ANNAMALAI UNIVERSITY
FACULTY OF AGRICULTURE
COMMON REGULATIONS FOR ALL M.SC. (AGRICULTURE/HORTICULTURE) AND MBA (AGRI. BUSINESS MANAGEMENT) PROGRAMMES OFFERED BY THE FACULTY OF AGRICULTURE
(with effect from 2022-2023)

1. Short title and commencement

These rules and regulations shall govern the post graduate studies leading to the award of degree of Master of Science (Agriculture/Horticulture) and MBA (Agri. Business Management) in the Faculty of Agriculture.

They shall come into force with effect from the academic year 2022 – 2023.

Academic Year and Registration

- An academic year shall be normally from July to June of the following calendar year otherwise required under special situations. It shall be divided into two academic terms known as semesters. The Academic Calendar will be developed by the University from time to time and notified accordingly by the Registrar in advance.
- An orientation programme shall be organized by the Dean, Faculty of Agriculture for the benefit of the newly admitted students immediately after commencement of the semester.
- On successful completion of a semester, the continuing students shall register for subsequent semester on the date specified in the Academic/ Semester Calendar or specifically notified separately. Every enrolled student shall be required to register at the beginning of each semester till the completion of his/ her degree programmes.

Registration Cards

- A student shall register the courses offered in a semester by writing all the courses in registration card in quadruplicate.
- The Chairman, PG 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 Head of the Department, Chairman and the student concerned.
- The list of courses registered by the students in each semester shall be sent by the Dean to the Controller of Examinations/University for preparation of Report Cards

2. Definitions

2.1 An "academic year" shall consist of two semesters.

2.2 "Semester" means an academic term consisting of 110 working days including final theory examinations.

2.3 "Subject" means a unit of instruction to be covered in a semester having specific No., title and credits.

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

2.5 "Grade Point of a subject" means the value obtained by dividing the percentage of marks earned in a subject by 10 and the Grade Point is expressed on a 10 points scale.

2.6 "Credit Point" means the grade point multiplied by credit hours.

2.7 "Grade Point Average" (GPA) means the quotient of the total credit points obtained by a student in various subjects 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 points scale and the GPA has to be corrected to two decimals.

2.8 "Overall Grade Point Average" (OGPA) means the quotient of cumulative credit points obtained by a student in all the subjects 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.

3. Courses offered

The details of various post-graduate degree programme at Masters' level offered in the Faculty of Agriculture are as follows:

- ✓ Agronomy
- ✓ Entomology
- ✓ Agricultural Microbiology
- ✓ Genetics and Plant Breeding
- ✓ Seed Science and Technology
- ✓ Plant Molecular biology and Biotechnology
- ✓ Horticulture -
  - ➢ Fruit Science
  - ➢ Vegetable Science
  - ➢ Floriculture and Landscape Architecture
- ✓ Plantation, Spices, Medicinal and Aromatic Crops
- ✓ Plant Pathology
- ✓ Soil Science and Agricultural Chemistry
- ✓ Agricultural Extension
- ✓ Agricultural Economics
- ✓ M.B.A (Agri. Business Management)

4. Eligibility for admission

Candidates for admission to the M.Sc. (Ag./Hort.) programme should satisfy the following requirements.

4.1. Candidates seeking admission to the M.Sc. (Ag./Hort.) Degree programme should have completed any one of the following four year degree programme from Faculty of Agriculture, Annamalai university or Universities/colleges accredited with ICAR, New Delhi.

I. **For M.Sc. (Ag.) Agronomy**

Eligibility: B.Sc. (Hons.) Agriculture / B.Sc. (Ag.) courses of four years duration.

- **For M.Sc. (Ag.) Entomology, Genetics and Plant Breeding, Plant Pathology, Soil Science and Agricultural Chemistry, Seed Science and Technology, Plant Molecular biology and Biotechnology, Agricultural Microbiology, Agricultural Extension, Agricultural Economics and M.B.A (Agri. Business Management)**

  Eligibility: B.Sc. (Hons.) Agriculture / B.Sc. (Hons.) Horticulture/B.Sc. (Ag.)/B.Sc. (Hort.) of four years duration.
- **For M.Sc. (Hort.)**

  Eligibility: B.Sc. (Hons.) Agriculture / B.Sc. (Hons.) Horticulture/ B.Sc. (Hort.) and B.Sc. (Ag.) courses of four years duration.

4.2. Candidates who have undergone the programme under conventional system should possess not less than a second class Bachelor's degree. The candidates under 4point grade systems should possess a minimum OGPA of 2.5 out of 4.00 and 2.75 out of 4.00 in the subject concerned. For those under 10point system a minimum OGPA of 6.50 out of 10.00 and 7.00 out of 10.00 in the subject concerned is required. However, for SC/ST candidates OGPA of 6.75 out of 10.00 in the subject concerned is sufficient.

4.3. An entrance test will be held separately for each Degree programme. Selection of candidates shall be based on OGPA, Subject OGPA, Entrance Test and Interview.

4.4. A student can apply to a maximum of two subjects only.

5.1. Residential requirements

The duration for the M.Sc. (Agriculture/Horticulture) and MBA programme will be of two years with four semesters. A student registered for M.Sc. (Agriculture /Horticulture) programme should complete the course within five Academic year from the date of his/her admission.

In case a student fails to complete the degree programme within the maximum duration of residential requirement, his/ her admission shall stand cancelled. The requirement shall be treated

as satisfactory in the cases in which a student submits his/ her thesis any time during the 4th semester of his/ her residentship at the University.

5.2 Credit Grade Point Requirements

A student enrolled for the Master's degree programme to earn eligibility for the degree is required to complete 70 credits as detailed below.

Course work	
Major Courses	20
Minor Courses	08
Supporting Courses	06
Common Courses	0**5**
Seminar	01
Thesis Research	30
Total credits	**70**

Major courses: From the Discipline in which a student takes admission. Among the listed courses, the core courses compulsorily to be taken will be given *mark

Minor courses: From the courses closely related to a student's major subject chosen by the students in consultation with the Head of the department and the Chairman based on their research specialization.

Supporting courses: The subjects not related to the major subject. It could be any subject considered relevant for student's research work (such as Statistical Methods, Design of Experiments, etc.) or necessary for building his/ her overall competence.

a. List of supporting courses for M.Sc. (Ag.) Agronomy, Agricultural Entomology, Genetics and Plant Breeding, Plant Pathology, Soil Science and Agricultural Chemistry, Seed Science and Technology, Plant Molecular biology and Biotechnology, Agricultural Microbiology and Horticulture are

STA 501 -Statistical Methods for Applied Sciences	3 (2+1)
COM 501 - Information Technology in Agriculture	3 (2+1)

b. List of supporting courses for M.Sc. (Ag.) Agricultural Extension, Agricultural Economics and M.B.A (Agri. Business Management)

STA 502 -Statistical Methods for social Sciences	3 (2+1)
COM 501 -Information Technology in Agriculture	3 (2+1)

Common Courses: The following courses (one credit each) will be offered to all students undergoing Master's degree programme:

1. PGS 501 - Agricultural Research, Research Ethics and Rural Development Programmes (1+0)
2. PGS 502 - Technical Writing and Communications Skills (1+0)
3. PGS 503 - Basic Concepts in Laboratory Techniques (0+1)
4. PGS 504 - Library and Information Services (1+0)
5. PGS 505 - Intellectual Property and its management in Agriculture (1+0)

Some of these courses are already in the form of e-courses/ MOOCs. The students may be allowed to register these courses/ similar courses on these aspects, if available online on SWAYAM or any other platform. If a student has already completed any of these courses during UG, he/ she may be permitted to register for other related courses with the prior approval of the Head of Department (HOD)/ Board of Studies (BoS).

5.4. Minimum Grade point requirement

A post graduate student should maintain a minimum Grade Point of 6.50 out of 10 to secure a pass in a subject. In the subjects in which a student fails, he/she has to reappear for the examination to get a pass in that subject.

6. Attendance requirement

6.1. One hundred per cent attendance is expected of each student. A student, who fails to secure a minimum of **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 will be required to repeat the subject when ever offered.

In case of new admission, who are permitted to join late due to administrative reasons, the attendance will be calculated from the date of joining of the student. However, for genuine reasons, condonation of attendance deficiency may be considered by the Vice-Chancellor on the recommendation of the Head of the Department and the Dean, Faculty of Agriculture on payment of condonation fee prescribed by the University.

6.2 Students absenting from the classes with prior permission of the Head of the Department/Dean, Faculty of Agriculture on official University business shall be given due consideration in computing attendance.

7. Advisory Committee

7.1. Each post-graduate student shall have an Advisory Committee to guide him/her in carrying out the research programme. The Advisory Committee shall comprise a Major Adviser (Chairman) and two members. Of the two members, one will be from the same Department and the other in the related field from the other Departments of Faculty of Agriculture. The Advisory Committee shall be constituted within three weeks from the date of commencement of the first semester.

7.2 For interdisciplinary research requiring expertise from teaching staff of other faculties, due permission need to be obtained from the Dean, Faculty of Agriculture to nominate them as Technical advisors. An official letter in this regard needs to be communicated to the individual concerned. However, they are restrained from the evaluation of Research/Seminar evaluation.

7.3. **Major Adviser (Chairman)**

Every student shall have a Major Adviser who will be from his/her major field of studies. The appointment of Major Adviser (Chairman) shall be made by the Head of the Department concerned. The chairman in consultation with the Head of the Department will nominate the other two members. In the event of the Major Adviser being away on other duty/leave for a period of more than three months, the member of the Advisory Committee from the same Department will officiate as the Major Adviser.

Advisor/ Co-guide/ Member, Advisory Committee from other collaborating University/ Institute/ Organization

• In order to promote quality Post-graduate research and training in cutting edge areas, the University will enter into Memorandum of Understanding (MOU) with other Universities/ Institutions for conducting research. While constituting an Advisory Committee of a student, if the Chairperson, Advisory Committee feels the requirement of involving of a faculty member/ scientist of such partnering university/ Institute/ Organization, he/ she may send a proposal to this effect to the Dean, Faculty of Agriculture along with the proposal for consideration of Student's Advisory Committee.

• The proposed faculty member from the partnering institution can be allowed to act as Chairperson/ Co-guide/ Member, SAC, by mutual consent, primarily on the basis of intellectual input and time devoted for carrying out the research work at the particular institution.

Allotment of students to the retiring persons

Normally, retiring faculty may not be allotted with M. Sc. Student if he/ she is left with less than 2 years of service.

Changes in the Advisory Committee:

i. Change of the Chairperson or any member of the Advisory Committee is not ordinarily permissible. However, in exceptional cases, the change may be effected with due approval of the Dean, faculty of Agriculture.

ii. Normally, staff members of the university on extra ordinary leave or on study leave or who leave the University service will cease to continue to serve as advisors of the Post-graduate

students of the University. However, the Dean, faculty of Agriculture may permit them to continue to serve as advisor subject to the following conditions:

a) The concerned staff member must be resident in India and if he/ she agrees to guide research and must be available for occasional consultations;
b) An application is made by the student concerned duly supported by the Advisory Committee;
c) The Head of the Department and the Dean, Faculty of Agriculture agree to the proposal;

iii. In case the Chairperson/ member of Advisory Committee retires, he/ she shall be allowed to continue provided that the student has completed his course work and minimum of 10 research credits and the retiring Chairperson/ member stays at the Headquarters of the College, till the thesis is submitted.

iv. The change shall be communicated to all concerned by the Head of Department.

Guidelines on the duties of the advisory committee

1. Guiding students in drawing the outline of research work
1. Guidance throughout the programme of study of the students.
2. Evaluation of research and seminar credits.
3. Correction and finalization of thesis draft.
4. Conduct of final Viva-Voce examination.
5. The proceedings of the Advisory Committee will be sent to the Head of the Department concerned within 10 working days.
6. Periodical review of the Advisory Committee proceedings will be made by the Head of the Department concerned.

8. Programme of study

8.1 The student's plan for the post-graduate work, drawn up by the Advisory Committee, shall be finalized before the end of the first semester.

8.2 The programme shall be planned by the Advisory Committee taking into account his/her previous academic training and interest.

8.3 Programme of research work

The outline of research work of the student, in the prescribed manner and as approved by the Advisory Committee, shall be forwarded by the Chairman to the Head of the Department concerned by the end of the first semester.

9. EVALUATION OF STUDENTS' PERFORMANCE

Multiple levels of evaluation (First Test, Midterm and Final semester) will be conducted

9.1 First Test (FT) and Mid-semester examination (MSE)

9.1.1 Every teacher handling a subject shall conduct first Test (FT) as per the scheme drawn by the Head of the Department concerned /PG coordinator on the fourth week from the date of registration of the course, and evaluate. The evaluation process will be based on objective type questions and short concepts.

9.1.2Every teacher handling a subject shall conduct Mid-Semester Examination (MSE) as per the scheme drawn by the Head of the Department concerned /PG coordinator, on the sixth week from the date of registration of the course and evaluate. The evaluation process will be of descriptive type**.**

9.1.3 The answer scripts of both FT and MSE will be shown to the student after valuation, and returned to the course teacher. The Head of the Department will be responsible to ensure the distribution of answer papers to the students. The marks obtained by the students should be sent to the Controller of Examinations through the Head of the Department concerned within fifteen working days.

9.1.4. Writing the first test and mid-semester examination is a pre-requisite for writing the final theory and practical examinations. If a student does not appear for FT/MSE, he/she is not eligible to appear for the final examinations. Such candidate has to reappear for the FT/MSE as and when

the respective examinations are conducted only after getting permission from the Head of the Department concerned.

9.1.5 The FT and MSE marks will not be shown separately in the grade sheet but will be combined with the respective final theory and practical marks. FT and MSE marks awarded in a course will be added to the supplementary examinations also.

9.1.6 The FT and MSE marks will be furnished to the Head of the Department within 10 days after the conduct of Ft and MSE. If the student is not satisfied with the award of the marks, he/she shall appeal to the Dean, through Head of the Department within three working days after the announcement of marks. The appeal will be considered and the results reviewed by a Cell consisting of the Dean and the Head of the Department concerned. The decision of the Review Cell shall be final. If the Head of the Department himself is the course teacher, one senior member of the department concerned shall be nominated by the Dean.

9.1.7 The first test will be of 30 minutes duration and MSE of theory will be of one hour duration.

9.1.8 If the student is not able to write the FT/ MSE due to deputation by the University, he/she may be permitted to take up missing FT/MSE. Such examination should be completed ordinarily within 15 working days after the respective Ft/MSE.

9.1.9 A student who fails to attend a first test and mid-semester examination due to unavoidable circumstances shall be permitted with prior approval of the head of the Department to take up missing examination of the particular course. Such tests should be completed ordinarily within 15 working days after the respective FT/MSE.

The distribution of marks will be as indicated below.

Test	Subjects with Practical	Subjects without Practical	Subjects without Theory
First test	10	20	30
Mid-Semester	20	30	30
Final theory	30	50	-
Final practical	40	-	50
Total	**100**	**100**	**100**

The question paper model and distribution of marks for Mid Semester examinations is as follows.

First Test (30 minutes duration) (Total Marks: 10)

1. Objective Type	10 out of 12	10 x 0.5 marks	5 Marks
2.Definitions/ Short Concepts	5 out of 7	5 x 1 marks	5 Marks

Mid-semester examination

For Subjects with practicals (One hour duration) (Total marks: 20)

1. Objective Type	10 out of 12	10 x 0.5 marks	5 Marks
2.Definitions/ Concepts	5 out of 7	5 x 1 marks	5 Marks
3. Short Notes	2 out of 3	2 x 2 ½ marks	5 Marks
4. Essay Type	1 out of 2	1 x 5 marks	5 Marks

For Subjects without practicals (One hour duration) (Total marks: 30)

1. Objective Type	10 out of 12	10 x 0.5	5 Marks
2.Definitions/Concepts	5 out of 7	5 x 1	5 Marks
3. Short Notes	4 out of 5	4 x 2 ½	10 Marks
4. Essay Type	2 out of 3	2 x 5	10 Marks

9.2. Final examinations

9.2.1. The final theory and practical examinations will be of two and a half hours duration each conducted separately by the University.

9.2.2. The final theory and practical examinations will be evaluated by respective course teacher)

9.2.3. The question papers for the final theory examinations will be set by the external examiners.

The question paper model and distribution of marks for final theory examinations are as follows.

Final theory examination

For subjects with practical (2½ hour duration) (Total marks: 30)

1. Definitions	5 out of 7	5 x 1 marks	5 marks
2. Short Notes	2 out of 3	2 x 2½ marks	5 marks
3. Essay Type	Either or type (one question from each unit)	5 x 4 marks	20 marks

For subjects without practical (2½ hour duration) (Total marks: 50)

1. Definitions	6 out of 8	6 x 1 marks	6 marks
2. Short Notes	3 out of 5	3 x 3 marks	9 marks
3. Essay Type	Either or type (one question from each unit)	5 x 7 marks	35 marks

9.2.4**. Practical Examination**

Practical examinations will be conducted in the last practical class. Proper maintenance and regular submission of practical records are required. Those who do not bring with them the certified practical records/ specimen collection/ assignments will not be allowed to appear for the practical examination. The marks awarded for specimen collection and assignments shall be noted in the record, at the time of first appearance and will be taken into account for subsequent appearances.

9.2.5. Assignment

Each student will be assigned a topic by the concerned course teacher. Such topic should cover a wide range of topics within the subject limits. The topic should be different from that of the credit seminar. Assignments will be evaluated during practical examination.

The distribution of marks for final practical examination for courses with theory and practical and only practical is as follows:

S. No.	Particulars	Courses with theory and practical	Courses only with practical
1	Practical part	25	55
2	Assignment/specimen collection	5	5
3	Record	5	5
4	Viva voce	5	5
Total		40	70

The pattern of practical part should be uniform in each department

9.3. GRADING

The student should secure 60 per cent marks separately in theory and practical and 65 per cent marks in aggregate to secure a pass in the subject. Students who secure marks below 65 per cent in a subject will be treated as Re-appearance (RA).

Each subject shall carry a maximum of 100 marks for purpose of grading. The grading shall be done as grade point, i.e., the percentage of marks earned in a subject is divided by ten. The grade point is expressed on 10 points scale up to two decimals.

The reappearance examinations for the candidates who fail in a subject or subjects will be held in the subsequent semester.

Students who did not fulfill the required minimum attendance of **80 per cent** will be awarded 'E' grade and has to repeat the subject.

9.4. Class / Percentage ranking

In calculation of percentage and class equivalent for OGPA the following classification shall be adopted.

OGPA	Percentage	Class
9.00 and above	90 and above	Distinction
8.00 to 8.99	80.00 to 89.99	I Class
7.00 to 7.99	70.00 to 79.99	II Class

6.50 to 6.99	65.00 to 69.99	Pass

10. Credit Seminar

Seminar is compulsory for all the students and each student should present a seminar of 0+1 credit in the third semester.

10.1 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 Chairman of the Advisory Committee in consultation with the Head of the Department concerned within 2 weeks after the commencement of the semester.

10.2. Under the guidance and supervision of the Chairman of the Advisory Committee, the student will prepare the seminar paper after reviewing all the available literature and present the seminar 2 weeks after completion of Mid-Semester Examination in the presence of the Head of the Department, Advisory Committee, staff members and PG students.

10.3. The circular on the seminars by the post-graduate students shall be sent to other Departments to enable those interested to attend the same.

10.4. The Chairman will monitor the progress of the preparation of the seminar paper and correct the manuscript containing not less than 25 typed/printed pages with a minimum number of 50 references covering the recent 10 years time. The student will submit 2 copies of the corrected manuscript to the Head of the Department concerned through the Chairman before presentation.

