

P. D. E. A's
Prof. Ramkrishna More Arts, Commerce and Science
College Akurdi Pune-411044
(Autonomous)

Affiliated to



Savitribai Phule Pune University [SPPU]



B. Sc. With Major Botany
(Three years B. Sc. in Botany / Four Years Honours in Botany)

2023 Pattern

Choice Based Credit System-2023 Pattern

Under

Autonomy and NEP-2020

From Academic Year
2026-2027

Syllabus

B. Sc. Botany with Honours

Board of Studies in Botany
Department of Botany
Prof. Ramkrishna More Arts, Commerce and Science
College Akurdi Pune-411044

Rules and Regulations

1. National Credit Framework (NCrF): For creditisation and integration of all higher education qualifications leading to a certificate/ diploma/ degree with multiple entry and exit options, college will refer to National Credit Framework (NCrF) which encompasses the qualification frameworks for higher education, vocational and skill education and school education, namely National Higher Education Qualification Framework (NHEQF), National Skills Qualification Framework (NSQF) and National School Education Qualification Framework (NSEQF) respectively.

2. Structure of Four years multidisciplinary UG Programme and Five Years Integrated Multidisciplinary Master's Degree Programmes with Multiple Entry and Exit Options at Different Levels:

(i) Students will have the flexibility to enter four years multidisciplinary Under Graduate Programme in odd semesters and exit a programme after the successful completion of even semesters as per their future career needs.

(ii) Students will get a Certificate after a One year programme (minimum 40 Credits), a Diploma after two years (minimum 80 Credits), a Bachelor's degree after three years (minimum 120 Credits), and a Bachelor's degree with Research or Honours after Four years (minimum 160 Credits).

3. Qualification Type and Credit Requirements of Four Years Multidisciplinary Degree Programme with Multiple Entry and Exit Options

(i) Details of qualifications, minimum credit requirements, exit credit courses, year and semester are as under:

Levels	Qualification Title	Credit Requirements		Semester	Year
		Minimum	Maximum		
4.5	UG Certificate	40	44	2	1
5.0	UG Diploma	80	88	4	2
5.5	Three Years Bachelor's degree	120	132	6	3
6.0	Bachelor's degree Honour's with Major	160	176	8	4
	Bachelor's degree Honour's with Major	160	176	8	4
7.0	Master's Degree	200	220	10	5
8.0	Ph. D.	----	-----	-----	----

(ii) An exit 6-credit bridge course(s) lasting two months, including at least 6-credit job specific internship/apprenticeship that will help the graduates acquire job-ready competencies required to enter the workforce will be an additional requirement for the award of the undergraduate Certificate/ Diploma/ three-year Bachelor's Degree.

(iii) On exit, the students will have the option to re-enter the programme in the college, or in a different higher education institution. Re-entry at various levels for lateral entrants in academic programmes should be based on the earned and valid credits as deposited and accumulated in the Academic Bank of Credits (ABC) through Registered Higher Education Institutions (RHEI) and proficiency test records.

(iv) Eligibility for admission to the fourth year of four-year **Honours with Research Degree Programmes** as per UGC guidelines: Minimum CGPA of 7.5 or minimum 75% at three-year degree.

(v) PG curriculum, as illustrated below, have flexibility a) One-year Post-Graduate Diploma (PGD), b) Two-year Post-graduate Programme and c) 5 Years Master's degree programmes with multiple Entry and Exit options at different levels.

(a) Post-Graduate Diploma (PGD): Programme duration- One year (2 semesters) after any bachelor's degree, min. 40 credits

(i) UGC: 1-Year (2 semesters) Post-Graduate Diploma (PGD) after 3-years Bachelor's degree: Level 6.0

(ii) UGC: 1-Year (2 semesters) PGD after 4 years Bachelor's degree (Honors/ Research): Level 6.5

(b) Master's Degree:

(i) UGC: 2-Years (four semesters) Master's Degree after obtaining a 3-years Bachelor's degree, Minimum 40 credits/year, second year devoted entirely to research, PG – 2nd year: Level 6.5

OR

(i) 1-Year (two semesters) Master's Degree after obtaining a 4-year Bachelor's degree (Honours/Research): Minimum 40 credits: Level 6.5

(c) Level 8 represents Ph. D. Research Degree.

(d) A 5-year Integrated Bachelor's and Master's programme shall have a minimum of 220 credits.

- (e) Master's and doctoral programmes, while providing rigorous research-based specialization, should also provide opportunities for multidisciplinary work, in academia, government, research institutions, and industry.

4. Lateral Entry/ Re-entry at higher Levels after exit from lower levels of four years multidisciplinary UG degree programme:

- (i) The credit points earned and accumulated shall be used to determine the eligibility for taking admission to various programs at multiple levels, subject to fulfilment of the broad principles laid down under NCERF. Students who leave with a Certification, Diploma, or a Basic Bachelor's Degree will be eligible to re-enter the programme at the exit level to complete or progress to the next level through lateral entry mode. Depending upon the academic and physical facilities available, the State Universities/ Autonomous Colleges (Higher Education Institutions or HEI) may earmark specific seats/ intake for lateral entry into the second year/ third year/ fourth year of a four years multidisciplinary UG degree programme as approved by Professional Standard Setting Bodies (PSSB/Govt. of Maharashtra/ statutory council of affiliating University plus any consequential vacancies caused by exits to an ongoing programme (four-year Degree Programme and Integrated Master's or second year Master's). Lateral entry or Re-entry is open to those students if he/she has either –
- (a) successfully completed the first year/second year/third year of the particular four years multidisciplinary degree programme in any ABC registered HEI with valid credits in ABC and re-entering into the second year/third year/fourth year, respectively of the same four years degree programme of any ABC registered HEI, within stipulated/ permissible period of years as decided by Statutory Councils of that HEI

OR

- (b) Already successfully completed a multidisciplinary four-year first-degree programme and is desirous of and academically capable of pursuing another multidisciplinary four years first-degree programme in an allied subject.
- (ii) A student will be allowed to enter/re-enter only at the odd semester. Re-entry at various levels for lateral entrants in academic programmes should be based on the earned and valid credits as deposited and accumulated in Academic Bank of Credits (ABC) through Registered Higher Education Institutions (RHEI) and proficiency test records. However, in terms of the admission eligibility requirements, the student shall belong to the same faculty/ discipline in terms of Major Subject i.e., the Major subject of his earlier Programme and the Major subject of the new Programme for which he is seeking admission must be from the same faculty/discipline. Reservation for lateral entry will be executed as per the Government of Maharashtra norms.

5. Distribution of Credits across Multidisciplinary Four Years Degree Programme:

- (i) Four-year multidisciplinary degree programme with Honours/ Specialization Degree will have Internship and Core /Major Courses with a minimum of 22 credits per sem. in the Fourth Year.
- (ii) Four-year multidisciplinary degree programme with Research will have Research Projects, Seminars, Dissertations and Internships with a minimum of 22 credits per Sem. in the Fourth Year.
- (iii) Students shall select a 'Major or Core Subject/ Discipline' and a '**Minor Subject/Discipline**' from the **lists of various Subject Combinations and Options provided the Colleges**. In general, for the four years multidisciplinary bachelor's degree programme, the distribution of credits will be as follows:
- (a) Disciplinary/interdisciplinary Major/ Core Subject (minimum of 68 credits)- Mandatory and Elective Courses
- (b) Disciplinary/interdisciplinary Minor Subject (maximum of 22 credits)
- (c) Skill based/Vocational studies corresponding to the Major/ Core Subject (8 credits)
- (d) Field projects/internship/apprenticeship/community engagement and service corresponding to the Major/ Core Subject (14-22 credits) with a maximum of six credits per Semester
- (e) Generic/ Open Electives through Baskets of Elective Courses (12 credits),
- (f) Ability Enhancement Courses including Languages, Literature and Environmental Studies (12 credits),
- (g) In-built modules on the Indian Knowledge System (IKS) in Major/ Core Subject at Level 4.5 – 2 credits
- (h) Value-based Education, Life Skills and Professional Ethics: Co-curricular Courses such as Sports and Culture, NSS/NCC and Fine/ Applied/Visual Arts (8 credits).

Student can earn some credits (SEC/VSC/GE/OE) in the form of online from-

- (i) The National Skills Qualifications Framework (NSQF) organizes qualifications for Vocational and

Skill Courses in a series of 8 levels based on professional knowledge, professional skills, core skills and responsibilities, in the increasing order of complexity and competency.

- (ii) University Grants Commission (Credit Framework For Online Learning Courses through Study Webs of Active-Learning for Young Aspiring Minds) Regulations, 2021, **permits up to 40 per cent of the total courses being offered in a particular programme in a semester through the Online Learning Courses offered through the Study Webs of Active-Learning for Young Aspiring Minds (SWAYAM) platform.**

6. Examination and Assessment Process:

- (i) The basic principle of the credit framework is that credits are a function of the successful completion of a program of study/ vocational education/ training and assessment. No credit can be earned by the student unless the student is assessed for the achievement of the desired competencies and outcome of a program.
- (ii) Exit options are provided with certification, diploma and basic Bachelor's degrees to the students at the end of the second, fourth and sixth semesters of a four years multidisciplinary degree programme. Students will receive a Bachelor's degree with Honours/ Research on successfully completing of all eight semesters of the UG Program either at a stretch or with opted exits and re-entries.
- (iii) For the smooth success of four-year multidisciplinary degree programme with multiple entry and exit systems, the examination mode will be based on the combination of innovative trends in formative (informal and formal tests administered during the learning process) and summative (evaluation of students learning at the end of an instructional unit) examination modes. This is in line with the UGC Report on 'Evaluation Reforms in Higher Educational Institutions (2019)'.

(iv) Evaluation of each students in each course will be done as follows

- Each theory or practical course will be of 2 credits = 50 marks
- Internal evaluation 30% weightage (15 marks)
- External evaluation 70% weightage (35 marks)
- Students should secure 40% marks in each type of evaluation for successful completion of a course (student should secure at least 6 marks in internal and 14 marks in external evaluation).

(v) Evaluation Pattern.

- Internal evaluation** - Two written test, each of 20 marks will be conducted i. e. two tests on two modules. 1st assignment after completing 6 weeks of teaching and 2nd on completion of 13th week of teaching. 5 marks out of 15 will be assigned from these written tests. Remaining 10 marks will be assigned from other types of evaluation such as seminars, orals, poster presentation, open book challenging tests, surprise test, objective test etc. Examination (Internal and external) will conducted so that CO, PO, PSO can be evaluated.
- External Evaluation** - External evaluation will be done at the end of each semester.
 - For theory, 35 marks written examination will be conducted and time of examination will be 2-hours.
 - For practical, 35 marks practical examination will be conducted and time of examination will be 4-hours.
 - For project / field project, 35 marks evaluation will done on the basis of viva-voce and examination of thesis by the examiners.
 - For OJT 35 marks evaluation will be done on the basis of report of industrial mentor / supervisor / industry and viva-voce. However, student has to produce and submit OJT certificate from competent authority of industry.

7. Attendance: The student must have at least 70% attendance, to appear any type of examination.

8. Declaration of Results:

- (i) Declaration of result is based on the Semester Grade Point Average (SGPA) earned towards the end of each semester or the Cumulative Grade Point Average (CGPA) earned at the completion of all eight semesters of the programme and the corresponding overall alpha-sign or letter grades as given in Table 2. If some candidates exit at the completion of the first, second or third year of the four years Undergraduate Programmes, with Certificate, Diploma or Basic Degree, respectively, then the results of successful candidates at the end of the second, fourth or sixth semesters shall also be classified on the basis of the CGPA obtained in the two, four, six or eight semesters, respectively. Successful candidates at the end of the tenth semester of the integrated Master's Degree Programmes shall also be classified on the basis of CGPA obtained in the ten semesters of the Programmes. Likewise, the successful candidates of one year or two semesters Master's Degree Programme are also classified on the basis of the CGPA of two semesters of the Master's Degree Programme.

Table-2: Grades on degree certificate/mark sheet will be assigned to the students as per the following table

Semester GPA/ Program CGPA Semester/Program	% of Marks	Alpha-Sign / Letter Grade Result
9.00-10.00	90-100	O (outstanding)
8.00 - <9.00	80.00 – <90.00	A+ (Excellent)
7.00 - <8.00	70.00-<80.00	A (Very Good)
6.00 - <7.00	60.00-<70.00	B+ (Good)
5.50 - <6.00	55.00-<60.00	B (Above Average)
5.00 - <5.50	50.00-<55.00	C (Average)
4.00 - <5.00	40.00-<50.00	P (Pass)
Below 4.00	< 40	F (Fail)
Ab	-----	Absent

- (ii) A student obtaining Grade F shall be considered failed and will be required to reappear in the examination. For non-credit courses 'Satisfactory' or 'Unsatisfactory' shall be indicated instead of the letter grade and this will not be counted for the computation of SGPA/CGPA.

9. Award of Major and Minor Degree:

- (i) A student pursuing four-year multidisciplinary UG programme will be awarded an appropriate Honours/ Research degree in Major/ Core Subject on completion of VIII Semester with the minimum of 176 credits if he secures in that Subject at least 50% of the total credits for that programme. He shall thus study the specific number of Mandatory Core Courses, Core Electives, Vocational and Skill Courses and Field projects/ Internships connected to Core Subjects in eight semesters so as to cover at least 50% of the total credits.
- (ii) In case of Research Degree, a student shall pursue research project and write dissertation in that Major in the VII and VIII semesters.

On the basis of above rules and regulations under NEP-2020 following course frame work is adopted by the Prof. Ramkrishna More Arts, Commerce and Science College, Akurdi, Pune-411044 for the completing of four years honours degree in Major and Minor subjects.

10. Distribution of Credits across Four Years Degree Programmes:

In general, for the four years' bachelor's degree programme, the distribution of credits will be as follows:

(a) Major (Core) Subject comprising Mandatory and Elective Courses:

- Minimum 50% of total credits corresponding to Three/Four - year UG Degree- Mandatory Courses offered in all Four years;
- 2 credit course on Major Specific IKS shall be included under Major;
- Elective courses of Major will be offered in the third and/or final year.
- Vocational Skill Courses, Internship/ Apprenticeship, Field Projects, Research Projects connected to Major first to fourth year.

(b) Minor Subject: 18-20 Credits

- The Minor subjects may be from the different disciplines of the same faculty of DSC Major (Core) or they can be from different faculty altogether.
- The credits of Minor subjects shall be completed in the first three years of UG Programme.

(c) Generic/ Open Elective Courses (OE): 10-12 credits

- It is to be offered in I and/or II year
- Faculty-wise baskets of OE shall be prepared by University/ Autonomous Colleges.
- OE is to be chosen compulsorily from faculty other than that of the Major.

(d) Vocational and Skill Enhancement Courses (VSEC): 14-16 credits

- # Vocational Skill Courses (VSC): 8-10 credits, including Hands on Training corresponding to the Major and/or Minor Subject:
- To be offered in first to three years;
 - Wherever applicable vocational courses will include skills based on advanced laboratory practicals of Major

Skill Enhancement Courses (SEC): 06 credits

- i. To be offered in I and II year;
- ii. To be selected from the basket of Skill Courses approved by University/ Autonomous Colleges

(e) Ability Enhancement Courses (AEC), Indian Knowledge System (IKS) and Value Education Courses (VEC): 14 Credits**• AEC: 08 credits**

- i. To be offered in I and II year
- ii. English: 04 Credits
- iii. Modern Indian Language: 04 credits
- iv. To be offered from the Basket approved by the College;

The focus for both languages should be on linguistic and communication skills.

o IKS: 2 Credits

- i. To be offered in I Year
- ii. Courses on IKS to be selected from the basket of IKS courses approved by the Colleges

o VEC: 04 Credits

- i. To be offered in I year
- ii. Value Education Courses (VEC) Environmental Science Education (Compulsory), Understanding India, and Digital and Technological Solutions.

(f) Field Projects/ Internship/ Apprenticeship/ Community Engagement and Service corresponding to the Major (Core) Subject, Co-curricular Courses (CC) and Research Project**o Internship/Apprenticeship corresponding to the Major (Core) Subject: 8 Credits****o Field Projects/Community Engagement and Service corresponding to the Major (Core) Subject: minimum 4-6 credits**

To be offered in II, and III years of UG Degree Programmes.

o Co-curricular Courses (CC) such as Health and Wellness, Yoga education sports, and fitness, Cultural Activities, NSS/NCC and Fine/ Applied/ Visual/ Performing Arts: 8 credits. To be offered in I and/or II year**o Research Projects: 12 credits**

To be offered in the final year for 4-year Honours with Research UG Degree

The UGC Regulations, 2021 permit up to 40% of the total courses being offered in a particular programme in a semester through the Online Learning Courses offered through the SWAYAM platform and/or other State Level Common Platforms which can be developed in due course with the participation of different Universities/ HEIs.

Abbreviations: Generic/ Open Electives: **GE/OE**; Vocational Skill and Skill Enhancement Courses: **VSEC**; Vocational Skill Courses: **VSC**; Skill Enhancement Courses: **SEC**; Ability Enhancement Courses: **AEC**; Indian Knowledge System: **IKS**; Value Education Courses: **VEC**; **OJT**: On Job Training; Internship/ Apprenticeship; Field projects: **FP**; Community engagement and service: **CEP**; Co-curricular Courses: **CC**; Research Methodology-**RM**; Research Project: **RP** Note: The Credit Distribution Table given above is illustrative only. The Universities/ Autonomous Colleges may suitably modify within the broader framework of credit distribution across six verticals.

11. Definitions:**i. One semester = 15 weeks**

ii. 1-credit theory = 15 hours i.e. for 1 credit, 1 hour per week teaching is to be performed.

15 hours of 1-credit are splinted as 12 hours actual teaching + 3 hours Tutorial (Numerical problem solving sessions, revision on difficult topics, dialog on student's difficulties, and internal evaluation)

iii. 1-credit practical = 30 hours. Thus, 1 credit practical = 2 contact hours in laboratory per week. 30 hours splinted as 24 hours actual table work and 6 hours for journal competition, oral on each practical and other internal evaluation.**iv. Each theory course of any type (major, minor, VSC, VEC, OE/GE, VEC, SEC, CC, etc.) is of 2 credits.****v. Theory per semester:** Each theory course is of 2 credits. Thus, for each theory course contact hours = 24 teaching + 6 tutorials**vi. Each practical course is of 2 credits = 60 hours per semester**

- a. Minimum 12 laboratory sessions will be conducted in one semester.
- b. Each laboratory sessions will be of 4 hour.

