

तार : विश्वविद्यालय
Gram : UNIVERSITY



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बुन्देलखण्ड विश्वविद्यालय, झाँसी

BUNDELKHAND UNIVERSITY, JHANSI (U.P.)

संदर्भ. BU/Milw/2022/BOS-7


झाँसी (उ.प्र.) 284128

The Minutes of Meeting of BOS

दिनांक 24.06.2022

In reference of the Board of Studies (BOS) of Department of Microbiology , Institute of Life Science held on 24.06.2022 regarding the revision of syllabus in tune with CBCS/ NEP-2020 and subsequent approval from Academic Council, This is to certify that the syllabus is 100% revised.


Dr. Pankaj Kumar Sagar
(Coordinator)


Prof. R. K. Saini
(Dean, Science)

बुन्देलखण्ड विश्वविद्यालय, झाँसी

सूचना


एदत् द्वारा सूचित किया जाता है कि माइक्रोबायोलॉजी पाठ्यक्रम समिति की बैठक दिनांक 24/06/2022 को अपरान्ह 03.00 बजे विश्वविद्यालय के सभागार में ऑनलाइन/ऑफलाइन के माध्यम से आहूत की गयी है। अतः आपसे अनुरोध है कि बैठक में निर्धारित तिथि एवं समय पर उपस्थित होने का कष्ट करें।

कार्यसूची :-

1. उत्तर प्रदेश शासन के पत्र संख्या-नि.-401/सत्तर-3-2022 दिनांक 09/02/2022 के अनुसार उच्च शिक्षण संस्थानों में पाठ्यक्रम पुनर्संरचना की राज्य स्तरीय समिति द्वारा प्रदेश के समस्त विश्वविद्यालयों एवं महाविद्यालयों में राष्ट्रीय शिक्षा नीति-2020 को स्नातक (शोध सहित), स्नातकोत्तर एवं पी0एच0डी0 स्तर पर लागू किये जाने हेतु सुझाव।
2. माइक्रोबायोलॉजी विभाग में बी0एस0सी0 (ऑनर्स) माइक्रोबायोलॉजी एवं एम0एस0सी0 माइक्रोबायोलॉजी कोर्स/प्रोग्राम में सत्र 2022-2023 से राष्ट्रीय शिक्षा नीति-2020 को लागू करने एवं इन कोर्स/प्रोग्राम के पाठ्यक्रम का निर्माण करने हेतु पाठ्यक्रम समिति की बैठक आहूत करने के सम्बन्ध में।
3. अन्य मद अध्यक्ष की अनुमति से।

सेवा में,

1	प्रो0 आर0के0सैनी, सांकायाध्यक्ष विज्ञान बुन्देलखण्ड विश्वविद्यालय, परिसर, झाँसी	संकायाध्यक्ष/संयोजक
2	डॉ0 ऋषि कुमार सक्सेना, बुन्देलखण्ड विश्वविद्यालय, परिसर, झाँसी	सदस्य
3	डॉ0 संगीता लाल, बुन्देलखण्ड विश्वविद्यालय, परिसर, झाँसी	सदस्य
4	डॉ0 पंकज कुमार सागर, बुन्देलखण्ड विश्वविद्यालय, परिसर, झाँसी	सदस्य
5	डॉ0 देवेन्द्र मणि त्रिपाठी, बुन्देलखण्ड विश्वविद्यालय, परिसर, झाँसी	सदस्य
6	डॉ0 रंजना भाटी, बुन्देलखण्ड विश्वविद्यालय, परिसर, झाँसी	सदस्य
7	डॉ0 संजय कुमार, बुन्देलखण्ड विश्वविद्यालय, परिसर, झाँसी	सदस्य
8	प्रो0 नवीन काँगो, डॉ0 हरीसिंह गौर विश्वविद्यालय, सागर, म0प्र0	वाह्य विशेषज्ञ
9	श्री भानुप्रताप सिंह, पराग डेयरी, झाँसी, 7838857301	वाह्य विशेषज्ञ


सहा0कुलसचिव(एक0)
कृते कुलसचिव


बुन्देलखण्ड विश्वविद्यालय, झाँसी


पत्रांक:- बु0वि0/एके0/2022/7507-7517

दिनांक:- 13/7/2022

प्रतिलिपि - निम्नलिखित को सूचनार्थ एवं आवश्यक कार्यवाही हेतु प्रेषित।

1. उपर्युक्त समस्त सदस्यगण
2. अध्यक्ष, एन0ई0पी0 टास्क फोर्स।
3. संकायाध्यक्ष- विज्ञान को सूचनार्थ।
4. वित्त अधिकारी।
5. सहायक कुलसचिव (अतिगोपनीय)।
6. कुलपति जी के निजी सचिव।
7. कुलसचिव के आशुलिपिक।


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कृते कुलसचिव

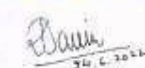

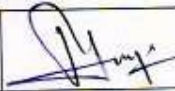

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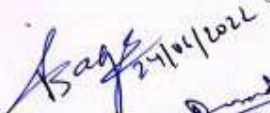


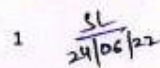
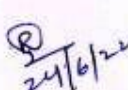


**Department of Microbiology
Bundelkhand University, Jhansi-284128 (UP)**

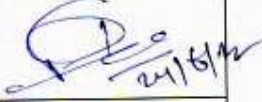
As per the notification given regarding the Board of Studies (BOS) of Microbiology session 2022-2023 vide Letter No -पत्रांक - बु० वि०/ए के०/2022/7507-7517, दिनांक: 12/07/2022.

Agenda of the Board of Studies (BOS) of Microbiology, session 2022-2023 on 24th June 2022:

1. Implementation of National Education Policy (NEP) - 2020 in B.Sc. (Hons.) Microbiology (undergraduate) and M.Sc. Microbiology (post graduate) course/ programmes from academic session 2022-23.
2. Developing curriculum and syllabus of B.Sc. (Hons.) Microbiology (undergraduate) and M.Sc. Microbiology (post graduate) course / programme under National Education Policy (NEP) - 2020.
3. Panel of experts for the Undergraduate and post graduate programme/course under NEP-2020.
4. Panel of experts of B.Sc. (Hons.) Microbiology (old pattern) and M.Sc. Microbiology (old pattern) for academic session 2022-23.
5. Panel of experts for Advance Post Graduate (P.G.) Diploma entitled as 'Advance P.G. Diploma in Microbiology and Food Technology' for academic session 2022-23.

Sr. No.	Name and address of Members of BOS	Signature
External Members: The external members have joined BOS 'ONLINE MODE'		
1.	Prof. Naveen Kango Department of Microbiology Dr. Harisingh Gour Vishwavidyalaya Sagar (M.P.)	 24.6.2022
2.	Sh. Bhanu Pratap Singh Parag Dairy, Jhansi (U.P.)	 24/06/2022
Convener of Board of Studies		
3.	Prof R. K.Saini Dean Science Bundelkhand University, Jhansi	
Internal Members (06)		

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4.	Dr Rishi Kumar Saxena Associate Professor, Department of Microbiology, Bundelkhand University, Jhansi	 24/6/22
5.	Dr Sangeeta Lal Assistant Professor, Department Microbiology, Bundelkhand University, Jhansi	SL 24/06/22
6.	Dr. Pankaj Kumar Sagar Assistant Professor, Department of Microbiology, Bundelkhand University, Jhansi	Sagar 24/06/2022
7.	Dr Devendra Mani Tripathi, Assistant Professor, Department of Microbiology, Bundelkhand University, Jhansi	Devendra 24/06/22
8.	Dr Ranjana Bhati Assistant Professor, Department of Microbiology, Bundelkhand University, Jhansi.	R 24/6/22
9.	Dr Sanjay Kumar Assistant Professor, Department of Microbiology, Bundelkhand University, Jhansi	SA 24.06.2022

Devendra
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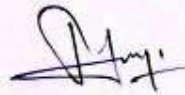
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24/6/22

Sagar
24/06/2022


Rishi


Sanjay

Department of Microbiology
Bundelkhand University, Jhansi-284128 (UP)

Minutes of Board of Studies (BOS) of Microbiology on 24th June 2022.

As per the notification given regarding the Board of Studies (BOS) of Microbiology session 2022-2023 vide Letter No -पत्रांक - बुं वि०/ए के० 7507-7517, दिनांक: 12/07/2022 the BOS has been held on 24th June 2022 at Bundelkhand University, Jhansi in the presence of BOS members.

The following decision have been made in the BOS meeting and approved by all the BOS members.

1. Ordinance and general rules, regulation & guidelines as per National Education Policy (NEP) 2020 for the **Bachelor in Honours (semester system) programme in Microbiology** will be provided by Bundelkhand University, Jhansi (U.P.) and will be implemented accordingly from 2022 onwards.

2. The ordinance which will be provided (and implemented from 2022 onwards) by Bundelkhand University, Jhansi (U.P.) supersedes all the previous relevant ordinances, rules and regulations.

3. The syllabus, course content and panel of expert for Major III (DSE) (Table 3a), Minor - I (GE) (Table 4), Minor-II (SEC/AEC) (Table 5), Minor- III (VAC) (Table 6) except syllabus of Agricultural Microbiology (Table 3a: Major -III for science (DSE) for Under Graduate Course (Science discipline) and Industrial Microbiology (Table 5: Skill enhancement/ ability enhancement course (SEC/AEC) or Minor -II for science, commerce and arts disciplines (for Under Graduate Course) will be as provided by Bundelkhand University, Jhansi (U.P.) and implemented accordingly.

4. The syllabus and panel of experts for Syllabus of Agricultural Microbiology (Table 3a: Major - III for science (DSE) for Under Graduate Course (Science discipline) and Industrial Microbiology (Table 5: Skill enhancement/ ability enhancement course (SEC/AEC) or Minor -II for science, commerce and arts disciplines (for Under Graduate Course) has been submitted and approved by the BOS members which will be implemented by Bundelkhand University for the courses of science, commerce and arts disciplines as required.

5. The syllabus and panel of experts for Major I (DSC I), Major II (DSCII) and Major III (DSC III) as well as practical (Lab course) I, II and III and training for undergraduate programme has been submitted and approved by the BOS members for academic session 2022-2023 (as Per National Education Policy-2020).

6. The panel of experts for B.Sc. (Hons.) Microbiology (as old pattern) has been submitted and approved by the BOS members for academic session 2022-2023.

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7. The syllabus, course content and panel of expert for Minor elective for post graduate programme will be as provided by Bundelkhand University, Jhansi (U.P.) and implemented accordingly.

8. The syllabus and panel of experts for Major I (DSC I), Major II (DSCII), Major III (DSC III), Major IV (DSCIV), Major V (DSCV) as well as practical (Lab course) I, II and research project / training for post graduate programme has been submitted and approved by the BOS members for academic session 2022-2023 (as Per National Education Policy-2020).

9. The panel of experts for M.Sc. Microbiology (as old pattern) has been submitted and approved by the BOS members for academic session 2022-2023.




10. The duration of training and report submission for undergraduate and post graduate programme (programme under NEP-2020) shall be of three weeks as per departmental time table schedule.

11. The curriculum and syllabus of undergraduate and post graduate programme (under NEP-2020) have been approved by BOS members.

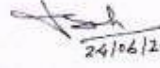
12. Panel of experts for Advance Post Graduate (P.G.) Diploma entitled as 'Advance P.G. Diploma in Microbiology and Food Technology' have been submitted and approved by BOS members for academic session 2022-23.

13. All the suggestions and directions provided by BOS members have been incorporated.


All the decision mentioned above have been incorporated and approved by BOS members.


Sr. No.	Name and address of Members of BOS	Signature
External Members: The external members have joined BOS 'ONLINE MODE'		
1.	Prof. Naveen Kango Department of Microbiology Dr. Harisingh Gour Vishwavidyalaya Sagar (M.P.)	 24/6/2022
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Internal Members (06)		

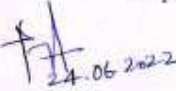
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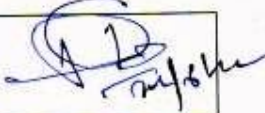

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4.	Dr Rishi Kumar Saxena Associate Professor, Department of Microbiology, Bundelkhand University, Jhansi	 24/06/22
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**ORDINANCE FOR POSTGRADUATE (SEMESTER SYSTEM) PROGRAMME
ARTS, SCIENCE & COMMERCE FACULTIES (2022 onward)**

1. INTRODUCTION

1.1 Preamble

This ordinance governs all the rules and regulations as per the NEP 2020 for the traditional post graduate programs (M.A., M.Sc., M.Com, Management courses, etc) which are not covered by any regulatory bodies (AICTE, BAR Council, PCI, NCTE etc) running in the University campus or its affiliated colleges in Bundelkhand University, Jhansi. This ordinance supersedes all the previous relevant ordinances, rules and regulations.

1.2 Duration

Bundelkhand University has adopted the semester system in various Postgraduate courses as per directives of Higher Education Department, Uttar Pradesh Government vide letter No 401/seventy-3-2022 dated 09-02-2022 to accelerate the teaching-learning process and enable vertical and horizontal mobility in learning from the academic session 2022-23 onwards.

The duration of PG courses shall be two years comprising of four semesters. In case a student(s) exits from this programme after completion of the first year (2 semesters), he/she may take exit from the programme and shall be awarded the Degree of Bachelor in Research. After the successful completion of two years (4 semesters) a student shall be awarded the Master's degree in the concerned subject. The maximum duration to complete the course shall be four years.

1.3 Eligibility for Admission

- Candidate, who wishes to seek admission in a course of study prescribed for a post graduate degree of the University, shall be admitted to campus or an affiliated college unless he/she has:
 - passed the three years Bachelor's degree course Examination of the University of Uttar Pradesh or any other Indian University incorporated by any law in force at the time of admission.
 - or
 - passed any other equivalent examination recognized by the University as equivalent thereto.
 - passed any other equivalent examination recognized by a Foreign University as equivalent thereto
- The date of admission shall follow the University academic calendar.

