SHRI GURU RAM RAI UNIVERSITY

PATEL NAGAR, DEHRADUN-248001

[Estd. by Govt. of Uttarakhand, vide Shri Guru Ram Rai University Act no. 03 of 2017 & recognized by UGC u/s (2f) of UGC Act 1956]

MINUTES OF MEETING

SECOND BOARD OF STUDIES MEETING IN BOTANY

A meeting of all the members of the Board of Studies in Botany was held on 3rd July 2021 from 11:00 am onwards at School of Basic & Applied Sciences, Shri Guru Ram Rai University, Patelnagar, Dehradun. The following members were present:

1. Prof. (Dr.) Kumud Saklani, Dean, School of Basic & Applied Sciences, Shri Guru Ram Rai University, Dehradun (Chairperson)
2. Prof. (Dr.) Gulshan Kumar Dhingra, Dean, School of Sciences, Pt. LMS Govt. PG College Sri Dev Suman Uttarakhand University Campus, Rishikesh (External Expert)
3. Prof. (Dr.) Arun Kumar, Dean Research, Shri Guru Ram Rai University, Dehradun (Member)
4. Prof. (Dr.) Maneesha Singh, Dean, School of Agricultural Sciences, Shri Guru Ram Rai University, Dehradun (Member)
5. Dr. Saurabh Guleri, Assistant Professor and Head, Department of Botany, Shri Guru Ram Rai University, Dehradun (Member)
6. Dr. Kamla Dhyani Jakhmola, Assistant Professor, School of Agricultural Sciences, Shri Guru Ram Rai University, Dehradun (Member)

PROCEEDINGS AND RESOLUTIONS:

The members of the BOS discussed the agenda item wise and resolutions were made accordingly

Agenda No. 1: To confirm the minutes of First Board of Studies in Botany held on 21st Aug 2017.

Resolution: The board confirmed and approved the last Board of Studies meeting held on 21st Aug 2017.

Agenda No. 2: Inclusion and finalization of Program outcomes (POs), Program specific outcomes (PSOs), Course outcomes (COs) and Course objectives of B.Sc. (Botany in combinations such as CBZ/Biotech/Micro as per CBCS) and M.Sc. Botany (as per CBCS).

Resolution: It was recommended by the members of the board that course outcomes and objectives should be included in the curriculum. The Program outcomes (POs), P...

were discussed in detail with the honorable members and all the members resolved to approve the same with minor corrections/suggestions from the honorable external expert.

Agenda No. 3: To consider distribution of courses for all semesters in B.Sc. (Botany in combinations as in CBZ/Biotech/Micro as per CBCS) and M.Sc. Botany as per CBCS for the Academic Session 2021-22 and also consider revision of course contents with addition, deletion or modification in syllabi, if required

Resolution: The distribution of courses for all semesters in the UG program and PG program as per CBCS was discussed in detail with the honorable members and it was resolved to approve and implement the same for the academic session 2021-22 with the recommendation to revise the course contents of few courses in 3rd, 4th 5th and 6th semesters for UG programme and in 3rd and 4th semester for PG programme.

The suggestions/recommendations by the members of Board to change the course contents to accommodate and address regional/local aspiration were approved by all in following courses for B.Sc. and M.Sc. Botany syllabi.

S. No.	Program	Course Category	Course Code	Course Name
1	B.Sc.	Core	BBOC301 BBOC401 BBOL401	Plant Anatomy and Embryology Plant Physiology and Metabolism Lab Course
		Elective	BBOD501 BBOL501 BBOD601a BBOD602 BBOD604 BBOL601a/ 602/604	Economic Botany and Biotechnology Lab Course Bioinformatics Research Methodology Genetics and Plant Breeding Lab Course
		Skill	BBOS402	Plant Diversity and Human Welfare
2	M.Sc. (Botany)	Core	MBOC301 MBOC302 MBOL303 MBOC401 MBOC402 MBOL403	Plant Physiology and Biochemistry Ecology and Remote Sensing Lab Course-I Conservation Biology Biotechnology and Genetic Engineering of Plants and Microbes Lab Course-I
		Elective	MBOE304 MBOL308	Palynology and Pollination Biology Lab Course-II

Agenda No. 4: To consider and approve the list of core subjects and elective subjects for Pre-Ph.D. programme in Botany.

Resolution: The Board confirmed and approved the list of core subjects and elective subjects along with allotment of course codes for Pre-Ph.D. course work in Botany as per SGRRU norms and also approved the incorporation of Research & Publication Ethics course of 2 credits as per UGC guidelines and the second amendment May 2020 to Ph.D. ordinance of SGRR University.

Agenda No. 5: Introduction of New Courses in B.Sc. (Botany in combinations as in CBZ/Biotech/Micro as per CBCS) and M.Sc. Botany (as per CBCS) for Academic Session 2021-2022.

S. No.	Program	Course Category	Couse Code	Course Name
1	B.Sc.	Elective	BBOD503b BBOL503b	Natural Resource Management Lab Course Based on BBOD503b
			BBOD601b BBOL601b	Industrial and Environmental Microbiology Lab Course Based on BBOD601b
		Skill	BBOS507 BBOS607	Plant curios – fascinating plants Soft skill for employability enhancement
2	M.Sc.	Elective	MBOE305 MBOE307 MBOL308	Fresh water algal flora of Himalaya Environment Microbiology Lab Course-II
		Self-Study	MBOS310 MBOS311 MBOS408 MBOS409	Introduction to medicinal and aromatic plants Pathogens and pests of crop plants Analytical Techniques in Plant Sciences Nursery and Gardening
		Replaced/ Deleted	MBOE304 MBOE305 MBOE309 MBOE310 MBOS314 MBOE406 MBOS409	Recombinant DNA Technology Natural Resource Management in Himalaya Applied Plant Anatomy Ecosystem Analysis, GIS and Remote Sensing Diversity and Cultivation of Mushrooms Bioinformatics and Biological database Propagation Techniques

Agenda No. 6: To introduce value added course in Disaster Management for batch 2021 and onwards.

Resolution: Approved and confirmed by all the members. The subject code VCSBAS002 was assigned to the value added course on Disaster Management.

Agenda No. 7: Revision in the list of recommended books for various courses.

Resolution: The board recommended the following books to be included in the list of recommended books for various courses.

S.No.	Course code	Course name	Recommended book
1.	BBOC301	Plant Anatomy and Embryology	Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.
2.	BBOC401	Plant Physiology and Metabolism	V.K. Jain. (2017). Plant Physiology. S.Chand Publication, New Delhi
3.	BBOL401	Lab Course Based on BBOC401	Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.
4.	BBOS403	Plant Diversity and Human Welfare	Krishnamurthy, K.V. (2004). An Advanced Text Book of Biodiversity – Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi
5.	BBOD501	Economic Botany and Biotechnology	Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
6.	BBOL501	Lab Course Based on BBOD501	Kampasi, B.K. and Sharma, R. (2020). Practical Botany (Economic Botany & Biotechnology). Vinesh and Dinesh Co., Pvt. Ltd. New Delhi.

7.	BBOD601a	Bioinformatics	Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
8.	BBOD602	Research Methodology	N. Arumugam. (2015). Research Methodology for Life Science, Saras Publication, 748p.
9.	BBOD604	Genetics and Plant Breeding	Acquaah, G. (2007). Principles of Plant Genetics & Breeding. Blackwell Publishing.
10	BBOL601a/602/604	Lab Course	Shui Qing Ye. (2007). Bioinformatics (A Practical Approach).Chapman and Hall/CRC Press.
11.	MBOC301	Plant Physiology and Biochemistry	Salisbury, F.B. and Ross, C.W. 1992. Plant Physiology (4th edition). Wadsworth Publishing Co., California, USA.
12.	MBOC302	Ecology and Remote Sensing	Sharma, P.D. (2010). Ecology and Environment. Meerut, India: Rastogi Publications. 8th edition
13	MBOL303	Lab Course Based on MBOC301&302	Bajracharya, D. 1999. Experiments in Plant Physiology: A Laboratory Manual. Narosa Publishing House, New Delhi. Kapoor /Govil. 2000. Experimental Plant Ecology.
14	MBOE304	Palynology and Pollination Biology	Bhattacharya, K. and Majumdar, M.R. 2011. A text book of Palynology. p364. New Central Book Agengcy.
15	MBOC401	Conservation Biology	Dhar, U. 1993 (Ed.). Himalayan Biodiversity: Conservation Straegies, Gyanodaya Prakashan, Nainital. Singh, J.S., Singh, S.P. & Gupta, S.R. 2007. Ecology, Environment and Resource Conservation. Anamaya Publishers, New Delhi.
16	MBOC402	Biotechnology and Genetic Engineering of Plants and Microbes	Bhojwani, S.S. and Razdan, M.K. 1996. Plant Tissue Culture: Theory and Practice (a revised edition). Elsevier Science Publishers, New York, USA. Dubey, R.C. 2018. Biotechnology. S.Chand Publ. Co. Pvt. Ltd., New Delhi.

Agenda No. 8: Allotment and description of course code and credits to different courses in the UG and PG programmes for all semesters.

Resolution:

The course codes in the UG and PG programmes were allotted as per University norms and all the members resolved to approve the same. The credit system in the UG and PG programmes were approved as per UGC norms. The theory lectures were of 4 credits each. Each lab course was of 2 credits for UG course programme and 3 credits for PG course programme where the teaching hours of lab course of each credit was of 2 hours in both UG & PG programmes.

Agenda No. 9: Medium of instruction, question paper pattern, medium of examination, and duration of examination, allotment of marks in internal and external exams.

Resolution:

- The members were of the view and recommended that the medium of instruction would be English medium/Hindi medium for UG Course program as per SGRR University norms.
- It was resolved by all the members that the duration of the End term examination would be as per the guidelines issued by the Board of Examination SGRR University from time to time including the duration of Lab Course examinations.

- Each paper would be of 100 marks. The allotment of marks in Pre-PhD course work shall be according to PhD ordinance of SGRR University. The distribution of mid-term and end term examination marks will be as per guidelines issued by the Board of Examination SGRR University from time to time.

Agenda No. 10: Evaluation pattern and distribution of marks

Resolutions: All the members of BOS were of the view that the evaluation pattern and distribution of marks should be at par with other subjects and should follow university norms to bring uniformity.

The meeting ended with the vote of thanks.

Prof. (Dr.) Gulshan Kumar Dhingra
(External Expert)

Prof. (Dr.) Kumud Saklani
(Chairperson)

Prof. (Dr.) Arun Kumar
(Member)

Prof. (Dr.) Maneesha Singh
(Member)

Dr. Saurabh Guleri
(Member)

Dr. Kamla Dhyani Jakhmola
(Member)

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SYLLABUS

FOR

Bachelor of Science (Botany)

Under CBCS Pattern

School of Basic & Applied Sciences

(w.e.f. 2021-2022)

Shri Guru Ram Rai University, Patel Nagar, Dehradun, Uttarakhand-248001

Bachelor of Science (Botany) CBZ

Programme outcome (POs)

PO1. Bachelor of Science offers theoretical as well as practical knowledge about different subject areas.
PO2. Graduates will develop scientific temperament to solve scientific problems in emerging areas of science at National and International level.
PO3. Graduates will acquire coherent understanding of the academic field to pursue multi and interdisciplinary science careers in future.
PO4. Graduate will have clarity of thought and expression. Qualities like logical thinking and decision making will be enhanced
PO5. Graduates plan and execute experiments or investigations, analyze and interpret data information collected using appropriate methods
PO6. Graduates will be able to compete in various national and international competitive examinations.
PO7. Graduates will understand the principles of basic and applied sciences and apply them logically in environmental and socio-technological context with a systematic approach towards sustainable development.
PO8. Graduates will have critical thinking, follow innovations and developments in Science and technology
PO9. Graduates will acquire effective communication skills
PO10.Graduates will understand ethical principles and responsibilities for effective citizenship.
PO11. Graduates will develop new and enhancing conversational skills that lead to not only to good communication but also to the excellent drafting abilities linked with technical reports and presentations.
PO12. Graduates will competent enough for doing jobs in Govt. and private sectors of academia, research and industry.

Program Specific Outcome (PSOs) For B.Sc. Botany Programme

The students will be able to:

PSO 1: Understand the biodiversity of Microbes, Algae, Fungi and Archegoniate.
PSO 2: Understand the basics of Plant Ecology and Taxonomy, Genetics and Plant Breeding,
PSO 3: Know the concepts and applications of plant systematic and Embryology, Economic botany and Biotechnology.
PSO 4: Learn the key concepts of plant physiology and Metabolism and apply the knowledge of Medicinal botany, Nursery and Gardening, Floriculture and Industrial and Environmental Microbiology.

Eligibility for admission:

Any candidate who has passed the Plus Two of the Higher Secondary Board of Examinations in any state recognized as equivalent to the Plus Two of the Higher Secondary Board in

with PCB not less than 45%-marks in aggregate is eligible for admission, However, SC/ST, OBC and other eligible communities shall be given relaxation as per University rules.

