KARNATAK UNIVERSITY, DHARWAD
ACADEMIC (S&T) SECTION

ಕರ್ನಾಟಕ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಧಾರವಾಡ
ವಿದ್ಯಾಮಂಡಳ (ಎಸ್&ಟಿ) ವಿಭಾಗ

ಸ್ವಾತಂತ್ರ್ಯದ ಅಮೃತ ಮಹೋತ್ಸವ

Tele: 0836-2215224
e-mail: academic.st@kud.ac.in
Pavate Nagar,Dharwad-580003
ಪಾವಟೆ ನಗರ, ಧಾರವಾಡ – 580003

NAAC Accredited
'A' Grade 2014

website: kud.ac.in

No. KU/Aca(S&T)/JS/MGJ(Gen)/2024-25/1436 Date: 11 NOV 2024

ಅಧಿಸೂಚನೆ

ವಿಷಯ: ರಾಷ್ಟ್ರೀಯ ಶಿಕ್ಷಣ ನೀತಿಯನುಸಾರ 2024–25ನೇ ಶೈಕ್ಷಣಿಕ ಸಾಲಿನಿಂದ ಎಲ್ಲ ಸ್ನಾತಕೋತ್ತರ ಪದವಿಗಳಿಗೆ / ಸ್ನಾತಕೋತ್ತರ ಡಿಪ್ಲೋಮಾಗಳಿಗೆ ಪಠ್ಯಕ್ರಮವನ್ನು ಪ್ರಕಟಣೆ ಕುರಿತು.

ಉಲ್ಲೇಖ: 1. ವಿದ್ಯಾವಿಷಯಕ ಪರಿಷತ್ ಸಭೆಯ ನಿರ್ಣಯ ಸಂಖ್ಯೆ: 2 ರಿಂದ 9, ದಿ: 08.11.2024.

2. ಮಾನ್ಯ ಕುಲಪತಿಗಳ ಅನುಮೋದನೆ ದಿನಾಂಕ: 11.11.2024.

ರಾಷ್ಟ್ರೀಯ ಶಿಕ್ಷಣ ನೀತಿಯನುಸಾರ 2024–25ನೇ ಶೈಕ್ಷಣಿಕ ಸಾಲಿನಿಂದ ಅನ್ವಯವಾಗುವಂತೆ, ಕರ್ನಾಟಕ ವಿಶ್ವವಿದ್ಯಾಲಯದ ಎಲ್ಲ ಸ್ನಾತಕೋತ್ತರ ಪದವಿಗಳಾದ M.A./ M.Sc / M.Com / MBA / M.Ed 1 ರಿಂದ 4ನೇ ಸೆಮೆಸ್ಟರ್‌ಗಳಿಗೆ ಮತ್ತು 1 & 2ನೇ ಸೆಮೆಸ್ಟರ್‌ಗಳ ಸ್ನಾತಕೋತ್ತರ ಡಿಪ್ಲೋಮಾಗಳಿಗೆ ವಿದ್ಯಾವಿಷಯಕ ಪರಿಷತ್ ಸಭೆಯ ಅನುಮೋದನೆಯೊಂದಿಗೆ ಈ ಕೆಳಗಿನಂತೆ ಪಠ್ಯಕ್ರಮಗಳನ್ನು ಅಳವಡಿಸಿಕೊಳ್ಳಲಾಗಿದೆ. ಕಾರಣ, ಸಂಬಂಧಪಟ್ಟ ಎಲ್ಲ ಸ್ನಾತಕೋತ್ತರ ವಿಭಾಗಗಳ ಅಧ್ಯಕ್ಷರು / ಸಂಯೋಜಕರು / ಆಡಳಿತಾಧಿಕಾರಿಗಳು / ಮಹಾವಿದ್ಯಾಲಯಗಳ ಪ್ರಾಚಾರ್ಯರುಗಳು / ಶಿಕ್ಷಕರು ಸದರಿ ಪಠ್ಯಕ್ರಮಗಳನ್ನು ಅನುಸರಿಸುವುದು ಮತ್ತು ಸದರಿ ಪಠ್ಯಕ್ರಮವನ್ನು ಕ.ವಿ.ವಿ. ಅಂತರ್ಜಾಲ www.kud.ac.in ದಲ್ಲಿ ಭಿತ್ತರಿಸಲಾಗಿದನ್ನು ಸಂಬಂಧಪಟ್ಟ ವಿದ್ಯಾರ್ಥಿಗಳಿಗೆ ಸೂಚಿಸುವುದು.

Arts Faculty

Sl.No	Programmes	Sl.No	Programmes
1	Kannada	8	MVA in Applied Art
2	English	9	French
3	Folklore	10	Urdu
4	Linguistics	11	Persian
5	Hindi	12	Sanskrit
6	Marathi	13	MPA Music
7	MVA in Painting		

Faculty of Science & Technology

Sl.No	Programmes	Sl.No	Programmes
1	Geography	10	M.Sc (CS)
2	Chemistry	11	MCA
3	Statistics	12	Marine Biology
4	Applied Geology	13	Criminology & Forensic Science
5	Biochemistry	14	Mathematics
6	Biotechnology	15	Psychology
7	Microbiology	16	Applied Genetics
8	Zoology	17	Physics
9	Botany	18	Anthropology

Faculty of Social Science

Sl.No	Programmes	Sl.No	Programmes
1	Political Science	8	Journalism m & Mass Commn.
2	Public Administration	9	M.Lib. Information Science
3	History & Archaeology	10	Philosophy
4	A.I.History & Epigraphy	11	Yoga Studies
5	Economics	12	MTTM
6	Sociology	13	Women's Studies
7	MSW		

Management Faculty

Sl.No	Programmes	Sl.No	Programmes
1	MBA	2	MBA (Evening)

Faculty of Commerce

Sl.No	Programmes	Sl.No	Programmes
1	M.Com	2	M.Com (CS)

Faculty of Education

Sl.No	Programmes	Sl.No	Programmes
1	M.Ed	2	M.P.Ed

OEC subject for PG

Sl.No	Programmes	Sl.No	Programmes
1	Russian	5	Veman Peetha
2	Kanaka Studies	6	Ambedkar Studies
3	Jainology	7	Chatrapati Shahu Maharaj Studies
4	Babu Jagajivan Ram	8	Vivekanand Studies

PG Diploma

Sl.No	Programmes	Sl.No	Programmes
1	PG Diploma in Chatrapati Shahu Maharaj Studies	2	P.G. Diploma in Women's Studies
3	P.G. Diploma in Entrepreneurial Finance		

ಕುಲಸಚಿವರು.

ಅಡಕ: ಮೇಲಿನಂತೆ

ಗೆ,

1. ಕ.ವಿ.ವಿ. ಸ್ನಾತಕೋತ್ತರ ಅಧ್ಯಕ್ಷರುಗಳಿಗೆ / ಸಂಯೋಜಕರುಗಳಿಗೆ / ಆಡಳಿತಾಧಿಕಾರಿಗಳಿಗೆ / ಮಹಾವಿದ್ಯಾಲಯಗಳ ಪ್ರಾಚಾರ್ಯರುಗಳಿಗೆ
2. ಎಲ್ಲ ನಿಖಾಯದ ಡೀನರು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.

ಪ್ರತಿ:

1. ಕುಲಪತಿಗಳ ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
2. ಕುಲಸಚಿವರ ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
3. ಕುಲಸಚಿವರು (ಮೌಲ್ಯಮಾಪನ) ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
4. ಅಧೀಕ್ಷಕರು, ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆ / ಗೌಪ್ಯ / ಜಿ.ಎ.ಡಿ. / ವಿದ್ಯಾಂಡಳ (ಪಿ.ಜಿ.ಪಿಎಚ್.ಡಿ) ವಿಭಾಗ/ ಸಿಸ್ಟಮ್ ಅನಾಲೆಸಿಸ್ಟ್ / ಸಂಬಂಧಿಸಿದ ಪದವಿಗಳ ವಿಭಾಗಗಳು, ಪರೀಕ್ಷಾ ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
5. ನಿರ್ದೇಶಕರು, ಕಾಲೇಜು ಅಭಿವೃದ್ಧಿ / ವಿದ್ಯಾರ್ಥಿ ಕಲ್ಯಾಣ ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
6. ನಿರ್ದೇಶಕರು, ಐ.ಟಿ. ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ ಇವರಿಗೆ ಕ.ವಿ.ವಿ. ಅಂರ್ತಜಾಲದಲ್ಲಿ ಪ್ರಕಟಿಸುವುದು.

KARNATAK UNIVERSITY, DHARWAD

"A" Grade

P.G. PROGRAMME

M.Sc. BOTANY

Curriculum Structure

With Effect from 2024-25

The Programme structure of the M.Sc. Botany

Semester	No. of compulsory & Specialization courses (credits/course)	Total credits for compulsory & Specialization course	No. of open elective course (credits/course)	Total credits of open elective course	Total credits for the semester
Sem. I	Th :04 (04) =16 Pra:04 (02)=08	**24**	-	-	**24**
Sem. II	Th :03 (04) =12 Pra:03 (02)=06	**18**	Th :01 (04) =04	4	**22**
Sem. III	Th :03 (04) =12 Pra:03 (02)=06	**18**	Th :01 (04) =04	4	**22**
Sem. IV	Th:03(04)=12 Pra:03(02)=06 Pj:1 (06)=06	**18** **06**	-	-	**24**
Total	Th 13 (04)=52 Pra 13 (02)=26 Pj: 1 (06)=06	**84**	Th: 02 (04)=08	08	**92**

COURSE STRUCTURE AND SCHEME OF EXAMINATION FOR M. Sc. COURSE IN BOTANY

M.Sc.-I Semester

Sem.	Type of course	Theory/ Practical	Course code	Course title	Instruction hour/week	Total hours/ sem.	Duration of exam	Marks			Credits
								Formative	Summative	Total	
I	DSC	Theory	A1BOT 001T	Microbiology, Mycology and Plant Pathology	04	60 Hrs.	03 Hrs.	20	80	100	04
	DSC	Practical	A1BOT 002P	Microbiology, Mycology and Plant Pathology	04	56 Hrs.	04 Hrs.	10	40	50	02
	DSC	Theory	A1BOT 003T	Algae, Bryophytes, Pteridophytes and Gymnosperms	04	60 Hrs.	03 Hrs.	20	80	100	04
	DSC	Practical	A1BOT 004P	Algae, Bryophytes, Pteridophytes and Gymnosperms	04	56 Hrs.	04 Hrs.	10	40	50	02
	DSC	Theory	A1BOT 005T	Plant Systematics and Plant Geography	04	60 Hrs.	03 Hrs.	20	80	100	04
	DSC	Practical	A1BOT 006P	Plant Systematics and Plant Geography	04	56 Hrs.	04 Hrs.	10	40	50	02
	DSC	Theory	A1BOT 007T	Plant Ecology and Environmental Biology	04	60 Hrs.	03 Hrs.	20	80	100	04
	DSC	Practical	A1BOT 008P	Plant Ecology and Environmental Biology	04	56 Hrs.	04 Hrs.	10	40	50	02
								120	**480**	**600**	**24**

Study tour of minimum of 5 to 8 days is compulsory for M.Sc. I Semester Students.

COURSE STRUCTURE AND SCHEME OF EXAMINATION FOR M. SC. COURSE IN BOTANY

M.Sc.-II Semester

Sem.	Type of course	Theory/ Practical	Course code	Course title	Instruction hour/week	Total hours/ sem.	Duration of exam	Marks			credits
								Formative	Summative	Total	
II	DSC	Theory	A2BOT 001T	Plant Physiology and Plant Biochemistry	04	60 Hrs.	03 Hrs.	20	80	100	04
	DSC	Practical	A2BOT 002P	Plant Physiology and Plant Biochemistry	04	56 Hrs.	04 Hrs.	10	40	50	02
	DSC	Theory	A2BOT 003T	Economic Botany and Evolutionary Biology	04	60 Hrs.	03 Hrs.	20	80	100	04
	DSC	Practical	A2BOT 004P	Economic Botany and Evolutionary Biology	04	56 Hrs.	04 Hrs.	10	40	50	02
	DSC	Theory	A2BOT 005T	Plant Anatomy and Pharmacognosy	04	60 Hrs.	03 Hrs.	20	80	100	04
	DSC	Practical	A2BOT 006P	Plant Anatomy and Pharmacognosy	04	56 Hrs.	04 Hrs.	10	40	50	02
	OEC	Theory	A2BOT 204T	Plant Resources in Human Welfare	04	60 Hrs.	03 Hrs.	20	80	100	04
								110	**440**	**550**	**22**

COURSE STRUCTURE AND SCHEME OF EXAMINATION FOR M. SC. COURSE IN BOTANY

M.Sc.-III Semester

Sem.	Type of course	Theory/ Practical	Course code	Course title	Instruction hour/week	Total hours/ sem.	Duration of exam	Marks			Credits
								Formative	Summative	Total	
III	DSC	Theory	A3BOT 001T	Reproductive Biology, Plant Cell, Tissue and Organ Culture	04	60 Hrs.	03 Hrs.	20	80	100	04
	DSC	Practical	A3BOT 002P	Reproductive Biology, Plant Cell, Tissue and Organ Culture	04	56 Hrs.	04 Hrs.	10	40	50	02
	DSC	Theory	A3BOT 003T	Cell Biology and Genetics	04	60 Hrs.	03 Hrs.	20	80	100	04
	DSC	Practical	A3BOT 004P	Cell Biology and Genetics	04	56 Hrs.	04 Hrs.	10	40	50	02
	DSC	Theory	A3BOT 005T	Plant Biotechnology and Genetic Engineering	04	60 Hrs.	03 Hrs.	20	80	100	04
	DSC	Practical	A3BOT 006P	Plant Biotechnology and Genetic Engineering	04	56 Hrs.	04 Hrs.	10	40	50	02
	OEC	Theory	A3BOT 204T	Gardening and Landscaping	04	60 Hrs.	03 Hrs.	20	80	100	04
								110	**440**	**550**	**22**

