JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
INSTITUTE OF SCIENCE & TECHNOLOGY
(AUTONOMOUS)
Kukatpally, Hyderabad – 500 085

ACADEMIC REGULATIONS 2021-22

For CBCS Based M.Sc. (Regular/Full Time) Programmes

(Effective for the students admitted into I year from the Academic Year **2021-22** and onwards)

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JNTUH offers 2 Year (4 Semesters) full-time Master of Science (M.Sc) degree Programmes, under Choice Based Credit System (CBCS) at its Autonomous Institute – Institute of Science & Technology with effect from the Academic Year 2021-22 onwards in the different branches of Science & Technology with different specializations.

1. ELIGIBILITY FOR ADMISSIONS:

Admissions to the PGPs shall be made subject to the eligibility, qualification and specializations prescribed by JNTUH Institute of Science & Technology, JNT University Hyderabad, for each Specialization under each M.Sc. Programme, from time to time.

Admission to the PGP shall be made on the basis of the Merit Rank obtained by the qualifying candidate at state level Common Post Graduate Entrance Tests (CPGET) conducted by Telangana State Government / on the basis of any other order of merit approved by the Telangana State Government, subject to reservations as prescribed by the Government from time to time.

The medium of instructions for all PG Programmes will be ENGLISH only.

2 M.Sc Programme Structure:

2.1 The **M.Sc** Programmes in Sciences of JNTUH-IST are of Semester Pattern, with 4Semesters constituting 2 Academic Years, each Academic Year having TWO Semesters (First/Odd and Second/Even Semesters). Each Semester shall be of 22 Weeks duration (inclusive of Examinations), with a minimum of 90 Instructional Days per Semester.

2.2. ***Semester Scheme:*** Each Semester having - 'Continuous Internal Evaluation (CIE)' and 'Semester End Examination (SEE)'. Choice Based Credit System (CBCS) and Credit Based Semester System (CBSS) as denoted are taken as 'references' for the present set of Regulations. The terms 'SUBJECT' or 'COURSE' imply the same meaning here, and refer to 'Theory Subject', or 'Lab Course', or 'Seminar', 'Project', as the case may be.

2.3. ***Credit Courses:*** All Subjects (or Courses) are to be registered by a student in a Semester to earn Credits. Credits shall be assigned to each Subject/ Course in a L: T: P: C (Lecture Periods: Tutorial Periods: Practical Periods: Credits) Structure, based on the following general pattern.

- One credit for One hour/ Week/ Semester for Theory/ Lecture (L) Courses; and,
- One credit for Two hours/ Week/ Semester for Laboratory/ Practical (P) Courses or Tutorials (T).

2.4. ***Subject/ Course Classification:*** The Institute has followed the guidelines issued by UGC. All Subjects/Courses offered for the PGP are broadly classified as Program Core, Program Elective, Open Elective, Seminar, Industrial Training and Dissertation.

2.5. ***Course Nomenclature:***

The Curriculum Nomenclature or Course-Structure Grouping for the M.Sc. Degree Programmes is as listed below …

S. No.	*Broad Course Classification*	*Course Group/ Category*	*Courses Description*
1.	Core Courses (CoC)	PC- Program Core	Includes core subjects related to the Parent Discipline/ Department/ Branch of Science.
		Dissertation	M.Sc Project or PG Project or PG Major Project
		Seminar	Seminar based on core contents related to parent discipline/department/branch
2	Elective Courses (EC)	PE– Program Electives	Includes Elective subjects related to the Parent Discipline/ Department/ Branch of Science.
		OE-Open Electives	Elective subjects which include inter-disciplinary subjects in an area outside the parent discipline/department/branch of Science.

3.0 Courses of Study:

The following specializations are offered at present for the M. Sc course of study.

1. Biotechnology
2. Microbiology
3. Organic Chemistry
4. Analytical Chemistry
5. Environmental Science and Technology

Departments offering M.Sc Programmes with specializations are mentioned below:

CENTRE FOR BIOTECHNOLOGY	Biotechnology Microbiology
CENTRE FOR CHEMICAL SCIENCE AND TECHNOLOGY	Organic Chemistry Analytical Chemistry

CENTRE FOR ENVIRONMENT	Environmental Science and Technology

3.1. Course Work:

- A student shall be declared eligible for the award of the M.Sc degree, if he/she pursues a course of study and completes it successfully in a minimum period of 2 academic years (4 Semesters)and within a maximum period of4 academic years (starting from the Date of Commencement of I Year I Semester).

- A student, who fails to fulfill all the academic requirements for the award of the degree within four academic years from the year of his/her admission, shall forfeit his seat in M.Sc course.

- The student shall register for all 96 credits and secure all the 96 credits.

- In order to qualify for the award of the Post-Graduate Degree, the candidate shall earn all the prescribed credits, as per the course structure.

4.0 Course Registration:

Student Advisor*: The Department in which the student gets admitted shall appoint an Advisor for him/her from amongst the members of the faculty concerned. All faculty members of the department shall function as Student Advisors and shall have more or less equal number of students. The Student Advisor shall advise the student in choosing courses and render all possible support and guidance to him/her.*

4.1 Course Registration:

a. The registration for courses shall be the sole responsibility of the student. No student shall be allowed to do a course without registration, and no student shall been titled to any credits in the course, unless he/she has been registered for the course by the scheduled date fixed by the Institute.

b. Every student has to register in each semester (in consultation with his/her Student Advisor)

c. For the courses he/she intends to undergo in that semester by applying in the prescribed proforma in triplicate, duly signed by him/ her. The Student Advisor and the Head of the department within the deadline notified for the purpose by the Institute.

d. Late Registration may be permitted by the Head/In charge of the Department up to a maximum of six weeks after the commencement of the semester, on payment of late fee.

e. As student shall register for a minimum of 26 credits in I semester in I year of M.Sc course. For II semester in I year and III semester in II year a student shall register for a minimum of 28 credits and In IV semester of II year (Comprehensive Viva Voce

and Project work)14 credits (subject to 96 credits throughout the duration of the two year PG programme), unless specified otherwise by the University for a programme of study/course

f. No Withdrawal from a course may be permitted up to two weeks from the date of registration, provided the courses registered after withdrawal shall enable the student to earn a minimum credits. Withdrawal from a course may not be allowed for those who had late registration.

g. A student may be allowed by the Head/ Incharge of the Department and OIE of the Institute to add a course or substitute a course for another course of the same type (elective).For valid reasons with the consent of the Student Advisor not later than two weeks from the date of commencement of the semester.

h. If a student registers himself/herself for more elective courses than the prescribed in the programme, while calculating the Semester/Cumulative Grade Point Average, only the prescribed number of elective courses for the programme of study shall be included in the descending order of the grades obtained by him/her.

i. The elective courses opted and registered by the student either from parent or other department and attempted in the end semester examination shall have to be qualified. Such elective courses shall not be replaced. However, a student shall have the option of choosing an elective course from other departments irrespective of the semester in which the course is offered. For example; a student of odd/even Semester can opt an elective course of other department offered in any odd/even semester respectively.

5.0 ATTENDANCE

5.1 Attendance in all classes (Lectures/Laboratories etc.) is compulsory. The minimum required attendance in each theory / Laboratory etc. is 75% including the days of attendance in sports, games, NCC and NSS activities for appearing for the End Semester examination. A student shall not be permitted to appear for the Semester End Examinations (SEE) if his attendance is less than 75%.

5.2 Condonation of shortage of attendance in each subject up to 10% (65% and above and below 75%) in each semester shall be granted by the IST Academic Committee on Medical grounds, based on the Student's representation with supporting evidence to be submitted by the student as and when such requirement arise but not at the end semester.

5.3 Shortage of Attendance below 65% in each subject shall not be condoned. Students whose shortage of attendance is not condoned in any subject are not eligible to write their end semester examination of that subject and their registration shall stand cancelled.

5.5 A prescribed fee shall be payable towards condonation of shortage of attendance.

5.6 A Student, whose shortage of attendance is not condoned in any Subject(s), Lab in any Semester, is considered as 'Detained in that Subject(s), Lab and is not eligible to write Semester End Examination (s) of such Subject(s), Lab (his/her Seminar Report or

Presentation are not eligible for evaluation) in that Semester; and he/she has to seek Re-registration for those Subject(s), Lab in subsequent Semesters, and attend the same as and when offered.

A student fulfilling the attendance requirement in the present semester shall not be eligible for readmission into the same class.

6 Evaluations - Distribution and Weightage of Marks:

The performance of the candidate in each semester shall be evaluated subject-wise, with a maximum of 100 marks for theory and 100 marks for practicals, on the basis of Internal Evaluation and End Semester Examination.

6.1 For the theory subjects 70 marks shall be awarded for the performance in the Semester End Examination (SEE) and 30 marks shall be awarded for Continuous Internal Evaluation (CIE) (25 mid exam and 5 for assignment). The Continuous Internal Evaluation shall be made based on average of marks secured in the two Mid Term-Examinations conducted, one in the middle of the Semester and the other, immediately after the completion of Semester instructions. Each mid-term examination shall be conducted for a total duration of 120 minutes.

6.2 For practical subjects, 70 marks shall be awarded for performance in the Semester End Examinations (SEE) and 30 marks shall be awarded based on mid exams (15 Marks) &day-to-day (15 marks) performance as internal marks.

6.3 For conducting laboratory end examinations of all PG Programmes, one internal examiner and one expert are to be proposed by the HOD and appointed by the Director.

6.4 There shall be one seminar presentation during II Semester & III semester. For seminar, a student under the supervision of a faculty member, shall collect the literature on a topic and critically review the literature and submit it to the department in a report form and shall make an oral presentation before the Departmental Academic Committee consisting of Head of the Department, Supervisor and One expert nominated by Director (Minimum Three member committee). For Seminar there will be only external evaluation of 50 marks. A candidate has to secure a minimum of 50% of marks to be declared successful. If he fails to fulfill minimum marks, he has to re appear during the supplementary examinations.

6.5 There shall be a Comprehensive Viva-Voce in II year IV Semester. The Comprehensive Viva-Voce is intended to assess the students' understanding of various subjects he has studied during the M.Sc. course of study. The Head of the Department shall be associated with the conduct of the Comprehensive Viva-Voce through a Committee. The Committee consisting of Head of the Department, one senior faculty member and an external examiner. For this, the Head shall submit a panel of 3 examiners. The external examiner shall be appointed by the Director forEvaluation. There are no internal marks for the Comprehensive Viva and evaluates for maximum of 100 marks. A candidate has to secure a minimum of 50% of marks to be declared successful. If he/she fails to fulfill minimum marks, he has to reappear during the supplementary examinations.

6.6 A candidate shall be deemed to have secured the minimum academic requirement in a subject if he secures a minimum of 40% (28 marks out of 70 marks) of marks in the Semester End Examination (SEE) and a minimum aggregate of 50% of the total marks in the Semester End Examination (SEE) and Continuous Internal Evaluation (CIE) taken together.

6.7 In case the candidate does not secure the minimum **academic requirement** in any subject (as specified in 6 .6) he has to reappear for the Semester End Examination in that subject.

6.8 A candidate shall be given one chance to re-register for the subjects if the internal marks secured by a candidate is less than 50% and failed in that subject for maximum of two subjects and should register within two weeks of commencement of the class work. In such a case, the candidate must re-register for the subject's and secure the required minimum attendance. The candidate's attendance in the reregistered subject(s) shall be calculated separately to decide upon his eligibility for writing the Semester End Examination in those subjects. In the event of the student taking another chance, his Continuous Internal Evaluation (internal) marks and Semester End Examination marks obtained in the previous attempt stands cancelled.

6.9 In case the candidate secures less than the required attendance in any subject, he shall not be permitted to write the Semester End Examination in that subject. He shall reregister for the subject when next offered.

7 Examinations and Assessment - The Grading System

7.1 Marks will be awarded to indicate the performance of each student in each Theory Subject, or Lab / Practicals, or Seminar, or Project, etc., based on the % marks obtained in CIE + SEE (Continuous Internal Evaluation + Semester End Examination, both taken together) as specified in Item 6 above, and a corresponding Letter Grade shall be given.

7.2 As a measure of the student's performance, a 10-point Absolute Grading System using the following Letter Grades (UGC Guidelines) and corresponding percentage of marks shall be followed:

% of Marks Secured in a subject/Course(Class Intervals)	*Letter Grade (UGC Guidelines)*	*Grade Points*
Greater than or equal to 90%	*O (Outstanding)*	*10*
□ *80 and less than 90%*	*A+ (Excellent)*	*9*
□ *70% and less than 80%*	*A (Very Good)*	*8*

□ *60% and less than 70%*	*B+ (Good)*	*7*
□ *50% and less than 60%*	*B (Above Average)*	*6*
Below 50%	*F (FAIL)*	*0*
Absent	***Ab***	***0***

7.3 A student obtaining F Grade in any Subject shall be considered 'failed' and is be required to reappear as 'Supplementary Candidate' in the Semester End Examination (SEE), as and when offered. In such cases, his Internal Marks (CIE Marks) in those Subjects will remain the same as those he obtained earlier.

7.4 A student not appeared for examination then 'Ab' Grade will be allocated in any Subject shall be considered 'failed' and will be required to reappear as 'Supplementary Candidate' in the Semester End Examination (SEE), as and when offered.

7.5 A Letter Grade does not imply any specific Marks percentage and it will be the range of marks percentage.

7.6 In general, a student shall not be permitted to repeat any Subject/ Course (s) only for the sake of 'Grade Improvement' or 'SGPA/ CGPA Improvement'.

7.7 A student earns Grade Point (GP) in each Subject/ Course, on the basis of the Letter Grade obtained by him in that Subject/ Course. The corresponding 'Credit Points' (CP) are computed by multiplying the Grade Point with Credits for that particular Subject/ Course.

Credit Points (CP) = Grade Point (GP) x Credits …. For a Course

7.8 The Student passes the Subject/ Course only when he **gets GP ≥6 (B Grade or above).**

7.9 The Semester Grade Point Average (SGPA) is calculated by dividing the Sum of Credit Points (ΣCP) secured from ALL Subjects/ Courses registered in a Semester, by the Total Number of Credits registered during that Semester. SGPA is rounded off to TWO Decimal Places. SGPA is thus computed as

$$\text{SGPA} = \{ \sum_{i=1}^{N} C_i G_i \} / \{ \sum_{i=1}^{N} C_i \} \text{ .... For each Semester,}$$

where 'i' is the Subject indicator index (takes into account all Subjects in a Semester), 'N'is the no. of Subjects 'REGISTERED' for the Semester (as specifically required and listedunder the Course Structure of the parent Department), C_i is the no. of Credits allottedto the i^{th} Subject, and G_i represents the Grade Points (GP) corresponding to the LetterGrade awarded for that ith Subject.

