ANNAMALAI UNIVERSITY
DEPARTMENT OF MICROBIOLOGY
FACULTY OF AGRICULTURE

S.no.	Course Code	Course Title	Credit Hours
		Compulsory Major Courses	
1	AGM - 501	Principles of Microbiology	3(2+1)
2	AGM - 502	Microbial Genetics	3(2+1)
3	AGM - 503	Microbial Physiology	3(2+1)
4	AGM - 504	Soil Microbiology	3(2+1)
5	AGM - 505	Food Microbiology	2(1+1)
6	AGM - 506	Biofertilizer Technology	3(2+1)
7	AGM- 507	Environmental Microbiology	3(2+1)
8	AGM -508	Microbial Taxonomy	3(2+1)
9	AGM- 509	Microbial Management of organic waste	2(1+1)
10	AGM- 510	Marine Microbiology	3(2+1)
11	AGM- 511	Industrial Microbiology	3(2+1)
12	AGM 591	Master's Seminar	1 (0+1)
13	AGM 599	Research	30(0+30)
16	PGS - 503	Basic concept in lab techniques	1(0+1)

PG Regulation

Distribution pattern of courses and credits (for research program)

Sl. No	Courses	Credit hours
	First Semester	
1	**Major courses**	**8**
	AGM501: Principles of Microbiology	3(2+1)
	AGM503: Microbial Physiology	3(2+1)
	AGM505: Food Microbiology	2(1+1)
2	**Minor course**	**-**
3	**Supporting Courses**	**6**
	STA501 : Statistical Methods for Applied Sciences	3(2+1)
	COM 501 : Information Technology in Agriculture	3(2+1)
4	**Common Courses**	**2**
	PGS 501 - Agricultural research, research ethics and rural development programmes	1
	PGS 502 - Technical writing and communications skills	1
	Total credits	**16**
	Second Semester	
1.	**Major courses**	**12**
	AGM502: Microbial Genetics	3(2+1)
	AGM 504: Soil Microbiology	3(2+1)
	AGM – 506:Biofertilizer Technology	3(2+1)
	AGM- 507:Environmental Microbiology	3(2+1)
2.	**Minor course**	**-**
3.	**Supporting Courses**	**-**
4.	**Common Courses**	**2**
	PGS 503 - Basic Concepts In Laboratory Techniques	1
	PGS 504 - Library and information services	1
5.	Research	6
	Total credits	**20**
	Third Semester	
1.	**Major courses**	**-**
2.	**Minor Courses**	**6**
	AGM510: Marine Microbiology	3(2+1)
	AGM511:Industrial Microbiology	3(2+1)
3.	**Supporting Courses**	**-**
4.	**Common Courses**	**1**
	PGS 505 - Intellectual Property Rights and its	1

	management in agriculture	
5.	Seminar	1
6.	Research	12
	Total	**20**
	Fourth Semester	
1.	**Major courses**	**-**
2.	**Minor Courses**	**2**
	AGM509: Microbial management of organic waste	(1+1)
3.	**Supporting Courses**	**-**
4.	**Common Courses**	**-**
5.	Research	12
	Total	**14**
	Grand Total	**70**

Distribution pattern of courses and credits (IDEA Program)

Sl. No	Courses	Credit hours
	First Semester	
1	**Major courses**	**8**
	AGM501: Principles of Microbiology	3(2+1)
	AGM503: Microbial Physiology	3(2+1)
	AGM505: Food Microbiology	2(1+1)
2	**Minor course**	**-**
3	**Supporting Courses**	**6**
	STA501 : Statistical Methods for Applied Sciences	3(2+1)
	COM 501 : Information Technology in Agriculture	3(2+1)
4	**Common Courses**	**2**
	PGS 501 - Agricultural research, research ethics and rural development programmes	1
	PGS 502 - Technical writing and communications skills	1
5.	**IDEA**	**-**
	Total credits	**16**
	Second Semester	
1.	**Major courses**	**12**
	AGM502: Microbial Genetics	3(2+1)
	AGM 504: Soil Microbiology	3(2+1)
	AGM – 506:Biofertilizer Technology	3(2+1)
	AGM- 507:Environmental Microbiology	3(2+1)
2.	**Minor course**	**-**
3.	**Supporting Courses**	-
4.	**Common Courses**	**2**
	PGS 503 - Basic Concepts In Laboratory Techniques	1
	PGS 504 - Library and information services	1
5.	**IDEA**	**-**
	Total credits	**14**
	Third Semester	
1.	**Major courses**	**-**
2.	**Minor Courses**	**6**
	AGM510: Marine Microbiology	3(2+1)
	AGM511:Industrial Microbiology	3(2+1)
3.	**Supporting Courses**	**-**
4.	**Common Courses**	**1**

	PGS 505 - Intellectual Property Rights and its management in agriculture	1
5.	**Seminar**	**1**
6.	**IDEA**	**10**
	Total	**18**
	Fourth Semester	
1.	**Major courses**	**-**
2.	**Minor Courses**	**2**
	AGM509: Microbial management of organic waste	(1+1)
3.	**Supporting Courses**	**-**
4.	**Common Courses**	**-**
5.	**Seminar**	**-**
6.	**IDEA**	**20(10+10)**
	Total	**22**
	Grand Total	**70**

Ph D Regulation

Semester	Major Courses	Minor Courses	Supporting Courses	Seminar	Research	Non-credit compulsory course	Credit Load
I	7	2	2	-	-	-	11
II	5	4	3	1	5	-	18
III	-	-	-	1	15	2	16
IV	-	-	-	-	20	2	20
V	-	-	-	-	20	-	20
VI	-	-	-	-	15	-	15
Total	**12**	**6**	**5**	**2**	75		**100**

Sl.No.	Course Code	Course Title	Credit Hours
		Compulsory Major Courses	
1	AGM 603	Recent development in Soil Microbiology	2(2+0)
2	AGM 601	Improvements in Fermentation Technology	3(2+1)
		Optional Major Courses	
3	AGM 602	Microbial Physiology and Regulation	2(2+0)
4	AGM 604	Recent Approaches in Environmental Microbiology	3(2+1)
5	AGM 605	Plant Microbe interactions	2(1+1)

6	AGM 606	Microbial Genetics	2(2+0)
7	AGM 607	Algal Biotechnology	2(2+0)
		Minor Courses	
8	AGM 609	Advances in Microbial Biotechnology	2(2+0)
9	AGM 608	Industrial Microbiology	2(2+0)
10	AGM611	Food Safety Management	2(2+0)
		Supporting Courses	
11	COM 601	Advances in Computer Application	2 (1 +1)
12	STA 601	Advances in Designs of Experiments	3 (2 + 1)
14	AGM 691	**Seminar**	1 (1 +0)
15	AGM692	**Seminar**	1 (1 +0)
14	AGM 699	**Research**	75 (0 + 75)

SEMESTER WISE DISTRIBUTION OF COURSES

Sl. No	Courses	Credit hours
	First Semester	
1	**Major courses**	**6**
	AGM603: Recent developments in Soil Microbiology	2(2+0)
	AGM606: Microbial Genetics	2(2+0)
	AGM605: Plant Microbe interactions	2(1+1)
2	**Minor course**	**4**
	AGM608: Industrial Microbiology	2(2+0)
	AGM611: Food safety management	2(2+0)
3	**Supporting courses**	**2**
	COM 601 Advances in Computer Application (1+1)	2 (1 +1)
4	AGM 691Seminar	1
5	AGM 699Research	2
6	Non-credit compulsory courses	-
	Total credits	**15**
	Second Semester	
1.	**Major courses**	**6**
	AGM601: Improvements in Fermentation Technology	3(2+1)
	AGM604: Recent approaches in Environmental Microbiology	3(2+1)
2.	**Minor course**	**2**

	AGM609: Advances in Microbial Biotechnology	2(2+0)
3	**Supporting courses**	**3**
	STA601: Advances in design of experiments	3(2+1)
4	AGM691 Seminar	1
5	AGM 699Research	10
6	Non-credit compulsory courses	-
	Total	**22**

	Third Semester	
1	Major courses	-
2	Minor courses	-
3	Supporting courses	-
4	AGM 699 Research	15
5	Non-credit compulsory courses	
6	Research and Public Ethics*	2
	Total	**15**
	Fourth Semester	
1	Major courses	-
2	Minor courses	-
3	Supporting courses	-
4	AGM 691 Seminar	-
5	AGM 699 Research	16
6	Non-credit compulsory courses	
	MOOC*	2
	Total	**16**
	Fifth Semester	
1	Major courses	-
2	Minor courses	-
3	Supporting courses	-
4	AGM 691Seminar	-
5	AGM 699Research	16
6	Non-credit compulsory courses	-
	Total	**16**
	Sixth Semester	
1	Major courses	-
2	Minor courses	-
3	Supporting courses	-
4	AGM 691 Seminar	-
5	AGM 699Research	16
6	Non-credit compulsory courses	-
	Total	**16**
	Grand Total	**100**

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

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

- "Subject" means a unit of instruction to be covered in a semester having specific No., title and credits.
- "Credit hour" means, one hour lecture plus two hours of library or home work or two and half hours of laboratory/field practical per week in a semester.
- "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 point scale.
- "Credit Point" means the grade point multiplied by credit hours.
- "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 point scale and the GPA has to be corrected to two decimals.
- "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 programmes 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 programmes from Faculty of Agriculture, Annamalai university or Universities/colleges accredited with ICAR, New Delhi.

- **For M.Sc. (Ag.) Agriculture Microbiology**

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 4 point 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 10 point 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.

I) Course work

Major Courses	20
Minor Courses	08
Supporting Courses	06
Common Courses	05
Seminar	01

ii) 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 subjectchosen 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.

7.4. **Guidelines on the duties of the Advisory Committee**

- Guiding students in drawing the outline of research work
- Guidance throughout the programme of study of the students.
- Evaluation of research and seminar credits.
- Correction and finalization of thesis draft.
- Conduct of final Viva-Voce examination.
- The proceedings of the Advisory Committee will be sent to the Head of the Department concerned within 10 working days.
- 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	20
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

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 x1 marks	5 marks
2. Short Notes	2 out of 3	2 x2½ marks	5 marks
3. Essay Type	Either or type (one question from each unit)	5 x 4 marks	20 marks

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

1. Definitions	6 out of 8	6 x1 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 Reappearence (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 a10 point 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 has 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/ unfavourable 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 favourable 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 fromplagiarism **above the specified level.**

14.4 Thethesis 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 dulyacknowledgedandnopartofthethesisisplagiarized **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 favourable, 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 examinerthe 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., resubmission 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. programmes 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 enhancedpartnerships 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 employability

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 and10 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.

*****

GMIC 21 AGM M.Sc. (Ag.) Agriculture Microbiology

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	AGM - 501	Principles of Microbiology	(2+1)
2	AGM - 502	Microbial Genetics	(2+1)
3	AGM - 503	Microbial Physiology	(2+1)
4	AGM - 504	Soil Microbiology	(2+1)
		Optional Major Courses	
5	AGM - 505	Food Microbiology	(1+1)
6	AGM - 506	Biofertilizer Technology	(2+1)
7	AGM- 507	Environmental Microbiology	(2+1)
8	AGM -508	Microbial Taxonomy	(2+1)
		Minor Courses	
9	AGM509	Microbial Management and organic waste	(1+1)
10	AGM510	Marine Microbiology	(2+1)
11	AGM511	Industrial Microbiology	(2+1)
		Supporting Courses	
12	STA 502	Statistical Methods for Applied Sciences	(2+1)
13	MCA 512	Information Technology in Agriculture	(2+1)
		Common courses	
14	PGS - 501	Agricultural research ethics and rural development	(1+0)
15	PGS - 502	Technology writing and communication skill	(0+1)
16	PGS - 503	Basic concept in lab techniques	(0+1)
17	PGS - 504	Laboratory and information science	(0+1)
18	PGS - 505	Intellectual property Rights and its Management in Agriculture	(1+0)
19	PGS-	Disaster Management (1+0)	-
20	PGS-	Constitution of India(Contact Hour 1+0)	-
21		**Value added course (3+0)** (https://annamalaiuniversity.ac.in/studport/value_added_crs.php)	-
22	AGM 591	**Master's Seminar**	1 (0+1)
23	AGM 599	**Research**	30

Programme Outcomes (POs)

GMIC 21 M.Sc. (Ag.) AGRICULTURAL MICROBIOLOGY

1. Graduate will have in depth knowledge on microbe's systematics, morphology, cytology, physiology and basic techniques of microbiology.
2. Graduate will have comprehensive knowledge to develop efficient strains of microbes through genetic variability, mutation and genetic recombination.
3. Graduate will develop knowledge on exploiting microbes in the production of fermented food and dairy products, principles of food preservation, Good Manufacturing practices (GMP) and Quality control (QC).
4. Graduate will have clear understanding to develop a model microbial system to explain the catabolic and anabolic pathways of energy production and their growth kinetics.
5. Graduate will acquire be trained skilfully to start a biofertilizer production unit and management of solid and liquid wastes to protect the environment

PO and CO Mapping Matrix

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

SEMESTER WISE DISTRIBUTION OF COURSES (RESEARCH)

Sl. No.	Course Title	Credit hours
	I Semester	
1.	Major Courses	8
2.	Supporting Courses	
	STA501 - Statistical Methods for Applied Sciences	3
	COM 501 - Information Technology in Agriculture	3
3.	Common Courses	
	PGS 501 - Agricultural research, research ethics and rural development programmes	1
	PGS 502 - Technical writing and communications skills	1
4.	**AGM 599 Research**	2
	Total	**18**
	II Semester	
1.	Major Courses	12
2.	Common Courses	
	PGS 503 - Basic Concepts In Laboratory Techniques	1
	PGS 504 - Library and information services	1
3.	**AGM 599 Research**	6
	Total	**20**
	III Semester	
1.	Minor courses	6
2.	Common course	
	PGS 505 - Intellectual Property Rights and its management in agriculture	1
3	Disaster Management (1+0)	-
4	Constitution of India(Contact Hour 1+0)	-
5.	**AGM 591 Master's Seminar**	1
6.	**AGM 599 Research**	10
7	**Value added course (3+0)** (https://annamalaiuniversity.ac.in/studport/value_added_crs.php)	
	Total	**18**
	IV Semester	
1.	Minor course	2
2.	**AGM 599 Research**	12 (8+4)
		14

SEMESTER WISE DISTRIBUTION OF COURSES (IDEA)

Sl. No.	Course Title	Credit hours
	I Semester	
1	Major Courses	8
	Supporting Courses	
2	STA501 - Statistical Methods for Applied Sciences	3
3	COM 501 - Information Technology in Agriculture	3
	Common Courses	
4	PGS 501 - Agricultural research, research ethics and rural development programmes	1
5	PGS 502 - Technical writing and communications skills	1
6	AGM 599 IDEA	
	Total	**16**
	II Semester	
1	Major Courses	12
	Common Courses	
2	PGS 503 - Basic Concepts in Laboratory Techniques	1
3	PGS 504 - Library and information services	1
4	AGM 599 IDEA	
	Total	**14**
	III Semester	
1	Minor courses	6
2	Common course	
	PGS 505 - Intellectual property and its management in agriculture	1
3	Disaster Management (1+0)	
4	Constitution of India(Contact Hour 1+0)	
5	AGM591 Master's Seminar	1
6	AGM 599 IDEA	10
7	**Value added course (3+0)** (https://annamalaiuniversity.ac.in/studport/value_added_crs.php)	
	Total	**18**
	IV Semester	
1	Minor course	2
2	AGM 599 IDEA	20 (10+10)
	Total	**22**

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	Aver age
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 and
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, Annamalainagar.

(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, Annamalainagar 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 :

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

- "Semester" means an academic term consisting of 110 working days including final theory examinations.
- "Subject" means a unit of instruction to be covered in a semester having specific No., title and credits.

- "Credit hour" means, one hour lecture plus two hours of library or home work or two and half hours of laboratory/field practical per week in a semester.
- "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 point scale.
- "Credit Point" means the grade point multiplied by credit hours.
- "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 point scale and the GPA has to be corrected to two decimals.
- "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 programmes 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 programmes from

Faculty of Agriculture, Annamalai university or Universities/colleges accredited with ICAR, New Delhi.

- **For M.Sc. (Ag.) Agriculture Microbiology**

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 4 point 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 10 point 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.

I) Course work

Major Courses	20
Minor Courses	08
Supporting Courses	06
Common Courses	05
Seminar	01

ii) 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 subjectchosen 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.

7.4. **Guidelines on the duties of the Advisory Committee**

- Guiding students in drawing the outline of research work
- Guidance throughout the programme of study of the students.
- Evaluation of research and seminar credits.
- Correction and finalization of thesis draft.
- Conduct of final Viva-Voce examination.
- The proceedings of the Advisory Committee will be sent to the Head of the Department concerned within 10 working days.
- 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	20
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 x1 marks	5 marks
2. Short Notes	2 out of 3	2 x2½ marks	5 marks
3. Essay Type	Either or type (one question from each unit)	5 x 4 marks	20 marks

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

1. Definitions	6 out of 8	6 x1 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 Reappearence (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 a10 point 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 has 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/ unfavourable 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 favourable 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 fromplagiarism **above the specified level.**

14.4 Thethesis 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 dulyacknowledgedandnopartofthethesisisplagiarized **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 favourable, 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 examinerthe 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., resubmission 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. programmes 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 enhancedpartnerships 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 employability

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 and10 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.