COURSE STRUCTURE AND SCHEME OF EXAMINATION FOR M. SC. COURSE IN BOTANY

M.Sc.-IV Semester

Sem.	Type of course	Theory/ Practical	Course code	Course title	Instruction hour/week	Total hours/ sem.	Duration of exam	Marks			Credits
								Formative	Summative	Total	
					04	60 Hrs.	03 Hrs.	20	80	100	04
IV	DSC	Theory	A4BOT 001T	Plant Breeding and Plant Propagation	04	60 Hrs.	03 Hrs.	20	80	100	04
	DSC	Practical	A4BOT 002P	Plant Breeding and Plant Propagation	04	56 Hrs.	04 Hrs.	10	40	50	02
	DSC	Theory	A4BOT 003T	Nanobiology	04	60 Hrs.	03 Hrs.	20	80	100	04
	DSC	Practical	A4BOT 004P	Nanobiology	04	56 Hrs.	04 Hrs.	10	40	50	02
	DSE	Theory	A4BOT 103AT	Applied Agriculture Microbiology, Mycology and Plant Pathology,	04	60 Hrs.	03 Hrs.	20	80	100	04
	DSE	Practical	A4BOT 103AP	Applied Agriculture Microbiology, Mycology and Plant Pathology,	04	56 Hrs.	04 Hrs.	10	40	50	02
	DSE	Theory	A4BOT 103BT	Plant Tissue Culture	04	60 Hrs.	03 Hrs.	20	80	100	04
	DSE	Practical	A4BOT 103BP	Plant Tissue Culture	04	56 Hrs.	04 Hrs.	10	40	50	02
	DSE	Theory	A4BOT 103CT	Plant Genetic and Genomic Resources	04	60 Hrs.	03 Hrs.	20	80	100	04
	DSE	Practical	A4BOT 103CP	Plant Genetic and Genomic Resources	04	56 Hrs.	04 Hrs.	10	40	50	02
	Project	Practical	A4BOT 003P					30	120	150	06
								120	**480**	**600**	**24**

***Each DSE theory shall have minimum two and maximum three papers and student shall select any one DSE in fourth semester (Allocated on the basis of choice cum merit basis).**

SEMESTER - I

Course Title: DSC MICROBIOLOGY, MYCOLOGY AND PLANT PATHOLOGY

Course Code: A1BOT001T

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**03 hrs.**	**20**	**80**	**100**

COURSE OUTCOMES (COS)

On successful completion of the course students will be able to

1. Know about microbes and their life to draw inspirations to hire them in applications.
2. Appreciate the fungal diversity and possible their interaction with nature.
3. Analyze the basic principles of plant pathology and to understand the role of environmental factors affecting the plant diseases.
4. Understand the epidemiology, defense mechanism, tools used in epidemiology, different methods of disease control, seed borne and storage diseases

Unit	Title	60 hrs/ Semester
Unit-1	**Bacteria:** Outline classification based on Bergey's manual of systematic bacteriology. Morphology and ultra-structure of bacterial cell. Methods of genetic transfer in bacteria: transformation, transduction and conjugation. Bacterial plasmids and their characteristics. Brief account on Actinomycetes. Structure and multiplication of Mycoplasma and Phytoplasma. Role of Bacteria in agriculture, medicine and industry. Beneficial and harmful microorganisms and Bacterial diseases. Brief account on Viruses.	15 Hours
Unit-2	**Fungi:** General characteristics and classification of Fungi. Structure, thallus organization, mobility and life cycle pattern in fungi. Reproduction: Asexual, Sexual, Heterokaryosis, Parasexuality and Heterothallism. Physiology of fungi: Fungal growth, Nutritional requirements, Assessment of fungal growth, Effect of environmental factors on growth, primary and secondary metabolism. Fungal enzymes and Mycotoxin. Biological population and its interaction with mycoflora: Mutualism, Predation, Parasitism and Antagonism.	15 Hours
Unit-3	**Plant pathology:** The concept of disease in plants, Koch's postulates. Classification of plant diseases. Attack of pathogens by Mechanical forces, Chemical weapons, Enzymes, Toxins (Non-host and host selective toxins) and Growth regulators. Mechanism of infection. Defense mechanism of plants. Management and control of plant disease. Environmental factors that cause plant disease.	15 Hours

Unit-4	**Epidemiology:** Traditional and modern concepts of disease triangle and tetrangle. Role of host, Pathogen and Environment in plant disease development. Patterns of epidemics, Methods of assessment of disease incidence, Disease forecasting by computer simulation, Disease severity and estimation of yield loss. New tools in epidemiology: GIS, Remote sensing and Image analysis.	15 Hours

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	**20 Marks**
Formative Assessment as per guidelines.	

PREFERENCES:

1. Joanne Willey, Kathleen Sandman, and Dorothy Wood, 2022. 12th edn. Prescott's Microbiology, McGraw-Hill Education.
2. Madigan, M.T., 2010. 13th edn. Brock Biology of Microorganisms. Benjamin-Cummings Pub Co.
3. Anantharayan and Paniker, 2022. 12th edn. Text book of microbiology, Universities Press (India) Pvt. Ltd.
4. Salle, A. J., 2001. 7th edn. Fundamentals and Principles of Bacteriology, Tata McGraw-Hill, Davis.
5. Klein's Microbiology, 7th edition, McGraw-Hill, New York.
6. Dubey, R. C. and Maheshwari, D. K., 2022, 5th edn. A Textbook of Microbiology, S Chand and Company Limited.
7. Sharma, P. D., 1999, Microbiology and Plant Pathology, Rastogi Publications, Meerut, India.
8. Tortora, G. J., Funke, B.R. and Case C. L., 2010. 10th edn. Microbiology: An Introduction, Pearson- Benjamin- Cummings. USA.
9. Sullia, S. B. and Shantharam, S., 2005. General Microbiology, Oxford and IBH, New Delhi.
10. Vaughan, H. C. I. G., 2006. 2nd edn. Fungi, Biotech Books, Delhi.
11. Sethi, I. K., Walia, S. K., 2011. Text book of Fungi and their allies, MacMillian Publishers Pvt. Limited, New Delhi.
12. David Orlovich, 2023. Fundamentals of Mycology and Phytopathology, American Academic Publisher.
13. Vashishta, B. R, Sinha, AK, Anil Kumar., 2016. Fungi.
14. Agrios, G. N., 2024. 6th edn. Plant Pathology. Elsevier.
15. Singh, R. S., 2023. Plant Disease. 9th edn. Oxford and IBH Pub. Co., New Delhi.
16. Roberts, D. A. and Boothroyd, C. W., 1984, 2nd edn. Fundamentals of Plant Pathology, CBCS publishers and distributors, Delhi.
17. Hall, R., 2014. Plant Virology, 5th edn. Elsevier, USA.

18. Mehrotra, R. S., 2017. Plant Pathology. 3rd edn. Tata Mc Graw-Hill Pub. Co. Ltd., New Delhi.
19. Vidhyasekaran, P., 1997. Fungal Pathogenesis in plants and crops. (Molecular Biology and host Defense mechanisms), Marcel Dekker Inc.
20. Rangaswamy, G. and Mahadevan, A., 2002. Diseases of crop plants in India, Prentice Hall of India Pvt. Ltd. New Delhi.

Course Title: DSC MICROBIOLOGY, MYCOLOGY AND PLANT PATHOLOGY

Course Code: A1BOT002P

Type of Course	Theory / Practical	Credits	Instructionhour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs**	**04 hrs.**	**10**	**40**	**50**

PRACTICALS:

1. Laboratory guidelines, design, tools, equipments and other requirements for studying microorganisms.
2. Preparation of different culture media, preparation of agar slants and methods of inoculum transfer.
3. Isolation and Enumeration of microorganisms (Bacteria, Actinomycetes, Fungi and Yeasts) from soil, water and air samples using selective media.
4. Calibration of ocular micrometer for different objectives of a microscope.
5. Measurement of microorganisms by the use of an Ocular Micrometer.
6. Simple and Gram staining of Bacteria.
7. Estimation of chlorophyll in diseased and healthy plant tissues.
8. Study of growth curve of Bacteria.
9. Study of motility of cells by hanging drop technique.
10. Study of spore germination.
11. Estimation of total phenols in diseased and healthy plant tissues.
12. Staining of fungi including VAM fungi.
13. Determination of microbial counts using Haemocytometer.

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	05
Internal Assessment Test 2	05
Total	**10 Marks**
Formative Assessment as per guidelines.	

Course Title: DSC ALGAE, BRYOPHYTES, PTERIDOPHYTES AND GYMNOSPERMS

Course Code: A1BOT003T

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**03 hrs.**	**20**	**80**	**100**

COURSE OUTCOMES (COS)

1. Understand the evolution of angiosperms and phases of classification
2. Understand to follow taxonomic key to identify family, genus and species
3. Understand the rules of ICN/ICBN regarding naming of plants
4. Understand to identify the plants using digital device and also to confirm with flora

Unit	Title	60 hrs/ Semester
Unit-1	**ALGAE:** Modern trends in algal classification- chief algal divisions and their principal characters- Cyanophyta, Chlorophyta, Bacillariophyta, Phaeophyta and Rhodophyta. Range of thallus organization in prokaryotic and eukaryotic algae, mode of reproduction prokaryotic and eukaryotic algae and life cycle pattern in algae, origin and evolution of sex organs in algae. Nitrogen fixation in algae**,** beneficial and detrimental aspects of algae, algal blooms, algal toxins. Overview of microalgae and their mass cultivation, status of Indian sea weed resources, marine algal farming and its application. Ecological importance of algae- as ecological monitors and indicators, role of algae in carbon sequestration. Commercial applications of algae as- polysaccharides, pigments, enzymes, antibiotics, osmoregulators, as a biofuels, nutraceutical, pharmaceutical and biomedical applications.	15 Hours
Unit-2	**BRYOPOHYTES:** Classification of bryophytes by Rothmaler 1951(brief general characters of class level only), Morphological variations, anatomical and cytological studies of Gametophyte and Sporophyte with special reference to Hepaticopsida, Anthocerotopsida and Bryopsida. Vegetative and sexual reproduction in Bryophytes, appendages of gametophyte in Bryophyte and their function. Nature of alternation of generation and origin of sporophyte in bryophyte. Evolution of sporophyte in Bryophyte- theory of progressive sterilization of sporogenous tissue, progressive simplification theory. fossil Bryophytes. Ecological significance and economic importance of Bryophyte.	15 Hours

Unit-3	**PTERIDOPHYTES:** Origin and classification of Pteridophytes (by G M Smith 2006), geographical distribution of Pteridophytes. General aspects of Psilopsida, Lycopsida, Sphenopsida, and Pteropsida. Apogamy, Apospory and Parthenogenesis in Pteridophytes. **Telome concept-** origin of telome and ancestors of primitive land plants, value of telome theory. **Stelar theory**- evolution of stelar system, influences of leaf trace in protostelic Pteridophytes, origin of siphono stele from protostele, leaf and branch gap. **Heterospory** – occurance, cause and significance. Ecological role and economic importance of Pteridophytes.	15 Hours
Unit-4	**GYMNOSPERMS:** General characters and classification (by K R Sporne), Evolutionary tendencies among Gymnosperms. Comparative account of Cycadopsida, Coniferopsida and Gnetopsida. Reproduction in Gymnosperms, organization of male and female cone in Gymnosperms. Embryology of Gymnosperms. Primary and secondary structures of wood in Cycades and Conifers. Economic importance of Gymnosperms.	15 Hours

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	**20 Marks**
Formative Assessment as per guidelines.	

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1. Bhatnagar, S.P. Moitra, Alok. (1996). Gymnosperms. New Age International.
2. Chhaya Biswas and B.M.Johri. The Gymnosperm. Springer; 1997, edition (16 April 2014)
3. Fundamentals of Algae – O.P. Sharma 2023 Meditech Science Press
4. Text book of Algae Awashthi and Ashok Kumar, Vikas Publishing House
5. Gangulee, H.C. and Kar, A.K., 2011, College Botany Vol. II (Algae+Fungi+Brophyta+Pteridophyta), New Central Book Agency, Kolkata
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8. Parihar N. S. 1991. An Introduction to Embyophyta-(vol.I) Bryophyta Central Book Depot. Allahabad
9. Parihar N. S. 1988. An Introduction to Embyophyta-(vol.II) Pteridophyta Central Book Depot. Allahabad
10. Puri, P. (1973). Bryophytes: A Broad Perspective. India: Atma Ram & Sons.

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17. Kamat, N.D. 1982. Topics in Algae. Saikripa Prakashan, Aurangabad.
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19. Venkataraman, L.V. and E.W. Becker, 1985. Biotechnology and utilization of algae. The Indian experience. DST, New Delhi
20. Verma B.N., A.N.Kargupta and S.K. Goyal 1998. Advances in Phycology. APC Pub. New Delhi

Course Title: DSC ALGAE, BRYOPHYTES, PTERIDOPHYTES AND GYMNOSPERMS

Course Code: A1BOT004P

Type of Course	Theory / Practical	Credits	Instructionhour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs**	**04 hrs.**	**10**	**40**	**50**

ALGAE: 12 Hours.

1. Identification and classification of algae by locally available aquatic and terrestrial forms.
2. Microscopic observation of vegetative and reproductive structures of algae by permanent slides.

BRYOPHYTES:

16 Hours.

3. Study of morphology and anatomy of gametophytes of Hepaticopsida, Anthocerotopsida, and Bryopsida locally available specimens and permanent slides.
4. Study of morphology and anatomy of sporophyte of Bryophytes locally available specimens and permanent slides.

PTERIDOPHYTES:

12 Hours.

5. Study of morphplogy, anatomy of root, stem and leaf of Pteridophytes available local specimens and permanent slides .

GYMNOSPERMS:

16 Hours.

6. Study of morphology, anatomy and reproductive structures of Cycas, Pinus ,Ginkgo, Araucaria, Podocarpus, Ephedra, cupresis, Zamia and Gnetum and permanent slides.

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	05
Internal Assessment Test 2	05
Total	**10 Marks**
Formative Assessment as per guidelines.	