7.10 The Cumulative Grade Point Average (CGPA) is a measure of the overall cumulative performance of a student over all Semesters considered for registration. The CGPA is the ratio of the Total Credit Points secured by a student in ALL registered Courses in ALL Semesters, and the Total Number of Credits registered in ALL the Semesters. CGPA is

rounded off to TWO Decimal Places. CGPA is thus computed from the I Year Second Semester onwards, at the end of each Semester, as per the formula

$$\text{CGPA} = \{ \sum_{j=1}^{M} C_j G_j \} / \{ \sum_{j=1}^{M} C_j \} \text{ ... for all S Semesters registered}$$

(ie., upto and inclusive of S Semesters, S ≥2),

where 'M' is the TOTAL no. of Subjects (as specifically required and listed under the Course Structure of the parent Department) the Student has 'REGISTERED' from the 1st Semester onwards upto and inclusive of the Semester S (obviously M > N), 'j' is the Subject indicator index (takes into account all Subjects from 1 to S Semesters), C_j is the no. of Credits allotted to the j^{th} Subject, and G_j represents the Grade Points (GP)corresponding to the Letter Grade awarded for that j^{th} Subject. After registration and completion of I Year I Semester however, the SGPA of that Semester itself may be taken as the CGPA, as there are no cumulative effects.

7.11 For Calculations listed in Item 7.6 – 7.10, performance in failed Subjects/ Courses (securing F Grade) will also be taken into account, and the Credits of such Subjects/ Courses will also be included in the multiplications and summations.

8 EVALUATION OF DISSERTATION WORK:

Every candidate shall be required to submit thesis or dissertation after taking up a topic approved by the Project Review Committee.

8.1 A Project Review Committee (PRC) shall not be less than 3 members and constituted with HOD as chairperson, project supervisor and one senior faculty member of the department offering the M.Sc programme. In case HOD is a supervisor then one more senior faculty member will be included in the committee to maintain not less than 3 members.

8.2 Registration of Project Work: A candidate is permitted to register for the project work after satisfying the attendance requirement of all the subjects (theory and practical subjects).

8.3 After satisfying 8.2, a candidate has to submit, in consultation with his /her project supervisor, the title, objective and plan of action of his project work to the project work review committee for its approval within two weeks from the commencement second year fourth semester. Only after obtaining the approval of Project Review Committee the student can initiate the Project work.

8.4 If a candidate wishes to change his supervisor or topic of the project he/she can do so with the approval of the Project Review Committee. However, the Project Review Committee shall examine whether the change of topic/supervisor leads to a major change of his/her initial plans of project proposal. If so, his/her date of registration for the project work starts from the date of change of Supervisor or topic as the case may be.

8.5 A candidate shall present his project work to the committee consisting of Supervisor and one senior faculty proposed by Head of the department, after three months from the date of approval of the abstract by committee. This project work review will be evaluated for 50 internal marks.

8.6 The work on the project shall be initiated in the beginning of the IV semester and the duration of the project is for one semester. A candidate is permitted to submit Project thesis only after successful completion of theory and practical course with the approval of PRC not earlier than 20 weeks from the date of registration of the project work. For the approval of PRC the candidate shall submit the draft copy of the thesis to the HOD for PRC approval.

8.7 After approval from the PRC, a soft copy of the thesis should be submitted to the Head of the Department for the ANTIPLAGIARISM check and the Head of the Department submitted the plagiarism report to the Director of the Institute. The Dissertation will be accepted for submission, if the similarity index is less than 30%. If the similarity index has more than the required percentage, the student is advised to modify accordingly and re- submit the soft copy of the Dissertation after one month. Plagiarism check for the thesis may be given 3 chances for the student on regular basis. If the student cannot clear in 3 Chances, the student can appeal to the director for the 4th chance wherein, based on merit of the work, the director has discretion to grant one more chance for plagiarism check. If the student fails to clear plagiarism check granted by the director, the matter may be referred to the academic council for further action on the plagiarism check to grant one more chance or not. If he fails in all the attempts the student has to Re-Register with the academic batch.

8.8 Three copies of the Project Thesis certified by the supervisor shall be submitted to the Institute.

8.9 Three copies of the Project Thesis certified by the supervisor shall be submitted to the College/School/Institute, after submission of a research paper related to the project work in a UGC approved journal. A copy of the submitted research paper shall be attached to thesis.

8.10 The thesis shall be adjudicated by an external examiner selected by the IST, Director. For this, the Head of the Department (HOD) shall submit a panel of three examiners from among the list of experts in the relevant specialization as submitted by the Supervisor.

8.11 If the report of the examiners is not favorable, the candidate shall revise and resubmit the thesis, in the time frame as described by Project evaluation committee consisting of both internal and external examiners. If the report of the examiner is unfavorable again, the thesis shall be summarily rejected.

8.12 If the report of the examiner is satisfactory, the Head of the Department shall coordinate and make arrangements for the conduct of Project Viva- Voce examination. The Project Viva-Voce examination shall be conducted by a board consisting of the Supervisor, Head of the Department and the external examiner who adjudicated the Thesis. The candidate thesis shall be evaluated for 100 marks and marks secured out of 100 shall be reported in the report of the examiners. The candidate has to secure a minimum of 50% of marks in Project Evaluation (Viva-Voce) examination.

8.13 If the report of the viva-voce is unsatisfactory, the candidate will retake the viva-voce

examination after one month. If he fails to get a satisfactory report at the second viva-voce examination, he will not be eligible for the award of the degree.

9 AWARD OF DEGREE AND CLASS

After a student has satisfied the requirements prescribed for the completion of the programmes and is eligible for the award of M. Sc. Degree he shall be placed in one of the following three classes based on CGPA:

Class Awarded	% of marks to be secured
First Class with Distinction	≥ 7.75
First Class	$6.75 \leq$ CGPA < 7.75
Second Class	$6.00 \leq$ CGPA < 6.75

A student with final CGPA (at the end of the PGP) < 6.00 will not be eligible for the Award of Degree.

10 WITH-HOLDING OF RESULTS:

If the candidate has not paid any dues to the university or if any case of in-discipline is pending against him, the result of the candidate will be withheld and he will not be allowed into the next higher semester. The issue of the degree is liable to be withheld in such cases.

11 TRANSITORY REGULATIONS:

Candidate who have discontinued or have been detained for want of attendance or who have failed after having undergone the course are eligible for admission to the same or equivalent subjects as and when subjects are offered, subject to 5.5 and 2.0

MALPRACTICES RULES
DISCIPLINARY ACTION FOR IMPROPER CONDUCT IN EXAMINATIONS

	Nature of Malpractices/Improper conduct	Punishment
	If the candidate:	
1. (a)	Possesses or keeps accessible in examination hall, any paper, note book, programmable calculators, Cell phones, pager, palm computers or any other form of material concerned with or related to the subject of the examination (theory or practical) in which he is appearing but has not made use of (material shall include any marks on the body of the candidate which can be used as an aid in the	Expulsion from the examination hall and cancellation of the performance in that subject only.

(b)	Gives assistance or guidance or receives it from any other candidate orally or by any other body language methods or communicates through cell phones with any candidate or persons in or outside the exam hall in respect of any matter.	Expulsion from the examination hall and cancellation of the performance in that subject only of all the candidates involved. In case of an outsider, he will be handed over to the police and a case is registered against him.
2.	Has copied in the examination hall from any paper, book, programmable calculators, palm computers or any other form of material relevant to the subject of the examination (theory or practical) in which the candidate is appearing.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted to appear for the remaining examinations of the subjects of that Semester/year. The Hall Ticket of the candidate is to be cancelled and sent to the University.
3.	Impersonates any other candidate in connection with the examination.	The candidate who has impersonated shall be expelled from examination hall. The candidate is also debarred and forfeits the seat. The performance of the original candidate, who has been impersonated, shall be cancelled in all the subjects of the examination (including practicals and project work) already appeared and shall not be allowed to appear for examinations of the remaining subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat. If the imposter is an outsider, he will be handed over to the police and a case is registered against him.
4.	Smuggles in the Answer book or additional sheet or takes out or arranges to send out the question paper during the examination or answer book or additional sheet, during or after the examination.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class-work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.

5.	Uses objectionable, abusive or offensive language in the answer paper or in letters to the examiners or writes to the examiner requesting him to award pass marks.	Cancellation of the performance in that subject.
6.	Refuses to obey the orders of the Chief Superintendent/Assistant – Superintendent / any officer on duty or misbehaves or creates disturbance of any kind in and around the examination hall or organizes a walk out or instigates others to walk out, or threatens the officer-in charge or any person on duty in or outside the examination hall of any injury to his person or to any of his relations whether by words, either spoken or written or by signs or by visible representation, assaults the officer-in-charge, or any person on duty in or outside the examination hall or any of his relations, or indulges in any other act of misconduct or mischief which result in damage to or destruction of property in the examination hall or any part of the College campus or engages in any other act which in the opinion of the officer on duty amounts to use of unfair means or misconduct or has the tendency to disrupt the orderly conduct of the examination.	In case of students of the college, they shall be expelled from examination halls and cancellation of their performance in that subject and all other subjects the candidate(s) has (have) already appeared and shall not be permitted to appear for the remaining examinations of the subjects of that semester/year. The candidates also are debarred and forfeit their seats. In case of outsiders, they will be handed over to the police and a police case is registered against them.
7.	Leaves the exam hall taking away answer script or intentionally tears of the script or any part thereof inside or outside the examination hall.	Expulsion from the examination hall and cancellation of performance in that subject and all the other subjects the candidate has already appeared including practical examinations and project-work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred for two consecutive semesters from class-work and all University examinations. The continuation of the course by the candidate is subject to the academic regulations in connection with forfeiture of seat.
8.	Possess any lethal weapon or firearm in the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project-work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat.

9.	If student of the college, who is not a candidate for the particular examination or any person not connected with the college indulges in any malpractice or improper conduct mentioned in clause 6 to 8.	Student of the colleges expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project-work and shall not be permitted for the remaining examinations of the subjects of that semester/year. The candidate is also debarred and forfeits the seat. Person(s) who do not belong to the College will be handed over to police and, a police case will be registered against them.
10.	Comes in a drunken condition to the examination hall.	Expulsion from the examination hall and cancellation of the performance in that subject and all other subjects the candidate has already appeared including practical examinations and project-work and shall not be permitted for the remaining examinations of the subjects of that semester/year.
11.	Copying detected on the basis of internal evidence, such as, during valuation or during special scrutiny.	Cancellation of the performance in that subject and all other subjects the candidate has appeared including practical examinations and project work of that semester/year examinations.
12.	If any malpractice is detected which is not covered in the above clauses 1 to 11 shall be reported to the University for further action to award suitable punishment.	

GENERAL:

- **Credit**: A unit by which the course work is measured. It determines the number of hours

of instructions required per week. One credit is equivalent to one hour of teaching (lecture or tutorial) or two hours of practical work/field work per week.

- **Credit Point:** It is the product of grade point and number of credits for a course.

- The Academic Regulations should be read as a whole for the purpose of any interpretation.

- The University/Institute reserves the right of altering the Academic Regulations and/or

Syllabus/Course Structure, as and when necessary. The modifications or amendments may be applicable to all the candidates on rolls, as specified by the University/Institute.

- Wherever the words ‘he’ or ‘him’ or ‘his’ occur in the above regulations, they will also

include ‘she’ or ‘her’ or ‘hers’.

- Wherever the word ‘Subject’ occurs in the above regulations, it implies the ‘Theory Subject’, ‘Practical Subject’ or ‘Lab.’ and ‘Seminar’.

- **In case of any ambiguity/ contradictory in the interpretations of the above regulations, the decision of the Director/ through resolution by the academic council will be the final.**

CENTRE FOR BIOTECHNOLOGY
INSTITUTE OF SCIENCE AND TECHNOLOGY
JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
Kukatpally, Hyderabad-500 085, Telangana State, India

Master of Science in MICROBIOLOGY

(FTPG)

COURSE STRUCTURE & DETAILED SYLLABUS W.E.F.2021

EACH SEMESTER IS APPROXIMATELY 20-21 WEEKS DURATION INCLUDING EXAMINATIONS. EACH PERIOD IS ABOUT 50 MINITUES DURATION. THERE WILL BE NORMALLY FOUR SESSIONS PER DAY EACH OF ABOUT 100 MINITUES DURATION. TWO SESSIONS OF LABORATORY IS EQUIVALENT TO ONE SESSION OF THEORY

Centre for Biotechnology (CBT)
M.Sc MICROBIOLOGY
Course Structure

Semester I

Subject Code	I semester	Course Title	Int. Marks	Ext. Marks	L	P	C
1MBPC101	**Program Core – I**	Cell Biology	30	70	4	-	4
1MBPC102	**Program Core – II**	Microbiology	30	70	4	-	4
1MBPC103	**Program Core – III**	Microbial Biochemistry	30	70	4	-	4
1MBPE104	**Program Elective- I**	i. Microbial Genetics & Molecular Biology ii. Microbial Physiology & Metabolism	30	70	4	-	4
1MBOE105	**Open Elective -I**	i.Basic Mathematics & Biostatistics ii.Bioenterprenurship	30	70	4	-	4
1MBL106	**Lab I**	Cell Biology & Microbiology Lab	30	70	-	6	3
1MBL107	**Lab II**	Microbial Biochemistry & Microbial Genetics and Molecular Biology Lab/Microbial Physiology & Metabolism Lab	30	70	-	6	3
TOTAL			**210**	**490**	**20**	**12**	**26**

Semester II

Subject Code	II semester	Course Title	Int. Marks	Ext. Marks	L	P	C
2MBPC208	**Program Core – IV**	Bioinformatics	30	70	4	-	4
2MBPC209	**Program Core – V**	Immunotechnology	30	70	4	-	4
2MBPC210	**Program Core – VI**	Virology	30	70	4	-	4
2MBPE211	**Program Elective- II**	i.Fermentation Technology ii. Microbial Biotechnology	30	70	4	-	4
2MBOE212	**Open Elective -II**	i.Microbial Ecology & Environmental Microbiology ii.Bioethics, Biosafety & Regulatory Affairs	30	70	4	-	4
2MBL213	**Lab III**	Bioinformatics & Virology Lab	30	70	-	6	3
2MBL214	**Lab IV**	Immunotechnology & Fermentation Technology Lab/ Microbial Biotechnology lab	30	70	-	6	3
2MBS215	**Seminar**	Seminar	-	50	3	-	2
TOTAL			**210**	**540**	**23**	**12**	**28**

Semester III

Subject Code	III semester	Course Title	Int. Marks	Ext. Marks	L	P	C
3MBPC316	**Program Core – VII**	r-DNA Technology	30	70	4	-	4
3MBPC317	**Program Core – VIII**	Enzymology & Bioenergetics	30	70	4	-	4
3MBPC318	**Program Core – IX**	Medical Microbiology	30	70	4	-	4
3MBPE319	**Program Elective- III**	i.Bioanalytical Techniques ii.Research Methodology & Communication Skills	30	70	4	-	4
3MBOE320	**Open Elective -III**	i.Food Science & Technology ii.Pharmaceutical Microbiology	30	70	4	-	4
3MBL321	**Lab V**	r-DNA Technology & Medical Microbiology Lab	30	70	-	6	3
3MBL322	**Lab VI**	Enzymology & Bioenergetics and Bioanalytical Techniques Lab	30	70	-	6	3
3MBS323	**Seminar**	Seminar		50	3	-	2
TOTAL			**210**	**540**	**23**	**12**	**28**

Semester IV:

Subject Code	IV Semester	Int. Marks	Ext. Marks	L	P	C
4MB424	Comprehensive Viva	-	100	-	-	4
4MB425	Dissertation Work Review	50	-	-	8	2
4MB426	Dissertation Evaluation (Viva Voce)	-	100	-	16	8
TOTAL		**50**	**200**	**-**	**24**	**14**

Marks: 700+750+750+250=2450

Credits: 26+28+28+14=96

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PROGRAM CORE I

CELL BIOLOGY

Course Objective: The cell biology course provides a basic understanding of the structure and function of cellular organelles and components, and the functional interaction of the cell with its microenvironment

UNIT-I: CELL STRUCTURE AND FUNCTION: Diversity of cell size and shape; Cell theory; Structure of Prokaryotic and Eukaryotic cells; Cellular organelles and their organization, Intracellular compartmentalization– Cytosol components, pH, Endoplasmic reticulum– types and function, peroxisomes– enzymes present– photorespiration, endosomes and lysosomes– function Structure, biogenesis and functions of mitochondria Structure, biogenesis and functions of chloroplast; Extracellular matrix, Structure and function of cell wall in microbes.