1.4 Choice of Subject and Course Structure

- i. University/ College shall admit students as per the eligibility criteria and availability of seats decided by the university.
- ii. A student shall take admission to post graduation first year of fourth year of Higher Education program of NEP 2020 after successful completion of Graduate course from NEP 2020 or old course of Science/ Arts/ Commerce/

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Management, etc. He/she shall have to choose respective faculty courses as per guidelines of NEP 2020 depending on the number of seats available in concerned subject and eligibility criteria. In case a candidate is willing to change the faculty, the following condition is required-

The candidate should have passed Bachelor degree in Science/ Commerce of NEP 2020 or old courses may take admission in some subjects of Arts faculty (excluding practical subjects like geography, psychology etc). Similarly, the Student from Commerce of NEP or old course of commerce may also be eligible to take admission in Arts subjects: Arts, Management and Commerce candidates cannot be admitted in Science subjects.

iii. Student(s) shall select subjects for Post graduation course from the major subjects that he / she had opted in the graduation course and shall continue with the same subjects in all the four semesters of the PG programme.

iv. The course structure shall be as follows:

There shall be four compulsory theory papers in the first semester. In the second and third semester there shall be two compulsory papers and one/two elective papers. The elective papers are the specialization papers.

Student(s) shall have to select one Minor Elective Course as **Minor subject** from any other faculty (except own faculty) or interdisciplinary subject in the first semester of the first year.

v. Student(s) shall take a Research Project /Survey/ Industrial /Field training program in both the years (Semester II and IV). No pre-requisite shall be required for this.

vi. List of Minor Elective Course: The candidate shall select any one subject from the following as minor subject in first year of post graduate course.

S No	Science	Arts	Commerce	Interdisciplinary
1.	Mathematical Biology	Tribal Culture and Heritage	Customer Relation Management	Ancient Medical Sciences
2.	Conservation and Water Resource Management	Principle of Administration and Implications	House Keeping and Hospitality	Traditional Medical Therapy
3.	Natural Resources and Conservation	Socio-Economics and Social Security	Share Market and Banking	Vedic Mathematics
4.	Pollution: Causes and Mitigation	Archeological Sites and Monuments	Retail Management and Accounting	Bio Medical Instrumentation and Health
5.	Computational Resources	Indian Constitution	Insurance Policy and Finance	Disaster, Mitigation, & Management
6.	Organic and Natural Farming	Communication and Soft Skill		Mining Plan and Resource Mapping
7.	Computer Hardware Handling	Sanskrit Knowledge System		Water Treatment System
8.	Computer Software	Technical		Climate Change

Signature *Signature*

	Handling	Translation and Trans creation		and Environmental Degradation
9.	Solar and Non Conventional Energy	Urban Economics and Planning		Medicinal and Aromatic Plants Cultivation, extraction and nutraceutical Values
10.	Cyber Crime	Actuarial Economics		
11.	Bee Keeping, Aquaculture and Fish Farming	Social Sector and Gender Economics		Non Conventional Energy Resource
12.	Entrepreneurship in Microbial and Botanical Products	Environmental Economics		Soil and Water Testing
13.				

2. SEMESTER AND CREDIT DISTRIBUTION

An academic year for post graduate program is divided into four semesters. The Odd semester may be scheduled from July to December and Even semester from January to June.

Fourth Year				
	VII Sem	Credits	VIII Sem	Credits
Major	Theory – 04 Papers	5 Credits each Total Credits=20	Theory – 04 Papers	5 Credits each Total Credits=20
	Or Theory – 04 Papers Practical -02	Or 4 Credits each Total Credits=16 2 Credit each Total Credits=4 Total Credits=20	Or Theory – 04 Papers Practical -02	Or 4 Credits each Total Credits=16 2 Credit each Total Credits=4 Total Credits=20
Minor	Minor Elective-1 paper of 04 credits	04 Credits Total Credits=04		
Research Project/ Industrial training/ Survey/ Field Training	One of each 04 Credits	04 Credits Total Credits=04	One of each 04 Credits	04 Credits Total Credits=04
Total Credits		28		24
Total in Both Semester				52 Credit

Kumar

Kumar

Fifth Year

Semester	IX	Credits	X	Credits
Major	Theory – 04 Papers	5 Credits each Total Credits=20	Theory – 04 Papers	5 Credits each Total Credits=20
	Or Theory – 04 Papers Practical -02	Or 4 Credits each Total Credits=16 2 Credit each Total Credits=4 Total Credits=20	Or Theory – 04 Papers Practical -02	Or 4 Credits each Total Credits=16 2 Credit each Total Credits=4 Total Credits=20
Research Project / Industrial training / Survey	One of each 04 Credits	04 Credits Total Credits=04	One of each 04 Credits	04 Credits Total Credits=04
Total Credits		24		24
Total in Both Semester	48 Credit			

3. ATTENDANCE

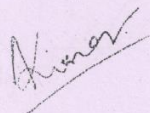

The expression "a regular course of study" wherever it is used in these Ordinances, means attendance of at least 75% of the lectures and other teaching in campus / affiliated college in the subject for the examination at which a candidate intends to appear and at such other practical work (such as work in a laboratory) as is required by any Statute, Ordinance or Regulation in force for the time being in the University.

A shortage up to 5% of the total number of lectures delivered or practical work done in each subject may be condoned by the Principal of the college/ Head of the Department (in case of University Campus) concerned.

A further shortage up to 10% may be condoned only by the Vice- Chancellor on the specific recommendation of the Principal of the college/Head of the Department concerned (in case of University Campus).

4. EXAMINATIONS

- There shall be examinations at the end of each semester as, for odd and even semesters in accordance with the academic calendar of the university. A candidate who does not pass the examination in any course(s) shall be permitted to appear in such failed course(s) in the subsequent examinations upto the maximum duration of the course.

2. A candidate should get enrolled/registered for the first semester examination and is mandatory. If enrolment/ registration is not possible owing to shortage of attendance / rules prescribed OR related joining or on medical grounds, such students shall not be permitted to proceed to the next semester. Such students shall re-do the first semester in the subsequent term of that semester as a regular student; however, a student of first semester shall be admitted in the second semester, if he/she has successfully completed the first semester.
3. It shall be mandatory for the student(s) to register for examination in each and every semester (i.e. to fill up the examination form with the requisite fee). If a student fails to register for the examination in any semester, he or she shall not be allowed to appear in that semester as a back paper student. Such student(s) shall appear in the (next) subsequent examination of that semester.

5. EVALUATION

The performance of a student in each course is evaluated in terms of percentage of marks with a provision for conversion to grade point. Evaluation for each course shall be done by a Continuous Internal Assessment (CIA) by the concerned course teacher as well as by end semester examination and will be consolidated at the end of course. The evaluation must be continuous and holistic and should be based on following parameters:

- i. Academic assessment
- ii. Skill assessment
- iii. Physical assessment
- iv. Personality assessment
- v. Extra-curricular assessment

5.1 THEORY PAPER

Semester Examinations shall be conducted by the university as mentioned in the academic calendar. The Question paper will be set by the examiners appointed by the Vice Chancellor based on the recommendation of the board of studies. The pattern of the question paper shall be as given in annexure II.

- i. Internal Assessment (C.I.A.) – 25% weightage of a course
 - Test/ Mid-Term Assessment - 10 marks
 - Term paper/Presentation on given project/assignment - 10 marks
 - Attendance/activities – 05 marks
- ii. End Semester Exam (External examination) – 75% weightage of course

5.2 PRACTICAL PAPER

Practical examinations will be conducted by the examiners appointed by the Vice Chancellor on the recommendations of the Board of Studies. Each student has to present the practical records.

- i. Internal Assessment (C.I.A.) – 25% weightage of a course
 - Test/ Mid-Term Assessment - 10 marks
 - Term paper/Presentation on given project/assignment - 10 marks
 - Attendance/activities – 05 marks

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- ii. End Semester Exam (External examination)- 75% weightage of a course

MINIMUM PASSING STANDARD

1. The minimum passing standard for combined external and internal examinations for each subject/paper shall be 45%, i.e. 45 out of 100 marks for theory and practical courses. The minimum passing standard for Aggregate in a semester end Examination shall be 45%.
2. Continuous Internal Assessment (CIA) shall be ensured by the Principal of the colleges / HODs for the Campuses courses. The Principal of the colleges / HODs of the Campus shall provide the marks of the same to the university and it shall be mandatory to maintain the records of the same till the maximum duration of that course.
3. The internal assessment, field training and practical examination awards of a student who fails in any semester examination shall be carried forward to the next examination.
4. It shall be mandatory for a student to secure minimum 45% marks (i.e. 34/75) in the theory and practical paper separately.

PROVISION FOR BACK PAPERS AND EX-STUDENTS

A Back Paper (B.P.) candidate shall be promoted to next semester. The back paper facility in a semester provides promotion to the next semester and another opportunity to obtain a minimum of the pass marks assigned for an individual paper or in the aggregate. Following category of students of Bundelkhand University shall be eligible for back paper facility as under,

1. A student shall be required to pass in minimum two subject papers in each semester. However, at the end of each year, it shall be mandatory for a student to pass in at least two subjects papers and minor paper otherwise he/she shall be deemed as failed and will be treated as a year back / ex- student.
5. Students shall get the attempts to appear in the Back paper examination in the subsequent odd / even semester till the maximum duration of the said course.
6. Special back paper examination shall be held only for regular students of the final year of PG course.
7. The candidates who fail in more than three of the total papers, will be deemed as failed. These candidates can appear only in subsequent examination of that semester as Ex- Students.

8. PROMOTION RULES

8.1 Semester Course & Examination:

The students who have taken admission in any post-graduation programme in a session and who have put in the minimum percentage of attendance for appearing at the Examination, presented himself/herself for internal assessment and have filled in the examination form in time for appearing at the End Semester Examination shall be allowed to appear at the respective examinations.

8.2 Declaration of results

After appearing in the Examination of both the semesters in a particular year, the student can be put in the following categories in the context of declaration of the results of the Semester Examination:

- Passed
- Promoted with Back Paper(s)
- Failed

8.3 Promotion to next Semester:



All students under category Passed and promoted with back papers shall be promoted to the next Semester.

"Failed" students may clear their UNCLEARED courses in subsequent examinations as ex-students. Students promoted with back papers shall clear their back papers in subsequent examinations as ex-students.

A student who has failed in a course shall get two more chances to clear this course subject to the maximum duration for passing the course. Further, each candidate shall have to clear all the courses within the maximum period of seven years from the date of his/her latest admission.

A candidate who has qualified for the Degree shall be placed in the First / Second Division as per following table:

8. COMPUTATION OF SGP AND CGPA

The guidelines formulated by Bundelkhand University shall be followed in order to bring uniformity in evaluation system of every CBCS based Course and computation of the SGPA (Semester Grade Point Average) and CGPA (Cumulative Grade Point Average) based on students' performance in examination. The number of core, elective, open elective papers and foundation papers and the required credit for each paper shall be formulated by respective Board of Studies (BOS) and faculty board. For the purpose of computation of work load the UGC proposed mechanism is adopted i.e. one credit=1 Theory period of one hour duration, 1 credit=1 Tutorial period of one hour duration, 1 credit=1 Practical period of one hour duration. The credit(s) for each theory paper/practical/tutorial/dissertation will be as per the respective Board of Studies of departments.

Letter Grade	Numerical grade
O (outstanding)	10
A+ (Excellent)	9
A (very good)	8
B+ (Good)	7
B (average)	6
F (Fail)	<5
Ab (Absent)	0

The minimum passing marks shall be 45% of the maximum marks as prescribed in the University Examination and 45% of marks in the aggregate marks in the subject including internal / sessional marks. i.e. Minimum Passing Grade is "B".

A student who obtains Grades "O" or "B" shall be considered as PASSED. If a student secures "F" grade, he/she shall be considered as FAILED and shall have to re appear in the examination. It is mandatory for a student to earn the required SGPA as in each semester. If a student is not able to secure 45% / B grade in any theory / practical / internal / sessional / viva-voce / internship / project examination, the awarded grade point shall be ZERO (0).

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9.1 The University, adopts absolute grading system where in the marks are converted to grades, and every semester results will be declared with semester grade point average (SGPA) and year result will be declared with year grade point average (YGPA). The Cumulative Grade Point Average (CGPA) will be calculated in end of final semester. The grading system except pharmacy department will be with following letter grades and grade points scale as given below:

Table A (For all courses except Pharmacy courses)

Level	Outstanding	Excellent	Very Good	Good	Average		Fail
Letter Grade	O	A+	A	B+	B		F
Grade Points	10	9	8	7	6		0
Score (Marks) Range (%)	≥90 (90-100)	<90, ≥80 (80-89.99)	<80, ≥70 (70-79.99)	<70, ≥60 (60-69.99)	<60, ≥45 (50-59.99)		<45 (0-39.99)

1.1 A student obtaining Grade "F" shall be considered failed and will be required to reappear in the examination. Such students after passing the failed subject in subsequent examination / will be awarded with grade respective of marks he/she scores in the subsequent examination/s.

1.2 The University has the right to scale/moderate the theory exam / practical exam / internal exam / sessional marks of any subject when ever required for converting of marks into letter grades on the basis of the result statistics of university as in usual practice, i.e. marks obtained in decimal will be converted in nearest integer.

9. CONVERSION OF GRADES IN TO PERCENTAGE

1.3 Conversion formula for the conversion of CGPA into Percentage is $CGPA \text{ Earned} \times 10 = \text{Percentage of marks scored}$.

Illustration: $CGPA \text{ Earned } 8.2 \times 10 = 82.0\%$

2. AWARD OF DIVISION

Division shall be awarded only after the final semester examination based on integrated performance of the student for all the semesters as per following details.