Duration of the Programme: 3 Years (Six Semesters)

STUDY & EVALUATION SCHEME

Choice Based Credit System

Bachelor of Science (Botany)

First Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	BBOC101	Biodiversity (Microbes, Algae, Fungi and Archegoniate)	4	0	0	4	30	70	100
2	Core	AECC101	Environmental Sciences	4	0	0	4	30	70	100
Practical										
1	Core	BBOL101	Lab Course Based on BBOC101	0	0	4	2	30	70	100
			Total	8	0	4	10	90	210	300

L – Lecture, T – Tutorial, P – Practical, C – Credit

Second Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	BBOC201	Plant Ecology and Taxonomy	4	0	0	4	30	70	100
2	Core	AECC202	English Communication	4	0	0	4	30	70	100
Practical										
1	Core	BBOL201	Lab Course Based on BBOC201	0	0	4	2	30	70	100
			Total	8	0	4	10	90	210	300

L – Lecture, T – Tutorial, P – Practical, C – Credit

Third Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	BBOC301	Plant Anatomy and Embryology	4	0	0	4	30	70	100
2	Skill	BBOS302	Mushroom Culture Technology	4	0	0	4	30	70	100
Practical										
1	Core	BBOL301	Lab Course based on BBOC301	0	0	4	2	30	70	100
			Total	8	0	4	10	90	210	300

L – Lecture, T – Tutorial, P – Practical, C – Credit

Fourth Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Core	BBOC401	Plant Physiology and Metabolism	4	0	0	4	30	70	100
2	Skill (Any one)	BBOS402/403/ 404	Medicinal Botany/ Plant Diversity and Human Welfare/ Intellectual Property Right	4	0	0	4	30	70	100
Practical										
1	Core	BBOL401	Lab Course based on BBOC401	0	0	4	2	30	70	100
			Total	8		4	10	90	210	300

L – Lecture, T – Tutorial, P – Practical, C – Credit

Fifth Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Elective	BBOD 501/502/503a/503b (Any one)	Economic Botany and Biotechnology/ Cell and Molecular Biology/ Analytical Techniques in Plant Sciences/Natural Resource Management	4	0	0	4	30	70	100
2	Skill	BB0S 504/505/506/**507** (Any one)	Herbal Technology/ Nursery and Gardening/ Floriculture/ Plant curios – fascinating plants	4	0	0	4	30	70	100
Practical										
1	Elective	BBOL501/502/503a/503b	Lab Course based on BBOD 501/502/503a/503b (Any one)	0	0	4	2	30	70	100
			Total	8		4	10	90	210	300

L – Lecture, T – Tutorial, P – Practical, C – Credit

Sixth Semester

S. No.	Course Category	Couse Code	Course Name	Periods				Evaluation scheme		Subject Total
				L	T	P	C	Sessional (Internal)	External (ESE)	
Theory										
1	Elective	BBOD 601a/601b/602/603/604 (Any one)	Bioinformatics/ Industrial and Environmental Microbiology / Research Methodology/ Dissertation/ Genetics and Plant Breeding/	4	0	0	4	30	70	100
2	Skill	BB0S 605/606/607 (SEC may be	Ethnobotany/ Biofertilizers/ Soft skill for employability	4	0	0	4	30	70	100

		chosen by the student from one of the subjects opted in B.Sc. course programme)	enhancement							
Practical										
1	Elective	BBOL 601a/601b/602/ 603/604	Practical (Based on D601a/601b/ 602 /603/604)	0	0	4	2	30	70	100
			Total	8	0	4	10	90	210	300

L – Lecture, T – Tutorial, P – Practical, C – Credit

ExaminationScheme:

Components	**Ist internal (Assignment/ Project)**	**IInd Internal (Written/ Attendance)**	**Internal Total**	**External (ESE)**
Weightage(%)	**15 Marks**	**15 Marks**	**30 Marks**	**70 Marks**

B.Sc. Botany

Course code	**: BBOC101**				
Course Name	**: Biodiversity (Microbes, Algae, Fungi and archegoniate)**				
Semester /Year	**: I**				
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:The objectives of this course are

1.This paper is both informative and interesting and will enable students to learn about Biodiversity not only as a plant or nature lover, but also for higher academic pursuits, particularly in the field of Biological Sciences, Environment and Biodiversity Conservation.

2. Combination of Theoretical and Practical components will provide comprehensive information and insight into the fascinating world of Microbes and Plants.

Course Contents

Unit 1: Microbes **(No. of Hours: 10)**

Viruses – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

U nit 2: Algae (No. of Hours: **12)**

General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: *Nostoc*, *Chlamydomonas, Oedogonium*, *Vaucheria, Fucus, Polysiphonia*. Economic importance of algae.

U nit 3: Fungi (12 Lectures)

Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition , nutrition, reproduction and classification; True Fungi- General characteristics, ecology and significance, life cycle of *Rhizopus* (Zygomycota) *Penicillium, Alternaria* (Ascomycota), *Puccinia, Agaricus*(Basidiomycota); Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance

Unit 4: Introduction to Archegoniate (No. of Hours: **2)**

Unifying features of archegoniates, Transition to land habit, Alternation of generations.

Bryophytes (No. of Hours: **10)**

General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of *Marchantia* and *Funaria*. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of *Sphagnum*.

Unit 5:Pteridophytes (No. of Hours: **8)**

General characteristics, classification, Early land plants (*Cooksonia*and *Rhynia*). Classification (up to family), morphology, anatomy and reproduction of *Selaginella*, *Equisetum* and *Pteris*. (Developmental details not to be included). Heterospory and seed habit, stelar evolution. Ecological and economic importance of Pteridophytes.

Gymnosperms **(No. of Hours: 6)**

General characteristics, classification. Distribution of Gymnosperm in Himalayas Classification (up to family), morphology, anatomy and reproduction of *Cycas*and *Pinus*. (Developmental details not to be included). Ecological and economic importance Gymnosperm with special reference to NW

Himalayas.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Remember to define and select the morphological diversity among Bacteria, Viruses, Algae, Fungi, Bryophytes, Pteridophytes and Gymnosperms.
CO 2	Understand to describe, discuss and distinguish vegetative and reproductive parts of various life forms including bacteria, viruses, algae, fungi and archegoniate.
CO 3	Apply to explain and write the status of Algae, Fungi, Bryophyte, Pteridophyte and Gymnosperm as a group in plant kingdom.
CO 4	Analyze to differentiate, explain the life cycle of selected genera.
CO 5	Evaluate to summarize, justify and select the economic and ecological importance of these plant groups.
CO6	Create to develop, write or construct morphology, anatomy and reproduction of alagae, bryophytes, pteridophytes and gymnosperms.

Suggested Textbooks:

1. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi,India.
2. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P)Ltd Publishers, New Delhi,India.
3. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. CentralBook Depot, Allahabad.
4. Singh, Pandey and Jain. (2018). Biodiversity (Microbes, Algae fungi and archegoniate). S. Chand Publication New Delhi.

Reference Books:

1. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd.Delhi. 2ndedition.
2. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction,Pearson Benjamin Cummings, U.S.A. 10thedition.
3. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies,MacMillan Publishers Pvt. Ltd., Delhi.
4. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology,John Wiley and Sons (Asia), Singapore. 4thedition.
5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. TataMcGraw Hill, Delhi,India.

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	2	3	....	2	2	.....	...	1	2	1	....	3	3	3	....	2.
CO2	3	...	2	3	3	2	2	1	3	2	2	3	1	1.	2	2.
CO3	2	2	2	2	2	.....	3	2	2	3	1	2	1	1.	2	3.
CO4	1	3	2	2	2	.....	...	1	3	2	2	2	2	3	....	1.
CO5	2	3	2	....	2	.....	3	1	3	2	...	1	2	3.	.....	3
CO6	3	2	1	2	3	2	2	2	3	2	2	1	3	2	2	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: BBOL101**				
Course Name	**: Lab Course (Based on BBOC 101)**				
Semester /Year	**: I**				
		L	**T**	**P**	**C**
		0	**0**	**4**	**2**

L - Lecture T – Tutorial P – Practical C – Credit

Course Contents

Practical

1. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.

2. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of rootnodule.

3. Gram staining

4. Study of vegetative and reproductive structures of *Nostoc, Chlamydomonas*(electron micrographs), *Oedogonium, Vaucheria, Fucus* and Polysiphonia*through temporary preparations and permanent slides. (* *Fucus*- Specimen and permanentslides)

5. *Rhizopus and Penicillium*: Asexual stage from temporary mounts and sexual structures through permanentslides.

6. *Alternaria:* Specimens/photographs and teasemounts.

7. *Puccinia*: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on Wheat and permanent slides of both thehosts.

8. *Agaricus*:Specimensofbuttonstageandfullgrownmushroom;Sectioningofgillsof *Agaricus*.

9. Lichens: Study of growth forms of lichens (crustose, foliose andfruticose)

10. Mycorrhiza: ecto mycorrhiza and endo mycorrhiza(Photographs)

11. ***Marchantia***- morphology of thallus, w.m. rhizoids and scales, V.S. thallus through gemma cup, w.m. gemmae (all temporary slides), V.S. antheridiophore, archegoniophore, l.s. sporophyte (all permanentslides).

12. ***Funaria***- morphology, W.M leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, T.S. capsule and protonema.

13. ***Selaginella***- morphology, W.M. leaf with ligule, T.S. stem, W.M. strobilus, W.M. microsporophyll and megasporophyll (temporary slides), l.s. strobilus (permanentslide).

14. ***Equisetum***-morphology,T.S.internode,T.S.strobilus,T.S.strobilus,W.M.sporangiophore, w.m. spores (wet and dry) (temporary slides); t.s rhizome (permanent slide).

15. ***Pteris***- morphology, T.S. rachis, V.S. sporophyll, W.M. sporangium, W.M. spores (temporary slides), T.S. rhizome, w.m. prothallus with sex organs and young sporophyte (permanentslide).

16. ***Cycas***-morphology(coralloidroots,bulbil,leaf),t.s.coralloidroot,t.s.rachis,v.s.leaflet, v.s. microsporophyll, w.m. spores (temporary slides), l.s. ovule, t.s. root (permanent slide).

17. ***Pinus***- morphology (long and dwarf shoots, w.m. dwarf shoot, male and female), w.m. dwarf shoot, t.s. needle, t.s. stem, ,l.s./t.s. male cone, w.m. microsporophyll, w.m. microspores (temporary slides), l.s. female cone, t.l.s. &r.l.s. stem (permanentslide).

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Remember the instruments, techniques, lab etiquettes and good lab practices for working in a microbiology laboratory.
CO 2	Understand to Develop skills for identifying microbes and using them for Industrial, Agriculture and Environment purposes. Learn to identify algae, lichens and plant pathogens along with their symbiotic and parasitic associations
CO 3	Apply a knowledge base in understanding diversity, economic values & taxonomy of bryophytes
CO4	Analyze morphology, anatomy, reproduction and developmental changes therein through typological study and
CO5	Evaluate by observation and table study of representative members of phylogenetically important groups to learn the process of evolution in a broad sense.
CO6	learn to create their small digital reports where they can capture the zoomed in and zoomed out pictures as well as videos in case they are able to find some rare structure or phenomenon related to Bryophytes

Suggested Textbooks:

1. B.P. Pandey. (2017). Practical Manual Vol 1. S. Chand Publ. New Delhi
2. O.P. Sharma. (2016). A text book of Practical Botany. Rastogi Publ.

Reference Book

1. Gupta, Bajpai and Singh. (2020). Integrated Biodiversity Manual Pragati Prakashan, Meerut.

Course code	**: BBOC201**				
Course Name	**: Plant Ecology and Taxonomy**				
Semester /Year	**: II**				
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1.To make students understanding about ecology and basic ecological concepts, inter-relation between the living world and environment.

2. To make them aware about identification, nomenclature and classification.

Course Contents

Unit 1:

Introduction **(No. of Hours: 2)**

Ecological factors (10 Lectures)

Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford law of tolerance. Adaptation of hydrophytes and xerophytes.

Plant communities **(No. of Hours: 5)**

Characters; Ecotone and edge effect; Succession; Processes and types.

Unit 2:Ecosystem **(No. of Hours: 7)**

Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Bio-geochemical cycling; Cycling of carbon, nitrogen and Phosphorous

Phytogeography **(No. of Hours: 3)**

Principle biogeographical zones India and North West Himalayas; Endemism

U nit 3:Introduction to plant taxonomy **(No. of Hours: 2)**

Identification, Classification, Nomenclature.

Taxonomic hierarchy **(No. of Hours: 1)**

Ranks, categories and taxonomic groups

Identification **(No. of Hours: 4)**

Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access

Taxonomic evidences from palynology, cytology, phytochemistry and molecular data. **(No. of Hours; 5)**

Unit 4: Botanical nomenclature **(No. of Hours: 4)**

Principles and rules (ICN); ranks and names; binominal system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.

Classification **(No. of Hours: 4)**

Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series).

Biometrics, numerical taxonomy and cladistics **(No. of Hours: 3)**

Characters; variations; OTUs, character weighting and coding; cluster analysis; phenograms, cladograms (definitions and differences).

Unit 5: Taxonomy, important distinguishing characters, classification, and economic importance of the following families: **(No. of Hours: 10)**

Ranunculaceae, Papaveraceae, Caryophyllaceae, Malvaceae, Rutaceae, Fabaceae, Apiaceae, Solanaceae, Apocyanaceae, Asclepidiaceae, Acanthaceae, Lamiaceae, Euphorbiaceae, Orchidaceae, Poaceae.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Remember to define various component of environment and ecosystem and taxonomic terminology
CO 2	Understand to describe, discuss, distinguish and identify plants which belong to dicot and monocot families
CO 3	Apply to explain the basic principles of classification of angiosperm plants.
CO 4	Analyze to differentiate and explain structure and functions of ecosystem, food chain and food web.
CO5	Evaluate to summarize, justify and select plant community and succession.
CO6	Create to develop, write or construct Biogeochemical cycling in nature

Suggested Textbooks:

1. Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8thedition.
2. V. Singh. (2016). Taxonomy of Angiosperm. S. Chand Publ., New Delhi

Reference Books:

1. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4thedition.
2. Simpson, M.G. (2006). *Plant Systematics.* Elsevier Academic Press, San Diego, CA,U.S.A.
3. Singh, G. (2012). *Plant Systematics:* Theory and Practice. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	1	2	....	....	1.	.....	...	1	3	2	...	2.	1	2	1	3
CO2	...	1	....	....	2	....	2	...	2	....	2	3	2	3	2	2
CO3	...	1	....	....	2	.....	2	....	2	1.	2	3.	2	2	3	1
CO4	...	3	....	2	1	.....	...	...	2	3	2	2	3	3	2	2
CO5	2	2	.....	2	3	2	....	2	3	3	1	2	3	2	3	2
CO6	2	3	....	2	2	2	2	3	1	3	2	2	2	1	1	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: BBOL201**				
Course Name	**: Lab Course (Based on BBOC 201)**				
Semester /Year	**: II**				
		L	**T**	**P**	**C**
		0	**0**	**4**	**2**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:The objectives of this course are

To develop scientific temperament among students through practical approaches and to enhance their knowledge through field trips.

