F5ANNAMALAI UNIVERSITY
(Accredited with 'A' Grade by NAAC)

FACULTY OF AGRICULTUREF5
(Accredited by ICAR)

DEPARTMENT OF GENETICS AND PLANT BREEDING

Academic Regulations and Syllabi

DOCTOR OF PHILOSOPHY IN MOLECULAR BIOLOGY AND BIOTECHNOLOGY

Under Choice based credit system (CBCS) with Outcome based Education

2022-2023 Onwards

COMMON REGULATIONS FOR ALL Ph.D. PROGRAMMES OF FACULTY OF AGRICULTURE

(*w.e.f. 2022-2023*)

1. DEFINITIONS

1.1 An **"Academic year"** shall consist of two semesters.

1.2 **"Semester"** means an academic term consisting of 110 instructional days excluding final theory examinations.

1.3 **"Course"** means a unit of instruction to be covered in a semester having specific No., title and credits.

1.4 **"Credit hour"** means, one hour lecture plus two hours of library or homework or two and half hours of library/field practical per week in a semester.

1.5 **"Credit load"** of a student during a semester is the total number of credits registered by that student during that particular semester.

1.6 "**Grade Point"** of a course means the value obtained by dividing the percentage of marks earned in a course by 10 and the Grade Point is expressed on a 10 point scale and rounded off to two decimal places.

1.7 **"Credit Point"** means the grade point multiplied by corresponding credit hours.

1.8 **"Grade Point Average (GPA)"** means the quotient of the total credit points obtained by a student in various courses at the end of each semester, divided by the total credit hours taken by the student in that semester. The grading is done on a 10 scale and the GPA has to be corrected to two decimals.

1.9 **"Overall Grade Point Average (OGPA)"** means the quotient of cumulative credit points obtained by a student in all the courses taken from the beginning of the first semester of the year divided by the total credit hours of all the subjects which he/she had completed up to the end of a specified semester and determines the overall performance of a student in all subjects during the period covering more than one semester. The OGPA has to be arrived at the second decimal place.

2. SYSTEM OF EDUCATION

2.1 These rules and regulations shall govern the Ph.D. programmes leading to the award of Degree of Doctor of Philosophy in the concerned subject in the Faculty of Agriculture, Annamalai University. They shall come into force with effect from the academic year 2022-2023.

2.2 The semester system shall be followed for all the Ph.D. degree programmes. The duration of doctoral programmes is as follows:

2.2.1 The duration of the programme and the time for admission of thesis are counted from the date of provisional registration.

2.2.2 The minimum duration of the programme is three years and the maximum duration of the programme shall be seven years.

2.2.3 Break of study shall be granted up to a maximum period of one year and it can be done only after completing the course work. Such request shall be made in advance by scholar in writing with the recommendation of Supervisor, Head of the Department (HoD) and Dean, Faculty of Agriculture and it should reach the Director, Directorate of Academic Research (DARE). The orders for the break of study shall be issued by the Director, DARE after assessing the need.

2.2.4 If prior permission is not sought and obtained, it will be considered as a case of discontinuation and action will be taken to cancel the registration of such scholars.

2.2.5 The scholars should remit the yearly fees during the break of study also.

3. PROGRAMMES OFFERED

The details of various Ph.D. programmes offered in the Faculty of Agriculture are as follows:

1. Agri Business Management
2. Agricultural Economics
3. Entomology
4. Agricultural Extension Education
5. Agricultural Microbiology
6. Agronomy
7. Genetics and Plant Breeding

8. Horticulture in Fruit Science
9. Horticulture in Vegetable Science
10. Horticulture in Floriculture and Landscaping
11. Horticulture in Plantation, Spices, Medicinal and Aromatic plants
12. Molecular Biology and Biotechnology
13. Plant Pathology
14. Seed Science and Technology
15. Soil Science

4. ELIGIBILITY FOR ADMISSION

Candidates seeking admission to Ph.D. programme should satisfy the following requirements.

4.1 Candidates with two year master's degree programmes from Universities recognized by Annamalai University are eligible to apply for Ph.D. programmes of the university (Table 1).

4.2 Candidates who have undergone the programme under conventional system should possess not less than a second class Master's degree. The candidates under trimester system should possess a minimum OGPA of 3.00 out of 4.00. For those under semester system 7.00 out of 10.00 is required for various Doctoral programmes.

Table 1: Eligibility Criteria

Doctoral Degree Programmes	Eligibility
1. Agri Business Management	MBA in Agribusiness / MBA Agri Business Management
2. Agricultural Economics	M.Sc. (Ag.) in Agrl. Economics / Agricultural Marketing Management
3. Entomology	M.Sc. (Ag.) in Entomology / Agricultural Entomology
4. Agricultural Extension Education	M.Sc. (Ag.) in Agricultural Extension / Agricultural Extension and Communication / Agricultural Extension Education / Extension Education
5. Agricultural Microbiology	M.Sc. (Ag.) in Agricultural Microbiology
6. Agronomy	M.Sc. (Ag.) in Agronomy
7. Genetics and Plant Breeding	M.Sc. (Ag.) in Genetics and Plant Breeding
8. Horticulture	M. Sc (Ag.) Hort. / M.Sc. (Hort.) / M.Sc. (Hort.) in Fruit Science / Vegetable Science / Floriculture and Landscape Gardening or Architecture / Plantation, Spices, Medicinal and Aromatic Crops
9. Plant Molecular Biology and Biotechnology	M.Sc. (Ag.) in Plant Molecular Biology / Agricultural Biotechnology
10. Plant Pathology	M.Sc. (Ag.) in Plant Pathology
11. Seed Science & Technology	M.Sc. (Ag.) in Seed Science & Technology
12. Soil Science	M.Sc. (Ag.) in Soil Science

4.3 All research scholars shall undergo course work for two semesters as prescribed by the Department. Duration of the programme will be for three years.

4.3.1 The Ph.D. scholars shall report in the Department and sign every day in the attendance register. In order to promote quality research and training in cutting edge areas, the University may permit the scholar to pursue his research work in Annamalai University or in other Universities/Research Institutes by entering with/without MOU between Annamalai University and the partner University/Institute after the completion of qualifying Viva voce examination.

4.3.2. Project staff/ fellow working in projects in the University, sponsored by Government of India/ Industries / Government of Tamil Nadu can also register.

4.3.3. Candidates in employment should be sponsored by their employer and should avail leave for the minimum duration of the programme and should be formally relieved from their duty to register.

4.3.4. Candidates who are selected under the national level fellowship programmes or by any recognized bodies and who satisfy the eligibility conditions as per the regulations shall apply in the respective discipline.

4.3.5. Admission to Foreign Students: Foreign students, who are selected under various scholarship schemes, either by the Ministry of Education and Culture or by the Ministry of External Affairs, will be given admission on the recommendation / sponsorship of the respective Ministry of Government of India. The other foreign students who seek admission should possess a research VISA issued by the Indian Embassies aboard and produce "No Objection Certificate" from the Ministry of Human Resource Development, Government of India, after clearance from the Ministry of External Affairs. They should also show proof for financial capability for staying, pursuing Ph.D. programme for three years.

5. MODE OF SELECTION

5.1. University shall issue notification for Ph.D. admission once in a year.

5.2. The candidates desirous of registering for Ph.D. programme shall apply by filling all the relevant details mentioned in the online application form posted in the University website and submit completed application online before the due date as indicated in the notification issued from time to time.

5.3 Incomplete applications and applications with false information in any respect shall be summarily rejected without any intimation to the candidate.

5.4. The Departmental Research Committee (hereafter referred to as DRC) of concerned Department shall screen the applications as per the eligibility norms and shall conduct the written test and interview only for eligible candidates.

5.5. The admission to Ph.D. students shall be based on the following criteria besides general eligibility.

5.5.1 An entrance test at post graduate level for 70 marks (70 multiple choice questions (MCQs), each question carrying one mark and duration of the test is 90 minutes followed by an interview that will have a weightage of 30 marks.

5.5.2 The candidates who secure 50% marks in entrance test and interview are eligible for admission.

5.5.3 A relaxation of 5 % marks (from 50 % to 45%) shall be allowed for the candidates belonging to SC/ST/OBC (non creamy layer)/ differentially able category.

5.5.4 Candidates with UGC- JRF / NET / ICAR/ICSSR qualified candidates and teacher fellowship holders are exempted from the Entrance test but they have to appear for the interview and evaluated for 100 marks.

5.6 Departmental Research Committee: The following is the constitution of the DRC. The members other than Head of the Department shall serve only for one academic year.

Designation	Members
Head of the Department	Convener
Two professors/ Senior Faculty nominated by the Vice-Chancellor in rotation	Members
One Associate Professor (in rotation)	Member
One Assistant Professor (in rotation)	Member

5.7. The DRC has the following functions

5.7.1 Selection of candidates for admission to the Ph.D. programme.

5.7.2 Facilitating research facilities in the Department.

5.7.3 Maintenance of research quality and quality of publications.

5.7.3 Sorting out any other research related issue of the Department.

5.8. If there is any dispute either in the constitution of functioning of the DRC, it shall be brought to the notice of the Director, DARE and the decision of the Vice-Chancellor shall be final.

5.9. The minutes of the DRC together with the list of selected candidates and their research supervisors along with recommendations of the Dean of the respective faculty will be placed before the Vice-Chancellor for approval.

6. ADMISSION

6.1. The selected candidates shall be issued admission cards and they will be admitted to Ph.D. programme in the respective Department based on his/her PG qualification, entrance and interview.

6.2. The provisional registration order for Ph.D. shall be issued to the candidates.

6.3. The scholar, supervisor, Research Advisor Committee members and examiners shall not be relatives to one another.

7. TUITION FEES AND OTHER FEES

7.1 The selected candidates shall pay the prescribed fees before the last date mentioned in the selection order, failing which they will forfeit the seats.

7.2. The yearly fees shall be paid by the scholars within the prescribed date till the scholar submits the thesis. The supervisors should monitor the regular payment of yearly fees by those scholars who are working under them.

7.3. The registration is liable for cancellation, if the research scholar has not paid the yearly fees within stipulated time.

7.4 Non-payment of yearly fees is a serious lapse on the part of the scholars. Explanation for non-payment of yearly fees shall be called for from the supervisors.

7.5 The various fees payable by the students will be decided by the university from time to time.

7.6 Admission to the hostel will be strictly restricted to the actual accommodation available and no associate will be allowed. A Ph.D. student may be allowed to stay in the hostel for a maximum of five years from the date of admission to the Ph.D. programme.

8. CREDIT GRADE POINT REQUIREMENTS

8.1. A student enrolled for Doctoral program is required to complete 100 credits inclusive of 75 credits of research to become eligible for the degree as detailed below:

Sl. No.	Details	Credit Hours
1	Major Courses	12
2	Minor Courses	6
3	Supporting Courses	5
4	Seminar	2
5	Research	75
	Non credit Compulsory courses	
	Research and Publication Ethics (Contact hours: 2) MOOC (Contact hours: 2)	
	Total	**100**

8.2. In a semester, a Ph.D. scholar can register a maximum of 15 credits excluding research. However, the research credits registered should not exceed 16 per semester. Semester-wise distribution of credits is given in the respective Ph.D. programmes.

