Final

Learning Outcomes Based Curriculum Framework (LOCF)

For

M.Sc. (Botany)

3rd & 4th semester (batch 2023-24)

First Year: PG Diploma in Botany
Second Year: M.Sc Botany

Department of Bio and Nano Technology

Guru Jambheshwar University of Science and Technology, Hisar 125001

2023-24

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GURU JAMBHESHWAR UNIVERSITY OF SCIENCE AND TECHNOLOGY, HISAR

Scheme of Examination for M.Sc. Botany (Semester System) as per NEP-2020 to be Implemented w.e.f. session 2023-24

Sr. No.	Course Code	Course Type	Course Title	Credits	L+T+P	Total Marks (T+IA)
Semester I						
1.	BOL-101	CC 1	Biology and Diversity of Viruses, Bacteria and Fungi	4	4+0+0	70+30
2.	BOL-102	CC 2	Biology and Diversity of Algae & Bryophytes	4	4+0+0	70+30
3.	BOL-103	CC 3	Physiology and Biochemistry	4	4+0+0	70+30
4.	BOL-104	SEC 1	Biochemical and Biophysical Techniques	4	4+0+0	70+30
5.	BOP-101	CC 4	Lab – I (Biology and Diversity of Viruses, Bacteria and Fungi, Biology and Diversity of Algae & Bryophytes)	3	0+0+3	70+30
6.	BOP-102	CC 5	Lab – II (Physiology and Biochemistry)	3	0+0+3	70+30
7.	BOP-103	SEC 2	Lab – III (Biochemical and Biophysical Techniques)	3	0+0+3	70+30
8.	OES-1	OP 1	Open Elective	4	4+0+0	70+30
			Total	29	20+9	800
Semester II						
1.	BOL-201	CC 6	Biology and Diversity of Pteridophytes & Gymnosperms	4	4+0+0	70+30
2.	BOL-202	CC 7	Cytogenetics	4	4+0+0	70+30
3.	BOL-203	CC 8	Molecular Biology	4	4+0+0	70+30
4.	BOL-204	DSC 1A	Principles of Plant Pathology	4	4+0+0	70+30
		DSC 1B	Cell and Developmental Biology			
		DSC 1C	MOOC			
5.	BOP-201	CC 9	Lab – IV (Pteridophytes, Gymnosperms & Cytogenetics))	3	0+0+3	70+30
6.	BOP-202	CC 10	Lab – V (Molecular Biology)	3	0+0+3	70+30
7.	BOP-203	DSC 2A	Lab – VI (Plant Pathology)	3	0+0+3	70+30
		DSC 2B	Lab – VI (Cell & Development Biology)			
8.	BOT-205	SEC 3	Summer Training (4-6 weeks)* (Field Visit/ Survey/ In-house Training/ Industrial Training)	4	0+4+0	70+30
			Total	25+4*	16+4+9	700+100*= 800

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Semester III						
1.	BOL-301	CC 11	Plant Systematics & Biology of Reproduction	4	4+0+0	70+30
2.	BOL-302	CC 12	Plant Diversity	4	4+0+0	70+30
3.	BOL-303	CC 13	Plant Tissue Culture	4	4+0+0	70+30
4.	BOL-304	SEC 4	Biostatistics & Bioinformatics	4	4+0+0	70+30
5.	BOP-301	CC 14	Lab – VII (Plant Systematics & Biology of Reproduction)	3	0+0+3	70+30
6.	BOP-302	CC 15	Lab – VIII Plant Diversity/Plant Tissue Culture)	3	0+0+3	70+30
7.	BOP-303	SEC 5	Lab – IX (Biostatistics & Bioinformatics)	3	0+0+3	70+30
			Total	**25**	**16+9**	**700**
Semester IV						
1.	BOL-401	CC 16	Plant Ecology: Principles and Concepts	4	4+0+0	70+30
2.	BOL-402	CC 17	Plant Biotechnology	4	4+0+0	70+30
3.	BOL-403	CC 18	Cardinal Principles of Academic Integrity and Research Ethics	4	4+0+0	70+30
4.	BOL-404	DSC 3A	Plant Growth and Development	4	4+0+0	70+30
		DSC 3B	Genomics			
		DSC 3C	Algae, Environment and Human Welfare			
5.	BOP-401	CC 19	Lab – X (Plant Ecology/Plant Biotechnology)	3	0+0+3	70+30
6.	BOP-402	DSC 4A	Lab – XI (Plant Growth & Development)	3	0+0+3	70+30
		DSC 4B	Lab – XI (Genomics)			
		DSC 4C	Lab – XI (Algae, Environment and Human Welfare))			
7.	BOS-410	CC 20	Credit Seminar**	2	0+2+0	50
8	BOD-411	CC 21	Project Work***	4	0+4+0	100
			Total	**28**	**16+6+6**	**750**
					Grand Total= 2950+100*	