Course Contents

Practical

1. Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and luxmeter.
2. Determination of pH, and analysis of two soil samples for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency by rapid field test.
3. Comparison of bulk density, porosity and rate of infiltration of water in soil of three habitats.
4. (a) Study of morphological adaptations of hydrophytes and xerophytes (foureach).
(b)Study of biotic interactions of the following: Stem parasite (*Cuscuta)*, Root parasite (Orobanche), Epiphytes, Predation (Insectivorousplants)
5. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to belisted)
6. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distributionlaw
7. Study of vegetative and floral characters of locally available families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham &Hooker'ssystemofclassification):Brassicaceae-*Brassica,Alyssum/Iberis;*Asteraceae -*Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax;* Solanaceae -*Solanumnigrum, Withania;* Lamiaceae -*Salvia, Ocimum*; Liliaceae - *Asphodelus / Lilium /Allium.*
8. Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the recordbook).
9. Taxonomic treatment of plant species belonging to families mentioned in thesyllabus.
10. Study of taxonomic terminology.
11. Field visit/Botanical excursion to know the vegetation wealth of Uttarakhand and collection of plants to make herbarium for future conservation

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Remember the knowledge of instruments used to measure microclimatic variables
CO 2	Understand vegetative and floral characters of locally available families
CO 3	Apply practical knowledge implemented in the biodiversity assessment and conservation.
CO4	Analysis of two soil samples for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency by rapid field test
CO5	Evaluate morphological adaptations of hydrophytes and xerophytes
CO6	Create a knowledge base in understanding the basis of plant diversity, economic values & taxonomy of plants.

Suggested Textbooks:

1. Bendre, A. 2017. Practical Botany Vol II. Rastogi Publication, Meerut
2. Bendre and Kumar. 2018. A text book of Practical Botany. Rastogi Publ.

Reference Book

1. Kampasi and Sumbria (2015). Practical Botany (Plant Ecology and Taxonomy). Dinesh, S. and Vishesh, S. Co., Pvt Ltd. HPU Shimla

Course code	**: BBOC301**				
Course Name	**: Plant Anatomy and Embryology**				
Semester /Year	**: III**				
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:The objectives of this course are

1. To identify different types of tissues and make them able to correlate their physiology in a better way.
2. To understand the anatomical features of monocot and dicot roots, stems and leaves, importance of cambium in secondary growth and wood development, how different plant tissue evolve and modify their structure and functions with respect to their environment.
3. To them understand how reproduction play significant role in defining population structure, natural diversity and sustainability of ecosystem in a better way.

Course Contents

Unit 1: Meristematic and permanent tissues **(No. of Hours: 8)**

Root and shoot apical meristems; Simple and complex tissues.

Unit 2: Organs **(No. of Hours: 8)**

Structure of dicot and monocot root stem and leaf.

Normal and Anomalous growth **(No. of Hours: 8)**

Vascular cambium structure and function, Normal behavior of cambium, abnormal behavior of cambium (*Bougainvillea stem, Nyctanthes stem, Dracena stem, Ficus root, Orchid root, Tinospora stem*), Activity of cork cambium. Wood (heartwood and sapwood).

Unit 3: Adaptive and protective systems **(No. of Hours: 8)**

Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.

Unit 4: Structural organization of flower **(No. of Hours: 8)**

Structure of anther and pollen; Structure and types of ovules; Types of embryo sacs, organization and ultrastructure of mature embryo sac.

Pollination and fertilization **(No. of Hours: 8)**

Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.

Unit 5: Embryo and endosperm **(No. of Hours: 8)**

Endosperm types, structure and functions; Dicot and monocot embryo; Embryo-endosperm relationship.

Apomixis polyembryony and parthenocarpy (No. of Hours: 8)

Definition, types and practical applications.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Remember to define and Understand the habit of the angiosperm plant body, the vegetative characteristics of the plant, various tissue systems; the normal and anomalous secondary growth in plants and their causes.
CO2	Understand to describe, discus and distinguish the Endosperm types, structure and functions; Dicot and monocot embryo; Embryo-endosperm relationship.
CO 3	Apply to explain and write about Vascular cambium – structure and function, seasonal activity. Secondary growth, Epidermis, cuticle, stomata;.
CO 4	Analyze to explain general account of adaptations in xerophytes and hydrophytes and differentiate Wood (heartwood and sapwood).
CO 5	Evaluate to summarize and justify about Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.
CO 6	Create to develop, construct or write about the apomixis and polyembryony with their practical applications.

Suggested Textbooks:

1. Bhojwani, S.S. &Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.
2. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

Reference Books:

3. Singh,V, Pande,P.C, Jain,D.K, Anatomy and embryology of Angiosperm, Rastogi Publication.

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	…	2	….	2	1	1	…	2	3	2	1	2	3	2	…	…..
CO2	2	…	1	….	3	2	2	…	3	2	1	2	3	….	3	3
CO3	1	…	….	2	3	…..	2	2.	2	3	2	2	3	….	3	2
CO4	…	3	1	3	2	2	…	…	2	3	2	2	2	3	2	…..
CO5	3	2	2	3	2	2	2	3	2	2	1	2	2	…	2	3
CO6	3	2	3	2	2	2	2	3	2	2	1	2	2	1	2	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: BBOL301**				
Course Name	**: Lab Course (Based on BBOC 301)**				
Semester /Year	**: III**				
		L	**T**	**P**	**C**
		0	**0**	**4**	**2**

L - Lecture T – Tutorial P – Practical C – Credit

Course Contents

Practical

1. Study of meristems through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
3. Stem: Monocot: *Zea mays;* Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
4. Root: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
5. Leaf: Dicot and Monocot leaf (only Permanent slides).
6. Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem).
7. Structure of anther (young and mature), (Permanent slides).
8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/ campylotropous.
9. Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/photographs).
10. Ultrastructure of mature egg apparatus cells through electron micrographs.
11. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).
12. Dissection of embryo/endosperm from developing seeds.
13. Calculation of percentage of germinated pollen in a given medium.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Remember tissue structure leaf morphology.
CO 2	Understand cell structure, secondary growth and adaptive anatomy in plants.
CO 3	Apply to explain the pollination and seed dispersal mechanism
CO 4	Analyze to differentiate cell structure in dicot and monocot
CO 5	Evaluate to summarize or justify adaptive anatomy of Xerophyte, Hydrophyte
CO 6	Create or develop or write structure of ovules and female gametophytes

Suggested Textbooks:

1. Sundra S. Rajan. (2003). Practical Manual of Plant Anatomy and Embryoogy, AnmolPbul. Pvt Ltd.

Reference Book

1. Bendre and Kumar. (2010) A text book of Practical Botany-II, Rastogi Publ. Meerut

Course code	**: BBOS302**				
Course Name	**: Mushroom Culture Technology**				
Semester /Year	**: III**				
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:The objectives of this course is

1. Learn the techniques and small scale and large scale industries can be established by the students.
2. Hand on experience will be given to students so they can utilize this training in long run. In small area also they can establish the business

Course Contents

Unit 1: **(No. of Hours: 5)**

Introduction, history. Nutritional and medicinal value of edible mushrooms; Poisonous mushrooms. Types of edible mushrooms available in India – *Volvariella volvacea, Pleurotus citrinopileatus, Agaricus bisporus*.

Unit 2: (No. of Hours: **5)**

Cultivation Technology : Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag.

Unit 3: **(No of Hours: 7)**

Pure culture: Medium, sterilization, preparation of spawn, multiplication. Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation - Low cost technology, composting technology in mushroom production.

Unit 4: **(No. of Hours: 8)**

Storage and nutrition: Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickels, papads), drying, storage in salt solutions. Nutrition - Proteins - amino acids, mineral elements nutrition - Carbohydrates, Crude fibre content - Vitamins.

Unit 4: **(No.of Hours: 5)**

Food Preparation_: Types of foods prepared from mushroom. Research Centres - National level and Regional level.Cost benefit ratio - Marketing in India and abroad, Export Value.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Remember the history and scope of mushroom cultivation
CO 2	Describe the steps and requirements of mushroom culture technology
CO 3	Explain about the various methods which can be used for the storage of mushrooms
CO 4	Analyze about the cost benefit ratio, marketing in India and abroad and export value of Mushroom
CO 5	Evaluate and measure about processing of edible mushrooms.
CO 6	Explain the types of foods prepared from edible mushrooms

Suggested Books

1. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications,Delhi.

2. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol.II.

Reference Books

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University,Coimbatore.
2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore -560018.

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	…	2	….	2	1	1	…	2	3	2	1	2	3	2	…	…..
CO2	2	…	1	….	3	2	2	…	3	2	1	2	3	….	3	3
CO3	1	…	….	2	3	…..	2	2.	2	3	2	2	3	….	3	2
CO4	…	3	1	3	2	2	…	…	2	3	2	2	2	3	2	…..
CO5	3	2	2	3	2	2	2	3	2	2	1	2	2	…	2	3
CO6	3	2	3	2	2	2	2	3	2	2	1	2	2	1	2	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: BBOC401**				
Course Name	**: Plant Physiology and Metabolism**				
Semester /Year	**: III**				
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:The objectives of this course are

1. Able to correlate morphology, anatomy, cell structure and biochemistry with plant functioning.
2. Create link between theory and practical syllabus is established, and the employability of youth would be enhanced.

Course Contents

Unit 1: Plant-water relations **(No. of Hours: 8)**

Importance of water, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

U nit 2: Mineral nutrition **(No. of Hours: 8)**

Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.

Unit 3: Photosynthesis **(No. of Hours: 12)**

Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C3, C4 and CAM pathways of carbon fixation; Photorespiration.

Unit 4: Respiration **(No. of Hours: 6)**

Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway.

Unit 5: Enzymes **(No. of Hours: 4)**

Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition.

Nitrogen metabolism **(No. of Hours: 4)**

Biological nitrogen fixation; Nitrate and ammonia assimilation.

Plant growth regulators **(No. of Hours: 6)**

Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.

Plant response to light and temperature **(No. of Hours: 6)**

Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure),Vernalization.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Define basic concepts of physiology and metabolism
CO 2	Understand the plants and plant cells in relation to water, nutrition, photosynthetic pathways and respiration
CO 3	Explain about the movement of sap and absorption of water in plant body
CO4	Analyze the plant, growth, flowering, movement, light response, dormancy and germination.
CO5	Summarize the process of photosynthesis in higher plants with particular emphasis on light and dark reactions, C3 and C4 pathways, respiration in higher plants with particular emphasis on aerobic and anaerobic respiration, ATP synthesis and nitrogen metabolism.
CO 6	Develop or write the role of phytohormone in plant growth and Nitrogen assimilation.

Suggested Textbooks:

1. V.K. Jain. (2017). Plant Physiology. S.Chand Publication, New Delhi
2. H.S. Srivastava. (2018). Plant Physiology and Biochemistry. Rastogi Publ., Meerut.

Reference Books:

1. Taiz, L., Zeiger, E., (2010). Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition.
2. Hopkins,W.G.,Huner,N.P.,(2009).IntroductiontoPlantPhysiology.JohnWiley&Sons, U.S.A. 4th Edition.

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	2	3	....	3	2	.....	...	2	3	2	...	.....	3	.....	3	2
CO2	2	...	2	2	3	2	1	2	3	....	3	3	2	2	2	3.
CO3	3	2	2	3	2	.....	2	3	3	....	3	2	2	....	2	2
CO4	...	3	2	2	3	.....	...	2	2	3	2	.....	3	2	1	3
CO5	2	2	2	....	2	.....	3	2	2	...	2	3	2	2	2	2.
CO6	3	2	....	3	2	2	2	3	2	1	2	3	2	3	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: BBOL401**				
Course Name	**: Lab Course (Based on BBOC 401)**				
Semester /Year	**: III**				
	L	**T**	**P**	**C**	
	0	**0**	**4**	**2**	

L - Lecture T – Tutorial P – Practical C – Credit

Course Contents

Practical

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. To study the effect of two environmental factors (light and wind) on transpiration by excised twig.
3. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
4. Demonstrate the activity of catalase and study the effect of pH and enzyme concentration.
5. To study the effect of light intensity and bicarbonate concentration on O2 evolution in photosynthesis.
6. Comparison of the rate of respiration in any two parts of a plant.
7. Separation of amino acids and chloroplast pigment by paper chromatography.

Demonstration experiments

1. Suction due to transpiration.
2. R.Q.
3. Respiration in roots.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Gain knowledge of determination of osmotic potential of plant cell sap
CO 2	Understand effect of environmental factors on transpiration.
CO 3	Apply the formula to calculate the stomatal index and frequency of plant leaf
CO 4	Analyze the separation of aminoacids by chromatography
CO 5	Evaluate the rate of respiration by Respirometer
CO 6	Develop to demonstrate suction due to transpiration

Suggested Textbooks:

1. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.

Reference Book:

1. Swami. (2012). Practical Botany Vol III. PragatiPrakashan, Meerut

Course code	**: BBOS402**				
Course Name	**: Medicinal Botany**				
Semester /Year	**: IV**				
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives:The objectives of this course are

1. To introduce students to complementary and alternative medicine and provide them an opportunity to explore uses of plants as medicine ranging from traditional indigenous approach for treating ailments to modern pharmaceuticals and to inculcate awareness about the rich diversity of medicinal plants in India.
2. Transforming the knowledge into skills for promotion of traditional medicine.

Course Contents

Unit 1: **(No. of Hours: 02)**

History, Scope and Importance of Medicinal Plants. Indigenous Medicinal Sciences;

Unit 2: **(No. of Hours: 08)**

Definition and Scope-Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in ayurvedic treatments, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept.

Unit 3: **(No. of Hours: 05)**

Conservation of endangered and endemic medicinal plants of India. Definition: endemic and endangered medicinal plants, Red list criteria; In situ conservation: Biosphere reserves, sacred groves, National Parks of India; Ex situ conservation: Botanic Gardens, Ethnomedicinal plant Gardens.

Unit 4: **(No. of Hours: 05)**

Propagation of Medicinal Plants: Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding.