*****

GMIC 21 AGM M.Sc. (Ag.) Agriculture Microbiology

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	AGM - 501	Principles of Microbiology	(2+1)
2	AGM - 502	Microbial Genetics	(2+1)
3	AGM - 503	Microbial Physiology	(2+1)
4	AGM - 504	Soil Microbiology	(2+1)
		Optional Major Courses	
5	AGM - 505	Food Microbiology	(1+1)
6	AGM - 506	Biofertilizer Technology	(2+1)
7	AGM- 507	Environmental Microbiology	(2+1)
8	AGM -508	Microbial Taxonomy	(2+1)
		Minor Courses	
9	AGM509	Microbial Management and organic waste	(1+1)
10	AGM510	Marine Microbiology	(2+1)
11	AGM511	Industrial Microbiology	(2+1)
		Supporting Courses	
12	STA 502	Statistical Methods for Applied Sciences	(2+1)
13	MCA 512	Information Technology in Agriculture	(2+1)
		Common courses	
14	PGS - 501	Agricultural research ethics and rural development	(1+0)
15	PGS - 502	Technology writing and communication skill	(0+1)
16	PGS - 503	Basic concept in lab techniques	(0+1)
17	PGS - 504	Laboratory and information science	(0+1)
18	PGS - 505	Intellectual property Rights and its Management in Agriculture	(1+0)
19	PGS-	Disaster Management (1+0)	-
20	PGS-	Constitution of India(Contact Hour 1+0)	-
21		**Value added course (3+0)** (https://annamalaiuniversity.ac.in/studport/value_added_crs.php)	-
22	AGM 591	**Master's Seminar**	1 (0+1)
23	AGM 599	**Research**	30

Programme Outcomes (POs)

GMIC 21 M.Sc. (Ag.) AGRICULTURAL MICROBIOLOGY

1. Graduate will have in depth knowledge on microbe's systematics, morphology, cytology, physiology and basic techniques of microbiology.
2. Graduate will have comprehensive knowledge to develop efficient strains of microbes through genetic variability, mutation and genetic recombination.
3. Graduate will develop knowledge on exploiting microbes in the production of fermented food and dairy products, principles of food preservation, Good Manufacturing practices (GMP) and Quality control (QC).
4. Graduate will have clear understanding to develop a model microbial system to explain the catabolic and anabolic pathways of energy production and their growth kinetics.
5. Graduate will acquire be trained skilfully to start a biofertilizer production unit and management of solid and liquid wastes to protect the environment

PO and CO Mapping Matrix

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

SEMESTER WISE DISTRIBUTION OF COURSES (RESEARCH)

Sl. No.	Course Title	Credit hours
	I Semester	
1.	Major Courses	8
2.	Supporting Courses	
	STA501 - Statistical Methods for Applied Sciences	3
	COM 501 - Information Technology in Agriculture	3
3.	Common Courses	
	PGS 501 - Agricultural research, research ethics and rural development programmes	1
	PGS 502 - Technical writing and communications skills	1
4.	**AGM 599 Research**	2
	Total	**18**
	II Semester	
1.	Major Courses	12
2.	Common Courses	
	PGS 503 - Basic Concepts In Laboratory Techniques	1
	PGS 504 - Library and information services	1
3.	**AGM 599 Research**	6
	Total	**20**
	III Semester	
1.	Minor courses	6
2.	Common course	
	PGS 505 - Intellectual Property Rights and its management in agriculture	1
3	Disaster Management (1+0)	-
4	Constitution of India(Contact Hour 1+0)	-
5.	**AGM 591 Master's Seminar**	1
6.	**AGM 599 Research**	10
7	**Value added course (3+0)** (https://annamalaiuniversity.ac.in/studport/value_added_crs.php)	
	Total	**18**
	IV Semester	
1.	Minor course	2
2.	**AGM 599 Research**	12 (8+4)
		14

SEMESTER WISE DISTRIBUTION OF COURSES (IDEA)

Sl. No.	Course Title	Credit hours
	I Semester	
1	Major Courses	8
	Supporting Courses	
2	STA501 - Statistical Methods for Applied Sciences	3
3	COM 501 - Information Technology in Agriculture	3
	Common Courses	
4	PGS 501 - Agricultural research, research ethics and rural development programmes	1
5	PGS 502 - Technical writing and communications skills	1
6	AGM 599 IDEA	
	Total	**16**
	II Semester	
1	Major Courses	12
	Common Courses	
2	PGS 503 - Basic Concepts in Laboratory Techniques	1
3	PGS 504 - Library and information services	1
4	AGM 599 IDEA	
	Total	**14**
	III Semester	
1	Minor courses	6
2	Common course	
	PGS 505 - Intellectual property and its management in agriculture	1
3	Disaster Management (1+0)	
4	Constitution of India(Contact Hour 1+0)	
5	AGM591 Master's Seminar	1
6	AGM 599 IDEA	10
7	**Value added course (3+0)** (https://annamalaiuniversity.ac.in/studport/value_added_crs.php)	
	Total	**18**
	IV Semester	
1	Minor course	2
2	AGM 599 IDEA	20 (10+10)
	Total	**22**

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	Aver age
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 and
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, Annamalainagar.

(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, Annamalainagar 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 :

AGM – 501 PRINCIPLES OF MICROBIOLOGY(2+1)

Objective

- To familiarize with what microorganisms are and their impact on life
- To teach basic microbiological techniques
- To set the stage for consideration of microbial structure and nutrition
- To teach about the microbial evolution and systematics
- To focus on the diversity of bacteria and viruses

THEORY

Unit I : Microbes and Microbiology, Microscopy

Scope of Microbiology- Types of Microorganisms- Emergence of different fields of Microbiology- Historical routes in the development of Microbiology. Microscopy- Bright field, Dark field and Electron Microscopes. Staining

Unit II : Cell Structure, Growth, Control of Growth

Cell structure and function in bacteria. Bacterial growth and reproduction– nutritional and environmental requirements. Sterilization

Unit III : Microbial Evolution, Microbial Systematics

Microbial evolution- Evolutionary relationship among Prokaryotes, Eukaryotes and Archaea. Evolutionary analysis. Microbial phylogeny. Construction of Phylogenetic tree

Unit IV : Microbial Systematics

Phenotypic and genotypic analysis of bacteria. Phylogenetic analysis. Use of DNA and RNA sequencing in classification. Species concept in Microbiology. Bergey's manual of systematic Bacteriology- Key characteristics of Proteobacteria and Gram-positive bacteria

Unit V : Human – Microbe Interaction, Overview of Viruses

Normal micro flora of Human body; Immune response- specific and non-specific host resistanceVirus structure and growth. Viral replication. Viral diversity – Overview of bacterial viruses

CURRENT STREAM OF THOUGHTS

Theory lecture schedule

1. Scope of Microbiology
2. Types of Microorganisms- Emergence of different fields of Microbiology
3. Historical routes in the development of Microbiology
4. Microscopy- principles and applications of light microscopes
5. Electron Microscopy, confocal laser microscopy
6. Staining- principles, simple, special staining
7. Cell structure and function in bacteria- fine structure of gram-positive bacteria

8. Cell structure and function in bacteria- fine structure of gram-negative bacteria
9. **First Test**
10. Internal structure-cell inclusions, special structures in bacteria
11. Bacterial growth and reproduction
12. Nutritional types of bacteria- nutritional requirement in bacteria
13. Environmental factors on growth of bacteria
14. Sterilization techniques
15. Microbial evolution- prebiotic evolution
16. Evolutionary relationship among Prokaryotes, Prokaryotes and archaea
17. **Mid semester Examination**
18. Evolutionary analysis, methods of evolutionary analysis
19. Microbial phylogeny
20. Construction of Phylogenetic tree
21. Phenotypic and genotypic analysis of bacteria.
22. Phylogenetic analysis.
23. Use of DNA and RNA sequencing in classification.
24. Numerical taxonomy
25. Species concept in bacterial classification
26. Bergey's manual of systematic Bacteriology- keys used for classification
27. Key characteristics of Proteobacteria
28. Key characteristics of Proteobacteria
29. Key characteristics of Gram-positive bacteria
30. Key characteristics of Archaea
31. Normal micro flora of Human body
32. Immune response-specific and non-specific host resistance
33. Virus structure and growth. Viral replication
34. Viral diversity – Overview of bacterial viruses

Practical Schedule

1. Working principles and handling of different types of microscopes – Bright and Dark field microscopy
2. Working principles and handling of different types of microscope- SEM and TEM-I
3. Working principles and handling of different types of microscope- SEM and TEM –II
4. Methods of isolation of microorganisms from different environments – soil, water, milk and food
5. Use of selective media for isolation of microorganisms
6. Purification techniques of bacteria and fungi
7. Enumeration and Quantification techniques
8. Maintenance and preservation of cultures
9. Assessment of microbial quality of potable water.
10. Morphological characterization of Bacteria
11. Morphological characterization of fungi
12. Biochemical characterization of bacteria
13. Biochemical characterization of fungi
14. Molecular characterization of bacteria by 16S rDNA sequencing and construction of phylogenetic tree

15. Molecular characterization of bacteria by 16S rDNA sequencing and construction of phylogenetic tree
16. Isolation of bacteriophages
17. **Final Practical Examination**

Course outcome

CO 1 -Knowledge on historical perspective of Microbiology

CO 2 -Basic knowledge on different structure of microbes, and their growth

CO 3 - Evolutionary relationship among microbes

CO 4 – Human microbe interaction

CO 5 – Viral diversity

CO – PO MAPPING MATRIX

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	1	-	-	-	-
CO 2	3	-	-	-	-
CO 3	2	-	-	-	-
CO 4	2	-	-	-	-
CO 5	1	-	-	-	-

Reference

1. Pelczar, M.J. Jr., Chan, E.C.S. and Kreig, N.R. 1997. Microbiology, Concepts and Application, 5th edition, Tata McGraw Hill, New York.
2. Prescott, L.M., Harley and Klein. 2002. Microbiology 5th Edition, Tata McGraw Hill, New York.
3. Bhatia, M.S.2009. Principles of Microbiology. Swastik Publishers., DeIhi.
4. Singh, U.S and K. Kapoor 2010. Introductory Microbiology. Oxford Book Company. Jaipur
5. Tortora, G. J., B.J. Funke and C.L. Case. 2010. Microbiology: an introduction.10th Ed. Benjamin Cummings., New York.

E resources

http://www.asmscience.org
http://www.asm.org
http://www.microbiologyonline.org.uk
http://www.microbeworld.org
https://sites.google.com/a/uasd.in/ecourse/agricultural-microbiology

AGM -502 Microbial Genetics (2+1)

LEARNING OBJECTIVES

- To acquire the basic knowledge about the genetic information of microorganisms.
- How heredity takes place in these organisms.
- To understand the expression and regulation of genes in bacteria.
- To know genetic recombination and mutations that causes variability.
- To develop the skills to work on polymerase chain reaction.

Theory

Unit I: Genome of Microorganisms

Introduction to microbial genetics – Historical perspectives of microbial genetics – terminology related to Microbial genetics - Genome of prokaryote, eukaryote (fungi, yeast) and virus. Genetic elements - chemical structure and property, enzymes associated with nucleic acid – different forms of DNA (A, B, and Z forms) - RNA- tRNA, mRNA, rRNA; DNA replication - Extra chromosomal DNA in bacteria and eukaryotic cells: chloroplast DNA, Mitochondrial DNA- plasmids: Structure, classification and replication-Biostatistics-survival analysis, clinical analysis

Unit II : Gene Expression and Regulation

Gene structure and expression: - Gene expression in prokaryote and eukaryotes – gene expression mechanism-intron and exons – Gene network-post transcriptional modifications - Regulation of gene expression - Principles of Operon Negative regulation (*lac* operon and *try* operon) – Positive regulation (cAMP).

Unit III :Mutation

Principles of mutation – Spontaneous and induced mutation – Classification of mutations - Selection principles of mutants – Mutagens and their mode of action – Transposable elements and insertion sequences - DNA damage – DNA repair mechanisms in bacteria – Role in carcinogenesis-Prion mutation-Emerging issues with microbial mutations.

Unit IV : Recombination

Genetic recombination in bacteria – mechanisms of recombination – Transformation, conjugation and transduction: Principles and process – Complementation: principles - Gene mapping by recombination and complementation: Principles and application-Primer: role of primers-RNA Primers in vivo-synthetic primers.

Unit V : Recombinant DNA Technology

Polymerase chain reaction: RT-PCR - DNA sequencing - Gene bank deposition – Principles of recombinant DNA technology – Site directed mutagenesis Plasmid, cosmid and phage vectors – cloning and expression vectors – Detection of recombinants and purification of recombinant protein –- Metagenomics - basic principles – impact of gene cloning on human welfare – Ethics in microbial gene cloning.

Current stream of thoughts:

THEORY SCHEDULE

1. Scope for microbial genetics – terms related to microbial genetics
2. Historical perspectives of microbial genetics
3. Structure of DNA and RNA, Properties of nucleic acid; Enzymes associated with DNA; different forms of DNA and RNA.
4. Concept of biostatistics in health related fields like including medicine biology and public health
5. DNA replication: Semi conservative; semi discontinuous method; θ replication and rolling circle method.
6. Genome of bacteria, fungi and virus; Yeast genetics
7. Extra-chromosomal DNA in bacteria: Plasmids and their classification; Mitochondrial DNA and chloroplast DNA.
8. Gene network and Gene arrangements in prokaryotes and eukaryotes –introns and exons
9. **First Test**
10. Gene expression and its mechanism in prokaryotes and eukaryotes: Post transcriptional modifications
11. Gene regulation – necessities; Positive and negative regulations
12. *lac* operon model (inducer): Promotor; Operator; Regulator; Structural genes; Terminators; cis-acting elements; Trans acting proteins.
13. *try* operon (repressor); cAMP Positive regulation
14. Mutation – types: Spontaneous Mutation / Induced M; Chromosomal aberration / Point M; Base pair substitution / Frame shift mutation; Silent M / Reverse M; Spontaneous mutations in bacteria/ prion mutation/ role in carcinogenesis.
15. Phenotypic expression of mutation; selection of mutants
16. Mutagens – Physical, chemical and biological: Mode of action
17. **Mid semester examination**
18. Transposable elements and insertion sequences

19. Causes of DNA damage in bacteria
20. DNA repair mechanisms in bacteria
21. Emerging issues with microbial mutations and Site directed mutagenesis and metagenomic analysis – Basic principles.
22. Genetic recombination and variability in bacteria
23. Genetic recombination and variability in fungi (Yeast and *Neurospora* as model)
24. Transformation – Principles, competence and application
25. Conjugation: Principles, F plasmids, process, HFR cells, application
26. Generalized and Specialized transduction – principle and process
27. Complementation assay – Principles and application
28. Gene mapping – Principles, methods and application and primer and its role, RNA primers in vivo synthetic primers.
29. Introduction to genetic engineering and Recombinant DNA technology.
30. PCR – RT-PCR, Principles and application.
31. DNA sequencing – different methods (Chemical degradation; chain termination and pyro sequencing) – Gene Bank deposition
32. Vectors in DNA technology – different types and applications;
33. Gene cloning in human welfare; ethics
34. Detection of Recombinants and recombinant proteins

PRACTICAL SCHEDULE

1. Isolation of genomic DNA from bacteria and fungi
2. Qualitative and quantitative assay of DNA (Spectrometry and gel-electrophoresis)
3. Visualization of mega plasmids of *Rhizobium* and *Agrobacterium* by in-gel lysis method
4. Isolation of plasmid DNA from *E. coli* by alkali lysis method
5. Curing of plasmid of *E. coli* by acridine orange
6. Isolation of phage DNA from *E. Coli*
7. Detection of spontaneous mutation
8. Induction of antibiotic resistance by UV rays and calculation of MIC for mutagens
9. Isolation of auxotrophic mutants by ethyl methane sulphonate and screening by replica plating technique
10. Preparation and transformation of competent *E. coli* using $CaCl_2$
11. Conjugation of bacteria for developing marker strain

12. PCR amplification of 16S rRNA gene from bacteria
13. Cloning of PCR product in cloning vector and expression in *E. coli*
14. Restriction digestion of plasmid DNA
15. DNA sequencing – *in silico* analysis (for species identification and phylogeny)
16. Isolation of metagenomic DNA from soil and waste water samples.
17. **Final Practical Examination.**

Course outcome:

CO 1: They will understand about the fundamental aspects of microbial genetics, historical perspective, genetic elements, chemical structure, properties, classification and its function.
CO 2: They will understand gene structure and expression in prokaryote and eukaryote, regulation on gene expression.
CO 3: Students will gain knowledge on mutation and its types, principles of mutants, mutagens, DNA repairing mechanism and emerging aspects on microbial mutations.
CO 4: Students will study about genetic recombination in bacteria and its mechanism, Gene mapping by recombination and complementation, its application and properties.
CO 5: Students will study and have practical knowledge on DNA sequencing. Polymerase chain reaction, principles of recombination DNA technology, cloning, its impact on human welfare and ethics in microbial gene cloning, site directed mutagenesis.

CO-PO MAPPING MATRIX

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

REFERENCE BOOKS

1. Brown, T.A. 2010. Gene cloning and DNA analysis: an introduction 6th ed., Wiley-Blackwell Publications, UK
2. Levin, B. 2002. Gene VIII. Oxford Univ. Press, New York.
3. Maloy, S.R., Cronan, J.E. and D.Freifelder. 2008. Microbial Genetics. (Second edition). Narosa Publishing house, New Delhi.
4. Streips, U.N. and R.E.Yasbin. 2006. Modern Microbial Genetics. Wiley – Liss Publ, New York
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AGM-503 MICROBIAL PHYSIOLOGY (2+1)

LEARNING OBJECTIVES

- To become an expert on the structure and function of prokaryotic cells and get an understanding of the genetic and physiological regulatory mechanisms.
- To develop the concepts and skills required to understand and critically evaluate research articles that address the physiology and biochemistry of microbes.
- To apply the theories of bacterial cell physiology to current problems in the area.
- To learn about an expanded role for microbial physiology in metabolic engineering and functional genomics.
- To know about tracking, tuning and terminating microbial physiology using synthetic riboregulators.

THEORY

Unit: I - Structure, Function and biosynthesis of cellular components

Microbial nutrition – Chemical composition of microbial cell – Structure, function and assembly of cell membrane in prokaryotes, archaea and fungi – Macro and Micro – nutrients and their physiological functions – Transport of solutes across the membrane.

Unit: II – Cell cycle, Cell division, Pathways and fermentation:

Microbial growth, Cell cycle and cell division. Bioenergetics – carbohydrate utilization via EMP, HMP, ED, TCA pathways, Aerobic and anaerobic respiration. Fermentative metabolism. Assimilation of nitrogen and sulphur – Oxygenic and anoxygenic photosynthesis – Mechanisms of carbon-dioxide fixation in prokaryotes. Ethanol, Lactic acid, butanol, acetone and mixed acid fermentation. Fermentation of nitrogenous organic compounds regulation of microbial metabolism.

Unit: III – Growth and factors affecting growth and culture systems – Nutritional classification and spore formation and germination:

Effects of physical, Chemical and other environmental factors on growth continuous culture, Diauxic growth and Synchronous culture. Method of growth measurement. Morphogenesis and cellular differentiation. Metabolic diversity in photoautotrophs, photoheterotrophs,

chemoautotrophs. Nutritional grouping/classification of microorganisms. Bacterial endospore-types, morphology, biochemistry and regulation of formation and germination.

Unit: IV – Enzyme kinetics and Mechanism of Enzymes and Microbial Metabolism

Enzyme kinetics: Michaelis Menten kinetics – mechanisms of inhibition of enzyme activity – coenzymes and prosthetic groups. Methods to determine free energy of biochemical reactions – high energy compounds. Microbial metabolism - generation of ATP, reducing power, development of proton gradient and biosynthesis of ATP.

Unit: V – Biosynthesis of Macromolecules

Biosynthesis of macromolecules – Synthesis and assembly of cell wall components – Methods of studying biosynthesis – regulation of microbial metabolism.

