

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

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 NCrF. 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

- a. Each theory or practical course will be of 2 credits = 50 marks
- b. Internal evaluation 30% weightage (15 marks)
- c. External evaluation 70% weightage (35 marks)
- d. 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.

a. 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.

b. External Evaluation - External evaluation will be done at the end of each semester.

- i. For theory, 35 marks written examination will be conducted and time of examination will be 2-hours.
- ii. For practical, 35 marks practical examination will be conducted and time of examination will be 4-hours.
- iii. For project / field project, 35 marks evaluation will done on the basis of viva-voce and examination of thesis by the examiners.
- iv. 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.

iv. Vocational Skill Courses, Internship/ Apprenticeship, Field Projects, Research Projects connected to Major first to fourth year.

(b) Minor Subject: 18-20 Credits

- i. 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.
- ii. 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

- i. It is to be offered in I and/or II year
- ii. Faculty-wise baskets of OE shall be prepared by University/ Autonomous Colleges.
- iii. 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:

- i. To be offered in first to three years;
- ii. 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.

PDEA's
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).

**P.D.E. A's. Prof. Ramkrishna More Arts, Commerce and Science College Akurdi, Pune-411044
(Autonomous) Affiliated to Savitribai Phule Pune University**

Revised Credit Framework / Structure for NEP-2020(II); CBCS Pattern-2024 with two Major at FY

To be Implemented from Academic Year 2024-25

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	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	0	2T (Major Specific)	2T	0	2	22	
	IV	4T + 2P/T	0		2T/P	2 CEP	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	22	
	VI	8T + 4P/T	2T + 2P/T		2T/P	4 OJT	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	0	0	0	0	0	22	
		10T + 4P/T	2T + 2P/T		0	4 OJT	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	22	
		10T + 2P/T	2T + 2P/T		0	6 RP	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;**SEC** – Skill Enhancement Course;**IKS** – Indian Knowledge System**FP** – Field Project**CEP** – Community Engagement Project**OJT** – On Job Training**AEC** – Ability Enhancement Courses**VEC** – Value Education Course**CC** – Curricular Courses**GE/OE** – Generic or Open elective courses**RP** – Research Project**RM** – Research Methodology**T** – Theory **P** – Practical

1. A student can select three subject from the same faculty in first year. **At second year From Subject-1 and -2 student will select any one subject as major and one subject as minor.** Student cannot select Major and Minor subjects other than these two subjects taken at first year.
2. **VSC, IKS-2, OJT, FP, CEP, RP, RM should be related to Major subject**
3. OE/GE – Must be selected form 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.

NEP Coordinator**IQAC Coordinator****Deans****Vice Principal****Principal**

1. **Arts Faculty** : _____
2. **Commerce Faculty:** _____
3. **Science Faculty:** _____
4. **Inter- disciplinary courses:** _____

Year	Sem	Major Courses	Major Elective Courses	Subject 2 (Minor Course)	OJT/ RP/ CEP/ FP	VSC	IKS	GE /OE	SEC
FY	I	2 Theory + 1 Practical BOMAT-111 Basic Plant Science BOMAT-112 Applied Plant Science BOMAP-113 Practical Botany I	0	0	0	0	1 Theory GEIKT-111 Generic IKS	1 Theory BOGET-111 Agrotourism and Ecotourism	1 Practical BOSEP-111 Practical on Cultivation technique of mushroom and algae
	II	2 Theory + 1 Practical BOMAT-121 Basics of Plant Ecology BOMAT-122 Cell Biology BOMAP-123 Practical Botany II	0	0	0	0	0	1 Theory/ 1 Practical BOGET-121 Plant resources	1 Theory BOSET-121 Practical on Biofertilizers and Biopesticides
SY	III	2 Theory + 1 Practical BOMAT -231 Lower Cryptogams BOMAT -232 Plant Physiology BOMAP -233 Practical Botany III	0	1 Theory + 1 Practical BOMIT-231 Nursery and Gardening Management BOMIP-232 Practical on Nursery and gardening management	FP BOFPP-231	1 Theory BOVST-231 Herbal Technology	1 Theory BOIKT-231 Indian Agriculture	1 Theory BOGET-231 Agriculture for Competitive Exams	0
	IV	2 Theory + 1 Practical BOMAT -241 Higher Cryptogams and Gymnosperms BOMAT -242 Phytochemistry BOMAP -243 Practical Botany IV	0	1 Theory + 1 Practical BOMIT-241 Applied Botany and Entrepreneurship BOMIP-242 Practical on Applied Botany & Entrepreneurship	CEP BOCEP-241	1 Practical BOVSP-241 Practical on Herbal Technology	0	1 Practical/ 1 Theory BOGET-241 Ayurvedic Botany	1 Practical BOSEP-241 Practical on Plant Identification and Herbarium
TY	V	4 Theory + 2 Practical BOMAT – 351 Angiosperms and Plant Evolution BOMAT -352 Plant	2Theory + 1Practical BOMET-351A Entrepreneurship in Botany BOMET-352A	0	RP BORPP-351	1 Theory BOVST-351 Plant Tissue Culture	0	0	0

		Molecular Biology BOMAT-353 Plant Pathology BOMAT-354 Plant anatomy and Embryology BOMAP -355 Practical Botany V BOMAP -356 Practical Botany VI	Gardening and Landscape designing BOMET-353A Medicinal Botany BOMEPE-351B Practical on Entrepreneurship in Botany and Landscape designing BOMEPE-352B Practical on Landscape designing and Medicinal Botany BOMEPE-353B Practical on Medicinal and Entrepreneurship in Botany						
	VI	4 Theory + 2 Practical BOMAT-361 Concepts of Genetics BOMAT-362 Plant Biotechnology BOMAT-363 Seed Technology and Post-Harvest technology BOMAT-364 Plant based Food and Nutrition BOMAP-365 Practical Botany VII BOMAP-366 Practical Botany VIII	1 Theory + 1 Practical BOMET-361A Computational Botany BOMET-362A Environmental Botany BOMEPE-361B Practical on Computational Botany BOMEPE-362B Practical on Environmental Botany	0	OJT BOOJT-361	1 Practical BOVSP-361 Practical on Plant Tissue Culture	0	0	0
VII and VIII Sem honors degree with Major and Minor									
Year	Sem	Major Courses	Major Elective Courses	Minor Courses	OJT/RP	VSC	IKS	GE/OE	SEC
TY Honors Major	VII	5 Theory + 2 Practical BOMAT-471 Plant Systematics - I (Algae & Fungi) BOMAT-472 Advanced Cell	1 Theory + 1 Practical BOMET -471A Crop Physiology BOMEPE -471B Practical on Crop Physiology	RM (2T+2P) 4 credits BORMT -471 Research Methodology BORMP -472 Practical on Research Methodology	0	0	0	0	0

		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	BOMET-472A Pharmacognosy BOMEPE- 472B Practical on Pharmacognosy						
	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 BOMEPE-481B Practical on Applied Biotechnology and Nanotechnology BOMET-482A Biodiversity BOMEPE- 482B Practical on Biodiversity	0	4OJT BOOJT - 481	0	0	0	0
VII and VIII Sem Honors degree with research									
TY Honors Research	VII	4 Theory + 1 Practical BOMAT-471R Plant Systematics - I (Algae & Fungi) BOMAT-472R Advanced Cell Biology BOMAT-473R	1 Theory + 1 Practical BOMET -471AR Crop Physiology BOMEPE -471BR Practical on Crop Physiology BOMET-472AR Pharmacognosy	RM (2T+2P) 4 credits BORMT -471R Research Methodology BORMP -472R Practical on Research Methodology	RP BORPP - 471R	0	0	0	0

	Genetics & Plant Breeding BOMAT-474R Plant Organism Interaction BOMAP-475R Practical botany IX	BOMEPE- 472BR Practical on Pharmacognosy						
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-476R Practical botany XI	1 Theory + 1 Practical BOMET-481AR Applied Biotechnology and Nanotechnology BOMEPE-481BR Practical on Applied Biotechnology and Nanotechnology BOMET-482AR Biodiversity BOMEPE- 482BR Practical on Biodiversity	0	RP BORPP - 481R	0	0	0	0

Program: B.Sc. [Botany], 2024-25

Program Outcomes (POs) for B.Sc. Botany:

1. **Core Botanical Knowledge:** Demonstrate a thorough understanding of core concepts in plant science including morphology, physiology, ecology, cell biology, taxonomy, and evolution.
2. **Applied Botanical Skills:** Apply botanical knowledge to practical areas such as biofertilizers, Biopesticides, nursery management, herbal technology, and Phytochemistry.
3. **Ecological & Environmental Awareness:** Develop ecological sensitivity and environmental consciousness through courses like plant ecology, environmental awareness.
4. **Scientific Research & Methodology:** Acquire skills in scientific research design, experimental techniques, data analysis, and scientific writing.
5. **Practical Laboratory Competence:** Perform standard laboratory Practicals in plant identification, microscopy, Phytochemistry, molecular biology, plant pathology, and biotechnology.
6. **Vocational skills:** Gain hands-on vocational skills in nursery techniques, herbal product development, plant tissue culture, and plant-based nutrition.
7. **Communication Skills:** Enhance scientific and creative communication skills in both regional languages (Marathi and Hindi) and scientific English through integrated language and writing courses.
8. **Computational & Analytical Skills:** Apply computational tools and quantitative reasoning in plant sciences, especially in genetics, bioinformatics, and data-driven ecological assessments.
9. **Interdisciplinary Approach:** Integrate concepts from biotechnology, nanotechnology, ethnobotany, and traditional knowledge systems to solve real-world botanical problems.
10. **Sustainable Development Goals Orientation:** Align botanical knowledge with sustainable agriculture, biodiversity conservation, and community welfare, especially in field projects and community engagement.
11. **Ethical and Social Responsibility:** Exhibit ethical practices and understand the socio-cultural implications of botanical research and biotechnological applications.
12. **Entrepreneurship and Employability:** Prepare for employment or entrepreneurship in the fields of agriculture, horticulture, herbal medicine, seed technology, and environmental consultancy.
13. **Global and Local Relevance:** Understand the global importance of plants in climate change, food security, and health, while valuing indigenous and local knowledge systems like Ayurveda and IKS.

Program Specific Outcomes(PSo):**PSO1: Understanding Plant Diversity and Evolution**

Demonstrate in-depth knowledge of plant biodiversity from lower cryptogams (algae, fungi, lichens) to higher cryptogams and gymnosperms, as well as the classification, morphology, and evolution of angiosperms.

PSO2: Mastery of Plant Function and Structure

Apply core concepts in plant physiology, cell biology, molecular biology, and phytochemistry to understand plant function, structure, and metabolism at the cellular and organismal levels.

PSO3: Application of Botany in Agriculture and Industry

Utilize botanical knowledge in agriculture, seed technology, herbal medicine, nursery and gardening, biofertilizers production, and food and nutrition sciences, with practical exposure to field and lab-based practices.

PSO4: Proficiency in Research and Scientific Inquiry

Design and conduct botanical experiments, analyse data using appropriate methods, and communicate findings through research methodology, scientific writing, and participation in field/research projects.

PSO5: Environmental and Ethical Awareness with Community Relevance

Evaluate ecological issues and biodiversity conservation strategies, apply traditional knowledge systems (e.g., Ayurveda, IKS), and engage in community-based initiatives for sustainable development and environmental education.

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

FIFTH SEMESTER

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

Department of Botany**T.Y. B. Sc. Botany****Fifth and Sixth Semester****T.Y.B.Sc. Botany**

Sr. No.	Subject Code	Subject Name	Allotted Credit	No. of Lecture or Practical	Allotted Workload
Sem V					
Major-4 Theory + 2 Practical					
1	BOMAT 351	Angiosperms and Plant Evolution	2	30L	2
2	BOMAT 352	Plant Molecular Biology	2	30L	2
3	BOMAT 353	Plant Pathology	2	30L	2
4	BOMAT 354	Plant Anatomy and Embryology	2	12P	2
5	BOMAP 355	Practical Botany V	2	12P	4
6	BOMAP 356	Practical Botany VI	2	12P	4
Major Elective Course 2Theory + 1Practical					
7	BOMET-351A	Entrepreneurship in Botany	2	30L	2
8	BOMET-352A	Gardening and Landscape designing	2	12P	4
9	BOMET-353A	Medicinal Botany	2	30L	2
10	BOMEPE-351B	Practical on Entrepreneurship in Botany and Landscape designing	2	12P	4
10	BOMEPE-352B	Practical on Landscape designing and Medicinal Botany	2	12P	4
10	BOMEPE-353B	Practical on Medicinal and Entrepreneurship in Botany	2	12P	4
VST- 1 Theory					
11	BOVST-351	Plant Tissue Culture	2	30L	2
Research Project					
12	BORPP-351	Research Project	2	180 Hrs	4
Sem VI					
Major-4 Theory + 2 Practical					
1.	BOMAT-361	Concepts of Genetics	2	30 L	2
2.	BOMAT-362	Plant Biotechnology	2	30L	2
3.	BOMAT-363	Seed Technology and Post-Harvest Technology	2	30L	2
4.	BOMAT-364	Plant based Food and Nutrition	2	30L	2
5.	BOMAP-365	Practical Botany VII	2	12P	4
6.	BOMAP-366	Practical Botany VIII	2	12P	4

Major Elective- 1Theory + 1Practical					
1.	BOMET-361A	Computational Botany	2	30L	2
2.	BOMET-362A	Environmental Botany	2	30L	2
3.	BOMEPE-361B	Practical on Computational Botany	2	12P	4
4.	BOMEPE-362B	Practical on Environmental Botany	2	12P	4
VSP-1 Practical					
1.	BOVSP-361	Practical on Plant Tissue Culture	2	12P	4
OJT					
1.	BOOJP-361	On Job Training	4	128 Hrs	4

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

Major-4 Theory and 2 Practical

Board of Studies in Botany

Department of Botany

Prof. Ramkrishna More Arts, Commerce and Science

College Akurdi Pune-411044

Botany (NEP)		B. Sc. Botany		RMC
Course	:	Major	Total Credit	: 2
Code	:	BOMAT 351	Course Type	: Theory
Subject	:	Angiosperm and Plant Evolution	Total Lecture	: 30L