Course Title: DSC PLANT SYSTEMATICS AND PLANT GEOGRAPHY

Course Code: A1BOT005T

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**03 hrs.**	**20**	**80**	**100**

COURSE OUTCOMES (COS)

1. Understand the evolution of angiosperms and phases of classification
2. Understand to follow taxonomic key to identify family, genus and species
3. Understand the rules of ICN/ICBN regarding naming of plants
4. Understand to identify the plants using digital device and also to confirm with flora

Unit	Title	60 hrs/ Semester
Unit-1	Aims and objectives of systematic Botany. Classification of plant Kingdom based on principles of evolution. Phases of development of classification: Alpha, Beta, Gamma and Omega Taxonomy. Artificial, Natural and phylogenmetic classification. Linnaeus, Benthem and Hooker and Engler and Prantl's system of classifications and principles of evolutionary characters of both vegetatitive and reproductive characters of Angiosperms as per Hucthinson and Bessey, brief account on Cronquist, Dhalaghrien, Taktajhan and Thorne system of classifications	15 Hours
Unit-2	APG. (IV) system of classification. Division of Angiosperms upto Clades level as per APG IV and LAPG. ICN (International code of Algae, Fungi and Plants). Principles of ICN, Typification, holotype, paratype, syntype, isotype, lectotype and topotype. Nomina conservanda and nomina rejecienda. Effective and valid publication of names. Concept of Genus, Species and Family. Taxonomic parameters of Anatomy, Cytology, Embryology, Palynology, Chemical, Molecular and their importance in solving taxonomic disputes with examples. Herbarium techniques'/Botanical Gardens and their significance.	15 Hours
Unit-3	Salient features of Bentham and Hooker Families and their systematic positions in APG IV. **Polypetalae**: Magnoliaceae, Annonaceae, Capardiaceae, Sterculaceae, Tiliaceae and Cucurbitaceae. **Gamapetalae**: Asclepidiaceae, Bignoniaceae, Convolvulaceae, Scrophulariaceae and Verbenaceae. **Monochlamydae**: Nyctaginaceae, Moraceae, Lauraceae, Caryophyllaceae, Portulacaeae, Depterocarpaceae, Malphigiaceae, Celastraceae, Sapindaeae, Turneraceae and Podestemaceae. **Monocots**: Alismataceae, Amaryllidaceae, Liliaceae, Iridaceae, Pontederiaceae, Pandanaceae, Araeceae, Commelinaceae and Cyperaceae	15 Hours
Unit-4	**Plant Geography:** Vavilov's centers of origin of cultivated plants. Phyto-geographical regions. Equatorial, Altitudinal and Latitudinal zones. Vegetation of zones of mountains. Vegetation types of the world. Floristic regions of the world and floristic regions of India and Karnataka. Continents, Oceans and Distribution of Plants (Continuous, Discontinuous and Endemic), Age and Area hypothesis and Vicariads.	15 Hours

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Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	**20 Marks**
Formative Assessment as per guidelines.	

REFERENCES:

1. Plant systematics: an integrated approach (4th Ed.) by Gurucharan singh, Science publishers, 2021.
2. Taxonomy of vascular plants by Lawrence H M George, Scientific Publishers (India), 2012.
3. Plant systematics: A phylogenetic approach (3rd Ed.) by Judd, Campbell, Kellogg, Stevens and Donoghue, Sinauer associates, inc publications, 2008.
4. Plant systematics by Michael G. Simpson, Elsevier academic press, 2006.
5. Systematic botany (2nd Ed.) by Bharati Bhattacharrya, Narosa publications, 2005.
6. Phylogeny and evolution of angiosperms by D. E. Soltis, P. S. Soltis, P. K. Endress and M. W. Chase, Sinauer associates, inc publications, 2005.
7. Flowering plants: taxonomy and phylogeny by Bharati Bhattacharrya and B. M. Johri, Narosa publications, 1998.
8. Introduction to the principles of plant taxonomy by V. V. Shivarajan, Cambridge University Press, 1991.
9. Taxonomy of angiosperms by V. N. Naik, Tata Mcgraw-hill publishing company ltd, 1984.
10. Vascular plant systematic by Albert E. Radford, Harper & Row publications, 1974.
11. The geography of the flowering plants (4th Ed.) by Ronald Good, Addison-Wesley Longman Ltd; 1974.

Course Title: DSC PLANT SYSTEMATICS AND PLANT GEOGRAPHY

Course Code: A1BOT006P

Type of Course	Theory / Practical	Credits	Instructionhour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs**	**04 hrs.**	**10**	**40**	**50**

PRACTICALS :

1. Botanical description of available flowering plants.
2. Identification of families by using artificial keys.
3. Identification of Genus and species by using flora.
4. E-Identification of Plants and confirmation with flora.
5. Preparation of artificial keys for selected plants.
6. Visit to Botanical garden of K.U. Dharwad
7. Field study of K.U Dharwad campus flora.
8. Study of Vavilov's centers of origin of cultivated plants.
9. Study of continents
10. Visit to museum of plants and animals of K.U. Dharwad

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	05
Internal Assessment Test 2	05
Total	**10 Marks**
Formative Assessment as per guidelines.	

Course Title: DSC PLANT ECOLOGY AND ENVIRONMENTAL BIOLOGY

Course Code: A1BOT007T

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**03 hrs.**	**20**	**80**	**100**

COURSE OUTCOMES (COS)

1. Students gain an understanding of ecology and complex environments to address social economics, present environmental challenges, and calls for a better future
2. Capable of establishing relationships between different environmental disciplines
3. Thinking critically on the concept of ecology and how important it is in context with human life and how humans affect the environment
4. Demonstrate the ability to explain biotic and abiotic interactions using symbiotic linkages
5. Students acquired an extensive knowledge of natural resources and followed guidelines to improve the economic climate
6. The capacity to preserve and exercise responsibility for the utilization of natural resources
7. Students will gain knowledge of computer-based geographic information systems focusing on climate change and the environment
8. Students learn about the economic, ecological, and therapeutic significance of plants as well as their biogeographical distribution for biodiversity conservation
9. Students learn about potential risks and pollution that have an impact on ecosystems, wildlife, and human existence, as well as how to mitigate these effects
10. Capable of explaining biogeochemical composition and the cycle of influence
11. Students will be able to comprehend the disaster management cycle and its risk reduction strategies, as well as the causes and environmental impacts of disasters
12. Using field research strategies, become acquainted with how to apply qualitative and quantitative analysis of the environment
13. Students will gain knowledge about the effects of population expansion on environmental ethics
14. Applying sustainability to comprehend and solve environmental issues through legislation, socioeconomic policies, and scientific research
15. Students will be able to assess the function of the Earth's surface atmospheric, hydrospheric and lithospheric interaction

Unit	Title	60 hrs/ Semester
Unit-1	**Basic Concepts of Plant Ecology:** Introduction to plant ecology and ecosystem studies. Structure, type, functions and characters of ecosystems. Climatic factors. Edaphic factor (soil). Biotic Factors interrelationship with plants. Dynamics of ecosystem: Food chain, food web, trophic levels, ecological pyramids, primary and secondary production, and energy flow in ecosystem. Biogeochemical cycles: Carbon, nitrogen, oxygen, phosphorous and sulphur cycle.	15 Hours
Unit-2	**Plant Patterns, Distribution and Diversity with Limiting Factors** : Ecological succession. Population ecology: Characters, growth curve, life history and strategies (R&K selection), concept of meta population. Biotic communities and limiting factors. Biogeography of plants: Principles, classification and distribution in India	15 hours

	and World. Mega-diversity centres and endemic plants. Plant adaptations: Types and ecological scopes. Ecological indicator plants. Forest plant diversity.	
Unit-3	**Environmental Pollution, Management and Bioremediation :** Pollution: Types, sources and impacts on intra and inter environment. Factors influencing environmental concentrations of toxicants and toxicity impacts on plant diversity. Climate change: Greenhouse effects and causes. Toxicological principles, types of toxins, sources and formulation in environment and bioremediation methods. Environmental impact assessment. Ecosystem restoration. Sustainable development of environment with plants. Biofuels, green energy, and non-conventional energy resources	15 hours
Unit-4	**Conservation and Biodiversity Management :** Conservation of plant diversity: Types, management and scopes. Remote sensing and GIS technology for plant conservation. Indian aquatic and floristic diversity: Threats to natural and manmade resources. National and international aid, policies and legislation. Global and national scenario of plant resources (terrestrial and marine) with utility values	15 hours

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	**20 Marks**
Formative Assessment as per guidelines.	

REFERENCES:

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2. Douben, E. T. (2003). *PAHs: An Ecotoxicological Perspective*. Wiley Publication, USA.
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4. Enger, E. D. and Smith, B. F. (2009). *Environmental Science* (12th Ed). McGraw-Hill, USA.
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12. Reiss, M. and Chapman, J. (2000). *Environmental Biology* (2nd Ed). Cambridge University Press, UK.
13. Ramsay, J. and Schroer, J. (2020). *Environmental Biology*. Kendall Hunt Publishing Company, USA.
14. Sangeetha, J., Thangadurai, D., David, M. and Abdullah, M. A. (2017). *Environmental Biotechnology: Biodegradation, Bioremediation and Bioconversion of Xenobiotics for Sustainable Development*. CRC Press, USA.
15. Sangeetha, J., Thangadurai, D., Hong-Ching, G. and Saher, I. (2019). *Biodiversity and Conservation: Characterization and Utilization of Plants, Microbes and Natural Resources for Sustainable Development and Ecosystem Management*. CRC Press, USA.
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17. Spellman, F. R. (2021). *The Science of Environmental Pollution*. CRC Press, USA.
18. Thangadurai, D., Busso, C. A., Luis-Gerardo, A. A. and Sangeetha, J. (2012). *Frontiers in Biodiversity Studies*. I. K. International Publishing House Pvt. Ltd. New Delhi, India.
19. Amiard-Triquet, C., Jean-Claude, A and Rainbow, P. S. (2013). *Ecological Biomarkers: Indicators of Ecotoxicological Effects*. CRC Press, USA.

Course Title: DSC PLANT ECOLOGY AND ENVIRONMENTAL BIOLOGY

Course Code: A1BOT008P

Type of Course	Theory / Practical	Credits	Instructionhour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs**	**04 hrs.**	**10**	**40**	**50**

PRACTICALS :

I. Ecological Experiments of Plants

1. Study the quantitative structure (number and size) of plant community by quadrat method.
2. Determination of frequency, density and abundance of plants.

II. Ecological Adaptations and Environmental Importance of Given Plants

Lemna, *Pistia*, *Eichhornia*, *Hydrilla*, *Ceratophyllum*, *Vallisneria*, *Jussiaea*, *Neptunia*, *Marsilea*, *Nymphaea*, *Opuntia*, *Euphorbia tirucalli*, *Euphorbia antiquorum*, *Asparagus*, *Ruscus*, *Muehlenbeckia*, *Acacia melanoxylon*, *Aloe vera*, *Casuarina*, and *Drosera*.

III. Environmental Instruments: Rain gauge, Hair hydrograph, Barograph, Thermograph, Soil thermometer, Psychrometer, Anemometer, Altimeter.

IV. Assessment of Ecological Components

1. Water: pH, conductivity, dissolved oxygen (DO), biological oxygen demand (BOD), COD, carbonates and bicarbonates, chlorides, free CO_2, hardness, and organic matter
2. Soil: pH, conductivity, organic carbon (OC), moisture, texture, capillary power of soil, percolation through soil and saturation capacity
3. Estimation of air polluted leaves covered with dust
4. Ecological measurements of noise pollution in different location and controlling plants
5. Plant productivity measurement by light and dark bottle method
6. Biodiversity of phytoplankton in fresh water and marine ecosystems
7. Floral diversity of mangroves ecosystem: Morphology and anatomy
8. Floral diversity estimation: Stomatal index, bark and branching and vein-lets
9. Floral diversity scopes: Biofertilizers, Biopesticides, medicinal plants and seaweeds

V. Introduction, Use and Scope of Geographic Tools: Google Earth and Google maps, Hand-held GPS, Land use-land cover categories in satellite imagery.

VI. Ecology, Environment and Economic Evaluation by Field Visit: Field visit to forest patch, wetland and coastline.

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	05
Internal Assessment Test 2	05
Total	**10 Marks**

Formative Assessment as per guidelines.

SEMESTER – II

Course Title: DSC PLANT PHYSIOLOGY AND PLANT BIOCHEMISTRY

Course Code: A2BOT001T

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**03 hrs.**	**20**	**80**	**100**

COURSE OUTCOMES (COS)

This course aims to educate students about biological molecules that gives rise to the processes and their physiology in plants

1. Acquaintance with mechanistic views on interactions with the plant environment
2. Comprehend the importance of water in plant life and mechanisms for the transport of water and solutes in plants
3. Acquire basic knowledge needed for a proper understanding of plant functioning
4. To illustrate knowledge of stress adaptations in biological systems
5. To deliver molecular understanding of primary and secondary metabolic processes
6. Critically understand the light reactions and carbon assimilation processes responsible for the synthesis of food in plants
7. Learn and understand mineral nutrition in plantsand their deficiency symptoms
8. Know the nitrogen metabolism and its importance
9. Students will be able to understand the various physiological life processes in plants that are the prerequisites and consequences of physiological phenomena for further manipulations
10. Familiarize with the basic skills and techniques related to plant physiology and plant biochemistry
11. Understand the role, structure, and importance of the biomolecules associated with plant life
12. Interpret the role of enzymes in plant metabolism

Unit	Title	60 hrs/ Semester

Unit-1	**Plant Water Relations** : Water: Role of water in plants, passive and active absorption of water. Concept and components of water potential and soil water relationship. Transporters in roots: translocation of water, ions, solutes and macromolecules from soil and aquaporin's. Transpiration, factors governing transpiration, water use efficiency of crops and antitranspirants. Stomata-structure and role of hormones and ions in stomatal movement.	15 hours
Unit-2	**Plant Biochemistry**: Plant Biomolecules: Structure and role of carbohydrates, proteins, lipids and enzymes. Photosynthetic pigments in relation to their functions, photosynthesis, C3, C4, and CAM pathways**.** Photophosphorylation and photorespiration. Glycolysis, Krebs cycle and electron transport chain. ATP synthesis, Pentose Phosphate Pathway and Gyoxylate cycle	15 hours
Unit-3	**Plant Nutrition and Nitrogen Metabolism**: Mineral Nutrition: Essential macro- and micro-elements. Role and mode of action in deficiency symptoms, toxicity symptoms. Absorption of mineral salts and mineral uptake. Atmospheric nitrogen fixation, nitrogen cycle, nitrogen assimilation. Nitrate reduction to their incorporation into amino acids and biological nitrogen fixation	15 hours
Unit-4	**Phytohormones and Stress Physiology**: Phytohormones: auxins, gibberellins, cytokinin, ethylene, abscisic acid, jasmonic acid, triacontinol, salicylic acid and their mode of action, signal transduction. Biochemistry of seed development and germination. Biochemistry of fruit ripening. Biochemical basis of abiotic stresses namely osmotic (drought, salinity), temperature, heavy metals, air and water pollutants. Synthesis and functions of proline, glycine and betaine in stress tolerance interaction between biotic and abiotic stresses and adaptations in plants. Oxylipins	15 hours

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	**20 Marks**
Formative Assessment as per guidelines.	