*Note: Students willing to exit the programme after second semester have to undertake the Internship/summer training

**Evaluation will be done by a committee constituted by Chairperson

***Evaluation will be done by External Examiner

Distribution of Total Credits

Name of M.Sc. Programme	Core Course (CC)	Discipline Specific Elective Course (DSC)	Skill Enhancement Course (SEC)	Open Elective (OP1)	Total Credits
Botany	75	14	14+4*	4	107+4*

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Core Course-11

BOL-301: Plant Systematics & Biology of Reproduction

Credit: 4 (Lectures: 60) Marks: 100

Exam duration: 3 Hrs. Theory: 70; IA: 30

Course Objective: This course aims to educate students on concept of systematics, taxonomic keys, classification of flowering plants, botanical nomenclature, plant molecular systematics, plant collection and documentation, male and female gametophyte, pollination and pollen pistil interaction.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	To acquaint students with nomenclature, systematics and taxonomic evidences
CO2	Students will be learnt about plant molecular systematics and plant documentation methods.
CO3	This course explores the reproductive biology. The students will effectively communicate scientific knowledge of how plant reproduce.
CO4	Acquire knowledge about the different interaction and apomixes.

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

UNIT-I

Systematics: Concepts and components; Plant identification: Taxonomic keys.

Classification of flowering plants: APG IV classification. Taxonomic evidence: structural and biochemical characters.

Salient Features of International Code of Nomenclature of Algae, Fungi and Plants (ICN),[Shenzhen Code (2018)].

UNIT-II

Botanical Nomenclature: Principles of nomenclature, Scientific names, Ranks, Author citation, Nomenclatural types, Valid publications, Priority of publications, Conservation of names, Name changes, Synonyms.

Plant Molecular Systematics: DNA sequence data, Types of sequence data, Sequence alignment, Phylogenetic analysis (parsimony, Maximum Likelihood, Bayesian approaches, Neighbour-Joining).

Plant Collecting and Documentation: Methods of collecting plants, Herbaria and data information systems, Herbarium specimens, Herbarium operations, Data Information Systems.

UNIT-III

Male gametophyte: Structure of anther, microsporogenesis, role of tapetum, Pollen development, male sterility; pollen germination, pollen tube growth and guidance; pollen allergy.

Female gametophyte: ovule development, megasporogenesis, Organisation of the embryosac, structure of

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embryo sac cells

UNIT-IV

Pollination: Pollination mechanisms and vectors.

Pollen-pistil interaction and fertilization: structure of pollen; pollen – stigma interaction,sporophytic and gametophytic incompatibility, double fertilization, Endospermdevelopment, polyembryony; apomixis.

Suggested Readings:

1. Bhojwani, S.S., and Bhatnagar, S.P., 2000, *The Embryology of Angiosperms* (4th Ed.),Vikas Publishing House, New Delhi.
2. Crawford, D.J., 2003, *Plant Molecular Systematics*, Cambridge University Press,Cambridge, UK.
3. Judd, W.S., Campbell, C.S, Kellogg, E.A., Stevens, P.A. and Donoghue, M.J.,2016, *Plant Systematics: A Phylogenetic Approach*. Sinauer Associates, Inc., Massachusetts.
4. Shivanna, K.R. and Johri, B.M., 1985, *The Angiosperm Pollen: Structure and Function.* Wiley Eastern Ltd., New Delhi.
5. Simpson, M.G., 2010, *Plant Systematics*, Elsevier, Amsterdam.
6. Steussy, T.F., Crawford, D.J., Soltis, D.E. and Soltis, P.S., 2014, *Plant Systematics: The origin, interpretation, and ordering, of plant biodiversity,* Koeltz Scientific Books,Konigstein, Germany.
7. Radford, A.F.,1986, *Fundamentals of Plant Systematics*, Harper and Row Publishers, Inc.

