SYLLABUS

M.Sc. Biotechnology (With CBCS)
2019-2021

M.Sc. Sem I 2019
M.Sc. Sem II 2020
M.Sc. Sem III 2020
M.Sc. Sem IV 2021

DEPARTMENT OF BOTANY AND BIOTECHNOLOGY

LACHOO MEMORIAL COLLEGE OF SCIENCE AND TECHNOLOGY (AUTONOMOUS), JODHPUR

Recognized by UGC under section 2 (f) and 12 (B)
Accredited by NAAC - UGC with 'A' grade in three consecutive cycles
Selected as College with Potential for Excellence (CPE) by the UGC
Selected under Star college scheme by the Department of Biotechnology,Govt. of India
Status of Model College (Centre for Excellence) awarded by Govt. Of Rajasthan

POST-GRADUATION IN BIOTECHNOLOGY

The Department offers a two- year integrated programme leading to Masters (M. Sc.) degree in Biotechnology. From the academic year 2017 -18, the Department is offering to students Choice Based Credit System (CBCS) with semesterization of the examination pattern.

GUIDELINES FOR CHOICE BASED CREDIT SYSTEM

Definitions of Key Words:

1. **Academic Year**: Two consecutive (one odd + one even) semesters constitute one academic year.
2. **Choice Based Credit System (CBCS):** The CBCS provides choice for students to select from the prescribed elective and skill courses. Each student need to select **one special/ elective paper** offered by the Department in which he/she is doing core course. This shall be part of core programme **during third semester**. Each student has to complete three **skill courses**: two within the Department and one from other Department within the college.
3. **Course**: Usually referred to, as 'papers' is a component of a programme. All courses need not carry the same weight. The courses should define learning objectives and learning outcomes. A course may be designed to comprise lectures/ tutorials/laboratory work/ field work/ project work/ self-study etc. or a combination of some of these.
4. **Credit Based Semester System (CBSS)**: Under the CBSS, the requirement for awarding a degree is prescribed in terms of number of credits to be completed by the students.
5. **Credit Point**: It is the product of grade point and number of credits for a course.
6. **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 period of teaching (lecture or tutorial) or two periods of practical work/field work per week.
7. **Cumulative Grade Point Average (CGPA)**: It is a measure of overall cumulative performance of a student over all semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.
8. **Grade Point**: It is a numerical weight allotted to each letter grade on a 10-point scale.
9. **Letter Grade:** It is an index of the performance of students in a said course. Grades are denoted by letters O, A+, A, B+, B, C, P and F.
10. **Programme**: An educational programme leading to award of the Postgraduate Degree in the Core subject in which he/she is admitted.
11. **Semester Grade Point Average (SGPA)**: It is a measure of performance of work done in a semester. It is ratio of total credit points secured by a student in various courses registered in a semester and the total course credits taken during that semester. It shall be expressed up to two decimal places.
12. **Semester**: Each semester will consist of 15-18 weeks of academic work equivalent to 90 actual teaching days. In the **fourth semester** the student shall carry out a minimum of three months of dissertation (research work/ training) in a recognized laboratory of any University / Institute/ Organization/Industry.
    The odd semester may be scheduled from July to November/ December and even semester from December/January to May.
13. **Transcript or Grade Card or Certificate:** Based on the grades earned, a statement of grades obtained shall be issued to all the registered students after every semester. This statement will display the course details (code, title, number of credits, grade secured) along with SGPA of that semester and CGPA earned till that semester.

Fairness in Assessment:

Assessment is an integral part of system of education as it is instrumental in identifying and certifying the academic standards accomplished by a student and projecting them far and wide as an objective and impartial indicator of a student's performance. Accordingly the BOS resolves the following:

a. All internal assessments shall be open assessment system only and that are based on test/ seminar.
b. Attendance shall carry the prescribed marks in all papers and Practical examination CCA.
c. In each semester two out of four theoretical component End Semester Examination shall be undertaken by external examiners from outside the college, who may be appointed by the competent authority.

Grievances and Redressal Mechanism

a) The students will have the right to make an appeal against any component of evaluation. Such appeal has to be made to the Head of the Department concerned as the case may be clearly stating in writing the reason(s) for the complaint / appeal.

b) The appeal will be assessed by the Principal as the Chairman and he shall place it before the **Grievance Redressal Committee (GRC)** comprising all HODs of the Faculty and if need be Course Teacher(s) be called for suitable explanation; GRC shall meet at least once in a semester and prior to CCA finalization.

c) The Committee will consider the case and may give a personal hearing to the appellant before deciding the case. The decision of the Committee will be final.

Table 1: Grades and Grade Points

S.No.	Letter Grade	Meaning	Grade Point
1	'O'	Outstanding	10
2	'A+'	Excellent	9
3	'A'	Very Good	8
4	'B+'	Good	7
5	'B'	Above Average	6
6	'C'	Average	5
7	'P'	Pass	4
8	'F'	Fail	0
9	'Ab'	Absent	0

i. A student obtaining Grade 'F' in a paper shall be considered failed and will be required to reappear in the University End Semester Examination.

ii. For noncredit courses (Skill Courses) 'Satisfactory' or "Unsatisfactory' shall be indicated instead of the letter grade and this will not be counted for the computation of SGPA/CGPA.