Module - I : Angiosperm 15L

Chapter 1 Introduction to Angiosperms 4L

- 1.1 Comparative study of different classifications viz. Linnaeus, Bentham and Hooker, Engler and Prantl, APG System
- 1.2 Detailed study of Bentham and Hooker and APG System
- 1.3 Advantages and Limitations of viz. Linnaeus, Bentham and Hooker's, Engler and Prantl, and APG System of Classification
- 1.4 Primitive Vs Advanced characters

Chapter 2 General characters of Angiosperms 5L

- 2.1 Habitat and Habit
- 2.2 Anatomical Characters
- 2.3 Reproduction
- 2.4 Gametophyte Generation
- 2.5 Pollination
- 2.6 Fertilization
- 2.7 Causes of evolutionary success angiosperms
- 2.8 Comparative account of monocotyledons and dicotyledons

Chapter 3 Study of Plant Families 6L

- 3.1 Salient Features (Vegetative (habit, leaf, inflorescence, flower, fruit, seed) & Reproductive characters, Floral Formula, Floral Diagram, Systematic Position and Economic importance with Suitable examples) Study of Plant Families wrt
Dicot families: Annonaceae → Malvaceae → Fabaceae → Brassicaceae → Apocynaceae → Solanaceae → Asteraceae.
Monocot families: Asparagaceae → Poaceae → Orchidaceae

Module - II : Plant Evolution 15L

Chapter 5 Origin of Life & Early Plants 3L

- 5.1 Introduction of Chemical origin of life, Miller Urey Experiment
- 5.2 Early photosynthetic organisms: Origin of first autotrophs, Cyanobacteria (Blue-green algae), Endosymbiotic theory, First eukaryotic algae, Evolutionary significance
- 5.3 Fossil evidence: Importance of fossils, Types of fossils, Evolution through geological time scale

Chapter 6 Evolution of Land Plants 5L

- 6.1 Transition from aquatic to terrestrial habit: Challenges of land life, Pre-adaptations in algae, significance of terrestrialization
- 6.2 Evolutionary adaptations in early land plants: Development of cuticle, Origin of stomata, Evolution of vascular tissue, Evolution of true roots, stems and leaves
- 6.3 Bryophyte evolution: Features linking algae and land plants, Evolution of gametophyte-dominant life cycle
- 6.4 Pteridophyte evolution & heterospory: Origin of earliest vascular plants, Rise of true vascular tissue (xylem & phloem), Stellar evolution

Chapter 7 Evolution of Seed Plants 3L

- 7.1 Origin of seed habit: Evolution of heterospory, Retention of megaspore within megasporangium, Formation of integuments, Evolution of seed, Advantages of seeds over spores
- 7.2 Gymnosperm evolution – Origin & early gymnosperms, Cycads, *Ginkgo biloba*,
- 7.3 Conifers and Gnetales, Evolutionary Transition from Gymnosperms to Angiosperms

Chapter 8 Origin & Evolution of Angiosperms

4L

- 8.1 Primitive vs advanced characters: Concept of primitive (plesiomorphic) vs advanced (apomorphic) traits, Primitive vs advanced vegetative characters, Examples of primitive families (Magnoliaceae) vs advanced families (Asteraceae)
- 8.2 Theories of angiosperm origin: Pteridosperm theory, Bennettitales theory, Gnetales affinity.
- 8.3 Co-evolution of angiosperms and pollinators: Definition of co-evolution, Specialized pollination mechanisms, Role of co-evolution in angiosperm diversification, Examples of classic co-evolutionary pairs (*Yucca* & *Yucca* moth, Fig & fig wasp)
- 8.4 Adaptive radiation in angiosperms (Hydrophyte, xerophytic, parasitic, Epiphytic forms).
- 8.5 Retrogressive evolution in angiosperms: Concept of reduction and simplification of floral organs, Reduction in number of stamens and carpels, Loss or reduction of perianth, catkin-bearing genera (*Salix*).

Suggested Readings:

1. Bhojwani, S.S. & Bhatnagar, S.P. 2010. *The Embryology of Angiosperms* (5th edition). Vikas Publishing House, New Delhi, India.
2. Pandey, B.P. 2014. *Taxonomy of Angiosperms*. S. Chand & Company Pvt. Ltd., New Delhi, India.
3. Singh, G. 2016. *Plant Systematics: Theory and Practice* (3rd edition). Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi, India.
4. Vashishta, P.C., Sinha, A.K. & Kumar, A. 2010. *Bryophytes, Pteridophytes and Gymnosperms*. S. Chand Publishing, New Delhi, India.
5. Sharma, O.P. 2013. *Plant Taxonomy*. Tata McGraw-Hill Publishing Co. Ltd., New Delhi, India.
6. Lawrence, G.H.M. 1951. *Taxonomy of Vascular Plants*. Macmillan Company, New York, USA.
7. Esau, K. 1977. *Anatomy of Seed Plants* (2nd edition). John Wiley & Sons, New York, USA.
8. Fahn, A. 1990. *Plant Anatomy* (4th edition). Pergamon Press, Oxford, UK.
9. Stewart, W.N. & Rothwell, G.W. 1993. *Paleobotany and the Evolution of Plants*. Cambridge University Press, Cambridge, UK.
10. Raven, P.H., Evert, R.F. & Eichhorn, S.E. 2013. *Biology of Plants* (8th edition). W.H. Freeman & Company, New York, USA.

Course Outcome

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

- CO1: Understand the basic principles of angiosperm classification, and nomenclature.
- CO2: Identify major angiosperm families with respect to morphological features
- CO3: Explain the role of meristems and secondary growth in angiosperm development.
- CO4: Describe reproduction in angiosperms.
- CO5: Summarize the origin of life and evolutionary trends in plants.

Botany (NEP)		B. Sc. Botany		RMC
Course	:	Major	Total Credit	: 2
Code	:	BOMAT 352	Course Type	: Theory
Subject	:	Plant Molecular Biology	Total Lecture	: 30L

Module – I: Basics of Molecular Biology **15L**

Chapter 1 Fundamentals of Molecular Biology **3L**

- 1.1 Introduction, History, Scope and Importance of Molecular Biology in Plant Science
- 1.2 Interrelationship with genetics, biochemistry, microbiology, biotechnology, and cell biology.
- 1.3 Applications in Agriculture, Plant Biotechnology, Medicine, and Conservation Biology.

Chapter 2 Introduction to genetic material **5L**

- 2.1 Genetic material DNA: Historical perspective from 1953 to 2020, Griffith's and Avery's transformation experiments, The Meselson-Stahl experiment (Semi-conservative nature of DNA), Hershey-Chase bacteriophage experiment.
- 2.2 Nucleic acids- structure, properties and function, Nucleoside and nucleotide Structure of DNA: DNA forms; A, B & Z
- 2.3 Types and structure of RNA: tRNA, rRNA, mRNA and noncoding RNA (miRNA, siRNA).

Chapter 3 DNA Replication **4L**

- 3.1 Introduction to replication: Concept of Central Dogma, Prokaryotic and Eukaryotic replication.
- 3.2 Enzymes involved in Replication: Prokaryotic and Eukaryotic.
- 3.3 Molecular mechanism of DNA replication: Initiation, Elongation and Termination.

Chapter 4 DNA Damage and Repair **3L**

- 4.1 Causes and Types of DNA Damage
- 4.2 Mechanism of DNA repair: Photo reactivation, base excision repair, nucleotide excision repair, mismatch repair, SOS repair, and recombination repair.

Module - II : Molecular Processes **15L**

Chapter 5 Transcription **4L**

- 5.1 Transcription in Prokaryotes and Eukaryotes
- 5.2 Structure and role of promoters, RNA polymerase, and transcription factors.
- 5.3 Molecular Mechanisms of Transcription: Initiation, Elongation and Termination
- 5.4 Enzymes and transcription factors are involved in transcription.
- 5.5 RNA processing: capping, splicing, polyadenylation.

Chapter 6 Translation **6L**

- 6.1 Structure of the Ribosome and Its Assembly
- 6.2 Protein Synthesis in Prokaryotes: Structure of the prokaryotic Initiator tRNA-fMet and tRNA charging.
- 6.3 Protein Synthesis in Eukaryotes: Mechanism of initiation, elongation and termination of polypeptides.
- 6.4 Fidelity of translation, Inhibitors of translation.
- 6.5 Posttranslational modifications of proteins.
- 6.6 Genetic Code: Concept and Properties of Genetic Code. Wobble hypothesis.

Chapter 7 Regulation of Gene Expression **2L**

- 7.1 Lac operon: Catabolite repression
- 7.2 The Tryptophan operon: Regulation by attenuation

Chapter 8 Molecular Biology Techniques**3L**

- 8.1 Gel electrophoresis: DNA, RNA, and proteins based on size and charge.
- 8.2 Restriction enzymes: EcoRI, HindIII.
- 8.3 DNA ligase, polymerases, hydrolases, proteases, reverse transcriptase, etc.
- 8.4 Cloning vectors: Plasmids and bacteriophages
- 8.5 Recombinant DNA technology
- 8.6 Blotting techniques: Southern blotting, Northern blotting, Western blotting.
- 8.7 Transformation and transfection methods
- 8.8 Bioinformatics tools and computational tools for the storage and analysis of molecular data.

Suggested Readings:

1. Brown, T.A. (2016). *Genomes 4*. Garland Science.
2. Alberts, B. et al. (2022). *Molecular Biology of the Cell, 7th Edition*.
3. Sambrook, J., Russell, D.W. (2001). *Molecular Cloning: A Laboratory Manual*, 3rd Edition.
4. Shendure, J., Ji, H. (2008). "Next-generation DNA sequencing." *Nature Biotechnology*, 26: 1135–1145.
5. Zhou, X., et al. (2018). "Next-generation sequencing in plant functional genomics." *Frontiers in Plant Science*, 9:1–15.

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

CO1: Understand the basic concepts, history, scope, and importance of molecular biology in plant science and related disciplines.

CO2: Explain the structure, properties, and functions of nucleic acids and their role as genetic material.

CO3: Describe the molecular mechanisms of DNA replication, transcription, and translation in prokaryotic and eukaryotic systems.

CO4: Understand the causes of DNA damage and explain various DNA repair mechanisms.

CO5: Explain the regulation of gene expression using operon models.

CO6: Describe the principles and applications of major molecular biology tools and techniques, including enzymes, cloning vectors, recombinant DNA technology, and bioinformatics tools.

Botany (NEP)		B. Sc. Botany		RMC
Course	:	Major	Total Credit	: 2
Code	:	BOMAT 353	Course Type	: Theory
Subject	:	Plant Pathology	Total Lecture	: 30L

Module – I: Introduction: 15L

Chapter 1 Fundamentals of Plant Pathology 6L

- 1.1 Introduction,
- 1.2 Important terminology- Incitants, Host, Symptoms, Parasite, Pathogen, Inoculum, Penetration, Infection, Incubation, Disease.
- 1.3 Economic impact of plant diseases,
- 1.4 History of plant pathology,
- 1.5 Introduction to Indian Agriculture Research Institute (IARI), International Crop Research Institute for Semi-Arid Tropics (ICRISAT),
- 1.6 Indian Scholars in Plant Pathology
- 1.7 Contribution of Anton De Bary and Prof. B.B. Mundkur

Chapter 2 Disease Development 9L

- 2.1 Concept of disease cycle, Inoculation, Prepenetration, Penetration, Infection, Dissemination. Epidemics-Forms, Decline, Exponential model.
- 2.2 **Defense Mechanisms:** Concept and Definition, Types-Preexisting- Structural and chemical, Induced- Structural and Biochemical, Phytoalexins,
- 2.3 **Methods of Studying Plant Diseases:** - Macroscopic study, microscopic study, Koch's postulates. Types of culture Media, Pure culture methods- Serial dilution, Streak plate, pour plate, Spread plate.

Module - II Diseases and Control Measures 15L

Chapter 3 Fungal Diseases 3L

- 3.1 **Fungal Plant Diseases:** - Introduction to fungi as plant pathogens. Study of Diseases- Downy mildew of Grapes, Head smut of Jowar, Tikka diseases of Groundnut with reference to causal organism, symptoms and disease management.

Chapter 4 Bacterial Diseases 3L

- 4.1 **Bacterial Plant Diseases:** - Introduction to bacteria as plant pathogens, Study of Diseases- Citrus Canker, Black arm of Cotton with reference to causal organism, symptoms and disease management.

Chapter 5 Mycoplasma Plant Diseases 3L

- 5.1 **Mycoplasma Plant Diseases:** - Introduction to Mycoplasma as plant pathogens, Study of Diseases Grassy shoot disease of sugarcane, little leaf of brinjal with reference to causal organism, symptoms and disease management.

Chapter 6 Viral Plant Diseases 3L

- 6.1 **Viral Plant Diseases:** -Introduction of Virus as plant pathogens. Study of Diseases- Papaya Mosaic Disease, Bunchy top of Banana with reference to causal organism, symptoms and causal organism.

Chapter 7 Principles of plant diseases control 3L

- 7.1 **Principles of plant diseases control:** General account, Quarantine, Eradication, cultural control practices, biological control. Curative measures, chemical control, Use of Effective Microorganism solution (EMS), Microbial Pesticides

Suggested Readings:

1. Singh R. S. (2019) Introduction to Principles of Plant Pathology 4th Ed (PB2019) Paperback.
2. Plant Pathology 2/e PB Sharma PD Paperback – 1 January 2016
3. A.V.S.S. Sambamurty (2010) Principles of plant pathology, Wiley distributor
4. George Agrios (2004) Plant Pathology 5th Edition, Academic Press.

Course Outcome:

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

CO1: Understand organisms and causal factor responsible for plant diseases and methods of studying plant diseases.

CO2: Know about the early development and role of different micro-organism in development of plant disease.

CO3: Acquire knowledge on general concepts and classification of plant diseases.

CO4: Learn different strategies for management of plant diseases.

CO5: Know about research institutes working on plant disease management.