Core Course-12

BOL-302: Plant Diversity

Credit: 4 (Lectures: 60) **Marks: 100**

Exam duration: 3 Hrs. **Theory: 70; IA: 30**

Course Objective: The course aims to have understanding of plant diversity, significance of diversity, need of classification, bases of classification, Plant adaptations, distribution of plants, evolutionary diversification.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Acquire knowledge about significance of plant diversity
CO2	Describe the morphological features, adaptations in plants in relation to habitat conditions
CO3	Understand the Plant diversity at different levels
CO4	Demonstrate an understanding of plants, their classification, characteristics, reproduction etc

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

UNIT-I

Plant diversity and Classification, Levels of biodiversity, various Phyla of Plants and theircharacteristics (Algae, Bryophytes, Pteridophytes, Gymnosperms and Angiosperms),

UNIT-II

Ecosystem services, Human Food and Plant diversity, Bacterial diversity, Terrestrial Plant diversity, Marine Plant diversity, Inland water diversity, Rain Forest ecosystem and plant diversity, Landscape diversity

UNIT-III

Biodiversity Hotspots, Keystone species, Threats to Plant diversity, Desertification,Endangered plants, Plant invasions, Loss of Plant diversity, Plant Restoration

UNIT-IV

Indigenous people and plant diversity, Traditional plant conservation practices, Plants inIndian tradition and culture, Plant animal interactions, Use and Economic values of plant diversity, Tourism and Plant diversity, Climate changeand plant diversity

Suggested Readings:

1. Kumar, U. and Sharma, A.K. (2001). Plant biotechnology and Biodiversity conservation.Agrobios, Jodhpur.
2. Dobson, A. (1996). Conservation and Biodiversity. Palgrave MacMillan
3. Levin, S.A. (2001). Encylopedia of Biodiversity Vol 1 to 5. Academic Press New York
4. Groombridge, B. and Jenkins, M.D. (2002). World Atlas of Biodiversity, Earth living resources inthe 21st Century. University of California Press
5. Singh, J.S., Singh, S.P. and Gupta, S.R. (2008). Ecology, Environment and Resourceconservation. Anamaya Publications, New Delhi
6. Krishnamurthy, KV. (2003). Text Book of Biodiversity. Science Publishers

Core Course-13

BOL-303: Plant Tissue Culture

Credit: 4 (Lectures: 60) **Marks: 100**

Exam duration: 3 Hrs. **Theory: 70; IA: 30**

Course Objective: The aim of this course is to give the students essential knowledge pertaining to micropropagation, somatic embryogenesis, haploid production, somatic hybridization, cryopreservation and secondary metabolite production.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Acquire knowledge about the non - conventional methods of plant propagation.
CO2	Learn about regeneration of complete plants from plant organs/cell other than seeds
CO3	Apply knowledge regarding in vitro techniques in Agriculture and forestry.
CO4	Attain practical knowledge of preparing artificial seeds. Develop curiosity about use of non - conventional methods in storage and conservation of germplasm.

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

UNIT-I

Plant Tissue Culture: History of Plant Tissue Culture, Basic concept, principles and scopeof plant cell and tissue culture, concepts of cellular differentiation; Totipotency; basic techniques of plant tissue culture; callus formation, organogenesis and embryogenesis.

Protoplast isolation, fusion and culture, somatic hybridization, hybrid selection and regeneration. Cybrids and their application.

UNIT-II

In vitro haploid production and its significance, Anther/Pollen culture and ovary culture; Embryo and ovule culture Production of triploids through endosperm culture.

Micropropagation: meristem culture and virus-free plants; Cryopreservation of plant celland tissue cultures and establishment of gene banks

Somaclonal variations and isolation of useful mutants; mechanisms and applications in genotype improvement.

UNIT-III

Plant Secondary Metabolites: Sources and production of secondary metabolites; criteria for cell selection, factors affecting the culture of cells; different bioreactors and their use in secondary metabolite production; biochemical pathways for the production of different secondary metabolites; biotransformation.

UNIT-IV

Somatic embryogenesis, production of synthetic seeds, importance, limitation and theirutilization.

Application of tissue culture in forestry and agriculture; status of tissue and cell culturetechnology in India edible vaccines, and their prospects.

Suggested Readings:

1. Bhojwani, S.S. and Razdan, M.K., 1996, *Plant Tissue Culture: Theory and Practice* (Arevised Edition), Elsevier Science Pub., New York, USA.
2. Chawla, H.S., 2020, *Introduction to Plant Biotechnology* (3rdEdition), Oxford and IBHPub. Co., New Delhi.
3. Collins, H.A. and Edwards, S. 1998, *Plant Cell Culture*, Bios Scientific Pub., Oxford,U.K.
4. Glick, B.R., and Pasternak, J.J., 1998, *Molecular Biotechnology: Principles andApplications*, ASM Press, Washington, DC.
5. Razadan, M.K., 1993, *An introduction to Plant Culture*, Oxford & IBH Pub., Co., NewDelhi, India.