2.1 A student who qualifies for the award of the degree securing "B" or above grades in all subjects pertaining to all semesters, and in addition secure as a CGPA of 8.0 and above shall be declared to have passed the examination in **FIRST DIVISION WITH HONOURS**.

2.2 A student who qualifies for the award of the degree securing "B" or above grades in all subject pertaining to all semesters, and in addition secures a CGPA of 7.0 and above shall be declared to have passed the examination in **FIRST DIVISION**.

Kumar *Kumar*

2.3 A student who qualifies for the award of the degree securing "B" or above grades in all subjects pertaining to all semesters, and in addition secures a CGPA of 5.0 and above shall be declared to have passed the examination in **SECOND DIVISION**.

10. **UNFAIR MEANS:**

Cases of unfair means in the End Semester Examinations and Mid-Term Tests shall be dealt as per the rules laid by the University.

Note:

1. Those students who are NOT eligible for promotion to next year shall have to reappear in the coming examination as ex-students. However, the marks of internal assessment shall be carried forward in such cases.
2. Scrutiny facility and Challenge evaluation facility shall be available for those students who want to improve their grades.

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BUNDELKHAND UNIVERSITY, JHANSI-284128

CURRICULUM

M. Sc. MICROBIOLOGY

(Four Semesters)

After completion of Ist year awarded for the degree of “BACHELOR OF RESEARCH IN MICROBIOLOGY” (Total Credits: 52)

After completion of IInd Year awarded for the degree of “MASTER OF SCIENCE IN MICROBIOLOGY (M.Sc. Microbiology)” (Total Credits: 100)

Year	Course	Major	Title of the paper	Type	Credits	External Assessment	Internal Assessment	Total Marks	
First Year	SEM - I	Major 1 (DSC1)	Fundamentals of Microbiology	Core	04	75	25	100	
		Major 2 (DSC2)	Microbial Biochemistry	Core	04	75	25	100	
		Major 3(DSC3)	Bioinstrumentation & Analytical techniques	Core	04	75	25	100	
		Major 4(DSC4)	Microbial Physiology and Metabolism	Core	04	75	25	100	
		Minor elective	As per List of Minor Elective Course. Student(s) shall have to select one Minor Elective Course as Minor subject from any other faculty (except own faculty) or interdisciplinary subject in the first semester of the first year.	Minor Elective	04	75	25	100	
		Practical I	Lab Course I	Core	02	75	25	100	
		Practical II	Lab Course II	Core	02	75	25	100	
		Training	Research Project/ Industrial training/ Survey/ Field Training	Core	04	75	25	100	
					Total Credits: 28 Marks				Total 800
	SEM - II	Major 1 (DSC1)	Biostatistics and Bioinformatics	Core	04	75	25	100	
		Major 2 (DSC2)	Environmental Microbiology	Elective 1	04	75	25	100	
		Major 3 (DSC3)	Agro technology & Food Nutrition	Elective 2	04	75	25	100	
		Major 4 (DSC4)	Microbial Genetics & Molecular Biology	Core	04	75	25	100	
		Major 5 (DSC5)	Cell Biology	Elective 3	04	75	25	100	
		Practical I	Lab Course I	Core	02	75	25	100	
Practical II		Lab Course II	Core	02	75	25	100		
Training		Research Project/ Industrial training/ Survey/ Field Training	Core	04	75	25	100		
					Total Credits : 24 Marks				Total 700
Note: Student has to opt any two electives in the second semester.									
Total Credits in M.Sc. I Year (I Semester + II Semester) =52									
After completion of M.Sc. I year awarded for the degree of “BACHELOR OF RESEARCH IN MICROBIOLOGY”									

DSC: Discipline Specific Core

Second Year	SEM – III	Major 1 (DSC1)	Immunology	Core	04	75	25	100	
		Major 2 (DSC2)	Food Microbiology	Elective 1	04	75	25	100	
		Major 3 (DSC3)	Medical Microbiology	Elective 2	04	75	25	100	
		Major 4 (DSC4)	Genetic Engineering	Core	04	75	25	100	
		Major 5 (DSC5)	Biosafety & Microbiological Resource Management	Elective 3	04	75	25	100	
		Practical I	Lab Course I	Core	02	75	25	100	
		Practical II	Lab Course II	Core	02	75	25	100	
		Training	Research Project/ Industrial training/ Survey/ Field Training	Core	04	75	25	100	
			Note: Student has to opt any two electives in the third semester						
				Total Credits : 24			Total		700
				Marks					
	SEM – IV	Major 1	Enzymology	Core	04	75	25	100	
		Major 2	Agriculture Microbiology	Core	04	75	25	100	
		Major 3	Industrial Bioprocess Technology	Core	04	75	25	100	
		Major 4	Microbial Ecology	Core	04	75	25	100	
		Practical I	Lab Course I	Core	02	75	25	100	
		Practical II	Lab Course II	Core	02	75	25	100	
		Training	Research Project/ Industrial training/ Survey/ Field Training	Core	04	75	25	100	
				Total Credits : 24			Total		700
				Marks					
Total Credits in M.Sc. II Year (III Semester + IV Semester) = 48									
After completion of IInd Year awarded for the degree of “MASTER OF SCIENCE IN MICROBIOLOGY (M.Sc. Microbiology)” (Total Credits: 100)									

DSC: Discipline Specific Core



**DEPARTMENT OF MICROBIOLOGY
BUNDELKHAND UNIVERSITY, JHANSI**

National Education Policy -2020

**DEPARTMENT OF MICROBIOLOGY
BUNDELKHAND UNIVERSITY, JHANSI**

SYLLABUS FOR THE DEGREE OF

“BACHELOR OF RESEARCH IN MICROBIOLOGY”

(In continuation of B.Sc (Hons.) Microbiology III Year)

(M.Sc. First year)

(Total Credits in First Year: 52)

(With effective from: academic session 2022-2023)

Name of Programme: Bachelor of Research in Microbiology

Year of Programme: M. Sc. Microbiology First Year

Programme Objective:

The programme has been designed in such a way so that the students will gain theoretical as well as practical knowledge on various domains of Microbiology and will be able to communicate and collaborate with other disciplines effectively.

Programme Outcomes (POs): After completion of programme students will be able to:

PO1: Understand the concept and fundamentals of various aspects of Microbiology subject as well as its implementation and also its interrelation with other subjects.

PO2: Apply the knowledge and technical skills for the benefit of society.

PO3: Develop ability to plan a scientific research and also interpretation of outcomes.

PO4: Develop ability to be a member of an organization / institution working in subject/field based as well as multidisciplinary environments.

PO5: Recognize the need and implementation of scientific approach for the betterment of humans, environment and entire nature.

PO6: The programme will help to develop a range of generic skills that are relevant in enhancing entrepreneurship skills among students and also become job providers.

Programme Specific Outcomes (PSOs):

PSO1: The student will be able to gain theoretical and practical/laboratory knowledge of various aspects of Microbiology including Fundamentals of Microbiology, Microbial Biochemistry, Bioinstrumentation & Analytical techniques, Microbial Physiology and Metabolism, Biostatistics and Bioinformatics, Environmental Microbiology, Agro technology & Food Nutrition, Microbial Genetics & Molecular Biology, Cell Biology.

PSO2: Student will be acquainted with the historical account and development of microbiology as a scientific discipline.

PSO3: The student will acquire in depth knowledge on diversity, distribution, cell structure and economic importance of bacteria, Algae, Fungi, Protozoa and Virus.

PSO4: Students will be well versed with instruments about their principle and working procedure of various instruments.

PSO5: Students will acquire information about nutritional requirements of bacterial growth and the parameters affect its growth.

BUNDELKHAND UNIVERSITY, JHANSI
DEPARTMENT OF MICROBIOLOGY
SYLLABUS FOR “BACHELOR OF RESEARCH IN MICROBIOLOGY” (Total Credits: 52)

Ist SEMESTER

(1) MAJOR 1 (DSC 1) CORE: FUNDAMENTAL OF MICROBIOLOGY

Title of paper: Fundamental of Microbiology **Type: Major 1 (DSC 1) CORE**

Total Credit: 04 **Total hours (L/T/P): 60**

Course objectives: The course introduces the fundamental and important concepts of microbiology, with special emphasis on microbial diversity.

Course learning outcome: On successful completion of the course, students will be able to:

1. Be acquainted with the historical account and development of microbiology as a scientific discipline.
2. Gain knowledge on microbial diversity, different system of classification.
3. Gain knowledge on structure of bacteria and bacterial growth kinetics.
4. Learn and gain skills on bacterial nutrition, bacteriological media and bacterial cultivation,
5. Gain knowledge about Physical and chemical method of sterilization
6. Acquire in depth knowledge on diversity, distribution, cell structure and economic importance of bacteria, Algae, Fungi, Protozoa and Virus.

Sr. No.	Unit No.	Syllabus Content	Hours (L/T/P)
1.	Unit-I	1. Introduction, history and Scope of Microbiology 2. Microorganism: General characteristics and composition of microbial world; Prokaryotes and Eukaryotes. 3. Classification of Microorganism: Hackle's three kingdom concept, Whittaker's Five kingdom concept, Classification and salient features of bacteria according to Bergey's manual of determinative bacteriology.	10 L/ 2T
2.	Unit-II	1. Morphology and ultra structure of bacteria: Size, shape and arrangement of bacterial cell membrane of Eubacteria and archeobacteria, relation of Gram's staining with bacterial cell wall. 2. Structure and function of Flagella, Fimbriae and Pilli, Capsule, Endospore. 3. Growth and kinetics of microorganisms.	10 L/ 2T
3.	Unit-III	1. Bacterial nutrition: Basic nutritional requirements, growth factors, nutritional categories, physical requirements of bacterial growth. 2. Bacteriological media: types (complex, synthetic, differential, and selective media) and their uses, culture characteristics of bacteria on different media, Cultivation of bacteria: aerobic and anaerobic culture. 3. Sterilization: Principle of sterilization, physical and chemical control of microorganism.	8L/2T
4.	Unit-IV	1. Algae: Importance, Distribution, Morphology, Reproduction, Classification and Ultra structure. 2. Fungi: Importance, Distribution, Morphology, Reproduction, Classification and Ultra structure of Mycorrhiza and Lichen. 3. Protozoa: Distribution, Group, Morphology, Nutrition and Morphology.	12L/ 2T
5.	Unit-V	1. General morphology and Ultra structure of viruses, Envelope, Viral genome and viral related agents-Viroids and prions 2. Assay of Viruses-Physical and Chemical methods, Serological methods. 3. Viruses: animal, plant and Bacteriophage, Lytic and Lysogenic cycle of Virus.	10L/ 2T

List of Reference Books

1. Michael J. Pelczar, JR Vth Eds, Tata Mc. Graw- Hill Publishing Company limited.
2. Prescott, Harley and Klein's Microbiology – Willey, Sherwood and Woolverton. McgrawHill, International Ed.
3. Dubey RC, Maheshwary DK, A text Book of Microbiology. S Chand.
4. Textbook of Microbiology (2013) by Naveen Kango, IK International Pub., New Delhi.

Teaching Methodology

- | | |
|------------------------------------|-------------------------------|
| (1) Classroom lectures | (2) Online classes/ E-content |
| (3) Power point presentation (PPT) | (4) Assignment |

Evaluation Criteria:

- | | | |
|------------------------------------|--|--|
| (1) Internal sessional examination | (3) Classroom seminar presentation and Viva-voce | |
| (2) Final semester examination | | |

(2) **Major 2 (DSC 2): MICROBIAL BIOCHEMISTRY**

Title of paper: Microbial Biochemistry

Type: Major 2 (DSC 2) CORE

Total Credit: 04

Total hours (L/T/P): 60 hours

Course objectives: Students will learn the fundamental of Biochemistry and the structure and function of various bio molecules. The objective of this paper is to provide students with a basic understanding of Structural, chemical biology and functions of macromolecules (Nucleic acids, proteins, carbohydrates and lipids).