REFERENCES:

1. Akazawa, T., Asahi, T. and Imaseki, H. (1983). *The New Frontiers in Plant Biochemistry*. Japan Scientific Societies Press. Japan.
2. Bowsher, C., Steer, M. and Tobin, A. (2008). *Plant Biochemistry*. Garland Science. https://doi.org/10.4324/9780203833483
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4. Lambers, H. and Oliveira, R. S. (2019). *Plant Physiological Ecology*. Springer International Publishing, Cham.
5. Moore, T. C. (2012). *Biochemistry and Physiology of Plant Hormones*. Springer Science & Business Media.
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9. Rashid, A. (2009). Molecular Physiology and Biotechnology of Flowering Plants. Alpha Science International Ltd. Oxford, UK.

Course Title: DSC PLANT PHYSIOLOGY AND PLANT BIOCHEMISTRY

Course Code: A2BOT002P

Type of Course	Theory / Practical	Credits	Instructionhour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs**	**04 hrs.**	**10**	**40**	**50**

PRACTICALS

1. Extraction and quantification of photosynthetic pigments in different crops, C3 and C4 plants and paper chromatography
2. Extraction and estimation of proteins by Lowry's method with Biuret reagent in different seeds during germination
3. Extraction and estimation of lipids in oil seeds by different methods
4. Study of the effect of pH, on enzyme activity
5. Effect of temperature on enzyme activity
6. Effect of substrate concentration on enzyme activity
7. Quantitative estimation of carbohydrates
8. Effect of light, K, Ca on stomata inhibitions and stomatal openings
9. Estimation of proline in stressed plants
10. Three-days plant physiology and plant biochemistry laboratory visit to national/international institute/university

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	05
Internal Assessment Test 2	05
Total	**10 Marks**
Formative Assessment as per guidelines.	

Course Title: DSC ECONOMIC BOTANY AND EVOLUTIONARY BIOLOGY

Course Code: A2BOT003T

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**03 hrs.**	**20**	**80**	**100**

COURSE OUTCOMES (COS)

1.

Unit	Title	60 hrs/ Semester
Unit - 1	**Economic Botany:** **Food and Medicinal plants:** Cereals, millets, pulses, food adjuncts (Spices and condiments) and medicinal and aromatic plants : Classification of medicinal plants. Roots rhizomes, bark wood, leaves and whole plants Sugar and starch yielding plants (Aerial and underground parts) – Botanical identity, systematic position, morphology of the parts and their economic uses.	15 Hours
Unit -2	**Commercial (Industrial) plants:**Alcoholic, nonalcoholic beverage plants, narcotic plants, fibres and fibre yielding plants, oils and oil yielding plants (Essential and aromatic oils, fats and tallow), rubber plants, tapping and processing of rubber, timber yielding plants: Quality timber, methods of wood seasoning (natural seasoning & artificial seasoning), plywood and veneers and their - Botanical identity, systematic position, morphology of parts and their economic uses.	15 Hours
Unit- 3	**Evolutionary Biology:** Historical and theories: Origin of life. Special creation theory. Theories of spontaneous generation or abiogenesis, the decline and fall of the theory of spontaneous generation, hypothesis of panspermia, theory of chemical evolution and spontaneous origin of life at molecular level, experimental support of Oparin's hypothesis-Miller's experiment, protenoid microspheres, Cairns-Smith's model, RNA first model, why RNA and not DNA was the first living molecules. Process of origin of life: structure of cosmos, primitive earth, prebiotic synthesis, evolution of progenote- origin and evolution of RNA world, origin and evolution of ribonucleoprotein (RNP) world, origin of plasma membrane, DNA world, origin of progenote, retrograde evolution, adaptive radiation in progenote, evolution of	15 Hours

	eukaryotes : endosymbiotic hypothesis, invagination of surface membrane hypothesis; molecular evolution: the evolution of proteins, examples of protein evolution- cytochrome c, neutral theory and molecular clock.	
Unit -4	**Evolution above species level**: Adaptive radiation: Examples of adaptive radiation; Simpson's adaptive grid and macroevolution; Mivart's dilemma and pre adaptation; microevolution, macroevolution, megaevolution and hypothesis of punctuated equilibria: population genetics, Hardy-Weinberg law, Factors influencing allele frequency or deviation from Hardy-Weinberg equilibrium, microevolution, macroevolution – the process involved in microevolution, macroevolution. Study of fossils: Types (impressions, compression, mould. cast, petrification, coal-balls, amber, peat, quartz, mica, feildspar, lime stone & petroleum.), process and methods of determining the age of fossils (Carbon dating method); Lepidodendron, Stigmaria, Lepidocarpon, Glassopteris. Stelar evolution in Pteridophytes.	15 Hours

REFERENCES:

1. Osborn, H. F. 2023. The Origin and Evolution of Life, Legare Street Press.
2. Rastogi, V. B. 2020. Organic Evolution (Evolutionary Biology). Generic.
3. Singh, V., Pande, P. C. and Jain, D. K. 2018. Economic botany. Rastogi Publications.
4. Kochar L. S. 2012. Economic botany in tropics, MacMillan.
5. Verma, V. 2009. Textbook of Economic Botany, ANE Books.
6. De Candolle, A. 2006. Origin of Cultivated Plants, Kessinger Pub Co.
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8. Verma P. S. and V. K. Agarwal. 1998. Concepts of evolution, S. Chand & Co.
9. Sen S. 1992. Economic botany, New central book agency, Calcutta.
10. Arora P. K. and E. K. Nayar. 1984. Wild relatives of crop plants in India, NBPGR Sci.

Course Title: DSC ECONOMIC BOTANY AND EVOLUTIONARY BIOLOGY

Course Code: A2BOT004P

Type of Course	Theory / Practical	Credits	Instructionhour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs**	**04 hrs.**	**10**	**40**	**50**

PRACTICALS

1. Study of millets and cereals.
2. Study of medicinal plants.
3. Study of fibre plants and wood plants.
4. Study of oil plants and beverage plants.
5. Study of Geological time scale.
6. Study of anatomical futures of locally available Pteridophytes and permanent slides
7. Study of morphological anatomical futures of sex organs of locally available Pteridophytes and permanent slides
8. Study of evolution of sporophytes in Bryophytes.
9. Study of evolution of stele in Pteridophytes.
10. Study of fossils.

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	05
Internal Assessment Test 2	05
Total	**10 Marks**
Formative Assessment as per guidelines.	

Course Title: DSC PLANT ANATOMY AND PHARMACOGNOSY

Course Code: A1BOT005T

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**03 hrs.**	**20**	**80**	**100**

COURSE OUTCOMES (COS)

1. Understand structure and component of Apical meristem and tissue system
2. Understand a structure of flower (ABC model of flower)
3. Understand identification and authentication of crude drugs
4. Understand powder microscopy of crude extract of herbal drugs

Unit	Title	60 hrs/ Semester
Unit-1	**Primary meristem:** concept of stem cells, Shoot apical meristem (SAM): A dynamic structure, cell differentiation at shoot apex and dynamism of shoot apical meristem. Cell fate: role of lineage or position, Root Apical Meristem (RAM): an organized structure, developmental domains of a root, types of stem cells in a root, post-embryonic meristems. Inflorescence meristem, floral meristem. Flowering pathways and flowering genes (Florigen, FT, Co and FD) and floral organ genes (APETALA, PISTILLATA and AGAMOUS), ABC model, ABCE model ABCD model and	15 hours
Unit-2	**Tissue system:** dermal or epidermal tissue system, fundamental or ground tissue system, vascular tissue system, stelar system, nodal anatomy, branch traces, branch gaps and closing of leaf gaps. Comparative Anatomy: comparison between simple pit and bordered pit, latex cells and latex vessels, sap wood and hard wood, sieve cells and sieve tubes, tracheids and vessels, protoxylem and metaxylem, protophloem and metaphloem, primary and secondary xylem and phloem, cystoliths, raphids, styloids, druces, sclereids, trichomes and stomata.	15 hours
Unit-3	Definition, history, scope and applications of pharmacognosy. Scheme for pharmacognostic studies of a crude drug. Sources of drugs-natural products, organized and unorganized drugs. Classification of drugs; alphabetical, morphological, taxonomical, pharmacological, chemical, chemo-taxonomicaland serotaxonomic classifications. Pharmacognostic study of *Ocimum sanctum, Bacopa monnieri, Centella asiatica, Adathoda vasica* and *Phyllanthus simplex*.	15 hours
Unit-4	Analytical pharmacognosy. Quality Control of drugs of Natural Origin, Adulteration of Drugs of Natural Origin, Evaluation by Organoleptic, Microscopic, Physical, Chemical and Biological Methods and Properties. Phytopharmaceuticals, Nutraceuticals-classifications, Cosmeceuticals- herbal drugs used in formulations for skin and hair disorders, retinoid acid, alpha hydroxy acid, boswellic acid and	15 hours

	vitamins. Immunomodulators and adaptogens	

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	**20 Marks**
Formative Assessment as per guidelines.	

REFERENCES

1. Plant anatomy by B.P. Pande. S. Chand publications, 2012.
2. Esaus Plant Anatomy: Meristems cells and tissues ff the plant body their structure function and development (3rd Ed.) by Evert R.F., Wiley India, 2017.
3. A textbook of Plant anatomy (7th Ed.) by P.C. Vasistha. S. Nagin and Co.
4. Plant anatomy (3rd Ed.) by A. Fahn. Pergamon press.
5. Pharmacognosy (15th Ed.) by C.K.Kokate, A.P. Purohit and S.B. Gokhale. Nirali Prakashan, 2014.
6. Trease and Evans Pharmacognosy (16th Ed.) by W.C. Evans, Elsevier, 2009.
7. Life the science of biology (9th Ed.) by Sadava, Hillis, Heller and Berenbaum. W.H. Freeman & co., 2011.
8. Plant Techniques: theory and practice (1st Ed.) by S.M. Khasim, K. Thammasiri, S. Rama Rao, M. Rahamtulla, Taylor and Francis, 2024.
9. Botanical micro technique (2nd Ed.) by J.E. Sass. Ames, Iowa State College Press.
10. Plant micro technique (1st Ed.) by D.A. Johansen, McGraw-Hill book company.
11. Medicinal plants: Their importance in pharmaceutical sciences by Kuntal Das, Kalyani publications. 2010.
12. Molecular physiology and biotechnology of flowering plants by A. Rashid, Narosa publications, 2009.

Course Title: DSC PLANT ANATOMY AND PHARMACOGNOSY

Course Code: A2BOT006P

Type of Course	Theory / Practical	Credits	Instructionhour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs**	**04 hrs.**	**10**	**40**	**50**

PRACTICAL:

1. Identification of dorsiventral and isobilateral leaf by free hand fresh section.
2. Identification of exarch and endarch from locally available plants and permanent slides.
3. Study of types of stomata and permanent slides.
4. Study of types of sclereids lenticels and tylosis.
5. Study of tissue systems
6. Identification of cystoliths, raphids, styloids, druces and trichomes.
7. Powder microscopy of selected medicinal plants.
8. Preliminary phytochemical tests of selected medicinal plants.
9. Pharmacognostic study of root, stem and leaf from locally available medicinal plants.
10. Organoleptic study of locally available medicinal plants

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	05
Internal Assessment Test 2	05
Total	**10 Marks**
Formative Assessment as per guidelines.	

Course Title: DSC PLANTS RESOURCES IN HUMAN WELFARE

Course Code: A2BOT204T

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**03 hrs.**	**20**	**80**	**100**

COURSE OUTCOMES (COS)

Course outcome:

On successful completion of the course students will be able to

- Explore the contribution of plants in the welfare of human race.
- Understand the basic developmental phases of plants.
- Value the commercially important plant products.

Unit	Title	60 hrs/ Semester
Unit-1	**Plants as welfare resources**: Introduction to plants, plant resources and their contribution in progress, prosperity and survival of human race. Plants as remedies for major global problems such as Energy, Pollution control, Agriculture, Global warming, Climate change, Soil fertility and Conservation.	15 Hours
Unit-2	**Exploring the world of plants**: Seed germination, Growth and flowering in plants, Soil and mineral nutrition of plants, Organic farming, Storage of agricultural products, Fruits. Vegetables and Food grains	15 Hours
Unit-3	**Different types of plants and plant products**: Vegetables, Oil yielding plants, Food crops, Spices and Condiments, Wild edible plants. Important timber yielding plants and non-wood forest products. Fiber yielding plants, Textile fibers, Forage-Fodder plants, Cordage fibers, Fibers for stuffing. Petro and sericulture crops. Avenue trees, Hedge and Edge plants. Resin, Dye, Tannin and Gum yielding plants and their applications in industry. Grasses and their importance in human civilization	15 Hours
Unit-4	**Industrial importance of plants**: Medicinal plants of India, Ayurvedic medicines and their industrial formulation. Aromatic plants and Essential oils. Drugs of Botanical origin, Nutraceuticals. Wild plants from Western Ghats having ornamental potential	15 Hours

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	**20 Marks**
Formative Assessment as per guidelines.	

REFERENCES:

1. Jain, S. K., 2004. 2nd edn. A manual of ethnobotany, Scientific publishers, India.
2. Varghese, E., 1996. Applied Ethnobotany: A case study among the Kharias of Central India.
3. Jha, L. K. and Sarma, P. K., 2009. Agroforestry: Indian Perspective.
4. EL Bassam, N., 1998. Energy Plant Species: Their Use and Impact on Environment and Development.
5. Jha, L. K. and Sarma, P. K., 1994. Forestry for the People.
6. Dogra, P.D. and Dhiman R. C., (eds.). 1994. Forestry Research and Education in India.
7. Aiyer, A. K., 1966. Field crops of India.
8. Shiva Vandana, Meherhomji V. M., and Joryal. N.D., 1992. Forest Resources-Crises and Management.
9. Manilal, K. S., 2001. Van Rheede's Hortus Malabaricus English Edition. University of Kerala Publication.
10. Sharma, P. P. and Kumar, 2007. Hand Book of Medicinal Plants: A complete Source Book, Agrobios India.
11. Leland J. C., 2006. Natural Products from Plants, CRC Press.
12. Kochhar, S. L., 2016. 5th edn. Economic botany: a comprehensive study, Cambridge India.
13. Verma, V., 2009. Textbook of Economic Botany, Ane Books India.
14. Berlatsky, N. (ed), 2014. *Biodiversity*. Greenhaven Press/Gale Cengage Learning.