SEC 4

BOL-304: Biostatistics & Bioinformatics

Credit: 4 (Lectures: 60) **Marks: 100**

Exam duration: 3 Hrs. **Theory: 70; IA: 30**

Course Objective: This course has a strong interdisciplinary component and is designed to equip students with essential skills in bioinformatics (at basic level). It will introduce applications of computational biology in diverse areas of biological sciences and provide training in the use of statistics in biological sciences.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Get introduced to basic tools and concepts of Bioinformatics and their significance in applied and basic biology. They will also learn application of various bioinformaticstools, biodiversity databases and biological resources.
CO2	Learn about various biological databases and bioinformatics tools.
CO3	Get conceptual understanding of Statistic and Statistics.
CO4	Learn about the various types of estimations and tests used in biostatistics.

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

UNIT-I

Introduction to Bioinformatics: Definition, history, role and applications of bioinformatics.
Biodiversity databases: IUCN, Species 2000, Fish Base, IPNI, ICTV, ITIS, Tree of life.
Biological materials resources: ATCC, MTCC, NCCS.

UNIT-II

Biological databases: Primary, secondary and structural Protein and Gene Information Resources–PIR, SWISSPROT, PDB, Gene bank, DDBJ, EMBL-EBI, Specialized genomicresources.
Bioinformatics Tools: homology and similarity tools (BLAST, FASTA, SSEARCH, or HMMER search), protein functional analysis tools (Pfam Scan, HMMER3 phmmer, Phobius, Pratt RADAR), sequence analysis tools.

UNIT-III

Biostatistics: Conceptual understanding of Statistic and Statistics; Parameters; Variable; Population, Finite and Infinite Populations; Sample; Discrete and Continuous Variable;
Sample: Simple random sample, Stratified Sample, Clustered Samples, Judgement Sample, Countable and Uncountable Sample; Variable and Attributes; Dichotomous attributes.

UNIT-IV

Estimation: Point Estimation; Interval estimation; Confidence Interval, Arithmetic mean, Median, Mode, Merits and demerits of Mean, Median and Mode; Range; Roles of t – statistic; when and where do we use it, Independent t – statistic, Paired t – statistic, Two samples t – statistic, One sample t – statistic, F –

statistic; Chi-square test and its uses; "testing" in statistic, Hypothesis, Null hypothesis, Two-sided hypothesis, One-sided hypothesis; Critical region; Level of significance, P – value; Standard deviation; Variance.

Suggested Readings:

1. Attwood, T.K. and Parry-Smith, D.J., 2004, *Introduction to Bioinformatics*, PearsonEducation, Singapore, Pvt. Ltd.
2. Dwyer, R.A., 2004, *Genomic Perl: From Bioinformatics Basics to Working Code*,Cambridge University Press, 1st south Asian edition.
3. Edwards, D., 2007, *Plant Bioinformatics: Methods and Protocols*, Humana Press, newJersey, USA.
4. Kulas, J.T., 2008, *SPSS Essential: Managing and Analyzing Social Science Data*, JohnWiley and Sons, New York.
5. Rosenkrantz, W.A., 2009, *Introduction to Probability and Statistics for Science,Engineering and Finance*, CRC Press, Boca Raton.
6. Schwartz, R., Phoenix, T. and d Foy, B., (2005), *Learning Perl* (4th edition), O'Reiley andAssociates, ISBN: 0-596-10105-8.

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Core Course-16

BOL-401: Plant Ecology: Principles and Concepts

Credit: 4 (Lectures: 60) **Marks: 100**

Exam duration: 3 Hrs. **Theory: 70; IA: 30**

Course Objective: The aim of this course is to give the students essential knowledge about basic concepts of plant ecology especially of structure of ecosystem, different niches, community, different energy flow pathways, biogeochemical cycles, population properties andecological succession.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Understand mechanisms by which organisms interact with other organisms and with their physical environment.
CO2	Develop insights about the concepts of populations, community and ecosystems and can use in management of natural resources for sustainable development.
CO3	Acquire knowledge about limiting factors controlling distribution and growth of organisms. Comprehend interactions among components of ecosystems for betterstability.
CO4	Describe biotic and abiotic factors that influence the dynamics of populations.

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

UNIT-I

Concept and structure of ecosystem: Cybernetic nature and stability (resistance and resilience) of ecosystems; structure and function of some Indian ecosystems: forest,grassland, freshwater, marine and eustarine. Brief idea of microcosms, spacecraft and cityas ecosystems.