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Prof. Ramkrishna More College, Akurdi, Pune 44
Department of Botany
Preamble

B.Sc.(Honours) in Botany is intended to provide a broad framework within which both the undergraduate programs in Botany help to create an academic base that responds to the need of the students to understand the basics of Botany and its ever evolving nature of applications in explaining all the observed natural phenomenon as well as predicting the future applications to the new phenomenon with a global perspective. The curriculum framework is designed and formulated in order to acquire and maintain standards of achievement in terms of knowledge, understanding and skills in Botany and their applications to the natural phenomenon as well as the development of scientific attitudes and values appropriate for rational reasoning, critical thinking and developing skills for problem solving and initiating research which are competitive globally and are on par in excellence with the standard Higher Education Institutions (HEI) in the advanced countries of America, Asia and Europe. The multicultural fabric of our nation requires that the institutions involved in implementing this curriculum framework also work hard towards providing an environment to create, develop and inculcate rational, ethical and moral attitudes and values to help the creation of knowledge society needed for scientific advancement of our nation.

Goals:

The Department has formulated three broad educational goals for the undergraduate degree programs:

Botany knowledge: To provide students with the basic foundation in Botany the interplay of theory and experiment, and to motivate scientific enthusiasm and curiosity and the joy of learning.

Problem solving skills: To provide students with the tools needed to analyse problems, apply experimentation, and synthesize ideas.

Employment and technical skills: To provide the students with technical skills necessary for successful careers in Botany and related or alternative careers for which a physics foundation can be very useful. These include computers and communication skills (oral and written).

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Revised Credit Framework / Structure for NEP-2020(II); CBCS Pattern-2024 with two Major at FY
Implemented from Academic Year 2024-25 (implemented phase wise 2024 to 2027)

Level / Difficulty	Sem	Subject-1				Subject-2	GE/OE	SEC	IKS	AEC	VEC	CC	Total
Certificate													
4.5 / 100	I	4T + 2P/T				4T + 2P/T	2T	2T/P	2T (General)	2T	2T	0	22
	II	4T + 2P/T				4T + 2P/T	2T/P	2T/P	0	2T	2T	2	22
Exit option: Award of UG Certificate in Major with 44 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor Continue option: Student will select one subject among the (subject 1, subject 2 and subject 3) as major and another as minor and third subject will be dropped.													
Diploma													
Level / Difficulty	Sem	Credits Related to Major				Subject-2: Minor	GE/OE	SEC	IKS	AEC	VEC	CC	Total
		Major Core	Major Elective	VSC	FP / CEP / OJT								
5.0 / 200	III	4T + 2P/T	0	2T/P	2 FP	2T+ 2T/P	2T	0	2T (Major Specific)	2T	0	2	22
	IV	4T + 2P/T	0	2T/P	2 CEP	2T + 2P/T	2T/P	2T/P	0	2T	0	2	22
Exit option: Award of UG Diploma in Major and Minor with 88 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor													
Three years Graduation Degree													
5.5 /300	V	8T + 4P/T	4T + 2P/T	2T/P	2 FP/RP	0	0	0	0	0	0	0	22
	VI	8T + 4P/T	2T + 2P/T	2T/P	4 OJT	0	0	0	0	0	0	0	22
	Total Credits	48	10	8	10	20	8	6	4	8	4	6	132
Four Years Graduate Degree with Honours (Major and Minor subjects)													
6.0 /400		10T + 4P/T	2T + 2P/T	0	0	4T RM (2T+2P)	0	0	0	0	0	0	22
		10T + 4P/T	2T + 2P/T	0	4 OJT	0	0	0	0	0	0	0	22
	Total Credits	76	18	8	14	24	8	6	4	8	4	6	176
Four Years Graduate Degree with Honours (Research)													
6.0 /400		8T + 2P/T	2T + 2P/T	0	4 RP	4T RM (2T+2P)	0	0	0	0	0	0	22
		10T + 2P/T	2T + 2P/T	0	6 RP	0	0	0	0	0	0	0	22
	Total Credits	68	18	8	22	24	8	6	4	8	4	6	176

Abbreviations:

VSC - Vocational Skill Course;

FP – Field Project

AEC – Ability Enhancement Courses

GE/OE – Generic or Open elective courses

T – Theory **P** – Practical

SEC – Skill Enhancement Course;

CEP – Community Engagement Project

VEC – Value Education Course

RP – Research Project

IKS – Indian Knowledge System

OJT – On Job Training

CC – Curricular Courses

RM – Research Methodology

1. A student can select two subject from the same faculty in first year. **At second year student will select any one subject from subject 1 and 2 at first year as major and another subject will be then minor.**
2. VSC, IKS-2, OJT, FP, CEP, RP, RM should be related to Major subject
3. OE/GE – Must be selected from basket approved by college and **selected from the faculty other than faculty of Major subject.**
4. SEC should be selected from the basket of same faculty approved by the college.
5. Each theory course may be of 2 or 4 credit; **Each practical course should be of 2 credit only.**
6. For those subject's practical cannot be conducted, they have to convert practical credits into theory credits. The decision should be taken BOS of respective subject.
7. This credit framework is applicable to all faculties in the college. The courses which are under AICET, they must take approval to this framework from AICET or respective body.
8. For any programs in any type course where practical is included (Major, Minor, VSC, SEC, GE/OE: Percent practical should be in the range 30 to 50%.
9. Evaluation pattern is 60% External and 40% Internal, there's separate passing for external and internal. For passing student must secure 40% marks in each type examination.
10. Format of Question paper should be provided at the end of syllabus.

Post Graduate Degree Course Framework under Autonomy as per NEP-2020, 2024 Pattern
Implemented from Academic Year 2026-27 for science Faculty

Sem.	Major Courses	Major Elective Courses	Minor Courses	FP/OJT/CEP	Total Credits
PG Part-I - Honours with Major and Regular					
I	14 Credits (10T + 4P)	4 credits (2T + 2P)	RM 4 Credits (2T + 2P)	0	22-Credits
II	14 Credits (10T + 4P)	4 credits (2T + 2P)	0	OJT (4 Credit) (P)	22-Credits
PG Part-II - Honours with Major and Regular					
III	14 credits (10T + 4P)	4 credits (2T + 2P)	0	Research Project-I (4 credits) (P)	22- Credits
IV	12 credits (10T + 2P)	4 credits (2T + 2P)	0	Research Project-II (6 credits) (P)	22 - Credits
PG Part-II, for Honours with Research Degree					
III	18 credits (14T + 4P)	4 credits (2T + 2 P)	0	0	22- Credits
IV	14 credits (10T + 4P)	4 credits (2T + 2P)	0	OJT (4 Credit) (P)	22 - Credits

Important Note:

1. Theory course may be 2 or 4 credit.
2. Practical course for any type of course will be of 2 credits.
3. For any programs in any type course where practical are included (Major, Minor, VSC, SEC, GE/OE: Percent practical should be in the range 30 to 50%.

Long Forms:

T-Theory; **P**- Practical; **RM** – Research methodology; **RP** - Research Project; **OJT** – On Job training;

Graduate and Honors Degree Course Framework under Autonomy as per NEP-

Year	Sem	Major Courses	Major Elective Courses	Minor Courses	VSC	IKS	GE /OE	SEC
FY	I	2 theory + 1 Practical BOMAT -111 Fundamentals of Plant Diversity I BOMAT-112 Introduction to Plant Morphology BOMAP-113 practical botany I	0	0	1 Theory BOVST-111 Cultivation techniques of Mushroom and Algae	1 Theory BOIKT-111 Indian knowledge system	1 theory + 1 Practical BOGET-111 Agrotourism & Ecotourism BOGEP-112 Agrotourism & Ecotourism	1 Practical BOSEP-111 Biofertilizers and Biopesticides
	II	2 theory + 1 Practical BOMAT-121 Fundamentals of Plant Diversity II BOMAT-122 Introduction to Plant Anatomy & Utilization BOMAP-123 Practical botany II	0	1 Theory BOMIT-121 Applied Botany	1 Practical BOVST-121 Cultivation techniques of Mushroom and Algae	0	2 theory BOGET-121 Plant Resources BOGEP-122 Plant Resources	1 theory BOSET-121 Biofertilizers and Biopesticides
SY	III	3 theory + 1 Practical BOMAT-231 Angiosperms' Taxonomy BOMAT-232 Phyto-Physiology BOMAT-233 Plant Ecology BOMAP-234 Practical botany III	0	1 Theory + 1 Practical BOMIT-231 Nursery and Gardening Management. BOMIP-232 Nursery and Gardening Management	1 Theory BOVST-231 Herbal Technology	0	1 theory BOGET-131 Agriculture for Competitive Exams	
	IV	3 theory + 1 Practical BOMAT-241 Reproductive Plant Biology BOMAT-242 Plant Biotechnology BOMAT-243 Cell Biology BOMAP-244 Practical botany IV	0	1 Theory + 1 Practical BOMIT-241 Landscape Designing BOMIP-242 Landscape Designing	0	0	1 Practical BOGEP-141 Ayurvedic Botany	1 Practical BOSEP-241 Plant Identification and Herbarium

Botany (NEP)

B. Sc. Botany

RMC

TY	V	3 theory + 2 Practical BOMAT-351 Lower Cryptogamic Botany BOMAT-352 Advanced Phyto-Physiology BOMAT-353 Molecular Biology BOMAP-354 Practical botany V BOMAP-355 Practical botany VI	1 Theory + 1 Practical BOMET-351 A Methods for Plant conservation BOMET-351 B Study of Medicinal plants BOMEPE-357 A Elective Practicals botany 2 A BOMEPE-357 B Elective Practicals botany 2 B	1 Theory + 1 Practical BOMIT-351 Medicinal Botany BOMIP-352 Medicinal Botany	1 Practical BOVSP- 351 Practical on Herbal Technology	0	0	0
	VI	3 theory + 2 Practical BOMAT- 361 Phytochemistry BOMAT-362 Plant Pathology BOMAT-363 Advance Plant Ecology BOMAP-364 Practical botany VII BOMAP-365 Practical botany VIII	1 Theory + 1 Practical BOMET-361 A Computational Botany BOMET-361 B Basis of Agroforestry BOMEPE-362 A Elective practicals botany 2A BOMEPE-361B Elective practicals botany 2B	1 Theory +1 Practical BOMIT-361 Environmental Botany BOMIP-362 Environmental Botany	0	0	0	0

VII and VIII Sem honours degree with Major and Minor									
Year	Sem	Major Courses	Major Elective Courses	OJT/ RP	Minor Courses	V	S	GE /OE	SEC
4 th Yr Honours With Major	VII	5 Theory + 2 Practical BOMAT-471 Plant Systematics - I (Algae & Fungi) BOMAT-472 Advanced Cell Biology BOMAT-473 Genetics & Plant Breeding BOMAT-474 Plant Organism Interaction BOMAT-475 Floriculture and Pomoculture BOMAP-476 Practical Botany IX BOMAP-477 Practical Botany X	1 Theory + 1 Practical BOMET -471A Crop Physiology BOME P -471B Practical on Crop Physiology BOMET-472A Pharmacognosy BOME P- 472B Practical on Pharmacognosy	0	RM (2T+2P) 4 credits BORMT -471 Research Methodology BORMP -472 Practical on Research Methodology	0	0	0	0
	VIII	5 Theory + 2 Practical BOMAT- 481 Plant Systematics - II (Bryophytes and Pteridophytes) BOMAT-482 Advanced Molecular Biology BOMAT-483 Biostatistics BOMAT-484 Tools and Techniques in Plant Science BOMAT-485 Plant Evolution BOMAP-486 Practical Botany XI BOMAP-487 Practical Botany XII	1 Theory + 1 Practical BOMET-481A Applied Biotechnology and Nanotechnology BOME P-481B Practical on Applied Biotechnology and Nanotechnology BOMET-482A Biodiversity BOME P- 482B Practical on Biodiversity	4OJT BOOJT -481	0	0	0	0	0
VII and VIII Sem honours degree with research									
4th Yr. Honours With Research	VII	4 Theory + 1 Practical BOMAT-471R Plant Systematics - I (Algae & Fungi) BOMAT-472R Advanced Cell Biology BOMAT-473R Genetics & Plant Breeding BOMAT-474R Plant Organism Interaction BOMAP-475R Practical botany IX	1 Theory + 1 Practical BOMET -471AR Crop Physiology BOME P -471BR Practical on Crop Physiology BOMET-472AR Pharmacognosy BOME P- 472BR Practical on Pharmacognosy	4RP BORPP -471R	RM (2T+2P) 4 credits BORMT - 471R Research Methodology BORMP - 472R Practical on Research Methodology	0	0		
	VIII	4 Theory + 1 Practical BOMAT-481R Plant Systematics - II (Bryophytes and Pteridophytes) BOMAT-482R Advanced Molecular Biology BOMAT-483R Biostatistics BOMAT-484R Tools and Techniques in Plant Science BOMAT-485R Plant Evolution BOMAP-486R Practical botany XI	1 Theory + 1 Practical BOMET-481AR Applied Biotechnology and Nanotechnology BOME P-481BR Practical on Applied Biotechnology and Nanotechnology BOMET-482AR Biodiversity BOME P- 482BR Practical on Biodiversity	6RP BORPP -481R	0	0	0		

Program: B.Sc. [Botany], 2026-27

Program Outcomes (POs)

After completing this course, students will be able to:

- 1. Understanding Plant Diversity**
Demonstrate comprehensive knowledge of plant diversity, including lower and higher plants, their evolution, classification, and ecological roles.
- 2. Morphological and Anatomical skill**
Apply detailed knowledge of plant morphology and anatomy to identify plant structures and explain their functions across various plant groups.
- 3. Taxonomy and Systematics Skills**
Develop skills in the identification, nomenclature, and classification of plants using traditional and modern taxonomic principles.
- 4. Knowledge of Plant Physiology and Biochemistry**
Understand the physiological processes and biochemical mechanisms in plants, including photosynthesis, respiration, nutrient transport, and hormonal regulation.
- 5. Ecological and Environmental Awareness**
Analyse ecological principles, plant-environment interactions, and the role of plants in ecosystem stability and climate adaptation.
- 6. Cell and Molecular Biology Foundations**
Demonstrate a sound understanding of cell biology, genetics, and molecular biology with applications in plant development and biotechnology.
- 7. Skill in Applied Botany and Technology**
Apply theoretical and practical knowledge in areas like floriculture, medicinal plants, agroforestry, tissue culture, and plant biotechnology for sustainable development.
- 8. Hands-on Laboratory and Field Techniques**
Acquire competence in laboratory techniques, herbarium preparation, field studies, and modern tools used in plant science research.
- 9. Use of Biostatistics and Computational Tools**
Utilize statistical methods and computational software for data analysis in plant science research and reporting.
- 10. Problem Solving and Research Aptitude**
Identify plant-related problems and propose scientific solutions using investigative and experimental methods.
- 11. Ethical and Sustainable Practices**
Promote sustainable use of plant resources with ethical awareness in the conservation of biodiversity and natural habitats.
- 12. Entrepreneurial and Vocational Readiness**
Gain skills in mushroom cultivation, nursery management, herbal product development, and other vocational aspects to support self-employment and entrepreneurship.
- 13. Indigenous and Traditional Knowledge Integration**
Appreciate and integrate traditional Indian knowledge systems in agriculture and plant utilization practices.
- 14. Learning and Competitive Exam**
Foster a mind-set for continuous learning, innovation, and readiness for competitive exams, higher studies, and diverse career paths in botany and allied sciences

Program Specific Outcomes (PSOs)

1. **PSO 1: Mastery of Plant Classification and Biodiversity**
Students will be able to classify and differentiate between diverse plant groups using taxonomic principles and demonstrate expertise in documenting plant biodiversity through field and herbarium techniques.
2. **PSO 2: Competence in Plant Structure and Physiology**
Students will be able to analyse the anatomical features and physiological processes of plants to explain growth, development, and adaptation mechanisms under various environmental conditions.
3. **PSO 3: Understand and Application of Molecular and Cellular Biology in Plant Science**
Students will be able to apply cellular, genetic, and molecular biology concepts in understanding plant functions and in developing solutions for crop improvement and biotechnology-based applications.
4. **PSO 4: Practical Skills in Laboratory, Fieldwork, and Research**
Students will be able to conduct laboratory experiments, perform ecological and environmental assessments, and utilize biostatistics and computational tools in scientific research and reporting.
5. **PSO 5: Integration of Traditional Knowledge and Modern Practices**
Students will be able to integrate indigenous knowledge systems with modern scientific practices for the sustainable use of plant resources in agriculture, medicine, and environmental conservation.