SEMESTER - III

Course Title: DSC REPRODUCTIVE BIOLOGY, PLANT CELL, TISSUE AND ORGAN CULTURE

Course Code: A3BOT001T

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**03 hrs.**	**20**	**80**	**100**

COURSE OUTCOMES (COS)

1. The course aims at the concept, scope, instrumentation, basic requirements and applied aspects of plant tissue culture.
2. It focuses on various types plants cultures. Course Learning Outcome:- Student will understand the basic properties of plant cell and with apply their basic knowledge of Plant Tissue Cultures in various fields for conservation, medicine, product development etc.
3. Grasp the various types of developmental correlations in plants, including physiological, genetic, and compensatory correlations, and how they influence plant growth and organ development.
4. Recognition of Plant Polarity and Symmetry.
5. Understand the structure and function of the meristem at cellular and molecular levels, Study and explain reproductive development processes such as microsporogenesis, megasporogenesis, and pollination-fertilization mechanisms.
6. Understand embryo development in monocots and dicots, endosperm development, and their physiological and biochemical roles, including applications in agricultural biotechnology.
7. Proficiency in Plant Cell and Tissue Culture Techniques- Develop skills in plant cell, tissue, and organ culture, covering essential aspects such as scope, instrumentation, fundamental requirements, and practical applications.
8. This includes mastery in media preparation, sterilization techniques, and cell suspension culture. Gain insight into various types of plant cultures and their uses in conservation, medicine, and product development, along with an understanding of the limitations of these techniques.

Unit	Title	60 hrs/ Semester
Unit-1	**DEVELOPMENTAL BIOLOGY OF PLANTS:** **Correlation**: Introduction, physiological correlations, compensatory correlation, genetic correlations, correlations between different parts. **Polarity**: Polarity expressed in external and internal structures, physiological manifestations of polarity. **Symmetry**: Introduction, inorganic and organic symmetry, radial symmetry, bilateral symmetry. **Abnormal growth:** Abnormal development of organs (organoid galls, fasciations, pelory) amorphous structures (intumescences, callus, and crown gall). **The sub-cellular and biochemical structures of the meristem:** Cytohistological zonation, ultra structure of meristem, biochemical activity of meristem, gene expression. **Origin of shoot apical meristem:** Regeneration of meristem in split or damaged apex, functions of shoot apical meristem, bud dormance, quiscent center, genetics of root development. The mechanism of leaf primordium initiation, positioning of the primordia, phyllotaxis, localization of primordium formation- packing theories, diffusion-reaction mechanism, experimental modification for primordiam positioning, chemical modification of phyllotaxis, surgical and mechanical modification of phyllotaxis, genes for phyllotaxis and primordium initiation **Transition to flowering:** The transition to flowering at shoot apex evocation, changes in biochemical changes (changes in respiratory activity, changes in protein complement). **New developmental patterns at the flowering specification of the floral organs**: Homeotic mutants, ABC, ABCDE model, MADS-box genes, reversal of flowering, modification of gene action by growth substances, cellular differences between floral organs, gene expression	15 Hours
Unit-2	**REPRODUCTIVE BIOLOGY:** **Microsporogenesis and formation of male gametophyte:** Ontogeny of anther and its histochemistry, male sterility and pollen abortion, male germ unit and its significance, different wall layer formation in anther, role of callose , mechanism of cohesion in composite pollen, pollen wall proteins and allergens. **Megasporogenesis and formation of embryo sac:** Ovule determination and development, megasporogenesis, organization of embryo sac, structure of embryo sac cells, gene function during megagametogenesis, haustorial behaviour of embryo sac, nutrition of embryo sac, concept of female germ unit and its significance.	15 Hours

	Pollination and fertilization: Agencies for pollination, artificial pollination, pollen storage, pollen viability tests-tetrazolium test, fluorescein diacetate test, X-ray, NMR method. **Fertilization:** Pollen-pistil interaction, growth and structure of pollen tube, composition and function of stigmatic exudates. **Sexual incompatibility:** Self incompatibility, barriers to fertilization, physiology and biochemistry of incompatibility, methods to overcome incompatibility. **Endosperm:** Development of endosperm, major types endosperm, reserve food substances, functions and applications of endosperm. **Embryo:** Development of embryo in dicots and monocots, embryo suspensor-biochemical, physiological and functional aspects, unusual features of embryo development, nutrition of embryo. **Polyembryony:** Introduction, causes of polyembryony, classification of polyembryony, practical value of polyembryony.	
Unit-3	**PLANT CELL, TISSUE AND ORGAN CULTURE** **General introduction**: History, introduction, terminology, scope, applications and limitations of plant tissue culture. **Laboratory organisation of plant tissue culture**: Requirements of laboratory organization, tools and techniques of sterilization, disinfectants, sanitization of plant tissue culture laboratory. **Plant tissue culture media:** Culture media, media constituents– inorganic nutrients, organic nutrients, vitamins, growth hormones and gelling agents. Media preparation, properties of media selection, media contaminants, antibiotics. **Preparation and inoculation of explants:** Properties for **s**election of explant, preparation of explant, sterilization agents used, inoculation of explant on nutrient media. **Cell suspension culture:** Introduction, techniques of cell suspension culture, types of batch and continuous culture. Importance of cell suspension culture. **Somatic embryogenesis** **Micropropogation:** Introduction, procedure of micropropagation, factors affecting micropropation. Advantages, disadvantages, and applications of micropropagation.	15 Hours
Unit-4	**Protoplast isolation and fusion:** Isolation of protoplast, different source of protoplast isolation (leaf, cell suspension culture, pollen mother cell), factors influencing protoplast yield and viability. Chemical and electrofusion method of protoplast fusion. Applications of somatic hybridization. **Haploid production:** Introduction, androgenesis with respect to anther culture, pollen culture, direct and indirect androgenesis. Advantages, disadvantages, significance, and applications of haploid culture. ***In vitro* production of zygotes and production of synthetic seeds**: Production and application of synthetic seed. General technique of zygote production, culture requirements of zygote production, applications. **Production of secondary metabolites:** Introduction, application of tissue culture for synthesis of useful compounds. Techniques of selecting cell lines for high yields	15 Hours

	of compounds of secondary metabolism. Mass cultivation of cells by bioreactors. Elicitor induced accumulation of products. **Cryopreservation:** Introduction, methods of cryopreservation, applications.	

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	**20 Marks**
Formative Assessment as per guidelines.	

REFERENCES:

1. Embryology of Angiosperms (1984) Ed. B.M. Johri Springer-verlag Publications
2. Introduction to the Embryology and Angiosperms (1950) by P. MaheshwariMcGraw Hill NY
3. Recent advances in the Embryology of Angiosperms (1963)Ed. P. Maheshwari. Intl. Soc. Plant morphol. Delhi
4. The embryology of angiosperms (2000) by Bhojwani S.S. and Bhatnagar S.A., Vikas publications house New Delhi
5. Pollen biology and biotechnology (2003) by K.R. Shivanna., Oxfard and IBH publishing House New Delhi
6. Fertilization in Angiosperms /seed plants (Molecular and Cytological) by Cristi.
7. Plant morphogenesis by Sinnott
8. Plant Growth and Development—A Molecular Approach. (1994) by Donald EF, Harcourt Brace & Company, U.S.A
9. Systematic Embryology of the Angiosperms (1996) by Davis GL., John Wiley and Sons, New York
10. Comparative embryology of angiosperms (1992) by Johri BM, Ambegaokar KB, Srivastava PS. Springer-Verlag, Berlin, New York.
11. Plant Growth and Development (2005) by Srivastav L, S Edition, Academic press.
12. An Introduction to Plant Structure and Development (2005) by Beck, C.B., Cambridge University Press, London U.K.
13. The Shoot Apical Meristem Its Growth and Development (1998) by Lyndon F. R., Cambridge University Press, London U.K.
14. S. S. Bhojwani and M. K. Razdan. 1996. Plant tissue culture: Theory and Practice. Elsevier Publishers, Amsterdam.
15. M. K. Razdan. 1993. An introduction to plant tissue culture, Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi.
16. K. Vasil (Ed.) Cell culture and somatic cell genetics of plants. Various volumes. Academic Publishers, Orlando.
17. R. A. Dixon and R. A. Gonzales (Ed.) 1994. Plant cell culture, a practical approach. Second Edition. Oxford University Press, Oxford.

18. O. L. Gamborg and G. C. Phillips. 1995. Plant cell, tissue and organ culture, fundamental methods. Springer International student Edition.
19. Molecular Biotechnology (2nd Edn.) B.R. Glick and J.J. Pasternak, ASM Press, Washington DC. 1998.
20. Genes VII, B. Lewin, Oxford University, Press, 2000
21. Gene cloning, T.A. Brown, Chapman and Hall Publ. 1994.

Course Title: DSC REPRODUCTIVE BIOLOGY AND PLANT CELL, TISSUE, ORGAN CULTURE

Course Code: A3BOT002P

Type of Course	Theory / Practical	Credits	Instructionhour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs**	**04 hrs.**	**10**	**40**	**50**

PRACTICALS:

1. Microtechnique: collection, fixation, storing, dehydration, infiltration and embedding of the plant material.
2. Sectioning of embedded material by using microtome.
3. preparation of permanent slide to study development of anther/ovule
4. Histochemical localization of macromolecules, anther at different developmental stages.
5. Preparation of Brew baker and Kwacks media to study pollen germination - by hanging drop technique.
6. Mounting of embryo and endosperms.
7. Root apical meristem and shoot apical meristem.
8. Organization of plant tissue culture laboratory, laboratory tools and instruments.
9. Preparation of stock solutions of MS media for plant tissue culture.
10. Preparation and sterilization of MS media for plant tissue culture.
11. Slant preparation and inoculation of explants on a nutrient medium.
12. Study of callus cytology obtained through plant tissue culture.

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	05
Internal Assessment Test 2	05
Total	**10 Marks**
Formative Assessment as per guidelines.	

Course Title: DSC CELL BIOLOGY AND GENETICS

Course Code: A3BOT 003T

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**03 hrs.**	**20**	**80**	**100**

COURSE OUTCOMES (COS)

1. Understand organization of Prokaryotic and Eukaryotic cell
2. Understand to calculate Chiasma frequency and crossing over
3. Understand division of Somatic and Gametic cell division
4. Understand life cycle and identification of mutant fruit fly

Unit	Title	60 hrs/ Semester
Unit-1	**CELL BIOLOGY** Organization of prokaryotic and eukaryotic cell, plasma membrane – molecular organization, cell differentiation. Nucleus – (nucleosome model) microscopic and sub microscopic organization. Structure and function of nuclear membrane. Nucleolus-ultrastructure and role in ribosome synthesis. Eukaryotic Chromosome – chromatin, its chemical nature, macro molecular organization. Heterochromatin and its significance, special types of chromosomes, polytene and lamp brush Chromosome. Sex Chromosome, Structural change in chromosomes. Numerical changes in Chromosome. Euploidy, haploidy, polyploidy.	15 Hours
Unit-2	Cytoskeletons– Microtubules, Cilia, flagella, structure and function of ER, Gogli complex, Mitochondria, Chloroplast, lysosome and peroxisome. Mechanism of cell division Mitotic apparatus, cytokinesis, Chromosome movement, molecular mechanisms of regulating mitotic events, meiotic stages, chromosome pairing, chiasma formation. Cell signaling, Signaling pathways in plants. Molecular biology of signaling in plants.	15 Hours
Unit-3	**GENETICS** Mendelian principles and experiments, rediscovery of Mendel views. Selection of parameters, monohybrid and dihybrid cross. Multiple alleles: Self sterility in tobacco. Gene interaction: Complementary genes (Flower colour in sweet pea), Albinism in maize (lethal genes in plants). Multiple gene interaction: Colour of wheat kernal, corolla length in tobacco. Linkage in sweet pea (coupling and repulsion) T series of linkage: differential multiplication theory and chromosome theory of linkage and factors affecting linkage. Chromosome mapping in maize. Sex determination in plants. Extra chromosomal inheritance.	15 Hours
Unit-4	Structure of plant gene, function of gene, mutation of gene: Transition and transversion, silent mutation, frame-shift mutation, nonsense mutation and point	15 Hours

	mutation and role of mutation in evolution. Transposonsable elements, split genes, overlapping genes. Regulation of gene expression in prokaryotes: Concept of operon model and mechanism of operon model (structural genes, promoter genes, regulator genes and operator genes). Regulation of gene expression in eukaryotes: Transcription, processing of RNA, translation. Epigenetics. Biostatistics. Measures of dispersion Measures of central tendencies (Mean, Median, Mode), Frequency of distribution, Standard deviation coefficient of variation and standard error. Probability and Chi-Square test. One way analysis of variance, two – way analysis of variance	

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	**20 Marks**
Formative Assessment as per guidelines.	

REFERENCES:

1. De Robertis, E. D. P. 2023: Cell and molecular biology 8th Ed. Wolters Kluwer.
2. Snustad, D. P., Simmons, M. J. 2015: Principles of Genetics 7th Ed. Wiley & sons, Inc.
3. Gupta, P. K. 2005: Cell and Molecular Biology 3rd Ed. Rastogi publications.
4. Lodish, H. Berk, A., Zipursky, S. L. Matsudaira, P., Baltimore, D. Darnell. J. 2000. Molecular cell biology. Freeman W.H. and Co. New York.
5. Karp, G. 2000: Cell and molecular Biology: concepts of experiments. John Wiley and sons Inc. New York.
6. Tamarin, R.M. 2000: Principles of Genetics,. 6th Ed. WMC. Brown Publ. Co. London.
7. Cooper, G. M. 1997. The cell: A molecular approach. ASM press, USA.
8. Powar, C. B. 1997: Cell biology, Himalaya publishing house, Delhi.
9. Strickberger, M. W. 1995: Genetics. 3rd Ed. Prentice Hall Inc. London.
10. Alberts, B. Bray, D. Lewis, J. Raff, M. Roberts, K. and Watson, J.D. 1994. Molecular biology of the cell., 3rd Ed.

Course Title: DSC CELL BIOLOGY AND GENETICS

Course Code: A3BOT004P

Type of Course	Theory / Practical	Credits	Instructionhour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs**	**04 hrs.**	**10**	**40**	**50**

PRACTICALS:

CELL BIOLOGY:

1. Preparation of cytological fixatives and stains,fixation of root tips and flower buds.
2. Preparation of grades of alcohol for cytological staing to study cell division.
3. Squash preparations to study mitotic stages and karyotype analysis.
4. Smear preparations to study meiotic stages to identify diakinesis/metaphase I of meiosis and to Calculate chiasma frequency.
5. Identification of B Chromosome.
6. Study of cytometry.
7. Study of Polytene Chromosome of larvae of chironomus and fruit fly.