Unit 5: **(No. of Hours: 10)**

Ethnobotany and Folk medicines. Definition; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: National interacts, Folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Define various types of medicines with their functions.
CO 2	Identify the medicinal plants with their applications.
CO 3	Explain the botanical name, family and plant parts used for human welfare.
CO 4	Analyze the process of propagation of medicinal plants.
CO 5	Evaluate the applications of natural products to certain diseases.
CO 6	Create green house for nursery preparation of medicinal plants

Suggested Books

1. Trivedi P C, 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India.

2. Purohit and Vyas, 2008. Medicinal Plant Cultivation: A Scientific Approach, 2nd edn. Agrobios,India.

Reference Books

1. John K. Crellin and Jane Philpott. (1990). A Reference Guide to Medicinal Plants: Herbal Medicine Past and Present. Published by Duke University Press
2. Anamika Singh and Mani Singh. (2022). Concepts of Medicinal Plants. IK International Publishing House Pvt. Ltd.

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	3	…	2.	2	2	2	…	1	3	2	…	…..	3	2	3	2
CO2	1	3	2	2	1	2	2	2	3	2	3	3	2	2	2	3.
CO3	3	2	2	3	2	2	3	2	3	1	3	2	2	2.	2	2
CO4	2	1	2	2	2	…	1	3	2	3	2	…..	3	2	1	3
CO5	1	3	2	1	1	3	2	3	2	1	2	3	2	2	2	2.
CO6	3	3	2	3	1	2	2	2	…	3	2	3	2	3	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: BBOS403**				
Course Name	**: Plant Diversity and Human Welfare**				
Semester /Year	**: IV**				
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. The students would be able to understand the value of biodiversity and its role in stabilizing the climate and economy.
2. They would know the causes and consequences of loss of biodiversity and planning of conservation strategies.

Course contents

Unit 1: **(No. of Hours: 6)**

Plant diversity and its scope- Genetic diversity, Species diversity, Plant diversity at the ecosystem level, Agrobiodiversity and cultivated plant taxa, wild taxa. Values and uses of Biodiversity: Ethical and aesthetic values, Precautionary principle, Methodologies for valuation, Uses of plants, Uses of microbes.

Unit 2: **(No. of Hours: 6)**

Loss of Biodiversity: Loss of genetic diversity, Loss of species diversity, Loss of ecosystem diversity, Loss of agrobiodiversity, Projected scenario for biodiversity loss,

Management of Plant Biodiversity: Organizations associated with biodiversity management-Methodology for execution-IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity legislation and conservations.

Unit 3: **(No. of Hours: 6)**

Conservation of Biodiversity: Principles and strategies of conservation; *In situ* and *ex situ* conservation, Social approaches to conservation, Biodiversity awareness programmes..

Unit 4: **(No. of Hours: 6)**

Role of plants in relation to Human Welfare; (a)

Cereals- Wheat, Rice, Maize; Pulses- A general account; Fruits- A general account with special reference to Uttarakhand Himalaya; Alcoholic beverages.

Unit 5: **(No. of Hours: 6)**

Role of plants in relation to Human Welfare; (b)

Importance of forestry its utilization and commercial aspects, Wood: Timber yielding plants of Uttarakhand Ornamental plants of India.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Remember to define or select the role of diversity of plants and microbes and their uses.
CO 2	Understand causes of loss of biodiversity and its management.
CO 3	Explain and apply process of conservation of biodiversity.
CO 4	Analyze or explain the functions of government acts and bodies for the conservation
CO 5	Evaluate or summarize role of plants in relation to Human Welfare and commercial importance: forestry and forest products, avenue trees, ornamental plants, alcoholic beverages, Fruits and nuts.
CO 6	Develop or write the various approaches of conservation of biodiversity

Suggested Textbooks

1. Krishnamurthy, K.V. (2004). An Advanced Text Book of Biodiversity – Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi

Reference Book:

1. V.S. Ramachandran. (2013). Plant Diversity and Conservation, Raj Publication

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	3	2	....	....	2.	.....	...	1	3	2	...	2.	1	2	1	3
CO2	3	1	....	....	2	....	2	...	2	....	2	3	2	3	2	2
CO3	1	1	....	....	2	.....	2	....	2	1.	2	3.	2	2	3	1
CO4	2	3	....	2	1	.....	...	...	2	3	2	2	3	3	2	2
CO5	2	2	.....	2	3	2	....	2	3	3	1	2	3	2	3	2
CO6	2	3	....	2	2	2	2	3	1	3	2	2	2	1	1	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: BBOS404**				
Course Name	**: Intellectual Property Rights**				
Semester /Year	**: IV**				
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course is

1. To have knowledge of roles regulations, laws and processes of patents, copyright trademarks and concepts of traditional knowledge and protection of plant varieties.

Course contents

Unit 1: **(No. of Hours: 05)**

Introduction to Intellectual Property:

Historical Perspective, Different Types of IP, Importance of protecting IP.

Copyrights

Introduction, How to obtain, Differences from Patents.

Unit 2: **(No. of Hours: 03)**

Trade Marks

Introduction, how to obtain, Different types of marks – Collective marks, certification marks, service marks, Trade names, etc. Differences from Designs.

Unit 3: **(No. of Hours: 04)**

Patents

Historical Perspective, Basic and associated right, WIPO, PCT system, Traditional Knowledge, Patents and Healthcare – balancing promoting innovation with public health, Software patents and their importance for India.

Unit 4: **(No. of Hours: 05)**

Geographical Indications

Definition, rules for registration, prevention of illegal exploitation, importance to India.

Trade Secrets

Introduction and Historical Perspectives, Scope of Protection, Risks involved and legal aspects of Trade SecretProtection.

Unit 5: **(No. of Hours: 13)**

Different International agreements

(a) Word Trade Organization(WTO):

(i) General Agreement on Tariffs & Trade (GATT),Trade Related Intellectual Property Rights (TRIPS)agreement

(ii) General Agreement on Trade related Services(GATS)

(iii) Madrid Protocol

(iv) Berne Convention

(v) Budapest Treaty

(b) Paris Convention

WIPO and **TRIPS, IPR** and Plant Breeders Rights, IPR and Biodiversity

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Define introductory aspects of Intellectual property rights.
CO 2	Describe the objectives and rights of patents.
CO 3	Explain the copyright law and transfer of copyright.
CO 4	Analyze and learn about the trademarks.
CO 5	Predict about the geographical indications.
CO 6	Write or manage the protection of traditional knowledge.

Suggested Textbooks:

1. N.K. Acharya: *Textbook on intellectual property rights*, Asia Law House (2001).
2. Manjula Guru &*M.B.* Rao, *Understanding Trips: Managing Knowledge in Developing Countries*, Sage Publications (2003).
3. P. Ganguli, Intellectual Property Rights: *Unleashing the Knowledge Economy,* Tata McGraw- Hill (2001).

Reference Books:

1. Arthur Raphael Miller, MichealH.Davis; *Intellectual Property: Patents, Trademarks and Copyright in a Nutshell,* West Group Publishers (2000).
2. JayashreeWatal, *Intellectual property rights in the WTO and developing countries,* Oxford University Press, Oxford.

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	2	…	2	3	…	2	1	2	3	3	1	2	2	1	2	…
CO2	2	…	1	2	…	1	2	2	3	….	3	3	2	2	3	2
CO3	2	…	1	3	…	2	1	2	3	….	3	2	1	2	2	3
CO4	3	…	2	1	…	2	1	2	2	3	2	1	3	2	2	3
CO5	2	…	3	1	….	3	2	2	2	…	2	3	2	3	2	2
CO6	2	….	3	2	…	2	2	2	2	2	3	3	2	3	2	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: BBOD501**				
Course Name	**: Economic Botany and Biotechnology**				
Semester /Year	**: V**				
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course-

1. To gain the knowledge on the economically important of plants, their life cycle, processing and plant part used.
2. Application of biotechnology for the production of plant resources and production of new varieties.
3. Understanding of morphology, and processing and economic value of plant sources of cereals, legumes, spices, oil, rubber, timber and medicines

Course contents

Unit 1: **(No. of Hours: 4)**

Origin of Cultivated Plants

Concept of centres of origin, their importance with reference to Vavilov's work; Harlen Work

Unit 2: **(No. of Hours: 10)**

Cereals

Wheat, Rice, Maize -Origin, morphology, uses

Legumes

General account with special reference to Gram and soybean

Fodder and Forage crops

U nit 3: **(No. of Hours: 10)**

Spices

General account with special reference to clove and black pepper (Botanical name, family, part used, morphology and uses)

U nit 4: **(No. of Hours: 08)**

Oils and Fats

General description with special reference to groundnut, soybean

Fibre Yielding Plants

General description with special reference to Cotton, Coir, Jute, Hemp (Botanical name, family, part used, morphology and uses)

Medicinal Plants: General account of some locally available medicinal plants (Botanical name, family, part used, morphology and uses)

Unit 5: **(No. of Hours: 16)**

Introduction to biotechnology

Plant tissue culture

Micropropagation; haploid production through androgenesis and gynogenesis; brief account of embryo & endosperm culture with their applications; Recombinant DNA Techniques

Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting;

Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR. Hybridoma and monoclonal antibodies, ELISA

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO 1	Remember the role of plants and biotechnology in human welfare. Students will able to gain the knowledge of Origin of Cultivated Plants, Cereals, Legumes, Spices, Oils and Fats, Fiber Yielding Plants, Medicinal Plants, Plant tissue culture, Recombinant DNA Techniques.
CO 2	Understand the economic uses of various plants.
CO 3	Develop the Knowledge of plant products and its utility and techniques of biotechnology.
CO4	Analyze the economically useful plants & techniques of biotechnology.
CO5	Evaluate the basic concept of biotechnology and its application with reference to plants.
CO6	Develop the knowledge of plant part use as in medical form, beverage form, Fodder and Forage from etc.

Suggested Textbooks:

1. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. TheNetherlands.
2. Singh, Pandey and Jain. (2007). Economic Botany. Rastogi Publication, Meerut.
3. R.C. Dubey. (2014). A Textbook of Biotechnology, S. Chand Publ., New Delhi

Reference Book:

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd.,New Delhi. 4th edition.

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	3	2	....	....	2.	.....	...	1	3	2	...	2.	1	2	1	3
CO2	3	1	....	....	2	....	2	...	2	....	2	3	2	3	2	2
CO3	1	1	....	....	2	.....	2	....	2	1.	2	3.	2	2	3	1
CO4	2	3	....	2	1	.....	...	...	2	3	2	2	3	3	2	2
CO5	2	2	.....	2	3	2	....	2	3	3	1	2	3	2	3	2
CO6	2	3	....	2	2	2	2	3	1	3	2	2	2	1	1	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: BBOL501**				
Course Name	**: Lab Course (Based on BBOD501)**				
Semester /Year	**: V**				
		L	**T**	**P**	**C**
		0	**0**	**4**	**2**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives :The objectives of this course are

1. Gain knowledge of economically important plants *viz.*, wheat, rice, clove, gram, soyabean, cotton, black pepper, tea and to conserve their Germplasm
2. To learn and familiarize with basic techniques in Plant Tissue Culture.

Course contents

Practical

1. Study of economically important plants : Wheat, Gram, Soybean, Black pepper, Clove, Cotton, Coir, Jute, Hemp, Groundnut, Soybean through specimens, sections and micro chemical tests and their germplasm storage
2. Familiarization with basic equipments in tissue culture.
3. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation.
4. Study of molecular techniques: PCR, Blotting techniques, AGE andPAGE.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Recognize& remember the economic important plant parts and molecular techniques used in biotechnology.
CO 2	Discuss the specimens of economic important plants.
CO 3	Practice the section cuttings.
CO4	Analyze the knowledge of Familiarization with basic equipments in tissue culture.
CO5	Test the biomolecules by micro-chemical tests.
CO6	Assemble the knowledge of Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation.

Suggested Books

1. Kampasi, B.K. and Sharma, R. (2020). Practical Botany (Economic Botany & Biotechnology). Vinesh and Dinesh Co., Pvt. Ltd. New Delhi.
2. A. Bendre. (2019). Practical Botany. Vol II. Rastogi Publ. Meerut.

Reference Book

1. B.P. Pandey. (2017). Economic Botany; S. Chand Publ. New Delhi
2. Gupta, P.K. (2017). Plant Biotechnology, Rastogi Publication, Meerut

Course code	**: BBOD502**				
Course Name	**: Cell and Molecular Biology**				
Semester /Year	**: V**				
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives :The objectives of this course are

1. Cell biology study will help the students to gain knowledge on the activities in which the giant molecules and miniscule structures that inhabit the cellular world of life are engaged. This will provide inside into the organization of cell, its features and regulation at different levels.
2. Contemporary approaches in modern cell and molecular biology.

Course contents

Unit 1: **(No. of Hours: 8)**

Techniques in Biology

Principles of microscopy; Light Microscopy; Phase contrast microscopy; Fluorescence microscopy; Confocal microscopy; Sample Preparation for light microscopy; Electron microscopy (EM)- Scanning EM and Scanning Transmission EM (STEM); Sample Preparation for electron microscopy; X-ray diffraction analysis.

Unit 2: **(No. of Hours: 18)**

Cell as a unit of Life

The Cell Theory; Prokaryotic and eukaryotic cells; Cell size and shape; Eukaryotic Cell components.

Cell Organelles

Mitochondria:_ Structure, marker enzymes, composition; Semiautonomous nature; Symbiont hypothesis; Proteins synthesized within mitochondria; mitochondrial DNA.

Chloroplast_ Structure, marker enzymes, composition; semiautonomous nature, chloroplast DNA.

ER, Golgi body & Lysosomes: _Structures and roles.

Peroxisomes and Glyoxisomes: Structures, composition, functions in animals and plants and biogenesis.

Nucleus:_Nuclear Envelope- structure of nuclear pore complex; chromatin; molecular organization, DNA packaging in eukaryotes, euchromatin and heterochromatin, nucleolus and ribosome structure (brief).

