatic environments, stratification and oceanic circulation
4. **Island Biogeography**: Types of islands, islands as model systems, MacArthur-Wilson theory of island biogeography, Effects of size and distance, equilibrium equation, modifications caused by selective nature of immigration and extinction and interspecific interactions.

SECTION-C

5. **Distributions of Single Species:** The geographic range projections and geographic coordinate systems, mapping and measuring range, distribution of individuals, populations and ecosystems, Hutchinson's multidimensional niche concept, relationship between distribution and abundance.
6. **Historical Biogeography** Dispersal and Immigration**,** Mechanisms of active and passive dispersal, Physiological, ecological and psychological barriers, biotics, exchange and dispersal routes: corridors, filters, sweepstakes routes, dispersal curves within and among species, establishment of colony and habitat selection, Dispersal & Vicariance in distant past and past community change, Ecosystem theories (Wedge effect, Bergmann's rule, Allen's rule, Gloger's rule, Jordon's rule and Merriam's classification).

SECTION-D

7. **Species Introductions:** Intentional and accidental, effects of non-native (invasive) species on the local flora, magnitude of the problem, concept of invasibility.

8. **Conservation Biogeography** Roots, relevance, aims and values, prospects and challenges, Biological invasions and homogenization of floras and faunas

References:

1. Brown, J.H. and Lomolino, M.V (1998). Biogeography. Sinauer Associates Inc., Sunderland, Massachusetts.
2. Cox, C. B. and Moore, P.D. (2000). Biogeography – An Ecological and Evolutionary Approach. Blackwell Scientific Ltd. pp. 298. London.
3. Fahrig, L., and K. Freemark. (1994). Landscape-scale effects of toxic events for ecological risk assessment. In J. Cairns and B.R. Niederlehner (eds.), Ecological Toxicity Testing, Scale, Complexity, and Relevance. Lewis Publishers, Boca Raton, FL.
4. Weinstein, D.A., and H.H. Shugart. (1983). Ecological modeling of landscape dynamics. In H.A. Mooney and M. Godron (eds.), Disturbance and Ecosystems. Springer-Verlag, New York.

BSL587- Immunology
(Elective Paper)

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. An Overview of the Immune System:Historical perspective, an introduction to the immune system–innate and adaptive immunity. Immunodeficiencies: secondary immunodeficiency disorders.
2. Antigens and Antigen Recognition: Antigens: prerequisites for immunogenicity, relative immunogenicity of different types of molecules, Molecules that enhance immunogenicity. Activators of lymphocytes: antigens, superantigens, mitogens. Antigen recognition by cells of innate immunity & adaptive immunity.

SECTION-B

3. Antibodies: Gamma globulins; structure, bifunctional property of antibodies, determining bifunctionality, cross reactivity, Antigen-antibody interactions: primary interactions, secondary interactions. Classification of antibodies: Isotypes, Allotypes, properties & biological functions of antibody isotypes, IgG,IgE,IgM, IgD, IgA, monoclonal antibodies.
4. Cells and Organs of Immune system: Hematopoiesis, cells of immune system: Lymphoid cells- B lymphocyte, T lymphocyte, Natural killer cells. Mononuclear Phagocytes: Phagocytosis, Granulocytic cells : Neutrophils, Eosinophils, Basophils, Mast cells. Organs of the Immune system: Primary lymphoid organs: Thymus, Bone marrow;Lymphatic system; Secondary lymphoid organs: Lymph nodes, spleen, mucosal-associated lymphoid tissue.

SECTION-C

5. Major Histocompatibility complex: General organization, MHC molecules and genes, MHC and disease susceptibility. Complement system: Function of complement, complement components, complement activation, regulation of the complement system, biological consequences of complement, complement deficiencies.