8.3. Registration Card: A student shall register the courses offered in a semester by writing all the courses in registration card in quadruplicate. The Supervisor, Ph.D. Coordinator and Head of the Department are responsible to furnish the registration particulars of the students with their signature in the Registration card to the Dean. The Dean shall approve the registration cards. The approved registration cards shall be maintained by the HoD, Supervisor and the student concerned. The list of courses registered by the students in each semester shall be sent by the Dean to the DARE for preparation of Report Cards.

8.4. The Ph.D. students should complete their course work within the first two semesters in Annamalai University campus.

8.5. Requirements for Ph.D. programme shall also include successful completion of Non-Credit Compulsory Courses, thesis research in the major field of study and submission of thesis thereon.

9. ATTENDANCE REQUIREMENT

9.1 One hundred per cent attendance is expected from each scholar. A student who fails to secure 80 per cent of attendance in each subject separately for theory and practical, shall not be permitted to appear for the final examination in that subject and shall be awarded 'E' (incomplete) and will be required to repeat the course whenever offered.

9.2 In respect of the student who has absented himself / herself for classes with or without valid reasons, that period will be treated as absence only and not as leave. Also, no attendance will be given for writing make up tests.

9.3 In case of new admission, for calculating 80 percent attendance in the first semester, the number of working days will be calculated from the date of joining of the students who are permitted to join late due to administrative reasons. However, for genuine reasons, condonation of attendance deficiency may be considered by the Vice - Chancellor on the recommendation of the Research Advisory Committee, HoD and Dean, Faculty of Agriculture on payment of condonation fee prescribed by the university.

9.4 Students absenting from the classes with prior permission of the HoD on official University business shall be given due consideration in computing attendance.

9.5 In respect of students who had absented for the mid-semester examination (MSE) on university business with prior permission of the HOD and Dean, Faculty of Agriculture, the makeup first test should be conducted ordinarily within 15 working days from the date of conduct of the first test.

9.6 The students who absent himself/herself for first test in a subject on genuine reasons shall be permitted on the recommendation of the course teacher / Research Supervisor and Head of the Department concerned. Missing examination should be completed within 15 working days from the date of respective examination on payment of missing examination fee prescribed by the university.

10. RESEARCH ADVISORY COMMITTEE

10.1 Each Ph.D. scholar shall have a Research Advisory Committee (RAC) to guide the scholar in carrying out his/her programme.

10.2 A Research Advisory Committee shall be constituted with the approval of the University for each candidate separately, immediately after his/her admission. The purpose of the RAC is to provide expert opinion on frontline research.

10.3 There shall be a Research Advisory Committee for every student consisting of not fewer than four members with the Supervisor as Chairperson. The Research Advisory Committee should have representatives from the major and minor fields. The major **Advisor/Research Advisor** will be from Annamalai University and Co-Research Supervisor will be from the partner institutes (Research Scholars pursuing in other institutes/universities) besides RAC members.

The Research Supervisor should convene a meeting of the Research Advisory Committee at least once in a semester. The research credit evaluation form should be communicated to the Head of Department and the Director, DARE for information.

10.4 **Research Supervisor**

10.4.1 Every scholar shall have a Research Supervisor (among the recognized guides), who will be appointed by the Vice-Chancellor on the recommendation of the DRC, Head of the Department and the Dean, Faculty of Agriculture. Research supervisors approved by the Vice-Chancellor only can be the guide for the students.

10.4.2 A teacher having Ph.D. with 5 years of service and PG teaching is eligible for teaching and guiding Ph. D. scholars. A teacher should have a minimum of three years of service before retirement for allotment of doctoral candidates.

10.4.3 The research supervisors who wish to avail leave/lien/deputation beyond a period of six months shall propose a Co-supervisor in the concerned subject for the candidates registered with them and it may be intimated to the University well in advance. The final approval of the proposal rests with the Vice-Chancellor.

10.5 **Functions of the RAC**:

10.5.1 Discuss, advice and recommend on all matters connected with the scholar's research from admission till the completion of the programme.

10.5.2 Approve the topic of research and the synopsis.

10.5.3 Assess and approve the progress reports of Ph.D. scholars in the prescribed format and to report to the University on the fitness or otherwise of the candidate to proceed with his/her research work for the Ph.D.

10.5.4 If necessary, recommend and approve change of title of dissertation / thesis and change of Research Supervisor.

10.5.5. Conduct the pre-submission presentation (before the submission of synopsis) and to give a certificate to this effect to be submitted along with the synopsis.

10.6 The Research Advisory Committee will meet every semester

10.6.1 To scrutinize the research proposal / progress report submitted by the research scholar.

10.6.2 To assess the conduct of experiments / field work, peruse laboratory notebooks, data recording, analysis, and publication.

10.6.3 To review and endorse the annual progress report of the research scholar.

10.6.4 To approve the synopsis of the thesis.

10.6.4 The Chairperson will convene the Research Advisory Committee meetings with intimation to the Director, DARE through the Head of the Department.

10.7 **Changes in RAC**

The proposals for changes in the RAC are to be sent to the Director, DARE, through HOD and Dean for approval, if it is keenly felt that such changes are absolutely necessary.

10.8 **Change of Research Supervisor**

10.8.1 Change of Research Supervisor shall not be permitted as a routine. In exceptional cases, such change may be permitted, if valid reasons are provided by the candidates. The Committee headed by the Vice-Chancellor shall look into the request of the petitioner, if there is any conflict between the scholar and the research supervisor.

10.8.2 The Research Supervisor under whom the scholar has originally registered shall give a "No Objection Certificate" and the new proposed Research Supervisor should give a "Certificate of Willingness" to guide the candidate. The final decision will rest with the University. However, the Vice-Chancellor, on the recommendation of the RAC and Dean's Committee, has the right to assign a new research supervisor to the research scholar.

10.8.3 When the change of Research Supervisor is approved, the candidate shall work for a minimum of one year with the new Research Supervisor, if the topic of his/her research is different under the new supervisor, provided he/she fulfils the attendance requirements.

10.9 **Change of Topic of Research**

10.9.1 Change of the specific area of research may be permitted within one year from the date of admission and request must be submitted with the recommendations of the RAC. In such cases, the minutes of the RAC meeting must include whether the course work undertaken by the research scholar is relevant to the new research area and the competence of the research supervisor in this field.

10.9.2 If the RAC is of the view that there is a major change in the specific area of research and is not relevant to the course work undertaken, the research scholar will have to go through the process of fresh examination pertaining to the area of research.

10.10 Absence of Member during Qualifying / Final Viva-Voce Examination

Under extra-ordinary circumstances if the qualifying / final viva-voce examination to Ph.D. student has to be conducted in the absence of one or two RAC members, permission to conduct the examination by co-opting another member in such contingencies should be obtained from the Director, DARE in advance.

11. EVALUATION OF STUDENT'S PERFORMANCE

All students shall abide by the rules for evaluating the course work under the semester system of education, as prescribed from time to time by the University.

12. EXAMINATIONS

12.1 There will be two examinations *viz.,* first test and final examination. Wherever the course has practical, there will be a final practical examination also.

12.2 The duration of first test will be of one and half an hour and final examinations in theory and practical will be conducted for three hours each.

12.2.1 The first test will be conducted by course teachers during the ninth week of the semester as per the scheme drawn by HOD, evaluate and send the marks obtained by the students to the Director, DARE through HOD within seven working days.

12.2.2. The question paper for the final examination will be set as per Bloom's taxonomy by the

concerned course teacher in consultation with the Head of the Department.

12.2.3 There will be final examination separately for theory and practical which will be conducted by the University. Each final theory and practical examinations will be evaluated by two examiners (one will be the course teacher and another will be the senior faculty of the Department).

The distribution of marks will be as indicated below:

S. No	Examination	Course with practical	Course without practical	Course without theory
1	First Test	30	30	30
2	Final theory	40	70	-
3	Final practical	30	-	70
	Total	**100**	**100**	**100**

The question paper model and distribution of marks for first test and final theory examinations are as follows:

First Test (30 marks) (1.5 hours duration)

1	Definitions/concepts	5 out of 7	(5 x 1)	5 marks
2.	Short notes	5 out of 7	(5 x 3)	15 marks
3	Essay type	2 out of 3	(2 x 5)	10 marks

Final Theory: Course without practical (70 marks) (3 hours duration)

1.	Short notes	5 out of 7	(5 x 4)	20 marks
2	Essay type	5 out of 7 (four questions must represent K6 level of Bloom's taxonomy)	(5 x 10)	50 marks

Final Theory: Course with Practical (40 marks) (3 hours duration)

1.	Short notes	5 out of 7	(5 x 2)	10 marks
2	Essay type	5 out of 7 (four questions must represent K6 level of Bloom's taxonomy)	(5 x 6)	30 marks

12.3 **Minimum Marks for Pass**

12.3.1 The student should secure a minimum of 60 per cent marks separately in the theory and practical and an aggregate of 70 per cent to secure a pass in the subject. Each subject shall carry a maximum of 100 marks for purpose of grading. The grading will be done as grade point, i.e., the percentage of marks earned in a subject is divided by 10. The grade point is expressed on a 10 point scale upto two decimals.

12.3.2 Students who secure marks below 70 per cent in a subject will be awarded 'RA' grade and students without having the required minimum attendance of 80 per cent will not be allowed to write the final examination and they will be awarded 'E' grade. Students who secure 'RA' grade should appear for re-examination in the subsequent semester. If a student secured 'E' grade, he/she has to re-register and attend the course again during the next academic year.

12.4 **Minimum GPA Requirement**

A Ph. D. student, to continue his/her studies in the University, should maintain certain minimum Average Grade Point prescribed here under:

a) Earn a Grade Point of 7.00 for a pass in each subject.
b) For purpose of continuing as a student in the university, a candidate is required to earn a Grade Point Average of not less than 7.50 at the end of each semester.

c) A Ph.D. student may repeat the course (s) in which he/she gets a Grade Point below 7.50 and above 7.0 to improve the OGPA.

12.5 Re-Examination

12.5.1 Re-examination is permitted only for the final theory and practical examinations. The students who secure 'RA' grade are permitted to write the re-examinations as and when conducted with the permission of university.

12.5.2 The re-examination fee as prescribed by university per course is to be paid on or before the prescribed date. A student is permitted to write the final theory and practical examinations only two times during the course period of three years excluding the regular final examination.

12.5.3 In the event of a student who fails to secure a pass in the two re-examinations permitted, he/she has to re-register for the course along with juniors. The marks secured in first test will be retained and the student should produce the practical record during re-examination. The registration for the re-examination shall be done after first test on the date specified by the Director, DARE. Each registration is considered as an attempt even if the student absents for the examination.