Botany (NEP)		B. Sc. Botany		RMC
Course	:	Major	Total Credit	: 2
Code	:	BOMAT 354	Course Type	: Theory
Subject	:	Plant Anatomy and Embryology	Total Lecture	: 30L

Module – I: Plant Anatomy		15L
Chapter 1	Introduction to tissue system	3L
	1.1 Definition	
	1.2 Scope of plant anatomy	
	1.3 Structure, types and functions of epidermis	
	1.4 Structure, types and functions of Stomata	
	1.5 Epidermal outgrowths- non-glandular and glandular	
	1.6 Motor cells	
Chapter 2	Development of tissue system	3L
	2.1 Meristems: Types: Primary and Secondary, Root Apical Meristem, Shoot Apical Meristem; Lateral meristem, intercalary meristem, Cambium	
	2.2 Growth and Tissue differentiation: of Root, Shoot and Leaf	
	2.3 Role of Cambium – Secondary growth and its anomalies.	
Chapter 3	Mechanical tissue system	4L
	3.1 Principles involved in distribution of mechanical tissues with one example each a) Inflexibility, b) Incompressibility, c) Inextensibility and d) Shearing stress	
	3.2 Vascular tissue system: Structure and function of xylem, phloem and cambium	
Chapter 4	Normal secondary growth	2L
	4.1 Introduction	
	4.2 Normal secondary growth in dicotyledonous stem	
	4.3 Development of annual rings, periderm, bark, tyloses and lenticel	
Chapter 5	Anomalous secondary growth	3L
	5.1 Introduction	
	5.2 Causes of anomalous secondary growth	
	5.3 Anomalous secondary growth in: a) Dicot stem (Bignonia), b) Dicot root (Raphanus), c) Monocot stem (Dracaena)	
Module – II: Plant Embryology		15L
Chapter 6	Introduction	1L
	6.1 Definition	
	6.2 Scope of Plant Embryology	
Chapter 7	Microsporangium and male gametophyte	4L
	7.1 Structure of tetrasporangiate anther	
	7.2 Types of tapetum	
	7.3 Sporogenous tissue	
	7.4 Microsporogenesis: process and its types	
	7.5 Types of microspore tetrad	
	7.6 Male gametophyte: structure and development of male gametophyte	
Chapter 8	Megasporangium and female gametophyte	4L
	8.1 Structure	
	8.2 Types of ovules	
	8.3 Types of megaspore tetrads	
	8.4 Female gametophyte: structure of typical embryo sac	
	8.5 Types of embryo sacs – monosporic, bisporic and tetrasporic	

Chapter 9 Pollination and Fertilization**3L**

- 9.1 Introduction and definition
- 9.2 Types of pollination
- 9.3 Germination of pollen grain
- 9.4 Entry of pollen tube- porogamy, mesogamy and chalazogamy
- 9.5 Double fertilization and its significance.

Chapter 10 Endosperm and embryo**3L**

- 11.1 Endosperm: Types – nuclear, helobial and cellular.
- 11.2 Structure of Dicotyledonous and Monocotyledonous embryo.

Suggested Readings:

1. Chandurkar P J, Plant Anatomy, Plant Anatomy Oxford and IBH publication Co. New Delhi 1971
2. B P Pandey, Plant Anatomy. S Chand and Co. Ltd, New Delhi 1978
3. Greulach V A and Adams J E Plant- An introduction to Modern Biology, Toppen Co. Ltd, Tokyo
4. Eams and Mc Daniel, An Introduction to Plant Anatomy, McGraw –Hill Book Co. Ltd and Kogakusha Co, Tokyo, Japan
5. Adriance S Foster Practical Plant Anatomy, D Van Nostrand Co. INC, New York
6. Esau, Plant Anatomy, Wiley Toppan Co. California, USA
7. Pijush Roy, Plant Anatomy. New Central Book Agency Ltd, Kolkata
8. Pandey S N and Ajanta Chadha, Plant Anatomy and Embryology, Vikas Publishing House, Pvt, Ltd, New Delhi
9. Bhojwani S S and Bhatnagar S P, An Embryology of Angiosperms
10. Maheshwari P, An introduction to Embryology of Angiosperm
11. Nair P K K Essentials of Palynology

Course Outcome:

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

- CO1: Tissue Analysis: Identify and describe epidermal, mechanical, and vascular tissue systems.
CO2: Growth Processes: Compare normal and anomalous secondary growth in dicots and monocots.
CO3: Male Gametogenesis: Understand anther anatomy and the development of male gametophytes.
CO4: Female Gametogenesis: Classify ovule types and the development of various embryo sacs.

Course : Major	Total Credit : 2
Code : BOMAP 355	Course Type : Practical
Subject : Practical Botany V (Practical based on BOMAT 351 & BOMAT 352)	Total Practical : 12

Sr. No	Practical Botany (Practical Based on BOMAT 351 and BOMAT 352)	12P
---------------	--	------------

Based on BOMAT 351 (Angiosperm and Plant Evolution)

- | | | |
|----|---|----|
| 1. | Study of Cyanobacteria, Algae and Bryophytes Demonstrating Early Evolution of Photosynthetic and Terrestrial Plants | 1P |
| 2. | Study of Evolutionary Trends in Pteridophytes with Reference to Vascular (Stelar) Organization and Heterospory (<i>Psilotum</i> , <i>Pteris</i> , <i>Selaginella</i> , <i>Marsilea</i>) | 1P |
| 3. | Study of Origin and Evolution of Seed Habit in Gymnosperms (<i>Cycas</i> , <i>Pinus</i> , <i>Gnetum</i>) and Study of Fossil Evidence | 1P |
| 4. | Systematic Study of Selected Angiosperm Families: Dicots (Annonaceae, Malvaceae, Solanaceae Asteraceae) | 1P |
| 5. | Systematic Study of Selected Angiosperm Families: Monocots (Asparagaceae, Poaceae Orchidaceae) | 1P |
| 6. | Study of Angiosperm Diversification and Adaptive Radiation Across Different Ecological Adaptations (Hydrophytes – <i>Hydrilla</i> , <i>Nelumbo</i> ; Xerophytes – <i>Opuntia</i> ; Parasitic – <i>Cuscuta</i>) | 1P |

Based on BOMAT 352 (Plant Molecular Biology)

- | | | |
|-----|--|----|
| 7. | General laboratory methods and safety procedures | 1P |
| 8. | Study of DNA replication mechanisms through models/photographs (Rolling circle, Theta replication and semi-discontinuous replication). | 1P |
| 9. | Extraction of DNA from cauliflower and estimation with suitable method. | 1P |
| 10. | Demonstration of separation of DNA by gel electrophoresis. | 1P |
| 11. | Separation of Protein by gel electrophoresis. | 1P |
| 12. | Estimation of RNA by Orcinol reagent. | 1P |
| 13. | Field Visit | 1P |

Suggested Readings

1. Singh, G. (2019). Plant systematics: An integrated approach (3rd ed.). Bengaluru, India: BSP Books.
2. Pteridophytes, Gymnosperms and Palaeobotany. (n.d.). Course material. Indore, India: ISU Botany Department.
3. Stebbins, G. L. (1950). Variation and evolution in plants. New York, NY: Columbia University Press.
4. Pandey, S. N., & Tiwari, P. S. (2020). A textbook of botany: Volume I & II (13th ed.). Vikas Publishing House Ltd., New Delhi, India — Covers plant kingdom diversity, algae, bryophytes,

- pteridophytes, gymnosperms, and angiosperms. **Sambrook, J. & Russell, D.W.** *Molecular Cloning: A Laboratory Manual*, 3rd Edition, Cold Spring Harbor Laboratory Press.
5. **Brown, T.A.** *Gene Cloning and DNA Analysis: An Introduction*, Wiley-Blackwell.
 6. **Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M., & Losick, R.** *Molecular Biology of the Gene*, Pearson.
 7. **Nelson, D.L. & Cox, M.M.** *Lehninger Principles of Biochemistry*, W.H. Freeman.
 8. **Wilson, K. & Walker, J.** *Principles and Techniques of Biochemistry and Molecular Biology*, Cambridge University Press.

Course Outcome

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

- CO1: Identify, observe, and classify algae and bryophytes to understand the origin of photosynthetic and land plants.
- CO2: Analyze vascular evolution, heterospory, and fossil evidence in pteridophytes and gymnosperms to interpret plant evolutionary trends and seed habit.
- CO3: Compare and classify angiosperm families and ecological adaptations to explain diversification and adaptive radiation.
- CO4: Recall basic laboratory methods, safety rules, and principles of molecular biology techniques.
- CO5: Explain the mechanisms of DNA replication and the principles behind DNA, RNA, and protein analysis techniques.
- CO6: Perform standard molecular biology experiments such as DNA extraction, electrophoresis, and RNA estimation.
- CO7: Demonstrate proper laboratory practices, data recording, and interpretation of results following ethical and safety guidelines.

Course : Major	Total Credit : 2
Code : BOMAP 356	Course Type : Practical
Subject : Practical Botany VI (Practical based on BOMAT 353 & BOMAT 354)	Total Practical : 12

Sr. No	Practical Botany (Practical Based on BOMAT 353 and BOMAT 354)	12P
Based on BOMAT 353 (Plant pathology)		
1.	Preparation of any one culture media for isolation of plant pathogens.	1P
2.	Culture technique- Streak plate methods, pour plate methods, Spread plate methods.	1P
3.	Study of any two of fungal (Downy mildew of Grapes, Head smut of Jowar, Tikka diseases of Groundnut) diseases.	1P
4.	Study of any two of each bacterial and mycoplasma diseases	1P
5.	Preparation of 1% Bordeaux mixture and Bordeaux paste 10% & Preparation of Jivamrut.	1P
6.	Study of Koch's Postulates.	1P
Based on BOMAT 354 (Plant Anatomy and Embryology)		
7.	Study of epidermal tissue system – non-glandular and glandular trichomes, multi-layered epidermis, typical stomata (Dicot and Monocot).	1P
8.	Study of mechanical tissues and their distribution in root, stem and leaves	1P
9.	Study of normal secondary growth in dicot stem – Annona /Moringa (Double stained temporary preparation).	1P
10.	Study of anomalous secondary growth in Bignonia and Dracaena stem (Double stained temporary preparation).	1P
11.	Study of tetrasporangiate anther and types of ovules with the help of permanent slides	1P
12.	Study of dicot and monocot embryo	1P

Suggested Readings

1. Mehrotra, R. S. & Aggarwal, A. – *Plant Pathology*
2. Singh, R. S. – *Introduction to Principles of Plant Pathology*
3. Aneja, K. R. – *Experiments in Microbiology, Plant Pathology and Biotechnology*
4. Mehrotra & Aggarwal – *Plant Pathology*
5. Schumann, G. L. – *Plant Diseases: Their Biology and Social Impact*
6. Cappuccino, J. G. & Sherman, N. – *Microbiology: A Laboratory Manual*
7. Rangaswami, G. & Mahadevan, A. – *Diseases of Crop Plants in India*
8. Dhingra & Sinclair – *Basic Plant Pathology Methods*
9. Pijush Roy, *Plant Anatomy*. New Central Book Agency Ltd, Kolkata

10. Pandey S N and Ajanta Chadha, Plant Anatomy and Embryology, Vikas Publishing House, Pvt, Ltd, New Delhi
11. Bhojwani S S and Bhatnagar S P, An Embryology of Angiosperms
12. Maheshwari P, An introduction to Embryology of Angiosperm
13. Nair P K K Essentials of Palynology

Course Outcome

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

- CO1: Identify various plant diseases and their control measures.
- CO2: Learn media preparation and different culture techniques for plant pathogen.
- CO3: Start small scale bio pesticide industry.
- CO4: Understand the allele and genotype frequency.
- CO5: Know the fossilization process.
- CO6: Understand species isolation process.
- CO7: Identify epidermal and mechanical tissues in various plant organs
- CO8: Analyze normal and anomalous secondary growth in stems
- CO9: Describe the anatomy of anthers and ovule types.

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

Major Elective Course (2 Theory and 1 Practical)

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

Botany (NEP)	B. Sc. Botany	RMC
Course	: Major Elective	Total Credit : 2
Code	: BOMET 351A	Course Type : Theory
Subject	: Entrepreneurship in Botany	Total Lecture : 30L

Module – I: Horticulture & Applied Plant Technologies **15L**

Chapter 1 Introduction to Horticulture, Floriculture and Pomology **7L**

- 1.1 Definition, scope, and importance of horticulture
- 1.2 Branches of horticulture – pomology, olericulture, floriculture.
- 1.3 Role of horticulture in nutrition, economy, and employment generation
- 1.4 Introduction to floriculture – definition, scope, and importance
- 1.5 Types of flowers – cut flowers, loose flowers, bedding plants, ornamental plants
- 1.6 Introduction to pomology – definition, importance, and major fruit crops
- 1.7 Present status and future prospects of horticulture in India.

Chapter 2 Organic Farming and Sustainable Agriculture **8L**

- 2.1 Concept and principles of organic farming
- 2.2 Need and scope of organic farming in India
- 2.3 Organic farming systems in horticulture and floriculture
- 2.4 Soil health management and crop rotation
- 2.5 Composting, vermicomposting, and bio-input production
- 2.6 Organic weed, pest, and disease management
- 2.7 Organic certification systems (NPOP, PGS – overview)
- 2.8 Economic, environmental, and social benefits
- 2.9 Case studies of successful organic farming.

Module – II: Post-Harvest & Processing Technology **15L**

Chapter 3 Fruit, Vegetable and Flower Processing Technology **7L**

- 3.1 Importance of post-harvest technology
- 3.2 Post-harvest losses and management
- 3.3 Processing of fruits (juices, jams, jellies, dehydration)
- 3.4 Processing of vegetables (pickles, sauces, drying, freezing)
- 3.5 Flower processing: essential oils, dry flowers, floral crafts
- 3.6 Packaging, storage, and food safety standards (FSSAI – basics)
- 3.7 Waste utilization and by-products.

Chapter 4 Natural Dyes and Greenhouse Technology **8L**

- 4.1 Introduction to natural dyes and their significance
- 4.2 Sources of natural dyes: plant-based dye-yielding materials
- 4.3 Important dye-yielding plants (indigo, turmeric, henna, madder, annatto)
- 4.4 Methods of dye extraction and mordanting
- 4.5 Applications of natural dyes in textiles, food, cosmetics, and handicrafts
- 4.6 Concept and types of greenhouse technology
- 4.7 Greenhouse structures, environmental control, and irrigation systems
- 4.8 Crops suitable for greenhouse cultivation and economic feasibility.