CURRENT STREAM OF THOUGHTS

THEORY SCHEDULE

1. Introduction and scope of Microbial Physiology
2. Microbial nutrition – Chemical composition of a microbial cell – Major and micro nutrients and their physiological functions.
3. Cell: Basic organizational units of living systems.
4. Cytoplasmic membrane: movement of material into and out of cells – structure of cytoplasmic membrane.
5. External structures that protect the cell – Bacterial cell wall and envelopes
6. Cell wall of archaea: cell wall of Eukaryotic microorganisms – fungi, algae and protozoa.
7. Sites of cellular energy transformations where ATP is generates: Bacteria, archae and eukaryotes.
8. Structure involved with movement of cells – Flagella – Taxis: Structure involved in attachment of cells.
9. **First Test**

10. Mechanisms of nutrients transport in bacteria – passive processes: active energy-linked transport processes, Microbial growth – Nature and expression of growth – measurement of growth.
11. Effect of environmental factors on microbial growth – response of microorganism to stress.
12. Nutritional diversity among prokaryotes – mechanisms behind diversity in extremophiles.
13. Respiration: Glycolysis
14. Alternate pathways of glucose metabolism-HMP-Pentose phosphate pathway.
15. EMP and Entner Dudroff pathway.
16. TCA cycle – Glyoxylate cycle
17. **Mid Semester Examination**
18. Enzyme kinetics-Michaelis – Menton constant-Co-enzymes and prosthetic groups
19. Mechanisms of inhibition of enzyme activity
20. Principles of bio-energetics; Laws of thermodynamics – Methods to determine free energy of biochemical reactions-High energy compounds.
21. Microbial metabolism – metabolic strategies for generating cellular energy – autotrophic, heterotrophic; Generation of ATP, reducing power.
22. Fermentation I: Lactic acid, ethanolic, propionic, mixed acid fermentations
23. Fermentation II: butanediol, butyric, amino acid fermentations, Fermentation of acetate to methane: methanogenesis
24. Photoautotrophy:Absorption of light-Oxygenic and anoxygenic photosynthesis
25. Assimilation of nitrogen and sulphur
26. Mechanisms of CO_2 fixation in prokaryotes-calvin cycle, hydroxypropionate pathway, C4 pathway
27. Assimilation of organic C_1 compounds – Methanotrophy, ribulose monophosphate pathway, serine pathway, Methylotrophy
28. Biosynthesis of macromolecules-Carbohydrate biosynthesis-Biosynthesis of storage compounds and energy reserves in bacteria

29. Synthesis and assembly of cell wall components-biosynthesis of polysaccharides, peptidoglycan biosynthesis, LPS biosynthesis
30. Lipid biosynthesis – Fatty acid biosynthesis, Biosynthes of PHB, Biosynthesis of phospholipids, biosynthesis of sterols.
31. Biosynthesis of amino acids for proteins – Nitrogen fixation and formation of ammonium ions
32. Biosynthesis of Nucleotides for nucleic acids – biosynthesis of pyrimidines, purines
33. Regulation of microbial metabolism – Feedback control mechanisms
34. Sporulation in bacteria – Survival through production of spores

PRACTICAL SCHEDULE

1. Determination of viable and total number of cells.
2. Measurement of cell size.
3. Gross cellular composition of microbial cell. Growth – Factors affecting growth.
4. Growth of microorganisms on various carbon and nitrogen sources.
5. Study of bacterial spores and factors affecting germination.
6. Demonstration of thermos - Meso and psychrophilic micro organisms.
7. Production and testing of inducible enzymes in bacteria.
8. Sporulation and spore germination in bacteria.
9. Protoplasts formation and regeneration.
10. Estimation of generation time and specific growth rate for bacteria and yeast.
11. Diauxic growth curve.
12. Production of synchronous cells.
13. Effect of chemicals and environmental factors on bacterial growth.
14. Isolation and Identification of reserve food material (Glycogen/Polyphosphates, PHB) from bacteria (*Azotobacter, Bacillus megaterium*).
15. Demonstration of endogenous metabolism in *E.coli* and their survival under starvation conditions.
16. Protoplast formation.

17. Final Practical Examination

COURSE OUTCOME

CO1 : The students will be able to understand the basic physiological process that can be taken place in cell.

CO2 : They will be knowing the catabolic process of various pathways in which energy production takes place in a cell and how the energy is utilized for the reproduction and sporulation.

CO3 : They will gain knowledge on the microbial growth kinetics

CO4 : Students will understand the role of microbes and their physiological functions in the evolution of life on earth.

CO5 : Students will be able to select suitable sources of nutrients for efficient production of metabolites

CO-PO MAPPING

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**
CO 1	**1**	**-**	**-**	**-**	**-**
CO 2	**-**	**-**	**-**	**3**	**-**
CO 3	**-**	**-**	**-**	**3**	**-**
CO 4	**2**	**-**	**-**	**-**	**-**
CO 5	**-**	**-**	**-**	**3**	**-**

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AGM 504 Soil Microbiology (2+1)

OBJECTIVE

- To teach about ecological aspects of soil microorganism
- To learn about the microbial diversity
- To learn about the plant microbe interaction and their role
- To teach role of soil microbes on nutrient transformation
- To impart knowledge on the microbial degradation of xenobiotics

THEORY

Unit I : History and Ecology of Soil Microorganisms

Landmarks in the history of soil microbiology. Soil biota, Soil microbial ecology, types of organisms in different soils; soil microbial biomass; factors affecting soil microflora. Abiotic factors (physical and chemical) affecting soil microflora as pH, chemicals, moisture, air, temperature etc.

Unit II : Microbial Diversity

Microbial diversity - assessment of microbial diversity. Unculturable soil biota. Endophytic microorganisms. Microbes in biotic and abiotic stress management. Antimicrobials.

Unit III : Plant Parts and Soil Interface Interaction

Microbial interactions.Microbiology and biochemistry of root-soil interface; phyllosphere, plant growth promoting rhizobacteria, soil enzyme activities and their importance

Unit IV : Microbial Transformation of Various Nutrients

Carbon cycle. Biochemical composition and biodegradation of soil organic matter and crop residues Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil. Siderophores and their role in iron nutrition and pathogen control

Unit V : Role of Microorganisms In Biodegradation of Xenobiotics and Pesticides

Biodegradation of pesticides, Organic wastes and their use for production of biogas and manures: Biotic factors in soil development

Current Stream of Thoughts

Theory Lecture schedule

1. Milestones in soil microbiology and Soil biota-major groups- types of organisms in different soils
2. Abiotic factors governing soil microflora such as pH, chemicals, moisture, air and temperature
3. Soil microbial ecology –ecological interrelationships and properties
4. Soil microbial biomass –measurement- role in soil fertility
5. Soil enzymes – types, activities and their importance
6. Microbial diversity - culturable and unculturable soil biota. Measures of microbial diversity
7. Endophytic microorganisms and their importance
8. Microbes in biotic and abiotic stress management
9. **First Test**
10. Antimicrobials – types, organisms and importance in pathogen reduction
11. Microbial interactions–beneficial and harmful interactions and their importance
12. Microbiology and biochemistry of root-soil interface (spermosphere, rhizosphere, rhizoplane; R:S ratio)
13. Phyllosphere, endophytes and plant growth promoting rhizobacteria (PGPR) and their significance.
14. Plant- microbiome interaction-holobiont- chemotaxis and quorum sensing
15. Protein secretary systems and their role in plant – microbiome interaction
16. Signal transduction between plant and PGPR- signals from both the partners and their effect on each other
17. **Mid semester Examination**

18. Signal transduction between Rhizobium – legume symbiosis and AMF- plant symbiosis- signals from both the partners and their effect on each other
19. Carbon cycle-Microbiology and biochemistry of aerobic decomposition of complex polymers-celluloses and hemicelluloses lignin, starch and pectin
20. Microbiology and biochemistry of anaerobic decomposition of complex polymers-cellulose hemicelluloses lignin, starch and pectin
21. Nitrogen cycle- microbiology and biochemistry of ammonification, nitrification and denitrification
22. Biological nitrogen fixation – free living, associative symbiotic, symbiotic and endophytic nitrogen fixers. Leaf, stem and root nodulating bacteria
23. Recent classification of legume and actinorhizal plants nodulating bacteria. Nodulation in legume –Rhizobium, and Frankia- actinorhizal symbiosis
24. Biochemistry of nitrogen fixation in free living, associative symbiotic, symbiotic and endophytic nitrogen fixers
25. Molecular biology of nitrogen fixation in free living, associative symbiotic, symbiotic and endophytic nitrogen fixers
26. Phosphorus cycle-microbial transformation of phosphorus- mineralization, immobilization, solubilization and –organisms involved –importance in soil and plant nutrition
27. Phosphate mobilization -mycorrhizae-types–ecto and endo mycorrhizae –role in phosphorous nutrition
28. Microbial transformation of potassium and sulphur. Sulphur cycle -microorganisms involved-importance in soil fertility
29. Microbial transformations of iron - organisms and mechanisms involved-importance in soil and plant nutrition
30. Microbial transformation of zinc and manganese in soil-organisms and mechanisms involved-importance in soil and plant nutrition
31. Siderophores –organisms involved and importance in iron nutrition and plant disease suppression
32. Biogas pathways-microorganisms involved- organic wastes for biogas generation production
33. Manures- principles of production microorganisms involved- utilization of important organic wastes for manures production, composting –aerobic and anaerobic methods of composting of different organic manures

34. Microbiology and biochemistry of degradation of pesticides and xenobiotics. Biotic factors in soil development

Practical Schedule

1. Qualitative analysis of soil microflora
2. Quantitative analysis of soil microflora- Isolation of rhizosphere, rhizoplane and bulk soil microorganisms and studying rhizosphere effect
3. Isolation of endophytic microorganisms from plant sample
4. Isolation of spermosphere and phyllosphere (PPFM) microorganisms
5. Studying rate of organic decomposition through CO_2 evolution technique
6. Assessment of soil dehydrogenase, urease and phosphatase activity
7. Studying ammonification and nitrification in soil
8. Studying denitrification in soil
9. Isolation of free living and associative symbiotic nitrogen fixers
10. Isolation of symbiotic and endophytic nitrogen fixers
11. Isolation of phosphate solubilizers and potassium releasers
12. Isolation of sulphur oxidizers and zinc solubilizers
13. Extraction and examination of AM spores from soil samples
14. Examination of arbuscular mycorrhizal infection in different crops
15. Visit to forest ecosystem, collection and examination of ectomycorrhizal fruiting bodies and lichens
16. Isolation of antibiotic producing microorganisms from soil and Isolation of pesticide degrading microorganisms
17. **Final Practical Examination**

Course Outcome

CO – 1 Students will become familiar to the types of microbes in soil and their association with plants.

CO - 2 The exclusive role of microorganisms in plant growth can be thoroughly understood.

CO – 3 Microbial transformations of different nutrients

CO – 4 Microbial degradations of xenobiotics and pesticides

CO – 5 Microbial diversity and interaction

CO – PO MAPPING MATRIX

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	2	-	-	-	-
CO 2	3	-	-	-	-
CO 3	-	-	-	3	-
CO 4	-	-	-	1	-
CO 5	2	-	-	-	-

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AGM 505 FOOD MICROBIOLOGY (1+1)

OBJECTIVE

- To impart knowledge on microbes and their diversity in foods, associated with food spoilage, food borne illness and beneficial microbes
- To impart knowledge on fermentation of foods by microorganisms for improved nutritional and health benefits
- To learn advanced techniques for rapid detection of food pathogens and their metabolites
- To learn about different types of fermented products
- To understand food safety measures and regulations to control food spoilage and food borne diseases

THEORY

Unit I : Historical and Scope of Microbiology in Food

Scope of food microbiology, historical developments in food microbiology, significance of microorganisms in food, spores and their significance, intrinsic and extrinsic factors influencing microbial growth in foods.

Unit II: Food Spoilage and Food Borne Illness

Important microorganisms in food and their sources, microbial spoilage of meat, poultry, fish, milk and milk products, fruits, vegetables and canned foods, food borne pathogens (bacteria, fungi, virus and protozoa), food infection and food intoxication

Unit III : Food Preservation Methods

Fermented dairy and indigenous fermented foods, physical, chemical and biological methods of food preservation, natural antimicrobial compounds, bacteriocins and their application

Unit – IV: Probiotics and Prebiotics

Concepts and scope of microbial fermentations - probiotics, prebiotics, synbiotics, bifidus factor, microbes as single cell protein

Unit V: Food Safety and Regulations

General principles of food safety and risk management, recent concerns on food safety, GAP, GMP, organic and GM foods, Hurdle technology, HACCP.

Current Stream of Thoughts

Lecture Schedule

a. Scope of food microbiology, Historical developments in food microbiology
b. Important and sources of microorganisms in foods and Spores and their significance in foods
c. Intrinsic and Extrinsic parameters influencing microbial growth in foods
d. Microbial spoilage of different groups of foods – meat, poultry, fish, egg, milk, milk products, vegetables and fruits
e. First Test
f. Microbial spoilage of different groups of foods – canned foods
g. Food borne pathogens (bacteria, fungi and virus) – food infection and intoxication
h. Mid semester Examination
i. Pathogenesis of Gram positive and Gram negative bacteria in foods
j. Food borne fungal diseases, mycotoxin, Viruses and other protozoans as agents of food borne illness
k. Fermented dairy products – curd, yoghurt, kefir, koumiss, cheese
l. Indigenous fermented foods – soy sauce, moromi, miso, natto, tempeh
m. Food preservation by physical methods and chemical methods, natural antimicrobials from microorganisms, bacteriocins
n. Probiotics, prebiotics and synbiotics; bifidus factor, Single cell protein – bacteria, fungi, Algae and yeast
o. Food Safety Risks - biological, chemical, physical risks; surveillance and risk assessment
p. Recent concerns on food safety - GAP, GMP, Organic foods, GM foods
q. Hurdle technology, HACCP concept and principles

PRACTICAL SCHEDULE

1. Isolation and enumeration of microorganisms from fruits
2. Isolation and enumeration of microorganisms from vegetables
3. Microbiological examination of Fish
4. Microbiological examination of egg
5. Detection and confirmation of *E.coli* and coliforms in infant foods and water by MPN technique
6. Resazurin test.
7. Assessing the quality of milk by Methylene Blue Reduction Test (MBRT)
8. Detection of Salmonella and Pseudomonas fluorescens in chicken sample
9. Detection of Staphylococcus aureus in meat products
10. Detection of Listeria sp. in milk and dry cereal based foods
11. Production of single cell protein (Bacteria/Fungi/Algae)
12. Fermentation of Sauerkraut and isolation of lactic acid bacteria from the fermented sauerkraut
13. Canned foods - Types of Spoilage - Microbial assessment of Canned Foods
14. Antimicrobial assay for food borne pathogens using chemical and bio preservatives
15. Microbiological examination of food processing surfaces and utensils

16. Visit to food processing industry
17. **Final Practical Examination**

Course Outcome

CO 1: Types of microorganisms in food (both beneficial and harmful)
CO 2: Food borne illness due to microbes and their preventive measures
CO 3: Biological-based preservation of foods
CO 4: Standard and Advanced techniques in detection of food-borne pathogens and toxins
CO 5: Working out HACCP Plan for foods

CO – PO MAPPING MATRIX

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	3	-	-	-	-
CO 2	2	-	-	-	-
CO 3	-	-	3	-	-
CO 4	-	-	2	-	-
CO 5	-	-	3	-	-

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AGM-506 Biofertilizer Technology (2+1)

LEARNING OBJECTIVES

- To impart knowledge on theoretical and practical aspects of biofertilizers production
- To acquire the basic knowledge about agriculturally important beneficial microorganisms
- To create awareness about the importance of biofertilizers in sustainable crop production.
- To understand and develop skills about the quality control and standards of biofertilizers
- Also to motivate students to become entrepreneurs

Unit I:Agriculturally important beneficial microorganisms

Agriculturally important beneficial microorganisms-Biofertilizers-Current Scenario-List of biofertilizers- nitrogen fixers (free living, associative symbiotic, symbiotic and endophytic), phosphate solubilizers, phosphate mobilizers,potassium releasers,zinc solubilizers,sulphur oxidizers,drought stress toleranceinducers (pink pigmented facultative methylotrophs PPFM) and plant growth promoting microorganisms (PGPM).mechanism of nitrogen fixation, mineral solubilization, mobilization sulphur oxidation and drought stress tolerance.Contribution of microorganisms in soil fertility and crop protectivity.

Unit II: Mass Production of Biofertilizers

Techniques for scale up process- equipments for laboratory, pilot and large scale. Mother inoculum production. Preservation of mother cultures. Raw materials. Mass production of bacterial biofertilizers- *Rhizobium*, *Azospirillum*, *Azotobacter*, *Glucanoacetobacterdiazotrophicus*, phosphate solublisers, potash releaser, zinc solubilizer sulphur oxidizer and PPFM. Mass production of arbuscular mycorrhizal

fungi (AMF)-carrier and root organ culture -algal biofertilizers (azolla& blue green algae). Shelf life enhancement and storage of liquid and carrier based biofertilizers.

Unit III: Quality Control and Standards

Quality control-FCO/BIS standards-*Rhizobium*, *Azospirillum*, *Azotobacter*, *Glucan acetobacterdiazotrophicus*, phosphate solubilizes, potash releasers, AM fungi and blue green algae. Stages of quality control. Molecular markers in identification of strains.

Unit IV: Formulation and Delivery

Formulation–types–carrier based and liquid inoculants. Equipments–tangential flow filtration (TFF)- centrifugation-freeze drying. Application technologies–form, dose, method and time of application of bioferilizers for different crops.

Unit V : Economics of Biofertilizer Production

Calculation of commercial production cost – fixed - cost of building, equipments and variable cost –glass wares and chemicals raw materials, labour cost and benefit –cost ratio. DPR. Constraints in biofertilizer production and marketing.

Current stream of thoughts

THEORY LECTURE SCHEDULE

1. Agriculturally important beneficial microorganisms-
2. Biofertilizers-Current Scenario- List of biofertilizers
3. Nitrogen fixers (free living, associative symbiotic, symbiotic and endophytic)
4. Phosphate solubilizers, phosphate mobilizers, potassium releasers
5. Zinc solubilizers and Sulphur oxidizers.
6. Drought stress tolerance inducers (Pink Pigmented Facultative Methylotrophs-PPFM)
7. Plant growth promoting microorganisms (PGPM).
8. Mechanism of nitrogen fixation,
9. **First Test**
10. Mechanism of mineral solubilization, mobilization

11. Mechanism of sulphur oxidation and drought stress tolerance.
12. Techniques for scale up process- equipment for laboratory,
13. Pilot and large scale. Mother inoculum production.
14. Preservation of mother cultures. Raw materials.
15. Mass production of bacterial biofertilizers
16. Mass production of arbuscular mycorrhizal fungi (AMF)-carrier and root organ culture
17. **Mid-semester examination**
18. Algal biofertilizers (azolla& blue green algae)
19. Shelf life enhancement and storage of liquid carrier based biofertilizers.
20. Quality control-FCO/BIS Standards-*Rhizobium*, *Azospirillum*, *Azotobacter*, *Glucanoacetobacterdiazotrophicus*,
21. Phosphate solublizers
22. potash releasers
23. Quality control-FCO/BIS Standards-
24. AM fungi and blue green algae.
25. Stages of quality control
26. Molecular markers in identification of strains.
27. Formulation–types–carrier based and liquid inoculants.
28. Equipments–tangential flow filtration (TFF)- centrifugation-freeze drying
29. Application technologies–form, dose
30. Method and time of application of biofertilizers for different crops
31. Calculation of commercial production cost – fixed - cost of building, equipment and variable cost.
32. glass wares and chemicals raw materials, labour cost and benefit –cost ratio.
33. Detailed project preparation for commercial biofertilizer production unit
34. Constraints in biofertilizer production and marketing.