12.6 Return of Valued Answer Papers

12.6.1 The valued answer papers of first test shall be shown to the students after the examination. Discrepancies if any, in awarding marks, the student can approach the teacher concerned immediately for rectification.

12.6.2 The answer paper should be retained with the course teacher for six months and then disposed off. Evaluated final theory papers have to be retained up to six months by the Director, DARE after the conduct of examination and then disposed off.

13. SEMINAR

Seminar is compulsory for all students and each student should register and present two seminars each with 0+1 credits. A student can register only one seminar in a semester and only after successful completion of the first seminar, the student is permitted to register for the second seminar.

13.1 Seminar Topic

13.1.1 The seminar topic should be only from the major field and should not be related to the area of thesis research. The seminar topics are to be assigned to the students by the Research Supervisor in consultation with HOD within three weeks after commencement of the semester.

13.1.2 Under the guidance and supervision of the Research Supervisor of the RAC, the student should prepare a seminar paper containing not less than 50 typed and printed pages with a minimum number of 75 references covering the recent 10 years time after reviewing all the available literature and present the seminar after completion of 80% attendance in the semester in the presence of the HoD, RAC, staff and post-graduate students of the concerned department.

13.1.3 The circular on the presentation of the seminars may be sent to other Departments to enable those interested to attend the same. The Research Supervisor will monitor the progress of the preparation of the seminar and correct the manuscript.

13.1.4 The student will submit two copies of the corrected manuscript to the HOD through Research Supervisor before presentation. The student will incorporate the suggestions and carry out corrections made during the presentation and resubmit three fair copies to the HOD (one to Dept. library, the second to the Research Supervisor and the third for student) within 15 days after presentation.

13.1.5 The performance of the student in the credit seminar will be evaluated and grade point awarded by the HOD along with the RAC for 100 marks. Grade Point may be given based on the following norms

Details	Marks
Coverage of literature	40
Presentation	30
Use of audio-visual aids	10
Capacity to participate in discussion and answer the questions	20
Total	**100**

14. QUALIFYING EXAMINATION

Only those students who successfully complete the qualifying examination will be admitted to candidacy of the degree. The qualifying examination consists of only Viva-voce examination.

14.1 Minimum requirement for qualifying Viva-voce Examination

The students who have completed all the courses and earned a grade point average of not less than 7.5 will be permitted to appear for the qualifying examination. Students who do not satisfy these requirements shall not be permitted to take up the qualifying examination. The qualifying examination will be conducted after the successful completion of course work.

14.2 Selection of Examiner

A panel of five external examiners for qualifying examinations shall be given by the RAC in consultation with HOD before three months of the date of completion of the student's course work to the Director, DARE. One of them will be appointed as external examiner.

14.3 Qualifying Viva-Voce Examination

14.3.1 The evaluation should cover both the research problem and theoretical background to execute the project. This shall assess the aptitude of the student and suitability of the student for the given research topic.

14.3.2 The RAC shall conduct the qualifying viva-voce examination with one external member, who shall be a specialist in the subject from outside the university.

14.3.3 The Head of the Department will monitor and coordinate the conduct of the qualifying viva. The performance of the candidate will be graded as Satisfactory / Unsatisfactory.

14.4 Communication of Results of Qualifying Examination

The Research Supervisor shall act as chairman for the examination committee and shall be responsible for communicating the results of the examination to the Director, DARE through HOD in the prescribed format.

14.5 **Failure /Absence in Qualifying Examination**

14.5.1 When a student fails or absents for the qualifying examination, he/she may apply again for permission to appear for re-examination to the Director, DARE with the recommendation of the RAC and Head of the Department.

14.5.2 A student, who applies for re-examination should attend viva-voce. Re-examination shall not take place earlier than one month after the first examination. It will be conducted by the RAC as previously indicated.

14.5.3 If a student fails in the re-examination, further re-examination will be considered on the recommendation of the RAC, HoD and Dean, Faculty of Agriculture. If the student fails in the qualifying examination, he/she is not permitted to register for further research credits in the next semester.

15. THESIS RESEARCH

15.1 **Selection of Topic**

15.1.1 The thesis research for the Ph.D. degree should be of the nature of a definite contribution to the subject and the results should be of sufficient importance to merit publication. The findings should have some practical utility or should lead to theoretical contribution.

15.1.2 The thesis shall be on a topic falling within the field of the major specialization and shall be the result of the student's own work. A certificate to this effect duly endorsed by the major advisor shall accompany the thesis

15.2 Research Proposal

15.2.1 The research scholars shall present their broad area of research and submit a proposal to the Research Advisory Committee at the end of the first semester.

15.2.2 The research proposal has to be presented by the student in a meeting organized by the Head of the Department to get the opinion / suggestion of the faculties of the Department for improving it. Three copies of the research proposal in the prescribed format should be sent to the Director (DARE) through the Head of the Department for approval.

15.2.3 The distribution of research credit will be as follows:

Semester	Credit Hours
I Semester	0+2
II Semester	0+10

III Semester	0+16
IV Semester	0+16
V Semester	0+16
VI Semester	0+15
Total	**0+75**

15.3 **Evaluation of Thesis Research**

15.3.1 After assigning the research problem, for each semester, the student has to submit a detailed programme of work to be carried out by him/her during the semester in the prescribed proforma. After scrutiny and approval, a copy of the research programme has to be given to the student for carrying out the work during that semester.

15.3.2 Attendance register must be maintained in the department by HOD for all the students to monitor whether the student has 80% of attendance in research.

15.3.3 The student has to submit his/her research observation note book to the Research Supervisor, who will scrutinize the progress and sign the note book with remarks as frequently as possible. This note book will form the basis for evaluation of research progress.

15.3.4 After completion of 80% attendance for research and on or before the last day of the semester, the research scholars, shall submit Progress Reports in the prescribed format duly endorsed by the Research Advisory Committee to the Director, DARE until they submit their synopsis.

15.3.5 Failure to submit the progress reports shall entail automatic cancellation of registration.

15.3.6 The minutes of the meeting of the Research Advisory Committee along with enclosures will be sent to the Director, DARE.

15.3.7 Candidates who are recipients of fellowships such as JRF/SRF directly from any of the funding agencies/ shall send the progress reports and the utilization certificates in the format prescribed by the respective funding agency through proper channel.

15.3.8 The procedure of evaluating research credits under different situations are explained hereunder.

SITUATION – I

The student has completed the research credits as per the approved programme and awarded **SATISFACTORY** by the RAC. Under the said situation, the student can be permitted to register for fresh research credits in the subsequent semester. If the student is awarded **UNSATISFACTORY**, he/she has to re-register the same block of research credits in the subsequent semester.

SITUATION – II

The student who has not secured the minimum attendance of 80 per cent shall be awarded grade 'E'. The student has to re-register the same block of research credits for which 'E' grade was awarded earlier in the following semester with prior permission. Until the completion of re-registered credits, the student should not be allowed to register for fresh (first time) research credits.

SITUATION – III

The student could not complete the research as per the approved programme of work for reasons beyond his/her control such as,

- Failure of crop
- Non-incidence of pests or disease or lack of such necessary experimental conditions.
- Non-availability of treatment materials like planting materials chemicals, etc.
- Any other impeding / unfavorable situation for satisfying the advisory committee.
- Under the said situations, grade **EE** should be awarded.

In the mark list, it should be mentioned that E grade or EE grade was awarded due to 'lack of attendance' or 'want for favourable experimental conditions'.

SITUATION – IV

When the student fails to complete the work even in the 'second time' registration, the student will be awarded **UNSATISFACTORY** and, in the mark, list the 'second time' should be mentioned.

For the registration of research credits for the third time, permission has to be obtained from the Dean based on the recommendation of the RAC, and HOD.

Permission for registration for the fourth time shall be given only by the University based on the recommendation of the RAC, HOD and Dean, Faculty of Agriculture.

16. SUBMISSION OF THESIS

16.1 The research credits registered in the last semester should be evaluated only at the time of the submission of thesis, by the RAC. Students can submit the thesis at the end of the final semester.

16.2 If a student has completed the thesis before the closure of the final semester, the research supervisor can convene the RAC meeting and take decision on the submission of the thesis, provided the student satisfies 80 per cent attendance requirement.

16.3 The candidate shall be allowed to submit his/her thesis after the completion of stipulated period. A grace period of 30 days may be allowed to submit the thesis after the prescribed duration. If the thesis is not submitted even after the grace period, the student shall pay the tuition fee for the ensuing year.

16.4 If a student is not able to submit the thesis within the grace period, the student has to re-register for the credits in the forthcoming semester. The student who re-registers the credits after availing of the grace period will not be permitted to avail of grace period for the second time. The Head of the Department can sanction the grace period based on the recommendation of advisory committee and a copy of the permission letter along with the receipt for payment of fine should accompany the thesis while submission.

16.5 Three copies of the thesis (in the approved format) shall be submitted together with the submission fee not later than three months after the submission of the synopsis.

16.6 No dues certificates from the Department and Central Libraries, Hostel, Stores, etc. must be submitted with the thesis copies. The Research Supervisor shall forward the thesis copies with the enclosures to the Director, DARE through the HOD and the Dean. A soft copy of the thesis in PDF format as prescribed by Shodhganga, shall also be submitted.

16.7 The Ph.D. scholars have to publish a minimum of two research papers in NAAS rated journals with 5 and above rating/ Scopus / Web of Science indexed journals at the time of publication of the papers. The synopsis will be accepted for processing only after showing evidences for publications of two such research papers.

16.8 The soft copy of the thesis shall be checked for plagiarism using Turnitin software. Beyond the percentage of reproduction prescribed by UGC, the thesis will not be accepted for valuation.

16.9 **Pre-submission Presentation**

16.9.1 The pre-submission presentation of the thesis is a requirement to enrich the scholar and to fine tune his/her research presentation. This presentation shall be conducted before the submission of the synopsis in the presence of the RAC, Supervisor/Co-Supervisor, HoD, Faculty members, Research Scholars and/or P.G. Students.

16.9.2 The scholar shall present the findings. The gathering may suggest ideas / references to be consulted / suggestions to improve the work.

16.9.3 A report on this event along with an attendance sheet shall be forwarded by the Research Supervisor with the endorsement of the RAC and HOD to the Director, DARE.

16.10 Submission of Synopsis

16.10.1 The submission of synopsis may be permitted 3 months before the completion of required duration on successful completion of course work.

16.10.2 The Research Scholar shall submit 3 copies of the synopsis approved by the Research Advisory Committee along with a soft copy to the Director, DARE through the Research Supervisor, the HOD and Dean of the respective Faculty.

16.10.3 Guidelines for the preparation of the synopsis are appended in Appendix I. Name of the candidate and name of the supervisor shall not be mentioned anywhere in the synopsis; enrolment number of the candidate alone shall be given. A model cover page for a synopsis is given in Appendix III.