The student will incorporate suggestions and carry out corrections made during the presentation and resubmit three fair copies to the Head of the Department concerned through the Chairman (one copy each to Dept. Library, Chairman and the student) within 10 days after presentation.

10.5 The performance of the student has to be evaluated for 100 marks and Grade Point will be awarded by Advisory Committee. The Grade Point may be given based on the following norms.

Coverage of Literature	40
Presentation	30
Use of Audio–Visual Aids	10
Capacity to Participate in the discussion and answer the Questions	20
Total	**100**

11. Absence of advisory committee member during final viva-voce examination:

11.1. Conducting final viva voce examination in the absence of advisory committee members is not allowed.

11.2. Under extra-ordinary circumstances if the final viva-voce examination to postgraduate student has to be conducted in the absence of one or two advisory committee members, permission to conduct the examination by co-opting another member in such contingencies should be obtained from the Dean in advance through the Head of the Department. The Chairman of the advisory committee in consultation with the concerned member and Head of the Department will co-opt another member.

11.3.The co-opted member should be from the same department of the member who is not attending the examinations.

11.4. In the absence of the Chairman of advisory committee, respective Heads of Departments should act as Co-chairman with prior permission of Dean.

12. Research Work

12.1. The topic of thesis research to be carried out by the student will be assigned by the Chairman of the Advisory Committee in consultation with the Head of the Department concerned. After assigning the topic, each student may be instructed 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 programme may be given to the

student for carrying out the work during the semester in the prescribed proforma. The evaluation of research work done by the student should be based on the approved programme.

12.2. The distribution of research credits will be as follows:

I Semester	0+2
II Semester	0+6
III Semester	0+10
IV Semester	0+ 12*
Total	**0+30**

*** In the fourth semester out of 12 credits, 8 credits will be for evaluation of research and remaining 4 credits for evaluation of viva voce.**

13. Evaluation of Thesis Research

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

13.2. The student has to submit his/her research observation note book to the major Adviser.The major Adviser 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.

13.3. After completion of 80% attendance for research and on or before the last day of the semester, the advisory committee should evaluate the progress of research work as per the approved programme and monitoring register and award **SATISFACTORY OR UNSATISFACTORY** depending upon quantity and quality of work done by the student during the semester.

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

Situation - I

The students have completed the research credits as per the approved program and awarded **'SATISFACTORY'** by the advisory committee. Under the said situation the student can be permitted to register fresh credits in the subsequent semester. If the student is awarded **'UNSATISFACTORY'** he/she has to register afresh the same block of the research credits in the subsequent semester.

Situation - II

The student who does not satisfy the required **80 per cent** attendance shall be awarded grade 'E'.

Situation-III

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

- Failure of crop
- Non-Incidence of pests or diseases or lack of such experimental conditions
- Non-availability of treatment materials like planting materials chemicals etc.
- Any other impeding/ unfavorable situation for satisfying the advisory committee
- Under the situations (II&III) grade 'E' should be awarded. The student has to re-register the same block of research credits for which 'E' grade was awarded in the following semester. The student should not be allowed to register for fresh (first time) research credits.
- In the mark sheet, it should be mentioned that 'E' grade was awarded due to lack of attendance or want for favorable conditions.

Situation – IV

The student who fails to complete the research work after repeating the registration for the second time will be awarded ' **Unsatisfactory'**.

- For the registration of research credits for the third time permission has to be obtained from the Dean of the Faculty and permission for further registration for the fourth time has to be obtained from the University.
- Re-registration of further research credits shall be decided by the University based on the recommendation of the Advisory Committee, Head of the Department concerned and the Dean, Faculty of Agriculture.

Situation -V

If a student could not complete qualifying examination till the end of the final semester/grace period, 'E' grade should be awarded for the final block of the research credits registered in the final semester. He/She has to re-register the same block of research credits in the next semester and attend the qualifying examination when conducted by the Controller of Examinations.

14. Submission of Thesis

14.1. The thesis for his/her Master's degree should be of such a nature as to indicate a student's potentialities for conduct of independent research. The thesis shall be on topic falling within the field of the major subject and shall be the result of the student's own work. A certificate to this effect duly endorsed by the Major Adviser (Chairman) shall accompany the thesis.

14.2 The research credits registered in the last semester of post graduate programmes should be evaluated only at the time of the submission of thesis, by the advisory committee. Students can submit the thesis at the end of the final semester. If a post graduate student has completed the thesis before the closure of the final semester, the chairman can convene the advisory committee meeting and take decision on the submission of thesis provided the student satisfies 80 per cent attendance requirement. Two copies of the thesis should be submitted in paper pack for evaluation to the HOD.

14.3 The thesis shall contain a certificate from the supervisor 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, Associateship, Fellowship or similar title. A statement from the supervisor indicating the extent to which the thesis represents independent work on the part of the candidate should also be made including free from plagiarism above the specified level.

14.4 The thesis shall also contain a declaration by the candidate that the work reported in the thesis has been carried out by the candidate himself/herself and that the material from other sources, if any, is duly acknowledged and no part of the thesis is plagiarized **more than 25 %.**

15. Grace period

15.1 Students can avail a grace period up to a month for submission of thesis/project report after the closure of final semester by paying necessary fine as prescribed by the University. If a student is not able to submit the thesis within a month grace period, the student has to re-register the credits in the forthcoming semester. The student (s) who re-register the credits after availing the grace period will not be permitted to avail grace period.

15.2 Based on the recommendation of advisory committee and the Head of the Department, the Dean, can sanction the grace period. A copy of the permission letter along with the receipt for payment of fine as prescribed by the University should accompany the thesis while submission.

16. Submission of thesis after re-registration

The minimum of 80 per cent 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 i.e. 2 years (4 semesters) and completed the minimum credit requirements for getting Degree.

17. Publication of articles

Part of the thesis may also be published in advance with the permission of the HOD. If any part is published the fact should be indicated in the certificate given by the chairman that the work has been published in part/full in the scientific or popular journals, proceedings, etc. The copies are to be enclosed in the thesis at the time of submission.

18. Evaluation of thesis

18.1 The thesis submitted in partial fulfillment of a Master's degree shall be evaluated by an external examiner. The external examiner shall be a specialist in the student's major field of study from outside Annamalai University and shall be appointed by the University as per the recommendation of the Head of the Department.

18.2 The external examiner will send the evaluation report in duplicate one marked to the Controller of Examination and another to the Head of the Department along with the corrected copy of the thesis. If the report is favorable, Viva-Voce will be arranged by the Head of the Department concerned and conducted by the Advisory Committee along with the external examiner. The chairman of the advisory committee shall send the recommendations of the examining committee to the Controller of Examinations through Head of the Department after the student duly carries out the corrections/ suggestions mentioned by the external examiner (a certificate to be enclosed along with the recommendation). On the unanimous recommendation of the committee and with the approval of the University, the degree shall be awarded to the candidate.

18.3 In case of rejection of the thesis by the external examiner the Head of the Department concerned and Advisory Committee refer the thesis for valuation by a second external examiner. If the second external examiner recommends the thesis for acceptance, Viva-Voce will be conducted.

18.4 If the revision of the thesis is recommended for repeating experiments, field trial etc., res-ubmission must be done by the candidate concerned after a minimum of six months. The revised version should be sent to the examiner who recommended revision.

18.5 After incorporating the suggestions of the examiners and those received at the time of viva-voce, two hard bound copies of thesis should be submitted to the Department (one to the scholar and one to the chairperson) and two soft copies in CDs to the University. At the time of final submission, the advisory committee members should certify the corrections and suggestions carried out as indicated by the examiners. However, fellowship holder has to submit a hard bound copy also as per the need, 3 copies of abstract of thesis (in 10-15 lines), 2 copies of the summary of the findings both in Tamil and English and also in C.D. form.

19. Revision of thesis

If an examiner recommends for revision of thesis the following norms will be adopted.

19.1 For revision of draft, the thesis should be resubmitted after a minimum of one month from the date of communication from the controller of examination

19.2 At the time of submission, the advisory committee should give certificate for carrying out the corrections/recommendations. The resubmitted copies of thesis should be got corrected carrying out the necessary corrections indicated by the external examiner and necessary certificates obtained from the chairman and HOD before the conduct of the final viva-voce.

19.3 A fine prescribed by the University to be collected from the students at the time of resubmission of thesis.

20. Failure to appear for final Viva-voce/ Non submission of thesis after viva-voce.

20.1 If a candidate fails to appear before the examining committee for final viva-voce, on the date fixed by the HOD the following are the time frame and penalty.

20.2 The re-viva-voce must be completed within two years. An amount of fine prescribed by the University must be charged to the candidate.

20.3 After successful completion of thesis final viva-voce if a student fails to submit the corrected version of the thesis within 15 days he/she will be levied a fine prescribed by the University at the time of sending the proposal for result declaration

21. Internship during Masters programme

Internship for Development of Entrepreneurship in Agriculture (IDEA)

Currently, a provision of 30 credits for dissertation work in M.Sc. Programme helps practically only those students who aspire to pursue their career in academic/ research. There is hardly any opportunity/ provision under this system to enhance the entrepreneurship skills of those students who could start their own enterprise or have adequate skills to join the industry.

Therefore, in order to overcome this gap, an optional internship/ in-plant training (called as IDEA) in lieu of thesis/ research work is recommended which will give the students an opportunity to have a real-time hands-on experience in the industry.

It is envisaged that the internship/ in-plant training would enhance the interactions between academic organizations and the relevant industry. It would not only enable the development of highly learned and skilled manpower to start their-own enterprises but also the industry would also be benefitted through this process. This pragmatic approach would definitely result in enhanced partnerships between academia and industry.

The main objectives of the programme:

1. To promote the linkages between academia and industry
2. To establish newer University – Cooperative R&D together with industry for knowledge creation, research and commercialization
3. Collaboration between Universities and industries through pilot projects
4. To develop methods for knowledge transfer, innovation and networking potential
5. To enhance skill, career development and employ-ability

Following criteria for IDEA will be taken into consideration:

- At any point of time there will not be more than 50% of students who can opt under IDEA.
- Major Advisor will be from Academia and Co-advisor (or Advisory Committee member) from industry.
- Total credits (30) will be divided into 20 for internship/ in-plant training and 10 for writing the report followed by viva-voce similar to dissertation.
- Work place will be industry; however, academic/ research support would be provided by the University or both. MoU may be developed accordingly.
- The IPR, if any, would be as per the University policy.

22. Result notification

22.1 After the completion of each semester, the student will be given the statement of marks by the Controller of Examinations/

22.2 The transcript will be prepared by Controller of Examinations. The various subjects taken by a student along with the credits and the grade obtained shall be shown on his transcript. Based on the total credits admitted, the final Grade Point Average shall be calculated and given.

23. Award of Medals

Medal should be awarded only if the student is a rank holder and secures at least 8.5 OGPA, clears all courses in first attempt and in the programme having a batch of at least three students.

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MBB M.Sc. (Ag.) Molecular Biology and Biotechnology

Courses with credit load

I) Course work	
Major Courses	**20**
Minor Courses	**08**
Supporting Courses	**06**
Common Courses	**05**
Seminar	**01**
II) Thesis Research / IDEA	**30**
Total credits	**70**

Distribution Pattern of Courses and Credit (For Research Program)

Semester	Major Courses	Minor Courses	Supporting Courses	Common Courses	Seminar	Research	Credit Load
I	8	-	6	2	-	2	18
II	12	-	-	2	-	6	20
III	-	6	-	1	1	10	18
IV	-	2	-	-	-	12	14
Credit Load	**20**	**8**	**6**	**5**	**1**	**30**	**70**

Distribution Pattern of Courses and Credit (For IDEA Program)

Semester	Major Courses	Minor Courses	Supporting Courses	Common Courses	Seminar	IDEA	Credit Load
I	8	-	6	2	-	-	16
II	12	-	-	2	-	-	14
III	-	6	-	1	1	10	18
IV	-	2	-	-	-	10 +10	22
Credit Load	**20**	**8**	**6**	**5**	**1**	**30**	**70**

Distribution Pattern of Courses and Credit

S. No.	Course Code	Course Title	Credit Hours
		Compulsory Major Courses	
1	MBB502*	Fundamentals of molecular biology	3+0
2	MBB503*	Molecular cell biology	3+0
3	MBB504*	Techniques in molecular biology I	0+3
4	MBB505*	Omics and system biology	2+1
		Optional Major Courses	
5	MBB501	Principles of biotechnology	3+0
6	MBB506	Plant genetic engineering	3+0
7	MBB507	Techniques in molecular biology II	3+0
8	MBB508	Introduction to bioinformatics	2+1
9	MBB509	Plant tissue culture	2+1
10	MBB514	Nano biotechnology	2+1
11	MBB518	Gene regulations	2+0
		Minor Courses	
12	MBB510	Microbial and industrial biotechnology	2+1
13	MBB511	Molecular plant breeding	2+1
14	MBB512	IPR, bio-safety and bioethics	2+0
15	MBB513	Immunology and molecular diagnostics	3+0

16	MBB515	Environmental biotechnology	3+0
17	MBB516	Bio-entrepreneurship	1+0
18	MBB517	Stress biology and genomics	2+0
		Supporting Courses	
22	PGS 501	Library and Information Services	0+1
23	PGS 502	Technical Writing and Communications Skills	0+1
24	PGS 503	Intellectual Property and its Management in Agriculture	1+0
25	PGS 504	Basic Concepts in Laboratory Techniques	0+1
26	PGS 505	Agricultural Research, Research Ethics and Rural Development Programme	1+0
27	AGR 591	Master's Seminar	1 (0+1)
28	AGR 599	Research	30

PROGRAMME OUTCOMES (POS)
1. Design, conduct experiments, analyze and interpret data for investigating problems in Biotechnological manipulation.
2. Gaining insight into the most significant molecular methods used today to expand our understanding of biology by utilizing modern equipments and instruments.
3. Comprehensive understanding in formulation and design Tissue culture protocols based on active principle production and confirmation for different agriculturally economic plants and accessibility of different agricultural plant species for genetic transformation
4. Understanding the physiological processes to understand source sink relationship in different groups of plants and also hormonal, environmental and stress physiology in crop plants
5. Suggest and outline solution to theoretical and experimental problems in Genomics and Proteomics fields.

PO and CO Mapping Matrix

AFFINITY LEVELS	
1	**Low**
2	**Moderate/ Medium**
3	**Substantial /High**

SEMESTER WISE DISTRIBUTION OF COURSES (RESEARCH)

Course code	Course Title	Credit hours
	I Semester	
	Major Courses	8
	Supporting Courses	
STA501	Statistical Methods for Applied Sciences	3
COM 501	Information Technology in Agriculture	3
	Common Courses	
PGS 501	Agricultural research, research ethics and rural development programme	1
PGS 502	Technical writing and communications skills	1
AGR 599	**Research**	2
	Total	**18**
	II Semester	
	Major Courses	12
	Common Courses	
PGS 503	Basic Concepts in Laboratory Techniques	1
PGS 504	Library and information services	1
AGR 599	**Research**	6
	Total	**20**
	III Semester	
	Minor courses	6
	Common course	
PGS 505	Intellectual property and its management in agriculture	1
	Disaster Management (1+ 0)	-
	Constitution of India (Contact hour 1+ 0)	-
AGR 591	**Master's Seminar**	1
AGR 599	**Research**	10
	Value Added Course (3+0) (https://annamalaiuniversity.ac.in/studport/value_added_crs.php)	-
		18
	IV Semester	
	Minor course	2
AGR 599	**Research**	12 (8+4)
	Total	**14**

SEMESTER WISE DISTRIBUTION OF COURSES (IDEA)

Course code	Course Title	Credit hours
	I Semester	
	Major Courses	8
	Supporting Courses	
STA501	Statistical Methods for Applied Sciences	3
COM 501	Information Technology in Agriculture	3
	Common Courses	
PGS 501	Agricultural research, research ethics and rural development programme	1
PGS 502	Technical writing and communications skills	1
AGR 599	IDEA	
	Total	**16**
	II Semester	
	Major Courses	12
	Common Courses	
PGS 503	Basic Concepts in Laboratory Techniques	1
PGS 504	Library and information services	1
AGR 599	IDEA	
	Total	**14**
	III Semester	
	Minor courses	6
	Common course	
PGS 505	Intellectual property and its management in agriculture	1
	Disaster Management (1+ 0)	-
	Constitution of India (Contact hour 1+ 0)	-
AGR 591	Master's Seminar	1
AGR 599	IDEA	10
	Value Added Course (3+0) (https://annamalaiuniversity.ac.in/studport/value_added_crs.php)	-
	Total	**18**
	IV Semester	
	Minor course	2
AGR 599	IDEA	20 (10+10)
	Total	**22**

COURSE OBJECTIVES AND OUTCOMES

MBB 501-PRINCIPLES OF BIOTECHNOLOGY (3+0)

Learning Objectives:

- To understand the basics of Molecular biology, plant and microbial Biotechnology
- Importance and applications of genetic engineering in agriculture, case studies and success stories
- To familiarize the students with the various molecular technique, their applications and scope.
- Perceive the student's Molecular marker for species diversification
- Public education, perception, IPR and related issues

Theory

UNIT I: BASICSOFBIOTECHNOLOGY

History, scope and importance of biotechnology - Nucleic acid structure and its function-Modes of DNA replication-Genetic code-Central dogma of life–Transcription-Translation.

UNIT II: RECOMBINANTDNATECHNOLOGY

Recombinant DNA technology-DNA modifying enzymes–Cloning Vectors-Plasmids-cosmids-phagemids-Shuttlevectors-BAC-YAC-HAC-applications.

Gene libraries–Genomic DNA and cDNA; Applications-Nucleic acid hybridization; Methods and Uses, Gene cloning and its applications in basi and applied research.

UNIT III: PCR

Variants of PCR, Molecular markers-PCR and Restriction based markers-applications of molecular markers- DNA sequencing- Sanger-Gilbert techniques-Omics- Genomics-transcriptomics-proteomics and phenomics– Genome editing technologies–Mega nucleases, ZFM, TALEN, CRISPRC as 9, MAGE–Applications and Limitations.

UNIT IV: GENETRANSFER

Gene transfer methods–*Agrobacterium*-mediated gene transfer, direct gene transfer, gene silencing–Principles of QTL and Marker Assisted Selection (MAS) - Achievements-Transgenic plants–Achievements –Current trends.

UNIT V: IPR

Intellectual property rights (IPR) in biotechnology. Bio-safety and bioethics issues - Public perception of biotechnology - Application of biotechnology in Agriculture, Medicine, Animal husbandry, Environmental remediation, Energy production and Forensics.

Theory lesson plan

1. History, scope and importance
2. Nucleic acid structure and its function
3. Modes of DNA replication
4. Central dogma of life,
5. Genetic code
6. Transcription
7. Translation
8. Recombinant DNA technology
9. DNA modifying enzymes
10. Cloning Vectors-Plasmids
11. Cosmids
12. Phagemids
13. **First test**
14. Shuttle vectors

15. BAC
16. YAC
17. HAC applications
18. Gene libraries –Genomic DNA
19. cDNA libraries
20. Nucleic acid hybridization
21. Methods and Uses-Southern blotting
22. Northern Blotting
23. **Mid-term examination**
24. Western Blotting
25. Gene cloning and its applications in basic and applied research
26. PCR amplification and variants
27. RAPD, PFLP
28. AFLP, SSR, ISSR, SNP, CAPS
29. DNA sequencing methods
30. Genetic engineering and transgenic
31. Genomics
32. Transcriptomics
33. Proteomics and Phenomics
34. Genome editing tools-Mega nucleases
35. ZFM, TALEN
36. CRISPRC as 9
37. MAGE–Applications and Limitations
38. *Agrobacterium*-mediated gene transfer
39. Direct gene transfer,
40. Introduction to QTL
41. MAS
42. Transgenic plants: insect resistance,
43. Genetic engineering for virus resistance,
44. Genetic engineering for to fungal /bacterial diseases,
45. Genetic engineering for longer shelf life
46. Intellectual property rights in biotechnology
47. General application of biotechnology in Agriculture
48. Public perception, Bio-safety and bioethics issues
49. Energy production and Forensics
50. Applications of biotechnology.