Course learning outcome:

- 1: Classification and structural properties of carbohydrates and lipids, glycoproteins and glycolipids and proteo glycans their significance in biological systems.
- 2: Structure and Classifications of aminoacids and protein based on different criteria, ramachandran plot and fibrous and globular protein. Evolution of proteins
- 3: Structure and conformations of nucleic acids, physical and functional property of DNA and RNA
- 4: understand importance of porphyrins
- 5: understand classification and properties of enzymes

Sr. No.	Unit No.	Syllabus Content	Hours (L/T/P)
1.	Unit-I	1. Classification of Carbohydrates.: Monosaccharides. Structure of glucose, fructose, mannose , galactose , oligosaccharides. lactose, Maltose, Isomaltose, Trehalose. Cellobiose. sucrose, Polysaccharides .glycogen, starch and cellulose. 2. Isomerism. Structural and sterioisomers- optical, geometric. Mutarotation, Enantiomers, epimers, and Diastereoisomers. Anomers.	10L/2T
2.	Unit-II	1. Lipids Classification. Fats and Oils, Classification of fatty acids, essential fatty acids. Triglycerides, Waxes, Phospholipids, sphingolipids, Sterols, Cholesterol. Bile pigments- chemical nature and physiological significance. 2. Lipoproteins . Glycoproteins and Glycolipids. Self assembly of lipids, micelle, biomembrane organizations.	8L/2T
3.	Unit-III	1. Classification of proteins - Amino acids, Classification and structure. Essential and non essential amino acids. Non protein and non standard amino acids. 2. Protein structure. Determination of amino acid sequences of proteins. Primary, secondary ,tertiary and quaternary structure of proteins. Forces stabilizing structure of proteins. Salting in and salting out of proteins. Denaturation and renaturation of proteins. Protein degradation and molecular pathways controlling protein degradation. Basic principles of protein purification. Protein folding. Chaperons. Diseases associated with protein folding. Ramachandran plot. 3. Evolution of protein structure.	12L/2T
4.	Unit-IV	Nucleic acid: Structure and properties of purine and pyrimidine bases and DNA and RNA. Functions of nucleic acids. Physical properties Secondary and tertiary structure. Base composition. Base pairing. Helix coil transitions. Tm and relation to GC content. Physical properties of RNA and classes.	8L/2T
5.	Unit-V	Porphyrin nucleus. Classification and structure of porphyrins. Metalloporphyrins.	6L/1T
6.	Unit-VI	Vitamins and Coenzymes. Fat soluble and water soluble vitamins. Vitamin ADE and K, Vitamin B Complex, Vitamin C. Coenzymes and their role in metabolic reactions.	6L/1T

List of Reference Books

1. Lehninger principles of biochemistry. (2013)David L Nelson; Michael M Cox; Albert L Lehninger New York : W.H. Freeman. 6th Edition
2. Biochemistry, Berg, J.M., Tymoczko, J.L. and Stryer, L. (2015) 8th edition, W.H. Freeman & Co., New York
3. Biochemistry, Voet, D. and Voet J.G. (2016) 5th Edition, John Wiley & Sons, New York.
4. Zubay, G. L., Biochemistry; 4Ed, Worthington, R., Ed.:McGraw-Hill Companies, Inc.: Dubuque
5. Biochemistry. U. Satyanarayana. (2014)

Teaching Methodology

- (1) Classroom lectures
- (2) Power point presentation (PPT)
- (3) Online classes/ E-content
- (4) Assignment

Evaluation Criteria:

- (1) Internal sessional examination
- (2) Final semester examination
- (3) Classroom seminar presentation and Viva-voce

Major 3 (DSC 3): BIOINSTRUMENTATION & ANALYTICAL TECHNIQUES

Title of paper: Bioinstrumentation & Analytical Techniques
Total Credit: 04

Type: Major 3 (DSC 3) CORE
Total hours (L/T/P): 60 Hours

Course objectives: The course introduces the knowledge of various tools and techniques, centrifuge, pH meter, colorimeter, Chromatography, SDS-PAGE their principle, working and their applications.

Course learning outcome: After the completion of this course students will be well versed with instruments about their principle and working procedure of various instruments.

Sr. No.	Unit No.	Syllabus Content	Hours (L/T/P)
1.	Unit-I	Chromatography Principle, types and applications- partition, adsorption, paper, thin layer, ion exchange, molecular sieve, supercritical fluid, gas chromatography and HPLC.	10L/2T
2.	Unit-II	Electrophoresis Principle, instrumentation and applications of moving boundary and zonal electrophoresis, including paper and gel (SDS-PAGE and Agarose) electrophoresis, isoelectrofocusing, PFGE and Capillary electrophoresis.	8L/2T
3.	Unit-III	Centrifugation Principles of sedimentation & centrifugation, relationship between RCF and RPM, types of centrifuge, differential and density gradient centrifugation (rate zonal and isopycnic).	12L/2T
4.	Unit-IV	Microscopy Principles and applications of light microscope, fluorescence, Phase contrast, Dark field, electron (TEM and SEM), interference, polarization, inverted and stereomicroscope. Freeze fracture, fixation and staining.	8L/2T
5.	Unit-V	Spectroscopy Principle, Instrumentation and applications of UV-Visible, IR, NMR, atomic absorption, Fluorescence spectroscopy, X-ray Crystallography and Mass Spectrometry.	6L/1T
6.	Unit-VI	Radiation Biology Radioisotope Techniques: Radio-tracers, interaction of radiation with matter, GM counter, Scintillation counters, autoradiography and radioimmunoassay.	6L/1T

List of Reference Books

1. Instrumental Analysis : D. Skoog
2. Biophysical Chemistry : David Sheehan
3. Principles of Biophysical Chemistry : David Frifelder
4. Biophysics : Upadhyay & Upadhyay
5. Methods of Instrumental Analysis : Willard
6. Principles and techniques of practical Biochemistry, by Wilson/Walker : Wiley Publication(2010)

Teaching Methodology

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|------------------------------------|-------------------------------|
| (1) Classroom lectures | (2) Online classes/ E-content |
| (3) Power point presentation (PPT) | (4) Assignment |

Evaluation Criteria:

- (1) Internal sessional examination
- (2) Final semester examination
- (3) Classroom seminar presentation and Viva-voce

Major 4 (DSC 4): MICROBIAL PHYSIOLOGY AND METABOLISM

Title of paper: Microbial physiology and Metabolism

Type: Major 4 (DSC 4) CORE

Total Credit: 04

Total hours (L/T/P): 60 Hours

Course objectives: The main objective of the course is to provide fundamental and basic knowledge of microbial physiology and metabolic pathways. The courses also focus on the bacterial growth parameters and different bacterial culture methods.

Course learning outcome: After the successful completion of the course, students will be able to:

1. Acquire information about nutritional requirements of bacterial growth and the parameters affect its growth.
2. Gain information about kinds of nitrogen fixing bacteria and nitrogen cycle.
3. Explain the various metabolic pathways of bacteria.
4. Learn about the different bacteriological media used for bacterial cultivation.
5. Explain Nutritional classification of microorganisms.

Sr. No.	Unit No.	Content	Hours (L/T/P)
1.	Unit-I	<ol style="list-style-type: none">1. Basic concepts of bioenergetics and metabolism2. Applications of Second Law of Thermodynamics, Redox potential, outline of intermediary metabolism. Bacterial growth curve: growth kinetics, growth curve, batch and continuous culture and synchronous culture, Measurement of growth and influence of environmental factor affecting the growth, synchronous growth.3. Nutritional classification of microorganisms, energy generation of cyanobacteria, green bacteria and purple sulphur bacteria.	10 L/ 2T
2.	Unit-II	<ol style="list-style-type: none">1. Carbohydrate metabolism: Glycolysis and its regulation, Feeder pathway of glycolysis and carbohydrate, Homo and Hetero lactic fermentation, Glycogenesis, Glyconeogenesis, Gluconeogenesis pathways and regulation.2. Pentose phosphate pathway, Kreb's cycle and Glyoxalate pathway.3. Substrate level phosphorylation and oxidative phosphorylation, Electron transfer reaction in Mitochondria.	10 L/ 2T
3.	Unit-III	<ol style="list-style-type: none">1. Bacterial photosynthesis: Structure of Chloroplast, Light reaction and dark reaction.2. Kelvin cycle, C3 and C4 pathway.3. Mechanism of energy generation in Cyanobacteria, Green bacteria and Purple sulphur bacteria and Chemolithotrops.	8L/2T
4.	Unit-IV	<ol style="list-style-type: none">1. Biological Nitrogen Fixation, Free living and symbiotic diazotrophic organism.2. Biochemistry of N₂ Fixation.3. Photosynthetic pigments and generation of reducing power by cyclic and non cyclic photophosphorylation.	12L/ 2T
5.	Unit-V	<ol style="list-style-type: none">1. Nitrate and ammonia assimilation in Prokaryotes2. Methylotrrops and pathways of methane oxidation.3. Assimilation of sulphur.	10L/ 2T

List of Reference Books

1. Microbial Physiology and Metabolism by Caldwell, DR, Edition 2nd, Star Pub Co.
2. Microbial Physiology, Moat, AG, Foster, JW and Spector, MP, Edition 4th, John Willey Publication.
3. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology.5th edition McMillan.
4. Brun. Y. V and Shimkets L. J. 2000 Prokaryotic development ASM press.
5. Advances in Microbial Physiology by Rabert Poole, RK., Volume 53 Elsevier Science & Technology

Teaching Methodology

- | | |
|------------------------------------|-------------------------------|
| (1) Classroom lectures | (3) Online classes/ E-content |
| (2) Power point presentation (PPT) | (4) Assignment |

Evaluation Criteria:

- (1) Internal sessional examination
- (2) Final semester examination
- (3) Classroom seminar presentation and Viva-voce

Title of paper: DSC Practical I/ Lab Course I
Total Credit: 02

Type: DSC Lab Course I CORE
Total hours (Hrs): L/T/P (0 Hrs. / 0 Hrs. /60 Hrs)

List of Practical	Hours
<ol style="list-style-type: none">1. Preparation of different agar based semisolid and broth culture media.2. Isolation and enumeration of microorganisms from water samples by serial dilution Pour plate method.3. Isolation of pure cultures of bacteria by streak plate method.4. Lactophenol cotton blue mounting for fungus.5. Staining of Bacteria: Simple staining, Gram's staining.6. Estimation of carbohydrate/protein/fats.7. Starch iodine test.8. Determination of pKa.	60 hours

List of Reference Books

1. Microbiology: A laboratory manual by J. Cappucino and C.T. Welsh. 11th edition, Pearson education, USA. 2016 2.
2. Aneja K.R., Experiments in Microbiology, plant pathology, Tissue culture and Mushroom Cultivation, New Age International, New Delhi.
3. 3. Dubey R.C. and Maheshwari D.K., Textbook of practical microbiology, S Chand Publications.
4. 4. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology, 5th edition McMillan.

Methodology for practical/experiment

- (1) Laboratory assignment
- (2) Power point presentation (PPT)
- (3) Laboratory practical / experiments
- (4) Practical record preparation

Evaluation Criteria:

- (1) Internal assignment
- (2) Final semester practical examination
- (3) Evaluation of practical record

Title of paper: DSC Practical II / Lab Course II

Type: DSC Practical II CORE

Total Credit: 02

Total hours (Hrs): L/T/P (0 Hrs. / 0 Hrs. /60 Hrs)

Practical:

List of Practical	Hours
<ol style="list-style-type: none">1. To study different instruments used in laboratory.2. Paper chromatography and TLC – Separation of pigments, amino acids.3. Isolation of pure cultures of bacteria from soil.4. Negative staining, capsule and Endospores5. Isolation and identification of bacteria by phenotypic and biochemical tests.6. To study the heterocyst morphology7. To prepare the growth curve of bacteria8. Motility of bacteria by hanging drop method	60 hours

List of Reference Books

1. Microbiology: A laboratory manual by J. Cappucino and C.T. Welsh. 11th edition, Pearson education, USA. 2016 2.
2. Aneja K.R., Experiments in Microbiology, plant pathology, Tissue culture and Mushroom Cultivation, New Age International, New Delhi.
3. 3. Dubey R.C. and Maheshwari D.K., Textbook of practical microbiology, S Chand Publications.
4. 4. Stanier RY, Ingraham JL, Wheelis ML and Painter PR. (2005). General Microbiology, 5th edition McMillan.

Methodology for practical/experiment

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|------------------------------------|--|
| (1) Laboratory assignment | (2) Laboratory practical / experiments |
| (3) Power point presentation (PPT) | (4) Practical record preparation |

Evaluation Criteria:

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|--|------------------------------------|
| (1) Internal assignment | (3) Evaluation of practical record |
| (2) Final semester practical examination | |

IInd SEMESTER

Major 1 (DSC 1) CORE: BIOSTATISTICS AND BIOINFORMATICS

Title of paper: Biostatistics and Bioinformatics

Type: Major 1 (DSC 1) CORE

Total Credit: 04

Total hours (L/T/P): 60 Hours

Course objectives: To deals with fundamentals of computer science and computational biology in analyzing and solving biological data. To aid students in understanding the pipeline of dry lab approach like databases, data analysis and interpretation.

Course learning outcome: After successful completion of the course student will be able to understand

- 1: understand basics of computer and bioinformatics. Aims and applications of bioinformatics in modern biological sciences.
- 2: students will get used to with the biological databases, types of databases, organization, Data retrieval systems used by various databases and searching the correct database to obtain the desired results. Students will also learn about the tools and algorithms to analyze biological data.
- 3: using bioinformatics tools to solve structural and evolutionary information of macromolecules
- 4: understand use of Biostatistics in hypothesis testing.

Sr. No.	Unit No.	Syllabus Content	Hours (L/T/P)
1.	Unit-I	1. Importance and scope of statistics in biochemical experimentation. 2. Probability, Distribution, Binomial, Poisson distribution, addition and multiplication theorems.	8L/2T
2.	Unit-II	1. Measure of central Tendency: Mean, median and mode 2. Measure of dispersion, range quality derivation, variance, standard deviation, coefficient of variance, confidence limits of population mean, tests of significance, student 'T' test, chi square test.	12L/2T
3.	Unit-III	1. ANOVA: One way & two ways ANOVA Anderson scattered. 2. Linear regression: regression diagram, regression coefficient relation between regression and correlation. 3. Test of goodness of fit and test of independence of attributes.	10L/2T
4.	Unit-IV	1. Bioinformatics: An overview, introduction and scope of bioinformatics. 2. Kind of data used, information molecules, Basic structure of nucleic acids: DNA and RNA, DNA sequencing and Polymerase Chain Reaction (PCR), Proteins structure, functions, Protein folding and characterization. 3. Biological databases: Types of databases (Entrez, Sequence Retrieval System (SRS), Protein Identification Resources (PIR), Genebank, Swiss-Prot and other databases etc)	12L/2T
5.	Unit-V	1. Major Bioinformatics databases and data analysis. 2. Sequence analysis: Models for sequence analysis, method for alignment (dot matrices), method for optical alignment (gap penalties and scoring matrices). Tools for sequence alignment- FASTA, BLAST, PSI-Blast. 3. Phylogenetic analysis: Phylogenetic trees, method of Phylogenetic evaluation.	8L/2T

List of Reference Books

1. Ghosh, Z. and Mallick, V. (2008). Bioinformatics-Principles and Applications. Oxford Univ. Press.
2. Fundamentals of Biostatistics: Bernard Rosner III Eds.
3. Basic Biostatistics: B. Burt Gerstman II Eds.
4. Biostatistics – Garret.
5. Pevsner, J. (2009). Bioinformatics and Functional Genomics. II Edition. John Wiley & Sons.