P. D. E. A's
Prof. Ramkrishna More Arts, Commerce and Science
College Akurdi Pune-411044
(Autonomous)

Affiliated to



Savitribai Phule Pune University [SPPU]



B. Sc. Major Botany With Honours
(Three years B. Sc. in Botany / Four Years Honors in Botany)

2023 Pattern

Choice Based Credit System-2023 Pattern
Under
Autonomy and NEP-2020

From Academic Year
2026-2027

Syllabus

B. Sc. Botany with Honours

Board of Studies in Botany
Department of Botany
Prof. Ramkrishna More Arts, Commerce and Science
College Akurdi Pune-411044

Department of Botany
B. Sc. Botany Honours with Major

Sr. No.	Subject Code	Subject Name	Allotted Credit	No. of L/P	Allotted Workload
Sem VII					
Major Theory + 2 Practical					
1	BOMAT 471	Plant Systematics – I (Algae & Fungi)	2	30L	2
2	BOMAT 472	Advanced Cell Biology	2	30L	2
3	BOMAT 473	Genetics & Plant Breeding	2	30L	2
4	BOMAT 474	Plant organism Interaction	2	30L	2
5	BOMAT 475	Floriculture and Pomoculture	2	30L	4
6	BOMAP 476	Practical Botany IX	2	12P	4
7	BOMAP 477	Practical Botany X	2	12P	4
Major Elective Course 1 Theory + 1 Practical					
8	BOMET 471A	Crop Physiology	2	30L	2
9	BOMET 472A	Pharmacognosy	2	30L	2
10	BOMEPE 471B	Practical on Crop Physiology	2	12P	4
11	BOMEPE 472 B	Practical on Pharmacognosy	2	12P	4
Minor Course					
12	BORMT 471	Research Methodology	2	30L	2
13	BORMP 472	Practical on Research Methodology	2	12P	4
Sem VIII					
Major Theory + 2 Practical					
1.	BOMAT 481	Plant Systematics - II (Bryophytes and Pteridophyte)	2	30L	2
2.	BOMAT 482	Advanced Molecular Biology	2	30L	2
3.	BOMAT 483	Biostatistics	2	30L	2
4.	BOMAT 484	Tools and Techniques in Plant Science	2	30L	2
5.	BOMAT 485	Plant Evolution	2	30L	2
6.	BOMAP 486	Practical Botany XI	2	12P	4
7.	BOMAP 487	Practical Botany XII	2	12P	4
Major Elective 1 Theory + 1 Practical					
8.	BOMET 481A	Applied Biotechnology and Nanotechnology	2	30L	2
9.	BOMET 482A	Biodiversity	2	30L	2
10.	BOMEPE 481B	Practical on Applied Biotechnology and Nanotechnology	2	12P	4
11.	BOMEPE 482B	Practical on Biodiversity	2	12P	4
OJT					
12.	BOOJT 481	On Job Training	4		

Department of Botany
B. Sc. Botany Honours with Research

Sr. No.	Subject Code	Subject Name	Allotted Credit	No. of L/P	Allotted Workload
Sem VII					
Major Theory + 1 Practical					
1	BOMAT 471R	Plant Systematics – I (Algae & Fungi)	2	30L	2
2	BOMAT 472R	Advanced Cell Biology	2	30L	2
3	BOMAT 473R	Genetics & Plant Breeding	2	30L	2
4	BOMAT 474R	Plant organism Interaction	2	30L	2
5	BOMAP 476R	Practical Botany IX	2	12P	4
Major Elective Course 1 Theory + 1 Practical					
6	BOMET 471AR	Crop Physiology	2	30L	2
7	BOMET 471BR	Pharmacognosy	2	30L	2
8	BOMEPP 472AR	Practical on Crop Physiology	2	12P	4
9	BOMEPP 472BR	Practical on Pharmacognosy	2	12P	4
Minor Course					
10	BORMT 471R	Research Methodology	2	30L	2
11	BORMP 472R	Practical on Research Methodology	2	12P	4
Project					
12	BORPP 471R	Research Project I	4		
Sem VIII					
Major Theory + 1 Practical					
1	BOMAT 481R	Plant Systematics - II (Bryophytes and Pteridophyte)	2	30L	2
2	BOMAT 482R	Advanced Molecular Biology	2	30L	2
3	BOMAT 483R	Biostatistics	2	30L	2
4	BOMAT 484R	Tools and Techniques in Plant Science	2	30L	2
5	BOMAT 485R	Plant Evolution	2	30L	2
6	BOMAP 486R	Practical Botany XI	2	12P	4
Major Elective 1 Theory + 1 Practical					
7	BOMET 481AR	Applied Biotechnology and Nanotechnology	2	30L	2
8	BOMET 481BR	Biodiversity	2	30L	2
9	BOMEPP 482AR	Practical on Applied Biotechnology and Nanotechnology	2	12P	4
10	BOMEPP 482BR	Practical on Biodiversity	2	12P	4
Project					
11	BORPP 471R	Research Project II	6	180 Hr	

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B. Sc. Botany with Honours
(Three years B. Sc. in Botany / Four Years Honours in Botany)

2023 Pattern

Choice Based Credit System-2023 Pattern

Under
Autonomy and NEP-2020

From Academic Year
2026-2027

Syllabus

B. Sc. Botany with Honours

Major-Theory and Practical

Board of Studies in Botany
Department of Botany
Prof. Ramkrishna More Arts, Commerce and Science College
Akurdi Pune-411044

Course	: Major	Total Credit	: 2
Code	: BOMAT 471	Course Type	: Theory
Subject	: Plant Systematics – I (Algae & Fungi)	Total Lecture	: 30L

Module - I : Algae		15L
Chapter 1	Introduction to Algae 1.1 Introduction to Algal diversity 1.2 Position of Algae in Domains & Kingdom 1.3 Classification systems of algae	3L
Chapter 2	Study of Cyanophyta and Chlorophyta 2.1 Introduction to Cyanophyta 2.2 structural and reproductive features of Cyanophyta 2.3 introduction to Chlorophyta 2.4 structural and reproductive features of Chlorophyta	3L
Chapter 3	Study of Charophyta & Euglenophyta 3.1 Introduction to Charophyta, 3.2 Structural and reproductive features of Charophyta 3.3 Introduction to Euglenophyta 3.4 Structural and reproductive features of Euglenophyta	3L
Chapter 4	Study of Chrysophyta, Xanthophyta, Bacillariophyta, & Dinophyta 4.1 Introduction to Chrysophyta, Xanthophyta, Bacillariophyta, & Dinophyta 4.2 Structural and reproductive features of - Chrysophyta, Xanthophyta, Bacillariophyta, & Dinophyta	3L
Chapter 5	Study of Phaeophyta & Rhodophyta 5.1 Introduction to Phaeophyta & Rhodophyta 5.2 Structural and reproductive features of - Phaeophyta & Rhodophyta	3L
Module - II : Fungi		15L
Chapter 6	Introduction to Fungi 6.1 Position of Fungi in Domains & Kingdom 6.2 Classification of fungi as per Ainsworth et al system (1973) 6.3 Contribution of fungal studies in India and world	2L
Chapter 7	Study of Myxomycotina 7.1 Distinguishing characters 7.2 Types of Plasmodium and fruit bodies 7.3 Life cycle pattern	2L
Chapter 8	Study of Mastigomycotina 8.1 Distinguishing characters 8.2 Thallus structure in Mastigomycotina 8.3 Life cycle pattern of Mastigomycotina	2L
Chapter 9	Study of Zygomycotina 9.1 Distinguishing characters 9.2 Thallus structure in Zygomycotina 9.3 Heterothallism and sexual reproduction in Zygomycotina 9.4 Life cycle pattern of Zygomycotina	3L

Chapter 10	Study of Basidiomycotina 10.1 Distinguishing characters 10.2 Thallus structure in Basidiomycotina 10.3 Types and structure of basidia and basidiocarps in Basidiomycotina 10.4 Life cycle pattern of Basidiomycotina	3L
Chapter 11	Study of Deuteromycotina 11.1 Distinguishing characters 11.2 Thallus structure in Deuteromycotina 11.3 fructifications, types of conidia & conidial ontogeny in Deuteromycotina 11.4 Life cycle pattern of Deuteromycotina	3L

Suggested Readings:

1. Lee R.E. (2008). Phycology. Cambridge University Press, pp.547
2. Ainsworth, Sussman and Sparrow (1973). The fungi. Vol IV A & IV B. Academic Press.
3. Brodie J. and Lewis J. (2007). (Ed.) Unravelling the algae: the past, present and future of algal systematics. CRC press, New York, pp 335.
4. Misra J.N. (1996). Phaeophyceae in India. ICAR, New Delhi
5. Prescott G.W. (1969). The algae
6. Smith G.M. (1950). The fresh water algae of the United States, Mc-graw Hill
7. Sharma O.P. Algae
8. Vashista B.R, Sinha A.K and Singh V.P. (2005). Botany for degree students – Algae, S. Chand's Publication
9. Alexopolous C.J., Minns C.W. and Blackwell M. (1999). (4th edn) Introductory Mycology. Willey, New York, Alford
10. R.A.Deacon J.W. (2006). Fungal Biology (4thEd.) Blackwell Publishing, ISBN. 1405130660.
11. Kendrick B. (1994). The fifth kingdom (paperback), North America, New York Publisher: 3rd edn, ISBN- 10: 1585100226.
12. Kirk et al. (2001). Dictionary of fungi, 9th edn, Wallingford: CABI, ISBN: 085199377X.

Course Outcome

After successful completion of this course, students will be able to....

CO1: Algal diversity in terms of thallus organization, reproduction and life history.

CO2: Detailed study of important groups of algae Cyanophyta, Chlorophyta, Xanthophyta, Bacillariophyta, Phaeophyta & Rhodophyta

CO3: Fungal diversity with respect to general Characters and reproduction.

CO4: Fungal taxonomy and classification systems for fungi

Course : Major

Total Credit : 2

Code : BOMAT 472

Course Type : Theory

Subject : Advanced Cell Biology

Total Lecture : 30L

Module - I: Cellular Processes		15L
Chapter 1	Cell Cycle 1.1. Phases of cell cycle 1.2. Structural and functional importance of each phase 1.3. Check points, Cyclins and protein kinases 1.4. Molecular events and Regulation of cell cycle	4L
Chapter 2	Vesicular Trafficking 2.1. Concept of Vesicular Trafficking 2.2. Intracellular vesicular trafficking from endoplasmic reticulum through Golgi apparatus to cell exterior.	5L
Chapter 3	Programmed cell death (PCD) 3.1. Concept of PCD 3.2. Molecular aspects of PCD 3.3. Role of different genes cell organelles during apoptosis 3.4. Genetic control of apoptosis	6L
Module - II : Signal Transduction		15L
Chapter 4	Basics of Cell Biology 4.1. Universal features of Cell 4.2. Cell theory 4.3. Introduction to signalling transduction	2L
Chapter 5	Receptors in plants 5.1. Types of receptors in plants 5.2. Structure, function and importance of receptors in plants	2L
Chapter 6	Ca²⁺ Calmodulin cascade 6.1. Structure of Ca ²⁺ Calmodulin cascade 6.2. Function and importance of Ca ²⁺ Calmodulin cascade.	2L
Chapter 7	Phospholipid Signalling 7.1. Types and Structure of Phospholipid Signalling 7.2. Significance of Phospholipid Signalling	2L
Chapter 8	Signalling mechanisms under Stress conditions in plants 8.1. Specific signalling mechanisms under abiotic stress condition in plants 8.2. Specific signalling mechanisms under biotic stress condition in plants	2L
Chapter 9	Hormone mediated Signalling in Plants 9.1 Role of Auxin in hormone mediated Signalling in Plants 9.2 Role of Cytokinin hormone mediated Signalling in Plants 9.3 Role of ABA hormone mediated Signalling in Plants	3L
Chapter 10	Special Signalling mechanism in Plants 10.1 Two Component signalling mechanism in Plants 10.2 Organelle targeting signalling transduction 10.3 Diversity in protein kinases and phosphatases	2L

Suggested Readings:

1. Alberts B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Watson, J. D. 1989. Molecular biology of the Cell (2nd edition). Garland Pub. Inc., New York.
2. Karp, G. 1999. Cells and Molecular Biology: Concepts & Experiments. John Wiley and Sons, Inc., USA.
3. Lodish S, Baltimore B, Berk, C and Lawrence K, 1995, Molecular Cell Biology, 3rd edn, Scientific American Books, N.Y
4. De Robertis and De Robertis, 1988, Cell and Molecular Biology, 8th edn, Info-Med, Hongkong.

5. Buchanan, Grisse and Jones, 2000, Biochemistry and Molecular Biology of Plants, American Soc. Plant Biologists, Waldorf.
6. Lewin, B. 2000. GENE VII. Oxford University Press, New York, USA
7. Cooper G M and Hausman R E, 2007, The Cell: Molecular Approach 4th Edn, Sinauer Associates, USA.

Course Outcome

After successful completion of this course, students will be able to....

- CO1: Explain cell features, cell theory, and basics plant signal transduction.
- CO2: Analyse plant signaling pathways including hormones, phospholipid and stress responses.
- CO3: Describe cell cycle phases, checkpoints and regulatory proteins.
- CO4: Evaluate molecular mechanism of Programmed cell death and apoptosis.
- CO5: Apply knowledge of vesicular trafficking and organelle targeting signaling.

Course	: Major	Total Credit	: 2
Code	: BOMAT 473	Course Type	: Theory
Subject	: Genetics & Plant Breeding	Total Lecture	: 30L

Module - I : Classical Genetics		15L
Chapter 1	Basics of Genetics 1.1 Concept of gene 1.2 Concept of allele and multiple alleles	1L
Chapter 2	Introduction to Mendelian Genetics 2.1 Dominance 2.2 Segregation 2.3 Independent assortment	2L
Chapter 3	Neo-Mendelian Genetics 3.1 Codominance 3.2 Incomplete dominance 3.3 Gene interactions, pleiotropy 3.4 Genomic imprinting 3.5 Penetrance and expressivity	4L
Chapter 4	Sex linked inheritance 4.1 Concept of Sex linkage 4.2 Sex limited and sex influenced characters	1L
Chapter 5	Gene Linkage and Crossing over 5.1 Concept and significance of Gene Linkage 5.2 Mechanism and significance of Crossing over	1L
Chapter 6	Cytoplasmic inheritance 6.1 Maternal effect 6.2 Plastid Inheritance 6.3 Mitochondrial Inheritance	4L
Chapter 7	Microbial Genetics 7.1 Conjugation 7.2 Transformation 7.3 Transduction	2L
Module - II : Plant Breeding		15L
Chapter 8	Introduction to plant breeding 8.1 Concept of plant breeding 8.2 History of plant breeding 8.3 Objectives of plant breeding 8.4 Application of Plant Breeding	3L
Chapter 9	Domestication and evolution of agricultural crop 9.1 Domestication of agricultural crop 9.2 Pattern of evolution in crop	2L
Chapter 10	Selection methods in plant breeding 10.1 Types of Selection methods 10.2 Self-pollinated crops 10.3 The Pure line theory 10.4 Effect of self-pollination on genotype 10.5 Variation in the Pure line 10.6 Selection in cross-pollinated crops	4L
Chapter 11	Hybridization crop plants 11.1 Objective of Hybridization 11.2 Steps involved in the Hybridization	3L

Chapter 12	Mutation in crop improvement 12.1 Spontaneous and induced mutation 12.2 Mechanism of action of Radiation 12.3 Chemical mutagen 12.4 Advantages and limitations of Mutation breeding	3L
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Suggested Readings:

1. Hartle D.L and Jones, E.W 1998 Genetics: Principles and Analysis (Fourth Edition). Jones and Bartlett Publishers, Massachusetts, USA.
2. Singh B.D 1996 Plant Breeding Principles and methods. Kalyani Publications, Ludhiana
3. Khush, G.S 1973. Cytogenetics of Aneuploids. Academic Press, New York, Lewis, R. 1997. Human Genetics: Concepts and Application (Second Edition). WCB McGraw Hill, USA.
4. Snustad, D.P & Simmons, M.J 2000. Principles of Genetics (Second Edition). John Wiley and Sons Inc., USA.
5. Strickberger 2005. (Third Edition). Genetics. Prentice Hall of India Pvt. Ltd., New Delhi.
6. Chahal GS & Gosal SS 2002. Principles & Procedures of Plant Breeding, Narosa Publishing House, New Delhi.
7. Phundan Singh Plant Breeding Kalyani Publications

Course Outcome**After successful completion of this course, students will be able to....**

CO1: Mendelian principles of heredity, Non-Mendelian, and Cytoplasmic inheritance

CO2: Sex linkage, sex limited and sex influenced characters as well as Microbial Genetics

CO3: History and objectives of plant breeding, domestication of crops and their evolution pattern, self-pollinated and cross-pollinated crops.

CO4: Hybridization and Mutation and application in plant breeding.

Course	: Major	Total Credit	: 2
Code	: BOMAT 474	Course Type	: Theory
Subject	: Plant Organism Interactions	Total Lecture	: 30L

Module - I : Plant- Plant interactions		15L
Chapter 1	Basics of Plant –Plant interactions 1.1 Introduction to Plant - Plant Interaction 1.2 Types of Plant - Plant interactions	2L
Chapter 2	Allelopathy in plants 2.1 Allelopathic plants 2.2 Native verses Invasive Plants	3L
Chapter 3	Types of interactions 3.1 Mutualism- obligate vs facultative Mutualism 3.3 Specific verses diffuse association 3.4 Exhabitional verses inhabitional Association 3.5 Mutualism verses other species interactions	3L
Chapter 4	Competitive mechanisms in Plants 4.1 Mechanisms of plant competition for nutrients 4.2 Mechanisms of plant competition for water 4.3 Mechanisms of plant competition for light 4.4 Complexity of resources 4.5 Pre-emption theory	4L
Chapter 5	Epiphytic plants 5.1 Definition 5.2 General characteristics and distribution 5.4 Adaptations and examples	3L
Module - II : Organisms - plant Interaction		15L
Chapter 6	Introduction to Organisms - plant Interaction 6.1 Herbivores Insect- plant interaction 6.2 Grazing animals – physical and biochemical interactions	2L
Chapter 7	Plant defence against herbivores 7.1 Plant signalling and defence against herbivores 7.2 Genetic engineering in plants for improved tolerance against herbivores	2L
Chapter 8	Adaptations in Carnivorous plants 8.1 Morphological features 8.2 Specialized biochemical mechanisms for nutrient processing	5L
Chapter 9	Plant interaction in Lichens and Fungi 9.1 Mycorrhizae, Nodulating bacteria 9.2 Algae-coral, Fungal-insect relationships	2L
Chapter 10	Pollination & dispersal biology 10.1 Pollination types & mechanism Pollination 10.2 Types & mechanism Pollinators- bees, beetles, butterflies, birds & mammal's 10.3 Co-evolution of pollinators & plants 10.4 Fig-fig wasp interaction, Humming birds-plant interaction 10.6 Seed dispersal mechanisms-fruit & seed morphology relevant to seed dispersal.	4L

Suggested Readings:

1. Carlos M. Herrera, Olle Pellmyr 2002 “Plant Animal Interactions: An Evolutionary Approach”
2. Jan Schirawski and Michael H. Perlin “Plant Microbe Interaction” 2017.
3. Zdenek Lastuvka, Barbara Politycka, S. S. Narwal, Jana Kalinova 2007, “Coactions and Competition in Higher Plants”, Scientific Publisher (India).

4. Malcolm C. Press, Jonathan D. Graves 1995, "Parasitic Plants", Chapman & Hall, 2-6 Boundary Row, London.

Course Outcome

After successful completion of this course, students will be able to....

- CO1: The different types of interactions and competitive mechanisms in plants.
- CO2: Genetic engineering in plants for improving tolerance capacity against herbivores.
- CO3: Relationship between algal & coral as well as fungal & insects.
- CO4: Explain allelopathic plants and their nature of interaction.
- CO5: Discuss the relationship between plant plant and plant organism interaction.