16.11 **Guidelines for Preparation of Thesis**

16.11.1 The thesis shall not exceed 250 pages excluding the Bibliography, Appendices, etc. If it exceeds the specified number of pages, the Research Supervisor should write to university with the reasons and get prior approval from the University. The candidate shall pay a penalty for the excess number of pages as decided by the Deans Committee. The thesis should be in A4 size.

16.11.2 The specification for the preparation of the thesis is given in Appendix II. A model cover page for a thesis is given in Appendix IV.

16.11.3 The thesis shall be typed on both sides of the page in order to save paper and postage. The thesis shall contain a Certificate from the guide (Annexure) specifying that the thesis submitted is a record of research work done by the candidate during the period of study under him/her and that the thesis has not previously formed the basis for the award of any Degree, Diploma, Associate ship, Fellowship or similar title.

16.11.4 A statement from the guide indicating the extent to which the thesis represents independent work on the part of the candidate should also be made. (Appendix V)

16. VALUATION OF THE THESIS

17.1 **Panel of Examiners**

17.1.1 The thesis submitted in partial fulfilment of the Ph.D. degree shall be evaluated by two external experts one from within the country and the other from outside the country appointed by the Vice-Chancellor on the recommendation of the Research Supervisor of the RAC, HOD and Dean.

17.1.2 The external experts shall be chosen from a panel of at least five names of specialists separately from within the country and outside the country in the particular field, suggested by the Research Supervisor.

17.1.3 The external experts shall send their evaluation reports on the thesis directly to the Director, DARE along with the copy of the evaluated thesis. The Director, DARE on receipt of the reports from the two examiners will send them to the concerned Research Supervisor who is the convener of viva-voce board.

17.1.4 The Research Supervisor will send the consolidated report with his remarks to the Director, DARE through the Head of the Department. Based on the satisfactory reports of the evaluation, Viva-voce examination will be arranged.

17.1.5 After a student's thesis for Ph.D. degree is evaluated as indicated above, the thesis shall be finally accepted for the award only after the student satisfactorily completes the final Viva-voce examination.

17.1.6 The Viva-Voce board comprises the student's RAC with the addition of the external examiner who valued the thesis, and the HOD. If the HOD happens to be the Research Supervisor, the Dean, Faculty of Agriculture will nominate a senior member of the staff of the concerned Department as a member.

17.1.7 The candidate is expected to defend the thesis at the Viva-voce examination. The degree shall be awarded on the unanimous recommendation of the Viva-Voce board as **satisfactory** with regard to the thesis and the performance of the student in the final Viva-voce examination.

17.1.8 The recommendation of the Viva-Voce board shall be forwarded to the Director, DARE by the Research Supervisor through HOD and Dean which shall be signed by all members of the committee and the external examiner.

17.1.9 A candidate who is not successful (unsatisfactory) at the Viva–voce examination will be permitted to undergo the Viva-voce examination again within a period of three months

17.2 **Revision and Resubmission of Thesis**

17.2.1 If an examiner recommends change / further work, the thesis will be referred to the same examiner after compliance for his/her opinion. In case of rejection by any one of the examiners, the thesis will be sent to another examiner and his / her recommendation will be final.

17.2.2 If the thesis is recommended to be revised by one or both examiners, the points of revision will be indicated clearly in the report. The necessary correction should be carried out, and the revised version should be sent to the concerned examiner(s). If the examiner(s) is / are still not satisfied with the revised version, the thesis will be rejected. If the thesis is accepted by the examiners (Evaluation), Viva–Voce examination will be conducted by the viva-voce board.

17.3 **Re-registration and Submission of Thesis**

The minimum of 80% attendance requirement for submitting the thesis after re-registration need not be

insisted for those students who have fulfilled the minimum academic and residential requirement of three years.

17.4 **Extension of Time**

17.4.1 Research scholars who do not submit the thesis within the stipulated period should apply for extension of time three months before the completion of three years. Extension of time and the fees to be paid will be considered by the Deans Committee, if the extension is duly recommended by the RAC, Head of the Department, and the Dean of the Faculty, such candidates will be eligible for extension of time for a maximum period of three years.

17.4.2 The scholar will have to enrol as fresh candidates if he/she fails to submit the thesis within the maximum extension period of three years when granted.

17.4.3 If a scholar requires a few more months after the expiry of the maximum extension period of three years for the submission of the thesis as per the evaluation of the RAC, duly recommended by the Head of the Department and the Dean of the Faculty, as an exceptional case, the Deans committee may consider for re-registration to enable the scholar to submit the thesis. In any case, the time granted shall not exceed six / twelve months.

17.5.1 Number of Chances

17.5.1 A candidate will not be permitted to submit a thesis for the degree on more than two occasions. However, it will be open to the Syndicate, if the Board of Examiners so recommend, to permit the candidate to submit a thesis on a third occasion.

17.5.2 Also, he / she will not be permitted to appear for the viva-voce examination on more than two occasions.

18. DISCONTINUANCE AND READMISSION

18.1 Students admitted to the Ph.D. degree who discontinue their studies before completing the degree with written permission from the university may be re-admitted to the degree programme, provided that the student should have completed the course work before such discontinuance. However, the period of such discontinuance should not exceed five years for Ph.D. Degree from date of admission.

18.2 After completion of course work and qualifying examination, a student is eligible to discontinue temporarily his research program only once within 5 years for Ph. D. program. If the discontinuation period exceeds two semesters, the student has to forego the research credits already registered and register afresh with revised program.

18.3 In the case of field experiments or laboratory experiments in which continuity is essential for research and if a student temporarily discontinues in the middle without completing the experiments, then the entire experiment should be repeated, even if the discontinuation period does not exceed two semesters.

18.4 A student joining the studies, after discontinuation should pay the fees of the existing semester.

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GENT 81 – Ph.D. in MOLECULAR BIOLOGY AND BIOTECHNOLOGY

PROGRAMME OUTCOME

PO 1	Developing skills in written work, oral presentation and publishing the results of their research in scientific journals with high impact factor, through constructive feedback.
PO 2	Encourage students to develop skills in making and testing hypotheses, developing new theories, and in planning & conducting experiments, analyze and interpret data for investigating problems in Biotechnological manipulation.
PO 3	Comprehensive understanding the plant tissue culture protocols, active principles from agriculturally economic plants and genetic engineering of different agricultural plant species for biotic and abiotic stress
PO 4	Appreciate and execute their professional roles in society as biotechnology professionals, employers and employees in various industries, regulators, researchers, educators and managers.
PO 5	Encourage students to evolve solution to local problems through ground breaking research and contribute to society through cutting edge research.to understand theoretical standard.
PO 6	Entrepreneurship ventures such as establishment of plant tissue culture laboratory, molecular biology laboratory, consultancy and training centers, and development of biotechnology firms.

CO-POD Mapping matrix

Correlation levels 1, 2 and 3 are as defined below:

1 - Low
2 - Moderate/ Medium
3 - Substantial /High

SEMESTER WISE DISTRIBUTION OF CREDIT

Semester	Major Course	Minor Course	Supporting Course	Seminar	Research	Total credit	Non credit Compulsory course
I	6	4	2	1	2	**15**	-
II	6	2	3	1	10	**22**	-
III	-	-	-	-	16	**16**	Research and Public Ethics
IV	-	-	-	-	16	**16**	**MOOC**
V	-	-	-	-	16	**16**	-
VI	-	-	-	-	15	**15**	-
Total credit	**12**	**6**	**5**	**2**	**75**	**100**	**-**

Course code	Course Title	Credit hour (Theory + Practical)
	Major Courses (Any 5 out of 7 major courses)	12
MBB 601#	Plant Molecular Biology*	3 (3+0)
MBB 602#	Plant Genome Engineering*	3 (3+0)
MBB 603	Plant Omics and Molecular Breeding	3 (3+0)
MBB 604	Commercial Plant Tissue Culture	2 (2+0)
MBB 605	Plant Microbe interaction	2 (2+0)
MBB 606#	RNA Biology	1 (1+0)
MBB 607	Plant Hormones and Signalling	2 (2+0)
MBB 608	Computational and Statistical tools in Biotechnology#Any other appropriate 500 series courses	3 (2+1)
	# Compulsory Course	
	Minor Course (Any 3 courses)	6
	6 credits from Genetics and Plant Breeding or Seed Science and Technology	
	Supporting Courses	5
COM 601	Advances in Computer Applications(1+1)	2
STA 601	Advances in Designs of Experiments (2+1)	3
	Seminar	
	Doctoral Seminar – I (0+1)	1
	Doctoral Seminar – II (0+1)	1
	Research	
	Doctoral Research (0+75)	75
	Non credit compulsory courses	
	MOOC (2+0)	-
	Research and Public Ethics (2+0)	-

Semester wise Distribution of Courses

Sl. No	Courses	Credit Hours
I	**First Semester**	
1	**Major Courses**	**6**

2	**Minor courses**	**4**
	4 credits from Genetics and Plant Breeding or Seed Science and Technology	
3	COM 601 Advances in Computer Application	1+1
4	AEC691 Seminar	0+1
5	AEC 699 Research	0+2
	Total credits	
II	**Second Semester**	
1	**Major Courses**	**6**
2	**Minor courses**	**2**
	2 credits from Genetics and Plant Breeding or Seed Science and Technology	
3	STA 601 Advances in Designs of Experiments	2+1
4	AEC 692 Seminar	0+1
5	AEC 699 Research	0+10
	Total credits	
III	**Third Semester**	
1	Research and Public Ethics*	2+0
2	AEC 699 Research	**0+15**
IV	**Fourth Semester**	
1	MOOC*	2+0
2	AEC 699 Research	**0+16**
V	**Fifth Semester**	
1	AEC 699 Research	**0+16**
VI	**Sixth Semester**	
1	AEC 699 Research	**0+16**
	Grand total	**100**

MBB 601- PLANT MOLECULAR BIOLOGY (3+0)

Learning objectives

- To provide in depth knowledge of recent developments of plant molecular biologyand applications
- To discuss case studies on RNAi in crop improvement
- Impart knowledge on biotic and abiotic stress tolerance
- Gain knowledge on *Agrobacterium* as a tool for genetic transformation
- To acquire complete information on hormone regulation in flowering

Unit I (Genome)

Genome organization in prokaryotes and eukaryotes; Chromatin structure and function- DNA replication-the mode of replication; enzymology of DNA replication initiation, elongation and termination in prokaryotes and eukaryotes.

Unit II (Male sterility)

Model Systems in Plant Biology (Arabidopsis, Rice, etc.) Forward and Reverse Genetic Approaches. Organization eXpression and interaction of nuclear, Mitochondrial and Chloroplast Genomes. Cytoplasmic male sterility.

Unit III (Transcriptomics)

Transcriptional and Post-transcriptional Regulation of Gene EXpression, Isolation of promoters and other regulatory elements, RNA interference, Transcriptional Gene Silencing, Transcript and Protein Analysis.