Suggested Readings:

1. Hartmann, H. T., Kester, D. E., Davies, F. T., & Geneve, R. L. *Plant Propagation: Principles and Practices*. Prentice Hall.
2. Chadha, K. L. *Handbook of Horticulture*. ICAR, New Delhi.
3. Singh, B. D. *Horticulture*. Kalyani Publishers.

4. Lampkin, N. *Organic Farming*. Farming Press, UK.
5. Yadav, S. R., & Jain, S. K. *Natural Dyes from Plants*. National Botanical Research Institute, Lucknow.
6. Chandra, R., & Kumar, V. *Post-Harvest Technology of Horticultural Crops*. CBS Publishers.
7. Sharma, R. R., & Singh, R. *Greenhouse Technology and Management*. Scientific Publishers.
8. Government of India publications on Organic Farming, NPOP, and PGS (ICAR / APEDA manuals).

Course Outcome:

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

- CO1: Describe the scope and importance of horticulture, organic farming, and applied botany.
- CO2: Apply principles of organic crop production, soil fertility management, and pest control in horticultural systems.
- CO3: Demonstrate methods of natural dye extraction and basic greenhouse cultivation techniques.
- CO4: Analyse post-harvest losses and processing techniques for fruits, vegetables, and flowers.
- CO5: Evaluate organic farming systems and certification standards for sustainable agriculture.
- CO6: Design simple value-addition or sustainable horticulture-based practices for small-scale applications.

Botany (NEP)		B. Sc. Botany		RMC
Course	:	Major Elective	Total Credit	: 2
Code	:	BOMET 352A	Course Type	: Theory
Subject	:	Gardening and Landscape designing	Total Lecture	: 30L

Module – I: Gardening Management **15L**

Chapter 1 Introduction to Gardening **4L**

- 1.1 Definition, Objectives and Scope of Gardening Management
- 1.2 History and Salient Features of Gardens in India Aryans period, Buddhist period, Mughal period, British period

Chapter 2 Plant Materials in Gardening **4L**

- 2.1 Classification of ornamental plants (trees, shrubs, climbers, creepers)
- 2.2 Annuals and perennials
- 2.3 Bulbous and seasonal flowering plants
- 2.4 Foliage and indoor plants
- 2.5 Selection of plants for different purposes
- 2.6 Indigenous and exotic garden plants.

Chapter 3 Garden Management Practices **3L**

- 3.1 Water and Nutrient Management
- 3.2 Pest and Disease Management
- 3.3 Development, maintenance and sustainable Practices.

Chapter 4 Gardens in India and the Globe **4L**

- 4.1 Features of famous botanical and aesthetic gardens of India and Globe:
 - i. Acharya Jagadish Chandra Bose, Indian Botanic Garden (Calcutta)
 - ii. National Botanical Research Institute (NBRI), (Lucknow)
 - iii. Royal Botanical Garden, Kew, UK
 - iv. Kyoto Botanical Garden, Japan
 - v. Botanical and Medicinal Plant gardens in Maharashtra
 - vi. Botanical Garden in SPPU

Module – II: Landscaping Designing **15L**

Chapter 5 Introduction to Landscape Designing **5L**

- 5.1 Historical perspectives and the importance of landscaping
- 5.2 Plant physiology relevant to landscape design
- 5.3 Ecological and Physiological principles in landscaping
- 5.4 Types of plants used in Landscaping.

Chapter 6 Design Principles, Site Analysis and Assessment **5L**

- 6.1 Art elements – Line, Colour, Form, Texture, Space, Light and Shade
- 6.2 Principles of design – Scale and proportion, unity and harmony, balance
- 6.3 Site evaluation techniques
- 6.4 Soil analysis and improvement
- 6.5 Climate considerations and microclimates.
- 6.6 Plant selection criteria (ecological, aesthetic, functional)
- 6.7 Designing with native plants
- 6.8 Designing for specific habitats (e.g. Dryland Wetland)

Chapter 7 Landscape styles **5L**

- 7.1 Formal garden style, informal garden style, Freestyle garden style, Wild style

garden design.

7.2 Features of famous landscape garden at global and local levels.

Suggested Readings:

1. A handbook of Landscape: CPWD
2. Complete gardening in India: Gopaldaswamiengar
3. Ornamental gardening in India: Misra
4. Home gardening: P. P. Trivedi
5. Sandhu, M.K. (1989). Plant Propagation. Walle Eastern Ltd. Bangalore.
6. Agrawal, P.K. (1993). Hand Book of Seed Technology. Dept. of Agriculture and Cooperation, National Seed Corporation Ltd. New Delhi.
7. Musser E., Andres. (2005). Fundamentals of Horticulture. McGraw Hill Book Co. New Delhi

Course Outcome:

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

CO1: Effectively identify, select & use the specified tools and equipment relevant to gardening

CO2: Understand the layout and design of the garden component

CO3: Area measurement and planning for the layout and design of the garden

CO4: To gain knowledge of gardening, cultivation, multiplication, and raising of seedlings of garden plants.

CO5: To get knowledge of new and modern techniques of plant propagation.

CO6: To develop an interest in nature and plant life.

Botany (NEP)	B. Sc. Botany	RMC
Course	: Major Elective	Total Credit : 2
Code	: BOMET 353A	Course Type : Theory
Subject	: Medicinal Botany	Total Lecture : 30L

Module – I: Introduction to Medicinal Botany: **15L**

Chapter 1 Indigenous Medicinal Systems of India **5L**

- 1.1 Medicinal Plants: History, Scope and Importance
- 1.2 Definition and scope of Indigenous medicinal systems of India as mentioned below:
 - Ayurveda
 - Siddha
 - Unani
 - Homeopathy
 - Amchi system of medicine
- 1.3 Chinese system of medicine.
- 1.4 National institutes for medicinal plant research under the Ministry of AYUSH.

Chapter 2 Study of Ayurveda, Siddha, and Unani: **5L**

- 2.1 Study of Ayurveda: History, Origin, Panchamahabhootas, Saptadhatu and Tridosh concept and Plants used in Ayurveda.
- 2.2 Siddha: History Scope and Origin of the Siddha medicinal system of India,
- 2.3 Unani: History, Concept: Umoor-e-tabiya, tumors treatments/therapy, polyherbal formulations.
- 2.4 Examine the scientific validation and modern therapeutic relevance of key Ayurvedic medicinal plants, focusing on their phytochemistry, evidence-based efficacy, and role in contemporary integrative healthcare.

Chapter 3 Medicinal Plants and Health **5L**

- 3.1 Impact on Human Health and Treatment of Diseases –Preventive applications; Common ailments: cold, fever, indigestion, skin diseases; Lifestyle diseases: diabetes, hypertension, arthritis.
- 3.2 Dosage and Methods of Use –Doses based on plant parts: decoction, powder, extract; Precautions in internal/external applications.
- 3.3 Adulterant Plants and Identification –Morphological.

Module - II: Folk Medicines, Conservation and Cultivation of Medicinal plants **15L**

Chapter 4 Folk Medicine and Ethnobotany: **5L**

- 4.1 Folk medicines of Ethnobotany, Ethnomedicine, Ethnoecology, and Ethnic communities of India.
- 4.2 Introduction and Definition of Ethnobotany: Scope and importance of Ethnobotany in India.
- 4.3 Methods to study Ethnobotany and Applications of Ethnobotany.
- 4.4 Applications of natural products to certain diseases such as Jaundice, Cardiac, infertility, diabetes, blood pressure, skin diseases, and Cancer.

Chapter 5 Cultivation and Conservation of Medicinal Plants. **5L**

- 5.1 Cultivation of Medicinal Plants –
 - Selection of Suitable Plants: Species selection based on local climate and soil; priority to indigenous and local species.
 - Cultivation Requirements: Climate, rainfall, sunlight, soil type and management, irrigation techniques, water conservation.

- Cultivation Methods: Nursery management, sowing time and spacing, and use of organic farming.
- Pest and Disease Management: Biological pest control, eco-friendly plant protection measures.

5.2 Conservation of Medicinal Plants –

- Definition and Importance of Conservation.
- Conservation Strategies –
 - a. In-situ conservation: Biodiversity parks, sacred groves.
 - b. Ex-situ conservation: Medicinal plant gardens, seed banks, tissue culture, gene banks.
 - c. Community participation: Conservation through local environment Documentation of traditional knowledge.
- Introduction to Good Sustainable Cultivation and Collection Practices (GSCCP) for medicinal plants).

Chapter 6 Medicinal Plant Business and Opportunities

5L

- 6.1 Business Opportunities –Medicinal plant farming; herbal product manufacturing; export of medicinal plants.
- 6.2 Introduction to top 10 medicinal plants used in pharmaceutical and herbal industries.
- 6.3 Start-up and Entrepreneurial Opportunities –Creation of “Plant-based wellness brands”; online sale of herbal products.
- 6.4 Government Schemes and Support –Information on National Medicinal Plants Board (NMPB) schemes; Grants under MSME, Startup.

Suggested Readings:

1. Chopra, R.N., Nayar, S.L., & Chopra, I.C. — Glossary of Indian Medicinal Plants.
2. Kirtikar, K.R., & Basu, B.D. — Indian Medicinal Plants.
3. Jain, S.K. — Manual of Ethnobotany.
4. Kokate, C.K., Purohit, A.P., & Gokhale, S.B. — Pharmacognosy.
5. Evans, W.C. — Trease and Evans' Pharmacognosy.
6. Nadkarni, K.M. — Indian Materia Medica.
7. Dash, B. — Materia Medica of Ayurveda.
8. Ghosh, G.R. — A Treatise on Natural Products.

Course Outcome:

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

CO1: Understand the history, scope, and importance of medicinal plants

CO2: Describe the foundations of Indigenous Medicinal Sciences: Ayurveda, Siddha, and Unani

CO3: Explain the core concepts of Ayurveda (Panchamahabhutas, Saptadhatu, Tridosha, Rasayana)

CO4: Compare the use of medicinal plants in Ayurvedic and Siddha treatments

CO5: Evaluate the conservation status of endangered and endemic medicinal plants.

Course : Major Elective	Total Credit : 2
Code : BOMEPE 351B	Course Type : Practical
Subject : Practical on Entrepreneurship in Botany and Landscape designing	Total Practical : 12

Sr. No	Practical Botany (Practical Based on BOMET 351A and BOMET 352A)	12P
---------------	--	------------

Based on BOMET 351A (Entrepreneurship in Botany)

- | | | |
|----|--|----|
| 1. | Study of Horticultural Crops: Identification, Cultivation Practices, and Economic Importance. | 1P |
| 2. | Soil Health Assessment and Nutrient Management in Horticultural Crops | 1P |
| 3. | Extraction of Natural Dyes from Plant Sources and their applications in industry. | 1P |
| 4. | To study different types of greenhouse structures and environmental control systems used in protected cultivation. | 1P |
| 5. | Preparation and Preservation of Lemon Squash from Fresh Citrus Fruits. | 1P |
| 6. | To study methods of drying flowers and making simple floral craft products. | 1P |

Based on BOMET 352A (Gardening and Landscape designing)

- | | | |
|-----|---|----|
| 7. | Create a landscape design plan on graph paper, including plant selection, layout, pathways, and focal points. | 1P |
| 8. | Hands-on training on Soil Testing for Landscape Design and Gardening. | 1P |
| 9. | Preparation of potting mixture: Potting and repotting | 1P |
| 10. | Performance of Seed Viability test | 1P |
| 11. | Study of Vegetative Propagation: Cutting, Budding, Layering and Grafting | 1P |
| 12. | Study of various online software and artificial intelligence in landscape garden designing. | 1P |
| 13. | Preparation of Terrarium to demonstrate a closed ecosystem. | 1P |
| 14. | Visit a nearby medicinal plants garden/Medicinal plants nursery/Medicinal plants industry. | 1P |

Suggested Readings

1. Chadha, K. L. *Handbook of Horticulture*. ICAR, New Delhi.
2. Hartmann, H. T., Kester, D. E., Davies, F. T., & Geneve, R. L. *Plant Propagation: Principles and Practices*. Prentice Hall.
3. Yadav, S. R., & Jain, S. K. *Natural Dyes from Plants*. National Botanical Research Institute, Lucknow.
4. Sharma, R. R., & Singh, R. *Greenhouse Technology and Management*. Scientific Publishers.
5. Chandra, R., & Kumar, V. *Post-Harvest Technology of Horticultural Crops*. CBS Publishers.

6. Lampkin, N. *Organic Farming*. Farming Press, UK.
7. Government of India: ICAR / APEDA manuals on organic farming, horticulture, and floriculture practices.
8. Hogg, R., 1881. *The Florist and Pomologist: A Pictorial Monthly Magazine of Flowers, Fruits, and General Horticulture...* Published at the "Journal of Horticulture" Office.
9. Paszt, L.S. and Zurawicz, E., 2005. Studies of the rhizosphere of strawberry plants at the Research Institute of Pomology and Floriculture in Skierniewice, Poland. *International journal of fruit science*, 5(1), pp.115-126.
10. Arora, J. S. *Introductory Ornamental Horticulture*.
11. Hartmann et al. *Plant Propagation: Principles and Practices*.
12. Laurie & Ries. *Landscape Architecture*.
13. Jain, S. M. *Landscape Gardening*.
14. Nyle & Ray. *The Nature and Properties of Soils*.

Course Outcome

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

- CO1: Identify major horticultural crops and describe their cultivation practices and economic importance.
- CO2: Assess soil health parameters and recommend nutrient management practices for horticultural crops.
- CO3: Extract natural dyes from plant sources and explain their applications in industry.
- CO4: Describe different greenhouse structures, environmental control systems, and demonstrate basic protected cultivation techniques.
- CO5: Prepare and preserve lemon squash using safe processing techniques and evaluate its quality.
- CO6: Dry flowers and prepare floral craft products; evaluate their quality and aesthetic appeal.
- CO7: Apply principles of landscape design to prepare basic layout plans.
- CO8: Analyze soil properties for effective gardening and landscaping.
- CO9: Demonstrate potting, repotting, and preparation of potting mixtures.
- CO10: Evaluate seed quality using seed viability tests.
- CO11: Apply vegetative propagation techniques for plant multiplication.