UNIT-II: PLASMA MEMBRANE STRUCTURE AND FUNCTION: Chemical composition and molecular arrangement (lipid bilayer, membrane proteins and carbohydrates), models of membranes (fluid mosaic)., Membrane Transport: Active and passive transport of ions, Na+/K+ pump, ATPase pumps, Co-transport, Symport, Antiport, Endo cytosis and Exocytosis.

UNIT-III: CELL INTERACTIONS AND CYTOSKELETON: Cell adhesion molecules: cadherins, Immunoglobulin like molecules, integrins and selectins.Cell junctions: tight junction, desmosome, hemidesmosome and gap junctions. Microtubules, microfilaments and their dynamics. Centrosome, cilia, flagella. Mitotic apparatus and movement of chromosomes.

UNIT-IV: CELL CYCLE AND CHECK POINTS AND CANCER: Cell cycle- Various phases of cell cycle, Interphase, Mitosis, Meiosis and Cytokinesis Cell cycle Control & Checkpoints, Disruption in cell cycle; Cancer; Types and stages. Tumor suppressor genes and protooncogenes. Molecular basis of cancer.

UNIT-V: CELL SIGNALING, APOPTOSIS AND NECROSIS: Overview, Cytosolic, Nuclear & membrane bound receptors, Concept of Secondary messengers, cAMP, cGMP, Protein kinases, G proteins, Signal transduction mechanisms. Wnt, JAK-STAT pathways. Senescence, Necrosis– classification, morphological patterns of necrosis, causes of necrosis, Apoptosis - programmed cell death; mechanisms of apoptosis; apoptosis triggered by internal signals; apoptosis triggered by external signals; apoptosis inducing factor; apoptosis in cancer Apoptosis - programmed cell death; mechanisms of apoptosis; apoptosis triggered by internal signals; apoptosis triggered by external signals; apoptosis inducing factor; apoptosis in cancer.

COURSE OUTCOMES:

At the end of the course student will be able to

CO1. Classify organisms, understand the basic differences between prokaryotic and eukaryotic cells, structural and functional integrity of a cell.
CO2. Evaluate the transport across plasma membrane transport across the organelles.
CO3. Analyze the cellular interactions and importance of cytoskeleton.
CO4. Evaluate the molecular mechanism behind cell cycle, causes of deregulation of cell cycle and effects
CO5. Understand the molecular mechanism of cell signaling, different types receptors, different signal transduction pathways with examples, difference between apoptosis and necrosis.

TEXT BOOKS:

1. Molecular Biology of cell, Alberts. B et al.
2. Molecular Cell Biology, Lodish et al.
3. Developmental Biology, SF Gilbert, Sinauer Associates Inc.
4. Cell in Development and inheritance, EB Wilson, MacMilan, New York.
5. Developmental Biology- Scott F Gilbert.
6. Essential Developmental Biology - Jonathan Slack
7. Developmental Biology,-Werner A Muller

REFERENCE BOOKS:

1. Reproduction in Eukaryotic cells, DM Prescott, Academic press.
2. Principles of Development - Lewis Wolpert
3. Fertilization, FT Longo, Chapman and Hall
4. The Coiled Spring, Ethan Bier, Cold Spring Harbor Press.

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PROGRAM CORE II

MICROBIOLOGY

Course Objective: The main objective of this course is to provide knowledge of the classification & identification of microorganisms, their nutrition, growth & ecological characteristics, culture & control methods, and genetics.

Unit – I. Pioneers of Microbiology:
Microscopy - Principles, Working and Applications of Bright Field Microscope, Fluorescent Microscope, Phase Contrast Microscope, Electron Microscope. **Microbial Cell Structure:** Prokaryotic & Eukaryotic cells, Organization and function of Cellular Organelles. General Characteristics & Economic importance of Bacteria, Algae, Fungi, & Protozoa's.

Unit – II. Control of Microorganism:
Control of Microorganism by Physical and Chemical Agents. Narrow and Broad Spectrum Antibiotics, Mode of action of antimicrobial agents. Antibiotic resistance mechanisms.

Unit – III. Microbial Growth and Nutrition:
Microbial Growth. Bacterial generation time. Monoauxic, Diauxic and Synchronized Growth Curves. Factors affecting microbial growth. **Principles of Microbial Nutrition**: Nutritional requirements, Major & Minor elements, Trace metals and Growth factors, Nutrient media (selective, differential, enriched, enrichment and special purpose media). Nutritional types based on energy source, carbon source and electron donor.

Unit – IV. Maintenance and preservation of microbial cultures:
Sub culturing, Slant culture, Stab culture, Soil culture, Mineral oil overlaying, Glycerol preservation and Lyophilization. Types of culture collection centers - Indian and Global - ATCC, MTCC and NCIM etc.

Unit – V. Identification Methods and Classification of Bacteria:
Microscopic Identification Characteristics, Staining methods. Ecological Identification Methods, Nutritional (Cultural) Identification Characters, Biochemical Identification Methods, Immunological Characteristics, Molecular and Genetic Characteristics Identification (16s rRNA). **Principles of Bacterial Taxonomy and Classification:** Numerical Taxonomy, Bergy's Manual and its importance, General properties of bacterial groups.

COURSE OUTCOMES:

At the end of the course student will be able:

CO1. Understand the basic information of the classification of microorganism and ultra structure of bacteria
CO2. Evaluate the knowledge of control of microorganisms.
CO3. Understand the Microbial Growth and Preservation of microorganisms.
CO4. Understanding the Knowledge of Identification methods, Classification and bacterial Taxonomy.
CO5. Analyze the knowledge of Microbial Genetics.

TEXT BOOKS:

1. A. J. Salle, Fundamental Principles of Bacteriology.
2. Brock T.D. Madigan M.T. Biology of Microorganisms. Preentice Hall Int. Inc.
3. Pelczar, M. J., Chan, E.C.S. and Krieg, N.R. (2001). Microbiology: Concepts and Applications. McGraw-Hill Inc. USA.
4. Willey, J.M., Sherwood, L., and Woolverton, C. (2013). Prescott's Microbiology 9th Revised Edition, McGraw Hill Higher Education, New York.
5. Jeffery C. Pommerville (2000). Alcamo's Fundamentals of Microbiology, Jones and Bartlett Publishers.

REFERENCE BOOKS:

1. Bergey's Manual of Systematic Bacteriology – P.H.A. Sneath, N.S. Mair, M. Elizabeth.
2. The Prokaryotes – A. Balows, A. G. Thuper, M. Dworkin, W. Harder, K. Schleifer Springer – Verlag 1991.
3. Principles of Biochemistry – Zubey GL, Parson WW and Vance DE, WM. C. Brown Publishers, Oxford, England.
4. Biochemistry – Stryer L, W.H. Freeman Company, New York.
5. Modern Microbiology – Brige EA, WM. C. Brown Publishers, Oxford, England.
6. General Microbiology – Stainer RY, Ingraham JL, Wheelis ML, Painter PR, Macmillan Ltd, London.
7. The Bacteria – Gunsales IC, Stainer RY, Vol. I, II, III, Academic Press.

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PROGRAM CORE III

MICROBIAL BIOCHEMISTRY

Course Objective: The main objective of the course is to study the various biomolecules, structures, properties and their biological importance.

Unit-I: Chemistry of Life and Special Microbial Molecules: Bonds: Covalent and Non Covalent intereactions, Water as a biological solvent and its role in biological processes. Concept of buffer, pH, Henderson-Hasselbalch equation, strength of buffer, range of buffer, important biological buffers.

Unit-II: Bioenergetics: Thermodynamics, entropy, enthalpy, free energy, Gibbs free energy equation, Oxidation and Reduction reactions, high energy compounds, coupled reactions, determination of feasibility of reactions. ATP and other different groups of high energy phosphate compounds.

Unit-III:Carbohydrates & Lipids: Carbohydrates: Monosaccharide's, disaccharides, oligosaccharides and polysaccharides. **Lipids:** Saturated and unsaturated fatty acids, Fatty acid oxidation, Biosynthesis of fatty acids (C16), Cholesterol synthesis.

Unit- IV: Proteins and Amino acids: Proteins: Structural features of amino acids, classification of amino acids, peptide linkage, structural classification of proteins, primary, secondary, tertiary and quaternary structures of proteins. Ramchandran plot, Transamination, Deamination and Decarboxylation, Metabolism of Glutamate, Tryptophan, Cysteine and Proline.

Unit-V: Nucleic Acids: Structure of purines, pyrimidines, nucleosides and nucleotides. Metabolism of purine and pyrimidine Nucleotides (Denovo and Salvage pathway).

COURSE OUTCOMES:

At the end of the course students will be able to

CO1. Understand the basics of biochemistry and buffers.
CO2. Evaluate the knowledge of bioenergetics in biochemistry.
CO3. Analyze the knowledge of carbohydrates and Lipids.
CO4. Evaluating the knowledge of Proteins and Amino acids.
CO5. Analyze the knowledge of types of nucleic acids and their properties.

TEXT BOOKS:

1. Berg, J.M., Tymoczko, J.L., Gatto, Jr., G.J., and Stryer, L. (2015). *Biochemistry,* 8th Edition.
2. Geoffrey L. Zubay (2017). *Principles of Biochemistry by* Brown Co, USA.
3. Moat A.G., Foster J. W Spector M. P. (2002) *Microbial Physiology* John Wiley& Sons.
4. Nelson D. L. and Cox M. M. (2017) Lehninger *Principles of Biochemistry* by W. H. Freeman.
5. White, D, Drummond J. Fuqua C (2011) *The Physiology and Biochemistryof Prokaryotes* Oxford University Press.
6. Cohen G. N. (2014) *Microbial Biochemistry* Springer.
7. Ferrier D. R. (2013) *Lippincott's Illustrated Reviews: Biochemistry* LippincottWilliams & Wilkins.
8. Irwin H. Segel (2004) *Biochemical Calculations* Wiley.
9. Palmer, T. Horwood E (1991) *Understanding Enzymes* Wiley.

REFERENCE BOOKS:

1. Biochemistry White, Handler and R.B. Smith 7th Ed. Fundamentals of Biochemistry by J.L. Jain, Sunjay Jain AND Nitin Jain, S. Chand and Company L
2. Donald Voet& Judith G. Voet Biochemistry second edition .
3. Bacterial Physiology and Metaboloism BH Kim, GM Gadd –

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PROGRAME ELECTIVE I

i. MICROBIAL GENETICS & MOLECULAR BIOLOGY

Course Objective: The objective of this course is to explain the basics in microbial genetics, structure of nucleic acids, gene regulation and Demonstrate knowledge and understanding of the molecular machinery of living cells and the principles that govern the structures of macromolecules and their participation in molecular recognition.

UNIT-I: MICROBIAL GENETICS: Bacterial Recombinations-Discovery, gene transfer, molecular mechanism, detection, efficiency calculation and applications. Bacterial transformation- Competency and resistance. Bacterial conjugation – Sex factor in bacteria, F and HFR transfer, linkage mapping. Bacterial transduction – transduction phenomenon, methods of transduction, co-transduction, generalized, specialized and abortive transduction, sex-ductions.

UNIT-II MUTATION and DNA REPAIR: Types of mutagens, Molecular basis of mutations. Physical and chemical mutagenic agents: UV, Ethidium Bromide and Nitrous oxide. Detection and analysis of mutations (Replica plating,Antibiotic enrichment, Ames test etc). DNA damage and repair mechanisms. Recombination: Homologous and non-homologous recombination.

UNIT-III: GENETIC MATERIAL & MOBILE GENETIC ELEMENTS: Discovery of DNA and RNA as genetic material; Structure and types of DNA, Replication. Eukaryotic chromosome Structure, regulatory elements. RNA**:** Different classes of RNA and their functions. Transposable elements – Types of bacterial transposons and their applications

UNIT-IV: GENE EXPRESSION REGULATION: Transcription in prokaryotes and eukaryotes, other post transcriptional modifications, RNA editing, transport mechanisms (exportins & importins). Regulations of gene expression in prokaryotes (Lac. Ara and His operons). Transcriptional controls in Eukaryotes (Complexity of genome organization, Regulatory elements, Motifs of protein secondary structure/Transacting elements); Regulation at Post-transcriptional level.

UNIT-V: GENE EXPRESSION - TRANSLATION: Genetic code, Wobble hypothesis, Translation in prokaryotes and eukaryotes, post translational modifications, translational controls and inhibitors of polypeptide synthesis, protein targeting.

COURSE OUTCOMES:

At the end of the course students will be able to

CO1. Understand the basic concepts in Microbial genetics.
CO2. Analyze the DNA repair & Mutation.
CO3. Differentiate DNA, RNA structures and understand the mobile genetic elements.
CO4. Analyze the gene regulation in prokaryotes and eukaryotes and understand the post translation modifications
CO5. Understand the process of translation, their inhibitors, post translation modifications and protein targeting.

TEXT BOOKS:

1. "Molecular Biology of the gene" by Waston et al 4th edition.
2. "Genes VI" by Benjamin Lewis
3. Biochemistry and Molecular biology, William H. Elliott and Daphne C. Elliott, Third Edition, Indian edition, Oxford University press, 2005.

REFERENCE BOOKS:

1. "Genetics" by Ursula Goodenough
2. "Cytogenetics" by lGarl P. Swanson, Mertz & Young
3. "Biochemistry" by Stryer

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PROGRAME ELECTIVE I

ii.MICROBIAL PHYSIOLOGY & METABOLISM

Course Objective: The main objective of the course is to study the Bacterial photosynthesis, aerobic and anaerobic respiration, and permeation and sporulation process.

Unit- I: Bacterial Photosynthesis: Photosynthetic microorganisms, photosynthetic pigments, and generation of reducing power by cyclic and non-cyclic photophosphorylation, electron transport chain in photosynthetic bacteria**.** Carbon dioxide fixation pathways.