Concept of Habitat and ecological niche; fundamental and realized niche; resource portioning: ecological equivalents, natural selection, allopatric and sympatric speciation. Artificial section and domestication.

UNIT-II

Concept of community: intra-community classification, analysis of communities (analyticand synthetic characters), species diversity, ecotones and edge effect.

Concept related to energy: primary productivity and its measurements, global pattern andcontrolling factors; food chain, food web, trophic levels, energy flow pathways, ecologicalenergetics, energy budgets, ecological efficiencies.

UNIT-III

Concept of limiting factors; Liebig's law of minimum, Shelford's law of tolerance, factorcompensation and ecotypes, ecads, ecological indicators.

Pattern and basic types of biogeochemical cycles (C, N, P and S), sedimentary cycle, cycling of non-essential elements and organic nutrients; nutrient cycling in the tropics, recycle index.

UNIT-IV

Population group properties: life history strategies (r and k selection), carrying capacity, population

regulation, types of interactions, concept of metapopulation – demes and dispersal, interdemic extinctions. **Ecological succession and its types,** relay floristics and initial floristics composition, hinergetics, models (facilitation, tolerance and inhibition), causes, changes in ecosystemproperties during succession, concept of climax; its unit's theories and forms.

Suggested Readings:

1. Chapman, J.L. and Reiss, M.J. 1998, *Ecology Principles and Applications* (2nd Edition), Cambridge University Press, U.K.
2. Odum, E.P. and Barrett, G.W., 2005, *Fundamentals of Ecology*, Thomson Books/Cole, U.S.A.
3. Sharma, P.D., 2011, *Ecology and Environment*, Rastogi Publ. Meerut.
4. Singh, J.S., Singh, S.P. and Gupta, S.R., 2006, *Ecology, Environment and Resource Conservation*, Anamaya Publishers, New Delhi.
5. Stiling, P., 1999, *Ecology: Theories and Applications*, Prentice Hall Inc., London.
6. Tiwari, S.C. 2005, *Concept of Modern Ecology*, Bishen Singh Mahendra Pal Singh.Dehra Dun.

Core Course-17

BOL-402: Plant Biotechnology

Credit: 4 (Lectures: 60) **Marks: 100**

Exam duration: 3 Hrs. **Theory: 70; IA: 30**

Course Objective: The aim of this course is to give the students essential knowledge pertainingto Recombinant DNA Technology, DNA cloning, gene amplification, genetic transformation methods and IPRs

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Understand various tools and techniques used in genetic engineering.
CO2	Demonstrate the strategies and measures for manipulation of genome by incorporating desirable genes pertaining to specific traits.
CO3	Acquire knowledge about different methods for genetic transformation of plants
CO4	Understand patent, copyright and trademark, the acts and policies in India and abroad.

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

UNIT-I

Techniques used in DNA technology: Gel electrophoresis, PFGE, Southern and westernblotting, Dot blots, Chemical synthesis of genes, DNA chip technology.
Isolation of genes, Sequencing of genes: Maxam & Gilbert's method, Sanger's methodand next generation sequencing technologies.
Brief account of proteomics and genomics

UNIT-II

DNA cloning methods: using vectors (Plasmids, phages, cosmids, phagemids, transposons, artificial chromosomes, BAC, YAC, MAC), cloning in bacteria and eukaryotes, genomic and C-DNA libraries.
Gene amplification by PCR: different types, DNA fingerprinting, molecular probes:General features and applications.

UNIT-III

Genetic engineering: Principles, methods and applications in agriculture. Methods for genetic transformation and transgenic plants production through *Agrobacterium tumefaciens* and *A. rhizogenes,* Gene transfer methods in plants; viral vectors and their applications, Bt cotton and Golden rice (A brief introduction).
Chloroplast transformation: its success with tobacco and potato.

UNIT-IV

Intellectual Property Rights: Patents, trade secrets, copyright, trademarks; GeographicalIndicators (GI); Registration, subject matter and ownership of IPRs.

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Plant genetic resources; GATT & TRIPPS; Patenting of biological material; Plant breeder'srights (PBRs) and farmer's rights. Infringement, passing off action and remedies availableto IPR holder. Some legal cases related to trademarks, copyrights and patents.