Course : Major**Total Credit : 2****Code : BOMAT 475****Course Type : Theory****Subject : Floriculture & Pomoculture****Total Lecture : 30L**

Module - I : Floriculture		15L
Chapter 1	Introduction to Floriculture 1.1 Concept and definition, of floriculture 1.2 Global and Indian scenario of floriculture 1.3 Scope and Importance of floriculture in India	1L
Chapter 2	Pre-requisites of Commercial floriculture 2.1 Soil and climate requirements 2.2 Field preparation 2.3 Systems of planting 2.4 Water and nutrient management 2.5 Pruning, training, manuring and aftercare 2.6 Weed management 2.7 Use of plant growth regulators 2.8 Special horticultural practices Commercial application of Floriculture	5L
Chapter 3	Harvesting and processing of flowers 3.1 Harvesting indices and harvesting techniques 3.2 Value addition, concrete and essential oil extraction 3.3 Harvesting techniques – grading and packing 3.4 Post-harvest handling: Pre cooling and storage	4L
Chapter 4	Commercial production of flowers 4.1 Introduction to Commercial varieties of flowers; Varietal wealth and diversity 4.2 Introduction to pests, diseases and their control measures for Commercial flowers varieties 4.3 Transportation and marketing, Agri-export zones 4.4 Export potential of cut flowers with special reference to Chrysanthemum, Gerbera, Tuberose, Anthurium; Loose flowers- Scented Rose and Jasmine	5L
Module - II : Pomoculture		15L
Chapter 5	Introduction to Pomoculture 5.1 Definition and concept of Pomoculture 5.2 Present status and scope of fruit growing in Maharashtra and India	2L
Chapter 6	Pre-requisites of Pomoculture 6.1 Growth and fruiting habits, 6.2 Fruit bud differentiation, fruit setting, fruit drop, seedlessness, Cracking of fruits, problems of fruiting 6.3 Role of plant growth substances 6.4 Pruning and training 6.5 Bahar treatment and Unfruitfulness	5L
Chapter 7	Commercial Production of Fruits 7.1 Varietal wealth and diversity, climate, soil preparation, 7.2 Aftercare and manuring, pruning and training, 7.3 Pests and diseases and control measures, 7.4 Harvesting and marketing of fruits, 7.5 Care after picking, packing of fruits, 7.6 Systems of marketing, export potential, air transport, transport by sea, 7.7 Cold storage of fruits	5L
Chapter 8	Dryland Pomoculture 8.1 Importance of dryland fruits	3L

	8.2 Selection of dry land fruits 8.3 Rainwater management	
Chapter 9	Organic Horticulture 9.1 Definition, Synonyms and misnomers 9.2 Principles, methods, merits and demerits, 9.3 Organic farming system	

Suggested Readings:

1. Carlos M. Herrera, Olle Pellmyr 2002 "Plant Animal Interactions: An Evolutionary Chadha K. L and Pareek O. P Advances in Horticulture Vol. IV, Malhotra Publications
2. Arora J. S Introductory Ornamental Horticulture Kalyani Publications
3. Sudheer K. P and Indira V Post Harvest Technology of Horticultural Crops New Delhi
4. Bose T. K and Yadav L. P Commercial Flowers Naya Prokash

Course Outcome

After successful completion of this course, students will be able to....

CO1: Apply concepts of Floriculture science to select, manage, and improve plants and their products

CO2: Demonstrate competence with laboratory and/or field-based technologies used in modern Floriculture

CO3: Commercial product of fruits

Course : Major
 Code : BOMAP 476
 Subject : Practical Botany IX

Total Credit : 2
 Course Type : Practical
 Total Practical : 12

Sr. No	Practical Botany (Practical Based on BOMAT 471 & 472)	12P
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Based on BOMAT 471 Plant Systematics-I (Algae & Fungi)

- | | | |
|----|---|----|
| 1. | Handling of compound microscope and methods to study algae | 1P |
| 2. | Macro & Microscopic, observations, classification with reasons of taxa belonging to the following group (One forms from each group) | 2P |
| | 1. Cyanophyta (<i>Nostoc</i>)
2. Chlorophyta (<i>Hydrodictyon</i>)
3. Charophyta (<i>Chara</i>)
4. Rhodophyta (<i>Batrachospermum</i>)
5. Phaeophyta (<i>Sargassum</i>) | |
| 3. | Study of vegetative, reproductive structures and classification with reasons of the representative genera belonging to following sub-divisions (One forms from each group) | 3P |
| | 1. Myxomycotina (<i>Stemonitis</i>)
2. Mastigomycotina (<i>Synchytrium</i>)
3. Zygomycotina (<i>Rhizopus</i>)
4. Ascomycotina (<i>Aspergillus</i>)
5. Basidiomycotina (<i>Puccinia</i>)
6. Deuteromycotina (<i>Cercospora</i>) | |

Based on BOMAT 472 Advanced Cell Biology

- | | | |
|----|--|----|
| 4. | Isolation of Chloroplasts to study Hill reaction to measure intactness | 1P |
| 5. | Isolation of Mitochondria for Estimation of succinic dehydrogenase activity. | 1P |
| 6. | Isolation of Lysosomal fraction and estimation of acid phosphatase activity | 1P |
| 7. | Study of induced cell senescence in leaf discs | 1P |
| 8. | Study of cell cycle using BrdU (demonstration). | 1P |
| 9. | Study of programmed cell death in plants. | 1P |

Suggested Readings:

- Vashishta, B. R., Sinha, A. K., & Singh, V. P. (2014). Botany for Degree Students: Algae. S. Chand Publishing. (Excellent for Cyanophyta, Chlorophyta, and Phaeophyta descriptions).
- Vashishta, B. R., & Sinha, A. K. (2016). Botany for Degree Students: Fungi. S. Chand Publishing. (Detailed keys for Myxomycotina through Deuteromycotina).
- Lee, R. E. (2018). Phycology. Cambridge University Press. (Modern classification and structural details of Algae).
- Plummer, D. T. (1988). An Introduction to Practical Biochemistry. Tata McGraw-Hill. (Best for protocols on Mitochondria isolation and SDH activity).

5. Sadasivam, S., & Manickam, A. (2008). Biochemical Methods. New Age International. (Standard protocols for Chloroplast isolation and Hill Reaction).
6. Hardin, J., Bertoni, G., & Kleinsmith, L. J. (2015). Becker's World of the Cell. Pearson. (Theoretical grounding for Cell Senescence, PCD, and BrdU labeling).

Course Outcome

After successful completion of this course, students will be able to....

CO1: The macro and microscopic characters and classification of different algal groups.

CO2: The vegetative, reproductive, and classification of different subdivisions of fungi

CO3: The cellular components are used to generate and utilize energy in cells.

Course : Major
Code : BOMAP 477
Subject : Practical Botany X

Total Credit : 2
Course Type : Practical
Total Practical : 12

Sr. No	Practical Botany (Practical Based on BOMAT 473, 474, 475)	12P
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Based on BOMAT 473 Genetics & Plant Breeding

- | | | |
|----|--|----|
| 1. | Study of Mitosis and Meiosis | 1P |
| 2. | Problems based on Mendelian Inheritance and analysis of F ₂ data by Chi-square Test, Gene and Genotypic frequencies, Gene Mapping | 1P |
| 3. | Study of polygenic inheritance by using suitable trait. | 1P |
| 4. | Use of Colchicine for induction of polyploidy in appropriate plant material. | 1P |
| 5. | Karyotype analysis, and preparation of C- metaphase chromosomes of appropriate material | 1P |
| 6. | Study of Meiotic configuration | 1P |

Based on BOMAT 474 & 475 Plant Organism Interaction and Floriculture & Pomoculture

- | | | |
|-----|---|----|
| 7. | Study of Parasitic, Epiphytic, Carnivorous Plant | 1P |
| 8. | In-vitro Alleopathic studies | 1P |
| 9. | Study of seed dispersal mechanism in plants | 1P |
| 10. | Propagation method for the economically important ornamental plants | 1P |
| 11. | Study of Grafting and budding method | 1P |
| 12. | Study of Air Layering and cutting method | 1P |

Suggested Readings:

1. Fukui, K., & Nakayama, S. (1996). Plant Chromosomes: Laboratory Methods. CRC Press. (Excellent for Karyotype analysis and C-metaphase preparation).
2. Sharma, A. K., & Sharma, A. (1999). Chromosome Techniques: Theory and Practice. Butterworth-Heinemann. (The definitive guide for Colchicine treatment and Mitosis/Meiosis staining).
3. Klug, W. S., Cummings, M. R., Spencer, C. A., & Palladino, M. A. (2018). Concepts of Genetics. Pearson. (Best for solving Mendelian problems, Chi-square tests, and Gene Mapping).
4. Rice, E. L. (1984). Allelopathy. Academic Press. (The foundational text for designing In-vitro Allelopathic studies).
5. Hartmann, H. T., Kester, D. E., Davies, F. T., & Geneve, R. L. (2011). Plant Propagation: Principles and Practices. Prentice Hall. (The world-standard reference for Grafting, Budding, Layering, and Cuttings).
6. Bose, T. K., & Yadav, L. P. (1989). Commercial Flowers. Naya Prokash. (Specific propagation methods for Ornamental plants).

Course Outcome

After successful completion of this course, students will be able to....

- CO1: The basic principles of inheritance at the molecular, cellular and organism levels.
 CO2: Students will learn the mechanism of seed dispersal in plants
 CO3: Different methods of propagation

Course : Major**Total Credit : 2****Code : BOMET 471A****Course Type : Theory****Subject : Crop Physiology****Total Lecture : 30L**

Module - I :		15L
Chapter 1	Introduction to Crop Physiology 1.1 Introduction – Importance of crop physiology in agriculture and horticulture 1.2 Crop physiological aspects of rice, wheat, maize, sorghum, millets, sugarcane, pulses, oil seeds, cotton Crops 1.3 Sustainable Agriculture	5L
Chapter 2	Plant Water Relations 2.1 Role & significance of water- diffusion, imbibition, osmosis & its significance Field capacity, water holding capacity of soil Plasmolysis and Permanent wilting point Absorption of water - mode of water absorption, active and passive absorption Factors affecting absorption Translocation of solutes - phloem and xylem transport, Transpiration - types - Steward's theory of mechanism - significance, Factors affecting transpiration, antitranspirants, and guttation	6L
Chapter 3	Mineral Nutrition/ Nutrio-Physiology 3.1 Introduction- criteria of essentiality of elements 3.2 Macro, secondary and micronutrients 3.3 Sand and soil less culture- hydroponics, Mechanism of uptake – 3.4 Physiological role of nutrients Foliar diagnosis - nutritional and physiological disorders - foliar nutrition and fertigation 3.5 Role of Mineral Nutrition in crop productivity	4L
Module - II: Physiology of Plant Growth		15L
Chapter 4	Photosynthesis 4.1 Photosynthesis and significance in plant growth, Development and crop productivity, Energy utilization efficiency by crops 4.2 Growth- growth curve, phases of growth and factors influencing growth, 4.3 Growth analysis - LAI, LAD, SLW, SLA, LAR, NAR, RGR and CGR in relation to crop productivity, - Source sink relationship	7L
Chapter 5	Photoperiodism 5.1 Role of phytochrome in flowering and regulation of flowering. 5.2 Transmission of stimulus - theories of flowering- 5.3 Vernalisation – devernalisation	
Chapter 6	Plant Growth Regulators (PGRs) 6.1 Definition, classification and physiological role of PGRs 6.2 Synthetic growth regulators and their uses in crop productivity 6.3 Practical application of Plant Growth Regulators in crop productivity	
Chapter 7	Stress Physiology 7.1 Environmental stresses- Water stress - physiological changes, adaptation to drought and amelioration, 7.2 Temperature stress - low and high temperature, Physiological changes, chilling injury, tolerance, alleviation 7.3 Low light and UV radiation stresses 7.4 Salt stress - physiological changes and alleviation 7.5 Global warming- Carbon Sequestration, physiological effects on crop productivity Biotic Stress- Causal organisms- Virus, bacteria, fungi, insects and pests, control measures Strategies for development of new tolerant crop varieties	8L

Suggested Readings:

1. Bidwell, R.G.S. 1974. Plant Physiology. Macmillan Pub. Co., N.Y.
2. Taiz, L. and Zeiger, E. 2006. Plant Physiology. 4th Edition. Sinauer Associates, Sunderland, Massachusetts, USA
3. Salisbury F.B. and Ross C.B. 2005. Plant Physiology. 5th Edition. Wadsworth Publishing Co. Belmont CA.
4. Helgi O'Leary, Stephen A. Rolfe, Arthur J. Willis. 2005. The Physiology of Flowering Plants, Cambridge University Press, UK
5. Kirkham, M.B. 2004. Principles of Soil and Plant Water Relations. Elsevier, Amsterdam, Netherlands.
6. Dennis, D.T., Turpin, D.H., Lefebvre, D.D. and Layzell, D.B. 1997. Plant Metabolism. 2nd Edition. Longman Group, U.K.
7. Fitter, A. and Hay, R.K.M. 2001. Environmental Physiology of Plants. Academic Press, UK.

Course Outcome**After successful completion of this course, students will be able to....**

- CO1: Understand: Explain physiological processes in major crops and the role of Sustainable Agriculture.
- CO2: Apply: Use Plant Growth Regulators (PGRs) and irrigation principles to enhance crop yield.
- CO3: Analyze: Examine growth indices (LAI, RGR, NAR) and source-sink relationships in relation to productivity.
- CO4: Evaluate: Assess the impact of environmental stresses (drought, salt, UV) and global warming on plant health.

Course	: Major	Total Credit	: 2
Code	: BOMEPP 471B	Course Type	: Practical
Subject	: Practical on Crop Physiology	Total Lecture	: 4hrs/Practical

Sr. No	Practical Botany (Practical Based on BOMAT 472A)	12P
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Practical Based BOMAT 471A Crop Physiology

1.	Preparation of solutions	1P
2.	Measurement of Relative Water content of Leaf	1P
3.	Study of Structure and Distribution of Stomata, Stomatal Index	1P
4.	Diagnosis of nutrient deficiencies for mineral nutrient	1P
5.	Study of rate of photosynthesis	1P
6.	Determination of sucrose content	1P
7.	Estimation of soluble protein.	1P
8.	Determination of starch content	1P
9.	Estimation of soluble proline	1P
10.	A) Effect of moisture and salinity stress on seedling growth, B) Measurement of chlorophyll stability index (CSI) in response to drought and salinity	1P
11	Effect of ABA on stomatal closure	1P
12	Field visit for foliar diagnosis.	1P

Suggested Readings:

1. Sadasivam, S., & Manickam, A. (2008). Biochemical Methods. New Age International. (The best resource for Starch/Sucrose estimation and Soluble Protein using Lowry's/Bradford method).
2. Thimmaiah, S. K. (2012). Standard Methods of Biochemical Analysis. Kalyani Publishers. (Detailed protocols for Chlorophyll Stability Index (CSI) and Proline estimation).
3. Plummer, D. T. (1988). An Introduction to Practical Biochemistry. McGraw-Hill. (Excellent for Preparation of solutions—molarity, normality, and buffers).
4. Dhopte, A. M., & Manuel, L. M. (2002). Principles and Techniques for Plant Scientists. Agrobios. (Highly recommended for Relative Water Content (RWC) and CSI in response to stress).
5. Malavolta, E. (1995). A Manual on Plant Cell Biology and Nutritional Diagnosis. (Useful for Diagnosis of nutrient deficiencies and field-based Foliar diagnosis).

Course Outcome

After successful completion of this course, students will be able to....

- CO1: Isolate and estimate the protein concentration
- CO2: Understand the physiology of stomata
- CO3: Know the importance of chlorophyll pigments

Course : Major Elective
Code : BOMET 472A
Subject : Pharmacognosy

Total Credit : 2
Course Type : Theory
Total Lecture : 30L

Module - I : Pharmacognosy I

15L

Chapter 1

Introduction to Pharmacognosy

2L

- 1.1 Definition and scope of Pharmacognosy: Historical background and current trends,
 1.2 Classification of crude drugs, Indian trade in medicinal and aromatic plants.

Chapter 2

Cultivation and collection of medicinal Plants:

3L

- 2.1 General aspects involved in cultivation of
 2.2 Medicinal plants. Factors affecting the cultivation of crude drugs. (I) Exogenous, (II) Endogenous factors, (III) Mineral supplements, (IV) Nutrients, (V) Soil and Soil fertility, (VI) Pest and Pest control, (VII) Plant Growth Regulators, (VIII) Genetic manipulators, and (IX) Diseases management of medicinal and aromatic plants

Chapter 3

Adulteration and Deterioration:

5L

- 3.1 Introduction, Types of Adulteration/ Substitution of Herbal drugs,
 3.2 Causes and Measures of Adulteration,
 3.3 Sampling Procedures, Determination of Foreign Matter, detection of heavy metals, pesticide residues, phytotoxin,
 3.4 microbial contamination in herbs and their formulations.

Chapter 4

Extraction Methods and Chromatography:

5L

- 4.1 General methods, types and principles of extraction.
 4.2 Selection of solvents for extraction and purification of extracts using chromatographic methods including TLC, HPLC and HPTLC.

Module - II : Pharmacognosy II

15L

Chapter 5

Ethnobotany: Ethnobotany in herbal drug evaluation,

3L

- 5.1 Impact of Ethnobotany in traditional medicine,
 5.2 Role of Ethno-pharmacology in drug evaluation,
 5.3 Reverse Pharmacology.

Chapter 6

Pharmacognostic study of drugs:

5L

- 6.1 With reference to source, cultivation, collection,
 6.2 macroscopic characters, and application – Isabgol (Plantago ovata), Aloes (Aloe vera), Digitalis (Digitalis purpurea), Dioscorea (Dioscorea bulbifera), Safed Musli (Chlorophytum borivillianum), Shatavari (Asparagus racemosus), Brahmi (Bacopa monnieri).

Chapter 7

Phyto-pharmaceuticals:

7L

- 7.1 Occurrence, isolation and characteristic features
 7.2 Chemical nature, uses in pharmacy, medicinal and health benefits of following. a) Carotenoids – i) α and β - Carotene ii) Xanthophyll (Lutein); b) Limonoids – i) d-Limonene ii) α - Terpineol; c) Saponins – i) Shatavarins; d) Flavonoids – i) Resveratrol ii) Rutin iii) Hesperidin iv) Naringin v) Quercetin; e) Phenolic acids- Ellagic acid; f) Vitamins; g) Tocotrienols and Tocopherols; h) Andrographolide (alkaloids), Glycolipids, Gugulipids, Withanolides, Vascine, Taxol and i) Miscellaneous

Suggested Readings:

1. Kokate C.K., Purohit A.P. and Ghokhale S.B (1996.) Text book of Pharmacognosy. Nirali Prakasshan, Pune
2. Rajopadhye A.A. and Upadhye AS. 2013. Determination of phenolic content and in vitro antioxidant potential of ethanol extract of seven sources of Ayurvedic drug 'Pittapapda'. Indian Journal of Natural Products and Resources 4(1): 81-87
3. Upadhye A. S., Rajopadhye A. A. and Kumbhalkar B. B. 2012. Pharmacognostic standardization to diminish involuntary adulteration and substitution in Ayurvedic herbs. Current Science 102(8): 1087-1088
4. Farooqui A.A. and Sreeramu B.S. (2001) Cultivation of medicinal and aromatic crops, University Press,
5. Wallis T.E. (2005) Text Book of Pharmacognosy, 5Th Edition, CBS.