SECTION-D

6. Cancer: Malignant transformation of cells, Oncogenes and Cancer Induction, Tumors of the Immune system, Tumors evasion of the Immune system, Cancer Immunotherapy. The Immune system in Health & Disease, specially AIDS.
7. Transplantation Immunology: Immunological basis of graft rejection, general Immunosuppressive therapy, clinical manifestations of graft rejection, specific immunosuppressive therapy, immune tolerance to allografts, clinical transplantation

References:

1. Goldsby, R.A. Kindt, T.J., Oxborne B.A., Kuby, J. (2003). Immunology.W.H. Freemen & Company, NewYork.
2. Stanley, J. (2002). Essentials of Immunology and Serology. Delmar Thomson Learning, USA

BSL588 - Perspectives in Conservation
(Elective Paper)

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. Biogeographical Classification of the World and India, Definition of Biodiversity and its relation to biogeography, Global Magnitude of Biodiversity, Levels and Gradients of Biodiversity and their measurements, Indices of biodiversity, Species -area relationships.
2. Economic and Ecological uses of biodiversity, Direct Use Value, Indirect Use Value, Aesthetic Value, Ethical Value, Option Value.

SECTION-B

3. Loss of Biodiversity, Causes of Loss, Conventional and modern, anthropogenic and natural Man- Wildlife Conflicts, Indian Scenario.
4. Species Extinction, Characters of Species Susceptible to Extinction, The IUCN Red List Categories, Top Ten Most Wanted Species Announced by WWF, Threatened Animal and Plant Species of India, Red Data Books.

SECTION-C

5. *In situ* Conservation of Biodiversity, Protected Areas, National Parks, Wildlife Sanctuaries, Biosphere Reserves, Preservation Plots, Project Tiger, Project Elephant, Sacred Forests and Sacred Lakes.
6. *Ex situ* Conservation, Botanical Gardens, Zoos or Zoological parks, Aquaria, National Bureau of Plant Genetic Resources (NBPGR), National Bureau of Animal Genetic Resources (NBAGR).

SECTION-D

7. Bio-Wealth of India, Mountains as Repositories of Biodiversity, The Indian Deserts, Indian Wetlands, Indian Mangroves, Indian Coral Reefs, Indian Lakes, Hot Spots of Biodiversity, Hot Spots of India, The Status of Wildlife in India.
8. International and National Efforts for Conservating Biodiversity, Biodiversity Treaties, Role of Environmental Institutions in Biodiversity Conservation, India's Efforts in Biodiversity Conservation, Group of Like-minded Megadiverse Countries, Biological Diversity Act 2002, The Cartagena Protocol on Biosafety, The Genetic Engineering Approval Committee, GEF-World Bank Capacity Building Project on Bio safety.

References:

1. Misra S.P. and Pandey S.N. (2011), Essential Environmental Studies (3rd Edition), Ane Books Pvt. Ltd. New Delhi, pp 722-742.
2. Pandey B. N., D. Sadhana and Joshi B.D.(2007) Biodiversity, A.P.H. Publishing Corporation, New Delhi.

ESL584 - Solid Waste Management
(Elective Paper)

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. Types, sources of solid waste, Physical and Chemical composition of solid waste. Solid waste management: Material flow in society, materials and energy recovery, Day to day solid waste management

SECTION-B

2. Solid waste generation, On site handling, storage and processing of solid waste. Collection of solid waste, Transfer and transport of solid waste, Laws and rules for solid wastes in India.

SECTION-C

3. Processing of solid waste: mechanical volume reduction, Thermal volume reduction. Composting and Vermicomposting, Anaerobic digestion, Refuse Derived Fuels, Gasification, Pyrolysis.

4. Landfilling, Design and operation of Landfills, Landfarming, Deep well injection. Methane emission estimates from Landfill sites. Overview of LandGeM software by USEPA.

SECTION-D

5. Fly ash disposal techniques, E-waste management, Biomedical waste management, Plastic waste management, Industrial Waste, Agricultural waste

References:

1. Freeman H, Standard Handbook for Hazardous Waste Management, McGraw Hill (1989)
2. Jagbir Singh & AL. Ramanthan. Solid Waste Management: present and Future Challenges, IK International Publishing, New Delhi.
3. Kreith F and Tchobanoglous G, Handbook of Solid Waste Management, McGraw Hill (2002)
4. LaGrega M, Buckingham P and Evans J, Hazardous Waste Management, McGraw Hill (1994)
5. Municipal Solid Wastes (management and Handling) Rules, 2000.
6. Peavy, H. S., Rowe, D. R. and Tchobanoglous, G. (1985). Environmental Engineering. McGraw-Hill Book Company, Singapore.
7. Pichtel J, Waste Management Practices: Municipal, Industrial and Hazardous, CRC Press (2005)

ESL585 - BIOREMEDIATION
(Elective Paper)

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. **Bioremediation:** Introduction, Major environment contaminants, Microbial transformation of chemical contaminants, Phytoremediation, Criteria for Bioremediation as an option, Advantages of Bioremediation approaches to environment safety.