Unit IV (Circadian rhythms)

Plant Developmental Processes, ABC Model of Floral Development, Role of hormones (Ethylene, Cytokinin, AuXin and ABA, SA and JA) in plant development. Regulation of Flowering, Plant photoreceptors and light signal transduction, vernalization, Circadian Rhythms.

Unit V (Plant microbe interactions)

Abiotic Stress Responses: Salt, Cold, Heat and Drought. Biotic Stress Responses. Molecular Biology of Plant-pathogen Interactions, Molecular Biology of *Rhizobium* and *Agrobacterium*-Plant interaction. Role of programmed Cell Death in Development and Defense.

Theory schedule

1. Define Genome
2. Genome organization in prokaryotes
3. Genome organization in eukaryotes
4. Chromatin structure
5. Chromatin function
6. Mode of DNA replication
7. Enzymology of DNA replication
8. Structure of DNA polymerase II
9. First test
10. DNA replication in prokaryotes
11. Replication in eukaryotes
12. Model Systems in Plant Biology-Arabidopsis
13. **First test**
14. Model Systems in Plant Biology-Rice
15. Forward Genetic Approaches
16. Reverse Genetic Approaches
17. Mitochondrial and Chloroplast Genomes
18. Organization eXpression and their interaction
19. Male sterile systems
20. Cytoplasmic male sterility.
21. Transcriptions and Translations
22. Post-transcriptional Regulation of Gene EXpression
23. Regulatory elements
24. Promoters in prokaryotes
25. **Mid term**
26. Promoters in eukaryotes
27. Isolation of promoters and Other regulatory elements
28. Gene silencing
29. RNA interference
30. Transcriptional Gene Silencing
31. Transcript and Protein Analysis

32. Plant Developmental Processes
33. ABC Model of Floral Development
34. Classes of hormones
35. Role of hormones Ethylene, Cytokinin,
36. Auxin and ABA
37. SA and JA)
38. Regulationof Flowering
39. Plant photoreceptors
40. Light signal transduction
41. vernalization
42. Circadian Rhythms
43. Abiotic Stress Responses-Salt and Cold
44. Abiotic Stress Responses-Heat and Drought
45. Biotic Stress Responses-pests
46. Biotic Stress Responses-Diseases
47. Microbial interaction in plant systems
48. Molecular Biology of Plant-pathogen interactions
49. Molecular Biology of *Rhizobium* and *Agrobacterium*- Plant interaction.
50. Role of programmed Cell Death in plant Development and defense

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Course Outcomes

CO1 Learning recent advances of Molecular Biology.

CO2 Understanding hormone regulatory pathways.

CO3 Understanding the mechanism of RNAi and gene silencing.

CO4 Learning the role of hormones in seed germination, flowering fruit ripening and senescence.

CO5 Gain knowledge on molecular basis for programmed cell death in plant development and defense

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1		2			3
CO2	1		1			
CO3		1			2	
CO4		2				3
CO5	1	2	1			

MBB 602 - GENOME ENGINEERING(3+0)

Learning objectives

- To get a basic overview of Plant Genetic Engineering
- Enhance knowledge of molecular cloning
- A theoretical idea on vectors and genomic library construction.
- To get an overview of PCR and its applications,
- Understanding genetic sequencing, gene knockouts, transgenics etc.

Theory

Unit I - Genetic engineering for abiotic resistance

Conventional versus non-conventional methods for crop improvement; Present status and recent developments on the available molecular markers; Transformation and genomic tools for crop improvement; Genetic engineering for abiotic resistance – Drought, Salinity, Flooding and Temperature

Unit II – Engineering for biotic stress

Genetic engineering for biotic resistance - Insect pests, Fungal, Viral, Bacterial diseases, Weeds; Genetic Engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation and nutrient uptake efficiency; Genetic engineering for quality improvement (protein, essential amino acids, vitamins, mineral nutrients, etc.); edible vaccines, etc.

Unit III - Plant trasformation

Recent developments in plant transformation strategies; Role of antisense and RNAi-based gene silencing in crop improvement; Regulated and tissue-specific expression of transgenes for crop improvement;

Unit IV - Gene stacking

Gene stacking; Pathway engineering; Marker-free transgenic development strategies; Genome editing: principles and methods, Development of genome edited plants; High throughput phenotyping of transgenic plants.

Unit V - Bio-safety issues in transgenics

Field studies with transgenic crops; Environmental issues associated with transgenic crops; Food and feed safety issues associated with transgenic crops; Risk assessment of transgenic food crops.

Theory schedule

1. An overview of transformation methods
2. Advances in transformation methods
3. Present status and recent developments on the available molecular markers
4. Transformation and genomic tools for crop improvement.
5. Genetic engineering for abiotic resistance – Drought
6. Genetic engineering for abiotic resistance – Salinity
7. Genetic engineering for abiotic resistance – Flooding
8. Genetic engineering for abiotic resistance – Temperature
9. Genetic engineering for biotic resistance – Insect pests
10. Genetic engineering for biotic resistance - Fungal
11. Genetic engineering for biotic resistance - Viral
12. Genetic engineering for biotic resistance - Bacterial diseases
13. **First test**
14. Genetic engineering for biotic resistance - Weeds
15. Genetic Engineering for increasing crop productivity by manipulation of photosynthesis, nitrogen fixation and nutrient uptake efficiency
16. Genetic engineering for quality improvement (protein, essential amino acids, vitamins, mineral nutrients, etc.); edible vaccines, etc.
17. Mid term
18. Recent developments in plant transformation strategies
19. Introduction of antisense and RNAi technology
20. Discovery of antisence and RNAi
21. RNA interference – micro RNAs and small interfering RNAs
22. Mode of action of Antisence and RNAi
23. Transcriptional gene silencing and Post transcriptional gene silencing
24. Advantages of RNAi and pitfalls
25. **Mid term**
26. Importance, Pros and Cons of RNAi technology
27. Role of antisense in crop improvement
28. Importance and Role of RNAi-based gene silencing in crop improvement
29. CRISPR technology – interference and its mechanism
30. Regulated and tissue-specific expression of transgenes for crop improvement
31. Gene stacking strategies
32. Tissue specific expression and functional validation of genes
33. Pathway engineering
34. Marker-free transgenic plants development strategies
35. Regulated and tissue specific expression of target genes
36. Pathway engineering; case studies
37. Genome editing: principles and methods
38. Gene traps, Yeast two hybrid system, etc.,
39. SNPs – Allele mining in crop improvement
40. Targeted genome modification – basics; ZFN and TALEN
41. Development of genome edited plants;
42. High throughput phenotyping of transgenic plants
43. Field studies with transgenic crops
44. Biosafety issues - Environmental issues associated with transgenic crop
45. Biosafety issues - Food and feed safety issues associated with transgenic crops
46. Risk assessment of transgenic food crops
47. Problem formulation – environmental risk assessment
48. Problem formulation – risk assessment for food and feed safety

49. Biosafety regulations at the national level
50. Regulation of products derived from RNAi and CRISPR technologies

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	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO1	-	2	-	-	2	-	-
CO2	-	3	3	-	-	-	-
CO3	3	3	2	-	1	-	-
CO4	3	3	1	-	-	-	3
CO5	3	2	1	-	-	-	3

MBB 603 -PLANT OMICS AND MOLECULAR BREEDING (3+0)

Learning Objectives

- To discuss the specialized topics and advances in field of genomics
- To gain knowledge on genomics assisted molecular breeding
- To be made aware of next generation sequencing
- To get skills on proteome analysis
- To get wise to the fact of metabolome analysis

Theory

Unit I. Quantitative Trait Locus Analysis

Complex traits and genetic architecture, Mapping genes and QTLs, statistical concepts in QTL mapping, high-throughput genotyping using automated platforms, genetic and physical mapping of genomes, study of population structure and kinship, association genetic analysis of QTL, case studies on QTL mapping using different approaches, map-based of cloning genes and QTLs–case studies.

Unit II. Marker Assisted Breeding

Marker Assisted Breeding(MAB):Principles and methods, marker assisted foreground and background selection, marker assisted recurrent selection, whole genome selection, case studies in MAS, requirement for successful marker assisted breeding, cost of MAB.

Unit III. Next Generation Sequencing

Concepts and methods of next generation sequencing (NGS), assembly and Annotation of NGSdata, genomere sequencing,DNA sequence comparison, annotation and gene prediction. Genome-wide insertion mutagenesis and its use in functional genomics, transcript me profiling using microarrays and deep sequencing.

Unit IV. Proteome Analysis

Study of methylome and its significance, proteome analysis using mass spectrometry, crystallography and NMR,analysis of proteomedata ,study of protein-protein interactions.

Unit V. Metabolome Analysis

Stud of the metabolome,use of1D/2DNMRandMSinmetabolomeanalysis,multivariate analysis and identification of metabolite as biomarkers, study of ionomeusinginductivelycoupledplasma–massspectroscopy(ICP-MS),correlating the data from genome, transcriptome, proteome ,metabolomeandionome with phenome.

Theory Schedule

1. Complex traits and genetic architecture
2. Mapping genes
3. Mapping QTLs
4. Statistical concepts in QTL mapping
5. Statistical concepts in QTL mapping
6. High-throughput genotyping using automated platforms
7. Genetic mapping of genomes
8. Physical mapping of genomes
9. Study of population structure and kinship
10. Association genetic analysis of QTL
11. Case studies on QTL mapping using different approaches, *cont.,*
12. Case studies on QTL mapping using different approaches
13. **First Test**
14. Map-based of cloning genes and QTLs–case studies, *cont.,*
15. Map-based of cloning genes and QTLs–case studies
16. Marker Assisted Breeding(MAB):Principles and methods
17. Marker assisted foreground selection
18. Marker assisted background selection
19. Marker assisted recurrent selection
20. Whole genome selection
21. Case studies in MAS, *cont.,*
22. Case studies in MAS
23. Requirement for successful marker assisted breeding
24. Cost required for MAB
25. **Mid-Term Examination**
26. Concept sand methods of next generation sequencing(NGS)
27. Assembly and annotation of NGS data, *cont.,*
28. Assembly and annotation of NGS data
29. Genome resequencing
30. DNA sequence comparison
31. Annotation and gene prediction

32. Genome-wide insertion mutagenesis and its use in functional genomics
33. Transcriptome profiling using microarrays
34. Transcriptome profiling using deep sequencing
35. Study of methylome and its significance
36. Proteome analysis using mass spectrometry
37. Proteome analysis using crystallography
38. Proteome analysis using NMR
39. Analysis of proteome data
40. Study of protein- protein interactions
41. Study of the metabolome, use of 1DNMR
42. Study of the metabolome, use of 2D NMR
43. MS in metabolome analysis
44. Multivariate analysis and identification of metabolite as biomarkers
45. Study of ionome using inductively coupled plasma – mass spectroscopy (ICP-MS)
46. Correlating the data from genome with phenome
47. Correlating the data from transcriptome with phenome
48. Correlating the data from proteome with phenome
49. Correlating the data from metabolome with phenome
50. Correlating the data from ionome with phenome

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Course Outcome

1. Understand the techniques in the field of genomics
2. Get to know about Quantitative Trait Locus Analysis
3. Gain knowledge about Marker Assisted Breeding
4. Made aware of Next Generation Sequencing
5. Acquire knowledge on Proteome and Metabolome Analysis

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2			3	2	2
CO2		3	2	3	3	2
CO3		3	3	3	2	
CO4		2	3	3	2	3

CO5		2		3	2	3

MBB 604 - COMMERCIAL PLANT TISSUE CULTURE (2+0)

Learning objective

1. To provide awareness f o r development of commercial scale plant tissue culture units.
2. To provide an insight into the commercial applications of plant tissue culture in agriculture.
3. To apply commercial plant tissue culture in medicine and industry.
4. To educate about biosafety and their regulatory.
5. To know about entrepreneurship as well as opportunities.