Course Outcome**After successful completion of this course, students will be able to....**

- CO1: Understand the principles and methods of quality control of herbal drugs and the importance of standardization
- CO2: Explain techniques used to extract and isolate bioactive compounds from natural sources.
- CO3: Understand the cultural and traditional uses of medicinal plants.
- CO4: Understand the current trends in pharmacognosy research, of modern science with traditional knowledge.

Course	: Major	Total Credit	: 2C
Code	: BOMEPT 472B	Course Type	: Practical
Subject	: Practical on Pharmacognosy	Total Lecture	: 4hrs/Practical

Sr. No	Practical Botany (Practical Based on BOMET 472A)	12P
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Practical Based BOMET 472A Pharmacognosy

1.	To study the morphological and anatomical features of medicinal plants.	1P
2.	To extract active compounds from medicinal plants using different solvent.	2P
3.	To prepare different forms of herbal medicines.	2P
4.	To separate and identify compounds in plant extracts.	2P
5.	To determine the concentration of bioactive compounds in plant extracts.	2P
6.	To study the antimicrobial activity of plant extracts against microorganisms.	2P
7.	To separate and identify plant compounds using TLC.	1P

Suggested Readings:

1. Khandelwal, K. R. (2008). Practical Pharmacognosy: Techniques and Experiments. Nirali Prakashan. (The primary resource for Morphological/Anatomical study, TLC, and Extraction).
2. Kokate, C. K., Purohit, A. P., & Gokhale, S. B. (2014). Pharmacognosy. Nirali Prakashan. (Comprehensive guide for Active compound identification and Herbal medicine preparation).
3. Harborne, J. B. (1998). Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis. Chapman & Hall. (Essential for Active compound extraction and TLC separation).
4. Evans, W. C. (2009). Trease and Evans' Pharmacognosy. Elsevier Health Sciences. (The global standard for identifying Bioactive compounds and medicinal anatomy).
5. Mukherjee, P. K. (2002). Quality Control of Herbal Drugs: An Approach to Evaluation of Botanicals. Business Horizons. (Best for Concentration determination and quality assessment).
6. Cappuccino, J. G., & Welsh, C. (2017). Microbiology: A Laboratory Manual. Pearson. (Standard protocols for Antimicrobial activity using Disk Diffusion and MIC methods).

Course Outcome

After successful completion of this course, students will be able to....

- CO1: Identify different compounds based on their mobility on the TLC plate.
 CO2: Understand to extract bioactive compounds from medicinal plants using various techniques.
 CO3: Know the importance of chlorophyll pigments

Course	: Major	Total Credit	: 2
Code	: BORMT 471	Course Type	: Theory
Subject	: Research Methodology	Total Lecture	: 30L

Module - I : Foundation of Research Methodology**15L****Chapter 1 Introduction to Research****3L**

- 1.1 Meaning and definition of research
- 1.2 Objectives & significance of research
- 1.3 Introduction to research methodology
- 1.4 Importance of model organisms
- 1.5 Examples and their relevance

Chapter 2 Types of Research**4L**

- 2.1 Descriptive vs. analytical
- 2.2 Applied vs. fundamental
- 2.3 Quantitative vs. qualitative
- 2.4 Conceptual vs. empirical
- 2.5 Library, field, laboratory research & Survey based research
- 2.6 Introduction to wet lab research & In-silico research

Chapter 3 Determining a Research Problem**5L**

- 3.1 Overview of biological research problems
- 3.2 Meaning, sources & characteristics of a good research problem
- 3.3 Problem definition techniques
- 3.4 Characteristics of good research questions
- 3.5 Meaning, need & features of good research design
- 3.6 Hypothesis: Basis, formulation, directional & non-directional
- 3.7 General lab practices, hazards & safety (chemical, fire, radiation, electrical, noise)

Chapter 4 Data in Research**3L**

- 4.1 Observation & experimental methods
- 4.2 Primary vs. secondary data
- 4.3 Selecting appropriate data-collection tools
- 4.4 Maintaining lab notebooks
- 4.5 Sampling, Wet lab data, In-silico data & its importance

Module - II : Scientific Writing Skills**15L****Chapter 5 Basics of Scientific Writing****1L**

- 5.1 Structure, clarity & precision
- 5.2 Numbers, units, abbreviations, scientific nomenclature
- 5.3 Components: Abstract, introduction, methods, results, discussion
- 5.4 APA & MLA citation styles

Chapter 6 Concept of Literature Review**4L**

- 6.1 Purpose & structure of literature review
- 6.2 Methods of reviewing literature
- 6.3 INFLIBNET, Shodhganga, UGC CARE Journals
- 6.4 Use of Mendeley for reference management
- 6.5 Impact factor, peer reviewed journals
- 6.6 Avoiding predatory journals
- 6.7 Introduction to AI tools in research writing

Chapter 7 Data Presentation Tools & Techniques**5L**

- 7.1 Tabulation
- 7.2 Generation of graphs
- 7.3 Imaging of tissue specimens
- 7.4 Use of scale bars & basics of scientific photography
- 7.5 PowerPoint presentation techniques
- 7.6 Structure of oral presentations
- 7.7 Complete workflow: problem → review → method → results → discussion
- 7.8 Preparing final report & seminar presentation

Chapter 8 Writing Research Reports/Dissertations**3L**

- 8.1 Title, introduction, review, materials & methods, Results, summary & conclusion, references & bibliography.
- 8.2 Research Writing: Elements of a proposal, Problem statement, objectives, methodology, expected outcomes

Chapter 9 Ethics in Research**2L**

- 9.1 Academic integrity
- 9.2 Plagiarism—types, detection tools, Copyright issues
- 9.3 Case study

Suggested Readings:

1. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches by John W. Creswell.
2. Research Methodology: Methods and Techniques by C.R. Kothari
3. Research Methodology: A Step-by-Step Guide for Beginners by Ranjit Kumar
4. The Craft of Research by Wayne C. Booth et al.
5. The SAGE Handbook of Qualitative Research by Norman K. Denzin & Yvonna S. Lincoln
6. Qualitative Research: A Guide to Design and Implementation by Sharan B. Merriam.
7. Constructing Grounded Theory by Kathy Charmaz
8. Quantitative Psychological Research: A Student's Handbook by David Clark-Carter.
9. Designing and Conducting Mixed Methods Research by John W. Creswell & Vicki L. Plano Clark.
10. Mixed Methodology: Combining Qualitative and Quantitative Approaches by Abbas Tashakkori & Charles Teddlie.

Course Outcome**After successful completion of this course, students will be able to....**

- CO1: To develop an overview for research
- CO2: Identify research problems and good research
- CO3: Develop data collection skills
- CO4: Develop data presentation skills
- CO5: Develop writing and presenting skill of research reports
- CO6: Develop understanding for plagiarism

Course : Minor
Code : BORMP 472

Total Credit : 2
Course Type : Practical

Subject : Practical on Research Methodology
(Practical based on BORMT 471)

Total Practical : 12

Sr. No	Practical Botany (Practical Based on Research Methodology)	12P
1.	Understand the concept of research using model organisms in biological research	2P
2.	Identification of Types of Research	2P
3.	Formulation of Research Problem & Hypothesis	1P
4.	Data Collection Methods & Lab Notebook Maintenance	1P
5.	Wet lab data & laboratory safety precautions.	1P
6.	In-Silico Data Analysis	1P
7.	Study structure, basic rules & principles of scientific writing.	
8.	Learn proper citation and referencing techniques.	1P
9.	Conduct a basic literature review using authentic academic databases (INFLIBNET, Shodhganga, UGC CARE Journal list)	1P
10.	Use of reference management software and evaluate journal quality, use of Plagiarism detection software.	1P
11.	Presentation of scientific data effectively using tables, graphs, and images using excel, power point & SPSS & R software	1P
12.	Importance of ethics in writing of introduction, review of literature, methodology, results, discussion, summary and conclusion of research project.	1P

Suggested Readings:

1. Research Methodology: Methods and Techniques by C. R. Kothari and Gaurav Garg (2014), New Age International Publishers.
2. Research Methodology: A Step-by-Step Guide for Beginners by Ranjit Kumar (2011), SAGE Publications.
3. Research Design: Qualitative, Quantitative, and Mixed Methods Approaches by John W. Creswell and J. David Creswell (2018), SAGE Publications.
4. The Craft of Research by Wayne C. Booth, Gregory G. Colomb, and Joseph M. Williams (2016), University of Chicago Press.
5. Practical Statistics for Data Scientists by Peter Bruce and Andrew Bruce (2020), O'Reilly Media.
6. Survey Methodology by Robert M. Groves, Floyd J. Fowler Jr., Mick P. Couper, James M. Lepkowski, Eleanor Singer, and Roger Tourangeau (2009), Wiley.
7. Questionnaire Design: How to Plan, Structure and Write Survey Material for Effective Market Research by Ian Brace (2018), Kogan Page.
8. Publication Manual of the American Psychological Association, 7th Edition (2020), American Psychological Association.
9. Microsoft Excel Data Analysis and Business Modeling by Wayne L. Winston (2019), Microsoft Press.

Course Outcome

After successful completion of this course, students will be able to....

- CO1: Formulate and review a research problem using relevant literature.
- CO2: Prepare a research proposal and select an appropriate research design.
- CO3: Collect, analyze, and interpret data using statistical tools and Excel.
- CO4: Present research findings through reports, graphs, and presentations.
- CO5: Apply software, AI, and plagiarism-checking tools ethically in research.

Research Methodology Practical Course (2 Credits)**Guidelines**

Expt. No.- 1 and 2: Formulation of Research Problem:

- a) Objective: Learn how to define and formulate a research problem.
- b) Activity: Identify a problem statement in your domain; define scope, objectives, and research questions.
- c) Title of research work and review writing related to research title (at least 30 papers must be included in last 15 years in the area of research work). Literature review using databases (e.g., Scopus, JSTOR, Google Scholar).

Expt. No.- 3 and 4: Writing research proposal in proper format.

Expt. No.-5: Research Design Selection

- a) Objective: Compare and choose between qualitative, quantitative, and mixed-methods designs.
- b) Activity: Prepare a research design for a given problem.

Expt. No.- :6 Data entry and calculation using EXCEL, (using different formulas of EXCEL for calculation); Analyse a dataset and interpret statistical test results. (mean standard deviation student t-test, students f-test, etc.)

Expt. No.-7: Graphical representation using EXCEL.

Expt. No.-8: Preparation of power point presentation of research proposal / research work.

Expt. No.-9: Research Report Writing

Objective: Learn structure and formatting of research reports/papers.

Activity: Prepare a mini research report following specific format (APA/MLA/Chicago) format.

Expt. No.- 10: a) Grammar checking tools b) Plagiarism-use of google tools to check Plagiarism c) Use of AI for your research.

Expt. No.-11: Effect use of software's for in your subject for - research, in writing, in presentation and calculation.

Expt. No.-12: Questionnaire Design & Validation

Objective: Learn principles of designing valid and reliable questionnaires.

Activity: Design a questionnaire and test it using pilot study and Cronbach's alpha.

Expt. No.-13: Data Collection Techniques

Objective: Learn to collect data using surveys, interviews, or observations.

Activity: Conduct mock data collection (e.g., using Google Forms or face-to-face interview).

Course	: Major	Total Credit	: 2
Code	: BOMAT 481	Course Type	: Theory
Subject	: Plant Systematics-II (Bryophytes & Pteridophytes)	Total Lecture	: 30L

Module - I : Bryophytes		15L
Chapter 1	Introduction to Bryophytes 1.1 Characteristic features and diversity of Bryophytes 1.2 Medicinal, Ecological and economic importance of Bryophytes	2L
Chapter 2	Systems of classification of Bryophytes 2.1 Classification of Bryophytes 2.2 Distribution studies 2.3 Morphological studies 2.4 Anatomical studies 2.5 Reproductive studies	1L
Chapter 3	Comparative account of Bryophytes 3.1 Study with respect to sporophyte and gametophyte 3.2 Interrelationships and evolutionary trends of the following orders: Sphaerocarpaceae, Calobryales, Takakiales, Marchantiales, Jungermanniales, Anthocerotales, Sphagnales, Andraeales, Polytrichales, Buxbaumiales Funariales	11L
Chapter 4	Fossil in Bryophytes 4.1 Major Fossil Types 4.2 Significant Bryophyte Fossils 4.3 Morphological Features Preserved in Fossils	1L
Module - II : Pteridophytes		15L
Chapter 5	Introduction to Pteridophytes 5.1 Pteridophytes diversity 5.2 Importance of Pteridophytes	1L
Chapter 6	Systems of classification 6.1 Introduction to Plant Classification 6.2 Principles of Classification 6.3 Major Historical Systems 6.4 Modern Classification Approaches	1L
Chapter 7	Evolutionary Concepts in Filicales 7.1 Telome concept 7.2 Soral evolution in Filicales	2L
Chapter 8	Gametophyte evolution in Pteridophytes 8.1 Heterospory and seed habit 8.2 Stellar evolution	1L
Chapter 9	Study of Fossil group- Psilopsida 9.1 Sailable features of Psilophytes	1L
Chapter 10	Pteridosperms 10.1 Sailable features of Pteridosperms 10.2 Lyginopteris 10.3 Oldhamia 10.4 Lagenostoma	1L
Chapter 11	External and internal morphology of Rhynia and Lycopsidea 11.1 Sailable features of Lepidodendrales	1L
Chapter 12	External and internal morphology of 12.1 Calamites 12.2 Annularia	1L

	12.3 Calamostactys	
Chapter 13	Comparative account of distribution 13.1 Morphological study, 13.2 Anatomical study, 13.3 Gametophyte study 13.4 Sporophyte and interrelationship of following orders – Psilotales, Lycopodiales, Isoetales, Equisetales, Ophioglossales	5L

Suggested Readings:

1. Sharma OP (1990) textbook of Pteridophyta. Mac Millan India Ltd. Delhi.
2. Parihar NS (1976) Biology and morphology of the Pteridophytes. Central Book Depot
3. Kashyap, S. R. (1932). Liverworts of the Western Himalayas and the Panjab plain (illustrated): Part 2 The Chronica Boanica New Delhi.
4. Rashid A (1999) An introduction to Pteridophyta. Vikas Publishing House Pvt.Ltd. New Delhi.
5. Parihar, N. S. (1980). Bryophytes: An introduction to Embryophyta Vol I, Bryophyta central Book Depot
6. Watson, E. V. (1971). Structure and life of bryophytes 3rd, Hutchinson University Library London
7. Prem puri (1981). Bryophytes: Morphology, Growth and Differentiation, Atma ram and Sons, New delhi
8. Sporne KR (1986) The morphology of Pteridophytes. Hutchinson University Press. London.
9. Surange KR (1966) Indian fossil Pteridophytes. Council of Scientific and Industrial Research.

Course Outcome

After successful completion of this course, students will be able to....

- CO1: Know the systematic, morphology, and structure of Bryophytes and Pteridophytes
 CO2: Identify the Bryophytic and Pteridophytic plant material.
 CO3: Understand the Biodiversity of Bryophytes and Pteridophytes
 CO4: Understand the importance of Bryophytic and Pteridophytic plants.
 CO5: Understand the economic importance of Bryophytic and Pteridophytic plants.

Course : Major**Total Credit : 2****Code : BOMAT 482****Course Type : Theory****Subject : Advanced Molecular Biology****Total Lecture : 30L**

Module - I : Gene Expression		15L
Chapter 1	Study of Gene 1.1 Organization and structure of Prokaryotic gene 1.2 Organization and structure of Eukaryotic gene	1L
Chapter 2	Regulatory genes and their role 2.1 Promotor 2.2 Classes of Promoter 2.3 Initiator 2.4 Enhancer 2.5 Terminator	3L
Chapter 3	Transcription in Prokaryotes & Eukaryotes 3.1 Types of RNA Polymerase 3.2 Transcription Factors 3.3 Effect of mutation on the efficiency of RNA polymerases 3.4 Interaction of multiple regions of RNA polymerase with DNA Promoter 3.5 Elongation and Termination 3.6 Anti-termination 3.7 Post- transcriptional changes	5L
Chapter 4	Translation in prokaryotes & Eukaryotes 4.1 Structure of RNA 4.2 Ribosomal assembly 4.3 Genetic code 4.4 Codon anticodon recognition 4.5 Initiation 4.6 Elongation and elongation factor 4.7 Termination	6L
Module - II : Instructive Molecular Biology		15L
Chapter 5	Operon concept 5.1 Lac Operon 5.2 Tryptophan Operon 5.3 Arabinose Operon	3L
Chapter 6	Phage Strategies 6.1 Lytic and Lysogenic Cycle 6.2 Regulation of Lytic and Lysogenic Cycle	3L
Chapter 7	Recombinant DNA Technology 7.1 Steps involved in Recombinant DNA Technology 7.2 Cloning Vectors -Plasmids, Phages, Cosmids, Phagemids, BACs and YACs	3L
Chapter 8	Genomics and proteomics 8.1 Introduction to Genomics and proteomics 8.2 Types (structural and functional)	4L
Chapter 9	DNA Sequencing methods 9.1 Sanger's dideoxy chain termination sequencing method 9.2 Maxam-Gilbert sequencing method	2L

Suggested Readings:

1. Pal Jayanta and Saroj S. Ghaskadabi Fundamentals of Molecular Biology, Oxford Higher Education.

2. Lewin B. Genes XI. Oxford University Press, New York
3. Alberts, B., Bray, D Lewis, J., Raff, M., Roberts, K and Walter (1999). Molecular Biology of the Cell. Garland Publishing, Inc., New York.
4. Wolfe S.L (1993) Molecular and Cellular Biology, Wadsworth Publishing Co., California, USA.
5. Buchanan B.B, Gruissm W. and Jones R.L (2000). Biochemistry and Molecular Biology of Plant. American Society of Plant Physiologist, Maryland, USA.

Course Outcome

After successful completion of this course, students will be able to....