Course Outcomes

CO 1: Ability to apply the concepts and principles of plant tissue culture techniques on research problems pertinent to crop improvement.

CO 2: Dissemination of skills on usage of the acquired knowledge on practical biotechnology tools to augment need based research.

CO 3: Technical know how and exhibition of contemporary knowledge in Biotechnology for economic utilization.

CO 4: Compile and interpret results applying tools of biotechnology research.

CO5: Applying learned process to undertake sustainable exploitation of plant and microbial resources in an environmentally-sensitive manner.

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

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MBB 502 Fundamentals of Molecular Biology (3+0)

Learning objectives

- To know about the structure of DNA and its function
- To familiarize about the concept of DNA replication and various models
- To learn about the transcription and factors involved in transcription
- To get an idea of genetic code and post transcriptional changes
- To study about gene regulation in prokaryotes and eukaryotes

Theory

Unit I-Structure of DNA

Historical developments of molecular biology, nucleic acids as genetic material, chemistry and nomenclature of nucleic acids; Structure of DNA: primary structure; secondary structure, forms of DNA: A, B, Z and their function; structure and types of RNA genome organization in prokaryotes and eukaryotes; DNA topology; DNA reassociation kinetics, types of repeat sequences.

Unit II-DNA Replication and DNA Modification

Central dogma of molecular biology; DNA replication-classical experiments, models of DNA replication; DNA replication, origin and steps in DNA replication -initiation, elongation and termination; enzymes and accessory proteins and their mechanisms; eukaryotic DNA replication in brief. types of DNA damages and mutations; DNA repair mechanisms, recombination: homologous and non-homologous, genetic consequences.

Unit III -Transcription

Prokaryotic transcription, initiation, elongation and termination, promoters, structure and function of eukaryotic RNAs and ribosomal proteins. Eukaryotic transcription –RNA polymerase I, II and III,

elongation and termination, eukaryotic promoters and enhancers, transcription factors, post-transcriptional processing, splicing: catalytic RNAs, RNA stability and transport, RNA editing.

Unit IV -Posttranscription

Genetic code and its characteristics, universal and modified genetic code and its characteristics, wobble hypothesis; translational machinery; ribosomes in prokaryotes and eukaryotes. Initiation complex formation, cap dependent and cap independent initiation in eukaryotes, elongation: translocation, transpeptidation and termination of translation; co-and post-translational modifications of proteins; translational control; protein stability-protein turn over and degradation.

Unit V –Gene regulation

Gene regulation in prokaryotes, Constitutive and Inducible expression, small molecule regulators; Operon concept: LAC and TRP operons, attenuation, antitermination, stringent control. Gene regulation in eukaryotes–regulatory RNA and RNA interference mechanisms, Silencers, insulators, enhancers, mechanism of silencing and activation; Families of DNA binding transcription factors: Helix turn-helix, helix-loop-helix etc. Epigenetic regulations.

Theory lesson plan

1. Historical developments in molecular biology,
2. Nucleic acids as genetic material,
3. Chemistry and Nomenclature of nucleic acids.
4. Structure of DNA: primary structure; secondary structure,
5. Forms of DNA: A, B, Z and their function.
6. Structure and Types of RNA Genome organization in prokaryotes and eukaryotes
7. DNA Topology and DNA reassociation kinetics,
8. Types of repeat sequences.
9. Central dogma of Molecular Biology
10. DNA replication-Classical experiments
11. Models of DNA replication; DNA replication,
12. Origin and Steps in DNA replication -initiation, elongation and termination
13. **First test**
14. Enzymes and accessory proteins and their mechanisms
15. Eukaryotic DNA replication in brief.
16. Types of DNA damages and mutations
17. DNA repair mechanisms,
18. Recombination: Homologous and non-homologous,
19. Genetic consequences.
20. Prokaryotic transcription, initiation, elongation and termination,
21. promoters,
22. Structure and function of eukaryotic RNA sand ribosomal proteins.
23. **Mid Semester**
24. Eukaryotic transcription–RNA polymerase I, II and III,
25. Elongation and Termination,
26. Eukaryotic promoters and enhancers,
27. Transcription factors, post-transcriptional processing,
28. Splicing: Catalytic RNAs, RNA stability and transport, RNA editing.
29. Genetic code and its characteristics,
30. Universal and modified genetic code and its characteristics,
31. Wobble hypothesis
32. Translational machinery

33. Ribosomes in prokaryotes and Eukaryotes
34. Initiation complex formation, Cap dependent and Cap independent initiation in eukaryotes,
35. Elongation: translocation, transpeptidation and termination of translation
36. Co-and Post-translational modifications of proteins
37. Translational control
38. Protein stability-Protein turn over and degradation.
39. Gene regulation in prokaryotes
40. Constitutive and Inducible expression
41. Small molecule regulators
42. Operon concept: LAC operons
43. Operon concept: TRP operons
44. Attenuation, antitermination, stringent control
45. Gene regulation in eukaryotes
46. Regulatory RNA and RNA interference mechanisms
47. Silencers, insulators, enhancers,
48. Mechanism of silencing and activation
49. Families of DNA binding transcription factors: Helix turn-helix, helix loop-helix etc.
50. Epigenetic regulations.

Course Outcomes

CO 1: Understand and apply the principles and techniques of Molecular Biology.
CO 2: To get insights into the Central Dogma, basic cellular processes
CO 3: To provide insight into cellular and molecular mechanisms
CO 4: The knowledge of DNA control mechanisms in terms of replication and recombination
CO5: To design and execute gene manipulation research under lying social and environmental ventures.

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

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MBB 503- Molecular Cell Biology (3+0)

Learning objectives

- To familiarize the students with the cell biology at molecular level.
- To provide aglimpse into the genomic organization of cellular organelles
- To study the various ways of cellular communications
- To know the various mechanics of cell division
- To brush up the ideas on cell growth and development

Theory

Unit I: Evolution of basics of cell biology

Origin of life, History of cell biology, Evolution of the cell: endo-symbiotic theory, tree of life, General structure and differences between prokaryotic and eukaryotic cell; Similarities and distinction between plant and animal cells; different kinds of cells in plant and animal tissues.

Unit II: Cell organelles

Cell wall, cell membrane, structure and composition of bio-membranes, Structure and function of major organelles: Endoplasmic reticulum Ribosomes, Golgi apparatus, Mitochondria, Chloroplasts, Lysosomes, Nucleus, Cyto-skeletal elements.

Unit III: Cellular Communication

Peroisomes, Micro-bodies, Vacuoles, Membrane transport; Diffusion, osmosis, ion channels, active transport, mechanism of protein sorting and regulation of intracellular transport, transmembrane and vesicular transport-endocytosis and exocytosis; General principles of cell communication: hormones and their receptors, signaling through G-protein coupled receptors, enzyme linked receptors; signal transduction mechanisms and regulation, Cell junctions, Cell adhesion, Cell movement; Extracellular matrix.

Unit IV: Mechanics of cell division

Chromatin structure, Cell division and regulation of cell cycle; Mechanisms of cell division, Molecular events at M-phase, mitosis and cytokinesis, Ribosomes in relation to cell growth and division, Extracellular and intracellular Control of Cell Division; abnormal cell division: cancer- hall marks of cancer and role of oncogenes and tumor suppressor genes in cancer development- Programmed cell death (Apoptosis).

Unit V: Cellular growth, development and determination

Morphogenetic movements and the shaping of the body plan, Cell diversification, cell memory, cell determination, and the concept of positional values; Differentiated cells and the maintenance of tissues and organ development; Stem cells: types and applications; Basics of Animal development in model organisms (*C. elegans*; Drosophila); Plant development.

Theory lesson plan

1. Cell theory
2. Structure of prokaryotic
3. Structure of eukaryotic cells
4. Similarities and distinction between plant and animal cells
5. Structure and function of major organelles
6. Nucleus Chloroplasts, Mitochondria, Ribosomes
7. Lysosomes, Peroxisomes
8. Endoplasmic reticulum

9. Microbodies, Golgi apparatus, Vacuoles
10. Cell division
11. Regulation of cell cycle
12. Membrane transport
13. **First test**
14. Transport of water molecules-Aquaporin
15. Transport of ion
16. Transport of biomolecules
17. Diffusion, osmosis, ion channels, active transport, ion pumps
18. Mechanism of protein sorting and regulation of intracellular transport
19. Cell communication and cell signaling
20. Cell junctions-gap junctions, extracellular matrix, integrins
21. Act in filaments, act in binding proteins, fibroin and muscle
22. Protein targeting.
23. **Mid-Semester examinations**
24. Organization of bacterial genome
25. Plant genome-Chloroplast genome
26. Plant genome-Mitochondrial genome
27. Genome organization of *Arabidopsis thaliana*
28. Structure of eukaryotic chromosomes
29. Role of nuclear matrix in chromosome organization and function
30. Matrix binding proteins
31. Heterochromatin and Euchromatin
32. Genome size and evolutionary complexity
33. Microbial genetics: plasmids, conjugation
34. Transduction and transformation in bacteria
35. Bacteriophages and their genetic systems
36. Lyticandly so genic phases of l phage
37. Genetic recombination and its molecular mechanism
38. Cellular responses to environmental signals in plants
39. Mechanisms of signal transduction (Rhizobium legume symbiosis, steroids, protein/peptides).
40. Morphogenetic movements and the shaping of the body plan
41. Ribosomes in relation to cell growth and division
42. Extra cellular and intra cellular Control of Cell Division
43. Abnormal cell division: cancer-hallmarks of cancer and role of on co-genes
44. Tumor suppressor genes in cancer development
45. Programmed cell death (Apoptosis).
46. Cell diversification, cell memory and cell determination
47. Concept of positional values
48. Differentiated cells and the maintenance of tissues and organ development
49. Stem cells: types and applications
50. Basics of Animal development in model organisms (*C. elegans*; Drosophila)

Course outcomes

CO 1: Implant Knowledge on energy utilization and generation in cells

CO 2: In sinuate causal relationships between molecule and cell level phenomena and organism- l level patterns of heredity

CO 3: Understand the structure and function of prokaryotic and eukaryotic cells, as whole entities and in terms of their sub cellular processes.

CO 4: Link the rapid advances in cell and molecular biology to better understanding of Diseases including cancer

CO 5: Demonstrate advanced laboratory bench skills, lab notebook recordkeeping, and teamwork.

	PO1	PO2	PO3	PO4	PO5
CO1	1		4		
CO2	2	4			
CO3					
CO4	4	3			
CO5					

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MBB 504-Techniques in Molecular Biology I (0+3)

Learning Objectives

- To get a basic over view of molecular biology techniques.
- To provide good lab practices.
- To import knowledge on recombinant DNA technology.
- To get a hands-on training in chromatography, protein analysis and nucleic acid analysis.
- To provide insight into bacterial and phage genetics.

Practical

Laboratory safety measures, Principle of centrifugation and spectrophotometry, Growth of bacterial culture and preparation of growth curve, Isolation of Genomic DNA and plasmid DNA from bacteria, isolation of phage DNA, Isolation and restriction of plant DNA (Rice, Moong, Mango & Marigold), Quantification of DNA - Agarose Gel electrophoresis, Spectrophotometry; PCR using isolated DNA, PAGE Gel electrophoresis, Restriction digestion of plasmid and phage DNA - ligation, Recombinant DNA construction; Transformation of *E.coli* and selection of transformants, Chromatographic techniques– TCL, Gel Filtration Chromatography, Ion exchange

Chromatography, Affinity Chromatography; blotting techniques-Southern hybridization, Northern hybridization, Western blotting; ELISA, Radiation safety and non-radio isotopic procedure

Practical lesson plan

1. Good lab practices, preparation of buffers and reagents
2. Principle of centrifugation
3. Principle of spectrophotometry
4. Growth of bacterial culture and preparation of growth curve
5. Isolation of Genomic DNA from bacteria, cont.,
6. Isolation of Genomic DNA from bacteria
7. Isolation of plasmid DNA from bacteria, cont.,
8. Isolation of plasmid DNA from bacteria
9. Growth of lambda phage and isolation of phage DNA, cont.,
10. Growth of lambda phage and isolation of phage DNA
11. Isolation and restriction of Rice DNA, cont.,
12. Isolation and restriction of Rice DNA
13. **First Test**
14. Isolation and restriction of Moong DNA, cont.,
15. Isolation and restriction of Moong DNA
16. Isolation and restriction of Mango DNA, cont.,
17. Isolation and restriction of Mango DNA
18. Isolation and restriction of Marigold DNA, cont.,
19. Isolation and restriction of Marigold DNA
20. Quantification of DNA by Agarose Gel electrophoresis, cont.,
21. Quantification of DNA by Agarose Gel electrophoresis
22. Quantification of DNA by Spectrophotometry, cont.,
23. **Mid-Semester Examination**
24. Quantification of DNA by Spectrophotometry
25. PCR using isolated DNA, cont.,
26. PCR using isolated DNA
27. PAGE Gel electrophoresis, cont.,
28. PAGE Gel electrophoresis
29. Restriction digestion of plasmid DNA, ligation, Recombinant DNA construction, cont.,
30. Restriction digestion of plasmid DNA, ligation, Recombinant DNA construction
31. Restriction digestion of phage DNA, ligation, Recombinant DNA construction, cont.,
32. Restriction digestion of phage DNA, ligation, Recombinant DNA construction
33. Transformation of *E.coli* and selection of transformants, cont.,
34. Transformation of *E.coli* and selection of transformants
35. Chromatographic techniques–TCL, cont.,
36. Chromatographic techniques–TCL
37. Chromatographic techniques–Gel Filtration Chromatography, cont.,
38. Chromatographic techniques–Gel Filtration Chromatography
39. Chromatographic techniques–Ion eXchange Chromatography, cont.,
40. Chromatographic techniques–Ion eXchange Chromatography
41. Chromatographic techniques–Affinity Chromatography, cont.,
42. Chromatographic techniques–Affinity Chromatography
43. Dot blot analysis, Southern hybridization, cont.,
44. Dot blot analysis, Southern hybridization
45. Northern hybridization, cont.,
46. Northern hybridization
47. Western blotting, cont.,
48. Western blotting
49. ELISA

50. Radiation safety and non-radio isotopic procedure

Course Outcomes

CO 1: Understand the principles and techniques of molecular tools
CO 2: Ability to isolate and quantify DNA samples
CO 3: Concrete knowledge on Recombinant DNA Technology
CO 4: Gain knowledge to adopt various methods of Transformation Technology
CO 5: Critical Understanding on various Blotting Techniques

CO-POMAPPINGMATRIX

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

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MBB 505: Omics and Systems Biology (2+1)

Learning Objectives

- To provide over view of genomics, proteomics, ion omics and metabolomics
- To impart the modalities of the application of omics science across the industry
- To give insight on the computational techniques related to DNA, RNA and protein analysis.
- To provide introduction to the various bioinformatic databases and about sequencing and analysis.
- To familiarize the students with hands on training about varied software programs in genetic analysis.

Theory

Unit I: Principles of omics science

Different methods of genome sequencing, principles of various sequencing chemistries, physical and genetic maps, Comparative and evolutionary genomics, Organelle genomics, applications in phylogenetics, case studies of completed genomes, preliminary genome data analysis, basics of ion omics analysis, different methods

Unit II: Protein, proteomics and analytics

Protein-basics: primary-, secondary- and tertiary structure, Basics of X-ray crystallography and NMR, Principal and Applications of mass spectrometry, Proteomics: Gel based and gel free, Basics of software used in proteomics, MASCOT, PD-Quest, etc., Study of protein interactions, Prokaryotic and yeast-based expression system and purification

Unit III: Metabolome-applications and analysis

Metabolomics and its applications, Use of 1D/2D NMR and MS in metabolome analysis, Multivariate analysis and identification of metabolite as biomarkers, Study of ionomer using inductively coupled plasma – mass spectroscopy (ICP-MS), X-Ray Fluorescence (XRF), Neutron activation analysis (NAA), Data integration using genome, transcriptome, proteome, metabolome and ionone with phenome.

Unit IV: Basics of systems biology

Introductory systems Biology -The biochemical models, genetic models and systems model, Molecules to Pathway, Equilibrium binding and co-operatively–Michaelis-Menten Kinetics, Biological oscillators, Genetic oscillators, Quorum Sensing

Unit V: Cellular network and communications

Cell-cell communication, Drosophila Development, Pathways to Network, Gene regulation at a single cell level, transcription network, regulatory circuits, Negative and positive auto-regulation, Alternative Stable States, Bi-modal Switches, Network building and analysis.

Practical

- Isolation of HMW DNA and brief over view of sequencing, Primary information on genome data analysis.
- BSA Standard curve preparation, EXtraction of protein and estimation methods.
- Quantification of proteins from different plant tissues using spectrophotometry.
- 2-D Gel Electrophoresis, 2-D Image analysis.
- EXperiments on protein-protein interaction (Yeast 2-hybrid, Split Ubiquitin system).
- Demonstration on MALDI-TOF.
- Demonstration on ICP-MS, AAS, Nitrogen estimation using various methods.

Theory lesson plan

1. Different methods of genome sequencing
2. Principles of various sequencing chemistries
3. Physical and genetic maps
4. Comparative and evolutionary genomics
5. Organelle genomics

6. Applications in phylogenetics, case studies of completed genomes
7. Preliminary genome data analysis
8. Basics of ion omics analysis and different methods
9. **First test**
10. Protein-basics: primary, secondary and tertiary structure
11. Basics of X-ray crystallography and NMR
12. Principal and Applications of mass spectrometry
13. Proteomics: Gel based and gel free
14. Basics of software used in proteomics, MASCOT, PD-Quest, etc.,
15. Prokaryotic and yeast-based expression system and purification
16. Metabolomics and its applications
17. **Mid-term**
18. Use of 1D/2D NMR and MS in metabolome analysis
19. Multi variate analysis and identification of metabolite as biomarkers
20. Study of ionome using inductively coupled plasma
21. Mass spectroscopy (ICP-MS)
22. X-Ray Fluorescence (XRF)
23. Neutron activation analysis (NAA)
24. Data integration using genome, transcriptome, proteome, metabolome and ionome with phenome.
25. The biochemical models, genetic models and systems model
26. Molecules to Pathway
27. Equilibrium binding and cooperatively-Michaelis-Menten Kinetics
28. Biological oscillators, Genetic oscillators and Quorum Sensing
29. Cell-cell communication, Drosophila Development, Pathways to Network
30. Gene regulation at a single cell level, transcription network
31. Regulatory Circuits,
32. Negative and positive auto-regulation
33. Alternative Stable States, Bimodal Switches,
34. Network building and analysis.

Practical lesson plan

1. Isolation of DNA
2. Sequencing, Primary information on genome data analysis.
3. BSA Standard curve preparation
4. Extraction of protein
5. Estimation methods
6. Quantification of proteins from different plant tissues using spectrophotometry
7. Protein Sequence Database
8. Structure Databases
9. 2-D Gel Electrophoresis,
10. 2-D Image analysis
11. Experiments on protein-protein interaction (Yeast 2-hybrid, Split Ubiquitin system).
12. Demonstration on MALDI-TOF.
13. Demonstration on ICP-MS
14. Demonstration on AAS
15. Nitrogen estimation using various methods.
16. Gene prediction and annotation using database
17. **Final Practical exam**

Course Outcomes

CO1: Learning about DNA and Protein biological database.