Unit 3: **(No of Hours: 12)**

Cell Membrane and Cell Wall

The functions of membranes; Models of membrane structure; The fluidity of membranes; Membrane proteins and their functions; Carbohydrates in the membrane; Faces of the membranes; Selective permeability of the membranes; Cell wall.

Cell Cycle Overview of Cell cycle, Mitosis and Meiosis; Molecular controls.

Unit 4: **(No. of Hours: 6)**

Genetic material

DNA: Miescher to Watson and Crick- historic perspective, Griffith's and Avery's transformation experiments, Hershey-Chase bacteriophage experiment, DNA structure, types of DNA, types of genetic material. DNA replication (Prokaryotes and eukaryotes): bidirectional replication, semi–conservative, semi discontinuous RNA priming, Ø (theta) mode of replication, replication of linear,

ds- DNA, replicating the 5 end of linear chromosome including replication enzymes.

Unit 5: **(No. of Hours: 12)**

Transcription (Prokaryotes and Eukaryotes)

Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types; Translation (Prokaryotes and eukaryotes), genetic code.

Regulation of gene expression

Prokaryotes:Lac operon and Tryptophan operon ; and in Eukaryotes.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Remember the principles and details of using light and electron microscopes and the role of X-ray diffraction in studying the structures of cellular organelles and biomolecules and Define various types of cell organelles and their functions
CO 2	Identify the role of enzymes in plant development.
CO 3	Explain the basic principles of microscopy.
CO 4	Analyze the process of cell cycle with reference to mitosis and meiosis.
CO 5	Compare and Discuss about the SEM and TEM with reference to their applications in plant study.
CO 6	Construct the structures of different RNA and enzymes used in transcription

Suggested Textbooks:

1. P.K. Gupta. (2017). Cell and Molecular Biology. Rastogi Publication, Meerut.
2. S.C. Rastogi. (2016). Cell and Molecular Biology. Published by New Age International Pvt. Ltd.

Reference Book:

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8thedition. Lippincott Williams and Wilkins,Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates,MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, SanFrancisco.

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	2	3	....	2	2	.....	...	1	2	1	....	3	3	3	....	2.
CO2	3	...	2	3	3	2	2	1	3	2	2	3	1	1.	2	2.
CO3	2	2	2	2	2	.....	3	2	2	3	1	2	1	1.	2	3.
CO4	1	3	2	2	2	.....	...	1	3	2	2	2	2	3	....	1.
CO5	2	3	2	....	2	.....	3	1	3	2	...	1	2	3.	.....	3
CO6	3	2	1	2	3	2	2	2	3	2	2	1	3	2	2	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: BBOL502**				
Course Name	**: Lab Course (Based on BBOD502)**				
Semester /Year	**: V**				
		L	**T**	**P**	**C**
		0	**0**	**4**	**2**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives :The objectives of this course are

1. To know and familiarize the structure of prokaryotic and eukaryotic cell organization.
2. To understand the structure of plant and animal cell through temporary mount
3. To Learn different techniques used in cell and molecular biology

Course contents

Practical

1. To study prokaryotic cells (bacteria), viruses, eukaryotic cells with the help of light and electronmicrographs.
2. Study of the photomicrographs of cellorganelles
3. To study the structure of plant cell through temporarymounts.
4. To study the structure of animal cells by temporary mounts-squamous epithelial cell and nerve cell.
5. Preparation of temporary mounts of striated musclefiber
6. To prepare temporary stained preparation of mitochondria from striated muscle cells /cheek epithelial cells using vital stain Janusgreen.
7. Study of mitosis and meiosis (temporary mounts and permanentslides).
8. Study the effect of temperature, organic solvent on semi permeablemembrane.
9. Demonstration of dialysis of starch and simplesugar.
10. Study of plasmolysis and deplasmolysis on *Rhoeo*leaf.
11. Measure the cell size (either length or breadth/diameter) by micrometry.
12. Study the structure of nuclear pore complex by photograph (from Gerald Karp) Study of special chromosomes (polytene&lampbrush) either by slides or photographs.
13. Study DNA packaging bymicrographs.
14. Preparation of the karyotype and ideogram from given photograph of somatic metaphase chromosome.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Examine various cell organelles through slides and photographs.
CO 2	Gain understanding of temporary mount and slides of mitosis and meiosis
CO 3	Determine to demonstrate dialysis of starch and simple sugar
CO 4	Illustrate the structure of nuclear pore complex by photograph.
CO 5	Measure the cell size (either length or breadth/diameter) by micrometry
CO 6	Test the process of plasmolysis and deplasmolysis on Rhoeo leaf

Suggested Textbook

1. P.K. Gupta. (2017). Cell and Molecular Biology. Rastogi Publication, Meerut

Course code	**: BBOD503a**				
Course Name	**: Analytical Techniques in Plant Sciences**				
Semester /Year	**: V**				
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To gain the knowledge on various techniques and instruments used for the study of plant biology.
2. Understanding of principles and use of light, confocal transmission and electron microscopy, centrifugation, spectrophotometry, chromatography, x-ray diffraction technique and chromatography techniques.

Course contents

Unit 1: **(No. of Hours: 15)**

Imaging and related techniques

Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freezeetching.

Unit 2: **(No. of Hours: 8)**

Cell fractionation

Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl2 gradient, analytical centrifugation, ultracentrifugation, marker enzymes.

Unit 3: **(No. of Hours: 8)**

Radioisotopes

Use in biological research, auto-radiography, pulse chase experiment.

Spectrophotometry

Principle and its application in biological research.

Unit4: **(No. of Hours: 14)**

Chromatography

Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ionexchange chromatography; Molecular sieve chromatography; Affinity chromatography.

Characterization of proteins and nucleic acids

Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE

Unit 5: **(No. of Hours: 15)**

Biostatistics

Statistics, data, population, samples, parameters; Representation of Data: Tabular, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Define various terms used in microscopy and biostatistics
CO 2	Understand process of microscopy, spectrophotometry and chromatography.
CO 3	Explain the formulae of biostatistics with suitable examples.
CO 4	Analyze the characteristics of proteins and nucleic acids.
CO 5	Summarize the applications of different techniques used in plant science.
CO 6	Create or write the applications of paper chromatography, column chromatography, TLC, GLC, HPLC

Suggested Textbooks:

1. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York.U.S.A
2. S.D. Ramteke and J.H. Meshram. (2019). Plant Analytical Techniques, p236, Daya Publication House, New Delhi

Reference Books:

1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw- Hill Publishing Co. Ltd. New Delhi. 3rd edition.
2. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.
3. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4thedition.

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	2	3	....	2	2	.....	...	1	2	1	....	3	3	3	....	2.
CO2	3	...	2	3	3	2	2	1	3	2	2	3	1	1.	2	2.
CO3	2	2	2	2	2	.....	3	2	2	3	1	2	1	1.	2	3.
CO4	1	3	2	2	2	.....	...	1	3	2	2	2	2	3	....	1.
CO5	2	3	2	....	2	.....	3	1	3	2	...	1	2	3.	.....	3
CO6	3	2	1	2	3	2	2	2	3	2	2	1	3	2	2	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: BBOL503a**				
Course Name	**: Lab Course (Based on BBOD503a)**				
Semester /Year	**: V**				
	L	**T**	**P**	**C**	
	0	**0**	**4**	**2**	

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

The objective of this course is to expose the students to different techniques which can be used to study different Biological processes

Course content

Practicals

1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.
2. Demonstration of ELISA.
3. To separate nitrogenous bases by paper chromatography.
4. To separate sugars by thin layer chromatography.
5. Isolation of chloroplasts by differential centrifugation.
6. To separate chloroplast pigments by column chromatography.
7. To estimate protein concentration through Lowry's methods.
8. To separate proteins using PAGE.
9. To separate DNA (marker) using AGE.
10. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).
11. Preparation of permanent slides (double staining).

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Remember and observe the details of Microscopy- Principles of light microscopy, electron microscopy (TEM and SEM).
CO 2	Understand and describe Chromatography and cultural techniques in Botany
CO 3	Explain the methods used in Micrometry, Microtomy and Microphotography
CO 4	Differentiate the blotting techniques
CO 5	Assess separation of chloroplast pigments by paper chromatography
CO 6	Prepare permanent slides by double staining

Suggested Textbooks:

1. Willard, H.H., Merritt L.L. Dean J.A. and Settle F.A., "Instrumental Methods of Analysis", 7th Ed., Wadsworth Publishing Co., 1986.

Reference Book:

1. Girja, S. 2020. Practical manual on Plant Molecular Biology and Analytical techniques, AkiNik Publications.

Course code	**: BBOD503b**				
Course Name	**: Natural Resource Management**				
Semester /Year	**: V**				
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To introduce the students with various Natural Resources and their management strategies.
2. To make them aware about the contemporary practices and efforts (national and international) in resources management.
3. It acquaint the students with various Natural Resources- their availability, causes of depletion, conservation, sustainable utilization and their management strategies.

Course contents

Unit 1 Natural resources **(No. of Hours: 2)**

Definition and types.

Unit 2 Sustainable utilization **(No. of Hours: 8)**

Concept, approaches (economic, ecological and socio-cultural).

Unit 3 Land **(No. of Hours: 8)**

Utilization (agricultural, pastoral, horticultural, silvicultural); Soil degradation (magnitude of problem and cause) and management strategies; Restoration of degraded lands.

Unit 4 Water **(No. of Hours: 8)**

Fresh water (rivers, lakes, groundwater, aquifers, watershed); Marine; Estuarine; Wetlands; Threats and management strategies, Ramsar convention.

Unit 5 Biological Resources **(No. of Hours: 12)**

Biodiversity-definition and types; Significance; Threats; Management strategies; Bioprospecting; IPR; CBD; National Biodiversity Action Plan)

Unit 6 Forests **(No. of Hours: 6)**

Definition, Cover and its significance (with special reference to India); Major and minor forest products; Depletion, Biological Invasion; Management.

Unit 7 Energy **(No. of Hours: 6)**

Renewable and non-renewable sources of energy

Unit 8 Contemporary practices in resource management **(No. of Hours: 8)**

EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste management.

Unit 9 National and international efforts in resource management and conservation **(No. of Hours: 4)**

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Define and select national and international initiatives, and policies adopted in natural resources management and conservation IUCN, UNESCO, UNEP, IBIN, WBBDB, BSI, ZSI
CO 2	Understand natural resources, Sustainable utilization, economic, ecological and socio-cultural approaches towards sustainable utilization.
CO 3	Explain about utilization, degradation, and management of energy, land, water and Biological Resources i.e. Bio-prospecting, Forest products; IPR; CBD; National Biodiversity Action Plan.
CO4	Explain about contemporary practices in resource management; EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Waste management.
CO5	Measure dominance of woody species by DBH (diameter at breast height) method
CO6	Plan and prepare strategies for sustainable natural resources management.

Suggested Textbooks:

1. Vasudevan, N. (2006). Essentials of Environmental Science. New Delhi, India: Narosa Publishing House.
2. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation.New Delhi, India: Anamaya Publications.

Reference Books:

1. Rogers, P.P., Jalal, K.F. and Boyd, J.A. (2008). An Introduction to Sustainable Development. New Delhi, India: Prentice Hall of India Private Limited

.

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	2	1	2	2	…	…	1	3	2	…	3	2	3	3	1	2
CO2	3	2	2	2	….	…	…	2	1	2	1	3	3	3	1	2
CO3	2	.1	2	2	2	….	2	…	3	2	2	1	1	2	2	3
CO4	2	1	3	2	1	3	…	…	3	2	…	3	2	2	3	…
CO5	2	1	1	2	3	…	2	2	2	3	2	2	2	1	2	3
CO6	3	2	2	2	1	3	1	1	3	2	…	…	2	3	2	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: BBOL503b**				
Course Name	**: Lab Course (Based on BBOD503b)**				
Semester /Year	**: V**				
	L	**T**	**P**	**C**	
	0	**0**	**4**	**2**	

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To aware and learn Sustainable utilization and understand economic, ecological and socio-cultural approaches towards sustainable utilization by practical approaches.
2. To understand the different protocols following the calculation and analyses of different management practices

Course contents

Practical

1. Estimation of solid waste generated by a domestic system (biodegradable and non-biodegradable) and its impact on land degradation.
2. Analyses for pH, hardness, TDS, Alkalinity, COD and BOD of water samples from various sources.
3. Diversity indices in field based/simulation experiment.
4. Collection of data on forest cover of specific area. Measurement of dominance of woody species by DBH (diameter at breast height) method.
5. Calculation and analysis of ecological footprint (carbon footprint using UN/WWF carbon calculator).

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Examine solid waste generated and its impact on land degradadtion
CO 2	Identify protocol for collection of data on forest cover.
CO 3	Calculate ecological or carbon footprint
CO 4	Analyse and interpret the physico-chemical properties of water samples
CO 5	Measure dominance woody species in specific forest
CO 6	Compilation of field based experimental data

Suggested Textbooks:

1. Singh, J. S., Singh, S.P. and Gupta, S. (2006). Ecology, Environment and Resource Conservation.New Delhi, India: Anamaya Publications

Reference Book

1. Jaswant Singh and Girish Pandey. (2015). Natural Resource Management and Conservation, Kalyani Publisher, New Delhi.

Course code	**: BBOS504**				
Course Name	**: Herbal Technology**				
Semester /Year	**: V**				
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course is

1. Developing entrepreneurship skills to establish value addition products, botanical extracts and isolation of bioactive compounds

Course contents

Unit 1: **(No. of Hours: 6)**

Herbal medicines: history and scope - definition of medical terms - role of medicinal plants in Ayurveda/Siddha systems of medicine; cultivation - harvesting - processing - storage - marketing and utilization of medicinal plants.

Unit 2: **(No. of Hours: 6)**

Pharmacognosy - systematic position medicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka.

Unit 3: **(No. of Hours: 6)**

Phytochemistry - active principles and methods of their testing - identification and utilization of the medicinal herbs; *Catharanthus roseus* (cardiotonic), *Withania somnifera* (drugs acting on nervous system), *Clerodendron phlomoides* (anti-rheumatic) and *Centella asiatica*(memory booster).