Unit- II: Bacterial aerobic Respiration: Bacterial aerobic respiration, components of electron transport chain, free energy changes and electron transport, oxidative phosphorylation and theories of ATP formation, inhibition of electron transport chain. Electron transport chain in heterotrophic and chemolithotrophic bacteria.

Unit–III: Bacterial Anaerobic Respiration: Introduction. Nitrate, carbonate and sulfate as electron acceptors. Electron transport chains in some anaerobic bacteria. Catalase, super oxide dismutase, mechanism of oxygen toxicity.

Unit - IV: Bacterial Permeation: Structure and organization of membrane (Glyco-conjugants and proteins in membrane systems), fluid mosaic model of membrane. Methods to study diffusion of solutes in bacteria, passive diffusion, facilitated diffusion, different mechanisms of active diffusion. Proton Motive Force, PTS, role of permeases in transport, different permeases in *E. coli*. Transport of amino acids and inorganic ions in microorganisms and their mechanisms.

Unit - V: Bacterial Sporulation: Sporulating bacteria, molecular architecture of spores, induction and stages of sporulation, Influence of different factors on sporulation. Cytological and macromolecular changes during sporulation. Heat resistance and sporulation. **Bacterial Chemolithotrophy**: Physiological groups of chemolithotrophs, ammonia oxidation by members of Genus Nitroso group, nitriteoxidation by Nitro group of genera. Oxidation of molecular hydrogen by *Hydrogenomonas* species. Ferrous and sulfur/sulfide oxidation by *Thiobacillus* species.

COURSE OUTCOMES:

At the end of the course students will be able to:

CO1: Understand about the Bacterial Photosynthesis
CO2: Evaluate the knowledge of Bacterial aerobic respiration
CO3: Analyze the knowledge of Bacterial aerobic and anaerobic respiration
CO4: Evaluate the various types of membrane transport mechanisms
CO5: Analyze the various sporulation of bacteria and cheamolithotrophy

TEXT BOOKS:

1. Caldwell D.R. (1995) *Microbial Physiology and Metabolism*. BrownPublishers.
2. Moat A.G. and Foster J. W. (2002) *Microbial Physiology,* Wiley.
3. Brun. Y.V. and Shimkets L.J. (2000) *Prokaryotic Development*. ASM Press.
4. Rose AH *Advances in Microbial Physiology*. Vol. 36, Academic Press NewYork.
5. Gunsalus IC, Stanier R. (1960) *The Bacteria*, Academic Press.
6. White, D. (2011) *The Physiology and Biochemistry of Prokaryotes*, 4th Edition, Oxford University Press

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OPEN ELECTIVE I

i. BASIC MATHEMATICS & BIOSTATISTICS

Course Objective: The course intends to provide the knowledge of differential and integral calculus, matrices, statistics and concept of random variable**s**

UNIT-I: DIFFERENTIAL CALCULUS: Functions, limits, continuity and differentiation (only basics). Differentiation of sum, product and quotient of function. Differentiation of implicit, explicit, trigonometric, inverse trigonometric functions; Partial differentiation (Basics).

UNIT-II: INTEGRAL CALCULUS: Basics, Methods of substitution integration by parts. Integration of rational, irrational, trigonometric functions (Basics), Definite integrals (Basics); Trapezoidal rule, Simpsons 1/3 rule, Simpsons 3/8 rule.

UNIT-III: MATRICES: Basics, addition, subtraction, multiplication and Determinants of Matrices (Basic concept). Co-factors of matrix, Adjoint, inverse of a matrix, Real matrices: Symmetric, Skew symmetric and orthogonal Matrices, Rank of matrix (Basic)-Det method.

UNIT-IV: INTRODUCTION- DEFINITION AND SCOPE OF BIOSTATISTICS: concept of probability-definition of probability- addition and multiplication laws of probability (without proofs) and examples. Population – Sample- primary data and Secondary data-graphical and diagrammatic representation of data. Measure of central tendency: Mean median and mode. Measure of dispersion: Range – standard deviation, Mathematical Expectation, Skewness, Curtosis.

UNIT-V: STATISTICAL OPTIMIZATION TECHNIQUES: Estimation, types of estimation, estimation of parameters. Testing of Hypothesis – Z-test, t-Test, f-Test (Basics). Correlation & Regression; Coefficient of correlation – Regression coefficient – The lines of regression (Basics).

COURSE OUTCOMES:

At the end of the course students will be able to

CO1. Attain knowledge of the Functions, limits, continuity and differentiation
CO2. Analyse integral calculus
CO3. Apply matrices
CO4. Understand the various concepts of biostatistics
CO5. Evaluate various concepts of statistical optimization techniques.

TEXTBOOKS:

1. Statistical methods S.P.Gupta. S Chand Pubplications
2. Business Statistics by S.P Gupta &M.P.Gupta
3. Engineering Mathematics - N.P. Bali and others.
4. Engineering mathematics - B.V. Ramana
5. Fundamentals of Statistics, Gupta.M.K. Goon A.M, The world press, 2012.
6. Introduction to the theory of statistics, 3rd edition, Mood.A.M. Graybill, F.A &Boes. D.C (2007)
7. Probability and statistics by Rukmangadachari . E, Pearsln publications.

REFERENCE TEXT BOOKS:

1. Differential Calculus - Shanthi Narayan
2. Integral Calculus - Shanthi Narayan

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OPEN ELECTIVE I

ii.BIOENTREPRENEURSHIP

Course Objectives: The objectives of this course are to teach students about concepts of entrepreneurship including identifying a winning business opportunity, gathering funding and launching a business, growing and nurturing the organization and harvesting the rewards.

UNIT-I: Basics of Bioentrepreneurship Importance of entrepreneurship; advantages of being entrepreneur - freedom to operate; introduction to bioentrepreneurship – biotechnology in a global scale; Scope in bioentrepreneurship; types of bio-industries – biopharma, bioagri, bioservices and bioindustrial; innovation – types, out of box thinking; skills for successful entrepreneur – creativity, leadership, managerial, team building, decision making; opportunities for bioentrepreneurship development programs of public and private agencies (MSME, DBT, BIRAC, Startup & Make in India); patent landscape, IP protection & commercialization strategies

UNIT-II: Accounting and Finance Business plan preparation; business feasibility analysis by SWOT, socio-economic costs benefit analysis; funds/support from Government agencies like MSME/banks and private agencies like venture capitalists:/angel investors for bioentrepreneurship; business plan proposal for „virtual startup company"; statutory and legal requirements for starting a company/venture; basics in accounting practices: concepts of balance sheet, profit and loss statement, double entry 36 bookkeeping; collaborations & partnerships; information technology for business administration and expansion

UNIT-III: Business Strategy Entry and exit strategy; pricing strategy; negotiations with financiers, bankers, government and law enforcement authorities; dispute resolution skills; external environment/ changes; avoiding/managing crisis; broader vision–global thinking; mergers & acquisitions

UNIT-IV: Marketing Market conditions, segments, prediction of market changes; identifying needs of customers; Market linkages, branding issues; developing distribution channels - franchising; policies, promotion, advertising; branding and market linkages for „virtual startup company"

UNIT-V: Knowledge Centre and R&D Knowledge centreseg, in universities, innovation centres, research institutions (public & private) and business incubators; R&D for technology development and upgradation; assessment of technology development; managing technology transfer; industry visits to successful bio-enterprises, regulations for transfer of foreign technologies; quality control; technology transfer agencies; Understanding of regulatory compliances and procedures (CDSCO, NBA, GLP, GCP, GMP)

COURSE OUTCOMES:

At the end of the course the student will be able to

CO1. Understand the advantages and identify the scope of entrepreneurship in biosciences.
CO2. Analyse the ways and means of raising funds
CO3. Evaluate the various issues related to entry, exit, pricing strategies and managerial skills
CO4. Understand the marketing strategies involved in entrepreneurship
CO5. Evaluate the ways and means of developing research for business growth and expansion

TEXT BOOKS:

1. Adams, D. J., & Sparrow, J. C. (2008). Enterprise for life scientists: Developing innovation and entrepreneurship in the biosciences. Bloxham: Scion.

2. Shimasaki, C. D. (2014). Biotechnology entrepreneurship: Starting, managing, and leading biotech companies. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier.

REFERENCE BOOKS:

1. Onetti, A., & Zucchella, A. (n.d.). Business modeling for life science and biotech companies: Creating value and competitive advantage with the milestone bridge. Routledge.
2. Jordan, J. F. (2014). Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press. 5. Desai, V. (2009). The Dynamics of Entrepreneurial Development and Management. New Delhi: Himalaya Pub. House.

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LAB I

CELL BIOLOGY & MICROBIOLOGY LAB

PART-A: CELL BIOLOGY LAB

Course Objective: To provide hands on training in cell biology techniques

LIST OF EXPERIMENTS:

1. Microscopy: Compound Microscope & Fluorescence Microscope
2. Motility of bacteria
3. Gram Staining
4. Osmosis -Egg
5. Cellular Fractionation
6. Analysis of subcellular fractions
7. Mitosis and cytokinesis

Course outcome: At the end of the course, students will have a thorough knowledge of the techniques involved in studying the motility of bacteria, isolation of cell organelles.

PART-B: MICROBIOLOGY LAB

Course Objective: To provide hands on training in microbiological techniques.

LIST OF EXPERIMENTS:

1) Isolation, Purification & Quantification of bacteria.
2) Cultural characteristics of bacteria
3) Morphological and Biochemical characterization of bacteria (Various staining, Amylase, Catalase, Gelatinase, Protease, Nitrate reductase, Urease, Indole, Methyl red, Vogesproskauer, Citrate utilization test).
4) Factors affecting bacterial growth (pH & Temperature).
5) Determination of thermal death point.
6) Determination of MIC of antimicrobial agents.

Course outcome: At the end of the course, students will have a thorough knowledge of distinguish between various types of microbial media, culturing methods, Inspect and isolate the microbes from the day to day sources.

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LAB II

MICROBIAL BIOCHEMISTRY AND MICROBIAL GENETICS & MOLECULAR BIOLOGY LAB/MICROBIAL PHYSIOLOGY & METABOLISM LAB

PART-A: MICROBIAL BIOCHEMISTRY LAB

Course objective: The main objective of the course is to study the different methods used to estimate the various biomolecules.

LIST OF EXPERIMENTS:

1. Titration of amino acids.
2. Determination of pK
3. Estimations of amino acids, Proteins, Sugars and Lipids
4. Analysis of oils-iodine number, Saponification value, acid number.
5. UV, Visible, Absorption spectra.
6. Centrifugation
7. Chromatography : Paper and TLC

Course outcomes: At the end of the course students will have through knowledge of Biomolecules estimations and analysis etc.

PART-B: MICROBIAL GENETICS & MOLECULAR BIOLOGY LAB

Course objective: The main objective of the course is to provide practical knowledge on microbial genetics and molecular biology techniques

LIST OF EXPERIMENTS:

1. Isolation of Nucleic Acids: Genomic DNA, RNA
2. Quality check for Isolated Nucleic Acids: Spectrophotometric (UV Method)
3. Visualization: Agarose gel Electrophoresis (Detection and separation of NA).
4. Induction of mutations by physical/chemical mutagens, screening and isolation of mutants,Replica plating technique.
5. Transformation in bacteria.

Course outcomes: At the end of the course students will have through knowledge of the techniques involved in isolation, quantification of DNA and gene transfer methods in bacteria.

PART-B: MICROBIAL PHYSIOLOGY & METABOLISM LAB

Course objective: The main objective of the course is to provide practical knowledge on the microbial growth on various media and factors affecting the microbial growth.

LIST OF EXPERIMENTS:

1. Preparation of microbiological media. Autotrophic media, minimal media, basic media, enriched media, enrichment media, differential media.
2. Culturing methods of microbes – slant and stab cultures, tube culture, flask cultures, shake flask cultures
3. Use of selective and /or differential media for isolation and Identification of specific bacterial cultures
4. Study of bacterial growth curve
5. Factors effecting the microbial growth (pH and temperature)
6. Effect of UV, gamma radiations, pH, disinfectant, chemicals and heavy metal ions on micro-organisms.

Course outcomes: At the end of the course students will have through knowledge of the microbial growth on various media and factors affecting the microbial growth

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PROGRAM CORE IV

BIOINFORMATICS

Course Objectives: This course is formulated to provide students an in depth knowledge of biological data analysis using compilation methods. It is also useful for investigating molecular biology Problems from computational perspective. To enhance knowledge about protein structural predictions, molecular docking and evolutionary relationships between organisms.

UNIT-I:INTRODUCTION TO BIOINFORMATICS & SEQUENCING ALIGNMENT CONCEPTS: Need of Computers in Biotechnology Research; File Transfer Protocol; Bioinformatics-Introduction, Scope, Applications; Pair wise Alignment-Local, Global alignment; Gap- Gap penalty; Comparison of Pair wise and Multiple alignment.

UNIT-II: BIOLOGICAL DATABASES AND DATAMINING:
Biological Information on the web- Introduction to databases; Classification of Biological databases; Information retrieval from Databases; Sequence database search- FASTA, BLAST; Amino acid substitution matrices- PAM and BLOSUM; Data Mining and Visualization (PYMOL).

UNIT-III: PHYLOGENETIC ANALYSIS AND PREDICTION: Evolutionary process; Origins of Molecular Phylogenetics; Common Multiple Sequence alignment methods; Phylogenetic analysis: Methods& Tools (Clustal W).

UNIT-IV: GENOME MAPPING AND PREDICTION:
Genome Mapping; Gene Prediction Methods &Tools, Gene Annotation; Human Genome Mapping (HGP), Promoter analysis.
RNA Sequence and structure Analysis - si-RNA design and development, RNA secondary structure, RNA structure Prediction Methods.

UNIT-V: PROTEIN STRUCTURE PREDICTION METHODS:
Basics of Protein biology (Classification, Structural Organization, Domains & Motifs); Protein Structure Prediction Concepts - Secondary & Tertiary Structure Predictions (Chou-Fasman Method, GOR Method, Neural Network method, Homology Modeling, Abintio method, Threading methods), Molecular docking methods.

COURSE OUTCOMES:

At the formal end of the course student will be able to

CO1. Understand the fundamentals and application of computational and bioscience useful for bioinformatics programming.
CO2. Classify and apply Databases, data retrieval process, data mining, knowledge about the BLAST, FAST and Visualization tools for Proteomics.
CO3. Evaluate evolutionary relationships between species, sequence alignment process and alignment tools.
CO4. Understand sequencing and mapping of genomes which are useful in their molecular biology studies and RNA design and development
CO5. Analyse Protein structures and protein modeling methods and tools.

TEXT BOOKS:

1. Bioinformatics: Methods and Applications- SC Rastogi, N Mendiratta& P Rastogi.
2. Bioinformatics Basics, Applications in Biological Science and Medicine- Hooman
3. Bioinformatics: Genome and sequence analysis by David W Mount.
4. Bioinformatics: A practical guide to analysis of genes and proteins by Baxevanis, Andreas D Wiley – Interscience publishers.