PRACTICAL SCHEDULE

1. Equipments in biofertilizer production – Fermentor, TFF, freeze drier, centrifuge and seed coating machine – their operation procedures. Inoculum development
2. Determination of beneficial properties of nitrogen fixers – nodulation efficiency and competitiveness
3. Determination of beneficial properties of nitrogen fixers –ARA and *in vitro* nitrogen fixation
4. Determination of functional properties of mineral solubilizers - phosphate, potassium & zinc solubilizers
5. Determination of AM spore and infective propagules.
6. Estimation of PGP traits- Indole acetic acid (IAA), and siderophore production by different organisms.
7. Estimation of PGP traits - ACCD activity, HCN production and testing efficacy of Sulphur oxidizers
8. Preparation of carrier material, broth and starter culture for mass production of different biofertilizers – Population count in broth and carrier material
9. Large scale production – formulations- carrier and liquid biofertilizers - population count during storage. Production of cell concentrates-TFF and centrifugation
10. Mass production of AM fungi in pot and root organ culture.
11. Mass production of Azolla and BGA
12. Quality control methods of biofertilizers as per FCO specifications
13. Testing the quality of biofertilizers through molecular techniques
14. Biofertilizer application - Form, dose and methodand Quality control methods of AM biofertilizers and BGA
15. Visit to a biofertilizer production plant.
16. DPR and Economics of biofertilizer production
17. **Final Practical Examination**

COURSE OUTCOME

CO 1: To learn about agriculturally important beneficial microorganisms

CO 2: A complete exposure in all kinds of biofertilizers along with their functions and properties

CO 3: Biofertilizer production and usage at national level

CO 4: To understand the requirements to establishing bioinoculants production unit and marketing to become an entrepreneur

CO 5: To learn about production and quality control aspects of biofertilizers

CO-PO MAPPING MATRIX

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

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AGM 507 ENVIRONMENTAL MICROBIOLOGY (2+1)

Learning Objectives

- Students will understand the Microbial communities in different ecosystem
- Students will know the sources of water pollution, and microbiological methods of controlling, treating the polluted water and safe disposal, by aerobic and anaerobic methods.
- Students will study the physical, chemical and biological methods of management of solid waste and its safe disposal.
- Students will learn the role of different microbes on leading of Areas and advanced biotechnological methods in controlling environmental pollution.
- Students will know about environmental laws in India and world

THEORY

Unit I: Microbial communities and ecosystems

Microbial community dynamics, structure of microbial communities. Ecosystems – concept and ecological pyramid. Structure and functions of some microbial communities in nature. Microbes in extreme environments: Habitat, biodiversity, adaptive strategies and biotechnological potential of thermophiles and hyperthermophiles, psychrophiles and psychrotrophs, halophiles, acidophiles and alkalophiles -**Bioremediation of nuclear wastes.Bioremediation-Types- Newer and enhanced processes.**

Unit II: Water pollution

Sources and types, physical, chemical and biological pollution of water, eutrophication and its control. Waste water treatment – methods and recent developments in developing countries – waste stabilization ponds – aerated lagoons, oxidation ditches, bio-methanation.

Unit III: Solid waste

Types and Classification. Municipal refuse composition – landfill sites and refuse emplacement strategies – refuse degradation – landfill products and site exploitation – toxic and hazardous wastes. Composting- types and methods. probiotic organisms – role of the lactic acid bacteria in silage additives - **Biodegradation of lignin and cellulose.**

Unit IV: Global environmental problems

Global warming, Ozone depletion, **greenhouse effects,**acid rain. Environmental monitoring: environmental impacts and their assessments using bioindicators, biomarkers, biosensors and toxicity testing, rDNA technology. Conservation strategies. **Climate change affecting microbes; role of microbes in climate change and recycling.**

Unit V:Indian environmental laws

State and Central government acts and governing bodies. World perspectives of environmental issues- status and scope of biotechnology in environmental protection. Impact of GMO on environment.

Current stream of thoughts

Theory Schedule

1. Microbial communities and ecosystems.
2. Ecosystems concept and ecological pyramid.
3. Microbes in extreme environment
4. Biotechnological potential of extremophiles.
5. Potential of hyperthermophiles, psychrophiles and psychrotrophs,
6. Potential of halophiles
7. Potential acidophiles and alkalophiles
8. Bioremediation Types, Newand enhanced processes, Bioremediation of nuclear wastes.
9. **First Test**
10. Water pollution – measurement of pollution and its control.
11. Waste water treatment concepts, waste stabilization ponds.
12. Aerated lagoons types and oxidation ditches
13. Concept of bio-methanation.
14. Solid waste – Types and classification
15. Municipal solid waste management.
16. Landfill sites and refuse emplacement strategies.
17. **Midsemester**
18. Toxic and hazardous wastes exploitation strategies.
19. **Biodegradation of lignin and cellulose.**
20. Composting methods and Types of composting.
21. Probiotic organisms – role of the lactic acid bacteria in silage additives.
22. Global environmental problems: air pollution.
23. Air pollution types and remedial measures.
24. **Climate change affecting microbes.**
25. **Role of microbes in climate change and recycling.**
26. Global warming phenomenon.
27. Ozone depletion issues and how to minimize& Acid rain- problems and control measures.
28. Environmental monitoring: environmental impacts and their assessments.
29. Bioindicators, biomarkers, biosensors and toxicity testin.
30. rDNA technology for environmental pollution abatement.
31. Conservation strategies for environment.
32. National and state environmental laws and governing bodies.
33. World perspectives of environmental issues.
34. Status and scope of biotechnology in environmental protection, Impact of GMO on environment.

Practical Schedule

1. Studies on microbial communities in soil – Succession
2. Isolation of microorganisms from extreme environment
3. Characterization of waste water
4. Estimation of biochemical oxygen demand
5. Estimation of chemical oxygen demand
6. Estimation of organic carbon
7. Estimation of ammonia and hydrogen sulfide
8. Estimation of *E.coli.* and total bacteria
9. Activated sludge systems
10. Biofilters and bioaccumulation
11. Solid waste treatment; composting determination of compost maturitycs
12. Vermicompost
13. Isolation of lactic acid bacteria
14. Isolation for cellulose degrading enzymes
15. Assessment of microorganisms in air
16. Impact of air pollution on Phyllosphere&Spermosphere.
17. **Practical examination**

Course outcome

CO1: The students will be able to understand different types of pollution and their impact on environment.

CO2: They will be able to employ microorganisms and genetic engineering of genes for treating, recycling and abatement of water and soil pollution.

CO3: The student will be aware of the current environmental issues on global and national level

CO4: Students will understand the concept of Global warming, Ozone depletion, and acid rain.

CO5: The will acquire knowledge on the Indian environmental laws and Acts and their personal responsibility in protecting the environment

CO – PO MAPPING MATRIX

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	-	-	-	-	3
CO 2	-	2	-	-	-
CO 3	-	-	-	-	3
CO 4	-	-	-	-	3
CO 5	-	-	-		3

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AGM 508 MICROBIAL TAXONOMY(2+1)

Objectives

- To expand knowledge on Evolution and microbial diversity.
- To understand bacterial taxonomy. study various classes of fungi in terms of their characteristic features.
- To assimilate the concepts of unculturable bacterial diversity.
- To expand knowledge on Evolution and microbial diversity.

Unit I

Differences in concept of 'species' in eukaryotes and prokaryotes - Definition of species in prokaryotes.Types of 'species'Evolution of species and concepts of speciation (in sexual and asexual organisms)Types of evolution (neutral, co-evolution); Types and levels of selection; r andk selection; molecular clocks; phylogeny and molecular distances

Unit II

The expanse of microbial diversity- Estimates of total number of species. Species Divergence and the measurement of microbial diversity. Measures and indices of diversity

Unit III

Introduction to Bacterial Taxonomy -The 5-Kingdom classification system - The 3-Domain classification system-Bergey's Manuals and the classification of prokaryotes. Determinative Bacteriology (Phenetic Approach) Systematic Bacteriology (Phylogenetic Approach and Polyphasic Approach)

Unit IV

The 6 Classes of Fungi. The differentiating characters among different Classes of fungi.The importance of morphological characters in fungal differentiation andclassification.

Unit VI

Concept of 'unculturable' bacterial diversity. Strategies for culture of 'unculturable' bacteria.Culture independent molecular methods for identifying unculturable bacteria.Methods of extracting total bacterial DNA from a habitat and metagenome analysis.

Current stream of thoughts

Theory schedule

1. Differences in concept of 'species' in eukaryotes
2. Concept of 'species' in prokaryotes.
3. Definition of species in prokaryotes.
4. Types of 'species'Evolution
5. Species and concepts of speciation
6. Types of evolution
7. Types and levels of selectionandk selection
8. molecular clocks
9. **First Class Test**
10. phylogeny and molecular distances
11. The expanse of microbial diversity
12. Estimates of total number of species
13. Species divergence and the measurement of microbial diversity
14. Measures and indices of diversity
15. Introduction to Bacterial Taxonomy
16. The 5-Kingdom classification system
17. **Mid semester**
18. The 3-Domain classification system
19. Bergey's Manuals and the classification of prokaryotes
20. Determinative Bacteriology
21. Systematic Bacteriology
22. Phylogenetic Approach and Polyphasic Approach
23. The 6 Classes of Fungi
24. The differentiating characters among different Classes of fungi.
25. The importance of morphological characters in fungal
26. Differentiation andclassification of fungi
27. Concept of 'unculturable' bacterial diversity
28. Strategies for culture of 'unculturable' bacteria.
29. Culture independent
30. Biochemical methods for identifying unculturable bacteria
31. Molecular methods for identifying unculturable bacteria
32. Methods of extracting total bacterial DNA
33. Metagenome analysis
34. Methods for identifying culturable bacteria

Practical schedule

1. Genomic DNA Isolation.
2. Plasmid DNA Isolation.
3. Restriction digestion.
4. Transformation.
5. Conjugation.
6. PCR
7. RAPD Fingerprinting (Demo).
8. Southern and Northern Blotting (Demo).
9. Quantification of biogas from different feedstock.
10. Analysis of nutritive value of biogas slurry.
11. Biomass briquetting – Coir pith, Groundnut cake, Bagasse.
12. Cultivation of button mushroom.
13. Cultivation of Oyster mushroom.
14. Production of microbial inoculants.
15. Cultivation of Azolla.
16. Preparation of molar solutions
17. **Final Practical Examination**

Course Outcome

CO1 Student will be able to understand the concepts microbial taxonomy and methods of nomenclature.

CO2 Student will be able to use the knowledge of microorganisms from variety of sources.

CO3 Student will be able to classify the microorganisms based on classical and advanced methods.

CO4 Student will be able to understand microbial diversity, species and estimation of various microbial species from different sources.

CO5 Student will be able to understand evolution of microbial species.

CO – PO MAPPING MATRIX

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	**2**	**-**	**-**	**-**	**-**
CO 2	**-**	**-**	**-**	**-**	**-**
CO 3	**1**	**2**	**-**	**-**	**-**
CO 4	**-**	**-**	**-**	**-**	**-**
CO 5	**2**	**-**	**-**	**-**	**-**

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AGM 509 MICROBIAL MANAGEMENT OF ORGANIC WASTE (1+1)

Learning Objectives:

- Students will know the basic information about different types of wastes, their processing, recovery and recycling.
- Students will study the various methods of composting techniques to get quality compost to enrich the soil for agriculture.
- Students will learn about the microbial inoculants for composting and use of effective microorganisms.
- Students will know about the different techniques involved in liquid waste management.
- Students will learn about the different methods of utilization of organic wastes and production of biofuels

Theory

Unit-I: Concept of organic waste and types of wastes

Characteristics and classification of waste- potential availability of agro industrial waste- collection handling and processing of waste – microbial decomposition of organic material- aerobic and anaerobic processes - factors affecting degradation- Wastes- types of wastes- Municipal solid wastes and household hazardous wastes- physical, chemical and biological properties.

Unit-II: Solid waste management

Solid waste management -Sources, types, and composition of solid wastes- Physical chemical and biological properties of solid waste- Treatment of solid wastes- Principle and methods of composting - aerobic and anaerobic composting techniques - windrow composting- Vermicomposting - advantages and disadvantages nutritive value - improved techniques in composting.

Unit-III: Role of microbes on enriched compost

Use of microorganisms in waste: Thermophiles, alkalophiles, acidophiles, halophiles and psycrophiles- Microbial inoculant for composting - microbial consortium for enriched compost – quality standard and maturity test for compost - handling-storage - Method of application - Effect on soil fertility and crop productivity.

Unit-IV: Liquid waste management

Liquid waste management- impact on environment - characterization of liquid waste - waste water treatment- primary: sedimentation, coagulation and flocculation – secondary (Aerobic): trickling filter, activated sludge process, oxidation ponds - tertiary treatments (Anaerobic): disinfection, chlorination - safe disposal of treated effluents- Bioreactor for wastes

water treatment: Reactors design and types- different types of water sampling tools and its uses.

Unit-V: Utilization of organic waste

Anaerobic digester – types - microbiology of anaerobic digestion - feedstock for anaerobic digesters-aquatic plants, organic waste and energy crops for biogas - factors influencing biogas production- Biodeterioration of paper, leather and wood- Bioremediation- Types- Newer and enhanced processes- Waste collection, handling and segregation, transport, storage and disposal methods.

Current stream of thought

Theory Schedule

1. Wastes-classification and characteristics- Various Agro Industrial waste- collections, handling, processing.
2. Decomposition of organic material- Factors affecting degradation.
3. Wastes- types of wastes- Municipal solid wastes- physical, chemical and biological properties**-** Household hazardous wastes- physical, chemical and biological properties**.**
4. Solid waste management- Sources, types, and composition of solid wastes- Physical chemical and biological properties of solid waste - Treatment of solid wastes
5. **First Test**
6. Principle and methods of composting - aerobic and anaerobic composting techniques - Windrow and vermicomposting- advantages and disadvantages nutritive value - improved techniques in composting.
7. Use of microorganisms in waste: Thermophiles, alkalophiles, acidophiles, halophiles and psycrophiles
8. Microbial inoculant for composting - selection and preparation- Microbes for enriched composting.
9. **Mid semester Examination.**
10. Quality standard - maturity test for compost.
11. Handling and storage of compost - Method of application - Effect on soil fertility and crop productivity.
12. Liquid waste management- impact on environment - characterization of liquid waste
13. Primary and secondary treatment- Tertiary treatment and safe disposal.
14. Bioreactor for wastes water treatment: Reactors design and types- different types of water sampling tools and its uses.
15. Anaerobic digester - types - microbiology of biogas production.

16. Biodeterioration of paper, leather and wood- Bioremediation-Types- Newer and enhanced processes.
17. Waste collection, handling and segregation, transport, storage and disposal methods.

Practical Schedule

1. Qualitative and quantitative enumeration of microorganisms from organic waste.
2. Degradation of cellulose.
3. Determination of CO_2 evaluation.
4. Quantification of methane from organic wastes.
5. Isolation of methane producing microorganisms from the wastes.
6. Methods of composting.
7. Vermicomposting.
8. Studying the coir pith degradation.
9. Testing the maturity and quality of compost.
10. Characterization of waste water – BOD & COD
11. Enumeration of coliform bacteria.
12. Anaerobic digester- utilization of aquatic weeds.
13. Single cell protein production using wastes.
14. Visit to sewage farm.
15. Isolation of bacteriophage from water bodies (Replica plate technique)
16. Utilization of microbial consortium for the treatment of solid wastes (Municipal solid wastes)
17. **Practical Examination**

Course outcome

CO1: At the completion of the course, students will be able to understand the different types of wastes, their characteristics and the techniques involved in the processing, recovery and recycling of wastes.

CO2: They will know about the various composting techniques and liquid waste management methods.

CO3: Student will learn about the indicator organism *E coli* contamination in water

CO4: They will understand how to utilize of organic wastes for biogas production.

CO5: Student will able to learn about the mass production of SCP production

CO – PO MAPPING MATRIX

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	-	-	-	2	-
CO 2	-	-	-	-	3

CO 3	**-**	**-**	**-**	**-**	**3**
CO 4	**-**	**-**	**-**	**-**	**3**
CO 5	**-**	**-**	**-**	**-**	**3**

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AGM 510 MARINE MICROBIOLOGY (2+1)

OBJECTIVE

- To understand the basic knowledge on Marine Microbial Environment
- To learn the advanced techniques used in Marine Microbial research.
- To explore the knowledge onMarine Extremophiles
- Studying their evolutionary process and understanding the Marine Microbial Diseases
- To introduced emphasis knowledge on Microbial biotechnological tools and its application in Marine Microbial Research.

THEORY

Unit - I

MARINE MICROBIAL ENVIRONMENT–Marine microbial community bacteria, fungi, protozoa. Structure: Bacteria, fungi, algae, protozoa and viruses; Classification of microbes;Ecologyofcoastal,shallowanddeepseamicroorganism-importanceandtheirsignificance. Diversity of microorganism Archaea,bacteria,cyanobacteria,algae,fungi, viruses and actinomycetes in the mangroves and coral environs.

Unit – II

MARINE EXTREMOPHILES: Survival at extreme environments – starvation – adaptive mechanisms in thermophilic, alkalophilic, osmophilic and barophilic, psychrophilic microorganisms –hyperthermophiles and halophiles.

Unit - III

SYMBIOTIC MICROBES: Microbe-microbe interactions – Lichens, antagonistic interactions amensalism,mycoparasitism – Animal-microbe interaction – Ectosymbiosis of Protozoa, Ruminantsymbiosis – Plant-microbe interaction – Rhizobium, Mycorrhizae, Anabaena – sponges. Carbon, nitrogen and phosphorus cycle; Decomposition of organic matter

Unit - IV

MARINE MICROBIAL DISEASE:Sea food borne pathogens & Water borne pathogens – Aeromonas, Vibrio,Salmonella, Pseudomonas, Leptospira, Cornybacter and viral diseases.

Unit - V

APPLICATIONS OF MARINE MICROBIAL BIOTECHNOLOGY: Production and applications of marine microbial products – pigments – Astaxanthin, β carotene – enzyme – antibiotics- polysaccharides – sea food preservation methods. Probiotic bacteria and their importance in aquaculture.Microbial biodegradation natural and synthetic material in the marine environment-pesticide, cellulose degradation, hydrocarbon production. Bioremediation of xenobiotics oil, heavy metals, pesticides, plastics, etc.

Current stream of thoughts

LECTURE SCHEDULE:

1. Microbes in the Marine Environment
2. Marine microbial habitats,benthic & littoral zone, saltpan, mangroves and estuarine microbes
3. Ecologyofcoastal,shallowanddeepseamicroorganism
4. coastal ecosystems, reef and coral reefs, sediments, food web
5. Marine microbial community
6. Importance of the Identification and Classification of Microorganisms
7. Structure: Bacteria, fungi, algae, protozoa and viruses
8. Methods of studying the marine micro-organisms
9. **First test**
10. Methods of collection, enumerationmarine microbes
11. Isolation, culture & identification based on morphological,physiologicaland biochemical characteristics
12. Extremophilic microorganisms
13. Survival at extreme environments
14. Mechanisms in thermophilic, alkalophilic, osmophilic microorganisms
15. Mechanisms in barophilic, psychrophilic hyperthermophiles and halophiles
16. Microbe-microbe interactions
17. **Mid Semester Examination**
18. Lichens, antagonistic interactions amensalism,mycoparasitism
19. Microbial Symbioses of Marine Animals
20. Animal-microbe interaction – Ectosymbiosis of Protozoa, Ruminantsymbiosis
21. Microbial Symbioses of Marine Plants

22. Plant-microbe interaction – Rhizobium, Mycorrhizae, Anabaena
23. Microbes in Ocean Processes — Carbon and Nitrogen Cycling
24. Microbes in Ocean Processes — Sulfur, Iron, Phosphorus and Silicon Cycling
25. Microbial Diseases of Marine Organisms
26. Sea food borne pathogens
27. Sea food Water borne pathogens
28. Vibrio,Salmonella, Pseudomonas, Leptospira, Cornybacter and viral diseases.
29. Production and applications of marine microbial products
30. pigments –Astaxanthin, β carotene – enzymeantibiotics- polysaccharides
31. Sea food preservation methods
32. Probiotic bacteria and their importance in aquaculture.
33. Microbial biodegradation-natural and synthetic material in the marine environment
34. Biodegradation of xenobiotics.