GENETICS:

8. Life cycle and culture technique and handling of *Drosophila melanogaster*.
9. Identification of male and female flies, mutant flies and mounting of sex comb from male fly.
10. Crossing experiments and simple Mendelian inheritance in fruit flies.
11. Solving of genetic problems and biostatistics problems.

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	05
Internal Assessment Test 2	05
Total	**10 Marks**
Formative Assessment as per guidelines.	

Course Title: DSC PLANT BIOTECHNOLOGY AND GENETIC ENGINEERING

Course Code: A3BOT005T

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**03 hrs.**	**20**	**80**	**100**

COURSE OUTCOMES (COS)

1. This course offers students in the applications of plant biotechnology in biological research.
2. Students will become familiar with the tools and techniques of genetic engineering, DNA manipulation enzymes, genome and transcriptome analysis and manipulation tools, gene expression regulation, production and characterization of recombinant proteins
3. A comprehensive understanding in plant biotechnologyaspects
4. Students will be aware of the modern tools and techniques of genomics and isolation and identification of genes
5. To understand the significance and impact of genes, their structure and their functions
6. To gain a hands-on experience in techniques used in molecular biology and their applications
7. To ensure the advances in plant biotechnology for agriculture via recombinant DNA technology
8. Students will learn the applications of plant transformation for improving the productivity and performance of plants under biotic and abiotic stresses

Unit	Title	60 hrs/ Semester
Unit-1	**Principles and Methods of Plant Biotechnology:** Plant gene structure as discontinuous gene. Approaches for identification of genes. QTL mapping and marker-assisted selection in plants. Applications of Plant Biotechnology: Plant transformations. CRISPR/Cas9 mediated biotic stress resistance in plants. Mechanism and mode of action of CRISPR/Cas9 technology. Applications of CRISPR/Cas9 in editing gene. Current and emerging trends in techniques for plant pathogen detection. Non-invasive optical and spectral detection methods, Cultivation-based methods. Enzyme linked immunosorbent assay (ELISA), Lateral flow immunoassays (LFIA), nucleic acid-based assays, conventional PCR and variants, digital droplet PCR, Isothermal nucleic acid amplification, Nucleic acid sequencing methods, amplicon sequencing, biosensors. Plant molecular farming. A brief history of molecular farming, molecular farming systems. Stable nuclear transformation, plastid transformation,	15 hours

	transient transformation of a crop species, Integration of multi-omics and systems biology approaches for crop improvement, role of panomics for crop breeding science	
Unit-2	**Tools and Techniques in Plant Biotechnology**: Promoters - open reading frames, linkers and adaptors, fusion protein. DNA amplification (principles and applications). RtPCR. Blotting techniques (Southern, Northern and Western blotting). Nonradioactive probe, Gene cloning recombinant DNA and PCR, Vectors, plasmid, cosmids, molecular sensor restriction endonuclease and molecular ligases. Gene theory, gene bank (NCBI and EBI). Softwares (Bioedit, ClustalW, NJplot), DNA chips, introduction of *Nif* genes and cloning of *Nif* genes. Molecular pharming: Concept of plants as biofactories, production of industrial enzymes and pharmaceutically important compounds, edible vaccines. Genotyping tools as plant variety protection, DNA bar-coding technology, hybrid purity tests, diagnostics (transgenics, forensics), establishing clonal fidelity, fingerprinting for BAC assembly for physical maps, supplementary mapping tools and methodologies: radiation hybrid maps, HAPPY mapping, comparative/synteny mapping. Genomics platforms for genome-wide analysis: DART seq, GBS (genotyping by sequencing) and other third generation sequencing platforms, GEBVs (Genomics estimated breeding values), GWAS (Genome-wide association studies). Molecular tools in detections of plant disease: Nested PCR, conventional PCR, multiplex PCR, FISH, Microarray, LAMP, NASBA, RNA-Seq, SAGE, PAGE FCM, thermography, fluorescence imaging, hyperspectral techniques.	15 hours
Unit-3	**Genetic Manipulation in Plants**: Plant transformation techniques: Agrobacterium-plant interaction, Ti and Ri plasmids, opines, vir genes, T-DNA transfer, disarmed Ti plasmid. Agrobacterium-mediated gene delivery. Binary and cointegrated vectors, use of promoters and reporter genes; viral and bacterial vectors, chloroplast and mitochondrial engineering, transformation of chloroplast genome in higher plants, crop improvement and gene tagging, physical maps using in-situ hybridisation (ISH), resolution gap. Targeting of transgene product into chloroplasts and mitochondria**.** Genetic engineering for biotic stress tolerance (insects, fungi, bacteria, virus and fungi). Genetic engineering for abiotic stress (Drought, flooding, Salt and temperature). Direct gene transfer methods. Particle bombardment, PEG-mediated, electroporation, screenable and selectable markers, selection of transformants. Transgenic plants: Herbicide resistance, pest resistance, plant disease resistance, abiotic stress tolerance; male sterility, improvement of crop yield and nutritional quality. Biosafety regulations of transgenics. Detection of nucleic acid sequences	15 hours
Unit-4	**IPRs and Plant Biotechnology**: Importance of gene banks, establishment of gene banks using plasmids and phages. Risk factors involved in the release of genetically engineered plants: Possible dangers of GEO's, biohazards of rDNA technology, risk evaluation and release of GEO's. GRAS, Bio safety handling of hazardous chemicals and radioisotopes. Intellectual Property Rights (IPR): IPRs in plant biotechnology implications for India, labelling of GM crops and foods.	15 hours

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	**20 Marks**
Formative Assessment as per guidelines.	

REFERENCE:

1. Adrian, S., Nigel, S. and Mark, F. (2008). *Plant Biotechnology: The Genetic Manipulation of Plants*. Oxford University Press, UK.
2. Chittaranjan, K. (2020). *Compendium of Plant Genomes*. Springer, Switzerland.
3. Chittaranjan, K. (2023). *Compendium of Crop Genome Designing for Nutraceuticals*. Springer Nature, Singapore.
4. Chittaranjan, K., Anurag, C., Kathleen, L.H. and Jogeswar, P. (2024). *Applications of Plant Molecular Farming*. Springer Nature, Singapore.
5. Malik, Z. A., Usha, K., Kamaluddin and Athar, A. (2017). *Plant Biotechnology*: *Principles and Applications*. Springer, Singapore.
6. Old, R. W. and Primrose, S. B. (2001). *Principles of Gene Manipulation*. Blackwell Publishing, MA.
7. Siddra, I., Imran, Ul. H. and Hayssam, M. A. (2024). *Trends in Plant Biotechnology*. Springer, Nature, Singapore.
8. Sivakumar, P., Gnanam, R., Khawar, K. M. and Thangadurai, D. (2010). *Grain Legume Research*: *Tissue Culture*, *Biotechnology and Genetic Engineering*. Bioscience Publications, India.
9. Thangadurai, D., Leena, T., Hemanth K. N. V. and Diana, J. C. (2009). *Crop Improvement and Biotechnology*. Bioscience Publications. India.
10. Thangadurai, D., Pullaiah, T. and Balatti P. A. (2005). *Genetic Resources and Biotechnology*, Volume- 2, Regency Publications, New Delhi, India.
11. Thangadurai, D., Pullaiah, T. and Pinheiro de Carvalho, M. A. A. (2005). *Genetic Resources and Biotechnology*, Volume- 1 Regency Publications, New Delhi, India.
12. Thangadurai, D., Pullaiah, T. and Tripathi, L. (2005). *Genetic Resources and Biotechnology*, Volume - 3 Regency Publications, New Delhi, India
13. Thangadurai, D., Tang, W. and Bennett, A. (2006). *Biotechnology for Food, Agriculture and Environment*, Volume -1 Regency Publications, New Delhi, India.
14. Tzfira, T. and Citovsky, V. (2008). *Agrobacterium*: *From Biology to Biotechnology*. Springer. New York.

Course Title: DSC PLANT BIOTECHNOLOGY AND GENETIC ENGINEERING

Course Code: A3BOT006P

Type of Course	Theory / Practical	Credits	Instructionhour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs**	**04 hrs.**	**10**	**40**	**50**

PRACTICALS:

1. DNA isolation of plant samples, amplification of plant DNA using PCR techniques
2. Agarose gel electrophoresis
3. Demonstration of gene transfer techniques, indirect methods
4. Random Amplified Polymorphisms of DNA (RAPD) analysis
5. Screening of transgenic plants by PCR
6. Mutation detection by analysis of DNA heteroduplexes in TILLING populations of diploid species
7. Tissue-Specific transcriptome profiling in Arabidopsis roots
8. Detection of Plant disease by using multiplex PCR
9. Detection of Plant disease by using FISH
10. Visit to plant biotechnology laboratory of National Institutes/ Universities
11. Study on vectors and plasmids

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	05
Internal Assessment Test 2	05
Total	**10 Marks**
Formative Assessment as per guidelines.	

Course Title: OEC GARDENING AND LANDSCAPING

Course Code: A3BOT204T

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**03 hrs.**	**20**	**80**	**100**

COURSE OUTCOMES (COS)

1. Student will learn different types of gardening techniques.
2. Landscaping- Maintenance and management residential and non-residential landscaping.
3. To understand the different types of nurseries and nursery techniques.
4. Student will learn the handling of tools and techniques to grow the indoor and outdoor gardening.
5. Student will learn the importance of Economy and ecotourism from gardening and landscaping.

Unit	Title	60 hrs/ Semester
Unit-1	**Introduction to Gardening and Landscaping:** Gardening**:** History of gardening and landscaping, principles involved in gardening; Types of gardens- Formal Gardens, Informal Gardens; English garden, Mughal gardens, Japanese garden and other gardens like Vertical gardening, kitchen gardening, terrace gardening, medicinal gardens; features of gardens; Merits and demerits of different gardens; Basic principles of ornamental gardening. Types of layouts for gardening and landscaping. Steps involved in conversion of land into gardens. Biological enemies of garden plants sacred gardens. **Landscaping :** Objectives, principles, landscape designing, categories, residential and non-residential landscaping, expected outcomes and plants used for landscaping, xeriscaping. Management and maintenance of landscaping and gardening. **Nursery :** Types, Designs, Sites for establishment, Management of nursery	15 Hours
Unit-2	**Tools and Techniques for gardening and landscaping:** Propagation of plants : Propagation by Seeds-Seed sources, processing, testing and storage, Propagation by cuttings – Types of cuttings, stock and scion and their relation, sources of cutting materials, rooting media, wounding. Grafting and their techniques. Types-Grafting, Budding, Layering and procedure involved. Propagation by some specialized stems and roots – Bulbs, corms, tubers, rhizomes, pseudobulbs.	15 Hours

	Treatment of soil and soil mixtures, fertilizers, and pesticides, making of potting mixtures: perlite, vermiculite, compost,saw dust, cocopeat, growth hormones etc. Potting mixtures for crop plants, vegetables plants, ornamental plants, xeric plants.Tools involved: Gloves, forks, secateurs, shovels, spades, trowels, hoes, pruners, saws, Lawnmowers, Hedge trimmers, etc	
Unit-3	**Indoor and organic gardening:** **Orchidarium-** Bonsai: The art of miniature plant culture; Terrariums culture; Bottle gardens; Hydroponics, Principles, Outcomes and Requirements and procedure involved,Merits and Demerits of indoor gardening. **Organic gardening:** Planning, composting and materials used, mulching, weed free garden, basic principles and protocols involved in organic gardening, pest control and disease control by using beneficial insects and other plants in gardening. **Vermiculture:** Process involved, establishing layout, components required and yield harvesting.	15 Hours
Unit-4	**Economy and ecotourism from gardening and landscaping:** Famous gardens in India and Karnataka; Botanical Gardens; locality parks, Parks for biodiversity conservations, Sustainable management during gardening and landscaping, Economic yields from gardens and landscaping. Development of ecotourism from gardening and landscaping. Plants species used in different types of gardens and landscaping. Selection of indigenous plants species over exotic species. Visit any garden to learn gardening techniques.	15 Hours

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	**20 Marks**
Formative Assessment as per guidelines.	

REFERENCES :

1. George Acquaah, 2002. Horticulture: principles and practices, Pearson Education Asia.
2. Guy W. Adriance and Fred R. Brison, 2009, Propagation of horticultural plants, McGraw Hill publications.
3. Hudson T. Hartmann, Dale E. Kester, Fred T. Davies, Robert L. Geneve, 2013, Plant Propagation: Principles and Practices,8th edition, Pearson Education Asia.
4. K. S. Gopalswami iengar, 1935. Complete Gardening in India, Revised edition, Hosali press, Bangalore.
5. Anil K. Singh, Anjana Sisodia 2020. Text book of floriculture and landscaping. New India Publishing Agency, Delhi.
6. T.W. Henslow Geoffrey 2019. Garden Construction, Odhoms Press Limited
7. Roger French 2021. Landscaping for Begineers : The ultimate Guide to create perfect Garden Design. Create Space Independent Publishing flatform.

SEMESTER – IV

Course Title: DSC PLANT BREEDING AND PLANT PROPAGATION

Course Code: A4BOT001T

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**03 hrs.**	**20**	**80**	**100**

COURSE OUTCOMES (COS)

1. Understanding of Plant Breeding and its scope.
2. Understand the impact of domestication on plant species and the role of plant genetic resources (PGR), including genetic erosion, classification, conservation, and utilization strategies for genetic resources.
3. Comprehension of Hybridization Techniques: Gain insight into hybridization, its types, and methods, especially for self-pollinated plants, along with their applications, challenges, and achievements.
4. Develop proficiency in breeding techniques to enhance resistance to diseases, insects, drought, and salinity, understanding the genetic mechanisms behind these traits and practical methods to incorporate them.
5. Understanding of Plant Propagation Structures and Techniques: (e.g., greenhouse, polyhouse, mist propagation units) and their applications.
6. Explain the concepts and significance of seed certification and seed legislation. Knowledge of national and international crop improvement organizations and seed certification agencies.
7. Clonal Propagation Techniques: The importance of clonal propagation, including techniques for producing and maintaining clones and identifying genetic variations.
8. Proficiency in Grafting, Budding, and Layering techniques and understand their applications in propagating different plant species
9. Apply research skills in plant breeding and propagation, with a focus on designing experiments, analyzing results, and making informed decisions for crop improvement and sustainable agriculture.