REFERENCE BOOKS:

1. Computational Molecular Biology – An Introduction by Peter Clote, Rolf Backofen, Jhon Wiley & Sons
2. Essential Bioinformatics by Jin Xiong, Cambridge University Press
3. Bioinformatics Principles & Applications by Zhumur Ghosh, Oxford University Press.

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PROGRAM CORE V

IMMUNOTECHNOLOGY

Course Objective: This course intends to provide the knowledge of cells, organs of immune system, innate & acquired immunity, humoral immunity & cell mediated immunity, the role of immunity in infectious diseases and type of vaccine & technology.

UNIT – I: Immune system:

Phylogeny of Immune System: Innate and acquired immunity. **Organs** and **Cells of the immune system**: Lymphoid organs-Lymphoid follicle, Thymus, Lymph node, Spleen, MALT, GALT, SALT. Hematopoiesis and differentiation, Macrophages, Dendritic cells, Natural killer and Lymphokine activated killer cells, Eosinophils, Neutrophils and Mast-Cells. Clonal nature of immune response, antigens, immunogens, super antigens & MHC.

UNIT – II: Humoral immunity:

B cell types, B cell receptors and activation, Immunoglobulin diversity, Antibody structure and function, Antigen- antibody interactions (including ADCC), CDC antibodies in diagnosis, Hybridoma technology, B cell memory.

UNIT – III: Cell mediated immunity:

MHC restriction, Antigen presentation, T cell subsets and functions of each, T cell activation and regulation, Cell mediated immune functions- cytotoxicity, interferon; T cell memory - Central and peripheral.

UNIT – IV Immuno diseases:

Immune response to infectious diseases (humoral, cell-mediated, examples), autoimmune disorders: Rheumatoid arthritis, Insulin dependent Diabetes Mellitus, Cells and organs transplantation, Graft rejection and psoriasis.

UNIT – V: Immunotherapy, Vaccines and Adjuvants:

Vaccines–Types, Technologies, Adjuvants–Function, mechanism of action, new generation adjuvants, Immunotherapy – antibodies (Polyclonal, Monoclonal), Cytokines, Cell therapy, diseases (HIV, HCV).

COURSE OUTCOMES

At the formal end of this course student will be able to

CO1. Classify innate immunity, nature of antigens and cells and organs of immune system.

CO2. Equipped with the knowledge of humoral immunity, Evaluate antigen – antibody interactions and hybridoma technology.

CO3. Thorough understanding of MHC, mechanism of cytotoxicity and evaluate cell mediated immunity.

CO4. Classify and evaluate autoimmune disorders and the role of immune system in transplantation.

CO5. Evaluate role immune system in infectious diseases and immunotherapy.

TEXT BOOKS:

1. Kuby Immunology (Kindt, Kuby Immunology)-Thomas J. Kindt, Barbara A. Osborne, Richard A. Goldsby, and publisher: W. H. Freeman, 2006.
2. Immunology-David Male, Jonathan Brostoff, David Roth, Ivan Roitt, publisher: Mosby, 2006.
3. Essentials of immunology by Roitt, 13th edition by Peter J Delves, Johan Wiley.

REFERENCE BOOKS:

1) Fundamental Immunology-William E Paul, publisher: Lippincott Williams & Wilkins, 2008
2) Immunology, Infection, and Immunity-Gerald B. Pier, Jeffrey B. Lyczak, Lee M. Wetzler, publisher: ASM Press, 2004
3) Lecture Notes: Immunology, 5th Edition-Ian Todd, Gavin Spickett, publisher: Wiley-Blackwell, 2005.
4) Immunology: A Short Course-Richard Coico, Geoffrey Sunshine, publisher: Wiley-Blackwell, 2009.
5) Cellular and Molecular Immunology-Abul K. Abbas MBBS, Andrew H. Lichtman MD PhD, Shiv Pillai MD, publisher: Saunders, 2007.
6) Roitt's Essential Immunology (Essentials)-Peter Delves, Seamus Martin, Dennis Burton, Ivan Roitt, publisher: Wiley-Blackwell, 2006.
7) Schaum's Outline of Immunology-George Pinchuk, publisher: McGraw-Hill, 2001.

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PROGRAM CORE VI

VIROLOGY

Course Objective: This course intends to provide insights into the historical developments in Virology, Structures, Classification, Virological diagnostics methods and viral replications etc.

UNIT-I: Microorganisms lacking cell structures: Introduction to virology, nature of viruses, nomenclature and classification of viruses, General characteristics of viruses: Physical, Biological, Biochemical properties, Methods of cultivation, Purification and assay of viruses Biology of sub-viral agents

UNIT-II: Virological Methods: Diagnostic Methods: Immunodiagnostic, Haemagglutination and Haemagglutination-inhibition tests, complement fixation, neutralization, RIA, flow cytometry and immunohistochemistry
Nucleic Acid Based Diagnosis: Hybridization, Blotting techniques, polymerase chain reaction, Microarray and nucleotide sequencing

UNIT-III: Virus Cell Interaction: Cellular Receptors and Virus Entry: Polio, Herpes, VSV, HIV Mechanism of Entry into cells, **Mechanisms of Host Cell Damage**: Host cell 'Shut off', Apoptosis, Necrosis, Stress response, Alteration of signaling pathways, Cellular basis of transformation, Types of cytopathic effects

UNIT-IV: Virus Replication: RNA Viruses: Replication of Plus stranded RNA virus (Polio), Negative Strand RNA viruses (VSV and influenza) Replication of double Stranded RNA viruses (rota), and retro viruses (HIV and HTLV. **DNA Viruses:** Replication of doubles Stranded DNA Viruses (SV 40 and Pox), ss DNA Viruses (AAV), DNA tumor virus (Hepatitis B Virus).

UNIT-V: Application of viruses in biomedicine Viral vectors: Development of viral vectors, gene transfer, gene therapy, vaccine development Protein expression, Viral subunits (Virus like particles VLP), Oncolytic Virus(Virotherapy for cancer)

COURSE OUTCOMES:

At the end of the course student will be able to:

CO1. Understand the knowledge of the viruses, structures and their properties.

CO2. Evaluate the knowledge of the viral diagnostic methods and their analysis.

CO3. Understand the knowledge of the virus cell interactions and host cell damage Mechanisms.

CO4. Evaluate the knowledge of the viral replication of DNA and RNA viruses.

CO5. Analyze the knowledge of the applications of the viruses in biomedicine.

TEXT BOOKS:

1. Introduction to Modern Virology - Dimmock NJ, Primrose SB, Blackwell Scientific Publications, Oxford.
2. Text Book on Principles of Bacteriology, Virology and Immunology – Topley and Wilson's, Edward Arnold, London.

REFERENCE BOOKS:

1. Medical Virology – Morag C and Timbury M.C, Churchill Livingstone, London.
2. Virology – III – Conrat HF, Kimball PC and Levy JA, Prentice Hall, Englewood Cliff, New Jersey.
3. Diagnostic procedures for Viral and Rickettsial diseases – Lennetter EH, American Public Health Association, NY.
4. The Genetics of Bacteria and their Viruses – William Hayes, Blackwell Scientific Publishers, London.

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PROGRAM ELECTIVE II

i. FERMENTATION TECHNOLOGY

Course objective: The major objective of this course is to familiarize students to microbes & microbial processes, including fermentation and optimization covering all areas of industrial biotechnology.

UNIT-I: INTRODUCTION AND METHODS IN MICROBIOLOGY: History, Scope & milestones of microbiology, Ultra-structural organization of prokaryotic and eukaryotic cells. Isolation, and screening methods for industrially important micro organisms, Primary screening and secondary screening

UNIT-II STRAIN IMPROVEMENT & PRESERVATION TECHNIQUES: Strain selection and Strain improvement by selection of induced mutants for primary metabolites, Auxotrophs mutant, induced mutant for secondary metabolites, Isolation of Auxotrophic, Resistant, Revertant mutants. Recombinant DNA techniques, protoplast fusion, conjugation, and transformation for strain development, culture preservation techniques.

UNIT-III: MICROBIAL GROWTH, MEDIA COMPONENTS AND MEDIA DESIGN: Microbial growth: Microbial growth curve - mathematical expression of growth, classification of microbes based on physical factors (pH, temperature, O_2 requirement).

Media formulation: Microbial nutrition and types of microbial culture media, Different components of microbial culture medium and their physiological role in microbial growth, raw materials used in preparation of medium..

UNIT-IV: INOCULUM DEVELOPMENT, STERILIZATION, & FERMENTATION OPERATIONS: Inoculum Development**, Sterilization**: Introduction, media sterilization, the design of batch sterilization process, the design of continuous sterilization process, sterilization of fermentor, sterilization of feed, sterilization of air and filter design**. Fermentors:** Fermentation equipment and its uses, types of fermentors and different fermentation modes

UNIT-V CASE STUDIES: Antibiotics - Penicillin, Streptomycin; Organic acids – Citric acid, Lactic acid, Alcoholic beverages – Ethanol, Beer, Wine. Monoclonal antibodies (mAb's) and Bio- therapeutics Eg.: Insulin , vaccines. Food industry: Bakers' yeast and bread making, rennet and other proteolytic enzymes in cheese making, production of different cheeses

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COURSE OUTCOMES:

At the formal end of the course student will be able to:

CO1: Acquire the knowledge of isolation and identification of microorganisms.

CO2: Determine the mathematical expression of microbial growth kinetics & media formulation

CO3: Design the process of fermentation

CO4: Explain the production process of r DNA based products

CO5: Explain the production process of food and allied products

TEXT BOOKS:

1. "Principles of fermentation technology" by P F Stanbury and A Whitaker, Pergamon press (1984).
2. Industrial Microbilogy by A.H. Patel, Macmillan India Ltd.
3. Industrial Biotechnology by S.N. Jogdand, First edition, Himalaya Publishing House, (2006).

REFERENCE BOOKS:

1. “General Microbiology” 5th Edition Stanier et al.
2. “Enzymes in food processing” by Gerald Reed, Academic press.
3. “Comprehensive Biotechnology” Vols III & IV, Editor M.Moo young.
4. “Industrial Microbiology” by Prescott
5. “Industrial Microbiology” by Casida.

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PROGRAM ELECTIVE II

ii. MICROBIAL BIOTECHNOLOGY

COURSE OBJECTIVE: This course enables students to understand the development of various microbial products and their production followed by beneficial microbes and application of microbes in nanotechnology.

Unit-I: Development of Microbial Products: Microbial production of penicillin, Tetracycline and peptide antibiotics; Acetic acid; Lactic acid; Gluconic acid, recombinant biomolecules and therapeutic proteins, vaccines production**,** DNA based vaccines, antibody production, therapeutic enzymes Microbial production and commercial applications of Amylases, Proteases and Lipases. Biotransformation of steroid and non-steroid compounds.

Unit-II: Production of Microbial Products: Single cell protein: Use of Microorganisms; raw material used as substrate; condition for growth and production; nutritive value and uses of SCP. Mushroom production: cultivation of different types of mushroom; edible mushroom; therapeutic value of an edible mushroom. Genetically modified foods and their importance. Synthesis of commercial products using microbial systems: Biopolymers-xanthan gum and PHA's (Bioplastics). Renewable Bioenergy using Microorganisms: Methanogenesis, Methane production by anaerobic digestion of waste organic materials. Bioethanol and Biobutanol production by using microorganisms. Biohydrogen Generation, Microbial Fuel. Biodiesel from algae.

Unit–III: Beneficial Microbes: Biofertilizers- *Rhizobium, Azospirillum, Azotobacter, Gluconacetobacter, Azorhizobium,* phosphobacteria - *mycorrhizae* - Blue Green Algae and *Azolla*. Mass production of biofertilizers and composting, Nanobiofertilizers for sustainable development of agriculture. Designer Microbes and Health: Gut microbiota and diseases, approaches for engineering gut microbiota, therapeutic uses of gut microbiota, Bacteriophages in control of bacteria. Microbial biosensors and its applications.

Unit-IV: Microbial Nanotechnology: Microbial synthesis of Nanoparticles. Synthesis of nanodrugs – metal nanoparticles and drug delivery vehicles – Nanoshells – Tectodentrimers Nanoparticle drug systems – Diagnostic applications of nanotechnology.

Unit –V: Regulatory Approvals and Clinical Trials: Good laboratory practice (GLP), Current Good Manufacturing Practice (CGMP), different phases of clinical trials, difference between biologics, biosimilar and bio-better, development of biosimilars and generic biomolecules, analysis of process economics.

COURSE OUTCOMES:

The students will be able to:

CO1: Understand about the development of various microbial products

CO2: To know the production of microbial products

CO3: Identify the beneficial microbes in biofertilizers and human health

CO4: Evaluate the use of microbes in nanotechnology

CO5: Analyze the Good laboratory practice and current good manufacturing practice

SUGGESTED BOOKS:

1. W. B. Hugo and A. D. Russell, (2011) *Pharmaceutical Microbiology,* 8th Edition. Blackwell Scientific Publications.
2. Frederick Kavanagh, (2014). *Analytical Microbiology* Volume II. Elsevier.
3. S. P. Vyas and V. K. Dixit, (2012) *Pharmaceutical Biotechnology*. CBSPublishers & Distributors, New Delhi.
4. Elisabeth Papazoglou and Aravind Parthasarathy (2007). *Bionanotechnology*. Morgan & Claypool Publishers.
5. Bernd Rehm (2006). *Microbial Bionanotechnology: Biological Self-assemblySystems and Biopolymer-based Nanostructures*. Horizon Scientific Press.
6. Willey, J.M., Sherwood, L., and Woolverton, C. (2013). *Prescott'sMicrobiology* 9th Revised Edition, McGraw Hill Higher Education, New York.
7. Mehrotra RS and KR Aneja (2015*). An Introduction to Mycology*, New AgePublishers
8. Steven L. Stephenson (2010) *The Kingdom Fungi: The Biology ofMushrooms, Molds and Lichens.*
9. Reisner DE, Bronzino JD. (2008). *Bio-nanotechnology:Global Prospects*. CRC Press.

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OPEN ELECTIVE II

i.MICROBIAL ECOLOGY & ENVIRONMENTAL MICROBIOLOGY

Course Objective: The main objective of this course is to impart students an understanding of ecology and ecosystems, functions of all various components in the ecosystem. It also familiarizes them with various Technologies used in treatment of air, water, soil and other persistent chemicals in the environment.

UNIT-I: **ECOLOGY AND ECOSYSTEMS:** Fundamentals of Ecology and Ecosystems, Components of Ecosystems, Food chain, Food Web, Trophic levels, Energy flow, Role of Producers, Consumers and Decomposers. **Ecosystems:** Types, characteristic features, structure and functions of the following ecosystems: Pond ecosystem- Marine ecosystems - Grassland ecosystem - Forest ecosystem- Desert ecosystem – Cropland Ecosystem.

UNIT-II: ENVIRONMENTAL POLLUTION AND CONTROL: Introduction to Environmental pollution, Air, water and soil pollution- Types, common effects and control measures

Air Pollution Treatment Technologies: Biofilters and Bioscrubbers for treatment of industrial waste.