Course : Major Elective	Total Credit : 2
Code : BOMEPE 352B	Course Type : Practical
Subject : Practical on Landscape designing and Medicinal Botany	Total Practical : 12

Sr. No	Practical Botany (Practical Based on BOMET 352A and BOMET 353A)	12P
Based on BOMET 352A (Gardening and Landscape designing)		
1.	Create a landscape design plan on graph paper, including plant selection, layout, pathways, and focal points.	1P
2.	Hands-on training on Soil Testing for Landscape Design and Gardening.	1P
3.	Preparation of potting mixture: Potting and repotting	1P
4.	Performance of Seed Viability test	1P
5.	Study of Vegetative Propagation: Cutting, Budding, Layering and Grafting	1P
6.	Study of various online software and artificial intelligence in landscape garden designing.	1P
Based on BOMET 353A (Medicinal Botany)		
7.	Identify, Classify and describe morphological features of medicinal plants, based on their chemical constituents and Prepare an herbarium of any 5 plants.	1P
8.	To prepare basic Ayurvedic formulations such as Churna, Kashaya, and Hima.	1P
9.	Evaluate the antimicrobial properties from suitable plant sample.	1P
10.	To study climate, soil, irrigation, and sunlight requirements for the cultivation of medicinal plants.	1P
11.	Preparation of Ayurvedic Herbal Oil (Taila) by Sneha Kalpana Technique.	1P
12.	Preparation of Shata-Dhauta Ghrita by Traditional Ayurvedic Method.	1P

Suggested Readings:

15. Arora, J. S. *Introductory Ornamental Horticulture*.
16. Hartmann et al. *Plant Propagation: Principles and Practices*.
17. Laurie & Ries. *Landscape Architecture*.
18. Jain, S. M. *Landscape Gardening*.
19. Nyle & Ray. *The Nature and Properties of Soils*.
20. Kirtikar & Basu. *Indian Medicinal Plants*.
21. Kokate et al. *Pharmacognosy*.
22. Trease & Evans. *Pharmacognosy*.
23. Sharma, P. V. *Dravyaguna Vijnana*.
24. *Ayurvedic Pharmacopoeia of India*.

Course Outcome:

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

CO12: **Apply** principles of landscape design to prepare basic layout plans.

CO13: **Analyze** soil properties for effective gardening and landscaping.

CO14: **Demonstrate** potting, repotting, and preparation of potting mixtures.

CO15: **Evaluate** seed quality using seed viability tests.

CO16: **Apply** vegetative propagation techniques for plant multiplication.

CO17: **Identify and classify** medicinal plants and **prepare** a herbarium.

CO18: **Apply** traditional methods to prepare basic Ayurvedic formulations.

CO19: **Analyze** antimicrobial properties of selected medicinal plants.

CO20: **Assess** climatic and soil requirements for medicinal plant cultivation.

CO21: **Demonstrate** preparation of Ayurvedic herbal oil (Taila).

Course : Major Elective	Total Credit : 2
Code : BOMEPE 353B	Course Type : Practical
Subject : Practical on Medicinal and Entrepreneurship in Botany	Total Practical : 12

Sr. No	Practical Botany (Practical Based on BOMET 353A and BOMET 351A)	12P
---------------	--	------------

Based on BOMET 353A (Medicinal Botany)

- | | | |
|----|--|----|
| 1. | Identify, Classify and describe morphological features of medicinal plants, based on their chemical constituents and Prepare an herbarium of any 5 plants. | 1P |
| 2. | To prepare basic Ayurvedic formulations such as Churna, Kashaya, and Hima. | 1P |
| 3. | Evaluate the antimicrobial properties from suitable plant sample. | 1P |
| 4. | To study climate, soil, irrigation, and sunlight requirements for the cultivation of medicinal plants. | 1P |
| 5. | Preparation of Ayurvedic Herbal Oil (Taila) by Sneha Kalpana Technique. | 1P |
| 6. | Preparation of Shata-Dhauta Ghrita by Traditional Ayurvedic Method. | 1P |

Based on BOMET 351A (Entrepreneurship in Botany)

- | | | |
|-----|--|----|
| 7. | Study of Horticultural Crops: Identification, Cultivation Practices, and Economic Importance. | 1P |
| 8. | Soil Health Assessment and Nutrient Management in Horticultural Crops | 1P |
| 9. | Extraction of Natural Dyes from Plant Sources and their applications in industry. | 1P |
| 10. | To study different types of greenhouse structures and environmental control systems used in protected cultivation. | 2P |
| 11. | Preparation and Preservation of Lemon Squash from Fresh Citrus Fruits. | 1P |
| 12. | To study methods of drying flowers and making simple floral craft products. | 1P |

Suggested Readings

1. Chadha, K. L. *Handbook of Horticulture*. ICAR, New Delhi.
2. Hartmann, H. T., Kester, D. E., Davies, F. T., & Geneve, R. L. *Plant Propagation: Principles and Practices*. Prentice Hall.
3. Yadav, S. R., & Jain, S. K. *Natural Dyes from Plants*. National Botanical Research Institute, Lucknow.
4. Sharma, R. R., & Singh, R. *Greenhouse Technology and Management*. Scientific Publishers.
5. Chandra, R., & Kumar, V. *Post-Harvest Technology of Horticultural Crops*. CBS Publishers.
6. Lampkin, N. *Organic Farming*. Farming Press, UK.
7. Government of India: ICAR / APEDA manuals on organic farming, horticulture, and floriculture practices.
8. Hogg, R., 1881. *The Florist and Pomologist: A Pictorial Monthly Magazine of Flowers, Fruits, and General Horticulture...* Published at the "Journal of Horticulture" Office.

9. Paszt, L.S. and Zurawicz, E., 2005. Studies of the rhizosphere of strawberry plants at the Research Institute of Pomology and Floriculture in Skierniewice, Poland. *International journal of fruit science*, 5(1), pp.115-126.
10. Kirtikar & Basu. *Indian Medicinal Plants*.
11. Kokate et al. *Pharmacognosy*.
12. Trease & Evans. *Pharmacognosy*.
13. Sharma, P. V. *Dravyaguna Vijnana*.
14. *Ayurvedic Pharmacopoeia of India*.

Course Outcome

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

- CO1: Explain the isolation and role of various soil bacteria in bio-fertilizer production.
- CO2: Describe the production steps and specific requirements for each bio-fertilizers.
- CO3: Demonstrate the restoration of soil fertility by performing the sustainable agricultural practices.
- CO4: Apply the Practical Skills in Flower Preservation.
- CO5: Identify and classify medicinal plants and prepare a herbarium.
- CO6: Apply traditional methods to prepare basic Ayurvedic formulations.
- CO7: Analyse antimicrobial properties of selected medicinal plants.
- CO8: Assess climatic and soil requirements for medicinal plant cultivation.
- CO9: Demonstrate preparation of Ayurvedic herbal oil (Taila).

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

Vocational Skill Course

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

Botany (NEP)		B. Sc. Botany		RMC
Course	:	Vocational Skill Course	Total Credit	: 2
Code	:	BOVST 351	Course Type	: Theory
Subject	:	Plant Tissue Culture	Total Lecture	: 30L

Module – I: Basics of PTC 15L

Chapter 1 Introduction 4L

- 1.1 Definition
- 1.2 Historical background of Plant Tissue Culture
- 1.3 Basics terms and definitions in plant tissue culture
- 1.4 Principle: Cell Competancey, Totipotency vs Pleuripotency, cyto differentiation and dedifferentiation, organogenesis
- 1.5 Scope and Importance of Plant Tissue Culture

Chapter 2 Laboratory and Equipments in PTC 6L

- 2.1 Design, layout, Space and Maintenance of Laboratory (Culture Room, Inoculation room, wash area, Media preparation Room, Instrumentation Room, Quarentine room, observation/data collection areas, storage room)
- 2.2 Lab wares, Good laboratory practices, Good safety practices,
- 2.3 Equipments: Principle and working, maintenance and management - pH meter, Hot air oven, Autoclave, LAF, Rotary Shaker. distillation unit, deep freezer, Growth chamber
- 2.4 Sterilization techniques- Dry heat sterilization, Wet Heat sterilization and Surface sterilization of ex-plants-Surface sterilants -different Methods.

Chapter 3 Media Preparation 5L

- 3.1 Introduction, various kinds of media and their importance
- 3.2 Composition and significance of media components (Macronutrients, Micronutrients Vitamins, PGRs, Carbon source, Gelling agent, Antibiotics, Unidentified supplements, Activate charcoal)
- 3.3 Preparation of stocks and Nutrient Media, Calculations, pH and Buffers and their significance in media, Selection of media

Module – II: PTC Techniques 15L

Chapter 4 Basics of Plant Tissue Technique 5L

- 4.1 Inoculation- Principle and procedure
- 4.2 Incubation- Culture conditions, Maintenance, Subculture, Observations and record keeping in PTC
- 4.3 Rooting and Hardening Techniques

Chapter 5 Types of Plant Tissue Culture 8L

- 5.1 Based on explant types (Meristem culture, Axillary bud, Shoot tip, Root culture, Leaf culture, Anther culture, Embryo culture, Ovary culture, Pollen culture, Endosperm *In vitro* micro grafting, Plant Protoplast Culture, Callus culture)
- 5.2 Media types (Semisolid, suspension culture) and culture conditions (Batch culture, continuous culture- Bioreactors)
- 5.3 Based on outcome of plant tissue culture (Micropropagation, organogenesis, embryogenesis, haploids and triplods)

Chapter 6 Applications of Plant Tissue Culture 3L

- 6.1 Scope and importance of Plant Tissue Culture: Mass production, elite cultures, secondary metabolite production, transgenics, hairy root cultures, synthetic seed

production, Germplasm conservation, Somaclonal variations and in vitro mutagenesis, Virus free plants, Edible vaccines

- 6.2 Challenges and constraints of the industry, Success stories- case study, future prospects

Suggested Readings:

1. Bhojwani, S.S. 1990. Plant Tissue Culture: Theory and Practical (a revised edition). Elsevier Science Publishers, New York, USA.
2. S S Bhojwani, M K Razdan (1996). Plant tissue culture: Theory and Practice. Elsevier Science Publishers, New York, USA
3. Vasil, I.K. and Thorpe, T.A. 1994. Plant Cell and Tissue Culture. Kluwer Academic Publishers, the Netherlands.
4. Shantharam, S. and Montgomery, J.F. 1999. Biotechnology, Biosafety and Biodiversity. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
5. Glick, B.R. and Thomson, J. E. 1993. *Methods in Plant Molecular Biology and Biotechnology*. CRC Press, Boca Raton, Florida.
6. A Text Book of Biotechnology, R. C. Dubey, S. Chand Publication
7. Smith R.H (2000) Plant Tissue Culture: techniques and Experiments, Second edition, Academic Press, USA
8. L Gamborg, G C Philips (Eds.) (2005). Plant cell, tissue and organ culture: Fundamental methods. Narosa Publishing House.
9. Kalian Kumar De (2003) An introduction to plant tissue culture, New central book agency pvt. Ltd.

Course Outcome:

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

- CO1: Understand the basic principles of plant tissue culture
CO2: To impart comprehensive overview of the scientific aspects of Plant tissue culture.
CO3: Discuss the process involved in micro propagation
CO4: Analyse the practical use of tissue culture in life
CO5: To develop theoretical orientation of cultured in vitro methods

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
BORPP-351

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 351

Course Type : Practical

Subject : Research Project

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

SIXTH SEMESTER

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

Botany (NEP)		B. Sc. Botany		RMC
Course	:	Major	Total Credit	: 2
Code	:	BOMAT 361	Course Type	: Theory
Subject	:	Concepts of Genetics	Total Lecture	: 30L

Module – I: Basics of Genetics: 15L

Chapter 1 Introduction to Genetics 8L

- 1.1 Definition, Mendel’s contribution, concept of heredity and variations
- 1.2 Monohybrid cross and principle of dominance: Law of segregation/law of purity of gametes; Dihybrid cross/Law of independent assortment
- 1.3 Back cross and test cross

Chapter 2 Gene & Chromosome organization 7L

- 2.1 Structure of Gene, Modern concept of Gene.
- 2.2 Chromosome theory of inheritance, Morphology and Structure of Chromosome. Karyotype: Karyotype variations such as changes in chromosome number, Centromere position; Special types of chromosomes - Lampbrush, Polytene and B- chromosomes in maize.

Chapter 3 Inbreeding and Heterosis

- 3.1 History, Genetic basis of inbreeding depression and heterosis,
- 3.2 Applications.

Chapter 4 Chromosomal aberrations

- 4.1 Introduction, Definition, Types of Chromosomal Aberrations;
- 4.2 Numerical change: Euploidy, aneuploidy and its types
- 4.3 Structural changes: Addition, deletion, substitution, translocation and inversion

Module - II : Population Genetics 15L

Chapter 5 Introduction to Population Genetics 10L

- 5.1 Definition and scope of population genetics
- 5.2 Historical background (Mendel → Darwin → Modern synthesis)
- 5.3 Population vs individual genetics
- 5.4 Applications in evolution, medicine, conservation, and agriculture

Chapter 6 Genetic Variation in Populations 5L

- 6.1 Types of genetic variation
- 6.2 Alleles, genotypes, and gene pools
- 6.3 Polymorphism and heterozygosity
- 6.4 Measuring genetic variation

Chapter 7 Allele and Genotype Frequencies

- 7.1 Calculating allele frequencies
- 7.2 Genotype frequencies
- 7.3 Gene frequency vs genotype frequency
- 7.4 Sample problems and exercises
- 7.5 Hardy–Weinberg Principle
- 7.6 Statement and assumptions

Chapter 8 Quantitative Genetics

- 8.1 Polygenic inheritance
- 8.2 Phenotypic vs genotypic variation
- 8.3 Heritability

Suggested Readings:

1. Atherly, A.G., Girton, J.R. and McDonald, J.F 1999. The Science of Genetics Saunders College Publishing, Frot Worth, USA.
2. Hartle D.L and Jones, E.W 1998 Genetics: Principles and Analysis (Fourth Edition). Jones and Bartlett Publishers, Massachusetts, USA.
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. Russel, P.J. 1998. Genetics (Fifth Edition). The Benjamin/Cummings Publishing Company IND., USA.
5. Snustad, D.P and Simmons, M.J 2000. Principles of Genetics (Second Edition). John Wiley and Sons Inc., USA. Gardner and Simmons Snustad 2005 (Eighth Edition).
6. Principles of Genetics, John Wiley and Sons, Singapore.
7. Sarin C 2004 (Sixth Edition) Genetics. TATA McGraw-Hill Publishing Company Ltd., New Delhi.
8. Ahluwalia K.B 2005 (First Edition). Genetics. New Age International Private Ltd. Publishers, New Delhi.
9. Burus and Bottino 1989. (Sixth Edition). The Science of Genetics. Macmillan Publishing Company, New York (USA).
10. Pawar C.B 2003 (First Edition). Genetics Vol. I and II. Himalaya Publishing House, Mumbai. 11. Strickberger 2005. (Third Edition). Genetics. Prentice Hall of India Pvt. Ltd., New Delhi. 12. Allard R.W 1995. Principles of Plant Breeding. John Wiley and Sons, Ice., Singapore.
11. Sharma J.R 1994 Principles and practices of Plant Breeding. Tata McGraw-Hill Publishers Company Ltd., New Delhi.