PRACTICALSCHEDULE:

1. Isolation and identification of microbes from Marine Ecosystem
2. Analysis of physico-chemical parameters of Marine Microbes
3. Isolation and characterization of microbes from coastal waters
4. Isolation and identification of microbes from mangroves
5. Isolation and identification of microbes from sediments
6. Isolations and Purification of Halophilic organisms
7. Isolations and Purification of Osmophilic Microorganisms
8. Isolations and Purification of Thermophilic Microorganisms
9. Isolations and Purification of Alkalophilic,organisms
10. Estimation of Salinity
11. Estimation of Dissolved Oxygen
12. Estimation BOD
13. Estimation COD

14. Isolation of Microbes from Rhizospere soil
15. Study of biofilm microorganisms
16. Enrichment and isolation of crude oil degrading marine bacteria.
17. Isolation of biosurfactant producing microorganisms.

Course Outcome

Co1 At the end of the course students will understand the basic knowledge of Marine microbiology

Co2 Explain the basic concepts of Microbiology specifically Marine Microbiology and differentiate the different groups of microbes

Co3 Students will be knowing the marine extremophile sand their Importance

Co4 To gain knowledge of Probiotic bacteria and their importance in aquaculture.

Co5 Students will be knowingMicrobialbiodegradation, natural and synthetic material in the marine environment

CO/PO MAPPING

CO/PO	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7
CO_1	2	-	-	-	-	-	-
CO_2	3	-	-	-	-	-	-
CO_3	-	-	-	-	-	-	-
CO_4			2	-	-	-	-
CO_5	-	-	-	-	3	-	-

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AGM 511 - INDUSTRIAL MICROBIOLOGY (2+1)

Learning objectives

- To make the students to understand the role of microorganism in various industries
- To impart knowledge on the preservation technologies
- To impart knowledge on production of different types of Antibiotics, food, dairy products and food safety measures.
- To make the students to know the various spoilage and food borne infection and disease caused by microbes
- To have knowledge on the fermentation technologies of producing value-added foods by microbes

THEORY

Unit- I- Introduction of fermentation

History of industrial microbiology – Isolation and screening methods – strain development strategies – fermentation media – raw materials used in media production and antifoam agents - fermentation process - dual and multiple fermentation process - batch and continuous fermentation, solid state, and submerged fermentation.

Unit-II- Bioreactors and its types

Bioreactors – basic functions - types, designs, and functional characteristics- upstream and downstream processing – automation of bioreactors; **Fermentor – basis and operations with CSTR- types of important fermenters**

Unit -III- Production of organic solvents, organic acids, amino acids and Beverages

Production of organic solvents such as ethyl alcohol and glycerol. organic acids production – butyric acid, citric acid and lactic acid. Amino acid production – lysine and glutamic acid. Beverage's production – beer and wine. – Alcohol production

Unit- IV- Production of Antibiotics, Vitamin and Enzymes

Industrial production of antibiotics – penicillin, streptomycin, and tetracycline production of vitamin B2 (Riboflavin), vitamin B12 and vitamin C. production of enzymes – amylase, protease, cellulase, pectinase and lipase immobilization and its type. **Biomining: recovery of minerals from low-grade ores.**

Unit- V- Fermented food products, biofertilizers and biopesticides production techniques

Milk and dairy product production – yoghurt, buttermilk, cultured milk and cheese **- single cell protein, recombinant proteins. Spirulina, mushroom, probiotic products -** Mass production of bacterial biofertilizers – *Azospirillum*, *Rhizobium* and Phosphobacteria. Mass production of Bio insecticides – *Bacillus thuringiensis*, *Beauveria bassiana* and *Metarhizium anisopliae* , Mass production of *Pseudomonas fluorescens* and *Trichoderma viride*. **Mechanisms of pesticide degradation by microbes.**

Current Stream of thoughts:

THEORY LECTURE SCHEDULE

1. History of industrial microbiology
2. Screening methods
3. Strain improvement of microorganisms
4. Methods of strain improvement
5. Fermentation media and their raw materials
6. Fermentation process of its Types
7. Bioreactors, design and functional characteristics
8. Types of bioreactors and Upstreaming Processing
9. **I st Test**
10. Downstream processing- introduction
11. Details of down steam processing
12. Fermenter and operation-CSTR
13. Production of organic solvents –ethyl alcohol and glycerol
14. Production of organic acid – Butyric, citric and Latic acid
15. Production of Amino acid - Lysine and glutamic acid
16. Production of Beverages - Beer and wine alcohol production
17. **Mid semester Examination**
18. Production of penicillin , streptomycin and tetracycline
19. Production of amylase and protease
20. Production of pectinase, cellulose
21. Production of Lipase
22. Immobilization and its types
23. Biomining: recovery of minerals from low-grade ores.
24. Milk product – Butter milk and culture milk
25. Yoghurt production
26. Cheese production
27. Single cell proteins and recombinant proteins.
28. Spirulina, mushroom, probiotic products.
29. Bacterial bio fertilizer production – Azospirillum, Rhizobium and Phosphobacteria
30. Quality control and method of application
31. Production of bioinsecticides – *Bacillus thuringiensis*
32. Mass production of *Beauveria bassiana* and *Metarhizium anisopliae*
33. Mass production of *Pseudomonas fluorescens* and *Trichoderma viride*
34. Mechanisms of pesticide degradation by microbes.

PRACTICAL SCHEDULE

1. Isolation of industrial important microorganisms from soil and buttermilk/ curd.
2. Strain improvement – Induced mutation of bacteria.
3. Preparation of Inoculum
4. Bioreactors and its functional characteristics
5. Alcohol production from Jaggery
6. Wine making
7. Amylase production
8. Citric acid production by solid waste fermentation
9. Antibiotic sensitivity test – penicillin, streptomycin and tetracycline
10. Extra – cellular amylase production
11. Production of penicillin
12. Production of enzymes using immobilization techniques
13. Mass production of single cell protein
14. Mass production of Rhizobium biofertilizer
15. Mass production of Bioinsecticide *Bacillus thuringiensis* (or) *Beauveria bassiana* (or) *Metarhizium anisopliae*
16. Mass production of *Pseudomonas fluorescens* and *Trichoderma viride*
17. **Practical Examination**

Course outcome:

CO 1 - To learn about the important industrial microbes and their products.

CO 2 - To learn about the strategies to improve the strain efficiency and preservation techniques for future purposes.

CO 3 -To make the students to understand the concepts and types of fermentation process, types of fermenters, their design and purposes.

CO 4 - To gain knowledge on the techniques of industrial production of organic acids, antibiotics, enzymes, and fermented foods.

CO 5 - To train the students to develop skills on the techniques of mass production of biofertilizers and bio pesticides

CO – PO MAPPING MATRIX

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	2	-	3	-	-
CO 2	-	2	3	-	-
CO 3	-	-	3	-	-
CO 4	-	-	3	-	-
CO 5	-	-	3	-	3

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

Learning Objectives

- To enlighten the students about the basics of commonly used techniques in laboratory at national and international levels
- To learn the appropriate basics of commonly used techniques and research methodologies adopted to carry out agriculture research problems.
- To learn the knowledge about various concepts and types of research laboratory techniques
- To able to design and follow original laboratory methods and will be able to do concise and persuasive scientific laboratory techniques
- To gain the experience in basic concepts in laboratory techniques and pursue quality research

PRACTICAL

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. 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; Neutralisation of acid and bases ;preparation of buffers of different strengths and ph values. Use and handling of vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sand bath and water bath. 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.

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 equipments.
3. Calibration and cleanliness of volumetric glass wares.
4. Methods of expressing strength of solutions.
5. Preparation of primary standard solutions and buffer solutions.
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. **Mid semester**
9. Handling of instruments-vacuum pumps, thermometers, magnetic stirrer.
10. Handling of instruments-ovens ,sand bath and water bath.
11. Handling and uses of microscopes and laminar flow.

12. Sterilization by physical methods.
13. Sterilization by chemical methods.
14. Preparation of different media for culturing the micro organisms.
15. Description of flowering plants-seed viability test and pollen fertility test.
16. Aseptic manipulations and media.
17. In vitro culture of different explants.

Course Outcomes

1. Have core knowledge leading to laboratory techniques and agriculture research system
2. To learn the various concept and terminologies for laboratory techniques.
3. Graduates will be acquiring knowledge about various laboratory techniques of national and international level.
4. Graduates will gains accurate and relevant analytical skill of different analytical skills and will have capacity interrupt information
5. Graduates will be able to develop a analytical skill like methods of soil and plant analysis

PO-CO MAPPING

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

Reference Books

1. Furr ,A.K.2000. CRC 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, 5thEdition, MC.GrawHill,USA.
4. Gupta,P.K.1997.Elements of Biotechnology,RastogiPublications.Meerut.
5. Singh,B.D. 2005.Bio technology ,Expanding Horizons, Kalyani Publications, New Delhi.

e-courses

1. Analytical chemistry vol.1(pdf) www.freebook centre.net.
2. Analytical chemistry Dr.michaelzehfuswww.free book centre.net.
3. Introduction to Instrumental Analytical Chemistry Roger Terrilwww.freebook centre.net.
4. Analytical Chemistry lecture notes sadhu malyadriwww.freebook centre.net.
5. Short introduction into analytical chemistry Dr.manfredsietz and Dr. Andreassonnenbergwww.freebook centre.net.

AGM – 501 PRINCIPLES OF MICROBIOLOGY(2+1)

Objective

- To familiarize with what microorganisms are and their impact on life
- To teach basic microbiological techniques
- To set the stage for consideration of microbial structure and nutrition
- To teach about the microbial evolution and systematics
- To focus on the diversity of bacteria and viruses

THEORY

Unit I : Microbes and Microbiology, Microscopy

Scope of Microbiology- Types of Microorganisms- Emergence of different fields of Microbiology- Historical routes in the development of Microbiology. Microscopy- Bright field, Dark field and Electron Microscopes. Staining

Unit II : Cell Structure, Growth, Control of Growth

Cell structure and function in bacteria. Bacterial growth and reproduction– nutritional and environmental requirements. Sterilization

Unit III : Microbial Evolution, Microbial Systematics

Microbial evolution- Evolutionary relationship among Prokaryotes, Eukaryotes and Archaea. Evolutionary analysis. Microbial phylogeny. Construction of Phylogenetic tree

Unit IV : Microbial Systematics

Phenotypic and genotypic analysis of bacteria. Phylogenetic analysis. Use of DNA and RNA sequencing in classification. Species concept in Microbiology. Bergey's manual of systematic Bacteriology- Key characteristics of Proteobacteria and Gram-positive bacteria

Unit V : Human – Microbe Interaction, Overview of Viruses

Normal micro flora of Human body; Immune response- specific and non-specific host resistanceVirus structure and growth. Viral replication. Viral diversity – Overview of bacterial viruses

CURRENT STREAM OF THOUGHTS

Theory lecture schedule

1. Scope of Microbiology
2. Types of Microorganisms- Emergence of different fields of Microbiology
3. Historical routes in the development of Microbiology
4. Microscopy- principles and applications of light microscopes
5. Electron Microscopy, confocal laser microscopy
6. Staining- principles, simple, special staining
7. Cell structure and function in bacteria- fine structure of gram-positive bacteria
8. Cell structure and function in bacteria- fine structure of gram-negative bacteria
9. **First Test**
10. Internal structure-cell inclusions, special structures in bacteria
11. Bacterial growth and reproduction

12. Nutritional types of bacteria- nutritional requirement in bacteria
13. Environmental factors on growth of bacteria
14. Sterilization techniques
15. Microbial evolution- prebiotic evolution
16. Evolutionary relationship among Prokaryotes, Prokaryotes and archaea
17. **Mid semester Examination**
18. Evolutionary analysis, methods of evolutionary analysis
19. Microbial phylogeny
20. Construction of Phylogenetic tree
21. Phenotypic and genotypic analysis of bacteria.
22. Phylogenetic analysis.
23. Use of DNA and RNA sequencing in classification.
24. Numerical taxonomy
25. Species concept in bacterial classification
26. Bergey's manual of systematic Bacteriology- keys used for classification
27. Key characteristics of Proteobacteria
28. Key characteristics of Proteobacteria
29. Key characteristics of Gram-positive bacteria
30. Key characteristics of Archaea
31. Normal micro flora of Human body
32. Immune response-specific and non-specific host resistance
33. Virus structure and growth. Viral replication
34. Viral diversity – Overview of bacterial viruses

Practical Schedule

1. Working principles and handling of different types of microscopes – Bright and Dark field microscopy
2. Working principles and handling of different types of microscope- SEM and TEM-I
3. Working principles and handling of different types of microscope- SEM and TEM –II
4. Methods of isolation of microorganisms from different environments – soil, water, milk and food
5. Use of selective media for isolation of microorganisms
6. Purification techniques of bacteria and fungi
7. Enumeration and Quantification techniques
8. Maintenance and preservation of cultures
9. Assessment of microbial quality of potable water.
10. Morphological characterization of Bacteria
11. Morphological characterization of fungi
12. Biochemical characterization of bacteria
13. Biochemical characterization of fungi
14. Molecular characterization of bacteria by 16S rDNA sequencing and construction of phylogenetic tree
15. Molecular characterization of bacteria by 16S rDNA sequencing and construction of phylogenetic tree
16. Isolation of bacteriophages
17. **Final Practical Examination**

Course outcome

CO 1 -Knowledge on historical perspective of Microbiology

CO 2 -Basic knowledge on different structure of microbes, and their growth

CO 3 - Evolutionary relationship among microbes

CO 4 – Human microbe interaction

CO 5 – Viral diversity

CO – PO MAPPING MATRIX

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	1	-	-	-	-
CO 2	3	-	-	-	-
CO 3	2	-	-	-	-
CO 4	2	-	-	-	-
CO 5	1	-	-	-	-

Reference

1. Pelczar, M.J. Jr., Chan, E.C.S. and Kreig, N.R. 1997. Microbiology, Concepts and Application, 5th edition, Tata McGraw Hill, New York.
2. Prescott, L.M., Harley and Klein. 2002. Microbiology 5th Edition, Tata McGraw Hill, New York.
3. Bhatia, M.S.2009. Principles of Microbiology. Swastik Publishers., DeIhi.
4. Singh, U.S and K. Kapoor 2010. Introductory Microbiology. Oxford Book Company. Jaipur
5. Tortora, G. J., B.J. Funke and C.L. Case. 2010. Microbiology: an introduction.10th Ed. Benjamin Cummings., New York.

E resources

http://www.asmscience.org
http://www.asm.org
http://www.microbiologyonline.org.uk
http://www.microbeworld.org
https://sites.google.com/a/uasd.in/ecourse/agricultural-microbiology

AGM -502 Microbial Genetics (2+1)

LEARNING OBJECTIVES

- To acquire the basic knowledge about the genetic information of microorganisms.
- How heredity takes place in these organisms.
- To understand the expression and regulation of genes in bacteria.
- To know genetic recombination and mutations that causes variability.
- To develop the skills to work on polymerase chain reaction.

Theory

Unit I: Genome of Microorganisms

Introduction to microbial genetics – Historical perspectives of microbial genetics –terminology related to Microbial genetics - Genome of prokaryote, eukaryote (fungi, yeast) and virus. Genetic elements - chemical structure and property, enzymes associated with nucleic acid – different forms of DNA (A, B, and Z forms) - RNA- tRNA, mRNA, rRNA; DNA replication - Extra chromosomal DNA in bacteria and eukaryotic cells: chloroplast DNA, Mitochondrial DNA- plasmids: Structure, classification and replication-Biostatistics-survival analysis, clinical analysis

Unit II : Gene Expression and Regulation

Gene structure and expression: - Gene expression in prokaryote and eukaryotes – gene expression mechanism-intron and exons – Gene network-post transcriptional modifications - Regulation of gene expression - Principles of Operon Negative regulation (*lac* operon and *try* operon) – Positive regulation (cAMP).

Unit III :Mutation

Principles of mutation – Spontaneous and induced mutation – Classification of mutations - Selection principles of mutants – Mutagens and their mode of action – Transposable elements and insertion sequences - DNA damage – DNA repair mechanisms in bacteria – Role in carcinogenesis-Prion mutation-Emerging issues with microbial mutations.

Unit IV : Recombination

Genetic recombination in bacteria – mechanisms of recombination – Transformation, conjugation and transduction: Principles and process – Complementation: principles - Gene mapping by recombination and complementation: Principles and application-Primer: role of primers-RNA Primers in vivo-synthetic primers.

Unit V : Recombinant DNA Technology

Polymerase chain reaction: RT-PCR - DNA sequencing - Gene bank deposition – Principles of recombinant DNA technology – Site directed mutagenesis Plasmid, cosmid and phage vectors – cloning and expression vectors – Detection of recombinants and purification of recombinant protein –- Metagenomics - basic principles – impact of gene cloning on human welfare – Ethics in microbial gene cloning.