Unit	Title	60 hrs/ Semester
Unit-1	**PLANT BREEDING:** Nature and scope of plant breeding. Plant breeders: M.S. Swaminathan, Norman Borlaugh, T.S Venkataramana, Dr. Benjamin Peary pal, Harbhajan singh. Mode of reproduction in relation to breeding methods - Method of reproduction and Mode of reproduction. **Domestication :** Introduction, selection under domestication, changes in plants species under domestication. **Plant Introduction:** History, Procedure, importance. **Acclimatization:** Introduction, Merit and Demerits. **Hybridization:** Types, Procedures, Techniques, Difficulties and consequences in Hybridization in self-pollinated plants; Pedigree method- its merits and demerits, achievements, Bulk method its advantages and disadvantages, achievements, Back cross method -Merit and Demerits and achievements. Plant genetic Resources (PGR): Genetic erosion, genetic pollution, Classification based on domestication and breeding, based on sexual hybridization, management, conservation, characterization, evaluation and utilization	15 Hours
Unit-2	**Distance Hybridization:** History, Barriers to production techniques for distance hybridization, sterility, Consequences, applications, limitations and achievements Inbreeding depression- History, effects of inbreeding, Degree of Inbreeding depression, homozygous and heterozygous balance. **Hybrid vigour (Heterosis):** Manifestation of heterosis, genetic basis of heterosis, theory of heterosis, applications **Breeding for disease resistance:** Reactions of the host for various pathogens, vertifolia effect, Boom and Bust cycle, Epiphytosis, Vertical, Horizontal resistance, mechanism of Disease resistance, genetic basis of disease resistance, methods of breeding disease resistance **Breeding for insect resistance:** Mechanism of insect resistance, Nature of insect resistance. Genetics of insect resistance, breeding methods. **Breeding for drought and salinity resistance:** mechanism for drought resistance, basis of drought resistance, breeding methods for drought resistance and salinity resistance. Improved seeds- Indian seed act, classes of quality seeds, seed production and processing, seed certification, maintenance, seed production organizations-NSC, SSC, SSCA. Intellectual property rights in plant breeding. National organizations for crop improvement in India, organization and functions of ICAR, Different institution under the control of ICAR. International institutes for crop improvement.	15 Hours

Unit-3	**PLANT PROPAGATION:** General aspects of Propagation. Plant Propagation structures: Green house, Poly house, Glass house, Shade house, Net house, Mist propagation unit, hot beds, cold frames, Lathe house, advantages of green house. **Containers for growing plants:** Flats, Clay pots, plastic pots, fiber pots, paper pots, polythene bags, wood containers, compressed peat pots.**Nursery:** Types, Establishment, Location and Site management, Hardening of seedlings. **Media:** Characteristics, Organic and Inorganic components (Peat moss, Soft wood, hardwood, barks, saw dust, and, soil, perlite, vermiculite, leaf mulch, soil mixtures). **Fertilizers and Sanitation.** **Seed propagation:** Advantages and Disadvantages, seed selection, process of seed germination, types of seed germination, seed dormancy, Treatment to stimulate seed germination, methods of testing seed viability, seed storage. **Vegetative propagation:** Advantages and Disadvantages, Selection and Management.	15 Hours
Unit-4	**Clones:** merits of vegetative clonal propagation, Genetic basis of clones, kinds of genetic ariations 1.Chimeras 2.Transposons 3.Somocolones. Production and maintenance of clones. Propagation by specialized stem and roots : bulbs, corms, tubers, rhizomes, suckers, runners **Grafting:** Tools and Accessories required for grafting, cutting, and budding, Scion-root stock relationship, types of grafting. **Budding :** Methods of budding: T-budding, inverted T- budding, Patch budding, chip budding, micro budding, Bud selection and certification. **Layering:** Types and procedures of layering (simple layering, tip layering, serpentine layering, air layering, stool layering). **Cuttings:** Types of cutting, rooting media, Factors influencing rooting, leaf cutting, treating cuttings with growth regulators. **Propagation method for important plants:** Nuts and fruits, Aromatic and medicinal plants, Ornamentals, Succulents and cacti, Shrubs and Trees	15 Hours

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	**20 Marks**
Formative Assessment as per guidelines.	

REFERENCES:

1. Poewman J.M and Brothukar 1998. Breeding of Asian plants. I.B.H, New-Delhi.
2. Poelman J.M. and Sleper D.A. 1999. Breeding field crops, Panima publ. Corp. New-Delhi.
3. Singh B.D. 2005. Plant breeding principle and method, 7th edition Kalyani publication. New-Delhi
4. Simmonds N.W. 1986. Evolution of crop plants, Longmann Sci. Tech .publ, England
5. Khoklov S.S. Apomixes and Plant breeding. Amerind. New York.
6. Frankel R. and Bet Dagan 1983. Heterosis Springer verlag. Berlin.
7. Russel E.G. 1978. Plant breeding for pest and disease resistance. Butterworth. London.
8. Hartman, H.J. et al 1990: Plant propagation. Principles and practices, prentices Hall, New-Delhi
9. Sharma,V.K 1996. Plant nurseries: Techniques, Production and management. Indian publisher. New-Delhi
10. Sadhu, M.K 1989: Plant propagation. New age publisher, New-Delhi
11. Chaudhari, H.K. (1984). Elementary principles of plant breeding, 2nd edition, New-Delhi, Oxford.
12. Chopra V.L. 2000. Plant breeding: theory and practice, 2nd edition, Oxford and I.B.H, New-Delhi.
13. Acquaah, G. (2007). Principles of plant genetics and plant breeding. New Jearsey, U.S: Blackwell publishing.
14. Sharma J.R. 1994. Plant breeding. T.M.H publication, New-Delhi.
15. Hartman and Kester 2017. Plant propagation. Principles and practices (9th edition), pearson Education, Inc., New York.

Course Title: DSC PLANT BREEDING AND PLANT PROPAGATION

Course Code: A4BOT002P

Type of Course	Theory / Practical	Credits	Instructionhour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs**	**04 hrs.**	**10**	**40**	**50**

PRACTICALS :

1. Reproductive biology of self-pollinated and cross pollinated plants.
2. Pollen fertility and hybridization.
3. Breaking seed dormancy and growing seedlings after treating with hormones.
4. Origin, distribution and centers of diversity of crop plants: ground nuts, rice, chilly, sugarcane, cotton, potato, sunflower, wheat, sorghum and coffee.
5. Visit to seed production unit and local nursery.
6. Preparation of media, treatment of soil and soil mixtures.
7. Propagation by specialized stem and roots- bulbs, corms, tubers, rhizomes suckers, runners, offsets.
8. Grafting methods: whip Grafting, side grafting, cleft grafting, bark grafting, approach grafting, epicotyl or stone grafting, Tools and accessories required for grafting, layering, budding, cuttings
9. Types of layering: simple layering, tip layering, serpentine layering, air layering, Methods of Budding: T-budding, inverted T- budding, Patch budding, chip budding.
10. Cuttings: cutting preparation for rooting treating cutting with growth regulators, leaf cutting.
11. Propagation of succulents by cutting and cacti by grafting.
12. Growing of ornamental plants in kitchen garden and containers for growing plants.

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	05
Internal Assessment Test 2	05
Total	**10 Marks**
Formative Assessment as per guidelines.	

Course Title: DSC NANOBIOLOGY

Course Code: A4BOT003T

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**03 hrs.**	**20**	**80**	**100**

COURSE OUTCOMES (COS)

On successful completion of the course students will be able to

1. Formulate procedures for the synthesis of nanoparticles to assess their potential activities.
2. Characterize the various types of nano particle synthesis and advocate promote the use of nano materials and nano composites.
3. Understand the toxicological aspects of nanomaterials on ecosystem.

Unit	Title	60 hrs/ Semester
Unit-1	**Introduction To Nanobiology**: History and scope of nanobiology and properties of nanomaterials. Natural bio-nanomaterials, Special note on self-assembly. Classification of Nanomaterials: Origin, Dimension- 0-D, 1-D, 2-D and 3-D. Structural configuration: Carbon based, Organic, Inorganic and Composites. Nanostructured materials: Quantum dots and quantum wire core/Shell structures.	15 Hours
Unit-2	**Synthesis of Nanomaterials**: Physical methods: Mechanical milling, Laser ablation, Photolysis, Radiolysis, Microwave and Ultrasound assisted synthesis, Electrosputtering, Electrospinning, and Lithography. Chemical methods: Precipitation and co-precipitation, Sol-gel, Spray pyrolysis, Flame pyrolysis, Hydrothermal, Microemulsion, Chemical reduction, Cryochemical synthesis, Chemical vapor deposition (CVD), Metal organic chemical vapor deposition (MOCVD). Biological methods: Sources, Concept of reducing and capping agents, Biomolecules as reducing and capping agents. Extracellular and intracellular synthesis.	15 Hours
Unit-3	**Characterization of Nanomaterials:** Structural Characterization: Powder X-ray diffractometer, FTIR spectrometer. Microscopic and surface analysis: Scanning electron microscope (SEM), Transmission electron microscope (TEM), Atomic force microscope (AFM), Scanning tunnelling microscope (STM), Laser confocal microscope, Energy dispersive X-ray analysis (EDX), Nuclear magnetic resonance (NMR). Thermal and Optical Properties: Differential scanning calorimeter (DSC), Thermogravimetric/Differential thermal analyzer (TG/DTA), UV-Visible spectrophotometer, Spectrofluorometer, Contact angle measurement and Dynamic	15 Hours

	light scattering (DLS).	
Uni-4	**Applications of Nanomaterials**: Textiles, Cosmetics, Agriculture, Fertilizers and plant disease management, Food, Environmental remediation. Nano medicine: Bio-sensors, Imaging, Drug delivery, Cancer therapy and tissue repair. Introduction to toxicity of nanoparticles, Types of nanoparticles causing toxicity, Fate of nanoparticles in the living systems, Cytotoxicity and genotoxicity. Toxicity mechanisms: Mechanisms for radical species production.	15 Hours

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	**20 Marks**
Formative Assessment as per guidelines.	

REFERENCES:

1. Rao, M. B. and Reddy. K. K., 2007. Introduction to Nanotechnology, Campus books international, New Delhi.
2. Lindsay, S. M., 2010. Introduction to Nanaoscience, Oxford university press. New York.
3. Kohler, M. and Fritzsche, W., 2004. Nanotechnology- An Introduction to Nano structuring Techniques. Wiley-VCH Verlag GmbH & Co. KGaA, Weinheim.
4. Nalwa, H. S., 2002. Nanostructured Materials and Nanotechnology, Academic Press.
5. Niemeyer, C. M., and Mirkin, C. A., 2004. Nanobiotechnology: Concepts, Applications, and Perspectives, Wiley-VCH, Weinheim, Germany.
6. Pradeep, T., 2012. A Textbook of Nanoscience and Nanotechnology, Tata McGraw Hill Education Pvt. Ltd.
7. Ratner, M. A., and Ratner, D., 2003. Nanotechnology: A Gentle Introduction to the Next Big Idea. Prentice Hall Professional, New York.
8. Boisseau, P., and Lahmani, M., 2009. Nanoscience: Nanobiotechnology and Nanobiology, Springer, UK.
9. Dupas, C., Houdy, P., Lahmani, M., 2007. Nanoscience: Nanotechnologies and Nanophysics, Springer-Verlag Berlin Heidelberg.
10. Nicolini, C., 2008. Nanobiotechnology and Nanobiosciences, Pan Stanford Publishing, Singapore.
11. Thangadurai, D., Sangeetha, J. and Prasad, R., 2020, Functional Bionanomaterials : From Biomolecules to Nanoparticles. Springer Nature, Cham, Switzerland.
12. Thangadurai, D., Sangeetha, J. and Prasad, R., 2020, Nanotechnology for Food, Agriculture and Environment, Springer Nature, Cham, Switzerland.

13. Thangadurai, D., Saher, I., Sangeetha, J. and Cruz-Martins, N., 2023. Biogenic Nanomaterials: Structural Properties and Functional Apllications, CRC Press, Boco Raton, Florida, USA.
14. Thangadurai, D., Saher, I. and Adetunji CO., 2022, Viral and Antiviral Nanomaterials: Synthesis, Properties, characterization, and Application, CRC Press, Boco Raton, Florida, USA.
15. Thangadurai, D., Sangeetha, J. and Prasad, R., 2022, Bioprospecting Algae for NanosizedMateriald, Springer Nature, Cham, Switzerland.

Course Title: DSC NANOBIOLOGY

Course Code: A4BOT004P

Type of Course	Theory / Practical	Credits	Instructionhour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs**	**04 hrs.**	**10**	**40**	**50**

PRACTICALS:

1. Study of different instruments used in characterization of nanomaterials (UV-VIS, FTIR, XRD, AFM, SEM, EDX, TEM, DLS and Zeta potential).
2. Preparation of plant extract (Organic and aqueous), Crushing, Grinding, Maceration, Hot extraction, using Sohxlet apparatus.
3. Phytochemical analysis of plant extracts.
4. Micro-wave assisted synthesis of Carbon Quantum Dots.
5. Synthesis of metal-oxide nanoparticles by Photocatalysis.
6. Synthesis of silver nanoparticles using sodium citrate (Lee-Meisel method).
7. Preparation of metal-oxide nanoparticles using co-precipitation method.
8. Synthesis of nanoparticles using fungal extracts.
9. Effect of pH on surface plasmon resonance of nanoparticles.
10. Effect of metal ion concentration on surface plasmon resonance of nanoparticles.
11. Determination of effect of nanoparticles on growth of pathogens.
12. Dye degradation using synthesized nanoparticles.
13. Determination of antimicrobial properties of nanoparticles.

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	05
Internal Assessment Test 2	05
Total	**10 Marks**
Formative Assessment as per guidelines.	

Course Title: DSC APPLIED AGRICULTURE MICROBIOLOGY, MYCOLOGY AND PLANT PATHOLOGY:

Course Code: A4BOT103AT

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**03 hrs.**	**20**	**80**	**100**

COURSE OUTCOMES (COS)

Course Outcomes (COs):At the end of the course students will be able:

On successful completion of the course students will be able to

1. Understand the fermentation technology, and the importance of microorganisms in agriculture.
2. Appreciate the value-added products of fungal origin.
3. Distinguish the plant diseases caused by fungi, bacteria and viruses and their control measures.
4. Know the various seed borne diseases and methods to manage them.