SECTION-B

2. **Biodegradation and Bioremediation of Petroleum and organic pollutants**: 4 soil treatment technologies (Phytoremediation technologies), optimizing environmental conditions, addressing other potential limitiations. Insufficient number of Hydrocarbon degrading microorganisms, lack of Cometabolism, Risk assessment and environment acceptability.

SECTION-C

3. **Bioremediation of Pesticide contaminants:** Organochlorines, Organophosphates, Carbamates, s-Triazines and other pesticides.

SECTION-D

4. **Biodegradation and Bioremediation of Explosives:** Structural properties and biodegradation of cyclic nitramine, TNT etc. and safety procedures.
5. **Biological treatment of Metallic pollutants**: Definition and scope, technologies used, microorganisms as remediation tool for suboxic environment.

References:

1. Singh A. and Ward O.P. (2004). Applied Bioremediation and Phytoremediation. pringer, U.S.A.
2. Bioremediation its Applications to Contaminated Sites in India - Ministry of Environment and Forests, Govt. of India (moef.nic.in/downloads/public Information/ Bioremediation Book.pdf) (2010).
3. Fulekar MH (2010). Bioremediation Technology, Capital Publishing, 1st ed.
4. Ronald LC and Donald LC (1996). Bioremediation Principle and Application, Cambridge

ESL586 - ENVIRONMENTAL SAFETY AND MANAGEMENT
(Elective Paper)

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20

End Semester Marks : 80

Mid Semester Examination: 20% weightage

End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. Need for integration of Safety, Health and Environment (SHE), General instructions for safety, Policy, Planning, Implementation and Operation, Hazardous materials: Definition and classification; Material safety data sheets; Handling of hazardous materials. Regulations: Rules and regulations pertaining to the management and handling of hazardous chemicals, hazardous wastes, biomedical wastes, hazardous microorganisms, genetically engineered organisms or cells, municipal solid wastes, E-wastes, batteries and plastics.

SECTION-B

2. Hazard Identification: Assessment of risk; Risk management; OSHAS 18001 and Occupational health and safety management systems.

3. Principles of Accident Prevention: Accident recording, analysis, investigation and reporting; On-site and off-site emergency preparedness and response plans; rules and regulations dealing with chemical accidents.

SECTION-C

4. Protection from Hazardous Materials: Personal protective equipment and clothing; Fire safety; Noise and vibrations; and Principles of noise control.

5. Hazardous Material – Storage, Disposal and Safety: Notification of sites; Safety reports; and safety audits.

SECTION-D

6. Laboratory work: Material safety data sheets (MSDS); On site and off-site emergency plans; Environmental risk analysis; Safety audits; Preparation of safety reports and notification of sites.

References:

1. Central Pollution Control Boards. Pollution Control Acts, Rules and Notifications Issued Thereunder. Pollution Control Law Series (PCLS/02/2006)
2. Gustin JF, Safety Management: A Guide to Facility Managers, Taylor & Francis (2003) http://moef.nic.in/modules/rules-and-regulations

ESL587 - Waste Stabilization Ponds
(Elective Paper)

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. General reactions in Ponds, Role of bacteria and algae in waste treatment, Conversion of solar energy, Effect of illumination, temperature, nutrients on treatment efficiency. Aerobic decomposition, Anaerobic decomposition, Protozoa and Fungi.

2. Design considerations: Quantity and nature of water, Sludge accumulation and grit, metrological data, Area requirements, Performance, Location, Shape and other constructional aspects, cost estimate.

SECTION-B

3. Constructional details: Pond bottom, Embankment, Top width, Slopes, Flood protection, Inlet arrangement, Inlet chamber, Grit removal channels, ponds interconnections, Outlet arrangement, Fencing, Warning sign, Access road and general lighting

SECTION-C

4. Operation and maintenance: Day to day inspection, Sampling and Analysis, maintenance of records, Overloading of ponds, Mosquitoes, Flies and water Fleas

5. Health aspects: bacterial removal, Removal of Salmonella, Virus removal, Removal of Helminthes, Amoeba and Snails vectors

SECTION-D

6. Effluent Utilization: Irrigation, Pisciculture, Harvesting of algae, Water reclamation.

References:

1. Archeivala SJ, Lakhshminarayana, JSSS, Alagarsamy, SR, Sastry, CA. (1970). Waste Stabilisation Ponds: Design, Construction & Operations in India. Central Public Health Engineering research Institute, Nagpur.
2. Sperling Marcos von ((2007). Waste Stabalisation Ponds. vol. 3, Biological Waste Treatment Series, IWA, London.