Current stream of thoughts:

THEORY SCHEDULE

1. Scope for microbial genetics – terms related to microbial genetics
2. Historical perspectives of microbial genetics
3. Structure of DNA and RNA, Properties of nucleic acid; Enzymes associated with DNA; different forms of DNA and RNA.
4. Concept of biostatistics in health related fields like including medicine biology and public health
5. DNA replication: Semi conservative; semi discontinuous method; θ replication and rolling circle method.
6. Genome of bacteria, fungi and virus; Yeast genetics
7. Extra-chromosomal DNA in bacteria: Plasmids and their classification; Mitochondrial DNA and chloroplast DNA.
8. Gene network and Gene arrangements in prokaryotes and eukaryotes –introns and exons
9. **First Test**
10. Gene expression and its mechanism in prokaryotes and eukaryotes: Post transcriptional modifications
11. Gene regulation – necessities; Positive and negative regulations
12. *lac* operon model (inducer): Promotor; Operator; Regulator; Structural genes; Terminators; cis-acting elements; Trans acting proteins.
13. *try* operon (repressor); cAMP Positive regulation
14. Mutation – types: Spontaneous Mutation / Induced M; Chromosomal aberration / Point M; Base pair substitution / Frame shift mutation; Silent M / Reverse M; Spontaneous mutations in bacteria/ prion mutation/ role in carcinogenesis.
15. Phenotypic expression of mutation; selection of mutants

16. Mutagens – Physical, chemical and biological: Mode of action
17. **Mid semester examination**
18. Transposable elements and insertion sequences
19. Causes of DNA damage in bacteria
20. DNA repair mechanisms in bacteria
21. Emerging issues with microbial mutations and Site directed mutagenesis and metagenomic analysis – Basic principles.
22. Genetic recombination and variability in bacteria
23. Genetic recombination and variability in fungi (Yeast and *Neurospora* as model)
24. Transformation – Principles, competence and application
25. Conjugation: Principles, F plasmids, process, HFR cells, application
26. Generalized and Specialized transduction – principle and process
27. Complementation assay – Principles and application
28. Gene mapping – Principles, methods and application and primer and its role, RNA primers in vivo synthetic primers.
29. Introduction to genetic engineering and Recombinant DNA technology.
30. PCR – RT-PCR, Principles and application.
31. DNA sequencing – different methods (Chemical degradation; chain termination and pyro sequencing) – Gene Bank deposition
32. Vectors in DNA technology – different types and applications;
33. Gene cloning in human welfare; ethics
34. Detection of Recombinants and recombinant proteins

PRACTICAL SCHEDULE

1. Isolation of genomic DNA from bacteria and fungi
2. Qualitative and quantitative assay of DNA (Spectrometry and gel-electrophoresis)
3. Visualization of mega plasmids of *Rhizobium* and *Agrobacterium* by in-gel lysis method
4. Isolation of plasmid DNA from *E. coli* by alkali lysis method
5. Curing of plasmid of *E. coli* by acridine orange
6. Isolation of phage DNA from *E. Coli*

7. Detection of spontaneous mutation
8. Induction of antibiotic resistance by UV rays and calculation of MIC for mutagens
9. Isolation of auxotrophic mutants by ethyl methane sulphonate and screening by replica plating technique
10. Preparation and transformation of competent *E. coli* using $CaCl_2$
11. Conjugation of bacteria for developing marker strain
12. PCR amplification of 16S rRNA gene from bacteria
13. Cloning of PCR product in cloning vector and expression in *E. coli*
14. Restriction digestion of plasmid DNA
15. DNA sequencing – *in silico* analysis (for species identification and phylogeny)
16. Isolation of metagenomic DNA from soil and waste water samples.
17. **Final Practical Examination.**

Course outcome:

CO 1: They will understand about the fundamental aspects of microbial genetics, historical perspective, genetic elements, chemical structure, properties, classification and its function.
CO 2: They will understand gene structure and expression in prokaryote and eukaryote, regulation on gene expression.
CO 3: Students will gain knowledge on mutation and its types, principles of mutants, mutagens, DNA repairing mechanism and emerging aspects on microbial mutations.
CO 4: Students will study about genetic recombination in bacteria and its mechanism, Gene mapping by recombination and complementation, its application and properties.
CO 5: Students will study and have practical knowledge on DNA sequencing. Polymerase chain reaction, principles of recombination DNA technology, cloning, its impact on human welfare and ethics in microbial gene cloning, site directed mutagenesis.

CO-PO MAPPING MATRIX

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

REFERENCE BOOKS

1. Brown, T.A. 2010. Gene cloning and DNA analysis: an introduction 6th ed., Wiley-Blackwell Publications, UK
2. Levin, B. 2002. Gene VIII. Oxford Univ. Press, New York.
3. Maloy, S.R., Cronan, J.E. and D.Freifelder. 2008. Microbial Genetics. (Second edition). Narosa Publishing house, New Delhi.
4. Streips, U.N. and R.E.Yasbin. 2006. Modern Microbial Genetics. Wiley – Liss Publ, New York
5. Malacinski GM. 2015. Freifelder's Essentials of Molecular Biology (Fourth edition), Jones & Bartlett's student edition.

E- RESOURCES

1. http://highered.mcgraw-hill.com/sites/0072552980/student_view0/chapter9/
2. http://highered.mcgrawhill.com/sites/0072835125/student_view0/animations.html
3. http://www.cliffsnotes.com/sciences/biology/microbiology
4. http://plato.acadiau.ca/courses/biol/Microbiology/home.HYPERLINK
5. http://plato.acadiau.ca/courses/biol/Microbiology/home.html"html

AGM-503 MICROBIAL PHYSIOLOGY (2+1)

LEARNING OBJECTIVES

- To become an expert on the structure and function of prokaryotic cells and get an understanding of the genetic and physiological regulatory mechanisms.
- To develop the concepts and skills required to understand and critically evaluate research articles that address the physiology and biochemistry of microbes.
- To apply the theories of bacterial cell physiology to current problems in the area.
- To learn about an expanded role for microbial physiology in metabolic engineering and functional genomics.
- To know about tracking, tuning and terminating microbial physiology using synthetic riboregulators.

THEORY

Unit: I - Structure, Function and biosynthesis of cellular components

Microbial nutrition – Chemical composition of microbial cell – Structure, function and assembly of cell membrane in prokaryotes, archaea and fungi – Macro and Micro – nutrients and their physiological functions – Transport of solutes across the membrane.

Unit: II – Cell cycle, Cell division, Pathways and fermentation:

Microbial growth, Cell cycle and cell division. Bioenergetics – carbohydrate utilization via EMP, HMP, ED, TCA pathways, Aerobic and anaerobic respiration. Fermentative metabolism. Assimilation of nitrogen and sulphur – Oxygenic and anoxygenic photosynthesis – Mechanisms of carbon-dioxide fixation in prokaryotes. Ethanol, Lactic acid, butanol, acetone and mixed acid fermentation. Fermentation of nitrogenous organic compounds regulation of microbial metabolism.

Unit: III – Growth and factors affecting growth and culture systems – Nutritional classification and spore formation and germination:

Effects of physical, Chemical and other environmental factors on growth continuous culture, Diauxic growth and Synchronous culture. Method of growth measurement. Morphogenesis and cellular differentiation. Metabolic diversity in photoautotrophs, photoheterotrophs, chemoautotrophs. Nutritional grouping/classification of microorganisms. Bacterial endospore-types, morphology, biochemistry and regulation of formation and germination.

Unit: IV – Enzyme kinetics and Mechanism of Enzymes and Microbial Metabolism

Enzyme kinetics: Michaelis Menten kinetics – mechanisms of inhibition of enzyme activity – coenzymes and prosthetic groups. Methods to determine free energy of biochemical reactions – high energy compounds. Microbial metabolism - generation of ATP, reducing power, development of proton gradient and biosynthesis of ATP.

Unit: V – Biosynthesis of Macromolecules

Biosynthesis of macromolecules – Synthesis and assembly of cell wall components – Methods of studying biosynthesis – regulation of microbial metabolism.

CURRENT STREAM OF THOUGHTS

THEORY SCHEDULE

1. Introduction and scope of Microbial Physiology
2. Microbial nutrition – Chemical composition of a microbial cell – Major and micro nutrients and their physiological functions.
3. Cell: Basic organizational units of living systems.
4. Cytoplasmic membrane: movement of material into and out of cells – structure of cytoplasmic membrane.
5. External structures that protect the cell – Bacterial cell wall and envelopes
6. Cell wall of archaea: cell wall of Eukaryotic microorganisms – fungi, algae and protozoa.
7. Sites of cellular energy transformations where ATP is generates: Bacteria, archae and eukaryotes.
8. Structure involved with movement of cells – Flagella – Taxis: Structure involved in attachment of cells.
9. **First Test**
10. Mechanisms of nutrients transport in bacteria – passive processes: active energy-linked transport processes, Microbial growth – Nature and expression of growth – measurement of growth.
11. Effect of environmental factors on microbial growth – response of microorganism to stress.

12. Nutritional diversity among prokaryotes – mechanisms behind diversity in extremophiles.
13. Respiration: Glycolysis
14. Alternate pathways of glucose metabolism-HMP-Pentose phosphate pathway.
15. EMP and Entner Dudroff pathway.
16. TCA cycle – Glyoxylate cycle
17. **Mid Semester Examination**
18. Enzyme kinetics-Michaelis – Menton constant-Co-enzymes and prosthetic groups
19. Mechanisms of inhibition of enzyme activity
20. Principles of bio-energetics; Laws of thermodynamics – Methods to determine free energy of biochemical reactions-High energy compounds.
21. Microbial metabolism – metabolic strategies for generating cellular energy – autotrophic, heterotrophic; Generation of ATP, reducing power.
22. Fermentation I: Lactic acid, ethanolic, propionic, mixed acid fermentations
23. Fermentation II: butanediol, butyric, amino acid fermentations, Fermentation of acetate to methane: methanogenesis
24. Photoautotrophy:Absorption of light-Oxygenic and anoxygenic photosynthesis
25. Assimilation of nitrogen and sulphur
26. Mechanisms of CO_2 fixation in prokaryotes-calvin cycle, hydroxypropionate pathway, C4 pathway
27. Assimilation of organic C_1 compounds – Methanotrophy, ribulose monophosphate pathway, serine pathway, Methylotrophy
28. Biosynthesis of macromolecules-Carbohydrate biosynthesis-Biosynthesis of storage compounds and energy reserves in bacteria
29. Synthesis and assembly of cell wall components-biosynthesis of polysaccharides, peptidoglycan biosynthesis, LPS biosynthesis
30. Lipid biosynthesis – Fatty acid biosynthesis, Biosynthes of PHB, Biosynthesis of phospholipids, biosynthesis of sterols.

31. Biosynthesis of amino acids for proteins – Nitrogen fixation and formation of ammonium ions
32. Biosynthesis of Nucleotides for nucleic acids – biosynthesis of pyrimidines, purines
33. Regulation of microbial metabolism – Feedback control mechanisms
34. Sporulation in bacteria – Survival through production of spores

PRACTICAL SCHEDULE

1. Determination of viable and total number of cells.
2. Measurement of cell size.
3. Gross cellular composition of microbial cell. Growth – Factors affecting growth.
4. Growth of microorganisms on various carbon and nitrogen sources.
5. Study of bacterial spores and factors affecting germination.
6. Demonstration of thermos - Meso and psychrophilic micro organisms.
7. Production and testing of inducible enzymes in bacteria.
8. Sporulation and spore germination in bacteria.
9. Protoplasts formation and regeneration.
10. Estimation of generation time and specific growth rate for bacteria and yeast.
11. Diauxic growth curve.
12. Production of synchronous cells.
13. Effect of chemicals and environmental factors on bacterial growth.
14. Isolation and Identification of reserve food material (Glycogen/Polyphosphates, PHB) from bacteria (*Azotobacter, Bacillus megaterium*).
15. Demonstration of endogenous metabolism in *E.coli* and their survival under starvation conditions.
16. Protoplast formation.
17. **Final Practical Examination**

COURSE OUTCOME

CO1 : The students will be able to understand the basic physiological process that can be taken place in cell.

CO2 : They will be knowing the catabolic process of various pathways in which energy production takes place in a cell and how the energy is utilized for the reproduction and sporulation.

CO3 : They will gain knowledge on the microbial growth kinetics

CO4 : Students will understand the role of microbes and their physiological functions in the evolution of life on earth.

CO5 : Students will be able to select suitable sources of nutrients for efficient production of metabolites

CO-PO MAPPING

	PO 1	**PO 2**	**PO 3**	**PO 4**	**PO 5**
CO 1	**1**	**-**	**-**	**-**	**-**
CO 2	**-**	**-**	**-**	**3**	**-**
CO 3	**-**	**-**	**-**	**3**	**-**
CO 4	**2**	**-**	**-**	**-**	**-**
CO 5	**-**	**-**	**-**	**3**	**-**

REFERENCE BOOKS

1. Moat, A.G. and J.W. Foster, 2002. Microbial Physiology, John Wiley & Sons, New York, USA, 11th Ed. Prentice – Hall, Inc. Englewood Cliffs, New Jersey.
2. Madigan, M.T, J.M. Martinko and J.Parker, 2006. Brock: Biology of Microorganisms, 11th Ed. Prentice-Hall, Inc. Englewood Cliffs, New Jersey.
3. White, D.2007. The Physiology and Biochemistry of Prokaryotes, 3rd Edition. Oxford University Press.
4. Downs, D.K.2006. Understanding microbial metabolism. Annual Review of Microbiology 60, 533-559.
5. Hosler *et al.* 2006. Energy Transduction: Proton Transfer Through the Respiratory Complexes. Annual Review of Biochemistry 75, 165-187

E-RESOURCES

1. http://www.mirobeworld.org
2. http://www.textbookofbacteriology.net
3. http://www.e-education.psu.edu
4. http://www.ncbi.nlm.nih.gov/pubmed/12050002
5. http://www.journals.elsevier.com/bba-bioenergetics

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

Learning Objectives

- To enlighten the students about the basics of commonly used techniques in laboratory at national and international levels
- To learn the appropriate basics of commonly used techniques and research methodologies adopted to carry out agriculture research problems.
- To learn the knowledge about various concepts and types of research laboratory techniques
- To able to design and follow original laboratory methods and will be able to do concise and persuasive scientific laboratory techniques
- To gain the experience in basic concepts in laboratory techniques and pursue quality research

PRACTICAL

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. 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; Neutralisation of acid and bases ;preparation of buffers of different strengths and ph values. Use and handling of vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sand bath and water bath. 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.

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 equipments.
3. Calibration and cleanliness of volumetric glass wares.
4. Methods of expressing strength of solutions.
5. Preparation of primary standard solutions and buffer solutions.
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. **Mid semester**

9. Handling of instruments-vacuum pumps, thermometers, magnetic stirrer.
10. Handling of instruments-ovens ,sand bath and water bath.
11. Handling and uses of microscopes and laminar flow.
12. Sterilization by physical methods.
13. Sterilization by chemical methods.
14. Preparation of different media for culturing the micro organisms.
15. Description of flowering plants-seed viability test and pollen fertility test.
16. Aseptic manipulations and media.
17. In vitro culture of different explants.

Course Outcomes

1. Have core knowledge leading to laboratory techniques and agriculture research system
2. To learn the various concept and terminologies for laboratory techniques.
3. Graduates will be acquiring knowledge about various laboratory techniques of national and international level.
4. Graduates will gains accurate and relevant analytical skill of different analytical skills and will have capacity interrupt information
5. Graduates will be able to develop a analytical skill like methods of soil and plant analysis

PO-CO MAPPING

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

Reference Books

1. Furr ,A.K.2000. CRC 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, 5thEdition, MC.GrawHill,USA.
4. Gupta,P.K.1997.Elements of Biotechnology,RastogiPublications.Meerut.
5. Singh,B.D. 2005.Bio technology ,Expanding Horizons, Kalyani Publications, New Delhi.

e-courses

1. Analytical chemistry vol.1(pdf) www.freebook centre.net.
2. Analytical chemistry Dr.michaelzehfuswww.free book centre.net.
3. Introduction to Instrumental Analytical Chemistry Roger Terrilwww.freebook centre.net.
4. Analytical Chemistry lecture notes sadhu malyadriwww.freebook centre.net.
5. Short introduction into analytical chemistry Dr.manfredsietz and Dr. Andreassonnenbergwww.freebook centre.net.

AGM 504 Soil Microbiology (2+1)

OBJECTIVE

- To teach about ecological aspects of soil microorganism
- To learn about the microbial diversity
- To learn about the plant microbe interaction and their role
- To teach role of soil microbes on nutrient transformation
- To impart knowledge on the microbial degradation of xenobiotics

THEORY

Unit I : History and Ecology of Soil Microorganisms

Landmarks in the history of soil microbiology. Soil biota, Soil microbial ecology, types of organisms in different soils; soil microbial biomass; factors affecting soil microflora. Abiotic factors (physical and chemical) affecting soil microflora as pH, chemicals, moisture, air, temperature etc.

Unit II : Microbial Diversity

Microbial diversity - assessment of microbial diversity. Unculturable soil biota. Endophytic microorganisms. Microbes in biotic and abiotic stress management. Antimicrobials.

Unit III : Plant Parts and Soil Interface Interaction

Microbial interactions.Microbiology and biochemistry of root-soil interface; phyllosphere, plant growth promoting rhizobacteria, soil enzyme activities and their importance

Unit IV : Microbial Transformation of Various Nutrients

Carbon cycle. Biochemical composition and biodegradation of soil organic matter and crop residues Microbial transformations of nitrogen, phosphorus, sulphur, iron and manganese in soil. Siderophores and their role in iron nutrition and pathogen control

Unit V : Role of Microorganisms In Biodegradation of Xenobiotics and Pesticides

Biodegradation of pesticides, Organic wastes and their use for production of biogas and manures: Biotic factors in soil development

Current Stream of Thoughts

Theory Lecture schedule

1. Milestones in soil microbiology and Soil biota-major groups- types of organisms in different soils
2. Abiotic factors governing soil microflora such as pH, chemicals, moisture, air and temperature
3. Soil microbial ecology –ecological interrelationships and properties
4. Soil microbial biomass –measurement- role in soil fertility
5. Soil enzymes – types, activities and their importance
6. Microbial diversity - culturable and unculturable soil biota. Measures of microbial diversity
7. Endophytic microorganisms and their importance
8. Microbes in biotic and abiotic stress management
9. **First Test**
10. Antimicrobials – types, organisms and importance in pathogen reduction
11. Microbial interactions–beneficial and harmful interactions and their importance
12. Microbiology and biochemistry of root-soil interface (spermosphere, rhizosphere, rhizoplane; R:S ratio)
13. Phyllosphere, endophytes and plant growth promoting rhizobacteria (PGPR) and their significance.
14. Plant- microbiome interaction-holobiont- chemotaxis and quorum sensing
15. Protein secretary systems and their role in plant – microbiome interaction
16. Signal transduction between plant and PGPR- signals from both the partners and their effect on each other
17. **Mid semester Examination**
18. Signal transduction between Rhizobium – legume symbiosis and AMF- plant symbiosis- signals from both the partners and their effect on each other
19. Carbon cycle-Microbiology and biochemistry of aerobic decomposition of complex polymers-celluloses and hemicelluloses lignin, starch and pectin
20. Microbiology and biochemistry of anaerobic decomposition of complex polymers-cellulose hemicelluloses lignin, starch and pectin
21. Nitrogen cycle- microbiology and biochemistry of ammonification, nitrification and denitrification
22. Biological nitrogen fixation – free living, associative symbiotic, symbiotic and endophytic nitrogen fixers. Leaf, stem and root nodulating bacteria

23. Recent classification of legume and actinorhizal plants nodulating bacteria. Nodulation in legume –Rhizobium, and Frankia- actinorhizal symbiosis
24. Biochemistry of nitrogen fixation in free living, associative symbiotic, symbiotic and endophytic nitrogen fixers
25. Molecular biology of nitrogen fixation in free living, associative symbiotic, symbiotic and endophytic nitrogen fixers
26. Phosphorus cycle-microbial transformation of phosphorus- mineralization, immobilization, solubilization and –organisms involved –importance in soil and plant nutrition
27. Phosphate mobilization -mycorrhizae-types–ecto and endo mycorrhizae –role in phosphorous nutrition
28. Microbial transformation of potassium and sulphur. Sulphur cycle -microorganisms involved-importance in soil fertility
29. Microbial transformations of iron - organisms and mechanisms involved-importance in soil and plant nutrition
30. Microbial transformation of zinc and manganese in soil-organisms and mechanisms involved-importance in soil and plant nutrition
31. Siderophores –organisms involved and importance in iron nutrition and plant disease suppression
32. Biogas pathways-microorganisms involved- organic wastes for biogas generation production
33. Manures- principles of production microorganisms involved- utilization of important organic wastes for manures production, composting –aerobic and anaerobic methods of composting of different organic manures
34. Microbiology and biochemistry of degradation of pesticides and xenobiotics. Biotic factors in soil development

Practical Schedule

1. Qualitative analysis of soil microflora
2. Quantitative analysis of soil microflora- Isolation of rhizosphere, rhizoplane and bulk soil microorganisms and studying rhizosphere effect
3. Isolation of endophytic microorganisms from plant sample
4. Isolation of spermosphere and phyllosphere (PPFM) microorganisms
5. Studying rate of organic decomposition through CO_2 evolution technique
6. Assessment of soil dehydrogenase, urease and phosphatase activity

7. Studying ammonification and nitrification in soil
8. Studying denitrification in soil
9. Isolation of free living and associative symbiotic nitrogen fixers
10. Isolation of symbiotic and endophytic nitrogen fixers
11. Isolation of phosphate solubilizers and potassium releasers
12. Isolation of sulphur oxidizers and zinc solubilizers
13. Extraction and examination of AM spores from soil samples
14. Examination of arbuscular mycorrhizal infection in different crops
15. Visit to forest ecosystem, collection and examination of ectomycorrhizal fruiting bodies and lichens
16. Isolation of antibiotic producing microorganisms from soil and Isolation of pesticide degrading microorganisms
17. **Final Practical Examination**

Course Outcome

CO – 1 Students will become familiar to the types of microbes in soil and their association with plants.