Unit 4: **(No. of Hours: 8)**

Analytical pharmacognosy: Drug adulteration - types, methods of drug evaluation - Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds)

Unit 5: **(No. of Hours: 4)**

Medicinal plant banks micro propagation of important species (*Withania somnifera*, neem and tulsi- Herbal foods-future of pharmacognosy)

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Remember and define role of medicinal plants, their cultivation, harvesting, processing, storage, marketing and utilization.
CO 2	Understand uses of herbs in curing various ailments.
CO 3	Explain phytochemistry of medicinal plants.
CO 4	Analyze the systematic position and medicinal uses of some important plants like Tulsi, Ginger, Fenugreek, Indian Goose Berry and Ashoka.
CO 4	Evaluate drug adulteration- types and methods of drug evaluation biological testing of herbal drugs for secondary metabolites
CO 6	Plan or prepare to cultivate medicinal plants in lab through micropropagation

Suggested Textbooks:

1. Glossary of Indian medicinal plants, R.N.Chopra, S.L.Nayar and I.C.Chopra, 1956. C.S.I.R, NewDelhi.
2. TheindigenousdrugsofIndia,Kanny,Lall,DeyandRajBahadur,1984.InternationalBookDistributors.

3. Herbal plants and Drugs Agnes Arber, 1999. Mangal DeepPublications.
4. Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass,Delhi

Reference Books:

1. Ayurvedic drugs and their plant source. V.V. Sivarajan and BalachandranIndra 1994. Oxford IBH _publishing Co.
2. Principles of Ayurveda, Anne Green, 2000. Thomsons, London.

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	3	…	2.	2	2	2	…	1	3	2	…	…..	3	2	3	2
CO2	1	3	2	2	1	2	2	2	3	2	3	3	2	2	2	3.
CO3	3	2	2	3	2	2	3	2	3	1	3	2	2	2.	2	2
CO4	2	1	2	2	2	…	1	3	2	3	2	…..	3	2	1	3
CO5	1	3	2	1	1	3	2	3	2	1	2	3	2	2	2	2.
CO6	3	3	2	3	1	2	2	2	…	3	2	3	2	3	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: BBOS505**				
Course Name	**: Nursery and Gardening**				
Semester /Year	**: V**				
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course

1. To gain knowledge of gardening, cultivation, multiplication, raising of seedlings of ornamental plants.
2. Students would have an understanding of:

a. How nursery of the plants is prepared?
b. How rooting is promoted in the stem cuttings?
c. How seeds are stored and what are the soil conditions for seed sowing and seedling growth?
d. How landscaping is designed?

Course content

Unit 1: **(No. of Hours: 4)**

Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities - Planting - direct seeding and transplants.

Unit 2: **(No. of Hours: 6)**

Seed: Structure and types - Seed dormancy; causes and methods of breaking dormancy - Seed storage: Seed banks, factors affecting seed viability, genetic erosion – Seed production technology - seed testing and certification.

Unit 3: **(No. of Hours: 6)**

Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings - Hardening of plants – green house - mist chamber, shed root, shade house and glass house.

Unit 4: **(No. of Hours: 8)**

Gardening: definition, objectives and scope - different types of gardening - landscape and home gardening - parks and its components - plant materials and design - computer applications in landscaping - Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting.

Unit 5: **(No. of Hours: 6)**

Sowing/raising of seeds and seedlings - Transplanting of seedlings - Study of cultivation of different vegetables: cabbage, brinjal, lady's finger, onion, garlic, tomatoes, and carrots - Storage and marketing procedures.

Course outcomes (COs):

Upon successful completion of the course student will be able to

CO 1	Describe the objectives and scope of Nursery, Gardening and cultivation of various vegetables.
CO 2	Explain about the structure and types of seed, seed dormancy, Seed production technology, seed testing and certification etc.
CO 3	Illustrate the methods of Nursery, Gardening and vegetative propagation.
CO4	Analyze the definition, objectives and scope of different types of Nursery & gardening
CO5	Summarized the knowledge sowing and raising of seeds and seedlings, transplanting and cultivation of seedlings and marketing procedures of vegetables.
CO6	Design the idea of Nursery and Gardening.

Suggested Textbooks

1. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.
2. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore,Madras.
3. Kumar, N., 1997, Introduction to Horticulture, Rajalakshmi Publications,Nagercoil.

Reference Book

1. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
2. Agrawal, P.K. 1993, Hand Book of Seed Technology, Dept. of 'Agriculture and Cooperation, National _Seed Corporation Ltd., NewDelhi.

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	1	2	3	3	2	1	2	…	2	3	2	1	1	3	2	1
CO2	1	3	2	2	1	2	2	2	3	2	3	3	2	2	3	2
CO3	3	2	2	3	2	2	3	2	3	1	3	2	2	2	3	3
CO4	3	3	2	2	2	…	1	3	2	3	2	…..	3	3	2	2
CO5	1	2	2	1	1	3	2	3	2	1	1	2	2	2	3	1
CO6	2	2	2	3	1	2	2	2	…	3	1	3	2	3	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: BBOS506**				
Course Name	**: Floriculture**				
Semester /Year	**: V**				
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course

1. To have knowledge of gardening and cultivation of ornamental plants and knowledge of landscaping, soil condition.
2. Students would be able to identify the ornamental plants, they will have an understanding of cultivation methods, landscaping and making the flower arrangement.

Course contents

Unit 1: **(No. of Hours: 2)**

Introduction: History of gardening; Importance and scope of floriculture and landscape gardening.

Unit 2: **(No. of Hours: 8)**

Nursery Management and Routine Garden Operations: Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary; Role of plant growth regulators.

Unit 3: **(No. of Hours: 4)**

Ornamental Plants: Flowering annuals; Herbaceous perennials; Divine vines; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and Selaginella; Cultivation of plants in pots; Indoor gardening; Bonsai.

Unit 4: **(No. of Hours: 8)**

Principles of Garden Designs: English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Water garden. Some Famous gardens of India. Landscaping Places of Public Importance: Landscaping highways and Educational institutions.

Unit 5: **(No. of Hours: 8)**

Commercial Floriculture: Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolous, Marigold,Rose, Lilium, Orchids). Diseases and Pests of Ornamental Plants.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Remember the definition, objectives and scope of Nursery and Gardening
CO 2	Understanding about the structure and types of seed,
CO 3	Apply the methods of vegetative propagation.
CO 4	Analyze the flower production process and diseases of ornamental plants
CO 5	Measure sowing and raising of seeds and seedlings, transplanting and cultivation of seedlings and marketing procedures of the following vegetables:
CO 6	Create landscape places or public importance

Suggested Textbooks

1. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.

2. Anil K. Singh and AnjanaSisodia. 2020. Textbook of Floriculture and Landscaping, New India Publishing Agency, India

Reference Books

1. George Glenny. 2012. Floriculture - A Book of Reference for Amateur and Professional Gardeners with Practical Suggestions on the Cultivation of Flowers Generally and Concise Hints on Window Gardening, Publ. Read Books.

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	3	…	2.	2	2	2	…	1	3	2	…	…..	3	2	3	2
CO2	1	3	2	2	1	2	2	2	3	2	3	3	2	2	2	3.
CO3	3	2	2	3	2	2	3	2	3	1	3	2	2	2.	2	2
CO4	2	1	2	2	2	…	1	3	2	3	2	…..	3	2	1	3
CO5	1	3	2	1	1	3	2	3	2	1	2	3	2	2	2	2.
CO6	3	3	2	3	1	2	2	2	…	3	2	3	2	3	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: BBOS507**			
Course Name	**: PLANT CURIOS – FASCINATING PLANTS**			
Semester /Year	**: V**			
	L	**T**	**P**	**C**
	4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course is

The course aims to have understanding of strange plants with respect to their habitat morphology, functions.

Course contents

Unit I: **(No. of Hours: 4)**

Plants of extreme conditions, Welwitschia, Podostemads, mosses, conifers, Cacti, Seaweeds, Orchids, Cordiceps

Unit II: **(No. of Hours: 8)**

Plants of unique morphology, Amorphophallus, Rafflesia arnoldii. Cleistocactus, Dracaena, Hydnora, Victoria amazonica, Populus tremuloides, Buttercup Plant ages and size, Lomatia tasmanica, Pinus sylvestris, Seqiuoia dendron, Sequoid sempervirens, Euphorbia obesa, Wolffia

Unit III: **(No. of Hours: 8)**

Plants of unique functions, Insectivorous plants, Dionaea, Nepenthes, Drosera, Utricularia, Codariocalyx motorius. Dancing Grass (Desmodium gyrans), Mirabilis, Baobab (Adansonia), Selaginellal epidophylla, Skunk Cabbage, Parasitic Plants

Unit IV: **(No. of Hours: 10)**

Defense strategies of plants, Lithops species, Dracunculus vulgaris Himalayan Blackberry, Hippophae, Poisonous plants, Giant Hogweed, Angel Trumpet, Amanita, Death Camas, Gympie-Gympie, Tree Nettle, Spurge Hogweed, Red Tide Algae, Invasive plants Unit V: Strange pollination mechanisms, Rare plants, Plant efficiencies, Ficus, Palms, Acacia, Neem, Plants in Worship, Myths

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Define habitat and ecology
CO 1	Understand about morphology and functions of strange plants
CO 2	Write about strategies of plants to survive in extreme conditions
CO 3	Explain morphological modifications, adaptation on plants
CO 5	Differentiate plants on the basis of unique morphology and functions
CO 6	Assess floral diversity in Indian and Himalayan region

Suggested Textbooks

1. Raven, P.H., Evert, R.F. and Eichhorn, S.E. (2005). Biology of Plants (7th ed.). New York: W. H. Freeman and Company
2. Sakai, A. and Larcher, W. (Eds.) (1987). Frost Survival of Plants. Springer-Verlag, New York NY. 321pp.
3. Kochhar, S.L. (2016). Economic Botany: A Comprehensive Study. Cambridge University Press.
4. Trewavas, A. (2003). Aspects of plant intelligence. Annals of Botany. 92 (1): 1–20.
5. Prance, G.T. (2001). Discovering the plant world. Taxon, 50 (2, 4): 345–359.

6. Acharya, D. and Shrivastava, A. (2008). Indigenous Herbal Medicines: Tribal Formulations and Traditional Herbal Practices. Jaipur, India: Aavishkar Publishers

Reference Books

1. Anderson, E.F. (2001). The Cactus Family. Pentland, Oregon: Timber Press.
2. Bold, H.C. (1977). The Plant Kingdom (4th ed.). Englewood Cliffs, NJ: Prentice-Hall.
3. Capon, B. (2005). Botany for Gardeners (2nd ed.). Portland, OR: Timber Publishing.
4. Cousens, R. and Mortimer, M. (1995). Dynamics of Weed Populations. Cambridge: Cambridge University Press.
5. Herrera, C.M. and Pellmyr, O. (2002). Plant Animal Interactions: An Evolutionary Approach. Hoboken, NJ: Blackwell Science.
6. Mauseth, J.D. (2012). Botany: An Introduction to Plant Biology (5th ed.). Sudbury, MA: Jones and Bartlett Learning.

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	1	2	3	3	2	1	2	…	2	3	2	1	1	3	2	1
CO2	1	3	2	2	1	2	2	2	3	2	3	3	2	2	3	2
CO3	3	2	2	3	2	2	3	2	3	1	3	2	2	2	3	3
CO4	3	3	2	2	2	…	1	3	2	3	2	…..	3	3	2	2
CO5	1	2	2	1	1	3	2	3	2	1	1	2	2	2	3	1
CO6	2	2	2	3	1	2	2	2	…	3	1	3	2	3	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: BBOD601a**			
Course Name	**: Bioinformatics**			
Semester /Year	**: VI**			
L	**T**	**P**	**C**	
4	**0**	**0**	**4**	

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. Training students in various aspects of Bioinformatics is the objective of this course.
2. With a working knowledge of the practical and theoretical concepts of bioinformatics, students will be well qualified to progress onto advanced graduate study.
3. The portfolio of skills developed on the programme is also suited to academic research or work within the bioinformatics industry as well as range of commercial settings.

Course contents

Unit 1: **(No. of Hours: 5)**

Introduction to Bioinformatics

Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics.

Unit 2: **(No. of Hours: 5)**

Databases in Bioinformatics

Introduction, Biological Databases, Classification format of Biological Databases, Biological Database Retrieval System.

Unit 3: **(No. of Hours: 25)**

Biological Sequence Databases

National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database Retrieval Tool, Sequence Submission to NCBI, Basic local alignment search tool (BLAST), Nucleotide Database, Protein Database, Gene Expression Database. EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction, Sequence Retrieval, Sequence Submission to EMBL, Sequence analysis tools.

Unit 4: **(No. of Hours: 10)**

Sequence Alignments

Introduction, Concept of Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices.

Unit 5: **(No. of Hours: 15)**

Molecular Phylogeny

Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.

Applications of Bioinformatics

Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Remember and define scope, branches and Research areas of Bioinformatics, Biological Databases, information submission to and retrieval from databases.
CO 2	Understand, handle and analyze nucleic acid and protein sequences, perform multiple sequence alignments, and Phylogenetic Analyses using different computational tools.
CO 3	Predict the molecular phylogenetic relationships of the taxa.
CO 4	Explain applications of Bioinformatics: Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement.
CO 5	Measure tools and applications of NCBI and other databases
CO 6	Design Methods of Phylogeny, Software for Phylogenetic Analyses

Suggested Textbooks:

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford UniversityPress.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.

Reference Books:

1. CampbellA.M.,HeyerL.J.(2006)DiscoveringGenomics,ProteomicsandBioinformatics._ II Edition. Benjamin Cummings.
2. ArchananVerma. (2016). Bioinformatics. Publ. by Laxmi Publication Pvt. Ltd.