UNIT-III: WASTE WATER TREATMENT: Water: Waste water, Types of waste water, Major contaminants in waste water, Physical, chemical and biological methods of waste water treatment **Aerobic:** Activated Sludge Process, Trickling Filters, Biological Filters, Rotating Biological Contractors, Fluidized Bed Reactor, **Anaerobic:** Anaerobic digestion, anaerobic digesters, Contact Digesters, Packed Column Reactors, UASB for biological treatment process.

UNIT-IV: BIOREMEDIATION AND PHYTOREMEDIATION: Definition, constraints and priorities of Bioremediation, Types of bioremediation: *In-situ* and *Ex-situ* bioremediation techniques, Factors affecting bioremediation, Applications of bioremediation. **Phytoremediation**: Definition, Types and their role in degradation of pollutants, Natural attenuation and Vermicomposting. Microbial degradation of pesticides and other recalcitrant chemicals, microbial degradation of petroleum and hydrocarbons; biodeterioration and control.

UNIT-V: BIOENERGY & BIOMINING: Bio Energy: Energy and Biomass Production from wastes, biofuels, bio hydrogen production. **Biomining:** Bioleaching, Types, Applications. Biofilms formations and its use, microbially enhanced oil recovery, microbial fuel cells and their applications.

COURSE OUTCOMES:

At the end of the course students will be able to:

CO1: Understand the knowledge of various types of pollution, common effects and Control measures.

CO2: Evaluate the knowledge of the types of waste water, their contaminants and Treatment technologies.

CO3: Analyze the Microbial ecology and their adaptations followed by phytoremediation techniques.

CO4: Understand the knowledge of Bioremediation techniques and their applications followed by Biodeterioration and their control.

CO5: Evaluate the knowledge of Bioleaching, Biomining and microbial fuel cells and their applications.

TEXT BOOKS:

1. Fundamentals of Ecology by Eugene P. Odum (Author), Gary W. Barrett
2. Introduction to Environmental Science Hardcover – 2004 by Y Anjaneyulu

REFERENCE BOOKS:

1. Wastewater Engineering-Treatment, Disposal, and Resuse, Metcalf and Eddy, Inc., Tata McGraw Hill, New Delhi.
2. Industrial Pollution control Engineering- AVN Swamy., Galgotia Publication, (2006).Environmental Biotechnology- Allan Stagg.

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OPEN ELECTIVE II

ii. BIO ETHICS, BIOSAFETY & REGULATORY AFFAIRS

Course Objective: To introduce basic concepts of ethics and safety that are essential for different disciplines of science and about regulatory affairs and documentation

UNIT I:BIOETHICS: PRINCIPLES OF BIOETHICS, ETHICS IN CLINICAL RESEARCH: Bioethics: History and Different aspects of health care, historical cases; Informed consent, mental competence, Bioethics in Microbial (Bioterrorism), Plant (GMO) & Animal (Stem Cells, Cloning, human embryos and IVF).

UNIT II: BIOSAFETY CONCEPTS & REGULATIONS: Definition of Biosafety, Biosafety for human health and environment; Levels of biosafety for microbes, plants & animals; Cartagena protocol; Assessment of Biological hazard; Use of genetically modified organisms and their release in to the environment (special procedures for r-DNA based products); International dimensions in Biosafety Biotechnology and food safety (Case study – Bt Cotton, Bt Brinjal); DBT Biosafety Guidelines.

UNIT III: REGULATORY AFFAIRS : Regulatory aspects of quality control & Quality assurance; Indian context – requirements and guidelines of GMP, understanding of Drugs and Cosmetics Act 1940 and Rule 1945 with reference to Schedule N,U & Y 4.

UNIT IV: RELATED QUALITY SYSTEMS: Pharmaceutical Quality Management systems, Quality Risk management; Objectives and guidelines of USFDA, WHO and ICH Introduction to ISO series.

UNIT V: DOCUMENTATION: Documentation & Records - Harmonized GMP requirements; Development for global filings, ANDA, NDA, CTD, dealing with post – approval changes – SUPAC; Handling and maintenance including electronic documentation, 21CFR.

COURSE OUTCOMES:

At the end of the semester students will able to:

CO1: Understand the knowledge of ethical issues related to the industry and research of biosciences

CO2: Understand of biosafety measures that need to be followed in bioscience related industries and research

CO3: Evaluate the guidelines of GMP and drug and Cosmetics Act 1940 and rules of 1945

CO4: Understanding of guidelines laid by different quality systems

CO5: Analyze the different aspects of documentation in regulatory affairs

TEXT BOOKS:

1. Bioethics – Shaleesha A Stanley, Wisdom Educational Service, Chennai, 2008
2. V Sree Krishna. Bioethics & Biosafety in Biotechnology. New age International Publications, 2007.
3. Deborah E. Bouchoux, Intellectual Property for Paralegals – The law of Trademarks, Copyrights,
4. Patents & Trade secrets, 3rd Edition, Cengage learning, 2012
5. N.S. Gopalakrishnan& T.G. Agitha, Principles of Intellectual Property, Eastern Book Company, Lucknow, 2009.

REFERENCES:

1. Singer, Peter A.; Viens, A.M. (2008), Cambridge Textbook of Bioethics, Cambridge: Cambridge University Press, ISBN 978-0-521-69443-8
2. Anitha Rao R &Bhanoji Rao "Intellectual Property Rights – A Primer", Eastern Book Company, 2008.
3. Thomas, J.A., Fuch, R.L. (2002). Biotechnology and Safety Assessment (3rd Ed). Academic Press.
4. M. M. S. Karki , Intellectual Property Rights: Basic Concepts, Atlantic Publishers, 2009
5. Neeraj Pandey &KhushdeepDharni, Intellectual Property Rights, Phi Learning Pvt. Ltd
6. AjitParulekar and Sarita D' Souza, Indian Patents Law – Legal & Business Implications; Macmillan India ltd, 2006.
7. B. L. Wadehra. Law Relating to Patents, Trade Marks, Copyright, Designs & Geographical Indications; Universal law Publishing Pvt. Ltd., India 2000.

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LAB III

BIOINFORMATICS AND VIROLOGY LAB

PART-A: BIOINFORMATICS LAB

Course Objective: The main objective of this course is to gain knowledge on different tools/software involved in Bioinformatics.

LIST OF EXPERIMENTS:

1. Data Retrieval Tools (Pub Med)
2. BLAST
3. Pair wise Alignment (EMBOSS)
4. Multiple Sequence Alignments & Phylogenetic Analysis (ClustalW)
5. Proteomic Analysis
   (a) Primary structure analysis,
   (b) Secondary structure prediction,
   (c) Tertiary structure Prediction (SPDBV),
   (d) Molecular Visualization tools (RASMOL, SPDBV).

Course Out comes: at the end of this course student gain practical training on different tools and softwares which were helpful in life sciences research.

PART- B: VIROLOGY LAB

Course objective: This course intends to provide insights to different isolation methods of viruses.

LIST OF EXPERIMENTS:

1. Mechanical Transmission of Tobacco Mosaic Virus.
2. Symptomatic Observation of Plant Viral Infections.
3. Effect of Nuclear Poly hedrosis Virus on Insects.
4. Quantification or Titration of Bacteriophages.
5. Isolation of Bacteriophages from Soil or Sewage.

Course Outcomes: By the end of the course students will have through knowledge of various method of for cultivation and enumeration of viruses**.**

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LAB IV

IMMUNOTECHNOLOGY & FERMENTATION TECHNOLOGY LAB/MICROBIAL BIOTECHNOLOGY LAB

PART-A: IMMUNOTECHNOLOGY LAB

Course Objective: This course intends to provide the practical knowledge of different immunological techniques.

LIST OF EXPERIMENTS:

1. Blood grouping – Agglutination
2. Agglutination reactions – Widal, VDRL, HA
3. Radial immuno diffusion,
4. Ouchterolony double immuno diffusion
5. Immuno-electrophoresis,
6. ELISA
7. Purification of antibodies
8. Latex agglutination test (Indirect agglutination-Pregnancy hCG Ag).

Course Outcome: By the end of this course student will acquire skill to perform different immune diffusion techniques, ELISA, immune-electrophoresis and purify antibodies.

PART- B: FERMENTATION TECHNOLOGY LAB

Course Objective: This course intends to provide the practical knowledge of Biopharmaceutical technology.

LIST OF EXPERIMENTS:

1. Microbial growth kinetics
2. Isolation of Industrially important microorganisms
3. Effect of operating parameters (PH, Temperature, Substrate concentration, Osmolarity, DO levels, etc).
4. Seeding Cell density
5. Effect of Time and level of induction
6. Absorbing of Fermenter
7. Effect of Impeller speed on growth profile
8. Kla Determination.

Course Outcome: By the end of this course student will acquire the knowledge of Fermenter principles and operating conditions etc.,

PART- B: MICROBIAL BIOTECHNOLOGY LAB

Course objective: The main objective of the course is to provide practical knowledge of production and estimations of industrially important components.

LIST OF EXPERIMENTS:

1. Estimation of streptomycin
2. Citric acid production by *Aspergillus niger*
3. Immobilization of microbial cells
4. Screening of amylase producing microorganisms
5. Screening of organic acid producing microorganisms
6. Strain improvement
7. Alcohol fermentation by Yeast cells
8. reparation of wine from Grapes and pomegranates

Course outcomes: At the end of the course students will have through knowledge of the production and estimations of the industrially important components

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PROGRAM CORE VII

r-DNA TECHNOLOGY

Course Objectives: To familiarize the student with emerging field of biotechnology i.e. recombinant DNA technology as well as create understanding and expertise in wet lab techniques in genetic engineering.

UNIT-I: INTRODUCTION AND TOLLS IN R-DNA TECHNOLOGY: Introduction to recombinant DNA technology , Molecular Tools in recombinant DNA technology – Restriction enzymes and DNA Modifying enzymes (Polmerases, Reverse Transcriptase, Ligases, Alkaline phosphatase, Terminal deoxynucleotide transferases, Nucleases - S1 nucleases etc) . Nucleic Acid isolation and purification yield analysis, Gel electrophoresis, DNA and RNA markers Restriction mapping of DNA fragments, Nucleic acid Amplification (PCR analysis) and its applications

UNIT-II: GENE CLONING STRATEGIES: Gene Cloning vectors (Plasmids, bacteriophages, cosmids, phagemids, Artificial chromosomes), Gene Cloning strategies, Transformation and selection of recombinants; Construction of DNA libraries (Genomic library and cDNA library preparations –mRNA enrichment, reverse transcription, use of linkers and adaptors); and their screening; Alternative strategies of Gene cloning; Cloning of differentially expressed genes

UNIT-III: GENE EXPRESSION: Study of introduced Gene expression – hybridization techniques, (Southern, Northern and Western blot analysis), Primer extension, S1 mapping, and Nucleic acid microarrays. Gene expression in bacteria and Yeast, expression in insect cells, expression in mammalian cells, expression in plants – characterization of recombinant proteins, stabilization of proteins; Phage display, Yeast Two- and three Hybrid system

UNIT-IV: TRANSGENIC TECHNOLOGY: Gene tagging (T-DNA tagging and Transposon tagging) in gene analysis (identification and isolation of gene), Transgenic and Gene Knockouts Technologies - Targeted gene replacement, Gene Therapy, Strategies of gene delivery, gene replacement/ augmentation, gene editing and silencing

UNIT-V: APPLICATIONS OF RECOMBINANT DNA TECHNOLOGY; Genome sequencing projects, site directed mutagenesis and protein engineering RNAi, antisense technology, CRISPAR/Cas 9

COURSE OUTCOMES:

At the end of the course students will be able to:

CO1. Understand the scientist's contribution and the enzymes involved in recombinant DNA technology and also know the PCR and its application

CO2. Analyze the knowledge on different types of vectors, cloning, transformation and selection and also Genomic and C-DNA library constriction and its application

CO3. Understand the different expression systems, protein interaction studies, and hybridization techniques.
CO4. Evaluate the different transgenic techniques (Gene Knockouts Technologies and Gene therapy) and also understand about gene tagging.
CO5. Understand the applications of genetic engineering principles.

TEXTBOOKS:

1. Molecular Cloning: a Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York, 2000.
2. DNA Cloning: a Practical Approach, .M. Glover and B.D. Hames, IRL Press, Oxford, 1995.

REFERENCES:

1. Molecular and Cellular Methods in Biology and Medicine, P.B. Kaufman, W. Wu. D. Kim and L.J. Cseke, CRC Press, Florida, 1995.
2. Methods in Enzymology vol. 152, Guide to Molecular Cloning Techniques, S.L. Berger and A.R. Kimmel, Academic Press, Inc. San Diego, 1998
3. Methods in Enzymology Vol 185, Gene Expression Technology, D.V. Goeddel, Academic Press, Inc., San Diego, 1990
4. DNA Science. A First Course in Recombinant Technology, D,A. Mickloss and G.A. Froyer. Cold Spring Harbor Laboratory Press, New YorK, 1990.
5. Molecular Biotechnology (2nd Edn.), S.B. Primrose. Blackwell Scientific Publishers, Oxford, 1994
6. Milestones in Biotechnology. Classic papers on Genetic Engineering, J.A. Davies and W.S. Reznikoff, Butterworth-Heinemann, Boston, 1992.
7. Route Maps in Gene Technology, M.R. Walker and R. Rapley, Blackwell Science Ltd., Oxford, 1997.

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PROGRAM CORE VIII

ENZYMOLOGY & BIOENERGETICS

Course objective: To provide deeper insights into how enzymes work and various applications of enzymes

UNIT-I: Introduction to Enzymes: Classification, Nomenclature and their chemical nature Factors affecting enzyme catalyzed reactions – pH, temperature, concentration of enzyme and concentration of substrate, Assay of enzymes.

UNIT-II: Enzyme Isolation & Purification: Methods of isolation and purification, recovery and yield, purity and characterization of enzyme preparations, Mechanism of action of – Chymotrypsin, Carboxy-peptidase, Ribonuclease, Lysozyme.

UNIT-III: Enzyme Kinetics: Derivation of Michaelis and Menten equation for uni-substrate reactions Determination of Km, V_{max}, K_{cat} and their significance, Linear transformation of Michaelis-Menten equation, Eadie-Hofstee, lineweaver-Burk, Hanes, Dixon plot, **Inhibition Kinetics:** Reversible and irreversible inhibition – competitive, non-competitive, uncompetitive inhibitions, determination of K_m and V_{max} in presence and absence of inhibitors Allosteric enzymes, **Immobilized Enzyme kinetics:** Methods of immobilization and applications of immobilized enzymes.

UNIT-IV: Application of Enzymes: Industrial applications of Enzymes, Production of glucose from starch, cellulose and dextran; use of lactase in dairy industry; production of glucose- fructose syrup from sucrose; use of proteases in food, detergent and leather industry; medical application of enzymes; use of glucose oxidase as enzyme biosensor, Ribozymes, Xeno nucleic acids.

UNIT-V: Bioenergetics: Biological oxido-reduction, Oxido-Reduction potential, Electron transport chain (ETC), ATP generation in ETC, Mechanism of Oxidative phosphorylation, ATP synthase, Incomplete reduction of oxygen.