Unit I Micro-propagation in plants

Micro-propagation of commercially important plant species; plant multiplication, hardening, and transplantation; genetic fidelity; scaling up and cost reduction; bioreactors; synthetic seeds; management and marketing.

Unit II Secondary production techniques

Production of useful compounds via, biotransformation and secondary metabolite production: suspension cultures, immobilization, examples of chemicals being produced for use in pharmacy, medicine and industry.

Unit III Transgenic plants production

Value-addition by transformation; development, production and release of transgenic plants; patent, bio-safety, regulatory, environmental and ethical issues; management and commercialization.

Unit IV COMMERCIAL APPLICATIONS OF PLANT TISSUE CULTURE-I

Project planning and preparation, economics (entrepreneurship, cost profit ratio), government policies (incubators, different facilitation projects, loan opportunities).

Unit V COMMERCIAL APPLICATIONS OF PLANT TISSUE CULTURE-II

Some case studies on success stories on commercial applications of plant tissue culture. Visits to some tissue culture based commercial units/industries.

Lecture schedule:

1. Micro-propagation of commercially important plant species
2. Somatic plants multiplication
3. Hardening in greenhouse
4. Field transplantation of somatic plants
5. Phenotyping analysis of somatic plants
6. Genetic fidelity analysis of somatic plants
7. Marketing of tissue cultured plants
8. Plants as Bioreactors
9. Production of Cotyledonary somatic embryos
10. **First Test**
11. Synthetic seeds using cotyledonary somatic embryos
12. What are biotransformation
13. Principle of Suspension cultures
14. Mechanism of Immobilization
15. Secondary metabolite through callus –suspension culture

16. Production of useful compounds by using biotransformation.
17. Production of useful compounds by using secondary metabolite.
18. Production of useful compounds by using immobilization.
19. Examples of chemicals being produced for use in pharmacy, medicine and industry.
20. **Mid semester examination**
21. Value-addition by biotransformation
22. List of commercialized transgenic plants
23. Development, production and release of transgenic plants.
24. Patent in commercial tissue culture
25. Bio-safety of tissue and transgenic plants
26. Regulatory bodies in tissue culture and transgenics
27. Environmental and ethical issues
28. Management and commercialization.
29. Project planning and preparation
30. Economics (entrepreneurship, cost profit ratio)
31. Government policies (incubators, different facilitation projects, loan opportunities).
32. Some case studies on success stories on commercial applications of plant tissue culture.
33. Success stories on commercialization of tissue culture banana
34. Visits to some tissue culture based commercial units/industries.

Suggested Reading

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Course outcomes

1. Standardize protocols for the *in vitro* propagation from ex vitro explants
2. To optimize the culture conditions for rapid propagation and regeneration of agriculturally important plants.
3. Biochemical monitoring of explants proliferation and regeneration
4. Optimization of medium and culture conditions for the enhancement ofactive principle production
5. Biochemical characterization of regeneration and genetic transformationusing *Agrobacterium.*
6. To acquire knowledge for commercial tissue culture laboratory.

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO1			1			
CO2			1			
CO3			1		2	3
CO4			1			
CO5			1		3	2
CO6			2			1

MBB 605- PLANT MICROBE INTERACTION(2+0)

Learning objective

- To get a basic overview of Microbial Communities
- Enhance knowledge of molecular aspects
- Impart Knowledge on Enzymes and Plant Parasite Interactions
- Gain Knowledge on Industrial applications of Microbes
- Understanding their resistant potential in enhancing crop growth and development

Theory

Unit I Microbial Interaction

Microbial communities in the soil and atmosphere, Community dynamics and population interactions with particular reference to plant–microbe and microbe-microbe interactions leading to symbiotic, associative, endophytic and pathogenic interactions, effects of microorganisms on plants, effects of plants on microorganisms.

Unit II Rhizobacteria and Mycorrhiza – Molecular aspects

Recognition processes and signal eXchange, Molecular aspects of Plant Growth Promoting Rhizobacteria (PGPR), Symbiotic diazotrophs: Rhizobia and association with legumes. Mycorrhizal associations: Ectomycorrhizae, Endomycorrhizae with particular emphasis to AM fungi, Ectendomycorrhizae. Biocontrol agents and their action,endophytes associations

Unit III Enzymes and Plant Parasite Interactions

Enzymes, toXins, pili, siderophores, secretion systems of microbes and plants determining soil health, nutrient availability and uptake defense responses in plants:pamp-triggered immunity,effector-triggered susceptibility,qualitative resistance, r genes, structure and function, effector -triggered immunity, regulation of plant cell death, planthormones inimmunity, Plant parasite interactions and its molecular basis and impact on plant functions including photosynthesis, respiration, nitrogen metabolism and translocation

Unit IV Microbes -Industrial applications

Quorum sensing in bacteria, understanding microbiome, phytobiomes, dynamics, Applied and ecological aspects of symbioses and pathogen defense, techniques to study plant microbe interaction including microbe tagging, metagenomics and use of organismal databases to identify genes involved in interactions. Industrial application of agriculturally important microbes.

Unit V Resistance- Plant and Microbial Gene Expression

Resistance mechanisms against attack by plant pathogens, gene-for-gene interactions; induced resistance; non-host resistance. Systemic Acquired Resistance (SAR) and Induced Systemic Resistance (ISR), Plant and microbial gene eXpression and signal eXchange, specific regulators for different interactions including transgenic plants. Recognition mechanism and signal transduction during plant – pathogen interaction.

Theory schedule

1. Microbial communities in the soil and atmosphere
2. Community dynamics and population interactions
3. Plant–microbe and microbe-microbe interactions
4. Symbiotic, associative, endophytic and pathogenic interactions
5. Effects of microorganisms on plants
6. Effects of plants on microorganisms
7. Recognition processes and signal eXchange
8. Molecular as pects of Plant Growth Promoting Rhizobacteria (PGPR)
9. Symbiotic diazotrophs: Rhizobia and association with legumes
10. **First test**
11. Mycorrhizal associations: Ectomycorrhizae, Endomycorrhizae withparticular emphasis to AM fungi
12. Ectendomycorrhizae. Biocontrol agents and theiraction
13. Endophytesassociations
14. Enzymes, toXins, pili, siderophores
15. Secretion systems of microbes and plants determining soil health, nutrient availability and uptake defense responses in plants
16. Pamp-triggeredimmunity,effector-triggeredsusceptibility,qualitativeresistance
17. **Mid Semester Examination**
18. r genes, structure and function, effect or-triggered immunity
19. Regulation of plant cell death
20. Plant hormones in immunity
21. Plant parasite interactions and its molecular basis
22. Impactonplantfunctions-photosynthesis,respiration,nitrogenmetabolismandtranslocation
23. Quorumsensing in bacteria, understanding microbiome, phytobiomes and dynamics

24. Applied and ecological as pects of symbioses and pathogen defense
25. Techniques to study plant microbe interaction microbe tagging
26. M etagenomics
27. Use of organic maldata bases to identify genes involved in interactions
28. Industrial application of agriculturally important microbes
29. Resistanceme chainsms against attack by plant pathogens
30. Gene-for-gene interactions
31. Systemic Acquired Resistance(SAR) and Induced Systemic Resistance (ISR),
32. Plant and microbial gene eXpression and signal eXchange
33. Specific regulators for different interactions including transgenic plants.
34. Recognition mechanism and signal transduction during plant – pathogen interaction

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VII CO- PO MATRIX

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7
CO1	-	2	-	-	2	-	-

CO2	-	3	3	-	-	-	-
CO3	3	3	2	-	1	-	-
CO4	3	3	1	-	-	-	3
CO5	3	2	1	-	-	-	3

MBB 606 : RNA Biology (1+0)

Learning Objectives:

- RNA structure and its functional evolution
- RNA genome evolution
- RNA synthesis, processing and regulation
- RNA genome regulation in prokaryotes and eukaryotes
- RNA epigenetic regulation

Theory:

Unit I:

RNA structure, functional evolution: RNA structure, types of RNA and function;

Unit II:

RNA Genome evolution: RNA as genetic material to regulatory molecule, Non Coding RNAs, structure, function and regulation.

Unit III:

RNA synthesis, processing and regulation: transcription and its regulation in prokaryotes and eukaryotes; RNA splicing and editing; Translation and its regulation in prokaryotes and eukaryotes.

Unit IV:

Genome regulation: Prokaryotic - attenuation, ribozymes, aptamers, riboswitches, CRISPER-Cas; eukaryotic- Exon skipping, non sense - mediated decay, RNAi, Long non-coding RNA.

UnitV:

Epigenetic regulation: RNA based gene silencing technologies and their applications for crop improvement.

Lecture schedule:

1. RNA structure.
2. Types of RNA and its function.
3. RNA as genetic material to regulatory molecule.

4. Non Coding RNAs and its structure
5. **First test**
6. Function and regulation of Non Coding RNAs
7. Transcription and its regulation in prokaryotes.
8. Transcription and its regulation in eukaryotes.
9. Mid-Semester Examination
10. RNA splicing and editing.
11. Translation and its regulation in prokaryotes.
12. Translation and its regulation in eukaryotes.
13. Prokaryotic - attenuation, ribozymes,
14. Prokaryotic - aptamers, riboswitches, CRISPER-Cas.
15. Eukaryotic - Exon skipping, nonsense-mediated decay.
16. RNAi, Long non-coding RNA.
17. RNA based gene silencing technologies.
18. The applications of RNA based gene silencing for crop improvement.

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Course Outcome:

At the end of the course students will be able to

1. Understand RNA structure, types and its function
2. Gain knowledge on Non Coding RNAs, structure, function and regulation
3. Gain knowledge on RNA synthesis, processing and regulation
4. Gain expertise on RNA genome regulation in prokaryotes and eukaryotes
5. Expose on RNA based gene silencing technologies and their applications for crop improvement

CO-PO MAPPING MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6

CO1	2		3			3
CO2	1		1			
CO3		1			2	
CO4		1				2
CO5	1	2	1			

MBB 607 : PLANT HORMONES AND SIGNALLING (2+0)

LEARNING OBJECTIVES:

- To provide in-depth knowledge of plant hormone biosynthesis, metabolism and its regulation at molecular level.
- Impart knowledge on functioning of hormones and their role in plant growth and development at cellular level.
- Make them to expertise in analysis of plant hormones using modern techniques.
- To teach the importance of endogenous growth substances other than hormones on senescence and defense mechanism.
- To understand the hormone signalling in plant parasitism and symbiosis.