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

- CO1: Understand the history of Genetics.
- CO2: Organisation of gene and chromosome through gene concept and chromosome theory
- CO3: Study on genetic variation and its effect on population.
- CO4: Study the basic population genetics and genetic variation in population.
- CO5: Study on allele and genotype frequencies as well as quantitative genetics.

Botany (NEP)		B. Sc. Botany		RMC
Course	:	Major	Total Credit	: 2
Code	:	BOMAT 362	Course Type	: Theory
Subject	:	Plant Biotechnology	Total Lecture	: 30L

Module – I: Fundamentals and Agricultural Biotechnology: 15L

Chapter 1 Introduction to Plant Biotechnology 7L

- 1.1 Definition, scope, and History of plant biotechnology
- 1.2 Conventional plant improvement methods versus modern biotechnological approaches
- 1.3 Importance and applications of plant biotechnology in agriculture, food security, medicinal plants, and industrial crops
- 1.4 Status, major achievements, and key institutions related to plant biotechnology in India and globally
- 1.5 Introduction to **omics technologies** and systems biology in plant science:
 - **Plant genomics:** concept, types, tools, and applications in crop improvement
 - **Plant proteomics:** concept, significance, and applications in understanding plant function and stress responses
 - **Plant metabolomics:** concept and role in plant growth, quality, and stress tolerance.

Chapter 2 Agricultural Biotechnology and Crop Improvement 8L

- 2.1 Concept and scope of agricultural biotechnology
- 2.2 Marker-assisted selection (MAS) and molecular breeding in crop improvement
- 2.3 Use of bioinformatics and omics tools in agricultural biotechnology
- 2.4 Integrated Nutrient Management (INM) and Integrated Pest Management (IPM)
- 2.5 Biotechnology in organic and eco-friendly farming
- 2.6 Role of plant biotechnology in the management of abiotic and biotic stress
- 2.7 Precision agriculture and digital tools supporting plant production

Module - II : Applied Biotechnology 15L

Chapter 3 Tools and Techniques in Biotechnology 7L

- 3.1 Autoclave, incubator, laminar airflow, fermenter.
- 3.2 Sterilisation methods and aseptic handling in plant biotechnology labs.
- 3.3 Isolation of high-quality DNA and RNA from plant tissues (CTAB method, commercial kits)
- 3.4 Principle and types: Conventional PCR, Real-Time PCR (qPCR), Digital PCR, Multiplex PCR.
- 3.5 DNA Sequencing: Sanger sequencing(principle and workflow overview)
- 3.6 Next-Generation Sequencing (NGS).
- 3.7 Molecular Markers and their applications.

Chapter 4 Fermentation Technology 3L

- 4.1 Fermentation: Definition with an example and importance
- 4.2 Organisms involved in fermentations
- 4.3 Substrates, Products and byproducts used in fermentation.
- 4.4 Types: Batch Culture and Continuous Culture
- 4.5 Bioreactors and their types: Tubular Tower bioreactor, Digestive bioreactor, Stirred tank Bioreactor.

Chapter 5 Biofuels 3L

- 5.1 Concepts of non-conventional energy sources
- 5.2 Introduction, advantages and disadvantages of bio-fuels.

- 5.3 Bio-energy sources: Petrocrops, wood, sugar and sugar crops.
- 5.4 Bio-Ethanol: Bioethanol against petrol production
- 5.5 Bio-ethanol and Bio-Diesel.

Chapter 6 Applications of Plant Biotechnology

2L

- 6.1 Applied plant biotechnology: concept and importance
- 6.2 Role of biotechnology in the improvement of Economically important plants.
- 6.3 Biotechnology for crop improvements: Genetically Modified Crops (GMO)

Suggested Readings:

1. Slater, A., Scott, N., & Fowler, M. Plant Biotechnology: The Genetic Manipulation of Plants. Oxford University Press.
2. Glick, B. R., Pasternak, J. J., & Patten, C. L. Molecular Biotechnology: Principles and Applications of Recombinant DNA. ASM Press.
3. Razdan, M. K. Introduction to Plant Tissue Culture. Oxford & IBH.
4. Brown, T. A. Gene Cloning and DNA Analysis: An Introduction. Wiley-Blackwell.
5. Primrose, S. B., & Twyman, R. Principles of Gene Manipulation and Genomics. Wiley.
6. Gupta, P. K. Plant Biotechnology. Rastogi Publications.

Course Outcome:

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

- CO1: Explain the fundamental concepts, scope, and historical development of plant and agricultural biotechnology.
- CO2: Differentiate between conventional plant improvement methods and modern biotechnological approaches.
- CO3: Apply knowledge of molecular biology and biotechnological tools such as PCR, sequencing, and molecular markers in plant biotechnology.
- CO4: Analyse the role of genomics, proteomics, metabolomics, and bioinformatics in crop improvement and stress management.
- CO5: Evaluate the applications of fermentation technology, biofuels, and eco-friendly biotechnological practices in agriculture.
- CO6: Demonstrate understanding of applied plant biotechnology in improving economically important plants and sustainable agricultural production.

Botany (NEP)		B. Sc. Botany		RMC
Course	:	Major	Total Credit	: 2
Code	:	BOMAT 363	Course Type	: Theory
Subject	:	Seed Technology and Post-Harvest Technology	Total Lecture	: 30L

Module – I: Seed Technology: **15L**

Chapter 1 Introduction and Seed Classification **4L**

- 1.1 Definition, importance and scope of seed Technology
- 1.2 Overview of seed structure w.r.t. embryo, endosperm and seed coat
- 1.3 Types of seeds (botanical, commercial, physiological)
- 1.4 Classification based on origin (field, processed)

Chapter 2 Seed Production **4L**

- 2.1 Principles of seed production
- 2.2 Seed production techniques for different crops
- 2.3 Field isolation and rouging
- 2.4 Seed production standards and certification

Chapter 3 Seed Physiology **3L**

- 3.1 Seed development and maturation
- 3.2 Seed dormancy and Seed Viability, Methods to break dormancy
- 3.3 Seed germination process and factors affecting germination

Chapter 4 Seed Testing **4L**

- 4.1 Sampling techniques
- 4.2 Physical purity test
- 4.3 Moisture content determination
- 4.4 Germination test
- 4.5 Vigour tests
- 4.6 Tetrazolium test
- 4.7 Seed health testing (pathogen detection)

Module - II : Post-Harvest Technology of Seeds: **15L**

Chapter 5 Seed Processing and Storage **3L**

- 5.1 Cleaning and grading of seeds, Seed drying and storage
- 5.2 Seed treatment (physical, chemical, biological), Seed packaging and labelling
- 5.3 Types of storage structures, Conditions for seed storage
- 5.4 Factors affecting seed longevity
- 5.5 Seed deterioration and methods of prolonging viability
- 5.6 Seed Banks and Introduction to Cryopreservation

Chapter 6 Seed Certification and Quality Control **3L**

- 6.1 Seed laws and regulations
- 6.2 Seed certification procedures
- 6.3 Seed quality standards (IS, ISTA)
- 6.4 Role of seed certification agencies

Chapter 7 Hybrid Seed Production and Seed Marketing **6L**

- 7.1 Principles of hybrid seed production

- 7.2 Techniques and challenges in hybrid seed production
- 7.3 Male sterility systems (GMS, CMS)
- 7.4 Maintenance of parental lines
- 7.5 Seed marketing channels
- 7.6 Seed pricing and economics
- 7.7 Role of public and private sectors in seed industry

Chapter 8 Recent Advances in Seed Technology

3L

- 8.1 Biotechnology in seed production
- 8.1 Seed banks and Introduction Cryopreservation
- 8.2 Seed coating and enhancement technologies

Suggested Readings:

1. Agrawal, R. L. (1995). *Seed technology*. Oxford & IBH Publishing.
2. Bewley, J. D., & Black, M. (1994). *Seeds: Physiology of development and germination*. Springer.
3. Copeland, L. O., & McDonald, M. B. (2001). *Principles of seed science and technology* (4th ed.). Springer.
4. Khan, A. A. (1983). *The physiology and biochemistry of seed dormancy and germination*. North-Holland Publishing.
5. Basu, R. N. (1995). *Seed quality: Basic mechanisms and agricultural implications*. CSIR Publications.
6. Kelly, A. F., & George, R. A. T. (1998). *Encyclopedia of seed production and technology*. CAB International.
7. Tayyar, R. L. (2016). *Seed science and technology*. New India Publishing Agency.
8. International Seed Testing Association. (2023). *International rules for seed testing*. ISTA.
9. Prasad, S. R. (2012). *Seed science and technology*. Kalyani Publishers.
10. Thompson, J. R. (1977). *Storage of seeds in genebanks*. IBPGR/FAO.
11. Chakraverty, A. (2004). *Post-harvest technology of cereals, pulses and oilseeds* (3rd ed.). Oxford & IBH Publishing Co. Pvt. Ltd.
12. Basu, R. N. (1995). *Seed quality: Basic mechanisms and agricultural implications*. CSIR Publications.
13. ISTA & FAO. (1985). *Seed storage: Methods and equipment*. FAO/IBPGR.
14. Dharmalingam, C. (2016). *Hybrid seed production in field and horticultural crops*. Kalyani Publishers.

Course Outcome:

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

- CO1: Recall and explain seed processing, cleaning, grading, and storage concepts.
- CO2: Explain and perform seed treatment, packaging, and labelling procedures.
- CO3: Apply suitable storage conditions and evaluate factors affecting seed longevity.
- CO4: Assess seed purity, quality, and certification procedures.
- CO5: Evaluate hybrid seed production techniques and suggest methods to maintain seed quality and viability.

Botany (NEP)		B. Sc. Botany		RMC
Course	:	Major	Total Credit	: 2
Code	:	BOMAT 364	Course Type	: Theory
Subject	:	Plant based Food and Nutrition	Total Lecture	: 30L

Module – I: Plant Based Foods: 15L

Chapter 1 Introduction of plants as food source 3L

- 1.1 Introduction to various plant parts as food sources
- 1.2 History of Plant based food for nutrition
- 1.3 Conventional Vs Non –Conventional food
- 1.4 Importance of plant based foods in Human diet

Chapter 2 Cereals & Pulses as food sources 3L

- 2.1 Concept of Cereals; Pulses -legumes-lentils
- 2.2 Importance of cereals, pulses, lentils & legumes as food
- 2.3 Comparative nutritional value of cereals, legumes, pulses & lentils

Chapter 3 Vegetables & Fruits as Plant food source 2L

- 3.1 Sources of Vegetables & Fruits
- 3.2 Importance of Vegetables & fruits' nutrition in Human lifestyle

Chapter 4 Spices & Beverages as Nutrition source 4L

- 4.1 Parts of plants used as source of Spices (Clove, Black Pepper, Star anise, Stone flower)
- 4.2 Medicinal values of spices
- 4.3 Concept of Beverages, beverages in India, Part of plants used for beverage preparations
- 4.4 Therapeutic values of beverages.

Chapter 5 Super foods and Nutraceuticals 3L

- 5.1 Definition of Super foods, Current trends of super foods in India and world
- 5.2 Contribution of Indian Native Plants as Super Food Globally used.
- 5.3 Definition & concept of nutraceuticals
- 5.4 Contribution of Indian native herbal plants as nutraceuticals

Module – II: Plant Nutrition and Human Health 15L

Chapter 6 Basics of Nutrition 4L

- 6.1 Diet and Nutrition: Definition of **diet** and **nutrition**, Importance of nutrition in growth, development and maintenance of health
- 6.2 Components of Diet: Carbohydrates, Proteins, Fats, Vitamins, Minerals, Dietary fibre, Water
- 6.3 Balanced Diet: Definition and Importance of balanced diet in Growth and energy, Immunity and Prevention of diseases, RDA
- 6.4 Dietary Fibre and Water

Chapter 7 Macronutrients 5L

- 7.1 Definition of Macronutrients
- 7.2 **Carbohydrates**: Definition, **Plant carbohydrates**- starch, resistant starch and sugars,
Sources- cereals, tubers and legumes, Role of carbohydrates as major energy source
- 7.3 **Proteins**: Definition and functions of proteins, Essential and non-essential amino acids,
Plant sources of proteins: pulses, soybean, nuts and seeds, Role of proteins in growth, repair and enzyme formation
- 7.4 **Fats**: Definition and types: saturated, unsaturated and trans fats, Visible and

invisible fats,

Plant sources of fats: nuts, seeds and vegetable oils, Role of fats in energy storage, absorption of vitamins and cell structure.