Suggested Readings:

1. Brown, T.A., 1999, *Genomes*, John Wiley & Sons (Asia) Pvt. Ltd., Singapore
2. Chawla, H.S., *Introduction to Plant Biotechnology* (2nd edition), Oxford and IBHPublishing, Co. Pvt. Ltd., New Delhi.
3. Glick, B.R. and Pasternak, J.J., 1998, *Molecular Biotechnology: Principles andApplications*, ASM Press, Washington DC.
4. Gupta, P.K. 1996, *Elements of Biotechnology*, Rastogi & Co., Pub., New Pub., Meerut,India.
5. Henry, R.J. 1998. Practical Applications of Plant Molecular Biology, Chapman &Hall, London, UK.
6. Lewin, B. 2005. Genes VIII, Oxford University Press, Oxford, UK.
7. Singh, B.D., 2007, *Biotechnology: Prospects and Applications*. Springer, Germany.
8. Snustad, D.P. and Simmons, M.J. 2000. Principles of Genetics (2nd Ed.) John Wiley &Sons. Inc., New York, USA

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Core Course-18

BOL-403: Cardinal Principles of Academic Integrity and Research Ethics

Credit: 4 (Lectures: 60) **Marks: 100**

Exam duration: 3 Hrs. **Theory: 70; IA: 30**

Course Objective: The aim of this course is to give the students essential knowledge about academic integrity values, writing skills, UGC policy for academic integrity and prevention, identification of publications misconduct, complains and appeals, conflicts of interest, predatory publisher and journals.

Course outcomes: At the end of the course, the students will know:	
CO1	Academic Integrity, Plagiarism (prevention and detection) and UGC regulations
CO2	Research and Publications ethics and best practices

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

UNIT-I

Academic Integrity: Introduction, Academic Integrity Values- Honesty and Trust, Fairness and Respect, Responsibility and Courage, Violations of Academic Integrity- typesand consequences.

UNIT-II

Plagiarism -definition, Plagiarism arising out of misrepresentation- contract cheating, collusion, copying and pasting, recycling, Avoiding Plagiarism throughreferencing and writing skills, UGC Policy for Academic Integrity and prevention, Some Plagiarism detection tools.

UNIT-III

Research and Publication ethics: Scientific misconducts- Falsifications, Fabrication and Plagiarism (FFP), Publication ethics- definition, introduction and importance, Best practices/standard setting initiatives and guidelines-COPE, WAME etc.,

UNIT-IV

Violation ofpublication ethics, authorship and contributor-ship, Identification of publications misconduct, complains and appeals, Conflicts of Interest, Predatory publisher and journals.

Suggested Readings:

1. Beall, J., 2012, *Predatory publishers are corrupting open access*, Nature, 489 (7415),179.
2. Chaddah, P., 2018, *Ethics in Competitive Research: Do not get scooped; do not getplagiarized*, ISBN: 978-9387480865.
3. Indian National Science Academy (INSA), 2019, *Ethics in Science Education, Researchand Governance*, ISBN: 978-81-939482-1-7.

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4. MacIntyre, A., 1967, *A short History of Ethics*, London.
5. National Academy of Sciences, National Academy of Engineering and Institute of Medicine, 2009, *On being a Scientist: A guide to Responsible Conduct in research*, (ThirdEdition), National Academies press.
6. Resnik D. B., 2011, *What is ethics in research & why is it important*, National Institute of Environmental Health Sciences, 1-10.s

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DSC 3A

BOL-404: Plant Growth and Development

Credit: 4 (Lectures: 60) **Marks: 100**

Exam duration: 3 Hrs. **Theory: 70; IA: 30**

Course Objective: The aim of this course is to give the students essential knowledge differentaspects of plant growth and development especially germination and dormancy of seeds, plantgrowth regulators, senescence and abscission, photomorphogenesis and response of plant to different abiotic stresses.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Understand the basic concepts of plant growth and development.
CO2	Acquire in depth knowledge about various plant growth regulators and their role in physiology of growth and development.
CO3	Describe metabolic changes associated with the senescence and abscission and their hormonal control.
CO4	Demonstrate an understanding of physiology of flowering and sensory biology.

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

UNIT-I

Plant Growth: Growth concepts, Growth curves, Growth analysis. Germination andDormancy of seeds; factors affecting dormancy and its regulation by plant growth regulators and environmental factors.
Stress Physiology: Response of plants to abiotic stresses: abiotic stress affecting plant productivity. Basic principles of crop improvement programme under stress.

UNIT-II

Plant Growth Regulators: Discovery, biosynthetic pathways, transport, influence onplant growth and mechanism of action of: Auxins, Gibberellins, Cytokinins, Ethylene, Abscisic acid.
Senescence and Abscission: Physiological and biochemical changes associated with senescence and abscission.