CO1: Understand the prokaryotic, eukaryotic, and viral genetics

CO2: Explain the central dogma of molecular biology

CO3: Understand the importance of Recombinant DNA Technology

CO4: Understand the DNA Sequencing methods and their significant importance

Course : Major
Code : BOMAT 483
Subject : Biostatistics

Total Credit : 2
Course Type : Theory
Total Lecture : 30L

Module - I : Basic Biostatistics		15L
Chapter 1	Introduction to Statistics 1.1 Sample 1.2 Sampling Type	1L
Chapter 2	Data in Statistics 2.1 Data Types 2.2 Graphical presentation of data - frequency distribution	1L
Chapter 3	Measures of central tendency 3.1 Mean 3.2 Mode 3.3 Median	1L
Chapter 4	Measures of dispersion 4.1 Variance 4.2 Standard deviation 4.3 Coefficient of variance	2L
Chapter 5	Symmetry and skewness, kurtosis 5.1 Introduction to Data Distribution 5.2 Symmetry and Asymmetry in Data 5.3 Skewness 5.4 Kurtosis	2L
Chapter 6	Correlation 6.1 Scatter diagram 6.2 Karl-Pearson's coefficient of correlation 6.3 Spearman's rank correlation coefficient	4L
Chapter 7	Regression: Equations of regression lines 7.1 Introduction to Regression Analysis 7.2 Regression Lines 7.3 Equations of Regression Lines 7.4 Calculation of Regression Coefficients	3L
Module - II : Experimental Statistics		15L
Chapter 8	Experimental designs 8.1 Completely randomized designs 8.2 Randomized block designs 8.3 factorial experimental designs	2L
Chapter 9	Analysis of Variance and F-Distribution 9.1 F-Distribution 9.2 Analysis of variance for different experimental designs	3L
Chapter 10	Statistical Tests for Comparison and Association 10.1 Tukey's test 10.2 Dunnet's test 10.3 Mann-Whitney U test	5L
Chapter 11	Chi-square test 11.1 Introduction to Chi-Square Test 11.2 Chi-Square Test for Goodness of Fit 11.3 Chi-Square Test for Independence	2L
Chapter 12	Normal and t Distributions with Confidence Intervals 12.1 Normal (z) distribution 12.2 t distribution,	3L

	12.3 Confidence interval	
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Suggested Readings:

1. Statistical Methods – Snedecor G.W. and Cochran W.G. Affiliated East-West Press Pvt. Ltd. 1989.
2. Statistical methods in Agriculture and Experimental Biology – Mead, R. and Curnow, R.N. Chapman and Hall, 1983.
3. Practical statistics and experimental design for plant and crop science – Clewer, A.G. and Scarisbrick, A.H., John Wiley, New York, 2001.
4. Bioinformatics - Westhead, DR, Parish JH and Twyman, RM, BIOS Scientific Publishers Ltd., Oxford, 2003.
5. P.N. Arora and P.K. Malhan (2002) Biostatistics, Himalaya publishing House.
6. Rama Krishnan, P. (1995) Biostatics, Saras publication A.R.P. camp Road, Periavilai,
7. Kottar, po. Nagercoil, Kanyakumari- Dist. Pin- 629 002.

Course Outcome

After successful completion of this course, students will be able to....

CO1: Design the experimental work

CO2: Identify the data and their types.

CO3: Understand the methodology to be implemented for the analysis

CO4: Apply the solution to analyze the data

Course	: Major	Total Credit	: 2
Code	: BOMAT 484	Course Type	: Theory
Subject	: Tools & Techniques in Plant Science	Total Lecture	: 30L

Module - I : Instrumentation I		15L
Chapter 1	1.1 Dissection, Maceration and Squash 1.2 Peeling and Pre-treatment 1.3 Mounting of specimen for Microscopy	3L
Chapter 2	Microscopic Techniques 2.1 Properties of Lights 2.2 Lens, and their Types 2.3 Magnification and Resolution 2.4 Light microscopy 2.5 Confocal microscopy 2.6 Phase Contrast microscopy 2.7 Fluorescence microscopy 2.8 Electron microscopy (SEM TEM and STEM) 2.9 Atomic force microscopy	5L
Chapter 3	Chromatography techniques 3.1 Principle, method and applications of Paper 3.2 Thin layer Chromatography 3.3 Gel filtration, Affinity Chromatography 3.4 Ion exchange Chromatography 3.5 HPLC and Gas chromatography	4L
Chapter 4	Electrophoretic techniques 4.1 Principle, method, and applications of Agarose gel electrophoresis 4.2 Sodium Dodecyl Sulphate polyacrylamide gel electrophoresis 4.3 2 Dimensional Gel Electrophoresis (2-D method)	3L
Module - II : Instrumentation II		15L
Chapter 5	Spectroscopic techniques 5.1 Beer and Lambert's Law 5.2 Electromagnetic radiations 5.3 Wavelength, Frequency, Light absorption and excitation of spectra 5.4 Principle, working and applications of UV-Visible spectroscopy 5.5 Nuclear Magnetic Resonance (NMR) spectroscopy 5.6 Infrared spectroscopy 5.7 Atomic absorption spectroscopy	5L
Chapter 6	Centrifugation techniques 6.1 Principles of Centrifugation 6.2 Types of Rotors 6.3 Speed and Unit 6.4 Factors affecting centrifugation 6.5 Ultra-centrifugation 6.6 Density Gradient Centrifugation	3L
Chapter 7	Immunological techniques 7.1 Introduction and Principles of Immunology 7.2 Antigen and Antibody 7.3 Immuno-diffusion and Immuno precipitation 7.4 Radio-immuno assay and Rocket Immuno-electrophoresis 7.5 ELISA	4L
Chapter 8	Analytical Techniques 8.1 Electrical conductivity 8.2 pH meter	2L

	8.3 Oxygen electrode	
Chapter 9	Traditional and Digital Herbarium 9.1 Definition and Importance of Herbarium 9.2 Traditional Herbarium Techniques 9.3 Digital Herbarium	1L

Suggested Readings:

1. Srivistava M.L. (2008). Bioanalytical Techniques. Narosa Publishing House (P) Ltd.
2. Plummer David (1987). An Introduction to Practical Biochemistry. 3rd Eds. Tata McGraw- Hill Publishing Company Ltd.
3. Sadasivam S, Manickam A. (1996). Biochemical Methods. 2nd Edn. New Age International (P) Ltd.
4. Khasim S.M. (2002). Botanical Microtechniques: Principles and Practice. Capital Publishing Company.
5. Wilson K., Walker J. (2005). Principles and Techniques in Biochemistry and Molecular Biology. Cambridge University Press.
6. Sharma V.K. (1991). Techniques in Microscopy and Cell Biology. Tata McGraw-Hill Publishing Company Ltd.

Course Outcome

After successful completion of this course, students will be able to....

- CO1: Understand the working mechanism and principle behind the instrumentation.
 CO2: Handle the instrument needed for the experiment.
 CO3: Analyze biological samples by using the different instruments
 CO4: Understand the data generated after the analysis of biological data

Course	: Major	Total Credit	: 2
Code	: BOMAT 485	Course Type	: Theory
Subject	: Plant Evolution	Total Lecture	: 30L

Module - I : Basics of Evolution		15L
Chapter 1	Introduction to evolution 1.1 Definition and Concept 1.4 Importance of evolution	2L
Chapter 2	Origin of Earth Vs Origin of life 2.1 Historical account of Origin of life 2.2 Gaia Hypothesis 2.3 Earliest Fossils 2.4 Prebiotic Evolution 2.5 Abiotic synthesis of organic matter 2.6 Primordial soup 2.7 Origin of membranes 2.8 Theory of Panspermia	4L
Chapter 3	Organic Evolution 3.1 The concept of organic evolution 3.2 Theories of Evolution 3.3 Pre-Darwinian period 3.4 Theory of Inheritance of acquired characters (Lamarck's theory) 3.5 Darwinism- Theory of Natural Selection 3.6 Post-Darwinian period- Modern synthetic theory	4L
Chapter 4	Concepts of Oparin and Haldane 4.1 Experiment of Miller 4.2 Evolution of the first cell 4.3 Evolution of prokaryote 4.4 Origin of eukaryotic cells 4.5 Evolution of unicellular eukaryotes	5L
Module - II : Theories in Evolution		15L
Chapter 5	Concepts of natural evolution 5.1 Molecular clocks 5.2 Molecular tools in phylogeny 5.3 Classification and identification 5.4 Protein and nucleotide sequence analysis 5.5 Origin of new genes and proteins 5.6 Gene duplication and divergence	3L
Chapter 6	Evolution Through Ages 6.1 Fossils and Geological Time scale 6.2 Fossils and Fossilization 6.3 Conditions of fossilization	2L
Chapter 7	7.1 Dating of fossils 7.2 Uranium Lead method 7.3 Radio-carbon method 7.4 U-series and ESR method 7.5 Geological Time scale: Eras, Periods, epochs 7.6 Duration in millions of years & plant life 7.7 Major events in the evolutionary time scale 7.8 Multicellular evolution	4L

	7.9 Major groups of plants & Animals 7.10 Fossils- Formation, Nature, Types, Geological time scale	
Chapter 8	Population genetics 8.1 Mechanisms, Populations, Gene pool, Gene frequency 8.2 Hardy-Weinberg Law 8.3 Concepts and rate of change in gene frequency through natural selection 8.4 Migration and random genetic drift 8.5 Adaptive radiation 8.6 Isolating mechanisms	4L
Chapter 9	Speciation 9.1 Allopatricity and Sympatricity 9.2 Convergent evolution 9.3 Sexual selection 9.4 Co-evolution	2L

Suggested Readings:

1. Srivistava M.L. (2008). Bioanalytical Techniques. Narosa Publishing House (P) Ltd.
2. Plummer David (1987). An Introduction to Practical Biochemistry. 3rd Eds. Tata McGraw- Hill Publishing Company Ltd.
3. Sadasivam S Manickam A. (1996). Biochemical Methods. 2ndEdn. New Age International (P) Ltd.
4. Khasim S.M. (2002). Botanical Microtechniques: Principles and Practice. Capital Publishing Company.
5. Wilson K., Walker J. (2005). Principles and Techniques in Biochemistry and Molecular Biology. Cambridge University Press.
6. Sharma V.K. (1991). Techniques in Microscopy and Cell Biology. Tata McGraw-Hill Publishing Company Ltd.

Course Outcome**After successful completion of this course, students will be able to....**

- CO1: Know the plant relationships phylogenetic systematics
 CO2: Evolution pattern of the plants,
 CO3: Explain the theories related to evolution of the organism
 CO4: Understand the fossil history plan

Course : Major
Code : BOMAP 486
Subject : Practical Botany XI

Total Credit : 2
Course Type : Practical
Total Practical : 12

Sr. No	Practical Botany (Practical Based on BOMAT 481, 482)	12P
Practical Based BOMAT 481 on Plant Systematics - I (Bryophytes & Pteridophytes)		
1.	Morphological, anatomical, and reproductive studies of any two members of Hepaticopsida (Liverworts)	1P
2.	Morphological, anatomical, and reproductive studies of any two members of Anthocerotopsida (Hornworts)	1P
3.	Morphological, anatomical, and reproductive studies of any two members of Musci (Mosses)	1P
4.	Morphological, anatomical and reproductive studies of Psilotum, Lycopodium, Selaginella, Equisetum, Pteris, Adiantum, and Marsilea	2P
5.	Study of available fossils specimen or Photographic Image of Pteridophytes	1P
Practical Based BOMAT 482 on Advanced Molecular Biology		
6.	Effect of temperature and alkali on absorption of DNA	1P
7.	Determination of absorption maxima of Nucleic acid and Protein	1P
8.	Separation and quantification of Seed Storage Protein by using a suitable method	2P
9.	Isolation of plant Genomic DNA.	1P
10.	Study of instruments used in Molecular Biology (photographs/PPT): PCR thermal cycler Gel documentation system ELISA reader Millipore distillation apparatus Lyophilizer Refractometer	1P

Suggested Readings:

- Vashishta, B. R., Sinha, A. K., & Kumar, A. (2014). Botany for Degree Students: Bryophyta. S. Chand Publishing. (Detailed structural diagrams for Liverworts, Hornworts, and Mosses).
- Vashishta, P. C., Ittyachen, A. K., & Sinha, A. K. (2014). Botany for Degree Students: Pteridophyta. S. Chand Publishing. (Excellent for anatomy of Psilotum to Marsilea).
- Parihar, N. S. (2010). An Introduction to Embryophyta: Vol. I (Bryophyta) & Vol. II (Pteridophyta). Central Book Depot. (A classic for understanding reproductive structures).
- Sambrook, J., & Russell, D. W. (2001). Molecular Cloning: A Laboratory Manual. Cold Spring Harbor Laboratory Press. (The global standard for DNA Isolation and Absorbance studies).
- Wilson, K., & Walker, J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press. (The best resource for Absorption Maxima, PCR, and ELISA theory).
- Sadasivam, S., & Manickam, A. (2008). Biochemical Methods. New Age International. (Protocols for Seed Protein quantification and DNA purity checks).
- Chawla, H. S. (2020). Introduction to Plant Biotechnology. Oxford & IBH. (Detailed section on Molecular Biology Instrumentation including Lyophilizers and Gel Docs).

Course Outcome

After successful completion of this course, students will be able to....

CO1: Understand the morphological, anatomical, and reproductive of Bryophyta and Pteridophyta.

CO2: Know the properties of Nucleic Acid

CO3: Isolate the DNA & Protein from the plants

CO4: Understand the working principle of different instruments in molecular biology.

Course : Major
Code : BOMAP 487
Subject : Practical Botany XII

Total Credit : 2
Course Type : Practical
Total Practical : 12

Sr. No	Practical Botany (Practical Based on BOMAT 483, 484, 485)	12P
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Practical Based BOMAT 483 on Biostatistics

- | | | |
|----|--|----|
| 1. | Calculation of Mean, Mode, Median, Variance, Standard Deviation, Standard Error of the different types of data | 1P |
| 2. | Determination of Karl-Pearson's coefficient of correlation from the given data | 1P |
| 3. | Study of polygenic inheritance by using suitable trait. | 1P |
| 4. | Determination of regression lines from the given data | 1P |
| 5. | Problems based on t-test | 1P |
| 6. | Analysis of variance of the given data | 1P |

Practical Based BOMAT 484 on Tools & Techniques in Plant Science

- | | | |
|-----|--|----|
| 7. | Study of Micrometry | 1P |
| 8. | Separation of given sample by using the chromatography and TLC | 1P |
| 9. | Study of Maceration technique | 1P |
| 10. | Study of Rocket immune electrophoresis | 1P |

Practical Based BOMAT 485 on Plant Evolution

- | | | |
|----|---|----|
| 11 | Study of Types of Fossils | 1P |
| 12 | Construction of Phylogenetic tree by using suitable software. | 1P |

Suggested Readings:

1. Mahajan, B. K. (2010). Methods in Biostatistics. Jaypee Brothers Medical Publishers. (A student favorite for step-by-step Mean, SD, and t-test).
2. Zar, J. H. (2010). Biostatistical Analysis. Pearson Education. (The "bible" for ANOVA, Correlation, and Regression analysis).
3. Rao, P. S. S., & Richard, J. (2012). Introduction to Biostatistics and Research Methods. PHI Learning. (Excellent for Polygenic inheritance calculations).
4. Gupta, S. P. (2021). Statistical Methods. Sultan Chand & Sons. (Comprehensive problems for Karl-Pearson's coefficient).
5. Wilson, K., & Walker, J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press. (Crucial for Chromatography, TLC, and Electrophoresis).
6. Sharma, A. K., & Sharma, A. (1999). Chromosome Techniques. Butterworth-Heinemann. (Best for Micrometry and Maceration techniques).
7. Hayat, M. A. (2000). Principles and Techniques of Electron Microscopy. Cambridge University

Press. (Though advanced, it provides the foundation for Micrometry and calibration).

Course Outcome

After successful completion of this course, students will be able to....

- CO1: Design the experimental work
- CO2: Identify the data and their types.
- CO3: Understand the methodology to be implemented for the analysis
- CO4: Analyze the primary and secondary data.
- CO5: Calculate the correlation between the data and significant effect of treatment.
- CO6: Do the experimental work by using the different techniques and tools
- CO7: Construct the phylogenetic tree as well as evolution pattern

Course : Major**Total Credit : 2****Code : BOMET 481A****Course Type : Theory****Subject : Applied Biotechnology & Nanotechnology****Total Lecture : 30L**

Module - I : Applied Biotechnology		15L
Chapter 1	Basics of genomics and proteomics 1.1 A brief of overview of prokaryotic eukaryotic genome organization 1.2 Extra-chromosomal DNA: Bacterial plasmids, mitochondria & chloroplast	3L
Chapter 2	Introduction to Genomic and cDNA libraries 2.1 Screening of Libraries 2.2 Isolation of Specific clones 2.3 Nucleic acid hybridization using specific nucleotide probes, antibodies 2.4 PCR amplification using gene specific primers.	5L
Chapter 3	GMOs 3.1 Potential problems with GMOs 3.2 Efforts to prevent these problems 3.3 Gene containment 3.4 Excision of antibiotic resistance markers from transformed plants 3.5 Regulatory bodies in the government	4L
Chapter 4	CRISPR-CAS 4.1 History of its discovery 4.2 Elucidation of the mechanism 4.3 Introduction to all the molecular players, 4.4 Development of applications for in vivo genome engineering 4.5 Promise of the technology as a next generation therapeutic method.	3L
Module - II : Nanotechnology		15L
Chapter 5	Introduction to Nanotechnology and Nanomaterials 5.1 Atomic structures: Molecular and atomic size, Bohr radius 5.2 Emergence of Nanotechnology 5.3 Challenges in Nanotechnology 5.4 Carbon age (New form of carbon from Graphene sheet to CNT)	5L
Chapter 6	Nanomaterials and their Properties: 6.1 Carbon Nanotubes (CNT), Metals, Metal oxides, Semiconductors, Ceramic 6.2 Polymeric Nanoparticles, Physical and Chemical properties.	5L
Chapter 7	Nanomaterial Fabrication and Characterization 7.1 Physical method 7.2 Physico-Chemical method 7.3 Chemical method 7.4 Biogenic method 7.5 Characterization of Nanoparticles	5L

Suggested Readings:

1. Zhong Lin Wang, Handbook of Nanophase and Nanomaterials (Vol 1 and II) Springer
2. J.C.Vickerman, Surface Analysis: The Principal Techniques, John Wiley and Sons
3. Roland Wiesendanger, Scanning Probe Microscopy and Spectroscopy: Methods and Applications, Cambridge Univ press
4. Recombinant DNA – Principles and Methodologies. Greene JJ and Rao VS, Marcel Dekker, New York, 1998.
5. Principles of gene manipulation and genomics. VIIth edition Primrose SB, Twyman RM, Blackwell Science, Oxford, 2006

Course Outcome

After successful completion of this course, students will be able to....