COURSE OUTCOMES:

At the end of the course students will be able to

CO1: Understand the basics of enzymes
CO2: Analyze the knowledge of isolation & purification of enzymes and their mechanisms of action
CO3: Analyze the thorough knowledge of Enzyme kinetics
CO4: Understand the generation of high energy compounds.
CO5. Analyze the various applications of enzymes in industries.

TEXT BOOKS:

1. Biochemical Calculations, lrwin H. Segel, John Wiley and Sons Inc.
2. General Chemistry. Linus Pauling, W.H. Freeman & Company.
3. Organic Chemistry, DJ Cram and GS Hammond, McGraw Hill.
4. Biochemistry, D Voet and JG Voet, J Wiley and Sons.
5. Physical Biochemistry, D Freifilder, W.H. Freeman & Company.

REFERENCES:

1. Enzyme Kinetics: Catalysis &control by Daniel Purich, academic press 1st ed.
2. Contemporary enzyme kinetics and mechanisms, DanielPurich, academic press, 3rd ed.

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PROGRAM CORE IX

MEDICAL MICROBIOLOGY

Course objectives: To provide the knowledge of various methods used to detect the pathogens and their diagnosis.

UNIT-I: INTRODUCTION: Introduction to Medical Microbiology, pathogenesis, components of microbial pathogenicity Population genetics of Microbial pathogenesis, methods to detect genetic diversity and structure in natural population, epidemiology, cryptic diseases.

UNIT-II: HOST DEFENCES & MODULATION OF IMMUNE RESPONSE: Host defense against pathogens, clinical importance of understanding host defense, components of the host surface defence systems like skin, mucosa, eye, mouth, respiratory tract Components of the systemic defense like the tissues and blood Modulation of immune response by vaccines, properties of vaccines, other immuno modulators.

UNIT-III: BACTERIAL INFECTIONS: Diphtheria disease by colonisation; Disease without colonisation, *Clostridium botulinum* and *Staphylococcus aureus;* Intestinal infections, *Shigella* and *Ecoli* infections; *Vibrio cholera, Salmonella* infections.

UNIT-IV: VIRULENCE AND HOST PARASITE INTERACTIONS: Virulence and virulence factors, Colonizing virulence factors, Virulence factors damaging host tissues, Measurement of virulence factors, virulence genes & regulation of virulence genes. Host parasite interactions related to bacterial and viral infections.

UNIT-V: Applications of Medical Microbiology: Gastric and duodenal ulcers, Lyme disease , Syphilis, Legionnaire's disease, Tuberculosis and other mycobacterial infections reemerging with vengeance Rheumatic fever and Glomerulo nephritis.

COURSE OUTCOMES:

At the end of the course students will be able to:

CO1: Understand the knowledge of introduction to microbial pathogenesis.
CO2: Evaluate the knowledge of host defense system against pathogens.
CO3: Understand the bacterial infections and their pathogenesis.
CO4: Analyze the knowledge of virulence and host parasite interactions with related to bacterial infections.
CO5: Analyze the future challenges of infections and their treatments.

TEXT BOOKS:

1. Iglewski B.H. and Clark V.L. Molecular basis of Bacterial pathogenesis, Academic press, 1990.
2. Janeway C.A. Jr, and Travers P. T. Immunobiology. Blackwell J Scientific Publishers, 1994.

REFERENCES:

1. Talaro K. and Talaro A. Foundations in Microbiology, W.C. Brown Publishers, 1993. Roitt I. Essentials of Immunology, 8th edition, Blackwell Scientific Publishers, 1994.
2. Austyn J.M. and Wood K.J. Principles Cellular and Molecular Immunology, OxfordUniversityPress,1993.

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PROGRAM ELECTIVE III

i.BIOANALYTICAL TECHNIQUES

Course Objectives: The objective of the course is to create general understanding of Microscopy, Spectroscopy, Electrophoresis, Sequencing methods and different chromatographic methods.

UNIT-I: MICROSCOPY: Microscopy (Theory: Simple and Compound, Types: Light Field, Dark Field, Phase Contrast, SEM, TEM, Fluorescent).

UNIT-II: SPECTROSCOPY: Spectroscopy techniques: (Theory of Light) UV, IR, NMR, LASER Raman Spectroscopy, Fluorescence Spectroscopy.

UNIT-III: RADIATION AND FLOURESCENCE BASED METHODS: Radioactivity, measurement of radioactivity, photographic emulsion, ionization chamber, autoradiography, RIA, Fluorescent and Chemiluminiscent methods, Fluorescent Probes, FISH.

UNIT-IV: SEQUENCING OF PROTEINS AND NUCLEIC ACIDS: N-terminal sequencing for determination of protein sequence (Edman degradation); MALDI-TOF analysis Nucleic acid sequencing automated methods (Sangers Dideoxy and Maxim Gilbert methods) and determination technologies.

UNIT-V: SEPARATION TECHNIQUES: Centrifugation: Preparative and analytical; Electrophoresis: Different methods of electrophoresis for protein, nucleic acids, small molecular weight compounds and immuno precipitates (Immuno electrophoresis), IEF; Chromatography: Adsorption, affinity, Ion exchange, gel permeation, TLC, GLC, RPC, HPLC etc.

COURSE OUTCOMES:

At the end of the course student will be able to

CO1: Evaluate the Comprehensive understanding on microscopic techniques.
CO2: Understand Knowledge on spectroscopy and principles of Beer- Lamberts Law.
CO3:Assess the knowledge on radioactivity, measurement of radioactivity and different Radiolabelled and fluorescence labelled based techniques involved in Biotechnology.
CO4: Analyze the different techniques involved in sequencing of proteins and nucleic acids
CO5: Understand on different biomolecules separation techniques like chromatography, Electrophoresis sedimentation and centrifugation.

TEXTBOOKS:

1. Essentials of Molecular Biology, David Friefilder, Jones and Barllett Publications.
2. Proteins-Structure and Molecular Properties. TE Creighton, WH Freeman and company.
3. Genes VII, B. Lewin, Oxford University Press.
4. Introduction to Protein Structure, C. Branden and J. Tooze, Garland Publishing, New York.
5. Encyclopaedia of Molecular Biology, J. Kendrew, Blackwell Scientific Publications, Oxford.
6. Physical Chemistry of Macromolecules, Tanford, C., John Wiley and Sons.
7. Introduction to Biophysical Chemistry, RB Martin, McGraw Hill, New York.
8. Biophysical Chemistry, Cantoz, WH Freeman.
9. Protein Structure, by Max Perutz.

REFERENCE BOOKS:

1. Hobert H Willard D. L. Merritt & J. R. J. A. Dean, Instrumental Methods of Analysis, CBS Publishers & Distributors, 1992
2. Vogal, Text Book of Quantitative Inorganic Analysis, 1990
3. Ewing, Instrumental Methods of Analysis, 1992
4. PranbkumarBanerjee,Introduction to Biophysics, S.chand Publications,2008.
5. Instrumental methods of chemical analysis-GurudeepR.ChatwAL 7 Sham K.Anand,Himalaya Publishing house,ISBN.
6. Principles & Techniques of Practical Biochemistry 5th edition. K. Wilson &J.Walker, Cambridge University Press, 2000.

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PROGRAM ELECTIVE III

ii. RESEARCH METHODOLOGY & COMMUNICATION SKILLS

Course Objectives: - - To use the framework of these methodologies for understanding effective lab practices and scientific communication - To use the framework of these methodologies to understand and appreciate scientific ethics.

Unit-I: History of Science and Science Methodologies Empirical science; The scientific method; Interrogative perturbation experiments and controls; Deductive and inductive reasoning; Descriptive science; Reductionist Vs holistic biology.

Unit-II: Preparation for Research Choosing a mentor, lab and research question; maintaining a lab notebook with date-wise entry.

Unit-III: Process of Communication Concept of effective communication- Setting clear goals for communication; Determining outcomes and results; Initiating communication; Avoiding repetitions & breakdowns while communicating; Creating value in conversation; Barriers to effective communication; Non-verbal communication Interpreting non-verbal cues; Importance of body language, Power of effective listening; recognizing cultural differences.

Unit-IV Presentation skills - Formal presentation skills; Preparing and presenting using Over Head Projector, Power Point slides with clearly legible fonts without crowding the content; Defending Interrogation; Scientific poster preparation & presentation; Participating in group discussions Computing Skills for Scientific Research Web browsing for information search; search engines and their mechanism of searching; Hidden Web and its importance in Scientific research; Internet as a medium of interaction between scientists; Effective email strategy using the right tone and conciseness.

Unit-V: Scientific Communication Technical Writing Skills - Types of reports; Layout of a formal report; Scientific writing skills - Importance of communicating science; Problems while writing a scientific document; Plagiarism; Scientific publication writing: Elements of a scientific paper including Abstract, Introduction, Materials & Methods, Results, Discussion, References; Drafting titles and framing abstracts; Publishing scientific papers - the peer review process and problems, recent developments such as open access and non-blind review; Plagiarism; Characteristics of effective technical communication; Scientific presentations; Ethical issues; Scientific misconduct.

COURSE OUTCOMES:

At the end of the course students will be able to:

CO1. Understand the an awareness of methodologies used to do research
CO2. Analyze the methodology for proper initiation and execution of research
CO3. Understand the knowledge of effective communication methods
CO4. Evaluate the knowledge of proper presentation skills
CO5. Analyze to get good knowledge of scientific communication and technical writing

TEXTBOOKS & REFERENCES:

1. Valiela, I. (2001). Doing science: Design, analysis, and communication of scientific research. Oxford: Oxford University Press.
2. On being a scientist: A guide to responsible conduct in research. (2009). Washington, D.C.: National Academies Press.
3. Gopen, G. D., & Smith, J. A. (n.d.). The Science of Scientific Writing. American Scientist, 78(Nov-Dec 1990), 550-558.

REFERENCE BOOKS:

1. Mohan, K., & Singh, N. P. (2010). Speaking English effectively, Delhi: Macmillan India.
2. Movie: Naturally Obsessed, The Making of a Scientist.

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OPEN ELECTIVE III

i. FOOD SCIENCE AND TECHNOLOGY

COURSE OBJECTIVES: This course enables students to understand the food laws, food chemistry, food microbiology, preservation techniques and knowledge of food hygiene & food quality.

UNIT-I: INTRODUCTION TO FOOD SCIENCE & TECHNOLOGY: Fundamentals and aims of food science and technology. Interdisciplinary approach, Nutritive value of foods, Food as a source of energy, Food Health and disease. Food laws: Overview of Food Safety Standards Act 2006, Food Safety Standards Rules & Regulations, 2011. Overview of other relevant national bodies (e.g. APEDA, BIS EIC, MPEDA, Spice Board) Overview of Codex Alimentarius - development and issue of standards, Committees under Codex, role in maintaining harmony in food standards.

UNIT-II: FOOD CHEMISTRY Food chemistry-definition and importance, water in food, water activity and shelf life of food. Carbohydrates- functional properties of sugars and polysaccharides in foods. Lipids: use of lipids in foods, physical and chemical properties, effects of processing on functional properties and nutritive value. Protein and amino acids: physical and chemical properties, distribution, amount and functions of proteins in foods, functional properties, effect of processing. -Losses of vitamins and minerals due to processing.

UNIT-III: FOOD MICROBIOLOGY Microbial growth pattern, Types of micro-organism normally associated with food mold, yeast, and bacteria. Micro-organisms in natural food products. Contaminants of foods-stuffs, Fisheries, milk and meat during handling and processing. Biochemical changes caused by micro-organisms, deterioration of various types of food product. Food poisoning and microbial toxins, standards for different foods. Food borne intoxicants and mycotoxins.

UNIT-IV: FOOD PRESERVATION, PROCESSING AND PACKAGING: Physical chemical and biological methods of preservations. Bioprocessing of meat, Fisheries, vegetables, diary products. Irradiated foods. Overview of food packaging methods and principles including novel packaging materials/techniques.

UNIT-V: GENERAL PRINCIPLES OF FOOD HYGIENE AND FOOD QUALITY ASSURANCE: General principles of food safety management systems including traceability and recall – sanitation, HACCP, Good production and processing practices (GMP,GAP,GHP, GLP, BAP, Principles of Quality assurance and Quality control with reference to food analysis and testing

Course outcomes:

At the end of the course students will be able to:

CO1: Understand about food science and technology
CO2: To know the chemical properties of food
CO3: Identify the microbiology of food
CO4: Provide solution for pathogenic and spoilage microorganisms associated with different foods and their commercial importance.
Co5: Explain the various principles of food hygiene and food quality assurance

Text Books:

1. Jay J.M. 1986. Modern Food Microbiology, 3rd Edn. VNR, New York
2. Food processing and Preservation PHI private itd, New Delhi
3. Food Microbiology fourth edition William C.Frazier, Tata Mc Graw Hill
4. Food Microbiology 2nd Edition, Michael P. Doyle , ASM press
5. Fennema, O.R. Ed. 1976. Principles of Food Science: Part-I Food Chemistry Marcel Dekker, New York.
6. Mever. L.H. 1973. Food Chemistry. East-West Press Pvt. Ltd., New Delhi.
7. Charalambous, G. and Inglett, G. 1981. The Quality of Foods and Beverages, (2 vol. set). Academic Press, New York.
8. Krammer, A. and Twigg, B.A. 1970. Quality Control for the Food Industry. 3rd Edn. AVI, Westport.

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OPEN ELECTIVE III

ii. PHARMACEUTICAL MICROBIOLOGY

COURSE OBJECTIVES: This course enables students to understand the microorganisms in pharmaceutical industry, mechanism and action of antibiotics on microorganisms, Regulatory practices and quality assurances, GMP and GLP in pharmaceutical industry.

Unit- I: Prokaryotic and Eukaryotic Cells in Biosimilars Production:
Actinomycetes in Biosimilar Production, *Saccharomyces cerevisiae* and Other Fungi in Biosimilar Production, Plants in Biosimilar Production, Transgenic Plants as Functional Foods or Neutraceuticals Transgenic Plants and Plant Cell Culture as Bioreactors of Secondary Metabolites.

Unit-II: Antibiotics:
Antibiotics-definition, types of antibiotics and their classification. Mode of action of important drugs-cell wall inhibitors (betalactum- eg, penicillin) membrane inhibitors (polymyxin), macromolecular synthesis inhibitors (streptomycin), antifungal antibiotics (nystatin). Drug resistance- The phenomenon clinical basis of drug resistance, biochemistry of drug resistance, genetics of drug resistance in bacteria. Non-medical use of antibiotics.

Unit- III: Microbes in Pharmaceutical Products:
Microbial contamination and spoilage of pharmaceutical products (sterile injectibles, non injectibles, ophthalmic preparations and implants) and their sterilization. Manufacturing procedures and in process control of pharmaceuticals. Other pharmaceuticals produced by microbial fermentations (streptokinase, streptodornase); Protein and DNA Vaccines.