UNIT-III

Tropism: Phototropism, nature of receptors, role of hormones, Geotropism and nastism.
Secondary metabolites and chemical defence: Natural products (secondary metabolites),their range and ecophysiological functions. Overview of terpenoidal, alkaloidal, and phenolic metabolites and their biosynthesis. Biochemical mechanisms of plants' chemical war against other plants and animals.

UNIT-IV

Phytochromes: mechanism of phytochrome action, photomorphogenesis and cryptochromes.
The Flowering Process: Photoperiodism and its significance, importance of dark periods, role of vernalization. Nature and events during flowering, florigen concept, chemical control of flowering.

Suggested Readings:

1. Garrett, R.H. and Grisham, C.M., 1999, *Biochemistry* (Second edition), Saunders CollegePublishing, Philadelphia.
2. Huner, N. and Hopkins, W., 2013, *Introduction to Plant Physiology*, (4th ed.), John Wiley& Sons, Inc.
3. Krishnamoorthy, H.N, (1993), *Physiology of Plant Growth and Development*, Atma Ramand Sons, Delhi.
4. Kumar, H.D. and Singh, H.N. (1993), *Plant Metabolism* (Second edition), Affiliated East-West Press Pvt Ltd. New Delhi.
5. Salisbury, F.B. and Ross, C.W. (1992). Plant Physiology. Fourth edition, WadsworthPublishing Co. Belmont, California, USA.
6. Srivastava, L.M. (2006). Plant Growth and Development: Hormones and Environment.Academic Press. Published by Elsevier India Pvt. Ltd., New Delhi.
7. Taiz, L., Zeiger, P. E. E., Mller, P. E. I. M., & Murphy, P. A. C. A., 2018, *Fundamentalsof plant physiology*, Sinauer Associates.

DSC 3B

BOL-404: Genomics

Credit: 4 (Lectures: 60)

Marks: 100

Theory: 70; IA: 30

Exam duration: 3 Hrs.

Course Objective: The aim of this course is to give the students detailed knowledge of basic methods involved in genome studies, their organization and function.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	Enhance knowledge about human genome project, genome sequencing projects formicrobes, plants and animals, accessing and retrieving genome project information from web
CO2	Develops ability to use genomes to understand evolution of eukaryotes, track emerging diseases and design new drugs, different methods of gene annotation and approachesof gene expression.
CO3	Spread awareness about the concept of forward and reverse genetics, gene tagging.
CO4	To acquaint students with RNAi, gene silencing, genome imprinting different method of genome engineering

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

UNIT-I

Genomics: Human Genome Project- methodology, outcomes and lessons learnt, Genome sequencing projects for microbes, plants and animals, accessing and retrieving genome project information from web, Annotation of genome/gene sequence, Synthetic genomes- current status and future prospects

Comparative Genomics: Identification and classification of organisms using molecular markers- 16S rRNA typing/sequencing, SNPs; use of genomes to understand evolution of eukaryotes, track emerging diseases and design new drugs; determining gene location in genome sequence.

UNIT-II

Methods of gene annotation: Principle of analyzing genome wide gene expression and itsutility.

Approaches to analyze differential expression of genes - ESTs, SAGE, microarrays andtheir applications. Use of high throughput RNA sequence data for differential expression analysis using various new approaches.

UNIT-III

Concept of forward and reverse genetics as applied to designing genome wide screensfor deciphering gene function.

Gene tagging: gene and promoter trapping, knockout and knockdown mutants.

Introduction to comparative genomics of model plants and related crop species.

UNIT- IV

Introduction to RNAi and gene silencing.

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Genome Imprinting: small RNAs and their biogenesis, role of small RNAs inheterochromatin formation and gene silencing.

Introduction of genome engineering: a comparative study of genome engineering methods.

Suggested Readings:

1. Birren, B., Green, E.D., Klapholz, S., Myers, R.M. and Roskams, J., 1997, *GenomeAnalysis*, CSHL Press.
2. Brown, T.A., 2007, *Genomes 3*, Garland Science Publishing New York, London.
3. Chawla, H.S., 2009, *Introduction to Plant Biotechnology* (3rd Ed.), Oxford & IBHPublishing Co. Pvt. Ltd., New Delhi.
4. Hartl, D.L. and Ruvolo, M., 2011, *Genetics- Analysis of Genes and Genomes* (8th Ed.),Jones and Bartlett Publishers, Inc., USA.
5. Hunt, S.P. and Livesey, F.J., 2000, *Functional Genomics*, Oxford University Press, NewYork. London.
6. Lewin, B., 2005, *Genes VIII*, Oxford University Press, Oxford, UK
7. Singer, M., and Berg, P., 1991, *Genes and Genomes: A Changing Perspective*; UniversityScience Books, CA, US.