Unit	Title	60 hrs/ Semester
Unit-1	**APPLIED AGRICULTURE MICROBIOLOGY** **Agriculture and Industrial Microbiology:** Agriculture microbiology: Concept of rhizosphere, rhizoplane, phyllosphere and phylloplane. Growth promoting rhizobacteria, siderophores. Mineralization and immobilization of nitrogen, nitrification, denitrification. Symbiotic nitrogen fixation: *Rhizobium* and *Frankia*. Nonsymbiotic nitrogen fixation: *Azotobacter*. Associative symbiotic nitrogen fixation: *Azospirillum*. Agrobacterium mediated gene transfer, Manipulation of host genes for plant protection. Biofertilizers: Types, production and quality control. Biopesticides: Types and applications. Industrial Microbiology: Fermentation, Process and its types, Production of Beer, Wine, Citric acid, Penicillin and Amylase by fermentation process	15 Hours
Unit-2	**Applied Mycology:** Preservation and maintenance of cultures- Batch, Synchronous, Continuous and Phased culture and their applications. Edible fungi and their nutritional value, Advancement of Mushroom production technology with reference to strain improvement. Cultivated species in India and abroad. Commercial valuable products by fungi- Hormones, Enzymes, Pigments, Alkaloids, Antibiotics and Mycotoxins. Single cell protein and feed stuffs.	15 Hours
Unit-3	**Plant Pathology:** Genetics of Pathogenicity. Plant Defense: Signaling mechanism behind the development of localized and systemic acquired resistance in plant. Biopesticides and their mode of action with special reference to induced systemic resistance. Transgenic approach to control plant diseases. Integrated control of plant	15 Hours

	diseases and Plant quarantine.	
Unit-4	**Seed pathology and Plant diseases**: Internal and external seed borne Fungi, Bacteria and Viruses. Biodeterioration of seeds. Special account on forest pathology. Specific plant diseases caused by Fungi, Bacteria, Virus, Mycoplasma, Nematodes and parasitic higher plants.	15 Hours

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	**20 Marks**
Formative Assessment as per guidelines.	

REFERENCES:

1. Reed, G., 1983, 4th edn. Prescott and Dunn's Industrial Microbiology, AVI Publishing Co., Connecticut, U.S.A.
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Course Title: DSC APPLIED AGRICULTURE MICROBIOLOGY, MYCOLOGY AND PLANT PATHOLOGY:

Course Code: A4BOT103P

Type of Course	Theory / Practical	Credits	Instructionhour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs**	**04 hrs.**	**10**	**40**	**50**

PRACTICALS:

1. Isolation of associative nitrogen fixing bacteria *Azospirillum*.
2. Estimation of Citric acid production by *Aspergillus niger*.
3. Wine preparation by fermentation method.
4. Stimulatory effect of plant extracts on spore germination of fungal pathogens.
5. Paper chromatographic separation of amino acids from culture filtrates.
6. Mushroom cultivation.
7. Isolation and culturing of *Rhizobium* from root nodules.
8. Study of *Rhizobium* from root nodules by staining.
9. Market pathology of fruits and vegetables.
10. Symptomology and histopathology of plant diseases.
11. Industrial visit and field study.

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	05
Internal Assessment Test 2	05
Total	**10 Marks**
Formative Assessment as per guidelines.	

Course Title: DSC PLANT TISSUE CULTURE

Course Code: A4BOT001T

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**03 hrs.**	**20**	**80**	**100**

COURSE OUTCOMES (COS)

1. Understanding Cellular Totipotency and Differentiation.
2. Develop proficiency in the principles, initiation, and maintenance of callus culture and cell suspension culture, including growth assessment, bioreactor design, and the application of these techniques in plant research and biotechnology.
3. Demonstrate understanding of somatic embryogenesis, including the hormonal and genetic regulation of embryo development, and the production of synthetic seeds, emphasizing their applications in crop improvement and conservation.
4. Gain expertise in haploid and triploid production techniques, including androgenesis, gynogenesis, and endosperm culture, understanding the methods' advantages, limitations, and applications in producing homozygous lines and seedless plants.
5. Apply in vitro techniques for pollination, fertilization, and embryo culture, with knowledge of their protocols, influencing factors, and practical applications, especially in overcoming reproductive barriers and improving crop yields.
6. Gain skills in protoplast isolation, culture, and somatic hybridization, including fusion techniques.
7. Understand and apply genetic transformation techniques, including Agrobacterium-mediated transformation and protoplast transformation.
8. Explain methods for producing disease-free plants, including meristem-tip culture, shoot-tip grafting, and virus indexing, and understand factors affecting the success of pathogen eradication in tissue cultures.
9. Develop skills in micropropagation and clonal propagation, understanding stages of multiplication, rooting, and hardening, with specific applications for economically important plants.
10. Explain tissue culture techniques for producing secondary metabolites.
11. Understand the modes and methods of germplasm conservation, including freeze preservation and cryopreservation techniques.
12. Apply research and practical skills in designing and conducting experiments in plant biotechnology, with a focus on tissue culture, genetic transformation, and conservation, to contribute to advancements in sustainable agriculture and biodiversity conservation.

Unit	Title	60 hrs/ Semester
Unit-1	**Cellular totipotency:** Totipotency, vascular differentiation (culture system, cytological and cytochemical aspects, physiological aspects), role of auxin during totipotency, cytodifferentiation, organogenesis (caulogenesis, rhizogenesis, caulorhizogenesis), factors affecting organogenic differentiation, totipotency of epidermal and crown-gall cells. **Callus Culture:** Principles of callus culture, initiation technique of callus. Morphology, internal structure and other characteristics of callus culture, and significance of callus culture. **Cell suspension culture:** Culture medium for suspensions, medium agitation, synchronization, growth assessment in suspension culture, viability assessment of cultured cells, single cell isolation, techniques used to grow single cell culture, factors affecting single cell culture. Plant cell reactors, selection and design of bioreactors, types of bioreactors. Applications of cell suspension culture. **Somatic embryogenesis:** Introduction, somatic embryogenesis in monocotyledonous and dicotyledonous cultures, Induction, development and maturation. Induction of somatic embryogenesis in root of *Daucus carota*. Factors affecting somatic embryogenesis, applications of somatic embryogenesis. Molecular biology of somatic embryogenesis (induction, development, synchronizing somatic embryo development). Hormonal regulation of somatic embryogenesis. Late embryogenesis abundant (LEA) gene expression. Genes isolated from somatic embryos. Expression of 'non embryonic' genes during somatic embryogenesis. Somatic embryo as a genetic system. **Artificial seeds**: Synthetic seed production, desiccated and hydrated synthetic seed, synthetic seed applications.	15 Hours
Unit-2	**Haploid production:** Androgenesis (anther culture, microspore culture), developmental aspects of androgenic haploids, factors influencing androgenic culture. Gynogenesis, factors effecting gynogenesis. Production of haploids by wide hybridization, production of homozygous diploids through diploidization. Applications and limitations of in vitro cultured haploids. **Triploid production**: Callusing, requirements and factors influencing triploid production, endosperm culture, histology and cytology of callus induced by endosperm culture, applications. **In vitro pollination and fertilization:** Introduction, techniques for in vitro pollination, ovule and ovary culture, factors affecting seed setting after in vitro pollinations. In vitro fertilization in maize. Applications of in vitro pollination and fertilization. **Zygotic embryo culture:** Types of embryo culture, techniques and requirements of embryo culture, role of suspensor in embryo culture, precocious germination, morphogenesis in the cultures of seeds with partially differentiated embryos. Study of growth and development of in vitro cultured embryo through microsurgical	15 Hours

	experiment. Embryo and seed culture of parasitic angiosperm, morphogenic potential of the embryo callus. Applications of zygotic embryo culture.	
Unit-3	**Somaclonal and gametoclonal variant selection**: Selection at plant and cell level, culture conditions, origin of somaclonal variation, mechanism underlying genetic variations, molecular basis of variants, assessment of somaclonal variations. Isolation of variants– disease resistant lines, herbicide resistant lines, stress tolerant lines, applications in plant breeding, nature of gametoclonal variation. **Protoplast isolation and culture**: Protoplast isolation methods, protoplast purification. Protoplast culture– cell wall, cell division and callus formation in in-vitro cultured protoplast, factors influencing cell division in protoplast cultures, plant regeneration from protoplast cultures. Properties and importance of protoplast culture, genetic engineering or gene transfer in plant via protoplast. **Somatic hybridization and cybridization** : Introduction, protoplast fusion, methods of protoplast fusion, selection of hybrids and cybrids, assessment of hybridity genetic consequences of protoplast fusion. Molecular analysis of nuclear genes and organellar genes in the somatic hybrids/cybrids. Protoplasts as a tool in cell biology and biotechnology. Importance of protoplast fusion and somatic hybridization, limitations of somatic hybridization. Cybridization, methods of cybridization. **Genetic transformation:** Transformation of protoplast, transformation using agrobacterium mediate system, selection of transformed cells through selectable reporter and marker genes, detection of integration and expression of foreign DNA in plant cells, applications in plant improvement.	15 Hours
Unit-4	**Production of disease free plants**: Introduction, methods of virus elimination by meristem-tip culture, in vitro shoot-tip grafting, callus culture, virus indexing, maintenance of virus free stocks. Factors affecting virus eradication by meristem tip culture, effects of virus elimination. Eradication of pathogens other than viruses. **Clonal propagation (Micropropagation)**: Introduction, Stages of micropropagation, factors affecting in vitro stages of micropropagation. Multiplication through axillary and apical shoots, multiplication by adventitious shoots, factors influencing shoot multiplication and rooting. Micropropagation of orchids, banana, potato, and walnut. Hardening/acclimatization of plants transferred to soil. Applications and limitations of micropropagation. **Production of secondary metabolites:** Introduction, application of tissue culture for synthesis of useful compounds. Techniques of selecting cell lines for high yields of compounds of secondary metabolism. Mass cultivation of cells by bioreactors. Elicitor induced accumulation of products. **Germplasm conservation**: Mode of conservation, Methods of conservation, freeze preservation, methods of freeze conservation and factors affecting freezing, long and short term storage, cryopreservation.	15 Hrs

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	**20 Marks**
Formative Assessment as per guidelines.	

REFERENCES:

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Course Title: DSC PLANT TISSUE CULTURE

Course Code: A4BOT103P

Type of Course	Theory / Practical	Credits	Instructionhour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs**	**04 hrs.**	**10**	**40**	**50**

PRACTICALS :

1. Micropropagation by proliferation of axillary bud.
2. Haploid production through anther culture.
3. Haploid production through microspore culture.
4. Protoplast isolation and culture.
5. Embryogenesis in cultured cells/tissues.
6. Preparation of synthetic seeds.
7. Extraction and quantification of secondary metabolites from callus.
8. PCR technique
9. Co-cultivation of leaf discs with Agrobacterium and study of GUS.

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	05
Internal Assessment Test 2	05
Total	**10 Marks**
Formative Assessment as per guidelines.	

Course Title: DSC PLANT GENETIC AND GENOMIC RESOURCES

Course Code: A4BOT003CT

Type of Course	Theory / Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**03 hrs.**	**20**	**80**	**100**

COURSE OUTCOMES (COS)

1. Ability to understand the diverse mechanisms of gene regulation
2. Ability to understand the molecular basics of various biological processes
3. Can solve diverse biological problems and are capable of analyzing the obtained results
4. Study about the plant genetic resources, centres of diversity and breeding for resistance to biotic and abiotic stresses
5. Use the learned techniques, skills and modern biological tools suitable to the problem encountered
6. Understand the genome organization, mapping and various gene sequencing techniques
7. Understand the techniques in plant genomics and omics
8. Study about molecular markers, Quantitative Trait Loci (QTL) mapping and Marker Assisted Selection and molecular genetics
9. Learn information about collection, germplasm exchange, quarantine and maintenance
10. Use of plant genetic resources including genetically modified plants and learn about germplasm data base management using modern tools and software's

Unit	Title	60 hrs/ Semester
Unit-1	**Plant Genetics and Genetic Resources** : Basic genetic resources and transgenes. Introduction, principles and types of plant genetic resources (PGRs). Application of genomic tools for PGR utilization: Molecular markers, genetic maps, Genome sequencing, Genomic selection, Genome editing, Genome wide association studies (GWAS). PGR Informatics: Concept of database development, management and bioinformatics. Plant genome projects and application of bioinformatics tools in structural and functional genomics	15 Hours
Unit-2	**Plant Germplasm and Genetic Variability**: History and importance of germplasm exploration. Evaluation, utilization and documentation of germplasm. Concept of core and mini-core collections. Storage technologies and sources of germplasm for plant breeding. Short-term and long-term plant germplasm storage. Post-genomic tools for genetic enhancement of germplasm. Application of biotechnology for genetic enhancement of crop plants. Analytical tools in molecular plant breeding	15 Hours

Unit-3	**Contributions of PGRs for Food and Crop Improvement:** Sustainable crop development and PGRs. Genetic diversity, ecosystem services and PGRs. PGRs for food security, crop production, and crop yield. Use of local and indigenous PGRs. Climate change and PGRs. Nutrition, health and PGRs. Economic development, poverty and PGRs. Diversification and the use of crop genetic diversity	15 Hours
Unit-4	A**dvances in Plant Genomics, Functional Genomics and OMICs Technologies**: Concept of structural and functional genomics in plant systems. OMICs technologies in plant breeding: Genomics, transcriptomics, proteomics, metabolomics, phenomics, epigenomics, and nutriomics. Proteome technology: 2D-PAGE, MS/MS, MALDI-TOF, protein microarray	15 Hours

Formative Assessment for Theory	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	10
Internal Assessment Test 2	10
Total	**20 Marks**
Formative Assessment as per guidelines.	

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Course Title: DSC: PLANT GENETIC AND GENOMIC RESOURCES

Course Code: A4BOT103CP

Type of Course	Theory / Practical	Credits	Instructionhour per week	Total No. of Lectures/Hours / Semester	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**02**	**04**	**56 hrs**	**04 hrs.**	**10**	**40**	**50**

PRACTICALS:

1. Genetic exercise on probability
2. Estimation of gene frequencies
3. Problems on multiple factors inheritance
4. Estimation of average effect of gene substitution and breeding value
5. Chromosome analysis in major field crops
6. Study of computational tools to explore plant genome databases
7. Demonstration of genetic map construction using molecular markers
8. Detection of transgenes in the exposed plant material
9. Sampling techniques of plant materials, visiting ports/airports to study the plant and seed quarantine regulations
10. 3-5 days laboratory visit to national/international institutes/university, seed banks, plant genetic resource conservation centres, transgenic glasshouse and learning the relevant practical considerations

Formative Assessment for Practical	
Assessment Occasion/ type	**Marks**
Internal Assessment Test 1	05
Internal Assessment Test 2	05
Total	**10 Marks**
Formative Assessment as per guidelines.	