Teaching Methodology

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|------------------------------------|-------------------------------|
| (1) Classroom lectures | (2) Online classes/ E-content |
| (3) Power point presentation (PPT) | (4) Assignment |

Evaluation Criteria:

- (1) Internal sessional examination
- (2) Classroom seminar presentation and Viva-voce
- (3) Final semester examination

Major 2 (DSC 2): ENVIRONMENTAL MICROBIOLOGY

Title of paper: Environmental Microbiology

Type: Major 2 (DSC2 Elective 1) Elective 1

Total Credit: 04

Total hours (L/T/P): 60 Hours

Course objectives: The main objective of this course is to aware and understand the basic principles of Ecology and Ecosystem along with diverse microbial interactions.

Course learning outcome: The student at the completion of the course will be able to:

1. Understanding of the basic principles of Ecology and Ecosystem along with diverse microbial interactions.
2. Will be familiar with the physiology of nitrogen and understand interactions between microbes and natural resources to improve soil health.
3. Students will be able to appreciate the diversity of microorganisms and microbial communities inhabiting a multitude of habitats playing key role in mitigation of metal and other environmental toxicity.

Sr. No.	Unit No.	Syllabus Content	Hours (L/T/P)
1.	Unit-I	1. Microbial ecology: Basic concepts, types and microbial habitats 2. Biogeochemical cycles: Carbon, Nitrogen, Phosphorus and Sulphur cycle. 3. Conservation and management of microbial diversity.	12L/2T
2.	Unit-II	1. Soil microbiology: Microflora of soil, Plant Growth Promoting Rhizobacteria (PGPR), other plant growth promoting microbial metabolites 2. Biofertilizers: Introduction, Preparation and their application. 3. Microbial Associations: Symbiosis, Commensalism, Amensalism, Antagonisms and Parasitism.	12L/2T
3.	Unit-III	1. Microbiology of air, Microorganisms of air, Enumeration of air microflora. 2. Significance of air microflora. 3. Brief account of air borne transmission of bacteria, fungi, pollen and viruses. 4. Air borne diseases and their prevention.	8L/2T
4.	Unit-IV	1. Water microbiology: Aquatic microorganisms, Algal bloom and biofilm and their effect on environment. 2. Water purity test and indicator organisms, Methods used in environmental studies- BOD, COD and DO. 3. Microbiology of waste water and effluent treatment, Primary, Secondary and Tertiary treatment: Trickle filter, Biomethanogenesis and Bioreactor technology for treatment of industrial effluents. 4. Common water borne diseases and their control measure.	10L/2T
5.	Unit-V	1. Bioleaching: Introduction, Process and Application of bacterial leaching. Microbial toxins 2. Remediation of contaminants: Bioremediation and Phytoremediation. 3. Extremophiles: Acidophilic, Alkalophilic, Thermophilic microbes .	8L/2T

List of Reference Books

1. Environmental Microbiology by Maier, RM, Pepper, IL, gerba, CP, Edition 2nd, Academic Press.
2. Principles of Microbial Ecology by Brock, TD, Edition 3rd, Prentice-Hall.
3. Microbial Ecology - Fundamentals and application by Atlas and Bartha, Edition 4th , Benjamin Cummings.
4. Soil Microbiology by Subba Rao NS. (1999). 4th edition. Oxford & IBH Publishing Co. New Delhi.
5. Microbiology of Extremes Environments by Edward, C, McGraw Hill, New York.
7. A text book of Ecology and Environment by P D Sharma.

Teaching Methodology

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|------------------------------------|-------------------------------|
| (1) Classroom lectures | (3) Online classes/ E-content |
| (2) Power point presentation (PPT) | (4) Assignment |

Evaluation Criteria:

- (1) Internal sessional examination
- (2) Final semester examination
- (3) Classroom seminar presentation and Viva-voce

Major 3 (DSC 3): AGRO TECHNOLOGY AND FOOD NUTRITION

Title of paper: Agro technology and Food Nutrition

Type: Major 3 (DSC3 Elective 2) Elective 2

Total Credit: 04

Total hours (L/T/P): 60 Hours

Course objectives: The main objective of this syllabus is to aware and understand the biogeochemical cycle and microbial interaction. Also to study about organic cultivation and food nutrition.

Course learning outcome: The student at the completion of the course will be able to:

1. Scientific knowledge about Indian Soil and Climatic Zones in response to crop production
2. Understand biogeochemical cycle and microbial interaction.
3. Amelioration in knowledge about organic cultivation.
4. Gain knowledge of Heavy metals toxicity in soil and other natural resources.
5. Well versed with different agriculture practices & IPM.

Sr. No.	Unit No.	Content	Hours (L/T/P)
1.	Unit-I	1. Concept of soil and types in India 2. Agro Climatic Zones, Global warming and greenhouse effect 3. Crop Rotation and importance of Biogeochemical Cycles	12L/2T
2.	Unit-II	1. Biofertilizers crop productivity. 2. Mycorrhizae, Rhizosphere & Microbial flora 3. Classification and Causes of plant diseases	12L/2T
3.	Unit-III	1. Pests and their Management by IPM 2. Weed and Economic loss 3. Heavy metals toxicity in Ground and Water Resources	8L/2T
4.	Unit-IV	1. Nutritional value of Cereals 2. Farming types 3. Functional foods of plant & animal origin	10L/2T
5.	Unit-V	1. Modern Agro practices and sustainable cultivation 2. FYM, Green Manure, Humus 3. Zero budget farming and Water use efficiency	8L/2T

List of Reference Books

1. Organic agriculture and climate change mitigation by Niggli, Urs
2. Fundamentals and application by Atlas and Bartha, Edition 4th Benjamin Cummings.
3. Dubey, R.C. and Maheshwari, D.K., A Text Book of Microbiology, S. Chand Publications, New Delhi.
4. Fertilizers and manures by Hall, Alfred Daniel

Teaching Methodology

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|------------------------------------|-------------------------------|
| (1) Classroom lectures | (3) Online classes/ E-content |
| (2) Power point presentation (PPT) | (4) Assignment |

Evaluation Criteria:

- (1) Internal sessional examination
- (2) Final semester examination
- (3) Classroom seminar presentation and Viva-voce

Major 4 (DSC 4): MICROBIAL GENETICS AND MOLECULAR BIOLOGY

Title of paper: Microbial Genetics and Molecular Biology
Total Credit: 04

Type: Major 4 (DSC4) CORE
Total hours (L/T/P): 60 Hours

Course objectives: The main objective of the course is to explain the concept of gene, molecular mechanism and flow of genetic information in terms of replication, transcription and translation in bacteria and also define the basic concept of genetic recombination and mutation.

Course learning outcome: At the completion of the course, the student will be able to:

1. Explain the basic concept of gene and its functional units and the process involved in central dogma.
2. Describe the replication, transcription and translation process of prokaryotic bacteria.
3. Describe the characters of genetic codes and relation with mutation.
4. Explain the various types of Mutation at phenotypic level, biochemical level and molecular level and its application.

Sr. No.	Unit No.	Syllabus Content	Hours (L/T/P)
1.	Unit-I	1. Nucleic acid as a genetic information carrier, experimental evidence. DNA denaturation and renaturation. 2. Concept of gene, genomic size, C-value and C-value paradox. 3. Gene as a unit of mutation and recombination: Molecular basis of mutations, Spontaneous and induced mutation, Application of mutation, Types of mutagens and their screening through Ames test.	12L/2T
2.	Unit-II	1. DNA damage and repair: Types of DNA damage, Repair mechanism: Mismatch repair, Nucleotide excision repair, Recombination repair, SOS repair. 2. DNA polymerase: <i>E. coli</i> DNA polymerase as proof of reader, DNA ligase, Asymmetric and dimeric nature of DNA polymerase III. 3. DNA replication: General principle, various modes of replication, Unwinding of DNA helix, Continuous and discontinuous synthesis of leading and lagging strands.	12L/2T
3.	Unit-III	1. Transcription: General principle and process of transcription, Initiation, Elongation and Termination, Types of RNA polymerase, Inhibitors of RNA synthesis. 2. Control of transcription by interaction between RNA polymerase and promoter regions, Controlled termination, Attenuation and antitermination. 3. Post transcriptional modification, maturation and Splicing of RNA transcripts.	8L/2T
4.	Unit-IV	1. Protein synthesis: Initiation, Elongation and Termination, Inhibitors of protein synthesis. 2. Post translational modification: Covalent modification, Phosphorylation, Glycosylation and Methylation. 3. Regulation of gene expression: Operon concept, Induction and expression, Positive and negative control, Catabolite repression and trp operon.	10L/2T
5.	Unit-V	1. Genetic code: Nature of genetic code, Codon, Anticodon, Wobble hypothesis. 2. Genetic recombination in bacteria, Transformation, Transduction and Conjugation. 3. Molecular aspects of genetic recombination, Transposable Elements.	8L/2T

List of Reference Books

1. Principles of Genetics by Eldon J. Gardner, 12thEds.
2. Molecular Biology of gene by Watson, 12th Eds.
3. Modern Genetic Analysis: Integrating Genes and Genomes by Anthony J.F. Griffiths 7th
4. Gene by Benjamin Lewin, IXthEds, Oxford Univ. Press, U.K..
5. Genetics: Analysis and Principles by Robert J. Brooker, IIIrdEds.
6. Malacinski GM, Essential of Molecular Biology, Jones and Bart left publishers, USA IV th Edition.
7. Benard R. Glick, Molecular Biotechnology, Principles Application of Biotechnology 3rd Edition, 2003. ASM Press.

Teaching Methodology

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|------------------------------------|-------------------------------|
| (1) Classroom lectures | (3) Online classes/ E-content |
| (2) Power point presentation (PPT) | (4) Assignment |

Evaluation Criteria:

- (1) Internal sessional examination
- (2) Final semester examination
- (3) Classroom seminar presentation and Viva-voce

Major 5 (DSC 5): CELL BIOLOGY

Title of paper: Cell Biology

Type: Major 5 (DSC5 Elective 3) Elective 3

Total Credit: 04

Total hours (L/T/P): 60 Hours

Course objectives: To appreciate the cell as a basic unit of life and learn the structure and functions of various cell organelles.

Course learning outcome: On successful completion of the course, students will be able to

1. Visualisation of cell as the basic unit of life.
2. Understand the structure and function of various cellular organelles and its significance
3. Have a better understanding on how cellular components work together to carry out life functions.
4. Acquire a better understating on how cell division and cell cycle enable organism to meet their basic needs and propagate.
5. Learn and gain skills on Microscopic techniques to visualise cell and cell organelles.

Sr. No.	Unit No.	Content	Hours (L/T/P)
1.	Unit-I	Membrane structure and function: Structure of model membrane, lipid bilayer and membrane protein diffusion, osmosis, ion channels, active transport, ion pumps, Prokaryotes and eukaryotic membranes. Movement of substances across cell membranes: Diffusion, Facilitated Diffusion & active transport. Interactions between cells and their Environment: Extracellular matrix, Interaction of cells with other cells, Tight Junctions, Gap Junctions and General structure of Bacterial Cell wall.	10L/2T
2.	Unit-II	Cell cycle – Molecular events including cell cycle check points and Cdk – cyclin complexes and their role in cell cycle regulation. Mechanism of cell division: Mitosis, Meiosis and Cytokinesis. Structural organization and function of intracellular organelles: Nucleus and chromatin, Ribosomes, Golgi bodies, lysosomes and endoplasmic reticulum.	12L/2T
3.	Unit-III	Mitochondria: Structure and Function, biogenesis and enzymatic compartmentation, mechanism of oxidative phosphorylation (TCA Cycle), Organization of mitochondrial respiratory chain, Formation of ATP.	8L/2T
4.	Unit-IV	Chloroplast: Structure and Function, the absorption of light, Photosynthetic units and Reaction centres, photophosphorylation. Carbon dioxide fixation and synthesis of Carbohydrates in C-3, C-4 and CAM plants. Photorespiration.	8L/2T
5.	Unit-V	Microscopic techniques: Visualization of cells and subcellular components by light microscopy, resolving powers of different microscopes, scanning and transmission microscopes. General Idea of Signal Transduction.	11L/3T

List of Reference Books

1. Hardin J, Bertoni G and Kleinsmith LJ. Becker's World of the Cell. Pearson.
2. Karp G. Cell and Molecular Biology: Concepts and Experiments. John Wiley & Sons. Inc.
3. De Robertis, EDP and De Robertis EMF. Cell and Molecular Biology. Lipincott Williams and Wilkins, Philadelphia.
4. Cooper, G.M. and Hausman, R.E. The Cell: A Molecular Approach. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
5. Lodish H., Berk A., Kaiser C., Krieger M., Scott M., Bretscher A., Ploegh H., Matsudaira P., Molecular cell biology .W H Francis and company, New York.
6. Alberts B., Johnson A., Lewis J., Raff M., Roberts K., Walter P., Molecular Biology of The Cell Garland science, Taylor and Francis group.

Teaching Methodology

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|------------------------------------|-------------------------------|
| (1) Classroom lectures | (3) Online classes/ E-content |
| (2) Power point presentation (PPT) | (4) Assignment |

Evaluation Criteria:

- (1) Internal sessional examination
- (2) Classroom seminar presentation and Viva-voce
- (3) Final semester examination

Title of paper: DSC Practical I/ Lab Course

Type: DSC Practical I CORE

Total Credit: 02

Total hours (Hrs): L/T/P (0 Hrs. / 0 Hrs. /60 Hrs)

Practical:

List of Practical	Hours
<ol style="list-style-type: none">1. Practical skills and Biosafety in the laboratory experiments in Microbiology.2. Preparation of different agar and other media required for agriculturally important microorganisms.3. Isolation of Rhizospheric microflora from soil.4. Staining and slant preparation of microbial strains5. Diauxic growth curve on lactose/glucose as carbon source in bacteria.6. Retrieving and analysis of data from various nucleotide and protein data banks.7. Isolation of <i>Azotobacter</i> from soil sample.8. Estimation of BOD and COD in water samples.	60 hours

List of Reference Books

1. Maier RM, Pepper IL and Gerba CP. (2009). Environmental Microbiology. 2nd edition, Academic Press
2. Atlas RM and Bartha R. (2000). Microbial Ecology: Fundamentals & Applications. 4th edition. Benjamin/Cummings Science Publishing, USA
3. Microbiology of Extremes Environments by Edward, C, McGraw Hill, New York.
4. Ghosh, Z. and Mallick, V. (2008). Bioinformatics-Principles and Applications. Oxford Univ. Press.
5. Fundamentals of Biostatistics: Bernard Rosner III Eds.
6. Basic Biostatistics: B. Burt Gerstman II Eds.