CO2: Understanding Bioinformatic tools.

CO3: Understanding information submission and retrieval.
CO4: Learning the protein structural analysis.
CO5: Gain knowledge on computer-based bioinformatics technologies.

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

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MBB – 506 Plant Genetic Engineering (3+0)

Learning objectives

- To study about recombinant DNA technology and hybridization techniques
- To get an idea about different types of cloning vectors used and construction of c DNA libraries
- To familiarize about the concept of PCR and types of primers used in PCR
- To study about direct and indirect methods of genetic transformation
- To know about various genome modification techniques like CRISPR

Theory

Unit I -Recombinant DNA Technology

Historical background, Restriction Enzymes; DNA Modifying enzymes, ligase, T4 DNA polymerase, Polynucleotide kinase etc, Cohesive and blunt end ligation; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization; Chromatin Immunoprecipitation; DNA-Protein Interactions: Electromobility shift assay.

Unit II -Cloning Vectors and methodologies

Plasmids; Bacteriophages; M13, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40;

Expression vectors; pMal, pET-based vectors; Protein purification; His-tag; GST-tag; MBP-tag, etc.; Baculovirus vectors system, Plant based vectors, Ti and Ri plasmids as vectors, Yeast vectors, Shuttle vectors. Transformation; Construction of libraries; Isolation of mRNA and total RNA; cDNA and genomic libraries; cDNA and genomic cloning, Jumping and hopping libraries, Protein-protein interactive cloning and Yeast two hybrid system; Phage display; Principles in maximizing gene expression; Codon optimization for heterologous expression. Introduction of DNA into mammalian cells; Transfection techniques.

Unit III-PCR

Principles of PCR, Primer design, DNA polymerases, Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; T-vectors; Applications of PCR in gene recombination, Site specific mutagenesis, in molecular diagnostics; Viral and bacterial detection; Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay.

Unit IV -Genetic transformation

Genetic transformation of plants: DNA delivery – Agrobacterium mediated method. Direct DNA delivery – chemical mediated electroporation and particle bombardment. Vectors and transgene design-Promoters and Marker genes. Chloroplast transformation.

Unit V -Genome modification

Development of marker-free plants. Analysis of transgenic plants – molecular and Biochemical assays, genetic analysis-Identification of gene integration site -Advance methods–cis genesis, intra genesis and targeted genome modification–ZFN, TALENS and CRISPR. Application of transgenic technology.

Theory Lesson Plan

1. Historical back ground of Plant Genetic Engineering
2. Restriction Enzymes
3. DNA Modifying enzymes, ligase, T4 DNA polymerase, Polynucleotide kinase etc, Cohesive and blunt end ligation
4. Labeling of DNA: Nick translation, Random priming,
5. Radio-active and non-radioactive probes
6. Hybridization techniques: Northern, Southern and Colony hybridization,
7. Fluorescence in-situ hybridization
8. Chromatin Immune-precipitation
9. DNA-Protein Interactions
10. Electro-mobility shift assay
11. Plasmids and Bacterio-phages M13 Phages and Lambda vectors
12. Insertion and Replacement vectors, Cosmids, Artificial chromosome vectors (YACs; BACs)
13. **First test**
14. Animal Virus derived vectors-SV-40, Expression vectors and pMal, pET-based vectors
15. Protein purification, His-tag, GST-tag, MBP-tag, etc.
16. Baculovirus vectors system, Plant based vectors, Ti and Ri plasmids as vectors, Yeast vectors, Shuttle vectors.
17. Transformation and Construction of libraries
18. Isolation of mRNA and total RNA
19. cDNA and genomic libraries; cDNA and genomic cloning
20. Jumping and hopping libraries
21. Protein-protein interactive cloning and Yeast two hybrid system
22. Phage display; Principles in maximizing gene expression; Codon optimization for heterologous expression.
23. **Mid Semester**
24. Introduction of DNA into mammalian cells, Transfection techniques
25. Principles of PCR and Primer designing, DNA polymerases

26. Types of PCR–multiplex, nested, reverse transcriptase, real time PCR, touch down PCR, hot start PCR, colony PCR,
27. Cloning of PCR products, T-vectors; Applications of PCR in gene recombination,
28. Site specific mutagenesis in molecular diagnostics; Viral and bacterial detection
29. Mutation detection-SSCP, DGGE, RFLP, Oligo Ligation Assay
30. Genetic transformation of plants, Recent developments in plant transformation strategies
31. DNA delivery–Agrobacterium mediated method
32. Agrobacterium tumefaciens Characteristics
33. Vectors, Ti-plasmid,
34. Process of T-DNA transfer and integration
35. Direct DNA delivery–Polyethylene (glycol mediated transformation) the chemical method
36. Direct DNA delivery -Electroporation
37. Direct DNA delivery -Particle-bombardment
38. Direct DNA delivery-Laser-induced DNA delivery
39. Vectors and trans gene designing
40. Promoters and Marker genes, Chloroplast transformation
41. Development of marker-free plants.
42. Analysis of transgenic plants
43. Molecular and Biochemical assays
44. Genetic analysis -Identification of gene integration site
45. Genetic analysis -Advance methods –cis-genesis
46. Genetic analysis-Advance methods–intra-genesis
47. Targeted genome modification
48. ZFN, TALENS, CRISPR
49. Marker-free transgenic plants development strategies
50. Application of transgenic technology.

Course Outcomes

CO 1: To get a basic overview of Plant Genetic Engineering
CO 2: Enhance knowledge of molecular cloning
CO 3: A theoretical idea on vectors and genomic library construction.
CO 4: To get an overview of PCR and its applications,
CO 5: Understanding genetic sequencing, gene knockouts, transgenic set.

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

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MBB 507–Techniques in Molecular Biology II (0+3)

Learning Objectives

- To get a basic over view of molecular biology techniques
- To acquire skills on good lab practices
- To gain knowledge in molecular marker techniques
- To get a hands on training in RNAi and micro array techniques
- To get a practical knowledge in immunological techniques

Practical

Construction of gene libraries (cDNA and Genomics), Synthesis and cloning of cDNA, Realtime PCR and interpretation of data, Molecular markers – RAPD, SSR, AFLP/ISSR and their analysis, Case study of SSR markers-construction of linkage map, QTL analysis using genotypic databased on SSR,SNP identification and analysis, Micro array studies and use of relevant software, Proteomics–2D gels, Mass spectrometry; RNAi- designing of construct, phenotyping of the plant,Yeast1 and 2- hybrid interaction, Generation and screening of mutants, Transposon mediated mutagenesis, Immunology and molecular diagnostics: Ouchter lony double diffusion, Immuno precipitation, Radiation Immuno diffusion, Immunoelectrophoretic, Rocket Immuno electrophoretic, Counter Current Immunoelectrophoretic, ELISA, LateX Agglutination, Immuno histochemistry.

Practical lesson plan

1. Construction of gene libraries (cDNA and Genomics)
2. Synthesis and cloning of cDNA, cont.,
3. Synthesis and cloning of cDNA
4. Real-time PCR and interpretation of data, cont.,
5. Real-time PCR and interpretation of data
6. RAPD Molecular marker and their analysis, cont.,
7. RAPD Molecular marker and their analysis
8. SSR Molecular marker and their analysis, cont.,
9. SSR Molecular marker and their analysis
10. AFLP Molecular marker and their analysis, cont.,
11. AFLP Molecular marker and their analysis
12. ISSR Molecular marker and their analysis, cont.,
13. **First Test**
14. ISSR Molecular marker and their analysis
15. Case study of SSR markers-construction of linkage map, cont.,
16. Case study of SSR markers-construction of linkage map
17. QTL analysis using geno-typic data based on SSR, cont.,
18. QTL analysis using geno-typic data based on SSR
19. SNP identification and analysis, cont.,
20. SNP identification and analysis
21. Micro array studies and use of relevant software, cont.,

22. Micro array studies and use of relevant software
23. **Mid-Semester Examination**
24. Proteomics-2Dgels
25. Proteomics-Mass spectrometry, cont.,
26. Proteomics-Mass spectrometry
27. RNA i- designing of construct, pheno typing of the plant, cont.,
28. RNA i- designing of construct, pheno typing of the plant
29. Yeast1and 2-hybrid interaction, cont.,
30. Yeast 1 and 2-hybrid interaction
31. Generation and screening of mutants, cont.,
32. Generation and screening of mutants
33. Transposon mediated muta-genesis, cont.,
34. Transposon mediated muta-genesis
35. Immunology and molecular diagnostics: Ouchterlony double diffusion, cont.,
36. Immunology and molecular diagnostics: Ouchterlony double diffusion
37. Immuno precipitation, cont.,
38. Immuno precipitation
39. Radiation Immuno diffusion, cont.,
40. Radiation Immuno diffusion
41. Immuno electrophoretic, cont.,
42. Immuno electrophoretic
43. Rocket Immuno electrophoretic, cont.,
44. Rocket Immunoelectrophoretic
45. Counter Current Immuno electrophoretic, cont.,
46. Counter Current Immuno electrophoretic
47. ELISA, cont.,
48. ELISA,
49. Latex Agglutination
50. Immuno histo-chemistry

Course Outcomes

CO 1: Understand the principles and techniques of molecular tools
CO 2: Capable to handle PCR products
CO 3: Acquire knowledge on marker assisted selection techniques
CO 4: Gain knowledge on QTL mapping strategies
CO 5: Critical Understanding on immune system of various diseases

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

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MBB 508: Introduction to Bioinformatics (2+1)

Learning objectives

- To get a basic overview of computational techniques related to DNA, RNA and protein analysis.
- Learn about bioinformatic database.
- To acquire complete information on sequencing and analysis.
- To get a hands-on training in software's and programs used to analyze, assemble or annotate genomes, phylogenetics, proteomics etc
- Perceive information about computing and retrieve data from molecular databases

Unit I Gene Bank

Bio-informatics basics, scope and importance of bio-informatics; Biological data bases for DNA and Protein sequences–Gene Bank, EMBL, NCBI, Gen Pept, Swiss-Prot, Tr EMBL, PIR, OWL, IPI, db EST, DDBJ, Gene Cards, Inter Pro, NCBI, OWL, PIR, PRF, Uni Port, EM Data Bank, Proteo-pedia, Bio-Mag Res Bank, ASTRAL.

Unit II Gene Data Base

Secondary database, structural data bases–PDB, SCOP and CATH, Specialized genomic resources, Micro array data base. Bioinformatics Tools Facilitate the Genome-Wide Identification of Protein-Coding Genes, Sequence analysis, Sequence submission and retrieval system-SEQUIN, BANKit, SAKURA, Webin,

Unit III NCBI Data Base

Sequence alignment, pair wise alignment techniques, multiple sequence alignment; Tools for Sequence alignment-BLAST and its variants; Phylogenetic analysis-CLUSTALX, CLUSTALW, Phylip, Tcoffee

Unit IV Protein Data Base

Sequencing of protein; Protein secondary structure prediction- Chousfasman, GOR Method, Protein 3D Structure Prediction: Evaluation of models- Structure validation and refinement - Ramachandran plot, Force field calculations, SAVES.

Unit V Drug Design

Protein function prediction- sequence and domain based, Primer designing- principles and methods. Drug discovery, Structure Based Drug Design- Rationale for computer aided drug designing, basic principles, docking, QSAR.

Practical

- Usage of NCBI resources
- Retrieval of sequence/structure from data bases and submission
- Different Databases, BLAST eXercises.
- Assembly of DNA and RNA Seq data
- Annotation of assembled sequences, Phylo-genetics and alignment

- Visualization of structures, Docking of ligand receptors
- Protein structure analysis and modeling

Theory lesson plan

1. Bioinformatics scope and importance.
2. Biological data bases for DNA-GenBank, EMBL, NCBI.
3. Gen Pept, Swiss-Prot, TrEMBL, PIR.
4. OWL, IPI and dbEST.
5. Biological data bases for Protein–DDBJ, Gene Cards, InterPro.
6. NCBI, OWL, PIR, PRF.
7. Uni Port, EM Data Bank, Proteopedia,
8. Bio Mag Res Bank, ASTRAL.
9. **First test**
10. Secondary database, structural databases-PDB, SCOP, CATH.
11. Specialized genomic resources
12. Micro array database
13. Genome-Wide Identification of Protein-Coding Genes
14. Sequence analysis system–PSSM, Ex PASy, FASTA.
15. Sequence submission and retrieval system-SEQUIN, BANKit, SAKURA, Webin,
16. Sequence alignment.
17. **Mid-term**
18. Pairwise alignment techniques.
19. Multiple sequence alignment.
20. Sequence alignment tool-BLAST and its variants.
21. Phylogenetic analysis-CLUSTALX, CLUSTALW,
22. Phylip, Tcoffee.
23. Sequencing of protein.
24. Protein secondary structure prediction-Chousfasman, GOR Method.
25. Protein 3D Structure Prediction
26. Structure validation and refinement-Ramachandran plot.
27. Force field calculations.
28. SAVES.
29. Protein function prediction
30. Protein sequence and domain based.
31. Primer designing-principles and methods.
32. Drug discovery -Structure Based Drug Design.
33. Rational e for computer aided drug designing-basic principles.
34. Computer aided drug designing -docking, QSAR.

Practical lesson plan

35. Usage of NCBI resources.
36. Retrieval of sequence/structure from data bases and submission
37. SRS of Biological Databases-Nucleotide/Genome Databases
38. Protein Sequence Database
39. Structure Databases
40. Protein Pattern Databases
41. 3.File format conversion-a.FmtSeq, b. ReadSeq c.Sequence manipulation Suite
42. Sequence Analysis-Dot Plot
43. Pairwise alignment
44. Multiple Sequence Alignment
45. Different Databases, BLAST exercises.
46. Assembly of DNA and RNA Seq data
47. Annotation of assembled sequences, Phylogenetics and alignment
48. Visualization of structures, Docking of lig and receptors
49. Protein structure analysis and modelling

50. Gene prediction and annotation using database
51. Final Practical exam

Course Outcomes

CO1 Learning about DNA and Protein biological database.
CO2 Understanding Bio-informatics tools.
CO3 Understanding information submission and retrieval.
CO4 Learning the protein structural analysis.
CO5 Gain knowledge on computer-based bio-informatics technologies.

CO-PO Mapping matrix:

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

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MBB 509 PLANT TISSUE CULTURE (2+1)

Learning objectives:

- To study the basic concepts of plant tissue culture its applications
- To know about organo genesis and somatic embryo genesis
- To study about the proto-plast isolation, purification and fusion.
- To get an idea about the distant hybridization and embryo rescue techniques
- To know about the callus culture, ovary culture and commercial tissue culture

Theory

UNIT 1: Basics of plant tissue culture

History of plant tissue culture, principle of Toti-potency; Tissue culture media; Plant hormones and morpho-genesis; Direct and indirect organo-genesis; Direct and indirect somatic embryogenesis; Applications of plant tissue culture; National certification and Quality management of TC plants; Genetic Fidelity testing and Virus indexing methods – PCR, ELISA

UNIT 2: MICROPROPAGATION TECHNIQUES

Micro-propagation of field and ornamental crops; Virus elimination by meristem culture, meristem tip culture and micro-grafting; Andro-genesis and gyno-genesis - production of andro-genic and gyno-genic haploids – diploidization

UNIT 3: PROTOPLAST CULTURE

Protoplast culture - isolation and purification; Protoplast culture; Protoplast fusion; Somatic hybridization - Production of Somatic hybrids and Cybrids; Wide hybridization-embryo culture and embryo rescue techniques; Ovule, ovary culture and endosperm culture.

UNIT 4: SECONDARY METABOLITES

Large-scale cell suspension culture - Production of alkaloids and other secondary metabolites- techniques to enhance secondary metabolite production, Somo-clonal and gameto-clonal variations – causes and applications; Callus culture and *in vitro* screening for stress tolerance; Artificial seeds

UNIT 5: PRESERVATION TECHNIQUES

In vitro germplasm storage and cryo-preservation. Commercial Tissue Culture: Case studies and success stories, Market assessment; project planning and preparation, economics, government policies.

PRACTICAL

- Preparation of stocks - macro-nutrients, micro-nutrients, vitamins and hormones, filter sterilization of hormones and antibiotics. Preparation of Murashige and Skoog medium.
- Micro-propagation of plants by nodal and shoot tip culture.
- Embryo culture to overcome incompatibility, Anther culture for haploid production.
- Callus induction in tobacco leaf discs, regeneration of shoots, root induction, role of hormones in morpho-genesis.
- Acclimatization of tissue culture plants and establishment in greenhouse.
- Virus indexing in tissue culture plants. (Using PCR and ELISA).
- Plan of a commercial tissue culture unit.

Theory lesson plan

1. Definition of Plant Tissue Culture and History of Plant Tissue Culture
2. Toti-potency and cellular differentiation with examples in plants
3. Tissue culture media: preparation method, types of media and properties of different media
4. Plant hormones and morpho-genesis
5. Direct and indirect organo-genesis
6. Direct and indirect somatic embryo-genesis
7. Applications of plant tissue culture
8. National certification and Quality management of TC plants
9. **First test**
10. Genetic Fidelity testing and Virus indexing methods – PCR, ELISA
11. Micropropagation of field and ornamental crops
12. Virus elimination by meristem culture
13. meristem tip culture and micro-grafting
14. Andro-genesis: production of androgenic haploids
15. Gyno-genesis: production of gyno-genic haploids and diploidization
16. Protoplast culture: isolation and purification
17. Protoplast culture: Protoplast fusion
18. **Mid-semester examination**
19. Somatic hybridization: Production of Somatic hybrids and Cybrids
20. Wide hybridization and its applications

21. Embryo culture: its method and applications
22. Different embryo rescue techniques
23. Ovule, ovary culture and endosperm culture.
24. Large-scale cell suspension culture
25. Production of alkaloids and other secondary metabolites
26. Techniques to enhance secondary metabolite production
27. Soma clonal variations: causes and its applications
28. Gameto clonal variations: causes and applications
29. Callus culture and *in vitro* screening for stress tolerance
30. Artificial seeds: production methods and applications
31. *In vitro* germplasm storage: definition and types
32. Cryo-preservation: techniques and properties
33. Commercial Tissue Culture: Case studies and success stories,
34. Market assessment; project planning and preparation, economics, government policies.

Practical lesson plan

1. Preparation of stocks - macro-nutrients
2. Preparation of stocks - micro-nutrients
3. Preparation of stocks - vitamins
4. Preparation of stocks - hormones
5. Filter sterilization of hormones and antibiotics.
6. Preparation of Murashige and Skoog medium.
7. Micro-propagation of plants by nodal and shoot tip culture.
8. Embryo culture to overcome incompatibility
9. Anther culture for haploid production.
10. Callus induction in tobacco leaf discs, regeneration of shoots, root induction
11. Role of hormones in morpho-genesis.
12. Acclimatization of tissue culture plants
13. Establishment in greenhouse.
14. Virus indexing in tissue culture plants Using PCR
15. Virus indexing in tissue culture plants using ELISA
16. Plan of a commercial tissue culture unit.
17. **Orientation for final examination.**

Course outcomes:

CO 1: The students be able to prepare and sterilize the growing medium

CO 2: Standardize protocols for the in-vitro propagation from ex-vitro ex-plants

CO 3: Students be able to excise ex-plants and transfer of plant material to tissue culture medium

CO 4: Biochemical characterization of regeneration and genetic transformation

CO 5: Students get an idea about different culture techniques and their uses

Co-Po Mapping Matrix

	PO1	PO2	PO3	PO4	PO5	PO6	PO7
CO1	-	-	-	3	2	-	3
CO2	2	-	-	1	2	3	1
CO3	3	-	-	-	3	-	-
CO4	2	-	-	3	-	2	-
CO5	1	-	-	-	2	-	3

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MBB 510-MICROBIAL/INDUSTRIAL BIOTECHNOLOGY (2+1)

Learning objectives:

- To study about the isolation and screening of industrially important microorganisms
- To know about primary and secondary metabolite production
- To study about the role of microbial enzymes in industrial processes
- To get an idea about bio-reactors and their types
- Study about the bio-remediation of soil and water

Theory

UNIT I: Basics of microbial biotechnology

Introduction, scope and historical developments; Isolation, screening and genetic improvement (involving classical approaches) of industrially important organisms.