THEORY

UNIT I : HORMONE BIOSYNTHESIS, METABOLISM AND ITS REGULATION

Auxin biosynthesis and metabolism, Gibberellin biosynthesis and Inactivation, Cytokinin biosynthesis and metabolism, Ethylene biosynthesis, Abscisic acid biosynthesis and metabolism, Brassinosteroid biosynthesis and metabolism. Salicylic acid and jasmonate biosynthesis and metabolism.

UNIT II: FUNCTIONING OF HORMONES IN PLANT GROWTH AND DEVELOPMENT

Transport of Auxins, Induction of vascular tissues by Auxin, Hormones and the regulation of water balance, seed development and germination, Hormonal control of day length and senescence.

UNIT III: ACTION OF HORMONES

Hormones in defense against insects and disease; Role of jasmonates, salicylic acids and peptide hormones for defense, growth, development and reproduction; Methods of plant hormone analysis. NPR 1 dependent Salicylic acid signalling, PAMP and effector triggered immunity, systemic acquired resistance and SA signalling.

UNIT IV: ENDOGENOUS GROWTH SUBSTANCES OTHER THAN HORMONES

Discovery, biosynthetic pathways metabolism and physiological role of Polyamines and Karrikins, Discovery, biosynthetic pathways metabolism and physiological roles of Jasmonates and Tricontanol, Discovery, biosynthetic pathways metabolism and physiological roles of systemins Concept of death hormone, Recent developments in elucidating responses of Salicylic acid, Peptide hormones and Polyamines at physiological and molecular level, Recent developments in elucidating responses of Jasmonates, Systemins, Karrikins and Tricontanol at physiological and molecular level.

UNIT V: HORMONE SIGNAL TRANSDUCTION

Auxin metabolism, transport and signal transduction, Cytokinin types, synthesis, metabolism, transport and signal transduction, Gibberellin biosynthesis, transport, signal transduction in stem elongation & Leaf Growth, Ethylene metabolism, perception and signaling in seedling growth and development, Ethylene signal transduction in fruits and flowers, Abscisic acid metabolism, transport and signal transduction in nuclear gene expression and stomatal responses. Brassinosteroid biosynthesis, catabolism and signal transduction. Strigalactone biosynthesis, transport and signaling in plant parasitism and symbiosis. Methods of Plant Hormone Analysis**:** Quantitative analysis of plant hormones based on LC/MS.

THEORY LECTURE SCHEDULE:

1. Plant hormones - importance – kinds and their role
2. Auxin biosynthesis and metabolism
3. Gibberellins biosynthesis and inactivation
4. Cytokinin biosynthesis and metabolism
5. Brassinosteroid biosynthesis and metabolism
6. Salicylic acid and jasmonate biosynthesis and metabolism
7. Transport of auxin and induction of vascular tissues
8. Hormones and its regulation in water balance, seed development and germination
9. **First test**
10. Hormonal control over day length and senescence
11. Role of hormones in defense mechanism against insects
12. Role of hormones in defense mechanism against diseases
13. Role of jasmonates on growth and development
14. Methods of plant hormone analysis on reproduction
15. NPR 1 dependent salicylic acid signalling
16. PAMP and effector triggered immunity
17. Mid semester Examination
18. Systemic acquired resistance
19. SA signalling at cellular level
20. Biosynthetic pathways metabolism and physiological role of Polyamines and Karrikins
21. Biosynthetic pathways metabolism and physiological role of Jasmonates and Tricantanol
22. Biosynthetic pathways metabolism and physiological role of Peptide hormones and systemins
23. Concept of death hormone
24. Recent developments in elucidating responses of Salicylic acid at physiological and molecular level
25. Recent developments in elucidating responses of peptide hormones at physiological and molecular level
26. Recent developments in elucidating responses of Jasmonates at physiological and molecular level
27. Recent developments in elucidating responses of Systemins at physiological and molecular level
28. Recent developments in elucidating responses of Karrikins at physiological and molecular level
29. Recent developments in elucidating responses of Tricantanol at physiological and molecular level
30. Auxin metabolism, transport and signal transduction
31. Cytokinin types, synthesis, metabolism, transport and signal transduction
32. Ethylene metabolism, perception and signaling in seedling growth and development
33. Abscissic acid metabolism, transport and signal transduction in nuclear gene expression and stomatal responses
34. Plant Hormone Analysis**:** Quantitative analysis of plant hormones based on LC/MS.

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COURSE OUTCOME:

CO 1: Gaining knowledge on importance of biosynthesis and metabolism of plant hormones on growth and development at molecular level

CO 2: To know about the hormonal signalling as defense mechanism against biotic and abiotic stresses at genetic level

CO 3: Help them to understand hormonal influence on various stages of plant development at physiological and cellular level

CO 4: Well known about various hormonal signal transduction in nuclear gene expression during various stages of crop plants

CO 5: Proficiency in assessing and analyzing techniques of plant hormones using innovative methods

CO-PO MAPPING MATRIX

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	2		2			3
CO2	1		1			
CO3		1			2	
CO4		1				2
CO5	3	3	1			

MBB 608 : COMPUTATIONAL AND STATISTICAL TOOLS IN BIOTECHNOLOGY (2+1)

OBJECTIVE

- To impart knowledge on the application of statistical principles to the problems on molecular biology.
- To utilize advanced statistical models to genome analysis.
- To teach of different gene prediction models.
- To in calculate the use of advanced statistical models to gene expression analysis.
- To expose different type of databases and retrieval system.

THEORY

Unit I : Basic molecular biology

Basic molecular biology; introduction to the basic principles of structure/function analysis of biological molecules; genome analysis; different types and classification of genome databases (e.g. HTGS, DNA, Protein, EST, STS, SNPs, Unigenes, etc.)

Unit II : Statistical techniques

Statistical Techniques: MANOVA, Cluster analysis, Discriminant analysis, Principal component analysis, Principal coordinate analysis, Multidimensional scaling.

Unit III : Multiple regression analysis

Multiple regression analysis; Likelihood approach in estimation and testing; Resampling techniques – Bootstrapping and Jack- knifing; Markov Models. Hidden Markov Models, Bayesian estimation and Gibbs sampling

Unit IV: DNA sequence retrieval system

DNA sequence retrieval system, various DNA and protein sequence file formats, Basic concepts of similarity searching and sequence alignments, pair wise and multiple sequence alignments, DNA sequence analysis, different gene prediction models and gene annotation tools,

Unit V : Protein sequence analysis and structure prediction

Protein sequence analysis and structure prediction, comparative genome analysis, phylogenetic analysis, gene expression analysis tools, programming languages and their applications in bioinformatics

PRACTICAL

Different Types of Databases and Database Search and Retrieval - DNA and Protein Sequence Analysis - Similarity Searching and Multiple Alignments - Gene Annotation - Phylogenetic Analysis - Sequence Analysis - Protein Structure Prediction - Analysis of Microarray Data - Programming Languages in Bioinformatics.

THEORY LESSON PLAN

1. Basic molecular biology
2. Structure of major biological molecules
3. Function of major biological molecules
4. DNA replication
5. Protein synthesis
6. Genome analysis
7. Types of classification of genome data basis
8. HTGS, DNA, Protein, EST, STS, SNPs, Unigenes

9. First Test
10. Statistical techniques in molecular biology – MANOVA
11. Cluster analysis
12. Discriminant analysis
13. Principle component analysis - Coordinate analysis
14. Multidimensional scaling - Multiple regression analysis
15. Likelihood approach in estimation testing - Bootstrapping and Jack – knifing
16. Markov Models – Hidden Markov Models
17. Mid Semester Examination
18. Bayesian estimation
19. Gibbs sampling
20. DNA sequence retrieval system
21. Various DNA and protein sequence file formats
22. Basic concepts of similarity searching and sequence alignments
23. Pair wise and multiple sequence alignments
24. DNA sequence analysis
25. Different gene production models
26. Gene annotation tools
27. Protein sequence analysis
28. Protein - Structure prediction
29. Comparative genome analysis
30. Physiological analysis
31. Gene expression
32. Gene analysis tools
33. Programming in bioinformatics languages
34. Applications of bioinformatics in molecular biology

PRACTICAL LESSON PLAN

1. Different Types of Databases
2. Database Search
3. Database Retrieval
4. DNA Sequence
5. DNA Analysis
6. Protein Sequence
7. Protein Analysis
8. Similarity Searching
9. Multiple Alignments
10. Gene Annotation
11. Phylogenetic Analysis
12. Sequence Analysis
13. Protein Structure
14. Protein Prediction

15. Analysis of Microarray Data
16. Programming Languages in Bioinformatics
17. Final Practical Exam

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2. http://Gene annotation.com

3. http://Multiple sequence alignments.com

4. http://Analysis of Microarray Data.com

5. http://Peptide array.com

COURSE OUTCOME

1. Understand the basic molecular biology
2. To know the statistical techniques
3. To study multiple regression analysis
4. Understand the DNA sequence retrieval system
5. To know the protein sequence analysis and structure prediction

CO-PO MATRIX

	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6
CO 1						
CO 2		2	2		1	
CO 3		2	2		1	

CO 4		2	2		1	
CO 5		2	2		1	

COM 601 ADVANCES IN COMPUTING APPLICATIONS (1+1)

Course Objective

- To acquaint the students with open source tool, Latex typesetting language, Python and its usage in the industry

Theory

Unit I Introduction to Latex:

Introduction to Latex – What is Latex – Document Structure, Start Text works, Title, Section, Table of content – Typesetting Text, Font Effects, Coloured Text, Font Size, List, Comments & Spacing, Special Charcters.

Unit II Packages and Classes in Latex:

Inserting Equations – Mathematical Symbols – Table of Content – Generating New Command – Figure handling numbering, List of figure, List of Tables. Packages – Geometry, Hyperref, amsmath, amssymbol – Classes – Article, Book, report - The BibTex file – Inserting Bibliography – Citing – References.

Unit III MS Access:

MSACCESS: Database, concepts and types - Uses of DBMS in Agriculture; creating database.

Unit IV Introduction to Python:

Python Introduction, Technical Strength of Python, Introduction to Python Interpreter and program execution, Using Comments, Literals, Constants, Python's Built-in Data types, Numbers (Integers, Floats, Complex Numbers, Real, Sets), Strings (Slicing, Indexing, Concatenation, other operations on Strings), Accepting input from Console, printing statements, Simple 'Python' programs.