Chapter 8 Micronutrients

4L

8.1 Definition of Micronutrients

8.2 **Vitamins:** water-soluble and fat-soluble, Sources, functions and role of: Vitamin A, B-complex, Vitamin C, Vitamin D, Vitamin E, Vitamin K

8.3 **Minerals:** Calcium, phosphorus, sodium, potassium, magnesium

8.4 **Trace elements:** iron, iodine, zinc and selenium,

Plant-based sources of minerals, Role of micronutrients in metabolism, immunity and overall health

8.5 Antioxidant Micronutrients

Chapter 9 Nutritional Deficiency Disorders and Malnutrition

9.1 Definition and types of malnutrition, Protein-Energy Malnutrition (PEM), Kwashiorkor and Marasmus: causes, symptoms and prevention

9.2 Deficiency diseases related to Vitamin A, B-complex, C, D, Iron, iodine and calcium Causes and preventive measures

Suggested Readings:

1. A Text Book on The Scientific Cultivation of Vegetables and Spices Crops by Pavan K. Patel, Anju Jayachandran, Krishan Kumar, Champa Lal Regar, Nidhi Sehgal
2. Eating Plant-Based food: Scientific Answers to Your Nutrition Questions by Shireen Kassam and Zahra Kassam
3. Plants for Health by Wendy Walrabenstein, Carlijn Wagenaar, and Prof. Dirkjan Van Schaardenburg
4. The Plant Power Doctor: A simple prescription for a healthier you by Dr Gemma Newman
5. Fung, D.Y.C. and Matthews, R. (1991): Instrumental Methods for Quality Assurance in Foods, Marcel Dekker, Inc. New York
6. Modern Nutrition in Health by Shils, M.E., Shike, M, Ross, A.C., Caballero B and Cousins RJ (2005)
7. Food Analysis: Theory and Practice, CBS Publishers and Distributor, New Delhi by Pomeraz, Y. and MeLoari, C.E. (2006)
8. Gopalan, C., Rama Sastri, B.V. & Balasubramanian, S.C. (2012). Nutritive Value of Indian Foods. National Institute of Nutrition (ICMR), Hyderabad, India.
9. Swaminathan, M. (2018). Essentials of Food and Nutrition (Revised Edition). The Bangalore Printing and Publishing Co. Ltd., Bangalore, India.
10. Whitney, E. & Rolfes, S.R. (2019). Understanding Nutrition (16th Edition). Cengage Learning, USA.
11. Gibson, R.S. (2005). Principles of Nutritional Assessment (2nd Edition). Oxford University Press, New York, USA.
12. Brown, J.E. (2017). Nutrition Through the Life Cycle (6th Edition). Cengage Learning, USA.
13. A textbook of Applied Botany Part II By Prof. B. N. Zaware, Dr. R S Zunjarrao, Dr. N A Patil, Prof. K B Jagdale, Dr. S. L. Laware, Prof. P B Cholke

Course Outcome:

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

CO1: Understand importance of plant parts as food source

CO2: Understand comparative nutritional value of plant food sources

CO3: Understand therapeutic values of spices & beverages

CO4: Understand importance of Indian native plants as super food & nutraceuticals.

CO5: Explain the roles of plant-derived macronutrients and micronutrients in human nutrition.

CO6: Analyse nutritional deficiencies and their relationship with plant-based diets and malnutrition.

CO7: Apply the concepts of bio-fortification and nutrient enhancement to improve dietary quality.

Course : Major	Total Credit : 2
Code : BOMAP 365	Course Type : Practical
Subject : Practical Botany VII (Practical based on BOMAT 361 and BOMAT 362)	Total Practical : 12

Sr. No	Practical Botany (Practical Based on BOMAT 361 and BOMAT 362)	12P
Based on BOMAT 361 (Concepts of Genetics)		
1.	Study of Mendelian Inheritance using Monohybrid and Dihybrid Crosses, Test Cross and Back Cross (test cross with homozygous recessive parent , Perform back cross with dominant parent)	1P
2.	Construct the linkage maps based on two-point test cross and three-point test crosses.	1P
3.	Karyotype Analysis and Study of Chromosome Morphology (Prepare karyotype charts from dividing <i>Allium cepa</i> root tip cells/photomicrographs).	1P
4.	Prepare/Permanent slides showing translocation ring, laggards and inversion bridge	1P
5.	Calculation of Allele and Genotype Frequencies using Hardy–Weinberg Principle	1P
6.	Study of Genetic Variation and Quantitative Traits (Data on quantitative traits like seed size/ maize cob length).	1P
Based on BOMAT 362 (Plant Biotechnology)		
7.	Study of Genetically Modified (GM) Crops: Identification, Traits, and Applications	1P
8.	Bioinformatics tools: NCBI sequence retrieval & BLAST analysis.	1P
9.	Analysis of molecular marker patterns RFLP and RAPD.	1P
10.	Study of natural dye extraction from plants such as anthocyanins, betalains, and chlorophyll.	1P
11.	Study of Genetically Modified (GM) Crops: Identification, Traits, and Applications	1P
12.	Bioinformatics tools: NCBI sequence retrieval & BLAST analysis.	1P
13.	Demonstration of Bioethanol / alcohol fermentation	1P
14.	Visit to Biotechnology Industry/ Research Institute.	1P

Suggested Readings

1. Atherly, A.G., Girton, J.R. and McDonald, J.F 1999. The Science of Genetics Saunders College Publishing, Frot Worth, USA.
2. Hartle D.L and Jones, E.W 1998 Genetics: Principles and Analysis (Fourth Edition). Jones and Bartlett Publishers, Massachusetts, USA.

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. Russel, P.J. 1998. Genetics (Fifth Edition). The Benjamin/Cummings Publishing Company IND., USA.
5. Snustad, D.P and Simmons, M.J 2000. Principles of Genetics (Second Edition). John Wiley and Sons Inc., USA. 6. Gardner and Simmons Snustad 2005 (Eighth Edition).
6. Principles of Genetics, John Wiley and Sons, Singapore.
7. Sarin C 2004 (Sixth Edition) Genetics. TATA McGraw-Hill Publishing Company Ltd., New Delhi.
8. Ahluwalia K.B 2005 (First Edition). Genetics. New Age International Private Ltd. Publishers, New Delhi.
9. Burus and Bottino 1989. (Sixth Edition). The Science of Genetics. Macmillan Publishing Company, New York (USA).
10. Pawar C.B 2003 (First Edition). Genetics Vol. I and II. Himalaya Publishing House, Mumbai. 11. Strickberger 2005. (Third Edition). Genetics. Prentice Hall of India Pvt. Ltd., New Delhi. 12. Allard R.W 1995. Principles of Plant Breeding. John Wiley and Sons, Inc., Singapore.
11. Sharma J.R 1994 Principles and practices of Plant Breeding. Tata McGraw-Hill Publishers Company Ltd., New Delhi.
12. Klug, W.S., Cummings, M.R. and Spencer, C.A. (2009) Concepts of Genetics, (9th edition). Benjamin Cummings, U.S.A.
13. Chawla, H. S. *Introduction to Plant Biotechnology*. Oxford & IBH.
14. Slater, A., Scott, N., & Fowler, M. *Plant Biotechnology*. Oxford University Press.
15. Mount, D. W. *Bioinformatics: Sequence and Genome Analysis*. Cold Spring Harbor.
16. Lesk, A. M. *Introduction to Bioinformatics*. Oxford University Press.
17. Primrose, S. B. & Twyman, R. *Principles of Gene Manipulation and Genomics*. Wiley.
18. Stanbury, P. F., Whitaker, A., & Hall, S. *Principles of Fermentation Technology*. Elsevier.
19. Harborne, J. B. *Phytochemical Methods*. Springer.

Course Outcome

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

- CO1: Understand about Mendelian Inheritance.
- CO2: Prepare linkage map
- CO3: Understand chromosome morphology, translocation, inversion.
- CO4: Interpret genotype frequencies calculation, genetic variation & quantitative traits.
- CO5: Explain the concept, traits, and applications of genetically modified (GM) crops.
- CO6: Retrieve biological sequences from NCBI and perform BLAST analysis to identify gene similarity.
- CO7: Analyze molecular marker patterns (RFLP and RAPD) to detect genetic variation.
- CO8: Extract and distinguish natural plant pigments such as anthocyanins, betalains, and chlorophyll.
- CO9: Demonstrate bioethanol/alcohol fermentation and evaluate its biotechnological applications.

Course	: Major	Total Credit	: 2
Code	: BOMAP 366	Course Type	: Practical
Subject	: Practical Botany VIII	Total Practical	: 12
(Practical based on BOMAT 363 and BOMAT 364)			

Sr. No	Practical Botany (Practical Based on BOMAT 363 and BOMAT 364)	12P
---------------	--	------------

Based on BOMAT 363 (Seed Technology and Post-Harvest Technology)

- | | | |
|----|--|----|
| 1. | Study of Physical purity analysis of seed samples and Moisture content determination of seeds | 1P |
| 2. | Study of Seed germination test (paper / sand method) and effect of chemical mutagens on percent seed germination | 1P |
| 3. | Study of Tetrazolium test for seed viability | 1P |
| 4. | Study of Seed vigour test | 1P |
| 5. | Study of seed processing (cleaning, grading and drying) and storage techniques | 1P |
| 6. | Study of Seed Deterioration and Factors Affecting Longevity | 1P |
| 7. | Techniques of Hybrid Seed Production (Emasculation and Bagging) | 1P |

Based on BOMAT 364 (Plant Based Food and Nutrition)

- | | | |
|-----|---|----|
| 8. | Qualitative detection of carbohydrates, proteins and fats in plant food samples | 1P |
| 9. | Estimation of total carbohydrates in plant samples (Anthrone method) | 1P |
| 10. | Estimation of protein content in plant samples (Lowry method) | 1P |
| 11. | Estimation of vitamin C in plant foods (iodometric titration). | 2P |
| 12. | Estimation of calcium/iron from plant food sources (colorimetric methods). | 1P |
| 13. | Visit to nutrition research centre. | 1P |

Suggested Readings

1. **Agrawal, R. L. (1995).** *Seed Technology*. Oxford & IBH Publishing Co., New Delhi.
2. **Copeland, L. O., & McDonald, M. B. (2001).** *Principles of Seed Science and Technology*. Springer, New York.
3. **George, R. A. T. (2011).** *Vegetable Seed Production*. CABI Publishing.
4. **Bewley, J. D., Bradford, K. J., Hilhorst, H. W. M., & Nonogaki, H. (2013).** *Seeds: Physiology of Development, Germination and Dormancy*. Springer.
5. **Indian Minimum Seed Certification Standards (IMSCS).** Central Seed Certification Board, Government of India.
6. **ISTA (International Seed Testing Association).** *International Rules for Seed Testing*. ISTA, Zurich.
7. **Singh, D. (2003).** *Seed Technology*. Kalyani Publishers, New Delhi.
8. **FAO (Food and Agriculture Organization).** *Seed Production and Quality Control Manuals*.

9. **Ranganna, S. (2019).** *Handbook of Analysis and Quality Control for Fruit and Vegetable Products* (2nd Edition). Tata McGraw-Hill Publishing Co., New Delhi, India.
10. **Sadasivam, S. & Manickam, A. (2008).** *Biochemical Methods* (3rd Edition). New Age International Publishers, New Delhi, India.
11. **Gopalan, C., Rama Sastri, B.V. & Balasubramanian, S.C. (2012).** *Nutritive Value of Indian Foods*. National Institute of Nutrition (ICMR), Hyderabad, India.
12. **FAO/WHO. (2004).** *Human Vitamin and Mineral Requirements*. Food and Agriculture Organization of the United Nations, Rome, Italy.
13. **Whitney, E. & Rolfes, S.R. (2019).** *Understanding Nutrition* (16th Edition). Cengage Learning, USA.

Course Outcome

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

- CO1: Understand seed quality parameters such as physical purity, moisture, viability and vigour.
- CO2: Apply standard methods for seed germination, tetrazolium and vigour testing.
- CO3: Analyze the effects of chemical mutagens, storage and processing on seed germination and longevity.
- CO4: Demonstrate seed processing techniques including cleaning, grading, drying and storage.
- CO5: Evaluate seed deterioration processes and factors affecting seed longevity.
- CO6: Identify major nutrients (carbohydrates, proteins and fats) in plant food samples using standard qualitative tests.
- CO7: Analyze and estimate nutrient content in plant-based foods.
- CO8: Interpret experimental data obtained from nutrient estimation experiments.

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

Major Elective Course (1 Theory and 1 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	: BOMET 361A	Course Type	: Theory
Subject	: Computational Botany	Total Lecture	: 30L

Module – I: Introduction: 15L

Chapter 1 Introduction to Biostatistics 7L

1.1 Definition

1.2 **Statistical terms:** Population, sample, primary and secondary data, qualitative and quantitative data, parameter and statistics, attributes, variables, discrete and continuous variables, statistical error, linear and non-linear functions of statistics, frequency, and its distribution c. Scope, applications and uses of biostatistics.

Sample and sampling

- Definition
- Sampling unit, sample and population
- Types of sampling i. Random sampling – with replicates, without replicates, systematic sampling, stratified sampling ii. Non-random sampling- Purpose, quota sampling

1.3 Need of randomness

1.4 **Achieving randomness** i. Lottery methods, ii. Use of random number table f. Merits and limitations of sampling

Chapter 2 Collection and representation of data 8L

2.1 **Classification of data** i. Meaning and need of classification ii. Objectives of classification iii. Classification according to class interval iv. Overlapping and non-overlapping frequency table

2.2 Methods of representation of statistical data

- Essential features of tabular presentation
- Advantages of tabular presentation
- Graphic representation of data and its advantages
- Types of graphic representation
 - Histogram
 - Frequency polygon
 - Frequency curve
 - Scatter or dot diagram
 - Merits and limitations of graphic representation
 - Diagrammatic representation of data: 1. Line diagram 2. Bar diagram 3. Pie diagram

Module – II: Measures of Central Tendency 15L

Chapter 3 Measures of central tendency of grouped and ungrouped data 4L

- Simple arithmetic mean, its merits and limitations
- Averages of position: Median and mode, their merits and limitations

Chapter 4 Measures of dispersion 5L

4.1 Meaning of dispersion

- Range: Computation in individual, discrete and continuous series, coefficient of range, merits and limitations
- Mean deviation and standard deviation: computation for grouped and ungrouped data, merits and limitation
- Variance: Definition, coefficient of variance
- ANOVA

Botany (NEP)	B. Sc. Botany	RMC
Chapter 5	Correlation and regression	3L
	5.1 Definition and types of correlation & regression	
	5.2 Coefficient of correlation and regression, and its properties	
Chapter 6	Probability and types of theoretical probability distribution	2L
	6.1 Concept of probability	
	6.2 Binomial distribution	
	6.3 Poisson distribution	
	6.4 Normal distribution i. Normal distribution curve ii. Relationship between normal curve area and standard deviation iii. Properties of normal distribution curve	
Chapter 7	Bioinformatics	1L
	7.1 Introduction	
	7.2 Scope & Importance of biostatistics	

Suggested Readings:

1. Introduction to biostatistics, Pranab Kumar Banerjee.
2. Fundamentals of biostatistics, Khan and Khanum
3. Methods in Biostatistics for medical students and research workers, B K Mahajan.
4. ABC of Research Methodology and Applied Biostatistics, M N Parikh and Nithya Gogtay
5. Biostatistics in brief, K Viswesara Rao
6. Introduction to Biometry, S G Purohit, V D Ranade and A V Dusane
7. Biostatistics-Basic Concepts and Methodology for the Health Sciences, Wayne W Daniel

Course Outcome:

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

- CO1: Explain Key Concepts of Computational Botany
- CO2: Explain the role and importance of computational approaches in plant sciences.
- CO3: Implement Data Mining for Predictive Plant Biology.
- CO4: Apply computational methods to study genetic diversity.