UNIT II: Primary and secondary metabolites

Primary metabolites, production of industrial ethanol as a case study; Secondary metabolites, bacterial antibiotics and non-ribosomal peptide antibiotics as case study; Recombinant DNA technologies for microbial processes; Strategies for development of industrial microbial strains with scale up production capacities; Metabolic path way engineering of microbes for production of novel product for industry.

UNIT III: Microbial enzymes and industrial application

Microbial enzymes, role in various industrial processes, production of fine chemicals for pharmaceutical industries; Bio-transformations, Bio-augmentation with production of vitamin-C as a case study; Bio-reactors, their design and types; Immobilized enzymes-based bioreactors Microencapsulation technologies for immobilization of microbial enzymes.

UNIT IV: Environmental biotechnology

Environmental Biotechnology, bio-treatment for pollution control, treatment of industrial and other wastes, bio-mass production involving single cell protein

UNIT V: Bio-remediation and biochemical production

Bio-remediation of soil and ground water; Production of eco-friendly agricultural chemicals, bio-pesticides, bio-herbicides, bio-fertilizers, bio-fuels, etc.

Practical

- Isolation of industrially important microorganisms, their maintenance and improvement.
- Lab scale production of industrial compounds such as alcohol, beer, citric acid, lactic acid and their recovery.
- Study of bio-reactors and their operations.
- Production of bio-fertilizers.
- Experiments on microbial fermentation process of antibiotics, bio-pigments, dairy products, harvesting purification and recovery of end products
- Immobilization of cells and enzymes, studies on its kinetic behavior, growth analysis and biomass estimation.
- Determination of mass transfer co-efficient.

Theory lesson plan

1. Introduction to microbial biotechnology
2. Scope and historical development of industrial biotechnology
3. Isolation, screening of industrially important microorganisms
4. Genetic improvement (involving classical approaches) of industrially important organisms.
5. Primary metabolites, production of industrial ethanol as a case study
6. Secondary metabolites, production of bacterial antibiotics as a case study
7. Secondary metabolites, production of non-ribosomal peptide antibiotics as case study
8. Recombinant DNA technologies for microbial processes and strategies for development of industrial microbial strains with scale up production capacities
9. **First test**
10. Strategiesfordevelopmentofindustrialmicrobialstrainswithscaleupproductioncapacities
11. Metabolic pathway engineering of microbes for production of novel product for industry.
12. Microbial enzymes, different types of microbial enzymes
13. Role of microbial enzymes in diary industry
14. Role of microbial enzymes inorganic acid production
15. Microbial enzymes, production of fine chemicals for pharmaceutical industries
16. Bio-transformations,
17. **Mid-semester examination**
18. Bio-augmentation with production of vitamin C as a case study
19. Bioreactors, their design and types
20. Immobilized enzymes-based bio-reactors
21. Microorganism possibility for future bio-production
22. Use of microbes in anti-biotic production
23. Strategies for efficient development of microbial bioprocesses
24. Microencapsulationtechnologiesforimmobilizationofmicrobialenzymes.
25. Environmental Biotechnology
26. Bio-treatment for pollution control
27. Treatment of industrial and other wastes
28. Biomass production involving single cell protein
29. Bio-remediation of soil
30. Production of eco-friendly agricultural chemicals
31. Production of bio-pesticides
32. Production of bio fuels
33. Production of bio-herbicides

34. Production of bio-fertilizers

Practical lesson plan

1. Isolation of industrially important microorganisms
2. Maintenance and improvement of microorganisms
3. Lab scale production of industrial compounds: Alcohol
4. Lab scale production of industrial compounds: Beer
5. Lab scale production of industrial compounds: Citric acid
6. Lab scale production of industrial compounds: Lactic acid
7. Recovery of different industrial compounds
8. Study of bio-reactors and their operations.
9. Different types of bio-reactors
10. Production of bio-fertilizers.
11. Experiments on microbial fermentation process of antibiotics, bio-pigments, dairy products
12. Harvestingpurificationandrecoveryofendproductsofmicrobialfermentation
13. Immobilization of cells and enzymes
14. Studies on kinetic behaviour of cells and enzymes
15. Growth analysis and biomasses timation of cells and enzymes
16. Determination of mass transfer coefficient.
17. **Orientation for final examination**

Course outcomes:

CO1: To familiarize about the various microbial processes

CO2: To get knowledge about the production of various industrial compounds

CO3: Get an idea about metabolites production and uses

CO4: Students be acquainted with different bio-remediation processes

CO5: To get an idea about the production of various biochemicals

CO-PO Mapping matrix

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

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4. **https://bitesizebio.com/48446/microbes-biotechnology/**
5. **https://academic.oup.com/jimb/article/45/7/449/5996678**

MBB511- Molecular Plant Breeding (2+1)

Learning objectives

- To impart knowledge on molecular biology tools in plant breeding.
- To impart knowledge on types of molecular markers and its application.
- To provide a hands on training in data analysis, diversity analysis and mapping of genes and QTLs.
- To learning formation about marker assisted selection.
- To provide knowledge on intellectual property rights.

Theory

Unit I Inheritance of qualitative and quantitative traits.

Inheritance of qualitative and quantitative traits. Heritability–its estimation, Population structure of self and cross-pollinated species, Factors affecting selection efficiency. Development of different kinds of segregating populations – F2, F3, BC1F1, BC1F2, BC4F2, RIL (Recombinant Inbred Lines), AIL (Advanced Intercrossed Lines), DH (Di-haploid population), NIL (Near Isogenic lines), NAM (Nested Association Mapping), MAGIC (Multi-parent Advanced Generation)

Unit II Molecular markers and its application

Causes of sequence variation and its types, Types of molecular markers and development of sequence based molecular markers – RFLP, AFLP, SCARs, CAPS, SSRs, STMS, SNPs InDel and DART seq; Inheritance of markers, Linkage analysis using test cross, F2, F3, BC1F1, RIL. Construction of genetic map, Mapping genes for qualitative traits; Genotyping by sequencing and high-density chip arrays.

Unit III Construction of QTL mapping using structured and unstructured populations

QTL mapping using structured populations; Association mapping using unstructured populations; Genome Wide Association Studies (GWAS), Principle of Association mapping–GWAS-SNP genotyping methods, DART array sequencing, Illumina's Golden Gate Technology, Genotyping by sequencing methods-Fluidigm; GBS, Illumina Hiseq-Nano-pore sequencing, Principles and methods of Genomic Selection, Fine mapping of genes/QTL; Development of gene based markers; Allele mining by TILLING and Eco-TILLING.

Unit IV Marker assisted selection

Tagging and mapping of genes. Bulk segregants and co-segregation analysis, Marker assisted selection (MAS); Linked, un-linked, recombinant, flanking, peak markers. Foreground and background selection; MAS for gene introgression and pyramiding: MAS for specific traits with examples. Haplotype concept and Haplotype-based breeding; Genetic variability and DNA fingerprinting.

Unit V Intellectual property rights

Molecular markers in Plant variety protection, IPR issues, Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement, hybrid purity testing, clonal fidelity testing and transgenic testing.

Practical

Construction of linkage map-QTL analysis using the QTL cartographer and other software-SNP data analysis using TASEEL-Development of segregating populations using RILs and NILs-DevelopmentofsegregatingpopulationsusingMAGICpopulation-Development of sequence based molecular markers – RFLP-Development of sequence based molecular markers–SSR-Principle of Association mapping–GWAS-SNP genotyping method-Detection of haplotype block using SNP data–p Link software-Geno typing by sequencing methods –

Illumina genotyping platform-Marker assisted breeding – MABB case studies quality traits in rice/maize-Genome Assisted Breeding in model crops, Genomic Selection models using the morphological and SNPdata-AlleleminingbyTILLINGandEco-TILLING-Taggingandmappingofgenes-Genetic variability and DNA fingerprinting

Theory lesson plan

1. Inheritance of qualitative and quantitative traits. Heritability–it's estimation.
2. Population structure of self and cross-pollinated species, Factors affecting selection efficiency.
3. Development of different kinds of segregating populations–F2, F3, BC1F1, BC1F2, BC4F2, RIL (Recombinant Inbred Lines), AIL (Advanced Intercrossed Lines),
4. DH (Di-haploid population), NIL (Near Iso-genic lines).
5. NAM (Nested Association Mapping), MAGIC (Multi-parent Advanced Generation Inter-cross population).
6. Causes of sequence variation and it's types.
7. Types of molecular markers and development of sequence based molecular markers–RFLP, AFLP, SCARs, CAPS.
8. SSRs, STMS, SNPs In Del and DART sequencing.
9. **First test**
10. Inheritance of markers, Linkage analysis using test cross, F2, F3, BC1F1, RIL.
11. Construction of genetic map, Mapping genes for qualitative traits.
12. Genotyping by sequencing and high-density chip arrays.
13. QTL mapping using structured populations.
14. Association mapping using unstructured populations.
15. Genome Wide Association Studies (GWAS).
16. Principle of Association mapping–GWAS-SNP genotyping methods.
17. **Mid semester**
18. DART array sequencing.
19. Illumina's Golden Gate Technology.
20. Genotyping by sequencing methods-Fluidigm; GBS.
21. Illumina Hiseq-Nano pore sequencing.
22. Principles and methods of Genomic Selection
23. Fine mapping of genes/QTL.
24. Development of gene based markers; Allele mining by TILLING and Eco-TILLING.
25. Tagging and mapping of genes. Bulk segregant and co-segregation analysis,
26. Marker assisted selection (MAS); Linked, unlinked, recombinant, flanking, peak markers.
27. Foreground and background selection; MAS for gene introgression and pyramiding: MAS for specific traits with examples.
28. Haplotype concept and Haplotype-based breeding;
29. Genetic variability and DNA fingerprinting.
30. Molecular markers in Plant variety protection, IPR issues, Protectable subject matters,
31. Protection in biotechnology, protection of other biological materials, ownership and period of protection.
32. National Bio-diversity protection initiatives; Convention on Biological Diversity.
33. International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies. Material transfer agreements, Research collaboration Agreement, License Agreement.
34. Hybrid purity testing. Clonal fidelity testing and transgenic testing.

Practical lesson plan

1. Construction of linkage map.
2. QTL analysis using the QTL cartographer and other software.
3. SNP data analysis using TASEEL.
4. Development of segregating populations using RILs and NILs.
5. Development of segregating populations using MAGIC population.
6. Development of sequence based molecular markers–RFLP.
7. Development of sequence based molecular markers–SSR.
8. Principle of Association mapping–GWAS-SNP genotyping method.
9. Detection of haplotype block using SNP data-p Link software.
10. Genotyping by sequencing methods–Illumina genotyping platform.
11. Marker assisted breeding –MABB case studies quality traits in rice/maize.

12. Genome Assisted Breeding in model crops
13. Genomic Selection models using the morphological and SNP data.
14. Allele mining by TILLING and Eco-TILLING.
15. Tagging and mapping of genes.
16. Genetic variability and DNA fingerprinting.
17. **Practical examination.**

Course Outcome:

CO 1: Studentacquireddiverseknowledgeonmolecularbiologytoolsinplantbreeding.
CO 2: Help on understanding of different types of molecular markers and its application.
CO 3: Gain a experience on hands training in data analysis, diversity analysis and mapping of genes and QTLs.
CO 4: Acquiring information about marker assisted selection.
CO 5: Understanding of intellectual property rights

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

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MBB - 512 IPR, BIO-SAFETY&BIOETHICS (2+0)

Learning objective

- To create public awareness about the benefits of Intellectual property among all sections of society.
- To stimulate the creation and growth of intellectual property by undertaking relevant measures.
- To have strong and effective laws with regard to IP rights, consistent with international obligations.

- To familiarize the students about ethical and biosafety issues in plant biotechnology.
- To provide a hands-on training in data analysis, diversity analysis and mapping of genes and QTLs.

Unit I Intellectual property rights-I

IPR: historical background in India; trade secret; patent, trademark, design & licensing; procedure for patent application in India; Patent Co-operation Treaty (PCT); Examples of patents in biotechnology-Case studies in India and abroad; copyright and PVP;

Unit II Intellectual property rights-II

Implications of IPR on the commercialization of biotechnology products, ecological implications; Trade agreements-The WTO and other international agreements and Cross border movement of germplasm.

Unit III Bio-safety regulations-I

Bio-safety and bio-hazards; General principles for the laboratory and environmental bio-safety; Bio-safety and risk assessment issues; handling and disposal of bio-hazards; Approved regulatory laboratory practice and principles, The Cartagena Protocol on bio-safety; Bio-safety regulations in India; national Bio-safety Policy and Law; Regulations and Guidelines related to Bio-safety in other countries

Unit IV Bio-safety regulations-II

Potential concerns of transgenic plants– Environmental safety and food and feed safety. Principles of safety assessment of Transgenic plants – sequential steps in risk assessment. Concepts of familiarity and substantial equivalence. Risk-Environmental risk assessment – invasiveness, weediness, gene flow, horizontal gene transfer, impact on non-target organisms; food and feed safety assessment – toxicity and allergenicity. Monitoring strategies and methods for detecting transgenics.

Unit V Bio-safety regulations-III

Field trails –Bio-safety research trials–standard operating procedures, labeling of GM food and crop, Bio-ethics-Mankind and religion, social, spiritual & environmental ethics; Ethics in Biotechnology, labeling of GM food and crop; Bio-piracy.

Theory lesson plan

1 IPR: historical background in India.
2 IPR: trade secret; patent.
3 IPR: trademark, design & licensing.
4 Procedure for patent application in India.
5 Patent Cooperation Treaty (PCT);
6 Examples of patents in biotechnology Case studies in India and abroad; copyright and PVP
7 Implications of IPR on the commercialization of biotechnology products, ecological implications
8 Implications of IPR on the commercialization of biotechnology products, ecological implications;
9 First Test
10 Trade agreements-The WTO and other international agreements and Cross-border movement of germplasm.
11 Trade agreements-The WTO and other international agreements and Cross-border movement of germplasm.
12 Bio-safety and bio-hazards; General principles for the laboratory and environmental bio-safety
13 Bio-safety and risk assessment issues
14 Bio-safety handling and disposal of bio-hazards
15 Approved regulatory laboratory practice and principles
16 The Cartagena Protocolon bio-safety
17 Mid-semester examination
18 Bio-safety regulations in India
19 National Bio-safety Policy and Law
20 Regulations and Guidelines related to Bio-safety in other countries
21 Potential concerns of transgenic plants–Environmental safety and food and feed safety.

22 Principles of safety assessment of Transgenic plants
23 Sequential steps in risk assessment.
24 Concepts of familiarity and substantial equivalence.
25 Risk-Environmental risk assessment–invasiveness, weediness, gene-flow, horizontal gene transfer
26 Impact on non-target organisms
27 Food and feed safety assessment–toxicity and allergenicity.
28 Monitoring strategies and methods for detecting transgenics.
29 Field trails–standard operating procedures, labeling of GM food and crop
30 Bio-safety research trials–standard operating procedures, labeling of GM food and crop
31 Bio-ethics-Mankind and religion,
32 Bio-ethics-social, spiritual & environmental ethics
33 Ethics in Biotechnology, Labeling of GM food and crop;
34 Bio-piracy

Course outcome

CO 1: Learn the impact of IPRs including PBR, PVP and PPVFRA
CO 2: Knowing the bio-safety rules and regulations
CO 3: Protocols for bio-safety
CO 4: Ethics to know in bio-technology
CO 5: WTO, Trade agreements and other international agreements

	PO1	PO2	PO3	PO4	PO 5
CO1			**1**		**1**
CO2			**1**		
CO3		**1**	**2**	**1**	
CO4		**2**	**1**		
CO5			**1**		

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MBB -513 IMMUNOLOGY AND MOLECULAR DIAGNOSTICS (3+0)

Learning objectives

- To know the basics of immune system and antigens
- To study about the major antigen-immuno globulin
- To understand the mechanism of B-cell and T-cell processing
- To make a vision on the inflammatory responses and MHC genes
- To address the co-operation between cells for immune response

THEORY

UNIT I: Basics of immunity and antigens

Immunity and its classification; Components of innate and acquired immunity; Lymphatic system; Hematopoiesis; Organs and cells of the immune system-primary, secondary and tertiary lymphoid organs Descriptions of Antigens -immunogens, hapten and adjuvants.

UNIT II: Immuno glogulins, B-cells and T-cells

Immuno globulins-basic structure, classes & sub-classes of immuno globulins, antigenic determinants; Multigene organization of immunoglobulin genes;B-cell receptor; Immuno globulin super family; Principles of cell signaling; Basis of self and non-self discrimination; Kinetics of immune response, memory; B cell maturation, activation and differentiation; Generation of antibody diversity; T-cell maturation, activation and differentiation and T-cell receptors; Functional T Cell Subsets; Cell-mediated immune responses, ADCC; Cluster of Differentiations (CDs), Cytokines-properties, receptors and therapeutic uses

UNIT III: Various antigens processing

Phagocytosis; Complement and Inflammatory responses; Major Histo-compatibility Complex - MHC genes, MHC and immune responsiveness and disease susceptibility, HLA typing; Antigen processing and presentation-endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens; Cell-cell co-operation, Hapten-carrier system

UNIT IV: Immunological assay techniques

Precipitation, agglutination and complement mediated immune reactions; Advanced immunological techniques–RIA, ELISA, Western blotting, ELISPOT assay, immuno-fluorescence, flow cytometry and immuno electron microscopy; Surface plasm on resonance, Bio-senor assays for assessing lig and–receptor interaction, CMI techniques- lympho proliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays, Apoptosis, Transgenic mice, Gene knock outs

UNIT V: Vaccine technology and auto-immunity

Active and passive immunization; Live, killed, attenuated, sub-unit vaccines; Vaccine technology-Role and properties of adjuvants, re-combinant DNA and protein based vaccines, plant-based vaccines, Antibody genes and antibody engineering- chimeric and hybrid monoclonal antibodies, Immunity to Infection, Bacteria, viral, fungal and parasitic infections, Hypersensitivity–Type I-IV; Autoimmunity; Types of auto-immune diseases, MHC and TCR in autoimmunity; Transplantation, Immunological basis of graft rejection, immuno suppressive therapy; Tumor immunology–Tumor antigens.