Unit-IV: Regulatory Practices and Quality Assurance:
Regulatory aspects of quality control & Quality assurance; Quality assurance and Quality management in pharmaceuticals ISO, WHO and US certification; Financing R&D capital and market outlook; Pharmacopeias - IP, BP, USP. Government regulatory practices and policies - FDA perspective; USFDA, WHO and ICH Introduction to ISO series.

Unit- V: GMP & GLP:
Good Manufacturing Practices (GMP) and Good Laboratory Practices (GLP) in pharmaceutical industry. Sterilization control and sterility testing (heat sterilization, D value, z value, survival curve, Radiation, gaseous and filter sterilization); Chemical and biological indicators; Design and layout of sterile product manufacturing unit (Designing of Microbiology laboratory); Safety Levels in microbiology laboratory.

Course outcomes:

At the end of the course students will be able to:

Co1: Understand about Microorganisms in Pharmaceutical industry
Co2: To know the mechanism and action of various antibiotics on microorganisms
Co3: Identify the microbes in pharmaceutical products
Co4: Evaluate the various regulatory practices and Quality assurance in pharma industry
Co5: Analyze the Good manufacturing and lab practices in pharmaceutical industries

SUGGESTED BOOKS:

1. W.B.Hugo & A.D.Russell *Pharmaceutical Microbiology*. Blackwell ScientificPublications.
2. Frederick Kavanagh *Analytical Microbiology* Academic Press New York.
3. David C. Hooper, John S. Wolfson *Quinolinone antimicrobial agents*. ASMWashington DC.
4. Murray S.Cooper *Quality control in the Pharmaceutical Industry*. AcademicPress New York.
5. H.J.Rehm & G.Reed, *Biotechnology*. VCH Publications, Germany.
6. S.P.Vyas & V.K.Dixit *Pharmaceutical Biotechnology*. CBS Publishers &Distributors, New Delhi.
7. Sydney H.Willig, Murray M.Tuckerman, William S. Hitchings, Mercel Dekker
   Good Manufacturing Practices for Pharmaceuticals New York.
8. Gregory Gregoriadis *Drug Carriers in biology & Medicine*. Academic Press New

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LAB V

r-DNA TECHNOLOGY & MEDICAL MICROBIOLOGY LAB

PART-A: r-DNA TECHNOLOGY LAB

Course Objective: This course intends to provide practical knowledge of different techniques involved in r-DNA technology.

LIST OF EXPERIMENTS:

1. Isolation of DNA
2. PCR-Amplification of DNA
3. Restriction digestion , Gel extraction
4. Ligation
5. Screening for recombinants

Course Outcome: By the end of this course student will acquire skill to perform techniques involved in isolation restriction digestion & ligation of DNA and screening of recombinants

PART- B: MEDICAL MICROBIOLOGY LAB

Course Objective: This course intends to provide the practical knowledge of different techniques used in medical microbiology lab.

LIST OF EXPERIMENTS:

1. Preparation of medically important media
2. Urea estimation
3. Glucose estimation
4. Acid-Fast staining
5. Bacteriological examination of blood, urine & pus
6. Determination of Hemoglobin
7. Erythrocyte Sedimentation Rate
8. Collection and culture of Nosocomial micro-organisms

Course Outcome: By the end of this course student will acquire skill to perform different methods used in medical field.

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LAB VI

ENZYMOLOGY, BIOENERGETICS & BIOANALYTICAL TECHNIQUES LAB

PART-A: ENZYMOLOGY AND BIOENERGETICS LAB

Course Objective: This course intends to provide the practical knowledge required to study different aspects of microbial enzymes

LIST OF EXPERIMENTS:

1. Isolation of industrially important microorganisms for microbial processes.
2. Determination of thermal death point (TDP) and thermal death time (TDT) of microorganism for design of a sterilizer.
3. (a) Determination of growth curve of a supplied microorganism and also determine substrate degradation profile.(b) Compute specific growth rate (m), growth yield ($Y_{x/s}$,) from the above
4. Comparative studies of Ethanol production using different substrates.
5. Production of Citric acid using *Aspergillus niger.*
6. Production and estimation of Alkaline Protease.
7. Use of alginate for cell immobilization.
8. Enzyme catalysis experiment

Course Outcome: By the end of this course student will acquire skill for production and estimation of microbial enzymes.

PART- B: BIOANALYTICAL TECHNIQUES LAB

Course objective: The main objective of this course is to gain knowledge on different analytical techniques involved in microbiology.

LIST OF EXPERIMENTS:

1. Microscopy: Compound and Fluorescence Microscopy
2. Electrophoresis of Proteins - native and under denaturing conditions –silver staining, coomasive staining.
3. Determination of Tm of nucleic acid.
4. Separation techniques (HPLC, GPC, FPLC, Ion-Exchange).
5. IEF Demonstration

Course outcomes: at the end of this course student gain practical training on different analytical techniques like microscopy Electrophoresis and Different chromatographic techniques.

M.Sc. Microbiology	2021

THESIS TEMPLATE

TITLE NAME

(Capital letters only, Centre & Bold, Bookman Old style -14)

A THESIS

(Centre & Bold, Bookman Old style - 12)

Submitted

(Italic, Centre & Bold, Bookman Old style - 12)

in the partial fulfillment of the requirements for the award of degree

(Italic, Centre & Bookman Old style -12)

MASTER OF SCIENCE

IN

MICROBIOLOGY

(Centre & Bold, Bookman Old style -14, Space line 1.5)

By

Mr. or **Miss. SAI MANISHA MALLELA**

[Roll No.: 19031D03**]

(Centre & Bold, Bookman Old style -14 & 12, Space line 1.5)

Under the supervision of

(Italic, Centre & Bookman Old style - 12)

Dr. K. VENKATESHWAR REDDY

Assistant Professor (C)

(Centre & Bold, Bookman Old style -14 & 12, Space line 1.5)

CENTRE FOR BIOTECHNOLOGY

INSTITUTE OF SCIENCE AND TECHNOLOGY,

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A-GRADE

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Kukatpally, Hyderabad – 500 085, Telangana State (India)

Dr. L. SAIDA, Ph.D.
Asst. Professor & Head

Hyderabad
Date:

CERTIFICATE

This is to certify that the dissertation entitled "**TITLE**" is being submitted by Mr./Miss. **Name** bearing Roll No.: ------ to the Centre of Biotechnology, Institute of Science and Technology, Jawaharlal Nehru Technology University Hyderabad in partial fulfillment for the award of **Master of Science** in **Biotechnology/ Microbiology** is a record of bonafide work carried out under the supervision of **Dr. K.VENKATESHWAR REDDY**, Assistant Professor (C), CBT, IST, JNTUH, Hyderabad.

Dr. L. Saida Naik
(**Head of the Department**)

If possible **Saida sir** students only write as:
is a record of bonafide work carried out by **him/her** at our organization/ institution. And remaining faculty members write as above format.

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(Established by Govt. Act No. 30 of 2008)
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Assistant Professor (C)

Hyderabad
Date:

CERTIFICATE

This is to certify that the dissertation entitled "**TITLE**" is being submitted by Mr./Miss. **Name** bearing Roll No.: ------- to the Centre of Biotechnology, Institute of Science and Technology, Jawaharlal Nehru Technology University Hyderabad in partial fulfillment for the award of **Master of Science** in **Biotechnology/ Microbiology** is a record of bonafide work carried out by **her/him** under my guidance and supervision.

The results embodied in this thesis have not been submitted to any other University or Institute for the award of any degree or diploma.

Dr. K. Venkateswar Reddy
(**Research Supervisor)**

Outside Project work students done by
Different Institutions Organization Certificates

With Letter Head/Letter Pad
(Soft/Hard copy, Taken/Collect in the department Office or Colour print)

DECLARATION

I hereby declare that the project work embodied in the dissertation entitled "**TITLE**" is being submitted to CBT, IST, JNTUH was carried out by me at Centre for Biotechnology (CBT), Institute of Science and Technology (IST), under the supervision of **Dr. Venkateshwar Reddy**, Assistant Professor (C), Centre for Biotechnology, Institute of Science and Technology, JNTUH. This report is submitted in partial fulfillment for the award of Master of Technology in Biotechnology at CBT, IST, Jawaharlal Nehru Technological University Hyderabad, Kukatpally – 500 085, Hyderabad, Telangana State, India.

This work is original and no part of this has been submitted to any other university or institute for the award of any degree or diploma.

Place: Hyderabad

Date:

Signature

(**Name**)

Reg. No.:------

ACKNOWLEDGEMENTS

(Acknowledge assistance from **advisors, sponsors, funding agencies, colleagues, technicians**, and so on.)

My sincere thanks to **Dr. L. SAIDA**, Assistant Professor and Head of the Department for permitting me to carry out the project work at Centre for Biotechnology, IST JNTUH.

My Sincere thanks to **Dr. ARCHANA GIRI**, Professor, Centre for Biotechnology, IST JNTUH for giving me an opportunity to perform lab work and to be a valued member of her team.

My heartfelt thanks to **Dr. A. UMA,** Associate Professor, and Centre for Biotechnology, IST JNTUH for guiding and supporting me throughout my project work at Centre for Biotechnology Laboratory.

My thanks are owed to **Teaching Staffs**, **Non-teaching staff's** members and Colleagues in the Biotechnology department of IST, JNTUH.

I would like to express my sincere thanks to all the **Colleagues** and **Ph.D scholars** of Centre for Biotechnology, IST, JNTUH for their valuable suggestions and support.

(**Name**)
Reg. No.: -----

ABSTRACT

- The abstract may not exceed **500 words** for a master's. In style, the abstract should be a miniature version of the thesis. It should be a briefly state the (1) Research problem, (2) Methodology, (3) Key summary of the results, (4) Conclusions or main arguments presented in the thesis.
- Abstract should be in minimum 3 to 5 paragraphs and **justify** with **1.5 space** lines**.**
- **Key words:** Minimum 5 key words**.**

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LIST OF ABBREVATIONS

Abbreviation	Signification
DNA	Deoxyribonucleic acid
RNA	Ribonucleic acid

UNITS OF MEASUREMENTS & SYMBOLS	
cm	: Centimetre
^{o}C	: Degree Celsius
gm	: Gram
h	: Hour
kg	: Kilogram
µg	: Microgram
mg	: Milligram
mM	: Millimolar
mm	: Millimeter
µm	: Micrometer
µl	: Microlitre
ml	: Millilitre
min	: Minutes
M	: Molar concentration

FULL THESIS FORMAT GUIDELINES IN DETAILS
(CBT, IST, JNTUH)
Thesis Templates

Some of our students have contributed thesis templates which you may find helpful as you begin your thesis writing. If you have developed a template that you would like to share, please let us know and we will add it to our department of CBT.

- **Thesis hard copy** should be in **A4 Size** format with **300 gsm Gray sheet** soft binding.
- The thesis document is to be **printed on single side of the executive bond-paper**.

Fonts Size & Spacing:

- All the text words should be in **Times new roman** and font size is **12**.
- All text words should be **Justified** with **1.5 space line**
- Only footnotes, long quotations, bibliography entries should be double spaced, table captions, and similar special material may be single spaced.
- Paragraph to paragraph **1.0 cm** distance.
- All **headings** should be same font and **bold**, size is **12**.

Margins:

- We recommend a **left margin of "1.5**" and a **top, bottom,** and **right margin of "1.0**".
- **Page numbers** do not need to meet the "1.0" margin requirement.
- If you do not follow the appropriate margin guidelines that are included here, you might lose content if your thesis is bound. Some students may wish to extend their work beyond the margin requirement for aesthetic reasons, this is acceptable.
- Labels for the Tables, Figures and Structures should be **centred**.

Table of contents:

- List the key **subject headings** and **subheadings** of your thesis with their page numbers.

List of figures:

- Include the figure numbers, figure titles, and page numbers.

List of tables:

- Include the table numbers, table titles, and page numbers and all text words should be **justified** with **1.0 space line anywhere in complete thesis.**

Hyperlinks:

- **Hyperlinks are not to be used** as a substitute for complete bibliographic citations.

Page numbering:

- Page numbers should be placed in the upper/ lower right corner of the page. Only the number should appear, not "page 9" or the abbreviation "p. 9."
- On the first page of each chapter, the number may be placed at the centred bottom, one double space below the last line of type (the conventional placement), or at the top right corner.

Body:

In the thesis body, you provide the introduction, narrative, and analysis of your work. The body includes these elements/chapters:

- **1. Introduction:** State (1) the purpose of the investigation, (2) the problem being investigated, (3) the background (context and importance) of the problem and **Objectives**.
- **2. Review of Literature:** It should be written based on update previous literature/available related to your work.
- **3. Materials, apparatus**, and **procedures:** List and describe key materials and apparatus. Then describe the procedure in detail that others can duplicate it. For design studies, this section includes component design, fabrication, assembly, and testing procedures. Use illustrations.
- **4. Results:** Present the results, usually with accompanying tables and graphs. Characterize the patterns and quality of the results and estimate their accuracy and precision. Detailed data may be presented as an appendix. Use analytical graphics.
- **4. Discussion:** Discuss the results, stating clearly what their significance is over the earlier reports. Compare the results with theoretical expectations and account for anything unexpected.
- **5. Conclusions:** Review the results in relation to the original problem statement. Assess the success of the study in light of the criteria of success you gave in the introduction.
- **6. Bibliography:** List alphabetically any works referred to in your study. Follow the bibliographical and footnote formats of your department.
- **Recommendations:** If applicable, recommend directions for future work.
- **Appendixes:** Provide detailed calculations, procedures, and data in separate appendixes. Give each appendix a title, a letter (Appendix A, B, C), and an introductory paragraph.

Standard References order should be following format:

1) All **Authors Names** included followed by **Year** of publication.
2) **Title of the publication**.
3) **Journals Names/ Title of the book; Subtitle & Publisher Names** (this should be written in ***italics***).
4) **Volume, Issue** and **Page Number**.
5) **Digital object identifiers** (DOIs) are commonly featured in reference entries for journal articles, as well as in entries for other types of electronic resources, **if available**.

Examples:

One Author:

1. Binnall, J. M (2019). Jury diversity in the age of mass incarceration: An exploratory mock jury experiment examining felon-jurors' potential impacts on deliberations. *Psychology, Crime & Law*, 25(4): 345–363. **DOI:** 10.1080/1068316X.2018.1528359.

Two Authors:

1) Machado, M. M., & Swank, J. M (2019). Therapeutic gardening: A counselling approach for bereavement from suicide. *Death Studies*, 43(10): 629–633. **DOI:** 10.1080/07481187.2018.1509908.

Three to More Authors:

1) Prinzie, P., Stams, G. J. J. M., Deković, M., Reijntjes, A. H. A., & Belsky, J (2009). The relations between parents' Big Five personality factors and parenting: A meta-analytic review. *Journal of Personality and Social Psychology*, 97(2): 351–362. **DOI:** 10.1037/a0015823.

If Book Chapters/ Text Books like:

1) Bale, T., Webb, P., & Poletti, M (2020). Foot soldiers: Political party membership in the 21st century. Oxford University Press. Routledge.

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- The plagiarism should be **less than 30**, if it is **more** than can't accept the thesis.

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