Methodology for practical/experiment

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|------------------------------------|--|
| (1) Laboratory assignment | (3) Laboratory practical / experiments |
| (2) Power point presentation (PPT) | (4) Practical record preparation |

Evaluation Criteria:

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|--|------------------------------------|
| (1) Internal assignment | (2) Evaluation of practical record |
| (3) Final semester practical examination | |

Title of paper: DSC Practical II/ Lab course II

Type: DSC Practical II CORE

Total Credit: 02

Total hours (Hrs): L/T/P (0 Hrs. / 0 Hrs. /60 Hrs)

Practical:

List of Practical	Hours
<ol style="list-style-type: none">1. UV sensitivity in bacteria and isolation of mutants.2. To demonstrate the photorepair of Mutant bacterial culture.3. Determination on Melting temperature of DNA.4. Quantification of DNA sample.5. To analyse Physico-chemical properties of soil.6. Specimen study of plant pathogens: Wheat, Sugarcane, Lemon, Potato and Tomato.7. Isolation of Heavy metal tolerant microbes.8. Visualization of cell division.	60 hours

List of Reference Books

1. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India
2. Sambrook J and Russell DW., Molecular Cloning: A Laboratory Manual. 4th Edition, 2004, Cold Spring Harbour Laboratory press.
3. Russell PJ. (2009). i Genetics- A Molecular Approach. 3rd Ed, Benjamin Cumming
4. Cooper, G.M. and Hausman, R.E. The Cell: A Molecular Approach. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
5. Lodish H., Berk A., Kaiser C., Krieger M., Scott M., Bretscher A., Ploegh H., Matsudaira P., Molecular cell biology .W H Francis and company, New York.

Methodology for practical/experiment

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|------------------------------------|--|
| (1) Laboratory assignment | (3) Laboratory practical / experiments |
| (2) Power point presentation (PPT) | (4) Practical record preparation |

Evaluation Criteria:

- | | |
|--|------------------------------------|
| (1) Internal assignment | (3) Evaluation of practical record |
| (2) Final semester practical examination | |

List of Minor Elective Course: The candidate shall select any one subject from the following as minor subject in first semester of the first year of post graduate course.

Sr. No.	Science	Arts	Commerce	Interdisciplinary
1.	Mathematical Biology	Tribal Culture and Heritage	Customer Relation Management	Ancient Medical Sciences
2.	Conservation and Water Resource Management	Principle of Administration and Implications	House Keeping and Hospitality	Traditional Medical Therapy
3.	Natural Resources and Conservation	Socio-Economics and Social Security	Share Market and Banking	Vedic Mathematics
4.	Pollution: Causes and Mitigation	Archeological Sites and Monuments	Retail Management and Accounting	Bio Medical Instrumentation and Health
5.	Computational Resources	Indian Constitution	Insurance Policy and Finance	Disaster, Mitigation, & Management
6.	Organic and Natural Farming	Communication and Soft Skill		Mining Plan and Resource Mapping
7.	Computer Hardware Handling	Sanskrit Knowledge System		Water Treatment System
8.	Computer Software Handling	Technical Translation and Trans creation		Climate Change and Environmental Degradation
9.	Solar and Non Conventional Energy	Urban Economics and Planning		Medicinal and Aromatic Plants Cultivation, extraction and nutraceutical Values
10	Cyber Crime	Actuarial Economics		
11	Bee Keeping, Aquaculture and Fish Farming	Social Sector and Gender Economics		Non Conventional Energy Resource
12	Entrepreneurship in Microbial and Botanical Products	Environmental Economics		Soil and Water Testing

Note:

1. Syllabus and course content of **Minor Elective Course (as mentioned in above list)** as provided by Bundelkhand University, Jhansi (U.P.).
2. After completion of First year “BACHELOR OF RESEARCH IN MICROBIOLOGY” will be awarded.



**DEPARTMENT OF MICROBIOLOGY
BUNDELKHAND UNIVERSITY, JHANSI**

National Education Policy -2020

**DEPARTMENT OF MICROBIOLOGY
BUNDELKHAND UNIVERSITY, JHANSI**

**SYLLABUS FOR THE DEGREE OF
“MASTER OF SCIENCE IN MICROBIOLOGY”**

(M.Sc. Second year)

(Total Credits in Second Year: 48)

IN CONTINUATION OF M.Sc. FIRST YEAR

(Total Credit For M.Sc. Microbiology: First Year (52)+ Second Year (48)=100)

(with effective from: academic session 2022-2023)

Name of Programme: Master of Science in Microbiology (M. Sc. Microbiology)
Year of Programme M.Sc. Microbiology, Second Year

Programme Objective:

The programme has been designed in such a way so that the students will gain theoretical as well as practical knowledge on various domains of Microbiology and will be able to communicate and collaborate with other disciplines effectively. Communicate and collaborate with other disciplines by effectively communicating the fundamental concepts of microbiology in written and oral format.

Programme Outcomes (POs): After completion of programme students will be able to:

- PO1:** Understand the concept and fundamentals of various aspects of Microbiology subject as well as its implementation and also its interrelation with other subjects.
- PO2:** Apply the knowledge and technical skills for the benefit of society.
- PO3:** Develop confidence to take up challenging tasks of research in the field of Microbiology and other related fields.
- PO4:** Develop ability to design and conduct a scientific research and also interpretation of outcomes.
- PO5:** To be a member of an organization / institution working in subject/field based as well as multidisciplinary environments.
- PO6:** Recognize the need and implementation of scientific approach for the betterment of humans, environment and entire nature.
- PO7:** The programme will help to develop a range of generic skills that are relevant in enhancing entrepreneurship skills among students and also become job providers.
- PO8:** To integrate science with society for the overall development of the nation.

Programme Specific Outcomes (PSOs):

- PSO1:** To gain theoretical and practical/laboratory knowledge of various fields of Microbiology and related area including Immunology, Food Microbiology, Medical Microbiology, Genetic Engineering, Biosafety & Microbiological Resource Management, Enzymology, Agriculture Microbiology, Industrial Bioprocess Technology, Microbial Ecology.
- PSO2:** The students will be able to explain the antigen-antibody interaction based diagnostic test and their specificity and sensitivity for currently bothering disease.
- PSO3:** Students will be able to explain about the availability vaccines for different diseases and their method of preparation and problems associated with the vaccine development. Know about the diagnosis and treatment strategies followed for the infectious diseases and also explain Classification of medically important microorganisms.
- PSO4:** Students get acquired with sufficient knowledge of relationship between food and microbes and fermented food products.
- PSO5:** To explain various techniques of genetic engineering and their applications in biological research. The course includes recombinant DNA technology and its application in agriculture, health and industry.

BUNDELKHAND UNIVERSITY, JHANSI
DEPARTMENT OF MICROBIOLOGY

Syllabus for “M.Sc. Microbiology” in continuation of First Year

(Total Credits in Second Year: 52)

IIIrd SEMESTER

(1) Major 1 (DSC 1) CORE: IMMUNOLOGY

Title of paper: Immunology

Type: Major 1 (DSC 1) CORE 1

Total Credit: 04

Total hours (L/T/P): 60 Hours

Course objectives: To make them understand structural components of immune system and their function. In-depth knowledge and understanding of major cellular and molecular mechanisms underlying immunological processes in health and diseases.

Course learning outcome: After completion of this course successfully, the students will be able to

1. Learn the key concepts of immunological mechanisms and how this could be extrapolated towards development of novel therapeutic interventions against various diseases.
2. Able to explain the procedure for the antigen-antibody interaction based diagnostic test and their specificity and sensitivity for currently bothering disease.
3. The vaccines available for different diseases and their method of preparation and will be able to explain the problems associated with the vaccine development for the infections without vaccines at present.

Sr. No.	Unit No.	Syllabus Content	Hours (L/T/P)
1.	Unit-I	<ol style="list-style-type: none"> 1. History and development of immunology as a discipline. 2. Infection: Type of infection, Sources of infection, vehicles and reservoirs of infection, spread of infection. 3. Inflammation: Signs and mechanism, acute and chronic inflammation. 4. Hematopoiesis. 	12L/2T
2.	Unit-II	<ol style="list-style-type: none"> 1. Immune response: Innate and Adaptive immune response mechanisms. 2. Anatomical organization of immune system: Primary lymphoid organs and Secondary lymphoid organs. 3. Cells of the immune system: Mononuclear cells and granulocytes, antigen presenting cells, lymphoid cells. 	12L/2T
3.	Unit-III	<ol style="list-style-type: none"> 1. Antigens and Hapten: Structure, Types and Properties. 2. Immunoglobulins: Structure, Type and Properties. 3. Complement system: Structure, components, activation pathways, regulation of activation pathways, Role of complement system in immune response. 4. Vaccines: Active and passive immunization, Whole organ vaccine, Purified macromolecules as a vaccine. DNA vaccine and Recombinant vaccine. 	10L/2T
4.	Unit-IV	<ol style="list-style-type: none"> 1. Hybridoma technology: Monoclonal antibody production and characterization. 2. ELISA and RIA. 3. Detection of antigen- antibody interaction by Precipitation and Agglutination. 	8L/2T
5.	Unit-V	<ol style="list-style-type: none"> 1. Hypersensitivity: Type I, II, III and IV. Immunodeficiency diseases: Primary and secondary immunodeficiency. 2. Major Histocompatibility complex (MHC). 3. Autoimmunity: Organ specific autoimmune diseases, Mechanism of autoimmune diseases and therapeutic approaches. 	8L/2T

List of Reference Books

1. Immunology: Kubey, VIth Eds.
2. Fundamental Immunology by William E Paul, VthEds.
3. Immunobiology by C. Janeway, VIIthEds.
4. Immunology by Riott and Riott.
5. Immunology by Richard C and Geiffrey S. (2009), 6th edition. Wiley Blackwell

Teaching Methodology

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|------------------------------------|-------------------------------|
| (1) Classroom lectures | (3) Online classes/ E-content |
| (2) Power point presentation (PPT) | (4) Assignment |

Evaluation Criteria:

- (1) Internal sessional examination
- (2) Classroom seminar presentation and Viva-voce
- (2) Final semester examination

(2) **Major 2 (DSC 2): FOOD MICROBIOLOGY**

Title of paper: Food Microbiology

Type: Major 2 (DSC 2 Elective) Elective 1

Total Credit: 04

Total hours (L/T/P): 60 Hours

Course objectives: To study general principles and basic concept of food microbiology fermented foods, food preservation, spoilage and Foodborne diseases.

Course learning outcome: On successful completion of the course, students will be able to

1. Get acquired with sufficient knowledge of relationship between food and microbes and fermented food products.
2. Explain the different methods of food preservation.
3. Gain knowledge about microbiology of milk, identify the role of microbes in the production of dairy products.
4. Know about microbial spoilage in foods with detection and characterization.
5. Gain knowledge on Foodborne diseases and their control.

Sr. No.	Unit No.	Syllabus Content	Hours (L/T/P)
1.	Unit-I	1. Microorganisms important in food microbiology, Characteristics and their importance. 2. Principles of food preservation, preservation by use of high temperature, low temperature, drying and desiccation. 3. Chemical preservation (additives) artificial preservative (merits and demerits) and radiation.	10L/2T
2.	Unit-II	1. Microbiology of milk: Sources and types of microorganisms in milk. 2. Microbiological examination of milk: Standard plate count, Direct microscopic count, Methylene blue reductase test and Phosphatase test. 3. Pasteurization of milk, Dairy products: Butter, Yoghurt and Cheese.	10L/2T
3.	Unit-III	1. Microbial spoilage of food: Chemical changes caused by the microorganisms during spoilage. 2. Factors affecting spoilage, Detection of spoilage, and its characterization. 3. Spoilage of fish, meat, poultry, eggs, fruits and vegetables.	11L/2T
4.	Unit-IV	1. Food intoxication: Staphylococcal intoxication, Clostridial poisoning. 2. Food born infections by <i>Clostridium perfringens</i> , <i>E.coli</i> , <i>Solmonella</i> and <i>Vibrio</i> . 3. Classification of food born diseases.	9L/2T
5.	Unit-V	1. Fermented food products: Bread, Malt beverages, Tempeh, Soy sauce, Idli. 2. Microorganisms as source of food: Single Cell Protein (SCP). 3. Mushrooms and their food value.	10L/2T

List of Reference Books

1. Food Microbiology by Frazier, WC, and Westhoff, DC. Fourth edition, Mac Graw Hills publication.
2. Food Microbiology Fundamentals and Frontiers by Doyle, MP, Beuchat, LR & Montville, TJ ASM Press.
3. Food Microbiology by Adams AR, & Moss MO Third edition, Royal Society of Chemistry publishing.
4. Modern Food Microbiology by Jay JM, Loessner MJ and Golden DA. (2005) 7th edition, CBS Publishers and Distributors, Delhi, India.
5. Microbiology: An Introduction by Tortora GJ, Funke BR, and Case CL. (2008). 9th Edition, Pearson.