Theory lesson plan

1. Definition of immunity and its classification
2. Acquired and innate immunity
3. Lymphatic system
4. Hemato poiesis
5. Organs and cells of the immune system
6. Descriptions of various antigens
7. Immuno globulins-basic structure, classes & sub-classes
8. Antigenic determinants
9. Cell signaling and its principles
10. Basis of self and non-self-discrimination;
11. Kinetics and memory of immune response
12. B-cell maturation, activation and differentiation
13. **First test**
14. T-cell maturation, activation and differentiation
15. T-cell receptors and Functional T-Cell Subsets
16. Cell-mediated immune responses
17. ADCC
18. Cluster of Differentiations (CDs)
19. Cytokines-properties, receptors and therapeutic uses
20. Basis of natural immune response

21. Complement and Inflammatory responses
22. Major Histo-compatibility Complex genes
23. **Mid-semester examination**
24. Immune responsiveness and disease susceptibility; HLA typing
25. Antigen processing and presentation
26. Endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens
27. Cell-cell co-operation
28. Hapten-carrier system
29. Basis of various Immunological assay techniques
30. Agglutination mediated immune reactions
31. Precipitation mediated immune reactions
32. Complement mediated immune reactions
33. Immunological techniques–RIA, ELISA, Western blotting, ELISPOT assay
34. Immunological techniques - immuno fluorescence, flow cyto-metry and immune-electron microscopy
35. Surface plasmon resonance
36. Bio-senor assays for assessing lig and–receptor interaction
37. CMI techniques-lympho proliferation assay, Mixed lymphocyte reaction, Cell Cytotoxicity assays
38. Gene knock out techniques
39. Active and passive immunization
40. Vaccine technology-Role and properties
41. Types of vaccines
42. Antibody engineering-chimeric monoclonal antibodies
43. Antibody engineering - hybrid monoclonal antibodies
44. Bacteria, viral, fungal and parasitic infections immune reponses
45. Hypersensitivity–Type I, Type II
46. Hypersensitivity – Type III, IV
47. Autoimmunity and Types of autoimmune diseases
48. Immunological basis of graft rejection
49. Immuno suppressive therapy
50. Tumor immunology

Course outcome:

CO1. The students be able to know all the classes of immune system.

CO2. Knowing about the B-cell and T-cell senable the students to know about the immune response to various dreadful diseases.

CO3.Students have a wide laboratory exposure on various immunological techniques like ELISA, RIA, Western blotting e.t.c.

CO4. Students are able to know about the latest gene knocking techniques, vaccine technology and types of vaccines.

CO5. Students be able to know about various auto immune diseases and tumor immunology.

CO-PO Mapping matrix

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

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MBB 514-NANO BIOTECHNOLOGY (2+1)

Learning objectives

- Understanding the molecular techniques involved in structure and functions of nano-biomolecules in cells such as DNA, RNA and proteins.
- Understanding the molecular techniques involved in Creation of bio-nano structures
- Understandingthestructure-propertyrelationshipsinpolymericmaterials
- Understanding the Nano-particle carrier systems
- Understanding the Gene therapy

Theory

Unit I- Nanotechnology

Introduction to Nanotechnology-Nanomaterials-Self-assembly to artificial assembly for creation of useful nanostructures – Bottoms up and Top down approach (Nanorods, nano cages, nanotubes, quantum dots, nanowires, metal/ polymer-based nanostructures) – Preparation and Characterization of nanoparticles (particle size analyzer, microscopy, viz. electron microscopy, atomic force microscopy, etc).

Unit II-Study of macromolecules

Cell structure–Bio macro molecules: Types, Structure, Dynamics and interaction with water – Cellular nano machines – cellular transducers, membrane channels, membrane transporters, Membrane motors

Unit III-Bio-nanostructures

Creation of bio-nanostructures (Nano liposomes, Nano micelles, Nanomotors, etc). Chemical, physical and biological properties of biomaterials and bio response:biomineralization,biosynthesis,andpropertiesofnaturalmaterials(proteins,DNA,andpolysaccharides).

Unit IV-Study of Polymeric materials

structure-property relationships in polymeric materials (synthetic polymers and structural proteins); Aerosol properties, application and dynamics; Statistical Mechanics in Biological System

Unit V-Nanoparticular carrier systems

Nanoparticular carrier systems; Micro- and Nano-fluidics; Drug and gene delivery system; Microfabrication, Biosensors, Chip technologies, Nano-imaging, Metabolic engineering and Gene therapy.

Practical

- Isolation of enzymes and nucleic acids involved in biosynthesis of nanomaterials
- Synthesis of Gold/silver Nanoparticles by biogenic methods, Synthesis of micelles and inverse micelles
- Synthesis of Carbon Nano-materials by Chemical Vapor Deposition and Sputtering technique
- Preparation of thiolate silver nanoparticles, Purification and measurement of carbon nanomaterials
- Zinc selenide quantum dot preparation, Synthesis of Iron Oxide Nanoparticle
- Thin film preparation by spin coating technique, Synthesis of Nickel metal nanoparticle by uread e composition method
- Synthesis of Zinc Oxide nanoparticle

Theory lesson plan

1. Introduction to Nanotechnology
2. Introduction to Nanomaterials
3. Self-assembly to artificial assembly for creation of useful nanostructures
4. Bottoms up and Top down approach-Nanorods, nanocages, nanotubes, quantum dots, nanowires.
5. Bottoms up and Top down approach -metal/polymer-based nanostructures
6. Preparation and Characterization of nanoparticles-particle size analyzer
7. Preparation and Characterization of nanoparticles–electron microscopy
8. Preparation and Characterization of nanoparticles-atomic force microscopy
9. **First test**
10. Cell structure, Biomacromolecules –Types
11. Biomacromolecules –Structure
12. Biomacromolecules–Dynamics
13. Biomacromolecules–interaction with water
14. Cellular nanomachines
15. Cellular transducers
16. Membrane channels, membrane transporters
17. **Mid semester**
18. Membrane motors
19. Creation of bio-nanostructures-Nanoliposomes
20. Creation of bio-nanostructures –Nano micelles
21. Creation of bio-nanostructures –Nanomotors
22. Chemical properties of biomaterials
23. Physical properties of biomaterials
24. Biological properties of biomaterials
25. Bio response
26. biomineralization, biosynthesis
27. properties of natural materials
28. structure-property relationships in polymeric materials (synthetic polymers and structural proteins)
29. Aerosol properties, application and dynamics
30. Nanoparticular carrier systems; Micro-Nano-fluidics
31. Drug and gene delivery system; Microfabrication
32. Nano-imaging,
33. Metabolicengineering
34. Genetherapy

Practical lesson plan

1. Isolation of enzymes and nucleic acids involved in biosynthesis of nanomaterials
2. Synthesis of Gold Nanoparticles 1
3. Synthesis of Gold Nanoparticles2
4. Synthesis of silver Nanoparticles1
5. Synthesis of silver Nanoparticles20
6. Synthesis of micelles
7. Synthesis of inverse micelles

8. Synthesis of Carbon Nano-materials by Chemical Vapor Deposition
9. Synthesis of Carbon Nano-materials by Sputtering technique
10. Preparation of thiolate silver nanoparticles
11. Purification of carbon nano materials
12. Measurement of carbon nano materials
13. Zinc selenide quantum dot preparation
14. Synthesis of Iron Oxide Nanoparticle
15. Thin film preparation by spin coating technique
16. Synthesis of Nickel metal nanoparticle by urea decomposition method
17. Synthesis of Zinc Oxide nanoparticle

Course outcome

CO 1:Knowledge of molecular techniques involved in structure and functions of nano-biomolecules in cells such as DNA, RNA and proteins.
CO 2: Knowledge of molecular techniques involved in Creation of bio-nanostructures
CO 3: Knowledge of structure-property relationships in polymeric materials
CO 4: Knowledge of Nanoparticular carrier systems
CO 5: Knowledge of Gene therapy

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

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MBB 515 -ENVIRONMENTAL BIOTECHNOLOGY (3+0)

Learning objectives

- To study the basic concepts of environmental pollution and its management.
- To know about solid and water waste management techniques.
- To understand the Aerobic and Anaerobic processes.
- To get idea about the biogas production and biodegradation.
- Study about the biotechnological approaches for the management environmental problems.

Unit I - Basic concepts in Biotechnology

Basic concepts and environmental issues; types of environmental pollution; problems arising from high-input agriculture; methodology of environmental management; air and water pollution and its control.

Unit II - Waste Water Management

Waste water treatment -physical, chemical and biological processes; need for water and natural resource management. Microbiology and use of micro-organisms in waste treatment; biodegradation; degradation of Xenobiotic, surfactants; bioremediation of soil & water contaminated with oils, pesticides and toxic chemicals, detergents etc;

Unit III - Waste Resource management

Aerobic processes (activated sludge, oxidation ditches, trickling filter, rotating drums, etc); anaerobic processes: digestion, filtration, etc. Renewable and non-Renewable resources of energy; energy from solid waste; conventional fuels and their environmental impact.

Unit IV - Bio degradation and process of energy production

Biogas; microbial hydrogen production; conversion of sugar to alcohol; gasohol; biodegradation of lignin and cellulose; biopesticides; biofertilizers; composting; vermiculture etc.

Unit V - Hazard management

Treatment schemes of domestic waste and industrial effluents; food, feed and energy from solid waste; bioleaching; enrichment of ores by microorganisms; global environmental problems: ozone depletion, UV-B, greenhouse effects, and acid rain; biodiversity and its conservation; biotechnological approaches for the management environmental problems.

Theory lesson plan

1. Basic concepts and environmental biotechnology.
2. Environmental issues.
3. Types of environmental pollution and problems.
4. Problems arising from high-input agriculture.
5. Methodology of environmental management.
6. Air pollution and its control.
7. Water pollution and its control
8. Waste water treatment–physical process.
9. Waste water treatment –chemical process.
10. Waste water treatment–biological process.
11. Need for water and natural resource management.
12. Use of micro-organisms in waste treatment.
13. **First Test**
14. Biodegradation.
15. Biodegradation of Xenobiotic.
16. Biodegradation of surfactants.
17. Bioremediation of soil contaminated with oils and pesticides.
18. Bioremediation of water contaminated with oils and pesticides.
19. Bioremediation of soil contaminated with toxic chemicals and detergents.
20. Bioremediation of water contaminated with toxic chemicals and detergents.
21. Aerobic processes
22. Anaerobic processes.
23. **Mid-term**
24. Renewable sources of energy.
25. Non-Renewable sources of energy.
26. Energy from solid waste.
27. Conventional fuels and their environmental impact.
28. Biogas.
29. Microbial hydrogen production
30. Conversion of sugar to alcohol

31. Conversion of sugar to gasohol
32. Biodegradation of lignin
33. Biodegradation of cellulose
34. Biopesticides.
35. Biofertilizers
36. Composting
37. Vermiculture
38. Treatment schemes of domestic waste
39. Treatment schemes of industrial effluents
40. Food, feed and energy from solid waste
41. Bioleaching
42. Enrichment of ores by microorganisms
43. Global environmental problems
44. Ozone depletion
45. Green house effects
46. Acid rain
47. Biodiversity and its conservation
48. Biotechnological approaches for the management environmental problems
49. UV -B Radiation
50. **Final Examination**

Course Outcome

CO 1: Learning recent advances in management of environmental pollution.

CO 2: Understanding waste management techniques.

CO 3: Students will get an idea about aerobic and anaerobic processes.

CO 4: The students will have the ability to do biogas production.

CO 5: Gain knowledge on biotechnological approaches for the management environmental problems

CO-PO Mapping Matrix

	PO1	PO2	PO3	PO4	PO5
CO 1	-	-	-	-	-
CO 2	-	-	-	-	-
CO 3	-	-	-	-	-
CO 4	-	-	-	-	-
CO 5	-	2	1	-	-

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MBB 516-BIO-ENTREPRENEURSHIP (1+0)

LEARNING OBJECTIVES

- The objective of this course is to introduce to provide students with theory and practical experience of use of which facilitate investigation of molecular biology and evolution-related concepts.
- Research and business belong together and both are needed.
- Bio-entrepreneurship, an interdisciplinary course, revolves around the central theme of how to manage and develop life science companies and projects.
- The objectives of this course are to teach students about concepts of entrepreneurship including identifying a winning business opportunity.
- Gathering funding and launching a business, growing and nurturing the organization and harvesting the rewards.

Unit I-Introduction to industrial biotechnology

Scope in biotechnology; types of bio-industries – bio-pharma, bio-agri, bio-services and bio-industrial; Importance of entrepreneurship; introduction to bioentrepreneurship–biotechnology in a global scale;

Unit II-Entrepreneurship development agencies

Skills for successful entrepreneur–creativity, leadership, managerial, team building, decision making; opportunities for bio-entrepreneurship-entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Startup & Make in India)

Unit III-Preparation of business planning

Business plan preparation; business feasibility analysis by SWOT, socio-economic costs benefit analysis; funds/ support from various agencies; statutory and legal requirements for starting a company/venture.

Unit IV-Marketing skills developement

Entry and exit strategy; identifying needs of customers; Market linkages, branding issues; developing distribution channels - franchising; policies, promotion, advertising; branding and market linkages for 'virtual startup company'. Pricing strategy.

Unit V-Extension activities

Knowledge centers e.g., in universities, innovation centres, research institutions (public & private) and business incubators; R & D for technology development and upgradation; assessment of technology development; managing technology transfer;

Theory lesson plan

1. Introduction and scope in Bio-entrepreneurship
2. Types of bio-industries
3. Sub-industries of the bio-sector (e.g. pharmaceuticals-Industrial biotech).
4. Strategy and operations of bio-sector firms
5. Entrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Make in India)
6. Concept of Profit and Loss Account
7. Understanding Balance Sheet related concepts.

8. **Mid semester examination**
9. Marketing and Negotiations Strategies
10. Assessment of market demand for potential products
11. Identifying needs of customers including gaps in the market.
12. Knowledge centers and Technology transfer agencies,
13. Extension activities in innovation centres (private & public).
14. Virtual startup company–branding and market linkage.
15. Assessment of technology development
16. Extension-technology transfer tools.
17. **Final examination**

Course outcomes

CO1: The students be able to know about the fundamentals of entrepreneurship.
CO2: To know about the virtual startup company ideas
CO3: Students be able to know about the private and public funding agencies
CO4: To know about the business feasibility analysis by SWOT.
CO5: Students get an idea about branding and marketing issues

CO-PO Mapping matrix

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

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MBB 517: Stress Biology and Genomics (2+0)

Learning objectives

- To provide in depth knowledge of recent developments of biotic and abiotic stress tolerance in crops.
- To discuss case studies on advancement in tolerance technologies.
- Impart knowledge on biotic and abiotic stress tolerance
- Gain knowledge on transgenic crops for biotic resistance.
- To acquire complete information on physiological and biochemical pathway of stress.

Unit I-Environmental Stress in crop plants

Different kinds of stresses (biotic and abiotic) and adaptation strategies: Plant cell as a sensor of environmental changes; role of cell membranes in signal perception; Ways of signal transduction in cells and whole plants as a response to eXternal factors. Abiotic stresses affecting plant productivity–Drought, salinity, water logging, temperature stresses, light stress and nutrient stress; Drought stress – Effects on plant growth and development; Components of drought resistance; Physiological, biochemical and molecular basis of tolerance mechanisms; Biotic stress (insect and pathogen) resistance mechanism.

Unit II-Plant mechanism to overcome stress

Strategies to manipulate drought tolerance–Osmotic adjustment and Osmo protectants - synthesis of proline, glycine betaine, polyamines and sugars; ROS and antioxidants; hormonal metabolism-ABA signaling; signaling components-transcription factors. Water logging stress – effects on plant growth and metabolism; adaptation to water logging, tolerance mechanisms -hormones and flooding tolerance. Strategies for improving submergence tolerance. Salinity stress-effects on physiology and metabolism of plants, SOS pathway sandion homeostasis, Strategies to improve salinity tolerance in plants.

Unit III-Other stress affecting crop plants

Physiological and biochemical changes–High & Low temperature tolerance mechanisms molecular basis of thermo tolerance. Morphological and physiological changes in plants due to high and low light stresses - photo oxidation -plastid development. Characters of heliophytes and sciophytes–solar tracking–sieve effect and light channeling. Heavy metal stress – Al and Cd stress - effects on plant growth and development, biotech Strategies to overcome heavy metal stress Nutrient stress-effects on plant growth and development. Genetic manipulation strategies to overcome the stress effects.

Unit IV Genome Library

Genomics; transcriptomes, small RNAs and epigenomes; functional genomics; transfer of tolerance/resistant genes to model plants and validation of gene function. Different techniques for the functional validation of genes.

Unit V Transgenic crops

Signaling pathway related to defense gene expression, R proteins, RNAi approach and genes from pathogens and other sources, coat protein genes, detoxification genes, transgenic and disease management. Bt proteins, resistance management strategies in transgenic crops, ecological impact of field release of transgenic crops. Bioinformatics approaches to determine gene function and network in model plants under stress.

Theory lesson plan

1. Different kinds of stresses and adaptation strategies.
2. Plant cell as a sensor of environmental changes. Role of cell membranes in signal perception in stress response.
3. Signal transduction in cells and whole plants as a response to external factors.
4. Abiotic stresses affecting plant productivity–Drought, salinity, water logging.
5. Abiotic stresses affecting plant productivity–temperature stresses, light stress and nutrient stress.
6. Effects on plant growth and development under drought stress.
7. Components of drought resistance-Physiological, biochemical and molecular basis of tolerance mechanisms.
8. Biotic stress resistance mechanism.
9. **First Test**
10. Strategies to manipulate drought tolerance-Osmotic adjustment and Osmo protectants synthesis of proline, glycine betaine, polyamines and sugars.
11. Strategies to manipulate drought tolerance-ROS and antioxidants
12. Hormonal metabolism of drought tolerance-ABA signaling; signaling components-transcription factors.
13. Effect of water logging stress on plant growth and metabolism.
14. Adaptation techniques to water logging, tolerance mechanisms, hormones and flooding tolerance.
15. Strategies for improving submergence tolerance.
16. Salinity stress-effects on physiology and metabolism of plants. SOS pathways and ion homeostasis.
17. **Mid-Semester**
18. Strategies to improve salinity tolerance in plants.
19. Physiological and biochemical changes–High & Low temperature tolerance mechanisms-molecular basis of thermos tolerance.
20. Morphological and physiological changes in plants due to high and low light stresses-photooxidation-plastid development.
21. Characters of heliophytes and sciophytes –solar tracking–sieve effect and light channeling.
22. Heavy metal stress–Al and Cd stress -effects on plant growth and development.
23. Biotechnological strategies to overcome heavy metal stress Nutrient stress- effects on plant growth and development.
24. Genetic manipulation strategies to overcome the stress effects.
25. Genomics: functional genomics -transcriptomes, small RNAs and epigenomes.
26. Transfer of tolerance/resistant genes to model plants.
27. Techniques for the functional validation of genes.
28. Signaling pathway related to defense gene expression, R proteins, RNAi approach.
29. Transgenic disease management-genes from pathogens and other sources, coat protein genes, detoxification genes.
30. Bt proteins, resistance management strategies in transgenic crops.
31. Ecological impact of field release of transgenic crops.
32. Bioinformatics approaches to determine gene function
33. Network in model plants under stress.
34. **Orientation for Final Examination**

Course Outcomes

CO1 Learning recent advances of biotic and abiotic stress response.
CO2 Understanding hormone regulatory pathways.
CO3 Understanding the biological mechanism for environmental stress.
CO4 Learning the role of genomics in developing stress tolerant crops.
CO5 Gain knowledge on resistance management strategies in transgenic crops.

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

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MBB-518 Gene Regulation (2+0)

Learning objectives:

- To understand the basics of gene regulation including a wide range of mechanisms that are used by organisms to increase or decrease the production of specific gene products in terms of time, space, conditions or their combinations.
- The students will learn about regulatory sequences, DNA binding domains and Recruitment of RNA Polymerase to promotor regions
- The students will study about the Gene silencing by RNA synthesis and function
- To study about non coding RNAs and their impact, categories and role in gene regulation.
- To study about gene silencing and Negative and Positive auto-regulation.

Theory

Unit I-Transcriptional Regulation

Transcriptional regulation–Regulatory proteins, Activators and Repressors, Binding of RNA polymerase, Allosteric regulation, DNA looping, Cooperative binding, Anti-termination, Combinatorial control – Regulation of *lac, trp* and *ara* Operons. Gene regulation in Lambda phage–lyticorly so genic establishment.