Course : Major	Total Credit : 2
Code : BOMEPE 361B	Course Type : Practical
Subject : Practical on Computational Botany	Total Practical : 12

Sr. No	Practical on Computational Botany	12P
Practical Based on BOMET 361 A (Computational Botany)		
1.	Computation of mean, mode, median raw data	1P
2.	To study the frequency distribution from given data	1P
3.	Calculate variance and standard deviation from the given data.	1P
4.	Calculate mean deviation , standard deviation and error from given data	1P
5.	Statistical problem solving based on data for correlation	1P
6.	Statistical problem solving based on data for regression	1P
7.	Representation of data by various graphical methods	2P
8.	Calculate Normal, Binomial and Poisons distribution from given data	2P
9.	Analysis of variance from given data (ANOVA)	2P

Suggested Readings

1. Introduction to biostatistics, Pranab Kumar Banerjee.
2. Fundamentals of biostatistics, Khan and Khanum
3. Methods in Biostatistics for medical students and research workers, B K Mahajan.

Course Outcome

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

- CO1: Perform Descriptive Statistical Analysis.
 CO2: Understand and use probability distributions relevant to biological phenomena.
 CO3: Formulate and test biological hypotheses using ANOVA.
 CO4: Calculate correlation coefficients and perform regression analyses between biological variables.
 CO5: Create and interpret meaningful graphical representations.

Botany (NEP)		B. Sc. Botany		RMC
Course	:	Major	Total Credit	: 2
Code	:	BOMET 362A	Course Type	: Theory
Subject	:	Environmental Botany	Total Lecture	: 30L

Module – I: Fundamentals of Environmental Botany: 15L

Chapter 1 The Environment: 3L

- 1.1 Introduction and scope of Environmental Botany.
- 1.2 Components of Environment: Abiotic and biotic, Interrelationship between the living world and the environment.
- 1.3 Biotic community relationship: mutualism, mycorrhizae, commensalisms, and amensalism, prey predation equation model.

Chapter 2 Soil and Plants 5L

- 2.1 Definition, and formation of soil (physical, chemical, biological).
- 2.2 **Composition of soil:** mineral matter, organic matter, soil water, soil air, microorganisms.
- 2.3 **Soil profile:** horizons and their characteristics.
- 2.4 **Soils of India:** Alluvial, black, red, laterite, arid/desert, saline/alkaline, marshy
- 2.5 Classification of plants based on habitat: **Hydrophytes, xerophytes, mesophytes, halophytes, epiphytes, and lithophytes.**

Chapter 3 Environmental Pollution 4L

- 3.1 Environmental pollution: types, causes, effects and controls; Air, water, soil and noise pollution,
- 3.2 Photochemical Smog: Concept, inhibition, adverse effect of photochemical smog, nuclear hazards and human health risks.
- 3.3 Mitigation of pollution by plants: water, soil and air

Chapter 4 Climate Change 3L

- 4.1 Evidence of Global climate change: Temperature rise, melting of glaciers, sea-level rise, and extreme weather events.
- 4.2 Causes of climate change – natural and anthropogenic factors.
- 4.3 Greenhouse effect and greenhouse gases (CO₂, CH₄, N₂O, CFCs).
- 4.4 Global Warming: Causes, effects, and consequences on environment and biodiversity.
- 4.5 Carbon sequestration: Concept and importance.
- 4.6 Role of biodiversity conservation in climate resilience.
- 4.7 National Action Plan on Climate Change (NAPCC) – relevance to plant-based sectors.

Module – II: Environmental Resource Management and Conservation 15L

Chapter 5 Natural Resources: 6L

- 5.1 Resources: Renewable and non-renewable energy resources
- 5.2 Important resources of India: forest resources, importance of forests, role of forests in **Biodiversity conservation.**
- 5.3 Forest management and policies – National Forest Policy, Forest Conservation Act (1980)
- 5.4 **Mineral resources:** Classification, major minerals of India, Environmental impacts of mining and mineral extraction.
- 5.5 Role of Biodiversity and vegetation in resource conservation.

Chapter 6 Conservation Strategies and Policies 5L

- 6.1 Concept and Principles of conservation – in situ and ex situ.
- 6.2 Biodiversity hotspots and protected areas (Biosphere reserves, National parks,

Wildlife sanctuaries).

6.3 Environmental laws and policies for natural resource management (Wildlife Protection Act, Environment Protection Act).

6.4 Role of NGOs, local communities, and Governmental organizations in resource management.

Chapter 7 Environmental Ethics and Social Responsibility

4L

7.1 Definition and scope of Environmental ethics

7.2 Major Environmental ethical theories

7.3 Ethical considerations in environmental decision-making

7.4 Role of individuals and communities in Environmental sustainability.

Suggested Readings:

1. Carson, R. 2002. Silent Spring. Houghton Mifflin Harcourt.
2. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.
3. Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. Conservation Biology: Voices from the Tropics. John Wiley & Sons.
4. Pepper, I.L., Gerba, C.P. & Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.
5. Wilson, E. O. 2006. The Creation: An appeal to save life on earth. New York: Norton. World Commission on Environment and Development. 1987. Our Common Future. Oxford University Press.
6. De, A. K. 2022. Environmental Chemistry, 10th Edition, New Delhi. NewAge International Pvt. Limited
7. Dennis, A., Seal, K.J., Gaylarde, C.C. 2004. Introduction to Biodeterioration, Cambridge University Press
8. Ahmed, N., Qureshi, F.M., Khan, O.Y. 2006. Industrial and Environmental Biotechnology, Horizon Press
9. Rana, S.V.S. 2015. Environmental Biotechnology, Rastogi Publications, India.

Course Outcome:

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

CO1: Understand the fundamental concepts of environmental botany, soil science, pollution, climate change, natural resources, and conservation strategies.

CO2: Describe the biotic interactions, ecological relationships, and plant adaptations to different habitats, strengthening their ability to analyze ecosystem dynamics and community structure.

CO3: Explain global climate change, understand greenhouse gas effects, and analyze potential environmental and biodiversity consequences of global warming.

CO4: Evaluate the causes, impacts, and control measures of air, water, soil, and noise pollution, and formulate plant-based mitigation strategies for improving environmental quality.

CO5: Develop a strong understanding of environmental legislation such as the Forest Conservation Act, Wildlife Protection Act, Environment Protection Act, and assess their significance in natural resource governance and conservation.

CO6: Learn how we as individuals are responsible to keep our environment clean and green.

Course : Major	Total Credit : 2
Code : BOME P 362 B	Course Type : Practical
Subject : Practical on Environmental Botany	Total Practical : 12

Sr. No	Practical on Environmental Botany	12P
---------------	--	------------

Practical Based on BOMET 361 B (Environmental Botany)

- | | | |
|-----|--|----|
| 1. | Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, hygrometer, rain gauge and lux meter. | 1P |
| 2. | Determination of organic matter in different soil samples by Walkley-Black rapid titration method. | 1P |
| 3. | Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law. | 1P |
| 4. | Study of Ecological adaptations of hydrophytes, xerophytes and halophytes (Any two) | 1P |
| 5. | Determination of pH, and analysis of two soil samples for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency by rapid field test. | 2P |
| 6. | Study of physicochemical properties of water body by using sacchi disc, pH meter and electric conductivity meter | 1P |
| 7. | Study of polluted water body with reference to BOD (D zero day and D fifth day) | 2P |
| 8. | Study of suitable ecosystem by line/belt transect method/nested quadrat method. | 1P |
| 9. | Acquisition of ecological data of particular locality by using GPS/altimeter/geographical maps etc. | 1P |
| 10. | Determination of bulk density, porosity and rate of infiltration of water in soil of three habitats | 1P |
| 11. | Field visit to familiarise students with ecology of different sites. | 1P |

Suggested Readings

- Pandey, Jitendra & Sharma, Madhu Sudan. (2003). Environmental Science: Practical and Field Manual. Yash Publications.
- Rajan, Sundara S. (2003). Practical Manual of Plant Ecology and Plant Physiology. Anmol Publications Pvt. Ltd.
- Misra, R. & Puri, G. S. (2018). Indian Manual of Plant Ecology. Scientific Publishers, India.
- Singh, Karuna Nidhan; Kumar, Vipin; & Navsare, Rahul Indar. (2024). A Practical Manual Soil and Water Conservation Engineering. Akinik Publication

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

- CO1: Understand the functioning of microclimatic instruments and measure temperature, humidity, wind speed, rainfall, and light intensity in the field, demonstrating practical skills in microclimate assessment.
- CO2: Describe the physiological adaptations of plants to specific environmental stresses and analyze how adaptations enhance survival in different habitats.
- CO3: Analyse the difference in the organic matter content among soil samples, linking soil fertility to ecological conditions.
- CO4: Evaluate the abundance and distribution of plant species, interpret ecological patterns, and compare observed data with theoretical frequency distributions.
- CO5: Collect, record, and interpret spatial ecological data, enabling mapping of species distribution and habitat characteristics.

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
Vocational Skill Course

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 : BOVSP 361	Course Type : Practical
Subject : Practical on Plant Tissue Culture	Total Practical : 12

Sr. No	Practical on Plant Tissue Culture	12P
Practical Based on BOVST 351 (Plant Tissue Culture)		
1.	Sterilization techniques in plant tissue culture	1P
2.	Preparation stocks and plant tissue culture media.	1P
3.	Demonstration of in vitro sterilization methods and inoculation methods using leaf and nodal explants of Tobacco/ Datura/ Brassica etc.	1P
4.	Shoot tip, auxillary bud, Meristem culture.	1P
5.	Micro propagation.	1P
6.	Establishment of callus culture.	1P
7.	Effect of Growth Hormones on organogenesis. a) Shoot differentiation. b) Callus differentiation. c) Root differentiation.	1P
8.	Subculture of initiated cultures	1P
9.	Hardening methods and their utility	1P
10.	Effect of Auxins and Gibberellins on seed germination.	1P
11.	Organogenesis in callus cultures	1P
12.	Plant secondary metabolites production in vitro	1P
13.	Field visit to a lab involved in tissue culture	1P

Suggested Readings

1. Bhojwani SS, Razdan MK. Plant tissue culture: theory and practice. Elsevier; 1986.
2. Trigiano RN, Gray DJ. Plant tissue culture, development, & biotechnology. CRC Press; 2016
3. Bhojwani SS, Dantu PK. Plant tissue culture: an introductory text. India: Springer; 2013.
4. Reinert J, Yeoman MM. Plant cell and tissue culture: a laboratory manual. Springer Science & Business Media; 2012
5. Smith RH. Plant tissue culture: techniques and experiments. academic press; 2013.
6. Park S. Plant tissue culture: techniques and experiments. Academic Press; 2021.
7. Chawla HS. Introduction to plant biotechnology (3/e). CRC Press; 2011.

Course Outcome

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

CO1: To familiarize with the tools and techniques of plant tissue culture

CO2: To understand the possibility for the production of elite plants

CO3: To apply the technique in micropropagation of plants

CO4: To impart comprehensive overview of technical aspects of Plant tissue culture.

CO5: To develop practical orientation of cultured in vitro methods for various applications

CO6: Design and carry out basic plant tissue culture experiments

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-361

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

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

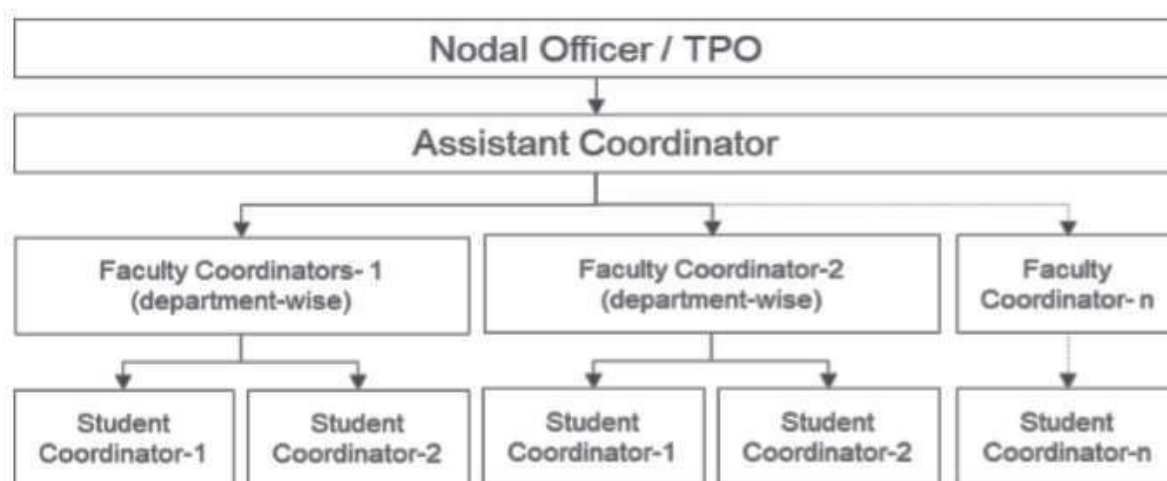
* Internship/Apprenticeship: 8 Credits + Field Projects/Community Engagement: 4-6 Credits For M.A., M.Sc., M.Com. and all professional PG degree courses, the indicative requirement regarding Internship duration and credits is as follows:

Internship	Schedule	Duration	Activities	Credits
Summers	After 2 nd Semester	4-6 weeks	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			
<p>confirm that I agree with the terms, conditions, and requirements of the Internship Policy</p> <p>Student Signature:</p> <p>Date: _____</p>			
<p>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.</p> <p>Sign of Department Faculty Coordinator:</p> <p>Date :</p>			

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:	
<ul style="list-style-type: none"> ➤ 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	Tue	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 marks