CO - 2 The exclusive role of microorganisms in plant growth can be thoroughly understood.

CO – 3 Microbial transformations of different nutrients

CO – 4 Microbial degradations of xenobiotics and pesticides

CO – 5 Microbial diversity and interaction

CO – PO MAPPING MATRIX

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	2	-	-	-	-
CO 2	3	-	-	-	-
CO 3	-	-	-	3	-
CO 4	-	-	-	1	-
CO 5	2	-	-	-	-

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2. Jan Dirk Van Elsas , J.T. Trevors Elizabeth M.H. Welling ton. 1997. Modern Soil Microbiology. Marcel Dekker, Inc. USA
3. The Rhizosphere Biochemistry organic substances at the soil-plant interface, RobertoPinton, Zena Varanini and Paolo Nannipieri. CRC Press, Canada.

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2. **www.sare.orgs**
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5. **https://libguides.wccnet.edu/oer-subjects/microbiology**

AGM 505 FOOD MICROBIOLOGY (1+1)

OBJECTIVE

- To impart knowledge on microbes and their diversity in foods, associated with food spoilage, food borne illness and beneficial microbes
- To impart knowledge on fermentation of foods by microorganisms for improved nutritional and health benefits
- To learn advanced techniques for rapid detection of food pathogens and their metabolites
- To learn about different types of fermented products
- To understand food safety measures and regulations to control food spoilage and food borne diseases

THEORY

Unit I : Historical and Scope of Microbiology in Food

Scope of food microbiology, historical developments in food microbiology, significance of microorganisms in food, spores and their significance, intrinsic and extrinsic factors influencing microbial growth in foods.

Unit II: Food Spoilage and Food Borne Illness

Important microorganisms in food and their sources, microbial spoilage of meat, poultry, fish, milk and milk products, fruits, vegetables and canned foods, food borne pathogens (bacteria, fungi, virus and protozoa), food infection and food intoxication

Unit III : Food Preservation Methods

Fermented dairy and indigenous fermented foods, physical, chemical and biological methods of food preservation, natural antimicrobial compounds, bacteriocins and their application

Unit – IV: Probiotics and Prebiotics

Concepts and scope of microbial fermentations - probiotics, prebiotics, synbiotics, bifidus factor, microbes as single cell protein

Unit V: Food Safety and Regulations

General principles of food safety and risk management, recent concerns on food safety, GAP, GMP, organic and GM foods, Hurdle technology, HACCP.

Current Stream of Thoughts

Lecture Schedule

1. Scope of food microbiology, Historical developments in food microbiology
2. Important and sources of microorganisms in foods and Spores and their significance in foods
3. Intrinsic and Extrinsic parameters influencing microbial growth in foods
4. Microbial spoilage of different groups of foods – meat, poultry, fish, egg, milk, milk products, vegetables and fruits
5. **First Test**
6. Microbial spoilage of different groups of foods – canned foods
7. Food borne pathogens (bacteria, fungi and virus) – food infection and intoxication
8. **Mid semester Examination**
9. Pathogenesis of Gram positive and Gram negative bacteria in foods
10. Food borne fungal diseases, mycotoxin, Viruses and other protozoans as agents of food borne illness
11. Fermented dairy products – curd, yoghurt, kefir, koumiss, cheese
12. Indigenous fermented foods – soy sauce, moromi, miso, natto, tempeh
13. Food preservation by physical methods and chemical methods, natural antimicrobials from microorganisms, bacteriocins
14. Probiotics, prebiotics and synbiotics; bifidus factor, Single cell protein – bacteria, fungi, Algae and yeast
15. Food Safety Risks - biological, chemical, physical risks; surveillance and risk assessment
16. Recent concerns on food safety - GAP, GMP, Organic foods, GM foods
17. Hurdle technology, HACCP concept and principles

PRACTICAL SCHEDULE

1. Isolation and enumeration of microorganisms from fruits
2. Isolation and enumeration of microorganisms from vegetables
3. Microbiological examination of Fish
4. Microbiological examination of egg
5. Detection and confirmation of *E.coli* and coliforms in infant foods and water by MPN technique
6. Resazurin test.
7. Assessing the quality of milk by Methylene Blue Reduction Test (MBRT)
8. Detection of Salmonella and Pseudomonas fluorescens in chicken sample
9. Detection of Staphylococcus aureus in meat products
10. Detection of Listeria sp. in milk and dry cereal based foods
11. Production of single cell protein (Bacteria/Fungi/Algae)
12. Fermentation of Sauerkraut and isolation of lactic acid bacteria from the fermented sauerkraut
13. Canned foods - Types of Spoilage - Microbial assessment of Canned Foods
14. Antimicrobial assay for food borne pathogens using chemical and bio preservatives
15. Microbiological examination of food processing surfaces and utensils
16. Visit to food processing industry
17. **Final Practical Examination**

Course Outcome

CO 1: Types of microorganisms in food (both beneficial and harmful)
CO 2: Food borne illness due to microbes and their preventive measures
CO 3: Biological-based preservation of foods
CO 4: Standard and Advanced techniques in detection of food-borne pathogens and toxins
CO 5: Working out HACCP Plan for foods

CO – PO MAPPING MATRIX

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	3	-	-	-	-
CO 2	2	-	-	-	-
CO 3	-	-	3	-	-
CO 4	-	-	2	-	-
CO 5	-	-	3	-	-

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2. Frazier, W.C. 2008. Food Microbiology, 4th Edition, Tata Mc Graw Hill, New Delhi
3. James M. Jay, Loessner M.J. and .Golden, D.A. 2005. Modern Food Microbiology, 7th Ed, Springer Publication, New York
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5. Doyle M.P and Beuchat L.R. 2007. Food Microbiology – Fundamentals and Frontiers, ASM Press, Washington DC.

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3. https://www.frontiersin.org/journals/microbiology/sections/food-microbiology
4. https://www.sciencedirect.com/journal/food-microbiology
5. 5.https://www.researchgate.net/publication/334595896_History_and_Scope_of_Food_Microbiology

AGM-506 Biofertilizer Technology (2+1)

LEARNING OBJECTIVES

- To impart knowledge on theoretical and practical aspects of biofertilizers production
- To acquire the basic knowledge about agriculturally important beneficial microorganisms
- To create awareness about the importance of biofertilizers in sustainable crop production.
- To understand and develop skills about the quality control and standards of biofertilizers
- Also to motivate students to become entrepreneurs

Unit I:Agriculturally important beneficial microorganisms

Agriculturally important beneficial microorganisms-Biofertilizers-Current Scenario-List of biofertilizers- nitrogen fixers (free living, associative symbiotic, symbiotic and endophytic), phosphate solubilizers, phosphate mobilizers,potassium releasers,zinc solubilizers,sulphur oxidizers,drought stress toleranceinducers (pink pigmented facultative methylotrophs PPFM) and plant growth promoting microorganisms (PGPM).mechanism of nitrogen fixation, mineral solubilization, mobilization sulphur oxidation and drought stress tolerance.Contribution of microorganisms in soil fertility and crop protectivity.

Unit II: Mass Production of Biofertilizers

Techniques for scale up process- equipments for laboratory, pilot and large scale. Mother inoculum production. Preservation of mother cultures. Raw materials. Mass production of bacterial biofertilizers- *Rhizobium*, *Azospirillum*, *Azotobacter*, *Glucanoacetobacterdiazotrophicus*, phosphate solublisers, potash releaser, zinc solubilizer sulphur oxidizer and PPFM. Mass production of arbuscular mycorrhizal

fungi (AMF)-carrier and root organ culture -algal biofertilizers (azolla& blue green algae). Shelf life enhancement and storage of liquid and carrier based biofertilizers.

Unit III: Quality Control and Standards

Quality control-FCO/BIS standards-*Rhizobium*, *Azospirillum*, *Azotobacter*, *Glucan acetobacterdiazotrophicus*, phosphate solubilizes, potash releasers, AM fungi and blue green algae. Stages of quality control. Molecular markers in identification of strains.

Unit IV: Formulation and Delivery

Formulation–types–carrier based and liquid inoculants. Equipments–tangential flow filtration (TFF)- centrifugation-freeze drying. Application technologies–form, dose, method and time of application of bioferilizers for different crops.

Unit V : Economics of Biofertilizer Production

Calculation of commercial production cost – fixed - cost of building, equipments and variable cost –glass wares and chemicals raw materials, labour cost and benefit –cost ratio. DPR. Constraints in biofertilizer production and marketing.

Current stream of thoughts

THEORY LECTURE SCHEDULE

1. Agriculturally important beneficial microorganisms-
2. Biofertilizers-Current Scenario- List of biofertilizers
3. Nitrogen fixers (free living, associative symbiotic, symbiotic and endophytic)
4. Phosphate solubilizers, phosphate mobilizers, potassium releasers
5. Zinc solubilizers and Sulphur oxidizers.
6. Drought stress tolerance inducers (Pink Pigmented Facultative Methylotrophs-PPFM)
7. Plant growth promoting microorganisms (PGPM).
8. Mechanism of nitrogen fixation,
9. **First Test**
10. Mechanism of mineral solubilization, mobilization
11. Mechanism of sulphur oxidation and drought stress tolerance.

12. Techniques for scale up process- equipment for laboratory,
13. Pilot and large scale. Mother inoculum production.
14. Preservation of mother cultures. Raw materials.
15. Mass production of bacterial biofertilizers
16. Mass production of arbuscular mycorrhizal fungi (AMF)-carrier and root organ culture
17. **Mid-semester examination**
18. Algal biofertilizers (azolla& blue green algae)
19. Shelf life enhancement and storage of liquid carrier based biofertilizers.
20. Quality control-FCO/BIS Standards-*Rhizobium*, *Azospirillum*, *Azotobacter*, *Glucanoacetobacterdiazotrophicus*,
21. Phosphate solublizers
22. potash releasers
23. Quality control-FCO/BIS Standards-
24. AM fungi and blue green algae.
25. Stages of quality control
26. Molecular markers in identification of strains.
27. Formulation–types–carrier based and liquid inoculants.
28. Equipments–tangential flow filtration (TFF)- centrifugation-freeze drying
29. Application technologies–form, dose
30. Method and time of application of biofertilizers for different crops
31. Calculation of commercial production cost – fixed - cost of building, equipment and variable cost.
32. glass wares and chemicals raw materials, labour cost and benefit –cost ratio.
33. Detailed project preparation for commercial biofertilizer production unit
34. Constraints in biofertilizer production and marketing.

PRACTICAL SCHEDULE

1. Equipments in biofertilizer production – Fermentor, TFF, freeze drier, centrifuge and seed coating machine – their operation procedures. Inoculum development
2. Determination of beneficial properties of nitrogen fixers – nodulation efficiency and competitiveness
3. Determination of beneficial properties of nitrogen fixers –ARA and *in vitro* nitrogen fixation
4. Determination of functional properties of mineral solubilizers - phosphate, potassium & zinc solubilizers
5. Determination of AM spore and infective propagules.
6. Estimation of PGP traits- Indole acetic acid (IAA), and siderophore production by different organisms.
7. Estimation of PGP traits - ACCD activity, HCN production and testing efficacy of Sulphur oxidizers
8. Preparation of carrier material, broth and starter culture for mass production of different biofertilizers – Population count in broth and carrier material
9. Large scale production – formulations- carrier and liquid biofertilizers - population count during storage. Production of cell concentrates-TFF and centrifugation
10. Mass production of AM fungi in pot and root organ culture.
11. Mass production of Azolla and BGA
12. Quality control methods of biofertilizers as per FCO specifications
13. Testing the quality of biofertilizers through molecular techniques
14. Biofertilizer application - Form, dose and methodand Quality control methods of AM biofertilizers and BGA
15. Visit to a biofertilizer production plant.
16. DPR and Economics of biofertilizer production
17. **Final Practical Examination**

COURSE OUTCOME

CO 1: To learn about agriculturally important beneficial microorganisms

CO 2: A complete exposure in all kinds of biofertilizers along with their functions and properties

CO 3: Biofertilizer production and usage at national level

CO 4: To understand the requirements to establishing bioinoculants production unit and marketing to become an entrepreneur

CO 5: To learn about production and quality control aspects of biofertilizers

CO-PO MAPPING MATRIX

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

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2. Vora, M. S., &Shelat, H. N. 2013. Handbook of biofertilizers and microbial pesticides. Satish Serial Publishing House.
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4. https://www.worldcat.org/search?q=biofertilisers&fq=dt%3Abks&dblist=638&qt=sort &se=yr&sd=desc&qt=sort_yr_desc
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AGM 507 ENVIRONMENTAL MICROBIOLOGY (2+1)

Learning Objectives

- Students will understand the Microbial communities in different ecosystem
- Students will know the sources of water pollution, and microbiological methods of controlling, treating the polluted water and safe disposal, by aerobic and anaerobic methods.
- Students will study the physical, chemical and biological methods of management of solid waste and its safe disposal.
- Students will learn the role of different microbes on leading of Areas and advanced biotechnological methods in controlling environmental pollution.
- Students will know about environmental laws in India and world

THEORY

Unit I: Microbial communities and ecosystems

Microbial community dynamics, structure of microbial communities. Ecosystems – concept and ecological pyramid. Structure and functions of some microbial communities in nature. Microbes in extreme environments: Habitat, biodiversity, adaptive strategies and biotechnological potential of thermophiles and hyperthermophiles, psychrophiles and psychrotrophs, halophiles, acidophiles and alkalophiles -**Bioremediation of nuclear wastes.Bioremediation-Types- Newer and enhanced processes.**

Unit II: Water pollution

Sources and types, physical, chemical and biological pollution of water, eutrophication and its control. Waste water treatment – methods and recent developments in developing countries – waste stabilization ponds – aerated lagoons, oxidation ditches, bio-methanation.

Unit III: Solid waste

Types and Classification. Municipal refuse composition – landfill sites and refuse emplacement strategies – refuse degradation – landfill products and site exploitation – toxic and hazardous wastes. Composting- types and methods. probiotic organisms – role of the lactic acid bacteria in silage additives - **Biodegradation of lignin and cellulose.**

Unit IV: Global environmental problems

Global warming, Ozone depletion, **greenhouse effects,**acid rain. Environmental monitoring: environmental impacts and their assessments using bioindicators, biomarkers, biosensors and toxicity testing, rDNA technology. Conservation strategies. **Climate change affecting microbes; role of microbes in climate change and recycling.**

Unit V:Indian environmental laws

State and Central government acts and governing bodies. World perspectives of environmental issues- status and scope of biotechnology in environmental protection. Impact of GMO on environment.

Current stream of thoughts

Theory Schedule

1. Microbial communities and ecosystems.
2. Ecosystems concept and ecological pyramid.
3. Microbes in extreme environment
4. Biotechnological potential of extremophiles.
5. Potential of hyperthermophiles, psychrophiles and psychrotrophs,
6. Potential of halophiles
7. Potential acidophiles and alkalophiles
8. Bioremediation Types, Newand enhanced processes, Bioremediation of nuclear wastes.
9. **First Test**
10. Water pollution – measurement of pollution and its control.
11. Waste water treatment concepts, waste stabilization ponds.
12. Aerated lagoons types and oxidation ditches
13. Concept of bio-methanation.
14. Solid waste – Types and classification
15. Municipal solid waste management.
16. Landfill sites and refuse emplacement strategies.
17. **Midsemester**
18. Toxic and hazardous wastes exploitation strategies.
19. **Biodegradation of lignin and cellulose.**
20. Composting methods and Types of composting.
21. Probiotic organisms – role of the lactic acid bacteria in silage additives.
22. Global environmental problems: air pollution.
23. Air pollution types and remedial measures.
24. **Climate change affecting microbes.**
25. **Role of microbes in climate change and recycling.**
26. Global warming phenomenon.
27. Ozone depletion issues and how to minimize& Acid rain- problems and control measures.
28. Environmental monitoring: environmental impacts and their assessments.
29. Bioindicators, biomarkers, biosensors and toxicity testin.
30. rDNA technology for environmental pollution abatement.
31. Conservation strategies for environment.
32. National and state environmental laws and governing bodies.
33. World perspectives of environmental issues.
34. Status and scope of biotechnology in environmental protection, Impact of GMO on environment.

Practical Schedule

1. Studies on microbial communities in soil – Succession
2. Isolation of microorganisms from extreme environment
3. Characterization of waste water
4. Estimation of biochemical oxygen demand
5. Estimation of chemical oxygen demand
6. Estimation of organic carbon
7. Estimation of ammonia and hydrogen sulfide
8. Estimation of *E.coli.* and total bacteria
9. Activated sludge systems
10. Biofilters and bioaccumulation
11. Solid waste treatment; composting determination of compost maturitycs
12. Vermicompost
13. Isolation of lactic acid bacteria
14. Isolation for cellulose degrading enzymes
15. Assessment of microorganisms in air
16. Impact of air pollution on Phyllosphere&Spermosphere.
17. **Practical examination**

Course outcome

CO1: The students will be able to understand different types of pollution and their impact on environment.

CO2: They will be able to employ microorganisms and genetic engineering of genes for treating, recycling and abatement of water and soil pollution.

CO3: The student will be aware of the current environmental issues on global and national level

CO4: Students will understand the concept of Global warming, Ozone depletion, and acid rain.

CO5: The will acquire knowledge on the Indian environmental laws and Acts and their personal responsibility in protecting the environment

CO – PO MAPPING MATRIX

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	-	-	-	-	3
CO 2	-	2	-	-	-
CO 3	-	-	-	-	3
CO 4	-	-	-	-	3
CO 5	-	-	-		3

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AGM 508 MICROBIAL TAXONOMY(2+1)

Objectives

- To expand knowledge on Evolution and microbial diversity.
- To understand bacterial taxonomy. study various classes of fungi in terms of their characteristic features.
- To assimilate the concepts of unculturable bacterial diversity.
- To expand knowledge on Evolution and microbial diversity.

Unit I

Differences in concept of 'species' in eukaryotes and prokaryotes - Definition of species in prokaryotes.Types of 'species'Evolution of species and concepts of speciation (in sexual and asexual organisms)Types of evolution (neutral, co-evolution); Types and levels of selection; r andk selection; molecular clocks; phylogeny and molecular distances

Unit II

The expanse of microbial diversity- Estimates of total number of species. Species Divergence and the measurement of microbial diversity. Measures and indices of diversity

Unit III

Introduction to Bacterial Taxonomy -The 5-Kingdom classification system - The 3-Domain classification system-Bergey's Manuals and the classification of prokaryotes. Determinative Bacteriology (Phenetic Approach) Systematic Bacteriology (Phylogenetic Approach and Polyphasic Approach)

Unit IV

The 6 Classes of Fungi. The differentiating characters among different Classes of fungi.The importance of morphological characters in fungal differentiation andclassification.