Unit II-Regulatory sequences

Regulatory sequences – Promoters, Enhancers, Silencers, Insulators, Locus Control Region. Activator proteins and their binding sites, DNA binding domain – Homeodomain, Zinc containing proteins, Leucine Zipper Motif, Helix-Loop-helix, HMG proteins.

Unit III-Epigenetic gene regulation.

Recruitment of RNA polymerase to promoter region, Nucleosomes and their modifiers. Signal integration. Signal transduction and transcriptional regulation. Gene Silencing. Epigenetic gene regulation.

Unit IV-Gene Silencing by RNA synthesis and function

Regulation by RNA in prokaryotes and eukaryotes, RNA as defense agents. Ribo- switches. Gene Silencing by RNA- siRNA & miRNA –synthesis and function. Non- coding RNAs their impact, categories and role in gene regulation, chromatin assembly etc.

Unit V-Negative and Positive auto-regulation

Negative auto-regulation, Positive auto-regulation, Bistable and Bimodal switch, Oscillating pattern of gene expression.

Theory lesson plan

1. Define gene regulation and expression, Types, Transcriptional regulation–Regulatory proteins, Activators and Repressors.
2. Binding of RNA polymerase.
3. Allosteric regulation, DNA looping, Cooperative binding.
4. Anti-termination, Combinatorial control–Regulation of *lac* Operons.
5. *Trp* and *ara* Operons.
6. Regulatory sequences –Promoters, Enhancers, Silencers, Insulators, Locus control region.
7. Activator proteins and their binding sites
8. DNA binding domain–Homeodomain, Zinc containing proteins.
9. **First test**

10. Leucine Zipper Motif, helix-Loop-helix, HMG proteins.
11. Recruitment of RNA polymerase to promoter region,
12. Nucleosomes and their modifiers.
13. Signal integration and Signal transduction 14 transcriptional regulation.
15. Gene Silencing and types
16. Epigenetic gene regulation
17. **Mid semester**
18. Gene Regulation by RNA in prokaryotes
19. Gene Regulation by RNA in Eukaryotes
20. RNA as defense agents
21. Ribo-switches.
22. Gene Silencing by RNA-siRNA & miRNA–synthesis and function.
23. Advantages and disadvantages of gene silencing
24. Application of gene silencing. Transgene silencing.
25. Non-coding RNAs their impact.
26. Non-coding RNAs their categories.
27. Non-coding RNAs their role in gene regulation
28. Negative control in gene regulation
29. Difference between positive and negative gene regulation
30. Positive and negative control in gene regulation
31. Bistable and Bimodal switch
32. Positive and negative control in gene expression.
33. Regulatory mutants
34. Regulation of gene expression-regulation of lac operon.
35. Stages of gene expression
36. Oscillating gene
37. Circadian gene
38. Oscillating pattern of gene expression

Course outcomes

CO 1: It enables the students to understand the basics of gene regulation including a wide range of mechanisms that are used by organisms to increase or decrease the production of specific gene products.

CO 2: Impart knowledge on regulatory sequences, DNA binding and Recruitment of RNA Polymerase to promotor regions

CO 3: The study about the Gene silencing by RNA synthesis and function.

CO 4: The students learn about the non-coding RNAs and their impact, categories and role in gene regulation.

CO 5: It is helpful for the students to understanding the Oscillating pattern of gene expression.

	PO1	PO2	PO3	PO4	PO5
CO1	1				
CO2		1		3	
CO3		2			

CO4			1		2
CO5	1		2		

Reference

1. Nelson,D.L. and CoX,M.M. 2017. *Lehinger's Principles of Biochemistry*, 7th edition, WH Free man Publication NewYork
2. Krebs, J. E., Goldstein, E. S., Kilpatrick, S. T. 2017. *Lewin's Genes* XII 12th edition, Jones & Bartlett Learning publisher, Inc
3. J.D.,Baker,T.A.,Bell,S.P.,Gann,A.,Levine,M.,&Lonick,R.2014.*Molecular Biology of the Gene*, 7th Edition, Cold Spring Harbor Laboratory Press, NewYork.
4. Gardner,E.J.,SimmonsMJ and Snustad,D.P. 2006. *Principles of Genetics* (2006) eighth Edition. Wiley
5. Kang MS. (2003). Handbook of Formulas and Software for Plant Geneticists and Breeders. Haworth Press Inc, NewYork, USA
6. Srivastava, P.S., Narula A., Srivastava Sh. (2005). Plant biotechnology and molecular markers. Anamaya Publishers, New Delhi, India
7. Kang, M. S. (2002) Quantitative Genetics, genomics and Plant Breeding. CABI, USA.
8. Weising K., Nybom, H., Wolff, K. and Kahl, G. 2005. DNA Fingerprinting in Plants: Principles, Methods and Applications. Taylor & Francis, London.
9. Nagata,T.,Lorz,H. and Widholm,J.M. (2005) Molecular Marker Systems in Plant Breeding and Crop Improvement. Springer-Verlag Berlin, German
10. Chittaranjan, K. 2006-07. Genome Mapping and Molecular Breeding in Plants. Vols. I-VII. Springer-Verlag, USA.

e-resourses:

1. http://pressbooks-dev.oer.hawaii.edu/biology/chapter/prokaryotic-gene-regulation/
2. https://bio.libretexts.org/Bookshelves/Cell_and_Molecular_Biology/Book%3A_Basic
3. https://www.nature.com/scitable/topicpage/operons-and-prokaryotic-gene-regulation-992/
4. https://bioprinciples.biosci.gatech.edu/module-4-genes-and-genomes/4-7-gene-regulation/
5. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0028805

Common Courses

STA 501-STATISTICAL METHODS FOR APPLIED SCIENCES (2+1)

Objectives

To acquaint the students about the basics of statistics and design of experiments

Theory

Unit – I

Box – Plot, Descriptive Statistics, Exploratory data analysis, Theory of Probability, Random variable and Mathematical Expectations. Concept of Discrete and Continuous Probability Distributions: Binomial, Poisson, Normal Distributions and their applications.

Unit – II

Concept of Sampling distribution; Chi – Square, t and F distributions. Tests of Significance based on Normal, Chi – Square, t and F distributions.

Unit – III

Simple, Multiple and Partial Correlation Coefficient; Rank Correlation, Simple and Multiple Linear Regression, Test of Significance of Correlation of Coefficient and Regression Coefficient and Coefficient of Determination

Unit – IV

Need for Design of Experiments, Characteristics of a good design, Basic Principles of Design of Experiments, Completely Randomized Design, Randomized Block Design and Latin Square Design Layout and their analysis.

Unit – V

Concepts of Factorial experiments 2^n, 3^2 factorial experiments; Concepts of Confounding in factorial experiments – Confounding in 2^3 factorial experiments; partial and total confounding; Split – plot design and Strip – plot design.

Lecture schedule

1. Meaning of Box-Plot
2. Descriptive Statistics – Concepts
3. Exploratory data analysis
4. Theory of Probability
5. Random variable and Mathematical Expectation
6. Discrete probability distributions – binomial and poison distribution
7. Continuous probability distributions – normal distribution and their application
8. Concept of sampling distribution – Standard Error
9. **First Test**
10. t distribution, F and Chi square distribution
11. Tests of significance based on t, z, (mean and equality of means only). X^2 test for goodness of fit.
12. Definition of correlation, significance and types
13. Properties of correlation coefficient
14. Definition of regression – measuring and uses of regression analysis properties.
15. Differences between correlation and regression.
16. Regression co – efficient - simple, linear.
17. **Mid- semester examination**
18. Multiple linear regression co - efficient – standard error of estimate
19. Test of significance of observed regression co -efficient and co - efficient of determination.
20. Characteristics of agricultural experiments: concepts – field studies.
21. Characteristics of agricultural experiments -pot-culture – quantitative and qualitative variables.
22. Sources of errors and estimate of errors
23. Design of Experiments– Basic principles
24. Completely Randomized Design
25. Randomized Block Design
26. Latin Square Design
27. Comparison of treatments – least significant difference method
28. Duncan's Multiple Range Test (DMRT)
29. Concept of factorial experiments

30. 2^n, 3^2 Factorial experiments
31. Principle of confounding in factorial experiments
32. Confounding in 2^3 Factorial experiments
33. Split-pot design
34. strip – plot design

Practical schedule

1. Estimation of samples statistic viz., means, SD, SE and CV.
2. Fitting of distributions – binomial and poison.
3. Z-test, t-test and paired t-test.
4. Comparison of two variances using F-test.
5. Bartlett's test for homogeneity of variances.
6. Chi-square test for test of goodness of fit and homogeneity of ratio test for independence of attributes.
7. Computation of correlation co-efficient and it's significance
8. Fitting of simple linear regression and testing the significance of regression coefficient
9. Multiple linear regressions fitting and testing
10. Determination of optimum plot size using uniformity trial.
11. Analysis of CRD and RBD
12. Analysis of LSD and DMRT
13. 2^2 Factorial Experiment
14. 2^3Factorial Experiment
15. Complete confounding in 2^3 Factorial Experiment
16. Analysis of Split-plot and Strip-plot design
17. **Final practical Examination**

Reference Books

1. Bhattacharyya, G.K. and R.A. Johnson. 1997. Statistical concepts and methods, John Wiley and Sons, New York.
2. Crozon, F.E. and D.J. Cowden . 1986. Applied General Statistics, Prentice Hall of India, New Delhi.
3. Gomez, K.A. and A.A. Gomez. 1984. Statistical procedure for Agricultural Research, John Wiley and Sons, New York.
4. Panse, V.G. and P.V. Sukhatme. 1961. Statistical methods for Agricultural Workers, ICAR, New Delhi.
5. Ramaswamy, R. 1995. A text book of Agricultural Statistics, Wiley Limited, New Delhi.

COM-501 INFORMATION TECHNOLOGY IN AGRICULTURE (2+1)

OBJECTIVES

1. Introduction to Networking and Internet Applications that aims at exposing the students to understand analogy of computer, basic knowledge of MS Office.
2. Give students an in-depth understanding of why computers are essential components in business, education and society.
3. Provide hands-on use of Microsoft Office applications Word, Excel, Access and PowerPoint. Completion of the assignments will result in MS Office applications knowledge and skills.

4. To get familiar with basics of the Internet Programming and different IT tools in Agriculture.

Theory

Unit I

Introduction to Computers, Anatomy of computer, Operating Systems, definition and types, Applications of MS Office for document creation & Editing, Data presentation, interpretation and graph creation, statistical analysis, mathematical expressions.

Unit II

Database, concepts and types, uses of DBMS in Agriculture, World Wide Web Statistical Sciences: Computer Application.

(WWW): Concepts and components, Introduction to computer programming languages, concepts and standard input/output operations. e-Agriculture, concepts and applications.

Unit III

Programming fundamentals with C – Constants and Variables – Data Types – Arithmetic expressions – assignment statements - Logical expressions – Control flow – Arrays and Structures.

Unit IV

Hyper Text Markup Language (HTML), DHTML, web based application development. Static websites, dynamic websites. Client Side processing – scripting languages.

Unit V

Use of ICT in Agriculture, Computer Models for understanding plant processes. IT application for computation of water and nutrient requirement of crops, Computer controlled devices (automated systems) for Agri-input management, Smartphone Apps in Agriculture for farm advises, market price, postharvest management etc.,

Lecture schedule

1. Introduction to Computers, Anatomy of Computers.
2. Memory concepts.
3. Booting sequence of operating system.
4. Operating systems.
5. DOS, Windows, Unix
6. Types of VIRUS.
7. MS Office word, Creating, Editing, Formatting a document and saving a document.
8. MS Excel Data Presentation, Data graph creation.
9. MS Power Point Presentation.
10. MS Access Concepts of Database, Creating Database.
11. Statistical analysis and mathematical expressions.
12. Database Concepts.
13. Database in Agriculture.
14. Internet - World Wide Web (WWW)
15. Programming Languages, Computer programming languages.
16. e-Agriculture concepts and applications.
17. Programming Fundamentals with C.
18. **Mid Semester Examination**
19. Constant and Variable.
20. Data Types.
21. Operators.

22. Arrays and Structures.
23. HTML-DHTML.
24. Web based applications development.
25. Client side processing.
26. Scripting Languages
27. ICT in Agriculture.
28. IT application.
29. Computer Control devices.
30. Agri input management.
31. Smartphone Apps in Agriculture.
32. Agriculture for farm advises.
33. Agri-input management.
34. Postharvest management.

Practical schedule

SL.	List of Programs
1.	MSWORD- Creating, Editing and Presenting a Scientific Document
2.	MS POWER POINT- creating, editing and presenting a scientific Document
3.	MSEXCEL- Creating a spreadsheet, writing expressions, Entering formula expression through the formula tool bar and use of inbuilt statistical, mathematical functions
4.	MSEXCEL- Creating graphs, analysis of scientific data- Data analysis t-test, Regression, ANOVA
5.	MSACCESS: Creating Database, preparing queries and reports
6.	MSACCESS: Demonstration of Agri-information system
7.	C program to find addition and subtraction of two numbers
8.	C Program to find whether the given input is palindrome or not
9.	C program to find the given number is Armstrong or not
10.	C program for finding Fibonacci series.
11.	C Program to find Factorial of a given number.
12.	C Program for calculating student grade using if-else and switch statement
13.	Introduction to World Wide Web (WWW) and its components
14.	HTML: Creation of website
15.	HTML: Creation of Scientific Calculator

16.	Internet: Presentation and management agricultural information through web
17.	Practical Exam

Course outcomes

At the end of the course students will be able to

CO 1: Describe the usage of computers and why computers in society.

CO2: E-Agriculture concepts and applications

CO 3: Learn categories of programs.

CO 4: Web based application development

CO 5: Information Technology applications and systems.

CO-PO Mapping matrix

	PO 1	PO2	PO3	PO4
CO1	3	3	3	3
CO2	0	1	3	1
CO3	0	3	2	3
CO4	3	0	0	0
CO 5	0	3	2	0

References

1. Satish Jain, M Geetha, Kratika, (2012) Computer Course Windows 7 With Ms Office 2010, Bpb Publications.
2. Anupama Jain and AvneetMehra (2012), Computer Fundamental MS Office: Including Internet & Web Technology 2010.
3. Programming in Ansi C Paperback – 8 May 2012, by E Balagurusamy (Author).
4. Cox V, Wermers L and Reding E.E. 2006. *HTML Illustrated Complete*. 3rd Ed. Course Technology.
5. Meera SN 2008 ICTs in agricultural extension: Tactical to practical.

COMPULSARY COMMON COURSES

PGS501 - AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES (1+0)

Objective

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programme and policies of Government.

Unit I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural

Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

Unit II

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

Unit III

Concept and connotations of rural development, rural development policies and strategies. Rural development programme: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/ Non-Governmental Organisation. Critical evaluation of rural development policies and programme. Constraints in implementation of rural policies and programme.

Unit IV

Research prioritization and selection of research problem – Research planning - review of literature – setting of objectives and hypothesis – research design and techniques – data collection – analysis – formulation of tables – interpretation of results- Computer software in tabulation, presentation - Thesis writing – writing of research articles-projects and report writing – Formulation and preparation of research / scheme proposal – Impact factor and citation index - citation and references- Guidelines for oral / poster presentations – Internet in scientific research.

Unit V

Authorship and copy right – Plagiarism – Scientific misconduct – Falsification of research results, data fabrication – Peer review, informed consent attribution of authorship and adequacy of peer review publication process -Responsibility of society and self – Public interest in research, relevance to society and motivation - Conflict of interest, moral commitment – Social trends on research ethics, adequate codes of conduct to regulate research activity.

Theory lecture schedule

1. History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment
2. National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR); International Agricultural Research Centres (IARC)
3. Partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.
4. Research ethics: research integrity, research safety in laboratories
5. **First test**
6. Welfare of animals used in research, computer ethics, standards and problems in research ethics.
7. Concept and connotations of rural development, rural development policies and strategies.

8. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Co-operatives, Voluntary Agencies/ Non-Governmental Organisations.
9. **Mid semester examination**
10. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.
11. Research prioritization and selection of research problem – Research planning - review of literature – setting of objectives and hypothesis – research design and techniques
12. Data collection -– analysis – formulation of tables – interpretation of results- Computer software in tabulation and presentation
13. Thesis writing – writing of research articles- projects and report writing – Formulation and preparation of research / scheme proposal
14. Impact factor and citation index - citation and references- Guidelines for oral / poster presentations – Internet in scientific research.
15. Authorship and copy right – Plagiarism – Scientific misconduct – Falsification of research results, data fabrication – Peer review, informed consent attribution of authorship and adequacy of peer review publication process
16. Responsibility of society and self – Public interest in research, relevance to society and motivation - Conflict of interest, moral commitment
17. Social trends on research ethics, adequate codes of conduct to regulate research activity

Reference

1. Bhalla GS and Singh G. 2001. *Indian Agriculture - Four Decades of Development*. Sage Publ.
2. Punia MS. *Manual on International Research and Research Ethics.* CCS Haryana Agricultural University, Hisar.
3. Rao BSV. 2007. *Rural Development Strategies and Role of Institutions - Issues, Innovations and Initiatives*. Mittal Publ.
4. Singh K. 1998. *Rural Development - Principles, Policies and Management*. Sage Publ.

PGS 502 - TECHNICAL WRITING AND COMMUNICATION SKILLS (0+1)

Objective

- To equip the students with skills *Viz.*, writing of dissertations, research papers, etc. and to communicate and articulate in English

Practical

Grammar - Tenses, parts of speech, clauses, punctuation marks; Error analysis Common errors; Concord; Collocation; Phonetic symbols and transcription; Accentual pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers. Proof reading. Technical Writing - Various forms of scientific writings- theses, technical papers, reviews, manuals, etc; Structure of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs

and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

Practical schedule

1. Grammar (Tenses, parts of speech)
2. Grammar (clauses, punctuation marks)
3. Error analysis (Common errors); Concord; Collocation;
4. Phonetic symbols and transcription;
5. **First test**
6. Accentual pattern: Weak forms in connected speech
7. Participation in group discussion, Facing an interview; presentation of scientific papers.
8. Technical Writing- Various forms of scientific writings- theses, technical papers
9. **Mid -semester examination**
10. Technical Writing- reviews, manuals
11. Structure of thesis and research communications
12. Writing of abstracts, summaries, précis, citations etc
13. Commonly used abbreviations in the theses and research communications
14. Illustrations, photographs and drawings with suitable captions
15. Pagination, numbering of tables and illustration, numbers and dates in scientific write-ups
16. Editing and proof-reading, Writing of a review article.
17. Final practical examination

Suggested Readings

1. Joseph G. 2000. MLA Handbook for Writers of Research Papers. 5th Ed. Affiliated East-West Press.
2. Mohan K. 2005. Speaking English Effectively. MacMillan India.
3. Richard WS. 1969. Technical Writing. Barnes & Noble.
4. Robert C. (Ed.). 2005. Spoken English: Flourish Your Language. Abhishek.
5. Wren PC & Martin H. 2006. High School English Grammar and Composition. S.Chand& Co.

PGS 503- BASIC CONCEPTS IN LABORATORY TECHNIQUES (0 + 1)

Objective

To acquaint the students about the basics of commonly used techniques in laboratory.

Practical

Unit-I-Safety measures and common laboratory equipment's

Safety measures while in labs; Handling of chemical substances; use of burettes, pipettes, measuring cylinders, flasks,separator funnel, condensers and micropipettes. Washing, drying and sterilization of glassware; drying of solvents/ chemicals.

Unit-II - Preparation of standard solutions

Weighing and preparation of solutions of different strengths and their dilution ; Handling techniques of solutions; preparations of different Agro-chemical doses in field and pot applications; preparation of solutions of acids; Neutralization of acid and bases ;preparation of buffers of different strengths and ph values.