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	2	1	1	1	3	2	1	2	2	3	2	1	2	3	2	3
CO2	1	2	2	1	2	1	1	3	3	2	3	3	3	2	2	1
CO3	2	1	1	1	1	3	1	2	3	1	3	2	…	3	3	2
CO4	1	1	2	1	2	1	2	3	2	3	2	…..	3	1	1	3
CO5	2	1	2	1	1	3	2	1	2	1	1	2	2	…	1	2
CO6	3	2	3	1	2	3	2	2	…	3	1	3	2	2	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: BBOL601a**				
Course Name	**: Lab Course (Based on BBOD601a)**				
Semester /Year	**: VI**				
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course-

1. To know how bioinformatics methods can be used to relate sequence to structure and function.
2. Hands-on sessions will be provided to train the students in both computer and experiment labs.

Course contents

1. Nucleic acid and protein databases.
2. Sequence retrieval from databases.
3. Sequence alignment.
4. Construction of phylogenetic tree.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Gain Knowledge of Nucleic acid and protein database.
CO 2	Gain understanding, hands-on training
CO 3	Apply the construction of phylogenetic tree.
CO 4	Analyze sequence alignment and similarity searching tools
CO 3	Evaluate various tools involved in genome annotation
CO 4	Collaborate informatics with structure and function

Suggested Textbooks

1. Andreas D. Baxevanis and B.F. Francis Ouellette. (2001). Bioinformatics (A practical guide to the analysis of genes and proteins). John Wiley and Sons Inc. Publ., USA.
2. Janusz M. Bujnicki. (2006). Practical Bioinformatics. Springer Publ.

Reference Book

1. Shui Qing Ye. (2007). Bioinformatics (A Practical Approach).Chapman and Hall/CRC Press.
2. PavelPevzner and Ron Shamir. (2011). Bioinformatics for Biologists. Cambridge University Press, London.

Course code	**: BBOD601b**				
Course Name	**: Industrial and Environmental Microbiology**				
Semester /Year	**: VI**				
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. Understand the basic principles of environment microbiology and application of the same in solving environmental problems – waste water treatment and bioremediation.
2. Understand how microbiology is applied in manufacturing of industrial products

Course contents

Unit 1 Scope of microbes in industry and environment; institutes of microbial research
(No. of Hours: 4)

Unit 2Bioreactors/Fermenters and fermentation processes **(No. of Hours: 12)**

Solid-state and liquid-state (stationary and submerged) fermentations; Batch and continuous Fermentations; Components of a typical bioreactor, Types of bioreactors: laboratory, pilotscale and production fermenters; Constantly stirred tank fermenter, tower fermenter, fixed bed and fluidized bed bioreactors and air-lift fermenter.

Unit 3 Microbial production of industrial products **(No. of Hours: 14)**

Microorganisms involved, microorganisms generally regarded as safe (GRAS), media, fermentation conditions, downstream processing and uses; Filtration, centrifugation, cell disruption, solvent extraction, precipitation and ultrafiltration, lyophilization, spray drying; production of industrially important products: enzyme (amylase); organic acid (citric acid); alcohol (ethanol); antibiotic (penicillin).

Unit 4 Microbial enzymes of industrial interest and enzyme immobilization
(No. of Hours: 8)

Overview of enzymes used for industrial applications, Methods of immobilization, advantages and applications of immobilization, large scale applications of immobilized enzymes: glucose isomerase and penicillin acylase.

Unit 5 Microbes and quality of environment. **(No. of Hours: 6)**

Distribution of microbes in air, soil and water; isolation of microorganisms from soil, air and water.

Unit 6 Microbial flora of water. **(No. of Hours: 10)**

Water pollution: various sources and control measures; role of microbes in sewage and domestic waste water treatment systems. Microorganisms as indicators of water quality: coliforms and fecal coliforms.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Know about design of bioreactors, factors affecting growth and production
CO 2	Understand the rationale in medium formulation & design for microbial fermentation, sterilization of medium and air
CO 3	Explain the different types of fermentation processes
CO 4	Calculate estimation of microorganism from soil and water
CO 5	Measure occurrence, abundance and distribution of microorganism in the environment and their role in the environment and also learn different methods for their detection
CO 6	Write role of microbes in sewage and domestic waste water treatment systems

Suggested Textbooks:

1. Pelczar, M.J. Jr., Chen E.C. S., Krieg, N.R. (2010). Microbiology: An application based approach. Tata McGraw Hill Education Pvt. Ltd., Delhi.
2. Patel, A.H. (2011). Industrial Microbiology, New Delhi: Laxmi Publications.
3. PK Mohapatra, (2008). Textbook of Environmental Microbiology. New Delhi, IK International.

Reference Books:

1. Tortora, G.J., Funke, B.R., Case. C.L. (2007). Microbiology. Pearson Benjamin Cummings, San Francisco, U.S.A. 9th edition
2. Peter F Stanbury, Allan Whitaker, Stephen J Hall, (2000). Principles of Fermentation Technology . Oxford: Butterworth-Heinemann.
3. Jean-Claude Bertrand, Pierre Caumette, Philippe Lebaron, Robert Matheron, Philippe Normand, TélesphoreSime-Ngando. (2015). Environmental Microbiology: Fundamentals and Applications, UK:Springer

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	2	3	....	2	2	.....	...	1	2	1	....	3	3	3	....	2.
CO2	3	...	2	3	3	2	2	1	3	2	2	3	1	1.	2	2.
CO3	2	2	2	2	2	.....	3	2	2	3	1	2	1	1.	2	3.
CO4	1	3	2	2	2	.....	...	1	3	2	2	2	2	3	....	1.
CO5	2	3	2	....	2	.....	3	1	3	2	...	1	2	3.	.....	3
CO6	3	2	1	2	3	2	2	2	3	2	2	1	3	2	2	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: BBOL601b**				
Course Name	**: Lab Course (Based on BBOD601b)**				
Semester /Year	**: VI**				
		L	**T**	**P**	**C**
		0	**0**	**4**	**2**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To train and understand students for handling of laboratory instruments and to good lab practices for working in the laboratory.
2. Developing skills for the isolation and identification of microorganisms.

Course contents
Practicals

1. Principles and functioning of instruments in microbiology laboratory (autoclave, laminar air flow, incubators, types of fermenters)
2. Preparation of different culture media (Nutrient medium/ Luria Bertani medium/Potato dextrose medium/Czapek Dox medium).
3. Hydrolysis of casein / starch by microorganisms
4. Alcohol production by yeast using sugar/ jaggery
5. Serial dilution method for isolation of microorganisms from water and soil and study of aeromicroflora.
6. Determination of BOD, COD, TDS and TOC of water samples
7. Determination of coliforms in water samples using eosin methylene blue (EMB) medium
8. A visit to any educational institute/ industry to see an industrial fermenter, and other downstream processing operations and a report to be submitted.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Gain Knowledge about Functioning of instrument
CO 2	Gain Understanding about preparation of different culture media
CO 3	Determine alcohol production by yeast using sugar
CO 4	Estimate determination of BOD, COD, TDS, TOC and coliforms from water samples
CO 5	Measure microorganisms from water and soil and air
CO 6	Develop protocol for the determination of coliforms in water samples

Suggested Textbooks

1. Aneja, K.R. (2003). Experiments in Microbiology, Plant Pathology and Biotechnology. E-edition 2022. New Age International Publisher

Reference Book

1. Sivakumar, P.K. (2010). An Introduction to Industrial Microbiology, p307. S. Chand Publ., New Delhi.

Course code	**: BBOD602**				
Course Name	**: Research Methodology**				
Semester /Year	**: VI**				
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. Gain an understanding of varied researches, research designs, formulation of research and criteria for good research.
2. Understanding the ethical considerations in research, plagiarism, quality of Journals, citations, indexing.

Course contents

Unit 1: **(No. of Hours: 10)**

Basic concepts of research

Research-definition and types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vsemperical). Research methods vs methodology. Literature-review and its consolidation; Library research; field research; laboratory research.

Unit 2: **(No. of Hours: 12)**

General laboratory practices

Common calculations in botany laboratories. Understanding the details on the label of reagent bottles. Molarity and normality of common acids and bases. Preparation of solutions. Dilutions. Percentage solutions. Molar, molal and normal solutions. Technique of handling micropipettes; Knowledge about common toxic chemicals and safety measures in their handling.

Unit 3: **(No. of Hours: 12)**

Data collection and documentation of observations Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of tissue specimens and application of scale bars. The art of field photography.

Overview of Biological Problems History; Key biology research areas, Model organisms in biology (A Brief overview): Genetics, Physiology, Biochemistry, Molecular Biology, Cell Biology, Genomics, Proteomics-Transcriptional regulatory network.

Unit 4: **(No. of Hours: 22**

The art of scientific writing and its presentation

Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. Powerpoint presentation. Poster presentation. Scientific writing and ethics, Introduction to copyright-academic misconduct/plagiarism.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Remember laboratory practices and acquire the knowledge about the common toxic chemicals and safety measures during their handling.
CO 2	Understand ability to review literature and documenting, and presenting data in a format suitable for publication in peer-reviewed journals
CO 3	Apply Knowledge of major instruments required to conduct research work
CO 4	Analyze technical aspects and essential requirements of tissue culture technology
CO 5	Evaluation of data, data collection and presentations.
CO 6	Create statistical tools for interpretation of data, and testing of hypothesis.

Suggested Textbooks

1. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, HongKong.
2. C.R. Kothari. (2004). Research Methodology-Methods and Techniques. New Age International (P) Ltd., New Delhi.

Reference Book:

1. N. Arumugam. (2015). Research Methodology for Life Science, Saras Publication, 748p.

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	…	2	….	2	1	1	…	2	3	2	1	2	3	2	…	…..
CO2	2	…	1	….	3	2	2	…	3	2	1	2	3	….	3	3
CO3	1	…	….	2	3	…..	2	2.	2	3	2	2	3	….	3	2
CO4	…	3	1	3	2	2	…	…	2	3	2	2	2	3	2	…..
CO5	3	2	2	3	2	2	2	3	2	2	1	2	2	…	2	3
CO6	3	2	3	2	2	2	2	3	2	2	1	2	2	1	2	3

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: BBOL602**				
Course Name	**: Lab Course (Based on BBOD602)**				
Semester /Year	**: VI**				
		L	**T**	**P**	**C**
		0	**0**	**4**	**2**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. Able to perform common calculations in botany laboratories; maintain a laboratory record, do tabulations and generate graphs, images with proper scales; prepare specimens for reagents for plant specific studies; Writing references; Present a Powerpoint presentation and Poster presentation.
2. Identify common toxic chemicals and safety measures in their handling. Scientific writing and ethics; copyright, academic misconduct/plagiarism.

Course contents

Practicals

1. Plant microtechnique experiments.
2. The art of imaging of samples through microphotography and field photography.
3. Poster presentation on defined topics.
4. Technical writing on topics assigned.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Gain knowledge of practical based on chemical calculation
CO 2	Gain understanding of plant microtechnique
CO 3	Apply to make images through microphotography
CO 4	Explain technical report writing
CO 5	Justify the research through presentation
CO 6	Validate ethcal guidelines

Suggested Textbooks

1. Dawson, C. (2002). Practical research methods. UBS Publishers, NewDelhi.

Reference Book

1. Ruzin, S.E. (1999). Plant microtechnique and microscopy. Oxford University Press, New York,U.S.A.

Course code	**: BBOD603**			
Course Name	**: Dissertation**			
Semester /Year	**: VI**			
	L	**T**	**P**	**C**
	4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To exhibit competent scientific writing (with critical analysis) and enhance presentation skills.
2. To demonstrate technical skills to conduct experiments operate various analytical techniques and instruments, and ability to interpret data to derive a solution / conclusion to complex problem.

Course content/Topic

Anatomy of Himalayan woods
Chromosome Analysis and Indexing of Himalayan Flora Conservation of endangered species
Environment Impact Assessment
High altitude Ecology and Climate Change Invasion Ecology
Inventorization of unexplored Areas and Hotspots Limnology
Plant Biodiversity Assessment Pollution Monitoring
Population/weed/ Reproductive Biology Survey of Less known Economic Plants
Any other current trends / topics suggested by the Departmental committee
Dissertation is an elective and optional for students scoring 75% or more upto fourth semester. The dissertation is to be allotted in the beginning of V Semester and would be submitted at the time of the examination of VI Semester

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Record awareness and interest towards research.
CO 2	Understand scientific temperament.
CO 3	Apply the fundamentals of research methodology.
CO 4	Organize skills for the writing of thesis and scientific papers.
CO 5	Evaluate to derive a solution
CO 6	Solve problem based on observation

Course code	**: BBOL603**			
Course Name	**: Lab Course (Based on BBOD603)**			
Semester /Year	**: VI**			
L	**T**	**P**	**C**	
0	**0**	**4**	**2**	

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To analyze scientific advancements to identify a research area, design objectives and utilize modern tools, e-resources for literature survey
2. To perform experiments related to the research topic

Course content:

1. Experiments related to research topic.
2. Laboratory safety measures
3. Literature survey
4. Report writing
5. Powerpoint presentation and publication

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Remember the basic concept of Research
CO 2	Understand and identify a research area
CO 3	Apply technical skills to conduct experiments
CO 4	Explain various analytical techniques and instruments
CO 5	Test competent scientific writing and enhance presentation skills.
CO 6	Solve data to derive a solution / conclusion to complex problem.

Course code	**: BBOD604**				
Course Name	**: Genetics and Plant Breeding**				
Semester /Year	**: VI**				
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To generate interest among the students in Genetics and make them aware about the importance and opportunities in higher education and research, the first unit should be Introductory dealing with how this area has revolutionized all aspects of our life from its growth from Mendel to Genetic Engineering. Modes of inheritance of traits/ phenotypes and Phenotype-genotype co-relation are the basic learning.
2. To gain knowledge on commercially important plants, their breeding systems and strategies employed for crop improvement.

Course contents

Unit 1: **(No. of Hours: 20)**

Heredity

1. Brief life history ofMendel
2. Terminologies
3. Laws ofInheritance
4. Modified Mandelian Ratios: 2:1- lethal Genes; 1:2:1- Co- dominance, incompletedominance; 9:7; 9:4:3; 13:3; 12:3:1.
5. ChiSquare
6. Pedigree Analysis
7. Cytoplasmic Inheritance: leaf variegation in Mirabilis jalapa, Malesterility.
8. Multipleallelism
9. Chromosome theory ofInheritance.