Unit V Using Databases in Python:

Database Programming: Connecting to a database, Creating Tables, INSERT, UPDATE, DELETE and READ operations, Transaction Control, Disconnecting from a database.

Theory Lecture Schedule

1. Introduction to Latex.
2. Document Structure.
3. Classes.
4. Typesetting Text.
5. Inserting Equations
6. Packages and Mathematical Symbols.
7. List of figure.
8. List of Tables.
9. **First Test**
10. Bibliography and References.
11. MS Access Concepts of Database, Creating Database.
12. DBMS in Agriculture.
13. Introduction to Python.
14. Built-in Data types.
15. Strings.
16. Python Console.
17. Database in Python.

Practical Schedule

1. Installation of Latex
2. Basic Latex commands
3. Latex Compilation, Page Layout
4. Building a Latex document, Previewing first.tex
5. Addition of some text in the.tex file, Finding the error and fixing it
6. Type setting of mathematics
7. Writing equations, matrix
8. Two figure next to each other, Formation of table
9. Typesetting with a new chapter heading, List of figures, List of tables
10. Citation, Bibliography, printing your document
11. MSACCESS: Creating Database, preparing queries and reports
12. MSACCESS: Demonstration of Agri-information system
13. Introduction to Python, Working with Data
14. Program Organization, Functions, and Modules, Classes and Objects
15. Inside the Python Object System
16. Testing, Debugging, and Software Development Practice
17. Packages

Course Outcome

CO 1: Problem solving and programming capability
CO 2: Analyse common problems using Latex
CO 3: Learn categories of programs
CO 4: Construct and execute basic programs in Python
CO 5: Use external libraries and packages with Python

CO-PO Mapping Matrix

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	3	3	1	1	2
CO 2	3	3	2	1	2
CO 3	3	3	2	2	3
CO 4	3	3	2	3	3
CO 5	3	3	2	3	3

Suggested Reading

1. Introduction to Latex by Tobias Oetiker
2. LaTeX: A Document Preparation System, 2nd Edition By Leslie Lamport
3. Charles Dierbach, "Introduction to Computer Science using Python", Wiley, 2015
4. Python Programming- A modular Approach (with Graphics, database, Mobile and Web Applications by Sheetal Taneja and Naveen Kumar, Pearson.
5. Head First Python by Paul Berry, O'Reilly

E-Resources

1. https://www.overleaf.com/learn/latex/Bibliography_management_with_bibtex
2. https://en.wikibooks.org/wiki/LaTeX/Bibliography_Management.
3. https://wiki.python.org/moin/PythonBooks.
4. https://devfreebooks.github.io/python/
5. https://www.digitalocean.com/community/books/digitalocean-ebook-how-to-code-in-python.

STA 601 ADVANCES IN DESIGN OF EXPERIMENTS (2+1)

Course Objective

- To acquaint the students to understand the concepts of statistical hypothesis, design of experiments, statistical methods, data collection, analysis and interpretation of results and to acquire Multivariate Statistical Analysis skills.

Theory

Unit–I: Sampling Techniques

Concept of sampling: Sampling vs complete enumeration. Planning of sample survey. Sampling from a finite population. Simple random sampling. Inverse sampling. Stratified sampling. Cluster sampling. Systematic sampling. Multistage sampling. Double sampling. Ratio and regression method of estimation. Non-sampling errors. Concept and levels of measurement. Non-parametric tests - Sign, Wilcoxon, Mann-Whitney U-test, Wald Wolfowitz run test, Run test for the randomness of a sequence. Median test, Kruskal- Wallis test, Friedman two-way ANOVA by ranks. Kendall's coefficient of concordance.

Unit–II: Statistical Methods

Classification, tabulation and graphical representation of data. Descriptive statistics. Theory of probability. Random variable and mathematical expectation. Box-plot. Probability distributions: Binomial, Poisson, Negative binomial, Normal distributions and their applications. Concept of sampling distribution: t, chi-square and F distributions. Tests of significance based on normal, t, chi-square and F distributions.

Unit–III: Correlation and Regression Analysis

Correlation, Rank correlation, Correlation ratio, Intra-class correlation. Test of significance of correlation coefficient. Coefficient of determination.- Path analysis - Regression analysis, Partial and multiple correlation and regression. Estimation of parameters. Predicted values and residuals. Introduction to multivariate analytical tools. Test of hypothesis on means, Multivariate analysis of variance and covariance, Cluster analysis, Classification by linear discriminant function, Canonical correlations, Principal components, Factor analysis, multi-dimensional scaling and Correspondence Analysis. Hierarchical clustering. Principal component analysis.

Unit–IV: Experimental Designs

Need for design of experiments, characteristics of a good design. Basic principles of designs - randomization, replication and local control. Uniformity trials, size and shape of plots and blocks; Analysis of variance and covariance; partitioning of degrees of freedom - Completely randomized design, randomized block design and Latin square design.

Unit–V: Factorial Experiments

Factorial experiments : Layout and analysis of factorial experiments – complete block design – split – plot design : strip-plot design : split split –plot design. Resolvable block designs and their applications. Randomization procedure, analysis and interpretation of results. Analysis of covariance. Missing plot technique and its application to RBD, LSD. Factorial experiments (symmetrical as well as asymmetrical). Factorial experiments with control treatment. Groups

of experiments. Transformation of data. Current trends in design of Experiments.

Practical

Exploratory data analysis, Box-Cox plots; Fitting of distributions ~ Binomial, Poisson, Negative Binomial, Normal; Large sample tests, Testing of hypothesis based on exact sampling distributions ~ chi square, t and F. Confidence interval. Estimation and point estimation of parameters of Binomial, Poisson and Normal distribution. Correlation and regression analysis. Fitting of orthogonal polynomial regression. Applications of dimensionality reduction and Discriminant function analysis. Non-parametric tests. Analysis of data obtained from CRD, RBD, LSD. Analysis of Covariance, Analysis of factorial experiments without and with confounding, Analysis with missing data. Split plot and strip plot designs. Groups of experiments, Transformation of data. Exercises on various Non-parametric tests; Random sampling, Use of random number tables, Simple random sampling, Determination of sample size, Exercises on Inverse sampling, Stratified sampling, Cluster sampling and Systematic sampling, Estimation using Ratio and regression estimators, Estimation using Multistage design and Double sampling.

Theory Lecture Schedule

1. Classification, tabulation and graphical representation of data.
2. Descriptive statistics.
3. Theory of probability. Random variable and mathematical expectation.
4. Box-plot. Probability distributions: Binomial, Poisson, Negative binomial.
5. Normal distributions and their applications.
6. Concept of sampling distribution: t, chi-square and F distributions.
7. Tests of significance based on normal, t, chi-square and F distributions.
8. Correlation, Rank correlation, Correlation ratio.
9. Intra-class correlation. Test of significance of correlation coefficient.
10. Coefficient of determination.
11. Path analysis.
12. Regression analysis.
13. Partial and multiple correlation and regression.
14. Estimation of parameters. Predicted values and residuals.
15. Introduction to multivariate analytical tools.
16. Test of hypothesis on means, Multivariate analysis of variance and covariance.
17. **First Test**
18. Cluster analysis, Classification by linear discriminant function.
19. Canonical correlations, Principal components.
20. Factor analysis, multi- dimensional scaling and Correspondence Analysis.
21. Hierarchical clustering.
22. Principal component analysis.
23. Need for design of experiments, characteristics of a good design.
24. Basic principles of designs - randomization, replication and local control.
25. Uniformity trials, size and shape of plots and blocks; Analysis of variance and covariance; partitioning of degrees of freedom.
26. Completely randomized design, randomized block design and Latin square design.
27. Factorial experiments: Layout and analysis of factorial experiments.
28. Complete block design – split – plot design.
29. Strip-plot design: split split –plot design.
30. Resolvable block designs and their applications.
31. Randomization procedure, analysis and interpretation of results.
32. Analysis of covariance. Missing plot technique and its application to RBD, LSD.
33. Factorial experiments (symmetrical as well as asymmetrical).
34. Factorial experiments with control treatment. Groups of experiments. Transformation of data.

PRACTICAL SCHEDULE

1. Exploratory data analysis, Box-Cox plots; Fitting of distributions ~ Binomial, Poisson, Negative Binomial, Normal; Large sample tests.
2. Testing of hypothesis based on exact sampling distributions ~ chi square, t and F. Confidence interval.
3. Estimation and point estimation of parameters of Binomial, Poisson and Normal distribution.
4. Correlation and regression analysis.
5. Fitting of orthogonal polynomial regression.
6. Applications of dimensionality reduction and Discriminant function analysis. Non-parametric tests.
7. Analysis of data obtained from CRD, RBD, LSD.
8. Analysis of Covariance.
9. Analysis of factorial experiments without and with confounding, Analysis with missing data.
10. Split plot and strip plot designs. Groups of experiments, Transformation of data.
11. Exercises on various Non-parametric tests.
12. Random sampling, Use of random number tables, Simple random sampling, Determination of sample size.
13. Exercises on Inverse sampling, Stratified sampling.
14. Cluster sampling and Systematic sampling.
15. Estimation using Ratio and regression estimators.
16. Estimation using Multistage design and Double sampling.
17. Practical Examination.

Course Outcome

CO 1: Gaining knowledge on basic and recent concepts of statistical methods
CO 2: Proficiency in data Collection, analysis and interpretation of results
CO 3: Understanding the testing of statistical hypothesis
CO 4: Knowledge on multivariate statistical analysis
CO 5: Design of experiments in agricultural field and data for analysis

CO – PO Mapping Matrix

CO / PO	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	3	3	1	1	1
CO 2	3	3	2	1	2
CO 3	3	3	2	1	2
CO 4	3	3	1	1	3
CO 5	3	3	1	1	2

Suggested Reading

1. Agarwal, B. L. 2003, Basic Statistics, New Age International. New Delhi.
2. Anderson, T.W. 1958. *An Introduction to Multivariate Statistical Analysis.* John Wiley, New Delhi.
3. Bansil, P.C. 2002. *Agrl. Statistics*. CBS Publishers. New Delhi.
4. Box, G.E.P., Jenkins, G.M. and Reinsel, G.C. 1994. *Time Series Analysis: Forecasting and Control*. Pearson Education, Delhi.
5. Campbell, R.A. 1974. *Statistics for Biologists.* Cambridge University Press. New York.
6. Cochran, W.G. and Cox, G.M. 1957. *Experimental Design.* John Wiley and Sons Inc. New York.
7. Das, M. N. and Giri, N.C. 1986. *Design and Analysis of Experiments.* New Age International. New Delhi
8. Federer, W.T. 2002. *Statistical Design and Analysis of Intercropping Experiments.* Springer-Verlag. New York
9. Gomez and Gomez. 1984. *Statistical procedure for Agrl. Research.* Wiley-interscience. New York

10. Gupta, S.P. 2004, Statistical Methods, S. Chand and Sons. New Delhi. Singh R and Mangat N.S. 1996. *Elements of Survey Sampling*. Kluwer Academic Publishers.

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