Unit-III-Use and handling of laboratory equipment's

Use and handling of vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sand bath and water bath.

Unit-IV - Microscopy and media preparation

Use and handling of microscope and laminar flow-preparation of media- differential, selective and enriched media. Methods of sterilization –physical methods-dry and moist heat, cold, filtration and radiation, chemical methods and disinfectants.

Unit-V - In-vitro culture techniques

Description of flowering plants in botanical terms in relation to taxonomy- seed viability test-pollen fertility test-tissue culture media-composition of media-media preparation –instant media-aseptic manipulation-procedure for in vitro culture of explants-leaf bit-stem bit-anthers-pollen –microspores-ovule and embryo.

Practical schedule

1. Safety measures in labs and handling of chemical substances.
2. Common laboratory equipment's. Calibration and cleanliness of volumetric glass wares.
3. Methods of expressing strength of solutions.
4. Preparation of primary standard solutions and buffer solutions.
5. **First test**
6. Preparation of standard solutions for nutrient analysis of soil, plant and water.
7. Preparation of different Agro-chemical doses for field experiments, Preparation of buffer solutions,
8. Handling of instruments-vacuum pumps, thermometers, and magnetic stirrer.
9. **Mid semester Examination**
10. Handling of instruments-ovens, sand bath and water bath.
11. Handling and uses of microscopes and laminar flow.
12. Sterilization by physical methods and Sterilization by chemical methods.
13. Preparation of different media for culturing the micro-organisms.
14. Description of flowering plants-seed viability test and pollen fertility test.
15. Aseptic manipulations and media.
16. In vitro culture of different explants.
17. Final practical examination

References

1. Furr, A.K.2000.Handbook of laboratory safety. CRC press.
2. Jackson, M.L. 1997. Soil Chemical Analysis. Prentice Hall of India pvt. Ltd., New Delhi.
3. Prescott.L.M, Harley, P and Klein, A. 2003. Microbiology, 5th Edition, McGraw Hill, USA.
4. Gupta, P.K. 1997.Elements of Biotechnology, Rastogi Publications. Meerut.
5. Singh, B.D. 2005.Biotechnology, Expanding Horizons, Kalyani Publications, New Delhi.

e-Reference

1. Analytical chemistry vol.1 (pdf) www.freebookcentre.net.

2. MichealZehfusAnalytical chemistry www.freebook centre.net.
3. Introduction to Instrumental Analytical Chemistry Roger Terrilwww.freebookcentre.net.
4. Analytical Chemistry lecture notes sadhu malyadricentre.net.
5. Manfred Sietz and Andreas Sonnenberg. Short introduction into analytical chemistry www.freebookcentre.net.

PGS 504 - LIBRARY AND INFORMATION SERVICES 0+1

Objective

- To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines etc.) of information search.

Practical

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary -Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services - (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing - information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized - library services; Use of Internet including search engines and its resources; e-resources access methods.

Practical Schedule

1. Introduction to library and its services
2. Role of libraries in education, research and technology transfer;
3. Classification systems and organization of library
4. Sources of information- Primary Sources, Secondary Sources and Tertiary Sources
5. **First test**
6. Intricacies of abstracting and indexing services
7. Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.);
8. Tracing - information from reference sources; Literature survey
9. **Mid- Semester**
10. Citation techniques/Preparation of bibliography;
11. Use of CD-ROM Databases,
12. Online Public Access Catalogue and other computerized - library services
13. Online Public Access Catalogue and other computerized - library services
14. Use of Internet including search engines and its resources 15. Use of Internet including search engines and its resources
15. e-resources access methods.
16. Final practical examination

PGS-505 INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE (1+0) (e-course)

Objectives

The objective of the course is to create awareness about intellectual property rights in agriculture. The course deals with management of patents, trademark, geographical indications, copy rights, designs, plant variety protection and biodiversity protection. The students will be taught on the marketing and commercialization of intellectual properties.

Theory

Unit I- World trade organization - introduction

World Trade Organization - Agreement on Agriculture (AOA) and Intellectual Property Rights (IPR) - importance of intellectual property management - IPR and economic growth - IPR and bio diversity - major areas of concern in intellectual property management - technology transfer and commercialization - forms of different intellectual properties generated by agricultural research.

Unit II- Patent document

Discovery *versus* invention - patentability of biological inventions - procedure for patent protection - preparatory work - record keeping, writing a patent document, filing the patent document - types of patent application - patent application under the Patent Cooperation Treaty (PCT).

Unit III- Plant genetic resources

Plant genetic resources - importance and conservation - sui generic system - plant varieties protection and farmers' rights act - registration of extinct varieties registration and protection of new varieties / hybrids / essentially derived varieties - dispute prevention and settlement - farmers' rights.

Unit IV- Trademark

Trademark - geographical indications of goods and commodities - copy rightsdesigns - biodiversity protection.

Unit V- Benefit sharing

Procedures for commercialization of technology - valuation, costs and pricing of technology - licensing and implementation of intellectual properties - procedures for commercialization - exclusive and non exclusive marketing rights - research exemption and benefit sharing.

Theory schedule

1. World Trade Organization - Agreement on Agriculture (AOA) and Intellectual Property Rights (IPR)
2. Importance of intellectual property management - IPR and economic growth - IPR and bio diversity
3. Major areas of concern in Intellectual property management - technology transfer and commercialization
4. Forms of different intellectual properties generated by agricultural research
5. **First test**
6. Discovery versus invention patentability of biological inventions
7. Procedure for patent protection, Preparatory work - record keeping, writing a patent document, filing the patent document
8. Types of patent application - patent application under the Patent Cooperation Treaty (PCT)

9. **Mid semester examination**
10. Plant genetic resources - importance and conservation
11. Sui generic system - plant varieties protection and farmers' rights act registration of extant varieties
12. Registration and protection of new varieties / hybrids / essentially derived varieties - dispute prevention and settlement - farmers' rights
13. Trade mark - geographical indications of goods and commodities - copy rights – designs, Biodiversity protection,
14. Procedures for commercialization of technology - valuation, costs and pricing of technology
15. Licensing and implementation of intellectual properties - procedures for commercialization
16. Exclusive and non-exclusive marketing rights - research exemption and benefit sharing.
17. **Final practical examination**

Reference books

1. Arun Goyal and Moor Mohamed, 2001. *WTO in the New Millennium*, Academy of Business Studies, New Delhi.
2. Bilek Debroy, 2004. *Intellectual Property Rights*, BR World of books, New Delhi.
3. Ganguli, P., 2001. *Intellectual Property Rights - Unleashing the Knowledge Economy*. Tata McGraw Hill, New Delhi.
4. Narayanan, R., 2006. *Patent Law*, Eastern Law House, New Delhi.
5. Ramappa, T., 2000. *Intellectual Property Rights under WTO - Tasks before India*, Wheeler Publishing, New Delhi.

Non gradial compulsory courses

NGC 001* DISASTER MANAGEMENT (1+ 0)

(e-Course)

Objectives

- To introduce students to the key concepts and practices of mitigation for natural disasters and calamities and to equip them for disaster preparedness to conduct thorough assessment of hazards, risks vulnerability and capacity building strategies.

Theory

Unit I – Natural disaster

Natural Disasters - meaning and nature of natural disasters, their types and effects. Floods, drought, cyclone, earthquakes, landslides, avalanches, volcanic eruptions, heat and cold waves.

Unit II – Climate change

Climatic change - Global warming, sea level rise, ozone depletion, Manmade disasters - Nuclear disasters, chemical disasters, biological disasters.

Unit III – Man – made disaster

Building fire, coal fire, forest fire, oil fire, air pollution, water pollution, deforestation, industrial waste water pollution, disaster management- efforts to mitigate natural disasters at national and global levels – India's key hazards, vulnerabilities and disaster response mechanisms in India.

Unit IV – Disaster warning, response and preparedness

Concept of disaster management, national disaster management framework; financial arrangements, role of NGOs, community-based organizations, and media central, state, district and local administration. Dissemination of disaster warning, response to natural disasters, national, state, district level, relief – food and nutrition – water – health – mental health services.

Unit V – Rehabilitation

Rehabilitation – food - clothing - utensils - fuel – shelter – relief camp – sanitation and hygiene. Resilent farming concepts – reclamation and revival of the agriculture system after natural disaster (Bio-shield). Preparedness – Emergency Operations Centres (EOCS).

Theory lecture schedule

1. Natural Disaster - meaning and nature of natural disasters, their types and effects.
2. Flood, drought, cyclone, earthquakes landslides, avalanches, volcanic eruptions, Heat and cold waves.
3. Climatic change- Global warming, sea level rise, ozone depletion
4. **First test**
5. Manmade disaster - Nuclear disasters, chemical disasters, biological disasters.
6. Building fire, coal fire, forest fire. oil fire.
7. Air pollution, water pollution, deforestation, industrial wastewater pollution.
8. Disaster management- efforts to mitigate natural disasters. India's key hazards, vulnerabilities and disaster response mechanism in India.
9. **Mid-Semester examination**
10. Concept of disaster management, national disaster management framework.
11. Financial arrangements, role of NGOs, community-based organizations and media.
12. Central, state, district and local administration.
13. Dissemination of disaster warning - response to natural disasters, national, state, district level.
14. Relief – food and nutrition – water – health – mental health services.
15. Rehabilitation – tolerant and resistant crops- resilient farming concepts – bioshields - livelihood options – insurance and compensation.
16. Disaster preparedness - clothing and utensils and fuel – shelter – relief camp – sanitation and hygiene.
17. Preparedness – Emergency Operations Centers (EOCS).

References

1. Gautam, D R. 2009. *Community based disaster risk reduction*. Mercy Corps, Lalitpur, Nepal.
2. Gupta, HK. 2003. *Disaster management*. Indian National Science Academy. Orient Blackswan.
3. Hodgkinson, PE and Stewart, M. 1991. *Coping with Catastrophe: A handbook of disaster management.* Routledge.
4. Ministry of Home Affairs. 2010. *Standard operating procedure for responding to natural disasters,* Ministry of Home Affairs – Disaster management Division, New Delhi.
5. Sharma,VK.2001. *Disaster management*. National Centre for Disaster Management, India.
6. Das, H.P. 2016. *Climate change and agriculture implications for global food security*. BS Publications, Hyderabad.

7. Kelkar, R.R. 2010. *Climate change -A Holistic view*. BS Publications, Hyderabad.

e resources

1. http:// research.un.org/en/disaste
2. https://searchworks.stanford.edu/
3. http://guodes.litrary.illinois.edu>c.php
4. http:// libguides. auu.edu.au>c.php
5. www.wcpt.org

NGC 512* CONSTITUTION OF INDIA (1+0)

Objectives

1. To understand the basic feature of Indian constitution
2. To gain knowledge about basic rights and duties of Indian citizens
3. To ponder over the form of Indian Political system
4. To have broad understanding about the pivotal provision related with liberty, quality and fraternity

Theory

Unit I-Constitution of india and **basic features and fundamental principles**

Meaning of the Constitution and Constitutionalism - Origin & Development of the Constitution of India - salient features of the Constitution of India.

Unit II-fundamental rights and duties

Fundamental Rights - Fundamental Duties - The Directive Principles of state policy

Unit III- Union government

Executive: President, Prime Minister and Council of Ministers. –Legislature, Parliament- Judiciary: Supreme Court

Unit IV-State government and local government

Executive: Governor, Chief Minister and Council of Ministers -Legislature- High Courts - Local Governments

Unit V-Constitutional commissions

Election Commission -UPSC- Finance Commission

Lecture schedule

1. Constitution of India – Definition, Basic features
2. Fundamental principles
3. Difference between constitution and constitutionalism
4. **First test**
5. Origin and development of constitution
6. Salient features of constitution of India
7. Fundamental rights and Fundamental duties
8. Direct principles of state policy
9. **Mid Semester Examination**
10. Union government - President, Prime Minister and Council of Ministers
11. Legislature, Parliament
12. Judiciary: Supreme Court
13. Executive: Governor
14. Chief Minister and Council of Ministers and Legislature
15. High Courts and Local Governments
16. Election Commission and UPSC
17. Finance Commission

References

1. The Constitution of India2017Kindle Edition- Government of India
2. Bahkshi P. M. 2015 The Constitution of India. Universal Law Publishing Co Ltd
3. Pylle M.V. 2018 An Introduction to The Constitution of India. Vikas Publishing
4. Bhansali S.R.2015. Textbook on The Constitution of India. Universal LexisNexis

ANNEXURE-1

PROFORMA FOR FORMATION OF RESEARCH ADVISORY COMMITTEE

(To be sent before the end of I Semester)

1. Name of the student :
2. Enrolment number: Reg. No. :
3. Degree :
4. Subject :
5. Advisory Committee :

S.No.	Advisory Committee	Name, Designation and Department	Signature
1.	Chairperson		
2.	Members		
	Additional Member		
	Reasons for additional Member		

Professor and Head

Additional members may be included only in the allied faculty related to thesis research with full justification at the time of sending proposals (Program of research).

ANNEXURE-II

PROFORMA FOR CHANGE IN THE RESEARCH ADVISORY COMMITTEE

1. Name of the student :
2. Enrolment number : Reg. No.
3. Subject :
4. Degree :
5. Proposed Change :

Advisory Committee	Name and designation	Signature
a. Existing member		
b. Proposed member		

6. Reasons for change

Chairperson

Signature of Professor and Head

ANNEXURE-III

PROFORMA FOR OUTLINE OF RESEARCH WORK (ORW)

(To be sent before the end of I Semester)

1. Name :
2. Enrolment number : Reg. No.
3. Degree :
4. Subject :
5. Date of Joining :
6. Title of the research project :
7. Objectives :
8. Duration :
9. Review of work done :
10. Broad outline of work/methodology :
11. Semester wise break up of work :

Signature of student

Approval of the advisory committee

Advisory committee	**Name**	**Signature**
Chairperson		
Members		
1.		
2.		

Professor and Head

ANNEXURE-IV

PROFORMA FOR CHANGE IN OUTLINE OF RESEARCH WORK (ORW)

1. Name :

2. Enrolment number : Reg. No

3 Degree :

4 Subject :

5 Reasons for change :

6 Proposed change in the approved Program of research :

7 Number of credits completed so far Under the approved program :

8 a. Whether already earned credits are to be retained or to be deleted :

b. if retained, justification :

Signature of the student

Approval of the Advisory Committee

Advisory committee	**Name**	**Signature**
Chairperson		
Members		
Intra		
Inter		

Professor and Head

ANNEXURE-V

DEPARTMENT OF _____

PROFORMA FOR EVALUATION OF SEMINAR

1. Name of the candidate :
2. Register Number :
3. Degree programme :
4. Semester :
5. Topic of the seminar and credit :
6. Distribution of marks

Distribution of marks	Max Marks				
i.Literature coverage	40				
ii.Presentation	30				
iii.Use of audio – visual aid	10				
iv.Interactive skills	20				
Total	100				
Name					
Designation		Chairperson	Intra Member	Inter Member	Average
Signature					

Grade point:

Head of the Department

ANNEXURE-VI

PROFORMA FOR REGISTRATION OF RESEARCH CREDITS

(To be given during first week of semester)

PART A: PROGRAM

Semester: Year: Date of registration:

1. Name of the student :
2. Enrolment number :Reg. No.:
3. Total research credits completed so far:
4. Research credits registered during the semester:
5. Program of work for this semester (list out the Items of research work to be undertaken during the semester) :

Approval of advisory committee

Advisory committee	**Name**	**Signature**
Chairperson		
Members		
1. Intra		
2. Inter		

Professor and Head

Approval may be accorded within 10 days of registration

ANNEXURE-VII

PROFORMA FOR EVALUATION OF RESEARCH CREDITS

PART B EVALUATION

(Evaluation to be done before the closure of Semester)

Date of Commencement semester: Date of closure of semester:

Date of evaluation :

1. Name of the student :
2. Enrolment number : Reg. No.:
3. Total research credits completed so far:
4. Research credits registered during the semester:
5. Whether the research work has been carried out as per the approved program :
6. If there is deviation specify the reasons :
7. Performance of the candidate : SATISFACTORY /NOT SATISFACTORY

Approval of the advisory committee

Advisory committee	**Name**	**Signature**
Chairperson		
Members		
1.Intra		
2.Inter		

Professor and Head

ANNEXURE- VIII
ANNAMALAI UNIVERSITY
FACULTY OF AGRICULTURE
DEPARTMENT OF _____
PROFORMA FOR EVALUATION OF THESIS

1. Name of the examiner :
2. Postal Address :
3. Telephone/Mobile :
4. E-Mail :
5. Name of the candidate :
6. Title of the thesis :
7. Date of receipt of the thesis copy:
8. Date of dispatch of the detailed report and thesis by the examiner to the Controller of Examinations :
9. Examiner's recommendations choosing one of the following based on quality of thesis

   Please give your specific recommendation (select any one decision from the list below) with your signature and enclose your detailed report in separate sheet(s).

a. I recommend that the thesis entitled ----------
   ---
   submitted by ---------- be accepted for award of the Degree of MASTER OF SCIENCE (AGRICULTURE / HORTICULTURE / AGRI BUSINESS MANAGEMENT) of Annamalai University, Annamalai nagar.

(OR)

b. I do not recommend the acceptance of the thesis entitled.

   ---------- Submitted by ----------
   for award of the Degree of MASTER OF SCIENCE (AGRICULTURE / HORTICULTURE / AGRI BUSINESS MANAGEMENT) of Annamalai University, Annamalainagar. (Please specify reasons)

Date:

Signature with Office Seal:

Note- Please enclose a detailed report in duplicate duly signed by you giving the merits and demerits of the thesis on the choice of problem, review of literature, methods followed, results and discussion, etc.

PROFORMA FOR REPORT OF THE FINAL VIVA VOCE EXAMINATION

The meeting of the Examining Committee for Mr./Ms. ----------M.Sc.(Ag.) Student Reg.No. ---------- Majoring in ----------was held at ----------a.m /p.m on ----------

The following members were present:

1. ---------- : Chairperson
2. ---------- : Member
3. ---------- : Member
4. _____ : External examiner

The committee took note of the report of the external examiner Dr. ----------recommending the thesis for acceptance.

The final viva voce examination for the candidate was conducted by the members of the Advisory Committee and external examiner. The candidate has secured satisfactory/unsatisfactory

The Committee recommends/ does not recommend unanimously the award of Degree of M.Sc.(Ag.).to Mr./Ms.----------

1. Chairman
2. Member
3. Member
4. External examiner:

The original report from the External Examiner is attached herewith

Chairperson of the Advisory Committee

Professor and Head

CERTIFICATE FOR HAVING CARRIED OUT THE SUGGESTIONS OF THE EXTERNAL EXAMINER AND ADVISORY COMMITTEE

Certified that Mr./ Ms. ---------- Reg. No. ----------has carried out all the corrections and suggestions as pointed out by the External examiner and the Advisory Committee. He / She has submitted **TWO** copies of his/ M.Sc.(Ag.)./(Hort.)/Agri Business Management thesis in hard bound cover and two soft copies in CD format, two copies each of the abstract of thesis and summary of the findings both in Tamil and English in CD format.

Chairperson

Professor and Head

ANNAMALAI UNIVERSITY

DEPARTMENT OF _____
FACULTY OF AGRICULTURE

Date:

CERTIFICATE

This is to certify that the thesis entitled "----------" submitted in partial fulfillment of the requirements for the award of the degree of **----------** to Annamalai University, Annamalai nagar is a record of bonafide research work carried out by ----------, under my guidance and supervision and that no part of this thesis has been submitted for the award of any other degree, diploma, fellowship or other similar titles or prizes and that the work has been published / not been published in part or full in any scientific or popular journals or magazines.

Chairman

1. Chairman :
2. Member :
3. Member :
4. External examiner :