- CO1: Know the importance of tools used in genetic Engineering
- CO2: Understand the Chromosomal organization in Viruses, Prokaryotes and Eukaryotes.
- CO3: Understand the phenomenon involved in GMO production.
- CO4: Understand the properties of Nanomaterial
- CO5: Utilize the nanomaterial for different purposes

Botany (NEP)		B. Sc. Botany		RMC
Course	:	Major	Total Credit	: 2
Code	:	BOME P 481B	Course Type	: Practical
Subject	:	Practical on Applied biotechnology and Nanotechnology	Total Lecture	: 4hrs/Practical

Sr. No	Practical Botany (Practical Based on BOMAT 482A)	12P
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Practical Based BOMAT 482A Applied Biotechnology

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|----|--|----|
| 1. | Isolation of Plasmid DNA and its Quantification | 1P |
| 2. | Separation of Plasmid DNA | 1P |
| 3. | Isolation and Quantification of Plant Genomic DNA. | 1P |
| 4. | Restriction Digestion of Plasmid DNA and its separation by electrophoresis | 2P |
| 5. | SDS-PAGE separation of seed storage proteins from legumes | 3P |

Practical Based BOMAT 482A Nanotechnology

- | | | |
|----|--|----|
| 6. | Synthesis of Nanoparticles by using a suitable method | 2P |
| 7. | Determination of Absorption Maxima of synthesized nanoparticles | 1P |
| 8. | Characterization methods for the nanomaterials (Demonstrative/PPT) | 1P |

Suggested Readings:

1. Sambrook, J., & Russell, D. W. (2001). Molecular Cloning: A Laboratory Manual (3-Volume Set). Cold Spring Harbor Laboratory Press. (The essential reference for Plasmid Isolation, Restriction Digestion, and Electrophoresis).
2. Wilson, K., & Walker, J. (2010). Principles and Techniques of Biochemistry and Molecular Biology. Cambridge University Press. (Excellent for the theory and practice of SDS-PAGE and DNA Quantification).
3. Sadasivam, S., & Manickam, A. (2008). Biochemical Methods. New Age International. (Standardized procedures for isolating Seed Storage Proteins from legumes).
4. Pradeep, T. (2007). Nano: The Essentials: Understanding Nanoscience and Nanotechnology. Tata McGraw-Hill. (Great for learning Synthesis methods and Absorption Maxima).
5. Hornyak, G. L., Tibbals, H. F., & Dutta, J. (2008). Fundamentals of Nanotechnology. CRC Press. (Detailed chapters on Characterization—XRD, SEM, TEM, and AFM).
6. Rai, M., & Posten, C. (2013). Green Biosynthesis of Nanoparticles: Mechanisms and Applications. CABI. (Specific protocols for Phyto-synthesis of Silver/Gold nanoparticles).

Course Outcome

After successful completion of this course, students will be able to....

- CO1: Isolate the DNA from Bacteria as well as Plant
- CO2: Understand the technique of proteins separation
- CO3: Understand the technique of DNA restriction and separation
- CO4: Synthesize the biogenic nanomaterials

Course	: Major	Total Credit	: 2
Code	: BOMET 482A	Course Type	: Theory
Subject	: Biodiversity	Total Lecture	: 30L

Module - I : Applied Biotechnology		15L
Chapter 1	Introduction to Biodiversity 1.1 Introduction & Definition of Biodiversity 1.2 Importance of Biodiversity Conservation 1.3 Types of Biodiversity i. Genetic Diversity, ii. Species Diversity iii. Ecosystem Diversity	4L
Chapter 2	Extent of plant diversity 2.1 Global perspective: Plant biodiversity across different continents 2.2 Indian Perspective: i. Diversity of Plant Species in India ii. Endemic Species iii. Hotspots of Plant Biodiversity in India	5L
Chapter 3	Habitat diversity and plant diversity 3.1 Relationship of habitats with plant diversity 3.2 Distribution of different major habitats across India 3.3 Habitat diversity in Maharashtra - Description of major habitats	6L
Module - II: Ecology and Conservation		15L
Chapter 4	Status of Plant Diversity 4.1 Assessment of diversity Species richness and abundance 4.2 Ecosystem health indicators 4.3. Threats to plant diversity i. Human activities (Deforestation, Habitat fragmentation, Pollution) ii. Invasive species iii. Overexploitation of resources	5L
Chapter 5	Ecology of Biodiversity 5.1 Ecological principles and biodiversity. 5.2 Habitat structure and species diversity. 5.3 Biogeography and its relationship to biodiversity. 5.5 Energy flow, nutrient cycles, and their impact on ecosystems. 5.6 Ecological interactions (competition, predation, symbiosis). 5.7 In-situ conservation: i. Traditional ways of conservation, ii. Sacred Groves, iii. Community reserves, iv. Reserve forests, v. Protected Areas (Wildlife Sanctuaries, National Parks, Biosphere reserves) vi. Legal and Policy framework for conservation 5.8. Ex-Situ Conservation: i. Botanical gardens, ii. Seed Banks	7L
Chapter 6	Methods of Conservation	3L

Suggested Readings:

1. Ambasth R.S. & N.K. Ambasth. A Textbook of Plant Ecology (15th edition.) CBS Publishers & Distributors.
2. Rahangdale S.S. & S.R. Rahangdale. 2024. Deorai. Department of Forests, Government of Maharashtra (Marathi).
3. Shukla and Chandel. Textbook of plant Ecology. S. Chand Publications.
4. Prema Michael. Ecological Methods for Field and Laboratory Investigations. Tata McGraw Hill publications. 1984.

Course Outcome

After successful completion of this course, students will be able to....

- CO1: The biodiversity of the plants.
- CO2: Levels and extent of plant diversity.
- CO3: Habitat diversity across India and Maharashtra
- CO4: Assessment methods and threats to plant diversity.
- CO5: Traditional and recent methods of conservation

Course	: Major	Total Credit	: 2
Code	: BOMEF 482B	Course Type	: Practical
Subject	: Practical on Biodiversity	Total Lecture	: 4hrs/Practical

Sr. No	Practical Botany (Practical Based on BOMAT 481B)	12P
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Practical Based BOMET 481B Biodiversity

- | | | |
|-----------|--|-----------|
| 1. | Understanding the species and genetic diversity.

[Plant Materials: Grains of different varieties of rice/wheat/beans, different colored flowers of Hibiscus for within species diversity] | 2P |
| 2. | Study of endemic species and possible causes of endemism and threatened. | 1P |
| 3. | Ecosystem Exploration

Visit different ecosystems in Maharashtra, such as forests, grasslands, wetlands, and coastal areas.

Observe and document the biotic and abiotic components of each ecosystem.

Note variations in vegetation, soil type, topography, and hydrology. | 3P |
| 4. | Ecosystem mapping: - Key features and special positions of components in an ecosystem | 2P |
| 5. | Species inventory of an ecosystem- Quadrat, Line and Belt transect methods of Sampling. | 2P |
| 6. | Estimation of Ecological parameters on the basis of data generated from practical no. 3 & 5. | 1P |
| 7. | Identification of indicator species of the ecosystem on the basis of data analyzed. | 1P |
| 8. | Ecological food web construction

Identify trophic levels and species interactions within each ecosystem.

Construct food webs depicting energy flow and nutrient cycling.

Discuss the role of keystone species and the consequences of species loss. | 2P |

Suggested Readings:

1. Misra, R. (1968). Ecology Workbook. Oxford & IBH Publishing Co. (The definitive guide for Quadrat, Line, and Belt transect methods).
2. Magurran, A. E. (2004). Measuring Biological Diversity. Blackwell Publishing. (Essential for quantifying Species and Genetic Diversity).
3. Michael, P. (1984). Ecological Methods for Field and Laboratory Investigations. Tata McGraw-Hill. (Step-by-step procedures for Ecological parameters and sampling).
4. Imeida, M. R. (1996–2009). Flora of Maharashtra (Volumes I-VI). Orient Press. (The primary resource for Species Inventory in Maharashtra).

5. Nayar, M. P., & Sastry, A. R. K. (1987). Red Data Book of Indian Plants. Botanical Survey of India. (Critical for studying Endemic and Threatened species).
6. Bharucha, E. (2005). Textbook of Environmental Studies for Undergraduate Courses. Universities Press. (Contains detailed profiles on Forests, Grasslands, and Wetlands of India).

Course Outcome

After successful completion of this course, students will be able to....

- CO1: The biodiversity of the plants.
- CO2: Levels and extent of plant diversity.
- CO3: Habitat diversity across India and Maharashtra
- CO4: Assessment methods and threats to plant diversity.
- CO5: Traditional and recent methods of conservation.

P. D. E. A's
Prof. Ramkrishna More Arts, Commerce and Science
College Akurdi Pune-411044
(Autonomous)

Affiliated to



Savitribai Phule Pune University [SPPU]



B. Sc. With Major Botany
(Three years B. Sc. in Botany / Four Years Honors in Botany)

2024 Pattern

Choice Based Credit System-2024 Pattern

Under
Autonomy and NEP-2020

From Academic Year
2026-2027

Syllabus

T. Y. B. Sc. Botany

Research Project
Subject code: BORPP 471R
Subject code: BORPP 481R

Board of Studies in Botany
Department of Botany
Prof. Ramkrishna More Arts, Commerce and Science
College Akurdi Pune-411044

Course	: Research Project	Total Credit	: 2C
Code	: BORPP 471R	Course Type	: Practical
Subject	: Research Project I	Total Lecture	: 12P
Code	: BORPP 481R	Course Type	: Practical
Subject	: Research Project II	Total Lecture	: 12P

GUIDELINE TO CARRY OUT PROJECTWORK

1. **Duration of Project work:** - One semester, 180 Laboratory hours. In each week 3 laboratory sessions of 4 hours should be allotted to the students.
2. College should allot research guide (mentor) to each student.
3. **Choice of Research Problem and Workout:** Student should select research-based project with the help of his mentor. Research problem should be related to any branch of botany. Outline should be prepared by student with the help of mentor to perform and complete research project within stipulated time.
4. **Internal Evaluation and Schedule for Submission of Project Work:**
 - a. Experiment work must be completed by within 12 weeks from the start of IV semester.
 - b. Internal evaluation will be performed by mentor and one internal examiner when project is near to completion.
 - c. The final copy of the project work (two Copies) should be submitted to department at the end of semester (15th week after commencement of IV semester).

Format for submission of project -

The project containing about 45-60 pages (*A₄ size paper, 1 inch margin from all sides, font - Times New Roman, Font size – 12 pt*). Should be divided into the following parts: -

- a. Title page
- b. Certificate of completion of Project Work from mentor and HOD.
- c. Declaration by candidate regarding plagiarism
- d. Index
- e. **Chapter-1:** Introduction to problem (introduction, signification of research problems selected, aims and objectives) (6-8 Pages)
- f. **Chapter-2:** Review of Literature (Related Research Problem) (12-15 pages)
- g. **Chapter-3:** Material and Methods (8-10 Pages)
- h. **Chapter-4:** Results and Discussion (20-25 Pages)
- f. **Chapter-5:** Conclusions (1-2 page)
- g. Bibliography
- h. Acknowledgement

GUIDELINE FOR SUBMISSION AND ASSESMENT OF PROJECT WORK

1. Internal assessment 30% marks of 150 marks and External assessment 70% marks of 150 marks.
2. At the end of IV semester two copies of research project must be submitted for certification and get both copies certified.
2. The certified copy of research project should be produced at the time of university project Examination by the candidate.
3. **Project External evaluation** – Power point presentation (20-30 minutes) by candidate followed by Viva-voce Exam purely based in project work. Marks will be assigned to i) Project work report (experimental work and accuracy in interpretation of results, discussions on results) – 50 marks; power point presentation and explanations given on results – 30 marks, question-answers – 25 marks.
4. After university project examination i.e. external evaluation of research project one copy must be submitted to department and one must be retained by the candidate.

Note:

1. Project can be completed at college laboratory or in research laboratory recognized by SPPU / Government of Maharashtra / Government of India.
2. In case, student is performing project work outside the college laboratory, then department should allot internal guide to the student and such guide will monitor the progress of research work of student. External guide will be from research institute where student is performing the research work. Student should obtain certificate of project completion from external guide which should be duly signed by internal guide. In this case Internal Evaluation will be jointly done by external and internal guides.

Pattern for External Evaluation

Theory: For the four credit papers (70 marks) (paper with two sections); question paper will be set section wise. Each section will be of 35 marks. For two credit paper will be of 35 marks. Question paper format will be as follows:

Course Outcome:

After successful completion of this course, students will be able to...

1. Identify and formulate research problems.
2. Design and develop solutions to the problem.
3. Analyze and solve complex problems.
4. Write effective technical reports and present their findings.
5. Understand and apply research methodologies appropriate to their chosen field.
6. Critically evaluate existing research and identify gaps in knowledge.

P. D. E. A's
Prof. Ramkrishna More Arts, Commerce and Science
College Akurdi Pune-411044
(Autonomous)

Affiliated to



Savitribai Phule Pune University [SPPU]



B. Sc. With Major Botany
(Three years B. Sc. in Botany / Four Years Honors in Botany)

2024 Pattern

Choice Based Credit System-2024 Pattern

Under
Autonomy and NEP-2020

From Academic Year
2026-2027

Syllabus

T. Y. B. Sc. Botany

On Job Training
Subject code: BOOJP-481

Board of Studies in Botany
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1. Introduction: All the Higher Educational Institutions (HEIs) are mandated to enable all the eligible students to take an active part in the Internship selection process. The Internship Cell constituted at the HEIs will extend all the possible support to the students. It will help in achieving the best-paid internship results in the given condition through the assistance and full cooperation of all the students, alumni, and recruiting organizations, making the HEI their most favored destination. The internship policy detailed hereunder will apply to academic session 2023-2024 onwards.

1.1. Background: The National Education Policy (NEP)¹, 2020 suggests that students must actively engage with the practical side of their learning as part of a holistic education to further improve their employability. It states that students at all HEIs will be provided with opportunities for internships with local industry and businesses as well as research internships with faculty and researchers at their own or other HEIs/research institutions.

University Grants Commission (UGC) released National Credit Framework (NCrF)² in April 2023. It underscores the significance of experiential learning as part of the curricular structure through internships, on-the-job training, industrial projects, etc. The focus is further streamlined through the Guidelines for Internship/Research Internship released later in October 2023.

In line with the NEP and tracing the provisions of NcrF, Government of Maharashtra has subsequently released two Government Resolutions (GRs)³ to reinforce NEP implementation and credit revision across Maharashtra HEIs. These GRs lay out detailed guidelines for curriculum interventions for Four Year UG Engineering and other UG AICTE courses, B.A./ B.Sc./ B.Com. (and all Non-AICTE UG courses), and M.A./ M.Sc./ M.Com. (and all PG courses).

To foster holistic education, which encompasses hands-on experience, the focus of Government now turns towards strengthening the internship ecosystem through a formalized Internship Policy. This strategic move comes as a response to the NEP's call for students to engage with practical learning through internships and apprenticeships, a practice proven to enhance employability and refine skill sets.

1.2. Objective and Vision: Internships serve as pivotal educational and career development opportunities, offering hands-on experience in specific fields or disciplines. They are structured, short-term, supervised Internships often centered around particular tasks or projects with predefined timeframes. An internship may be compensated, partially compensated, or unpaid; however, it must be meaningful and beneficial to both the intern and the hosting organization. Following are the objectives of the Internships envisaged for the students enrolled in State HEIs:

- Exposing students to industrial environments that cannot be replicated in a classroom.
- Providing opportunities to acquire and refine analytical and managerial skills crucial for a professional career.
- Offering hands-on experience in teamwork, thereby enhancing professional skills like communication, work ethics, conflict resolution, etc., with a lasting impact on lifelong learning and professional development.
- Establishing links between students and potential future job or research opportunities.

1.3. Types of Internships: Internships are an integral part of the academic curricula. Satisfactory completion of an internship is a mandatory requirement for the degree to be awarded by the HEI. Furthermore, considering the curriculum structure approved by the HEI, multiple modes of internships are possible and are assigned academic credits within the curricula. The general idea is to enable students to undertake immersive assignments within the organizations for a limited period.

The following is a brief overview of credit requirements in line with GoM GRs, UGC, and AICTE4:

- 12 credits of Internship activities may be accounted for UG Engineering (AICTE) courses.
- 12-14 credits of Internship activities may be accounted for B.A., B.Sc., B.Com. and all Non-AICTE professional UG degree courses.
- 10-12 credits of Internship activities may be accounted for M.A., M.Sc., M.Com. and all professional PG degree courses.

It must be noted that 1 credit is equivalent to minimum 30 hours of work. An intern is expected to spend 30 hours per week on Internship and related activities. Furthermore, Internships may be done through offline / online mode.

However, indicative requirement regarding Internship duration and credits for Four Year UG Engineering and other UG AICTE courses is as follows:

Internship	Schedule	Duration	Activities	Credits
Semester Integrated Internship	6 th / 8 th Semester	full-time across semester with other courses on online mode	Project work, Seminar, Industrial Training (excluding credits for Advanced Courses). This can be Industrial/Govt./ NGO/MSME/ Rural Internship/ Innovation / Entrepreneurship / academic / industry research project	12

For B.A., B.Sc., B.Com. and all Non-AICTE professional UG degree courses, the indicative requirement regarding Internship duration and credits is as follows:

Internship	Schedule	Duration	Activities	Credits
Summers	After 4 th or 6 th Semester	4-8 weeks	Industrial/Govt./ NGO/MSME/ Rural Internship/ Innovation / Entrepreneurship	8
Winters	After 3 rd / 5 th Semester	2-4 weeks	Inter/ Intra Institutional Activities, Research Project, Community Engagement	2-4
Semester Integrated	6 th / 8 th Semester	can be part-time- duration can be as per HEI's discretion	Project work, Seminar (excluding credits for Advanced Courses)	2-4

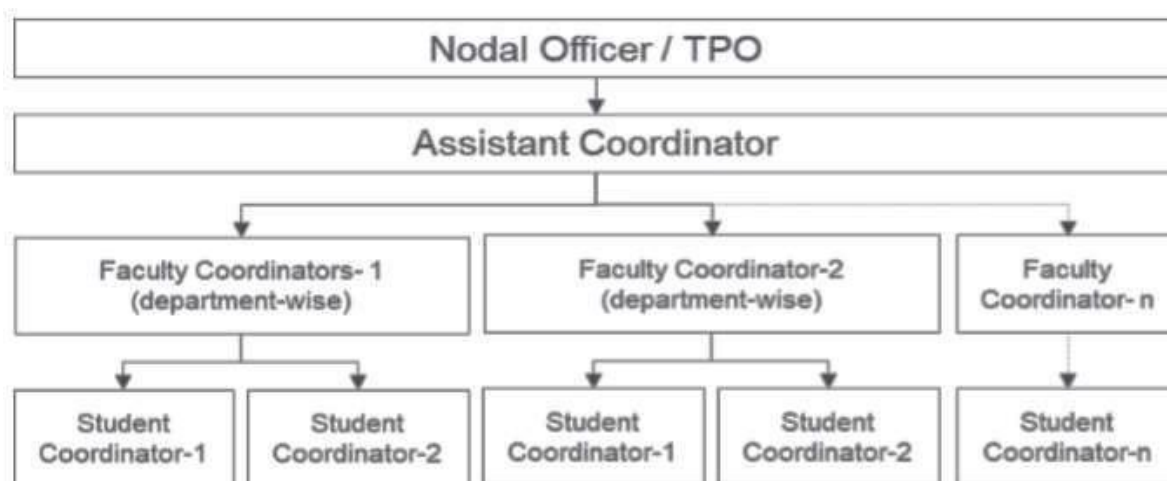
* Internship/Apprenticeship: 8 Credits + Field Projects/Community Engagement: 4-6 Credits For M.A., M.Sc., M.Com. and all professional PG degree courses, the indicative requirement regarding Internship duration and credits is as follows:

Internship	Schedule	Duration	Activities	Credits
Summers	After 2 nd Semester	4-6 weeks	Industrial/Govt./ NGO/MSME/ Rural Internship/ Innovation / Entrepreneurship	4
Semester Integrated	3 rd & 4 th Semester	can be part-time- duration can be as per HEI's discretion	Project work, Seminar, Industrial Training (excluding credits for Advanced Courses). This can be Industrial/Govt./ NGO/MSME/ Rural Internship/ Innovation / Entrepreneurship / academic / industry research project	10-12

During the internship registration, the students are to notify their preference on whether they are seeking academic or industrial internships.