Unit VI

Concept of 'unculturable' bacterial diversity. Strategies for culture of 'unculturable' bacteria.Culture independent molecular methods for identifying unculturable bacteria.Methods of extracting total bacterial DNA from a habitat and metagenome analysis.

Current stream of thoughts

Theory schedule

1. Differences in concept of 'species' in eukaryotes
2. Concept of 'species' in prokaryotes.
3. Definition of species in prokaryotes.
4. Types of 'species'Evolution
5. Species and concepts of speciation
6. Types of evolution
7. Types and levels of selectionandk selection
8. molecular clocks
9. **First Class Test**
10. phylogeny and molecular distances
11. The expanse of microbial diversity
12. Estimates of total number of species
13. Species divergence and the measurement of microbial diversity
14. Measures and indices of diversity
15. Introduction to Bacterial Taxonomy
16. The 5-Kingdom classification system
17. **Mid semester**
18. The 3-Domain classification system
19. Bergey's Manuals and the classification of prokaryotes
20. Determinative Bacteriology
21. Systematic Bacteriology
22. Phylogenetic Approach and Polyphasic Approach
23. The 6 Classes of Fungi
24. The differentiating characters among different Classes of fungi.
25. The importance of morphological characters in fungal
26. Differentiation andclassification of fungi
27. Concept of 'unculturable' bacterial diversity
28. Strategies for culture of 'unculturable' bacteria.
29. Culture independent
30. Biochemical methods for identifying unculturable bacteria
31. Molecular methods for identifying unculturable bacteria
32. Methods of extracting total bacterial DNA
33. Metagenome analysis
34. Methods for identifying culturable bacteria

Practical schedule

1. Genomic DNA Isolation.
2. Plasmid DNA Isolation.
3. Restriction digestion.
4. Transformation.
5. Conjugation.
6. PCR
7. RAPD Fingerprinting (Demo).
8. Southern and Northern Blotting (Demo).
9. Quantification of biogas from different feedstock.
10. Analysis of nutritive value of biogas slurry.
11. Biomass briquetting – Coir pith, Groundnut cake, Bagasse.
12. Cultivation of button mushroom.
13. Cultivation of Oyster mushroom.
14. Production of microbial inoculants.
15. Cultivation of Azolla.
16. Preparation of molar solutions
17. **Final Practical Examination**

Course Outcome

CO1 Student will be able to understand the concepts microbial taxonomy and methods of nomenclature.

CO2 Student will be able to use the knowledge of microorganisms from variety of sources.

CO3 Student will be able to classify the microorganisms based on classical and advanced methods.

CO4 Student will be able to understand microbial diversity, species and estimation of various microbial species from different sources.

CO5 Student will be able to understand evolution of microbial species.

CO – PO MAPPING MATRIX

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	2	-	-	-	-
CO 2	-	-	-	-	-
CO 3	1	2	-	-	-
CO 4	-	-	-	-	-
CO 5	2	-	-	-	-

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AGM 509 MICROBIAL MANAGEMENT OF ORGANIC WASTE (1+1)

Learning Objectives:

- Students will know the basic information about different types of wastes, their processing, recovery and recycling.
- Students will study the various methods of composting techniques to get quality compost to enrich the soil for agriculture.
- Students will learn about the microbial inoculants for composting and use of effective microorganisms.
- Students will know about the different techniques involved in liquid waste management.
- Students will learn about the different methods of utilization of organic wastes and production of biofuels

Theory

Unit-I: Concept of organic waste and types of wastes

Characteristics and classification of waste- potential availability of agro industrial waste- collection handling and processing of waste – microbial decomposition of organic material- aerobic and anaerobic processes - factors affecting degradation- Wastes- types of wastes- Municipal solid wastes and household hazardous wastes- physical, chemical and biological properties.

Unit-II: Solid waste management

Solid waste management -Sources, types, and composition of solid wastes- Physical chemical and biological properties of solid waste- Treatment of solid wastes- Principle and methods of composting - aerobic and anaerobic composting techniques - windrow composting- Vermicomposting - advantages and disadvantages nutritive value - improved techniques in composting.

Unit-III: Role of microbes on enriched compost

Use of microorganisms in waste: Thermophiles, alkalophiles, acidophiles, halophiles and psycrophiles- Microbial inoculant for composting - microbial consortium for enriched compost – quality standard and maturity test for compost - handling-storage - Method of application - Effect on soil fertility and crop productivity.

Unit-IV: Liquid waste management

Liquid waste management- impact on environment - characterization of liquid waste - waste water treatment- primary: sedimentation, coagulation and flocculation – secondary (Aerobic): trickling filter, activated sludge process, oxidation ponds - tertiary treatments (Anaerobic): disinfection, chlorination - safe disposal of treated effluents- Bioreactor for wastes water treatment: Reactors design and types- different types of water sampling tools and its uses.

Unit-V: Utilization of organic waste

Anaerobic digester – types - microbiology of anaerobic digestion - feedstock for anaerobic digesters-aquatic plants, organic waste and energy crops for biogas - factors influencing biogas production- Biodeterioration of paper, leather and wood- Bioremediation-Types- Newer and enhanced processes- Waste collection, handling and segregation, transport, storage and disposal methods.

Current stream of thought

Theory Schedule

1. Wastes-classification and characteristics- Various Agro Industrial waste- collections, handling, processing.
2. Decomposition of organic material- Factors affecting degradation.
3. Wastes- types of wastes- Municipal solid wastes- physical, chemical and biological properties**-** Household hazardous wastes- physical, chemical and biological properties**.**
4. Solid waste management- Sources, types, and composition of solid wastes- Physical chemical and biological properties of solid waste - Treatment of solid wastes
5. **First Test**
6. Principle and methods of composting - aerobic and anaerobic composting techniques - Windrow and vermicomposting- advantages and disadvantages nutritive value - improved techniques in composting.
7. Use of microorganisms in waste: Thermophiles, alkalophiles, acidophiles, halophiles and psycrophiles
8. Microbial inoculant for composting - selection and preparation- Microbes for enriched composting.
9. **Mid semester Examination.**
10. Quality standard - maturity test for compost.
11. Handling and storage of compost - Method of application - Effect on soil fertility and crop productivity.
12. Liquid waste management- impact on environment - characterization of liquid waste
13. Primary and secondary treatment- Tertiary treatment and safe disposal.
14. Bioreactor for wastes water treatment: Reactors design and types- different types of water sampling tools and its uses.
15. Anaerobic digester - types - microbiology of biogas production.
16. Biodeterioration of paper, leather and wood- Bioremediation-Types- Newer and enhanced processes.
17. Waste collection, handling and segregation, transport, storage and disposal methods.

Practical Schedule

1. Qualitative and quantitative enumeration of microorganisms from organic waste.
2. Degradation of cellulose.
3. Determination of CO_2 evaluation.

4. Quantification of methane from organic wastes.
5. Isolation of methane producing microorganisms from the wastes.
6. Methods of composting.
7. Vermicomposting.
8. Studying the coir pith degradation.
9. Testing the maturity and quality of compost.
10. Characterization of waste water – BOD & COD
11. Enumeration of coliform bacteria.
12. Anaerobic digester- utilization of aquatic weeds.
13. Single cell protein production using wastes.
14. Visit to sewage farm.
15. Isolation of bacteriophage from water bodies (Replica plate technique)
16. Utilization of microbial consortium for the treatment of solid wastes (Municipal solid wastes)
17. **Practical Examination**

Course outcome

CO1: At the completion of the course, students will be able to understand the different types of wastes, their characteristics and the techniques involved in the processing, recovery and recycling of wastes.

CO2: They will know about the various composting techniques and liquid waste management methods.

CO3: Student will learn about the indicator organism *E coli* contamination in water

CO4: They will understand how to utilize of organic wastes for biogas production.

CO5: Student will able to learn about the mass production of SCP production

CO – PO MAPPING MATRIX

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	-	-	-	2	-
CO 2	-	-	-	-	3
CO 3	-	-	-	-	3
CO 4	-	-	-	-	3
CO 5	-	-	-	-	3

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AGM 510 MARINE MICROBIOLOGY (2+1)

OBJECTIVE

- To understand the basic knowledge on Marine Microbial Environment
- To learn the advanced techniques used in Marine Microbial research.
- To explore the knowledge onMarine Extremophiles
- Studying their evolutionary process and understanding the Marine Microbial Diseases
- To introduced emphasis knowledge on Microbial biotechnological tools and its application in Marine Microbial Research.

THEORY

Unit - I

MARINE MICROBIAL ENVIRONMENT–Marine microbial community bacteria, fungi, protozoa. Structure: Bacteria, fungi, algae, protozoa and viruses; Classification of microbes;Ecologyofcoastal,shallowanddeepseamicroorganism-importanceandtheirsignificance. Diversity of microorganism Archaea,bacteria,cyanobacteria,algae,fungi, viruses and actinomycetes in the mangroves and coral environs.

Unit – II

MARINE EXTREMOPHILES: Survival at extreme environments – starvation – adaptive mechanisms in thermophilic, alkalophilic, osmophilic and barophilic, psychrophilic microorganisms –hyperthermophiles and halophiles.

Unit - III

SYMBIOTIC MICROBES: Microbe-microbe interactions – Lichens, antagonistic interactions amensalism,mycoparasitism – Animal-microbe interaction – Ectosymbiosis of Protozoa, Ruminantsymbiosis – Plant-microbe interaction – Rhizobium, Mycorrhizae, Anabaena – sponges. Carbon, nitrogen and phosphorus cycle; Decomposition of organic matter

Unit - IV

MARINE MICROBIAL DISEASE:Sea food borne pathogens & Water borne pathogens – Aeromonas, Vibrio,Salmonella, Pseudomonas, Leptospira, Cornybacter and viral diseases.

Unit - V

APPLICATIONS OF MARINE MICROBIAL BIOTECHNOLOGY: Production and applications of marine microbial products – pigments – Astaxanthin, β carotene – enzyme – antibiotics- polysaccharides – sea food preservation methods. Probiotic bacteria and their importance in aquaculture.Microbial biodegradation natural and synthetic material in the marine environment-pesticide, cellulose degradation, hydrocarbon production. Bioremediation of xenobiotics oil, heavy metals, pesticides, plastics, etc.

Current stream of thoughts

LECTURE SCHEDULE:

1. Microbes in the Marine Environment
2. Marine microbial habitats,benthic & littoral zone, saltpan, mangroves and estuarine microbes
3. Ecologyofcoastal,shallowanddeepseamicroorganism
4. coastal ecosystems, reef and coral reefs, sediments, food web
5. Marine microbial community
6. Importance of the Identification and Classification of Microorganisms
7. Structure: Bacteria, fungi, algae, protozoa and viruses
8. Methods of studying the marine micro-organisms
9. **First test**
10. Methods of collection, enumerationmarine microbes
11. Isolation, culture & identification based on morphological,physiologicaland biochemical characteristics
12. Extremophilic microorganisms
13. Survival at extreme environments
14. Mechanisms in thermophilic, alkalophilic, osmophilic microorganisms
15. Mechanisms in barophilic, psychrophilic hyperthermophiles and halophiles
16. Microbe-microbe interactions
17. **Mid Semester Examination**
18. Lichens, antagonistic interactions amensalism,mycoparasitism
19. Microbial Symbioses of Marine Animals
20. Animal-microbe interaction – Ectosymbiosis of Protozoa, Ruminantsymbiosis
21. Microbial Symbioses of Marine Plants

22. Plant-microbe interaction – Rhizobium, Mycorrhizae, Anabaena
23. Microbes in Ocean Processes — Carbon and Nitrogen Cycling
24. Microbes in Ocean Processes — Sulfur, Iron, Phosphorus and Silicon Cycling
25. Microbial Diseases of Marine Organisms
26. Sea food borne pathogens
27. Sea food Water borne pathogens
28. Vibrio,Salmonella, Pseudomonas, Leptospira, Cornybacter and viral diseases.
29. Production and applications of marine microbial products
30. pigments –Astaxanthin, β carotene – enzymeantibiotics- polysaccharides
31. Sea food preservation methods
32. Probiotic bacteria and their importance in aquaculture.
33. Microbial biodegradation-natural and synthetic material in the marine environment
34. Biodegradation of xenobiotics.

PRACTICALSCHEDULE:

1. Isolation and identification of microbes from Marine Ecosystem
2. Analysis of physico-chemical parameters of Marine Microbes
3. Isolation and characterization of microbes from coastal waters
4. Isolation and identification of microbes from mangroves
5. Isolation and identification of microbes from sediments
6. Isolations and Purification of Halophilic organisms
7. Isolations and Purification of Osmophilic Microorganisms
8. Isolations and Purification of Thermophilic Microorganisms
9. Isolations and Purification of Alkalophilic,organisms
10. Estimation of Salinity
11. Estimation of Dissolved Oxygen
12. Estimation BOD
13. Estimation COD

14. Isolation of Microbes from Rhizospere soil
15. Study of biofilm microorganisms
16. Enrichment and isolation of crude oil degrading marine bacteria.
17. Isolation of biosurfactant producing microorganisms.

Course Outcome

Co1 At the end of the course students will understand the basic knowledge of Marine microbiology

Co2 Explain the basic concepts of Microbiology specifically Marine Microbiology and differentiate the different groups of microbes

Co3 Students will be knowing the marine extremophile sand their Importance

Co4 To gain knowledge of Probiotic bacteria and their importance in aquaculture.

Co5 Students will be knowingMicrobialbiodegradation, natural and synthetic material in the marine environment

CO/PO MAPPING

CO/PO	PO_1	PO_2	PO_3	PO_4	PO_5	PO_6	PO_7
CO_1	2	-	-	-	-	-	-
CO_2	3	-	-	-	-	-	-
CO_3	-	-	-	-	-	-	-
CO_4			2	-	-	-	-
CO_5	-	-	-	-	3	-	-

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AGM 511 - INDUSTRIAL MICROBIOLOGY (2+1)

Learning objectives

- To make the students to understand the role of microorganism in various industries
- To impart knowledge on the preservation technologies
- To impart knowledge on production of different types of Antibiotics, food, dairy products and food safety measures.
- To make the students to know the various spoilage and food borne infection and disease caused by microbes
- To have knowledge on the fermentation technologies of producing value-added foods by microbes

THEORY

Unit- I- Introduction of fermentation

History of industrial microbiology – Isolation and screening methods – strain development strategies – fermentation media – raw materials used in media production and antifoam agents - fermentation process - dual and multiple fermentation process - batch and continuous fermentation, solid state, and submerged fermentation.

Unit-II- Bioreactors and its types

Bioreactors – basic functions - types, designs, and functional characteristics- upstream and downstream processing – automation of bioreactors; **Fermentor – basis and operations with CSTR- types of important fermenters**

Unit -III- Production of organic solvents, organic acids, amino acids and Beverages

Production of organic solvents such as ethyl alcohol and glycerol. organic acids production – butyric acid, citric acid and lactic acid. Amino acid production – lysine and glutamic acid. Beverage's production – beer and wine. – Alcohol production

Unit- IV- Production of Antibiotics, Vitamin and Enzymes

Industrial production of antibiotics – penicillin, streptomycin, and tetracycline production of vitamin B2 (Riboflavin), vitamin B12 and vitamin C. production of enzymes – amylase, protease, cellulase, pectinase and lipase immobilization and its type. **Biomining: recovery of minerals from low-grade ores.**

Unit- V- Fermented food products, biofertilizers and biopesticides production techniques

Milk and dairy product production – yoghurt, buttermilk, cultured milk and cheese **- single cell protein, recombinant proteins. Spirulina, mushroom, probiotic products -** Mass production of bacterial biofertilizers – *Azospirillum*, *Rhizobium* and Phosphobacteria. Mass production of Bio insecticides – *Bacillus thuringiensis*, *Beauveria bassiana* and *Metarhizium anisopliae ,* Mass production of *Pseudomonas fluorescens* and *Trichoderma viride*. **Mechanisms of pesticide degradation by microbes.**

Current Stream of thoughts:

THEORY LECTURE SCHEDULE

1. History of industrial microbiology
2. Screening methods
3. Strain improvement of microorganisms
4. Methods of strain improvement
5. Fermentation media and their raw materials
6. Fermentation process of its Types
7. Bioreactors, design and functional characteristics
8. Types of bioreactors and Upstreaming Processing
9. **I st Test**
10. Downstream processing- introduction
11. Details of down steam processing
12. Fermenter and operation-CSTR
13. Production of organic solvents –ethyl alcohol and glycerol
14. Production of organic acid – Butyric, citric and Latic acid
15. Production of Amino acid - Lysine and glutamic acid
16. Production of Beverages - Beer and wine alcohol production
17. **Mid semester Examination**
18. Production of penicillin , streptomycin and tetracycline
19. Production of amylase and protease
20. Production of pectinase, cellulose
21. Production of Lipase
22. Immobilization and its types
23. Biomining: recovery of minerals from low-grade ores.
24. Milk product – Butter milk and culture milk
25. Yoghurt production
26. Cheese production
27. Single cell proteins and recombinant proteins.
28. Spirulina, mushroom, probiotic products.
29. Bacterial bio fertilizer production – Azospirillum, Rhizobium and Phosphobacteria
30. Quality control and method of application
31. Production of bioinsecticides – *Bacillus thuringiensis*
32. Mass production of *Beauveria bassiana* and *Metarhizium anisopliae*
33. Mass production of *Pseudomonas fluorescens* and *Trichoderma viride*
34. Mechanisms of pesticide degradation by microbes.

PRACTICAL SCHEDULE

1. Isolation of industrial important microorganisms from soil and buttermilk/ curd.
2. Strain improvement – Induced mutation of bacteria.
3. Preparation of Inoculum
4. Bioreactors and its functional characteristics
5. Alcohol production from Jaggery
6. Wine making
7. Amylase production
8. Citric acid production by solid waste fermentation
9. Antibiotic sensitivity test – penicillin, streptomycin and tetracycline
10. Extra – cellular amylase production
11. Production of penicillin
12. Production of enzymes using immobilization techniques
13. Mass production of single cell protein
14. Mass production of Rhizobium biofertilizer
15. Mass production of Bioinsecticide *Bacillus thuringiensis* (or) *Beauveria bassiana* (or) *Metarhizium anisopliae*
16. Mass production of *Pseudomonas fluorescens* and *Trichoderma viride*
17. **Practical Examination**

Course outcome:

CO 1 - To learn about the important industrial microbes and their products.

CO 2 - To learn about the strategies to improve the strain efficiency and preservation techniques for future purposes.

CO 3 -To make the students to understand the concepts and types of fermentation process, types of fermenters, their design and purposes.

CO 4 - To gain knowledge on the techniques of industrial production of organic acids, antibiotics, enzymes, and fermented foods.

CO 5 - To train the students to develop skills on the techniques of mass production of biofertilizers and bio pesticides

CO – PO MAPPING MATRIX

	PO 1	PO 2	PO 3	PO 4	PO 5
CO 1	2	-	3	-	-
CO 2	-	2	3	-	-
CO 3	-	-	3	-	-
CO 4	-	-	3	-	-
CO 5	-	-	3	-	3

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