Teaching Methodology

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|------------------------------------|-------------------------------|
| (1) Classroom lectures | (2) Online classes/ E-content |
| (3) Power point presentation (PPT) | (4) Assignment |

Evaluation Criteria:

- (1) Internal sessional examination
- (2) Final semester examination
- (3) Classroom seminar presentation and Viva-voce

Major 3 (DSC 3) Elective: MEDICAL MICROBIOLOGY

Title of paper: Medical Microbiology

Type: Major 3 (DSC 3 Elective) ELECTIVE 2

Total Credit: 04

Total hours (L/T/P): 60 Hours

Course objectives: The main objective of this course to explain the various immunological reaction and antigen antibody interaction that reflects the immunology/immune system. This course also focus on the various microorganism related to infections.

Course learning outcome: At the completion of course the student will be able to :

1. Know about the historical development of Medical Microbiology.
2. Explain the microorganisms associated with various infectious diseases.
3. Know about the diagnosis and treatment strategies followed for the infectious diseases.
4. Explain Classification of medically important microorganisms.

Sr. No.	Unit No.	Syllabus Content	Hours (L/T/P)
1.	Unit-I	1. Early discovery of pathogenic microorganisms. Classification of medically important microorganisms. 2. Normal micro flora of human body 3. Pathogenicity of microorganisms: Virulence factors, establishment, spreading and tissue damage	12L/2T
2.	Unit-II	1. Pneumotropic viral diseases: Influenza. 2. Dermatotropic viral disease: Herpes simplex, Small pox, Measles, mumps and Rubella. 3. Viscerotropic viral diseases: Dengue fever, Hepatitis and Acquired Immuno Deficiency Syndrom, Neurotropic viral diseases: Rabies and Poliomyelitis.	12L/2T
3.	Unit-III	1. Fungal infection: Description and classification of pathogenic fungi. 2. Infection caused by Dermatophytes (<i>Microsporum</i> , <i>Trichophyton</i> and <i>Epidermatophyton</i>). 3. Definition, Causative agent, source of infection, epidemiology, symptomatology and diagnosis of Aspergillosis, Candidiasis, Blastomycosis and Histoplasmosis.	8L/2T
4.	Unit-IV	1. Source of infection, Pathogenicity, Epidemiology and lab diagnosis of the <i>Corynebacterium</i> and <i>Clostridium</i> . 2. Source of infection, Pathogenicity, Epidemiology and lab diagnosis of members of family enterbacteriaceae <i>Ciliform</i> , <i>Salmonella</i> . 3. <i>Mycobacterium</i> , <i>Staphylococcus</i> , <i>Actinomycetes</i> , and <i>Spirocheates</i> .	10L/2T
5.	Unit-V	1. Bacterial zoonoses: Brucellosis and Salmonellosis. 2. Viral zoonoses: Encephalitis and Yellow fever. 3. Pathogenesis, diagnosis and life cycle of protozoa: <i>Plasmodium</i> , <i>Entamoeba histolytica</i> and <i>Leshmania</i> .	8L/2T

List of Reference Books

1. Textbook of Microbiology by Ananthanarayan R and Paniker CKJ. (2005) 7th edition University Press Publication.
2. Microbiology by Prescott, Harley and Klein's Willey JM, Sherwood LM, and Woolverton CJ. (2008), Mc Graw Hill Higher.
3. Medical Microbiology by Brooks GF, Carroll KC, Butel JS and Morse SA. (2007). Jawetz, Melnick and Adelberg's. McGraw Hill Publication.

Teaching Methodology

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|------------------------------------|-------------------------------|
| (1) Classroom lectures | (3) Online classes/ E-content |
| (2) Power point presentation (PPT) | (4) Assignment |

Evaluation Criteria:

- (1) Internal sessional examination
- (2) Classroom seminar presentation and Viva-voce
- (3) Final semester examination

Major 4 (DSC 4): GENETIC ENGINEERING

Title of paper: Genetic Engineering

Type: Major 4 (DSC 4) CORE 2

Total Credit: 04

Total hours (L/T/P): 60 Hours

Course objectives: The main objective of this course is to explain various techniques of genetic engineering and their applications in biological research. The course includes recombinant DNA technology and its application in agriculture, health and industry.

Course learning outcome: At the completion of course the student will be able to :

1. Explain the basic principles behind molecular cloning.
2. Gain knowledge about recombinant DNA Technology and its application.
3. Explain the methods for production of gene libraries.
4. Explain the method of polymerase chain reaction and its application.

Sr. No.	Unit No.	Syllabus Content	Hours (L/T/P)
1.	Unit-I	1. Recombinant DNA Technology Enzymes used in DNA technology: DNA manipulating enzymes (Restriction Endonucleases , Polymerases, Ligase, Kinases and Phosphatases Nucleases). Linker, Adaptor, Homopolymer tailing. Cloning vectors: Plasmids, Phasmids, Cosmids, Artificial chromosomes, Shuttle vectors and Expression vectors, Viruses as vectors 2. Application of Recombinant DNA technology in agriculture, health and industry.	8L/2T
2.	Unit-II	1. Polymerase Chain Reaction (PCR): Principle, types and its application. 2. Principle and techniques of hybridization: Western, Northern and Southern blotting, Microarray based detection. DNA finger printing.	8L/2T
3.	Unit-III	1. Isolation and purification of DNA, Gel electrophoresis. 2. Molecular Markers: Principles, types and application, Restriction Fragment Length Polymorphism (RFLP), Amplified Fragment Length Polymorphism (AFLP). Random Amplified Polymorphic DNA (RAPD), Single Nucleotide Polymorphism (SNP).	8L/2T
4.	Unit-IV	1. Gene transfer methods: Electroporation, Microinjection, calcium phosphate co-precipitation, lipofection. 2. Analysis of protein-DNA and protein-protein interactions: Gel retardation assay, DNA footprinting, Modification interference assay, Deletion analysis, Phage display and yeast two hybrids assay.	8L/2T
5.	Unit-V	1. DNA sequencing method: Sanger's method, Maxam and Gilbert Method, Automated method. 2. Transgenic technologies and their applications.	8L/2T
6.	Unit VI	1. DNA libraries: construction of genomic and cDNA, screening method of DNA libraries. 2. Molecular diagnostic Methods, Biosafety and Ethical considerations.	8L/2T

List of Reference Books

1. DNA Technology: The Awesome Skill by Alcamo IE. (2001). 2nd Elsevier Academic Press, USA.
2. Gene Cloning and DNA Analysis by TA Brown. Blackwell Publishing, Oxford, U.K.
3. Molecular Biotechnology by Glick BR and Pasternak JJ. ASM Press Washington D.C.
4. Principle of gene cloning by Old and primrose VthEds.
5. S B Primrose and R M Twyman Principles of Gene Manipulation and Genomics Seventh edition 2006 Blackwell Publisher, Australia.
6. Watson JD, Candy AA, Myers RM and Witkowski JA, Recombinant DNA (Gene and Genome – A short course) WH Freeman and Company, New York, IInd Edition 1992.
7. Biotechnology. Singh, B. D.

Teaching Methodology

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|------------------------------------|-------------------------------|
| (1) Classroom lectures | (2) Online classes/ E-content |
| (2) Power point presentation (PPT) | (4) Assignment |

Evaluation Criteria:

- (1) Internal sessional examination
- (2) Final semester examination
- (3) Classroom seminar presentation and Viva-voce

Major 5 (DSC 5): BIOSAFETY & MICROBIOLOGICAL RESOURCE MANAGEMENT

Title of paper: Biosafety & Microbiological Resource Management
Total Credit: 04

Type: Major 5 (DSC 5 Elective) Elective 3
Total hours (L/T/P): 60 Hours

Course objectives: The main objective of this paper is to provide scientific knowledge about Biosafety procedures, Xenobiotics, Pesticides, possible remediation methods.

Course learning outcome: The student at the completion of the course will be able to:

1. Scientific knowledge about genetically modified organisms (GMOs) & Biosafety.
2. Heavy metals toxicity and possible remediation methods.
3. Amelioration in knowledge about Xenobiotics, Pesticides.
4. Well versed with Weed, Plant diseases and their IPM.

Sr. No.	Unit No.	Content	Hours (L/T/P)
1.	Unit-I	1. Introduction and Concepts of Biosafety. 2. Laboratory safety levels 3. Genetically modified organisms (GMOs)	12L/2T
2.	Unit-II	1. Heavy metals toxicity and remediation 2. Bioremediation 3. Phytoremediation	12L/2T
3.	Unit-III	1. Xenobiotics, Pesticides 2. Basic Concept of Integrated Pest Management 3. Weed Control measures.	8L/2T
4.	Unit-IV	1. Stress Biology 2. Rainfed area and crop production 3. PGPR, Mycorrhizae and BGA	10L/2T
5.	Unit-V	1. Microbial Cultures and role in Natural Resource Management 2. Agro -Climatic zones and Crop selection 3. Significance of Organic cultivation.	8L/2T

List of Reference Books

1. Microbial Ecology (Basic Microbiology) by CAMPBELL
2. Fundamentals and application by Atlas and Bartha, Edition 4th Benjamin Cummings.
3. Dubey, R.C. and Maheshwari, D.K., A Text Book of Microbiology, S. Chand Publications, New Delhi.
4. Fundamental Agricultural Microbiology by K.R. Aneja.

Teaching Methodology

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| (1) Classroom lectures | (2) Online classes/ E-content |
| (3) Power point presentation (PPT) | (4) Assignment |

Evaluation Criteria:

- (1) Internal sessional examination
- (2) Classroom seminar presentation and Viva-voce
- (3) Final semester examination

Title of paper: DSC Practical I / Lab course I

Type: DSC Practical I CORE

Total Credit: 02

Total hours (Hrs): L/T/P (0 Hrs. / 0 Hrs. /60 Hrs)

Practical:

List of Practical	Hours
<ol style="list-style-type: none">1. Isolation of lipolytic organisms from butter.2. Determination of quality of milk samples by MBRT.3. Isolation and staining of molds from bread.4. Detection and enumeration of microorganisms in bakery products.5. Enumeration of bacterial colonies in milk samples by Standard Plate Count.6. To perform slide agglutination test.7. Determination of blood group.8. Specimen study of pathogenic microorganism.	60 hours

List of Reference Books

1. Microbiology: A laboratory manual by J. Cappucino and C.T. Welsh. 11th edition, Pearson education, USA. 2016 2.
2. Aneja K.R., Experiments in Microbiology, plant pathology, Tissue culture and Mushroom Cultivation, New Age International, New Delhi.
3. Dubey R.C. and Maheshwari D.K., Textbook of practical microbiology, S Chand Publications.
4. Mukerji K.G., Laboratory Manual of Food Microbiology, IK Publishers.

Methodology for practical/experiment

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| (1) Laboratory assignment | (3) Laboratory practical / experiments |
| (2) Power point presentation (PPT) | (4) Practical record preparation |

Evaluation Criteria:

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| (1) Internal assignment | (3) Evaluation of practical record |
| (2) Final semester practical examination | |

Title of paper: DSC Practical II/ Lab course II

Type: DSC Practical II CORE

Total Credit: 02

Total hours (Hrs): L/T/P (0 Hrs. / 0 Hrs. /60 Hrs)

List of Practical	Hours
<ol style="list-style-type: none">1. Isolation of Genomic DNA from Bacterial Cell.2. Agarose Gel Electrophoresis.3. Elution of DNA from agarose gel.4. Isolation of root rhizobia from root nodule.5. Knowledge about Laboratory safety levels & measures to be followed while handling Xenobiotics and microbes.6. Preparation of different culture media simulated with metals for culturing Bacteria and fungi.7. To learn isolation, culturing and maintenance of pure culture of different Microbial cultures.8. Specimen study of Weeds and plant pathogens	60 hours

List of Reference Books

1. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press 5
2. Primrose SB and Twyman RM. (2008). Genomics: Applications in human biology. Blackwell Publishing, Oxford, U.K.
3. Brown TA. (2010). Gene Cloning and DNA Analysis. 6th edition. Blackwell Publishing, Oxford, U.K.
4. Fundamentals and application by Atlas and Bartha, Edition 4th Benjamin Cummings.
5. Dubey, R.C.and Maheshwari, D.K., A Text Book of Microbiology, S. Chand Publications, New Delhi.
6. Aneja K.R., Experiments in Microbiology, plant pathology, Tissue culture and Mushroom Cultivation, New Age International, New Delhi.

Methodology for practical/experiment

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| (1) Laboratory assignment | (2) Laboratory practical / experiments |
| (3) Power point presentation (PPT) | (4) Practical record preparation |

Evaluation Criteria:

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| (1) Internal assignment | (2) Evaluation of practical record |
| (3) Final semester practical examination | |

IVth SEMESTER

Major 1 (DSC 1): ENZYMOLOGY

Title of paper: Enzymology

Type: Major 1 (DSC 1) CORE

Total Credit: 04

Total hours (L/T/P): 60 Hours

Course objectives: The course will cover a wide range of subjects such as vitamins and co-enzyme, classification of enzyme, mechanism and kinetics of enzyme catalyzed reaction. The final part will deal with the production, extraction, purification, characterization and application of enzymes.

Course learning outcome: Upon successful completion of this course, the student will learn:

1. The major classes of enzyme and their functions in the cell.
2. Role of co-enzyme cofactor in enzyme catalyzed reaction.
3. Differentiate between equilibrium and steady state kinetics and analyzed simple kinetic data and estimate important parameter (Km, Vmax, Kcat etc).
4. Enzyme purification and enzyme engineering.
5. To define the molecular biology of enzymes.