DSC 3C

BOL-404: Algae, Environment and Human Welfare

Credit: 4 (Lectures: 60)

Marks: 100

Exam duration: 3 Hrs.

Theory: 70; IA: 30

Course Objective: This course aims to educate students towards advance topics involving algae for Industrial/environmental application and for human welfare. The course also deals with photosynthesis, lipid metabolism, Nitrogen fixation and assimilation in algae.

Course outcomes (CO): On successful completion of this course, the students will be able to:	
CO1	The student will learn about organization of the photosynthesis apparatus from blue green algae to red algae, photosynthetic pigments and light harvesting, light absorption: PSI and PSII, electron transport chain which is important for production of ATP with the help of ATP synthase.
CO2	The students will learn about uptake mechanism(s) of HMs through various transporters present on plasma membrane.
CO3	The course teaches about various beneficial products from algae and their industrial production. These include various algae utilized for food, as neutraceuticals or as fuel
CO4	They will also learn about how algal cells have various strategy to counterthe HMs induced oxidative stress and their negative consequences on vital metabolic occurrences like photosynthesis and nitrogen metabolism

Note: Examiner will set nine questions in all, selecting two questions from each unit and one question of short answer/objective type covering the entire syllabus, which will be compulsory. Students will have to attempt five questions in all selecting one from each unit and the compulsory question. All questions will carry equal marks.

Unit I

Photosynthesis advancement in various class of algae

Organization of the photosynthesis apparatus from blue green algae to red algae,photosynthetic pigments and light harvesting, light absorption: PSI and PSII, electrontransport chain, proton transport and ATP synthesis, CO_2 assimilation under dark reaction,RUBISCO activity and its interaction with light and oxygen.

Unit II

Nitrogen fixation and assimilation in algae: GS-GOGAT cycle, GDH cycle, Nitrogenase, Heterocyst differentiation, structural significance, physiological and biochemical adaptation for Nitrogen fixation, NR, NiR, GS, GOGAT, and AspAT enzymes biosynthesis, structure and their functions, nitrogen fixation and photosynthesis-relationship, nitrate reduction and assimilation in algae, assimilation of organic nitrogen in algae: urea, amino acids and amides.

Unit III

Tolerance and detoxification mechanisms of HMs in algae: Effective methods of culturing the potent algae for efficient phycoremediation of HMs, various methods implied by algae for efficient accumulation of HMs, uptake of HMs by various cell membrane associated transporters, reactive oxygen species, oxidative stress, carbonylation of proteins during HMs stress, metallothionein, antoxidative

enzymes: SOD, CAT, APX, GR, DHAR, MDHAR and non enzymatic antioxidants: GSH, AsA, proline, and polyamines.

Unit IV

Algal application for human welfare: Algae for food, pigments, antioxidants, proteins and carbohydrate. Algal Lipids, biodiesel and biofuel production: Fatty acid biosynthesis, Polyunsaturated fatty acid accumulation, Biodiesel production,Biohydrogen, Bioethanol production. Research hurdles and possible solutions.

Biotechnological advancements in algal research: Genetic engineering in algae, Mutagenesis for strain improvement, engineering efforts for advancement in culturing techniques, Integrated multitrophic aquaculture.

Suggested Readings:

1. egyankosh.ac.in/bitstream/123456789/16683/1/Unit-7.pdf
2. Carmichael, W.W. (ed.) (2013). The Water Environment: Algal Toxins and Health. Plenum Press,NY. ISBN 13: 978-1-4613-3269-5. 490pp
3. Mihir Kumar Das. 2010. Algal Biotechnology. Daya Publishing House, New Delhi.
4. Vashishta, P.C. 2014. S.Chand & Company Ltd, New Delhi.
5. Ian Morris. 1977. An introduction to the algae. Hutchinson & Co (Publishers) Ltd. London.
6. Kumar, H.D. 1999. Introductory Phycology. Affiliated East-West Press, Delhi.
7. Hoek, C. Van, D. 1999. An Introduction to Phycology. Cambridge University Press.
8. Bold, H.C and Wynne, M.J. 1985. Introduction to the Algae. Prentice Hall of India, New Delhi
9. Fritsch, F.E. 1945. Structure and reproduction of Algae. Cambridge University press.
10. Round, FE. 1984.The Ecology of Algae. Cambridge University Press.
11. Lee, R.D. 2008.Phycology 4th Edition, Cambridge University Press, New York