ESL588 - Water and Wastewater Analysis
(Elective Paper)

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20
End Semester Marks : 80

Mid Semester Examination: 20% weightage
End Semester Examination: 80% weightage

Instructions for the Paper Setters:
Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. Errors in quantitative analysis: Accuracy, Precision, Method Performance and Method validation.
2. Expression of results, Sampling, Grab, Composite, Integrated, Laboratory apparatus and reagents, Preservation of samples,
3. Precipitation, Filtration, Drying or Ignition, Desiccation. Preparation of standard solutions.

SECTION-B

4. Analytical balance, Gravimetric analysis, Volumetric analysis, Preparation of Normal solution, Primary and Secondary standards, Indicators used in water analysis,
5. Acid and base titrations, precipitation method, Oxidation-reduction methods,
6. Basics concepts of colorimeter, spectrophotometer, Calibration curve,.

SECTION-C

7. Conductivity, Turbidity (Nephelometric), Colour (Visual comparison, Spectrophotometric), Taste (Flavour threshold test), Oil & grease (Partition-Gravimetric),
8. Hardness (EDTA titration method), Alkalinity (Titration method), Sulphates (Gravimetric and Turbidimetric), Chlorides (Argentometeric),
9. Nitrite (Colorimetric), Nitrates (UV Screening and Cadmium reduction),
10. Iron (Phenanthroline), Flouride (SPANDS).

SECTION-D

11. BOD (5 day BOD and Respirometric method), COD (Closed reflux, Titrimetric),
12. Sample preparation for heavy metals, Extraction and enrichment in sample preparation, Principle of Extraction: Liquid-Liquid extraction, Liquid –solid extraction, Solid-Phase extraction.
13. Tests on Sludge: Oxygen consumption rate, Settled volume sludge, Sludge volume index, Zone settling rate, specific gravity, Capillary suction time, Time-to-Filter.

References:

1. Standard Methods for Examination of Water and Wastewater, APHA, 20th Ed.

ESL589 - Water Treatment Processes
(Elective Paper)

Credits 3-0-0

Time: 3 Hours **Max. Marks: 100**

Mid Semester Marks : 20

End Semester Marks : 80

Mid Semester Examination: 20% weightage

End Semester Examination: 80% weightage

Instructions for the Paper Setters:

Eight questions of equal marks (Specified in the syllabus) are to be set, two in each of the four Sections (A-D). Questions may be subdivided into parts (not exceeding four). Candidates are required to attempt five questions, selecting at least one question from each Section. The fifth question may be attempted from any Section.

SECTION-A

1. General layout plan for water treatment. Control of algae, Causative factors for growth of algae, remedial measures. Control of taste and odour in water, Preventive and corrective measures.

SECTION-B

2. Cause of colour, Colour due to presence of Iron and manganese and its removal techniques (precipitation, contact beds, Zeolite, catalytic method), Algae, Colloidal organic matter, Industrial waste, Oxidation of colour, Treatment by activated carbon.

SECTION-C

3. Water softening: Lime treatment, Lime-Soda process, and ion-exchange. Deflouridation of water, Demineralization of water, Distillation (Solar stills, Single and multiple effect distillation).

SECTION-D

4. Desalination of water using Reverse osmosis and electro dialysis. Case studies of desalination system.

Reference:

1. Manual of Water Supply and Treatment. (1999). Central Public Health and Environmental Engineering Organization, Ministry of Urban Development, New Delhi.
2. Metcalf & Eddy Inc. Revised by Tchobanoglous, G., Burton, F. L. and Stensel, H. D. (2002). Wastewater Engineering Treatment and Reuse 4/e. Tata McGraw-Hill Publishing Company Limited, New Delhi.
3. Peavy, H. S., Rowe, D. R. and Tchobanoglous, G. (1985). Environmental Engineering. McGraw-Hill Book Company, Singapore.