Sr. No.	Unit No.	Syllabus Content	Hours (L/T/P)
1.	Unit-I	Introduction of enzyme, enzyme classification and nomenclature, concept of enzyme substrate complex, active site, specificity, factors affecting rate of enzyme catalyzed reactions, mechanism of enzyme action, enzyme units.	10L/2T
2.	Unit-II	Microbial sources of enzymes, kinetics of enzyme activity, Michaelis-Menten equation and its derivation, different plots for the determination of Km and Vmax and their physiological significance, two substrate reactions, enzyme inhibition, types of inhibition	12L/2T
3.	Unit-III	Microbial enzyme production, submerged and solid state fermentation, Important parameter in enzyme production. Enzyme purification techniques-Precipitation, Chromatographic separation, gel filtration, anion and cation exchange, zymography	10L/2T
4.	Unit-IV	Methods for large scale production of enzymes, immobilized enzymes and their comparison with soluble enzymes, methods for immobilization of enzymes, applications of immobilized and soluble enzymes in health and industry, applications of fundamental studies of Biotechnology	10L/2T
5.	Unit-V	Thermal stability and catalytic efficiency of enzyme, site directed mutagenesis and enzyme engineering, modification of active site of an enzyme.	8L/2T

List of Reference Books

1. Voet, D and Voet, J 1995. Biochemistry, 2nd ed. John Wiley and Sons.
2. Nelson, DL and Cox, MM 2005. Lehninger Principles of Biochemistry, 4th ed. WH Freeman and Company, New York.
3. Rodwell, VW, Bender, DA, Botham, KM, Kennelly, PJ and Weil, PA 2015. Harper's Illustrated Biochemistry, 30th ed. McGraw Hill Education.
4. Stryer, L 2006. Biochemistry, 6th ed. WH Freeman
5. Enzyme Kinetics. A modern approach. Marangoni, A.G.
6. Fundamentals of Enzymology. Price, N.C. and Stevens, L.

Teaching Methodology

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|------------------------------------|-------------------------------|
| (1) Classroom lectures | (3) Online classes/ E-content |
| (2) Power point presentation (PPT) | (4) Assignment |

Evaluation Criteria:

- (1) Internal sessional examination
- (2) Final semester examination
- (3) Classroom seminar presentation and Viva-voce

Major 1 (DSC 2) CORE: AGRICULTURE MICROBIOLOGY

Title of paper: Agriculture Microbiology

Type: Major 2 (DSC 2) CORE

Total Credit: 04

Total hours (L/T/P): 60 Hours

Course objectives: The main objective of this paper to provide the fundamental knowledge about the soil, agricultural and Microbes. Understand microbial interactions with plants.

Course learning outcome: The student at the completion of the course will be able to:

1. Fundamental knowledge about the soil, agricultural and Microbes.
2. Understand microbial interactions among themselves and with higher plants.
3. Knowledge about the diverse microbial populations in various natural habitats like soil, air, water.
4. Sound knowledge about crops suitable for agro-climatic zones.

Sr. No.	Unit No.	Syllabus Content	Hours (L/T/P)
1.	Unit-I	Soil as an environment for microorganisms. Classification of soil: physico chemical and microbial properties. Soil conservation, erosion and its management. Soil pollution. Microbial interactions - mutualism, commensalism, amensalism, synergism, parasitism, predation and competition.	12L/2T
2.	Unit-II	Soil microbial diversity: bacteria, fungi and actinomycetes. Rhizospheric microflora, Mycorrhizae: classification and their economic importance. PGPR and their application, Biodiversity conservation, Green house effect and global warming.	12L/2T
3.	Unit-III	Biofertilizers: types, production and applications, Vermicomposting, Integrated pest management. Bioinsecticides – viral, bacterial and fungal. . Roles of microbes in biogeochemical cycles – carbon, nitrogen, phosphorus, sulphur. Biochemistry and genetics of Nitrogen Fixation and nodule formation, Microbial transformations.	8L/2T
4.	Unit-IV	Cropping patterns in different agro-climatic zones of the country. Microbial diseases of agricultural crops -pathogens, symptoms and control measures with reference to paddy, wheat, maize, citrus and potato. Plant protection – phenolics – phytoalexins and related compounds.	10L/2T
5.	Unit-V	Secondary metabolites: Mycotoxins, Classification of Mushroom and their cultivation techniques, Composting, transgenic crops, Agricultural price policy and crop Insurance.	8L/2T

List of Reference Books

1. Atlas, R.A. and Bartha, R. 2000. Microbial Ecology, Fundamentals and Application, Benjamin Cummings, New York.
2. Alexander M. 1997. Introduction to soil microbiology, John Wiley & Sons, Inc, New York.
3. SubbaRao, N.S. 1995. Soil Microorganisms and Plant Growth, Third Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
4. Dubey, R.C. and Maheswari, D.K. 2013. A text book of Microbiology, Revised S. Chand and Company Ltd, NewDelhi.

Teaching Methodology

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|------------------------------------|-------------------------------|
| (1) Classroom lectures | (3) Online classes/ E-content |
| (2) Power point presentation (PPT) | (4) Assignment |

Evaluation Criteria:

- (1) Internal sessional examination
- (2) Classroom seminar presentation and Viva-voce
- (3) Final semester examination

Major 3 (DSC 3): INDUSTRIAL BIOPROCESS TECHNOLOGY

Title of paper: Industrial Bioprocess Technology

Type: Major 3 (DSC 3) CORE

Total Credit: 04

Total hours (L/T/P): 60 Hours

Course objectives:

1. The purpose of this course is to teach students about applying biotechnology to industrial process
2. To teach the basic principles of processing of bioproducts
3. To expose students to relevant advancement in industrial Bioprocess technology

Course learning outcome:

- 1: Student can appreciate the relevance of microorganisms and have a better understanding to industrial context
- 2: Students will learn the design and operations of various bioreactors and downstream processing
- 3: Student will be able to apply gene manipulation technique to industrially important microorganisms

Sr. No.	Unit No.	Syllabus Content	Hours (L/T/P)
1.	Unit-I	Scope and history of industrial microbiology. Isolation, Maintenance and Preservation of industrial strains. Screening and Methods of strain improvement (mutagenesis, strain protoplast fusion etc) of industrial important strains.	8L/2T
2.	Unit-II	Composition of typical Fermentation media. Inoculum Preparation. Medium sterilization, design of a batch and continuous sterilization processes, holding time, Scale up of sterilization	8L/2T
3.	Unit-III	Fermenter design body construction Basic concepts of fermenter-batch, continuous, fed batch, packed bed, bubble column, trickle, plug flow reactors. Fermentations-Submerged and solid state, fluidized bed	8L/2T
4.	Unit-IV	Downstream Processing: Cell disintegration: Physical, chemical and Enzymatic Methods. Removal of microbial cells and other solid matter, foam separation, precipitation, filtration, centrifugation, Liquid- liquid extraction, drying and crystallization.	8L/2T
5.	Unit-V	Industrial production of Penicillin and Streptomycin. Production of Amylase and Protease enzyme. Industrial production of Lysine, Glutamic acid and Single Cell Protein (SCP).	8L/2T
6.	Unit VI	Industrial production of Vitamin B12 and Riboflavin. Industrial production of organic acids: Lactic acid and Citric acid. Industrial production of Vinegar, alcohol and alcoholic beverages (Beer and Wine).	8L/2T

List of Reference Books

1. Principles of fermentation Technology by Stanbury PF, Whitaker A and Hall SJ. (2006).
2. Industrial Microbiology by Casida LE. (1991). 1st edition. Wiley Eastern Limited.
3. Biotechnology - A text book of Industrial Microbiology WulfCrueger&AnnelieseCrueger.
4. Prescott and Dunn's Industrial Microbiology by Reed, G, CBS Publishers & Distributors.
5. Industrial Microbiology: An introduction by Waites, MJ, Morgan, NL, Rockey, JS, Higton, G, Edition .1st, Wiley-Blackwell.

Teaching Methodology

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|------------------------------------|-------------------------------|
| (1) Classroom lectures | (2) Online classes/ E-content |
| (3) Power point presentation (PPT) | (4) Assignment |

Evaluation Criteria:

- (1) Internal sessional examination
- (2) Final semester examination
- (3) Classroom seminar presentation and Viva-voce

Major 4 (DSC 4): MICROBIAL ECOLOGY

Title of paper: Microbial Ecology

Type: Major 4 (DSC 4)

Total Credit: 04

Total hours (L/T/P): 60 Hours

Course objectives: The course introduces the fundamental and important concepts of Microbial Ecology.

Course learning outcome: On successful completion of the course, students will be able to

1. Be acquainted with the historical account and development of microbial ecology as a scientific discipline.
2. Gain knowledge on earth origin and generation of microbial diversity.
3. Gain knowledge on interactions of microbial populations.
4. Gain knowledge about Biogeochemical Cycling and some important microbial activities such as Bioremediation, Microbial Methylations, and Biofertilizers.
5. Acquire in depth knowledge on Ecosystem and Biosphere and associated terminology.
6. Learn and gain skills on bacteriological media, bacterial cultivation and Characterization of Microbial Communities.

Sr. No.	Unit No.	Syllabus Content	Hours (L/T/P)
1.	Unit1	Historical developments and the significance of microbial ecology, A brief history of Earth origin, Chemical and Cellular evolution; Microbial Adaptations and Diversification.	8L/2T
2.	Unit 2	Interactions among Microbial Populations (Neutralism, Commensalism, Mutualism, Amensalism, Symbiosis, Competition, Parasitism and Predation); Interactions between Microorganisms and Plants (Rhizosphere and Mycorrhizae, Nodulation and Nitrogen fixation)	10L/2T
3.	Unit3	Biogeochemical Cycling (Nitrogen, Carbon, Phosphorus and Sulphur); Microbes in Action (Bioremediation, Microbial Methylations, and Biofertilizers)	12L/2T
4.	Unit 4	Basic concept of Ecosystem and Biosphere, Habitat and Niche, Population growth, Food chain- Food web and Energy flow; Microbial Diversity, Alpha and Beta Diversity, Microbial Communities and Community Dynamics, Succession.	12L/2T
5.	Unit 5	Concept of Culturability, Determination of Total and Viable Microbial Number, Biomass and Activity; Characterization of Microbial Communities: (Culture-based methods, PCR, Molecular Fingerprints, FISH and General Idea of Sequencing)	8L/2T

List of Reference Books

1. Environmental Microbiology by Maier, RM, Pepper, IL, Gerba, CP, Edition 2nd Academic Press.
2. Microbial Ecology: Fundamentals & Applications by Atlas RM and Bartha R. Benjamin/Cummings Science Publishing, USA.
3. Principles of Microbial Ecology by Brock, TD, Edition 3rd, Prentice-Hall.
4. Microbiology of Extremes Environments by Edward, C, McGraw Hill, New York.
5. A text book of Ecology and Environment by P D Sharma.

Teaching Methodology

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|------------------------------------|-------------------------------|
| (1) Classroom lectures | (2) Online classes/ E-content |
| (3) Power point presentation (PPT) | (4) Assignment |

Evaluation Criteria:

- (1) Internal sessional examination
- (2) Final semester examination
- (3) Classroom seminar presentation and Viva-voce

Title of paper: DSC Practical I/ Lab course
Total Credit: 02

Type: DSC Practical I CORE
Total hours (Hrs): L/T/P (0 Hrs. / 0 Hrs. /60 Hrs)

List of Practical	Hours
<ol style="list-style-type: none">1. Physico chemical properties of soil.2. Preparation of different agar and other media required for agriculturally important microorganisms.3. Isolation & identification of Plant growth promoting Rhizobacteria (PGPR).4. Staining and slant preparation of microbial strains.5. Isolation and identification of coliforms from water by presumptive, confirmed & completed test.6. Effect of pH, Temperature, Substrates, Inhibitor on enzyme activity.7. Enzyme kinetics – Km, Vmax, Specific activity and activity determination.8. To determine the amylase activity.	60 hours

List of Reference Books

1. Enzyme Assays: A practical approach. Eisenthal and Danson
2. Fundamental Agricultural Microbiology by K.R. Aneja
3. Dubey, R.C and Maheshwari, D.K., A Text Book of Microbiology, S. Chand Publications, New Delhi
4. SubbaRao, N.S. 1995. Soil Microorganisms and Plant Growth, Third Edition, Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi.
5. Singh A, Kuhad, RC & Ward OP (2009). Advances in Applied Bioremediation. Volume 17, Springer-Verlag, Berlin Hedeilberg.
6. S. K. Sawhney, Randhir Singh, Introductory Practical Biochemistry, 2000, Narosa.

Methodology for practical/experiment

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| (1) Laboratory assignment | (3) Laboratory practical / experiments |
| (2) Power point presentation (PPT) | (4) Practical record preparation |

Evaluation Criteria:

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| (1) Internal assignment | (3) Evaluation of practical record |
| (2) Final semester practical examination | |

Title of paper: DSC Practical II/ Lab course
Total Credit: 02

Type: DSC Practical II CORE
Total hours (Hrs) (L/T/P): (0 Hrs. / 0 Hrs. /60 Hrs)

List of Practical	Hours
<ol style="list-style-type: none">1. Ethanol/ Citric acid production.2. Isolation of antibiotic producing organism.3. Isolation of antibiotic producing microorganisms from soil.4. Antibiotic sensitivity test.5. Isolation of yeast from grape samples.6. Isolation of lactic acid bacteria from curd.7. Isolation of nitrogen fixing bacteria.8. Microbial activity measurement from soil sample.	60 Hours

List of Reference Books

1. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited
2. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International
3. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
4. Principles of Microbial Ecology by Brock, TD, Edition 3rd, Prentice-Hall
5. Aneja K.R., Experiments in Microbiology, plant pathology, Tissue culture and Mushroom Cultiation, New Age International, New Delhi.
6. Dubey R.C. and Maheshwari D.K., Textbook of practical microbiology, S Chand Publications.

Methodology for practical/experiment

- (1) Laboratory assignment
- (2) Power point presentation (PPT)
- (3) Laboratory practical / experiments
- (4) Practical record preparation

Evaluation Criteria:

- (1) Internal assignment
- (2) Evaluation of practical record
- (3) Final semester practical examination

Note:

1. After completion of Second year "MASTER OF SCIENCE IN MICROBIOLOGY" will be awarded.