2. Internship Cell

2.1. Governance Structure: For every HEI, the Internship Cell shall be led by Internship Governing Council comprising of Vice Chancellor/Dean/Principal, Nodal Officer/TPO, and Assistant Coordinator(s). The Cell will further have Department-level Faculty Coordinators. Additionally, Student Coordinators shall be appointed from each Department by the nominated Faculty for efficient outreach to students. The following chart illustrates the Governance structure envisaged for the Cell:



It must be noted that: • The Nodal Officer/TPO and Assistant Coordinators shall be appointed by the Vice Chancellor/Dean/Principal. • Each HEI Campus will have an Assistant Coordinator reporting to Nodal Officer. • The Nodal Officer shall report the progress and details of internships in each academic year to Vice Chancellor/Dean/Principal.

2.2. Duties and Responsibilities: The Internship Cell shall be responsible for the proper functioning of the Internship processes at the HEI. The overall role of the Cell is of a facilitator and counselor for Internship related activities. The brief activities of the Cell would include: • The Cell shall work to identify projects linked to the local industry needs and create a pool available. • The Cell is responsible to conceptualize a digital portal where they can register experts, industries, organizations, mentors, faculty members which are visible to students.

Internship Cell shall maintain a uniform record-keeping mechanism. It shall also ensure that the evaluation rubrics are implemented as per the mandate of NEP, 2020, GRs released by Government of Maharashtra, and National Credit Framework by UGC. • The cell shall streamline internship selection process including, but not limited to Resume Screening, PPTs, Tests, GDs, Interviews, etc. • The Cell shall map students to student coordinators from the department. They are first point of contact in the Cell and would help throughout the process – answering all queries and managing the whole process. • The Student Coordinators in consultation with the department/school-level faculty shall carry out the task of resume verification at the start of the academic session. • Internship Cell shall make a sincere effort every year to bring in new companies in upcoming sectors to ensure better and more diverse opportunities for students., the Cell shall make their best efforts in reaching out to the organizations preferred by students. • The Cell shall work towards connecting with the organization and signing MOUs with them on the behalf of HEI to establish long-term collaboration for providing internship. • The Cell shall organize preparatory events throughout the year. Information regarding the sessions will be provided to the students via mail and other

mediums. The Cell shall collate and share reference books, sample questions, mock test papers among students. • The Cell shall facilitate the onboarding of students for Internships, through online or offline medium, in line with Organization's requirements. • The Cell shall ensure protection of students in case of any offenses by the organizations. The Nodal Officer/TPO shall be the final arbiter on such matters.

Additional functions of the Internship Cell include arranging experts for student's personality development, improve communication skills, vocabulary, prepare students for resume preparation & email writing, group discussion, interview skills, aptitude training & practice tests, technical report writing, presentation skills, foreign languages proficiency etc.

The department-level Faculty Coordinators and student coordinators shall act as facilitators between HEI, recruiters and students. The team will be responsible for managing databases, facilitating and overseeing outreach, addressing Internship-related Q&As, understanding and reporting student preferences, and resolving queries with respect to the internships.

Additionally, a Mentor shall be identified by the Internship Cell or by each students through their network. The role of a Mentor shall be to provide professional/research guidance to the student during the internship. They shall also facilitate networking with other subject matter experts/professionals, which will enhance the internship experience and learning of the students.

The department-level Faculty Coordinator and Mentors will be nominated at the start of the academic year for each department. Student Coordinators will be elected by the students through the process laid down by the Nodal Officer/TPO. These Student Coordinators, upon satisfactory performance and contribution, shall be promoted to being Student Placement Coordinators in their later years of study.

2.3. Organization Outreach: The Cell, through the powers vested by Nodal Officer/TPO, shall reach out to the prospective companies in a formal and professional manner. The primary outreach shall be inclusive of following processes: • Development of Internship Brochure – soft copy as well as hard copy. • Preparing list of potential recruiters and past recruiters • Preferences mentioned by students in their Internship Undertaking

On these lines, the HEI is mandated to create Industry / academic linkages with organizations and institutions for establishing long-term partnership in recruiting interns. These linkages are to be made accessible on the University portal. The HEI shall further enable these potential recruiters to register on public platforms like AICTE for better visibility of opportunities across Maharashtra.

2.4. Data Management: The Cell shall maintain a uniform database for Internships at department-level and HEI level. The Cell shall have a restricted access to the database. It shall have detailed profiles of students, their contact details, prior education & experience, academic credentials, location / sectoral preferences, and internship status (companies shortlisted, awaiting response, internship offer, etc.). This database shall have a common skeletal framework and it shall be archived every academic year. Additionally, the data pertaining to Organization profiles shall be revised and updated with organization POCs and their coordinates.

3. Internship Guidelines for Students

3.1. Eligibility and Timeline All the bonafide students enrolled in the HEI are eligible for internships, provided they have two or fewer backlogs at the start of the odd semester of the academic year. The HEI shall, at the start of each academic year, specify the timelines pertaining to undertakings, resume submission deadlines, resume proof-checking and verification, organizing outreach, and selection process.

3.2. Internship Application

- The Internship Cell shall proactively inform the students when internship opportunities are floated along with the nature of internship, compensation structure, work mode/location, etc.
- Interested students shall give their names to the department coordinators, who shall pass them on to the Assistant Coordinator with their resume.
- Once the resumes are submitted to the organizations, the selection process shall start. The Cell will assist companies in scheduling pre-placement talks, tests, GDs, Interviews.
- Students are to strictly adhere to the schedule such events

3.3. Code of Conduct

- Each student is eligible to accept at most one Internship offer through the process. They would be deregistered from the process after receiving the offer.
- Any off-campus opportunities given to the students must be reported to the HEI for subsequent procedures of relieving to take place in time.
- Students are required to dress in formal clothing and footwear with a presentable persona throughout the selection process. Casual clothing will not be allowed during any part of the whole process.
- If any student has any grievances with respect to termination and/or any penal action ordered by concerned HOD, then such student can submit his appeal in writing to the Nodal Officer/TPO, who shall be the final arbitrator on such matters.
- After performing exceedingly well in the Internship, the student may be provided with a Pre-placement Offer (PPO). It needs to be accepted/rejected by the student within the deadline as set forth by the organization. A student who accepts the PPO will be considered “placed” and de-registered from the Placement process. If a student rejects a PPO, they can appear for further placements with the cell without any restrictions.

3.4. Internship Evaluation

After completion of Internship, students are to prepare a comprehensive report highlighting their learnings and takeaways during the internship period. The report shall be signed by the Internship Supervisor, Nodal Officer/TPO and Faculty Mentor.

The students are mandated to give a seminar based on the internship undertaken before an expert committee constituted by the concerned department, as per Performa for Evaluation of Internship (Appendix IX).

The internship shall be evaluated on the basis of performance, as reflected in the student log (Appendix V), Attendance record (Appendix VI), supervisor evaluation form (Appendix VII).

The assessment of internship will be based on the following criteria:

- Quality and effectiveness of presentation
- Depth of knowledge and demonstrated skills
- Variety and relevance of learning experience

- Practical applications and relationships with concepts taught in the course
- Internship Report

Seminar presentation will enable sharing knowledge & experience amongst students & teachers and build communication skills and confidence in students. The weightage given to the Internship evaluation shall be as per the discretion of the concerned HODs and Nodal Officer/TPO. The credits will be allocated on the basis of overall grade (above Pass) received by the students during the assessment.

4. Appendix**4.1. Appendix I:****Internship Undertaking**

1. Student Name:			
2. Current Address			
3. Residence Address			
4. Email id			
5. Mobile Nos.			
6. Aadhar			
7. PAN			
8. Overall GPA			
9. Mode of Internship			
10. Internship Preferences			
	Location	Core Area	Organization / Institute
Preference-1			
Preference-2			
Preference-3			
confirm that I agree with the terms, conditions, and requirements of the Internship Policy Student Signature: _____ Date: _____			
I confirm that the student has attended the internship orientation and has met all paperwork and process requirements to participate in the internship program, and has received approval from his/her mentor. Sign of Department Faculty Coordinator: _____ Date : _____			

4.2. Appendix II:**Draft Resume Template****Name:****Contact Number and Email ID:****Education:**

HEI Name	Year
Degree / Specialization:	
CGPA:	
HEI Name: <bachelor's degree>	Year Degree / Specialization:
CGPA:	
Internship / Work Experience	

Organization	Year
Project:	
Brief:	
Academic Experience	

Semester	Year
Project:	
Brief:	
➤ Emphasize accomplishments that are relevant to the field ➤ Be specific—omit unnecessary words and sentences ➤ Start your sentence with an action verb, not a passive one Use past-tense verbs to show what you have accomplished Quantify results as much as possible ➤ Use key words that will catch a recruiter's eye Other Achievements and Personal	
Interests	
➤ List other achievements also in reverse chronological order ➤ Leadership positions held outside of your formal work environment ➤ Personal interests and accomplishments that will distinguish you from other applicants ➤ Volunteer service/Social Work	

4.3. Appendix III:**Organization Outreach Letter**

<HEI Letter Head>

To,

The (Manager, HR)

Subject: Request for_____weeks internship of Students pursuing < >

Dear Sir,

The HEI established in <year>, <HEI>, Maharashtra reflects the vision of leading industrialists and educationalists. Institute is accredited with ‘< >’ grade by NAAC in March 2015. The HEI has been recognized about it’s over all academic excellence and infrastructure.

In view of the above, I request your good self to allow our following (no. of students) students for practical raining in your esteemed organization. Kindly accord your permission and give at least one-week time for students to join training after confirmation.

No.	Name	Roll no.	Year	Department

The resumes of these students are attached with this letter. If vacancies exist, kindly do plan for Interviews for the students in above branches.

A line of confirmation will be highly appreciated.

Yours sincerely,

Nodal Officer/TPO

<HEI Name and Date>

4.4. Appendix IV:**Relieving Letter of
Student**

<HEI Letter Head>

To,

The General Manager (HR)

.....

Subject: Relieving letter of student

Dear Sir,

Kindly refer your letter/e-mail dated. _____ on the above cited subject. As permitted by your good self the following students will undergo Industrial Internship in your esteemed organization under your sole guidance and direction

No.	Name	Roll no.	Year	Department

This training being an essential part of the curriculum, the following guidelines have been prescribed in the curriculum for the training. You are therefore, requested to please issue following guidelines to the concerned student mentor.

- Internship schedule may be prepared and a copy of the same may be sent to us.
- Each student is required to prepare Internship diary and report.
- Kindly check the Internship diary of the student daily.
- Issue instruction regarding working hours during training and maintenance of the attendance record

You are requested to evaluate the student's performance on the basis of grading i.e.

Excellent, Very Good, Satisfactory and Non-Satisfactory on the below mentioned factors:

- Attendance and general behavior
- Relation with workers and supervisors
- Initiative and efforts in learning
- Knowledge and skills improvement
- Contribution to the organization

The performance report may please be forwarded to the undersigned on completion of training in sealed envelope.

Your efforts in this regard will positively enhance knowledge and practical skills of the students, your cooperation will be highly appreciated, and we shall feel obliged.

The students will abide by the rules and regulation of the organization and will maintain a proper discipline with keen interest during their internship. The students will report to you on dated. _____ along with a copy of this letter.

Yours sincerely,
Nodal Officer/TPO
HEI Name and Date>

4.5. Appendix V:**Student Diary (Log) Recording Format**

Week	Date From - to	Task Assigned	Activities Performed	Key Learnings	Additional Remarks
1					
2					
3					
4					
5					
6					

Signature of Industry Supervisor

4.6. Appendix VI:**Attendance Sheet**

<Organization Letter Head>

Name & Address of Organization

.....

.....

.....

Name of the Student	
Roll Number	
Name of Course	
Date of Commencement of Training	
Date of Completion of Training	

Week	Mon	Thu	Wed	Thu	Fri	Sat
1						
2						
3						
4						
5						
6						

- Attendance Sheet should remain affixed in Daily Training Diary. Do not remove or tear it off.
- Holidays should be marked in Red Ink in attendance column. Absent should be marked as 'A' in Red Ink.

Name and Signature with date of Internship Supervisor: _____

4.7. Appendix VII:**Supervisor or Evaluation of Intern**

<Organization Letter Head>

Student Name: _____ **Date:** _____**Work Supervisor:** _____ **Title:** _____**Organization:** _____**Internship Address:** _____**Dates of Internship:** From _____ To _____

Please evaluate intern by indicating the frequency with which you observed the following behaviours:

Parameters	Needs Improvement	Satisfactory	Good	Excellent
Behaviors				
Performs in a dependable manner				
Cooperates with co-workers and supervisors				
Shows interest in work				
Learns quickly				
Shows initiative				
Produces high quality work				
Accepts responsibility				
Accepts criticism				
Demonstrates organizational skills				
Uses technical knowledge and expertise				
Shows good judgment				
Demonstrates creativity/originality				
Analyzes problems effectively				
Is self-reliant				
Communicates well				
Writes effectively				
Has a professional attitude				
Gives a professional appearance				
Is punctual				
Uses time effectively				

Overall performance of student intern (circle one): (Needs improvement / Satisfactory / Good / Excellent)

Additional comments, if any:

Signature of Industry supervisor _____

HR Manager _____

4.8. Appendix VIII:**Student Feedback of Internship**

(To be filled by Students after Internship completion)

Student Name: _____ Date: _____

Industrial Supervisor: _____ Title: _____

Supervisor Email: _____ Internship is: _____ Paid _____ Unpaid _____

Organization: _____

Internship

Address: _____

Faculty Coordinator: _____ Department: _____

Dates of Internship: From _____ To _____

Give a brief description of your internship work (title and tasks for which you were responsible):

Was your internship experience related to your major area of study?

- Yes, to a large degree
- Yes, to a slight degree
- No, not related at all

Indicate the degree to which you agree or disagree with the following statements.

Experience has:	Strongly Agree	Agree	No opinion	Disagree	Strongly Disagree
Given me the opportunity to explore a career field					
Allowed me to apply classroom theory to practice					
Helped me develop my decision-making and problem-solving skills					
Expanded my knowledge about the work world prior to permanent employment					
Helped me develop my written and oral communication skills					
Provided a chance to use leadership skills (influence others, develop ideas with others, stimulate decision-making and action)					
Expanded my sensitivity to the ethical implications of the work involved					
Made it possible for me to be more confident in new situations					
Given me a chance to improve my interpersonal skills					
Helped me learn to handle responsibility and use my time wisely					
Helped me discover new aspects of myself that I didn't know existed before					
Helped me develop new interests and abilities					
Helped me clarify my career goals					

Provided me with contacts which may lead to future employment					
Allowed me to acquire information and/ or use equipment not available at my Institute					

- In the Institute internship program, faculty members are expected to be mentors for students. Do you feel that your faculty coordinator served such a function? Why or why not?
- How well were you able to accomplish the initial goals, tasks and new skills that were set down in your learning contract? In what ways were you able to take a new direction or expand beyond your contract? Why were some goals not accomplished adequately?
- What areas did you most develop and improve?
- What has been the most significant accomplishment or satisfying moment of your internship?
- What did you dislike about the internship?
- Considering your overall experience, how would you rate this internship? (Circle one). Satisfactory/ Good/ Excellent
- Give suggestions as to how your internship experience could have been improved. (Could you have handled added responsibility? Would you have liked more discussions with your professor concerning your internship? Was closer supervision needed? Was more of an orientation required?)

<Signature of Student>

<Name, Roll number, Date>

4.9. Appendix IX:**Performa for Evaluation of Internship by Institute**

<HEI Letter Head>

1. Name of Student _____
2. Mob. No. _____
3. Roll No. _____
4. Branch/Semester _____
5. Period of Training _____
6. Home Address with contact No. _____
7. Address of Training Site: _____
8. Address of Training Providing Agency: _____
9. Name/Designation of Training In- charge _____
10. Type of Work _____
11. Date of Evaluation _____
12. Please rate the following:

S.no	Particular	Grade
1	Quality and effectiveness of presentation	
2	Depth of knowledge and demonstrated skills	
3	Variety and relevance of learning experience	
4	Practical applications and relationships with concepts taught	
5	Internship Report	
6	Attendance record, student log, supervisor evaluation	

Overall grade: _____

Additional Remarks: Signature

of Faculty Mentor

Course Outcome**After successful completion of this course, students will be able to....**

- CO1: Better understanding of the work environment
- CO2: Increase engagement and retention
- CO3: Opportunities for career
- CO4: Adaptability and Improved efficiency
- CO5: Increased productivity
- CO6: Faster integration and onboarding

Question Paper Pattern Courses Related to Botany

Marks: 35		Time: 2 Hour	
Instructions to the Candidate:			
1. All questions are compulsory.			
2. Figures to right indicate full marks.			
3. Use of Log table and scientific calculator is allowed/ Draw well labelled diagram wherever necessary.			
Question-1	Solve Any five of the following (Short Answers) i. ii. iii. iv. v. vi. vii.	Three def. type, two tricky questions and two questions problem type (if applicable)	5 Marks
Question-2	A. Solve any two of the following i. ii. iii.	Note or Describe type questions	6 Marks
	B. Solve the following Single question of four marks i. ii.	Problem type or tricky reasoning type question	4 marks
Question-3	A. Solve any two of the following i. ii. iii.	Write Note / Differentiate type questions	6 Marks
	B. Solve the following Single question of four marks i. ii.	Problem type or Derive equation or Tricky discussion type question	4 marks
Question-4	Solve Any four of the following i. ii. iii. iv. v.	Application type, Justification type question	10