Unit 2: **(No. of Hours: 12)**

Sex-determination and Sex-linked Inheritance Linkage and Crossing over

Linkage: concept & history, complete & incomplete linkage, bridges experiment, coupling & repulsion, recombination frequency, linkage maps based on two and three factor crosses. Crossing over: concept and significance..

Unit 3: **(No. of Hours: 4)**

Mutations and Chromosomal Aberrations

Types of mutations, effects of physical & chemical mutagens. Numerical chromosomal changes: Euploidy, Polyploidy and Aneuploidy; Structural chromosomal changes: Deletions, Duplications, Inversions& Translocations.

Unit 4: **(No. of Hours: 16)**

Plant Breeding

Introduction and objectives. Breeding systems: modes of reproduction in crop plants. Important achievements and undesirable consequences of plant breeding.

Methods of crop improvement

Introduction: Centres of origin and domestication of crop plants, plant genetic resources; Acclimatization; Selection methods: For self-pollinated, cross pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations.

Unit 5: **(No. of Hours: 8)**

Inbreeding depression and Heterosis

History, genetic basis of inbreeding depression and Heterosis; Applications.

Crop improvement and breeding

Role of mutations; Polyploidy; role of biotechnology in crop improvement.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Describe the properties of hereditary, Sex-determination and Sex-linked Inheritance Linkage and Crossing over, Mutations and Chromosomal Aberrations, Plant Breeding, Methods of crop improvement, Inbreeding depression and Heterosis.
CO 2	Understand and Learn about the important objectives of the plant breeding.
CO 3	Illustrate the Knowledge about crossing-over, linkage, gene mapping methods, extra chromosomal inheritance and sex-linked inheritance, Methods of crop improvement.
CO 4	Analyze the Mendelian principles, pedigree analysis and heredity traits and disorders.
CO 5	Summarize the procedure, advantages and limitations of various crop improvement methods used for self-pollinated, cross pollinated and vegetatively propagated crops.
CO6	Generalize the knowledge of heredity and plant breeding.

Suggested Textbooks:

1. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5th edition.
3. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., BenjaminCummings
4. Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to Genetic Analysis. W. H. Freeman and Co., U.S.A. 10thedition.

Reference Books:

1. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
2. Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7thedition.
3. Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH. 2ndedition.
4. Acquaah, G. (2007). Principles of Plant Genetics & Breeding. BlackwellPublishing.

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	1	2	3	3	2	1	2	…	2	3	2	1	1	3	2	1
CO2	1	3	2	2	1	2	2	2	3	2	3	3	2	2	3	2
CO3	3	2	2	3	2	2	3	2	3	1	3	2	2	2	3	3
CO4	3	3	2	2	2	…	1	3	2	3	2	…..	3	3	2	2
CO5	1	2	2	1	1	3	2	3	2	1	1	2	2	2	3	1
CO6	2	2	2	3	1	2	2	2	…	3	1	3	2	3	1	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: BBOL604**				
Course Name	**: Lab Course (Based on BBOD604)**				
Semester /Year	**: VI**				
	L	**T**	**P**	**C**	
	0	**0**	**4**	**2**	

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course is

To generate interest among the students in Genetics and Plant Breeding through Laboratory experiments and Hand-on sessions

Course content

Practical

1. Mendel's laws through seed ratios. Laboratory exercises in probability and chisquare.
2. Pedigree analysis for dominant and recessive autosomal and sex linked traits.
3. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
4. Study of aneuploidy: Down's, Klinefelter's and Turner's syndromes through photographs.
5. Hybridization techniques - Emasculation, Bagging (For demonstration only).
6. Induction of polyploidy conditions in plants (For demonstration only).

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Recall Knowledge about Mendel's laws through seed ratios.
CO 2	Express the understanding of Chromosome mapping using point test cross data.
CO 3	Apply the Hybridization techniques - Emasculation, Bagging
CO 4	Evaluate the problems of Incomplete dominance and gene interaction through seed ratios.
CO5	Conclude the knowledge of Mendel's laws.
CO6	Create the idea of polyploidy conditions in plants.

Suggested Textbooks

1. Bineeta Singh and G.M. Lal. (2022). Practical Manual of Genetics and Plant Breeding. Satish Serial Publ. House, New Delhi.

Reference Book

1. B.D. Singh. (2022). Plant Breeding: Principles and Methods 12th ed. MEDTech Science Press.

Course code	**: BBOS605**				
Course Name	**: Ethnobotany**				
Semester /Year	**: VI**				
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. To gain knowledge of the plants used by the local communities, tribals, ethenic groups, their nutritive and medicinal value.
2. Students would gain an understanding of the treasure, value and usefulness of the natural products and their efficient use by the local communities as food and medicine and their conservation practices

Course contents

Unit 1: **(No. of Hours: 6)**

Ethnobotany

Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their life styles. Plants used by the tribals: a) Food plants b) intoxicants and beverages

c) Resins and oils and miscellaneous uses.

Unit 2: **(No. of Hours: 6)**

Methodology of Ethnobotanical studies

a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places.

Unit 3: **(No. of Hours: 07)**

Role of ethnobotany in modern Medicine

Medico-ethnobotanical sources in India; Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) *Azadiracta indica* b) *Ocimum sanctum* c) *Vitex negundo*. d) *Gloriosa superbae*) *Tribulus terrestris* f) *Pongamia pinnatag*) *Cassia auriculata* h) *Indigofera tinctoria*. Role of ethnobotany in modern medicine with special example *Rauvolfia sepentina, Trichopus zeylanicus, Artemisia, Withania*.

Unit 4: **(No. of Hours: 03)**

Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management).

Unit 5: **(No. of Hours: 8)**

Ethnobotany and legal aspects

Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge.

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Knowledge about history, concept, scope and relevance of herbal drugs in Indian system of medicine
CO 2	Understand the techniques for drug evaluation (Chemical, Physical and Biological), Phytochemical investigations, standardization and quality control of herbal drugs
CO 3	Apply the technique of medicinal gardening - Cultivation practices, marketing and utilization of selected medicinal plants
CO 4	Analyze the macroscopic and microscopic characters, chemical constituents, adulterants, therapeutical and pharmaceutical uses of medicinal plants
CO 5	Summarize the legal aspects of ethnobotanical studies
CO 6	Collaborate ethnobotany to ethnic group.

Suggested Textbooks

1) S.K. Jain (ed.) Glimpses of Indian. Ethnobotany, Oxford and I B H, New Delhi –1981.
2) S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur,1995.
3) S.K.Jain(ed.)1989.Methodsandapproachesinethnobotany.Societyofethnobotanists, Lucknow, India.
4) S.K. Jain, 1990. Contributions of Indian ethnobotny. Scientific publishers,Jodhpur

Reference Books

1) Colton C.M. 1997. Ethnobotany – Principlesand applications. John Wiley and sons – _Chichester
2) Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah._
3) Rajiv K. Sinha – Ethnobotany The Renaissance of Traditional Herbal Medicine – INA –SHREE Publishers,Jaipur-1996.

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	3	…	2.	2	2	2	…	1	3	2	…	…..	3	2	3	2
CO2	1	3	2	2	1	2	2	2	3	2	3	3	2	2	2	3.
CO3	3	2	2	3	2	2	3	2	3	1	3	2	2	2.	2	2
CO4	2	1	2	2	2	…	1	3	2	3	2	…..	3	2	1	3
CO5	1	3	2	1	1	3	2	3	2	1	2	3	2	2	2	2.
CO6	3	3	2	3	1	2	2	2	…	3	2	3	2	3	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: BBOS606**				
Course Name	**: Biofertilizers**				
Semester /Year	**: VI**				
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course-

1. The student would have a deep understanding of ecofriendly fertilizers.
2. They will be able to understand the growth and multiplication conditions of useful microbes such as Rhizobium, cyanobacteria, mycorrhizae, Azotobactoretc, their role in mineral cycling and nutrition to plants.
3. They can also think of the methods of decomposition of biodegradable waste and convert into the compost.

Course contents

Unit 1: **(No. of Hours: 4)**

General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.

Unit 2: **(No. of Hours: 8)**

Azospirillum: isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms. *Azotobacter*: classification, characteristics – crop response to *Azotobacter* inoculum, maintenance and mass multiplication.

Unit 3: **(No. of Hours: 4)**

Cyanobacteria (blue green algae), *Azolla* and *Anabaena azolla* association, nitrogen fixation, factors affecting growth, blue green algae and *Azolla* in rice cultivation.

Unit 4: **(No. of Hours: 8)**

Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

Unit 5: **(No. of Hours: 6)**

Organic farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Remember the knowledge of classification, characteristics and culture maintenance of Rhizobium and Azotobacter, green manuring, organic fertilizers.
CO 2	understanding about the green manuring, organic fertilizers, , characteristics and culture maintenance of Rhizobium and Azotobacter, Mycorrhizal association
CO 3	Applying the knowledge about the role of Mycorrhizal associations in influencing the growth and yield of crop plants, isolation, identification, mass multiplication of Biofertilizers.
CO 4	Analyze the General account about the microbes used as Biofertilizer.
CO5	Summarized the recycling of biodegradable waste materials, methods of making biocompost and vermicomposts.
CO6	Create the idea of making Biofertilizers.

Suggested Textbooks

1. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.

2. Subha Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, NewDelhi.
3. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming AktaPrakashan,Nadiad

Reference Book

1. Acharya, Sen and Rai. (2019). Biofertlizers and Biopesticides. Techno World Press.

CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	3	…	2.	2	2	2	…	1	3	2	…	…..	3	2	3	2
CO2	1	3	2	2	1	2	2	2	3	2	3	3	2	2	2	3.
CO3	3	2	2	3	2	2	3	2	3	1	3	2	2	2.	2	2
CO4	2	1	2	2	2	…	1	3	2	3	2	…..	3	2	1	3
CO5	1	3	2	1	1	3	2	3	2	1	2	3	2	2	2	2.
CO6	3	3	2	3	1	2	2	2	…	3	2	3	2	3	3	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated

Course code	**: BBOS607**				
Course Name	**: Soft Skills for Employability Enhance**				
Semester /Year	**: VI**				
		L	**T**	**P**	**C**
		4	**0**	**0**	**4**

L - Lecture T – Tutorial P – Practical C – Credit

Course Objectives: The objectives of this course are

1. Realize their personal and professional resourcefulness so as to augment the same to lead a successful life.
2. Work in teams to become good at people skills, persuasion through effective communication and inter-personal skill.
3. Understand confidence building strategies and thereby to make effective presentations. Learn to build resume on their own thereby prepare to face mock-interviews and job interviews successfully.
4. Imbibe an impressive personality, etiquette, professional ethics & values, effective time management & goal setting. Understand the elements of professional update & upgrade through industry exposure in a mini-live project

Course contents

UNIT-I **(No. of Hours: 6)**

Introduction of Soft Skills: Definition and Significance of Soft Skills; Process, Importance and Measurement of Soft Skill Development, Beliefs, Moral Values, Attitude, Virtue.

UNIT-II **(No. of Hours: 6)**

Well thinking and Effective Time Management: Attendance, Discipline, Punctuality, Act in time on commitment setting realistic goals, self-confidence and assertiveness, stress management, moral values, Thinking skills - positive attitude, improving perceptions and Driving out Negativity.

UNIT-III **(No. of Hours: 6)**

Self-discovery skills: Self-Evaluation, Self-Discipline, Self-Criticism, Recognition of one's own limits and deficiencies, Independency etc. Thoughtful & Responsible, Self-Awareness, adaptability, grooming and etiquette, communication media, etiquette, academic ethics and integrity, empathy and sympathy.

UNIT-IV **(No. of Hours: 6)**

Coordinating skills: Team-building skills, Problem Solving Skills, Conflict Management Skills, Persuasion skills, Negotiation Skills, Analytical Skills, Feedback Skills, Counseling Skills, Mentoring and adjust to the Environment.

UNIT- V **(No. of Hours: 6)**

Interpersonal skills: 1. Leadership and Assertiveness Skills: A Good Leader; Leaders and Managers; Leadership Theories; Types of Leaders; Leadership Behaviors; Assertiveness Skills. 2. Emotional Intelligence: Meaning, History, Features, Components, Intrapersonal and Management Excellence; Strategies to enhance Emotional Intelligence

Course outcomes (COs):

Upon successful completion of the course a student will be able to

CO 1	Remember learning by themselves to improve thinking and effective time management skills through soft skills.
CO 2	Understand professional communication situations and participate in such presentations with confidence
CO 3	Apply assertion and change to adapt to corporate culture by being sensitive - personally and sensible - professionally.
CO 4	Analyse good professional exposure through the mini-live project
CO 5	Evaluate negotiation and analytical skills
CO 6	Design Strategies to enhance Emotional Intelligence

Suggested Textbooks

1. MadhaviApte , "A Course in English communication", Prentice-Hall of India, 2007
2. LeenaSen , "Communication Skills", Prentice-Hall of India, 2005
3. Dr.ShaliniVerma, "Body Language- Your Success Mantra", S Chand, 2006
4. Edgar Thorpe and Showick Thorpe , "Objective English", 2nd edition, Pearson Education, 2007
5. Ramesh, Gopalswamy, and Mahadevan Ramesh, "The ACE of Soft Skills", New Delhi: Pearson, 2010
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CO-PO Mapping

Course	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	PS O1	PS O2	PS O3	PS O4
CO1	2	3	.....	3	2	2	...	1	3	2	...	.....	2.	2	3	1
CO2	3	2	3	2	1	2	2	2	3	2	3	3	2	2	3	2
CO3	1	2	2	2	2	2	3	2	3	1	3	2	2	2.	3	2
CO4	2	3	.....	1	2	...	1	3	2	3	2	.....	2	2	2	3
CO5	1	2	3	2	1	3	2	3	2	1	2	3	2	2	2	3
CO6	2	2	3	3	1	2	2	2	...	3	2	3	2	3	...	2

3: Highest Correlated, 2: Medium Correlated, 1: Lowest Correlated