Grade Point assignment

=and > 95 % marks Grade Point 10.0
90 to less than 95 % marks Grade Point 9.5
85 to less than 90 % marks Grade Point 9.0
80 to less than 85 % marks Grade Point 8.5
75 to less than 80 % marks Grade Point 8.0
70 to less than 75 % marks Grade Point 7.5
65 to less than 70 % marks Grade Point 7.0
60 to less than 65 % marks Grade Point 6.5
55 to less than 60 % marks Grade Point 6.0
50 to less than 55 % marks Grade Point 5.5
45to less than 50 % marks Grade Point 5.0
41to less than 45 % marks Grade Point 4.5
= 40 % marks Grade Point 4.0

Computation of SGPA and CGPA:

i. The SGPA is the ratio of sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student,
i.e.

$$\textbf{SGPA}\ (Si) = \Sigma\ (Ci \times Gi) / \Sigma Ci$$

WhereCi is the number of credits of the ith course and Gi is the grade point scored by the student in the ith course.

ii. The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a program,
i.e.

$$\textbf{CGPA} = \Sigma\ (Ci \times Si) / \Sigma\ Ci$$

Where Si is the SGPA of the ith semester and Ci is the total number of credits in that semester.

iii. The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

***Illustration* for SGPA:**

S.No.	Course	Credit	Grade letter	Grade point	Credit Point (Credit x Grade)
1	Course 1	**4**	**B**	**6**	**4 x 6 =24**
2	Course 2	**4**	**B+**	**7**	**4 X 7 =28**
3	Course 3	**4**	**B**	**6**	**4X 6 = 24**
4	Course 4	**4**	**O**	**10**	**4 X 10 =40**
5	Course 5 Practical I	**4**	**C**	**5**	**4 X 5 =20**
6	Course 6 Practical II	**4**	**B**	**6**	**4 X 6 = 24**
	Total	**24**			**24+28+24+40+20+24 =160**

Thus, **SGPA =160/24 =6.67**

***Illustration* for CGPA:**

	Semester- I	Semester-II	Semester-III	Semester-IV
Credit	**24**	**24**	**24**	**24**
SGPA	**6.67**	**7.25**	**7**	**6.25**

CGPA = (24X6.67+ 24X 7.25 + 24X7 + 24 X 6.25)/ 96

652.08/96 = 6.79

Semester-wise Theory Papers/Practical / Skill component(Biotechnology)

Type of course	Course code	Title of the Course	L-T-P*/Week	NC#	CCA$	ESE£	Total
Semester I							
Core course 1	MSBT111	Principles of Microbiology	4-0-0	4	30	70	100
Core course 2	MSBT112	Cell Biology, Genetics and Cytogenetics	4-0-0	4	30	70	100
Core course practical 1	MSBT121	Board I covering theory papers MSBT 111 and MSBT112	0-0-16(8+8)	4	30	70	100
Core course 3	MSBT113	Fundamentals of Immunology	4-0-0	4	30	70	100
Core course 4	MSBT114	Basic Molecular Biology	4-0-0	4	30	70	100
Core course practical 2	MSBT122	Board II covering theory papers MSBT 113 and MSBT114	0-0-16(8+8)	4	30	70	100
Skill Course I	MSBTSC131 As per the list		2-0-4				
Total				24	180	420	600
Semester II							
Core course 5	MSBT211	Principles of Biochemistry	4-0-0	4	30	70	100
Core course 6	MSBT212	Bioanalytical Techniques	4-0-0	4	30	70	100
Core course practical 3	MSBT221	Board I covering theory papers MSBT 211 and MSBT 212	0-0-16(8+8)	4	30	70	100
Core course 7	MSBT213	Computational Biology & Bioinformatics	4-0-0	4	30	70	100
Core course 8	MSBT214	Genetic Engineering, Genomics and Proteomics	4-0-0	4	30	70	100
Core course practical 4	MSBT222	Board II covering theory papers MSBT 213 and MSBT214	0-0-16(8+8)	4	30	70	100
Skill course II	MSBTSC231 As per the list		2-0-4				
Total				24	180	420	600
Semester III							
Core course 9	MSBT311	Environmental Biotechnology	4-0-0	4	30	70	100
Core course 10	MSBT312	Animal Cell Culture and Applications	4-0-0	4	30	70	100
Core course practical 5	MSBT321	Board I covering theory papers MSBT311and MSBT312	0-0-16(8+8)	4	30	70	100
Core course 11	MSBT313	Plant Biotechnology	4-0-0	4	30	70	100

Core course practical 6	MSBT322	Board II covering theory paper MSBT313	0-0-8	2	15	35	50
Discipline Specific Special Paper / Elective	MSBT314 A/B/C One paper from the list of elective papers		4-0-0	4	30	70	100
Discipline Specific Special Paper/Elective practical	MSBT323	Board III covering elective theory paper MSBT314 A/B/C	0-0-8	2	15	35	50
Skill course III	MSBTSC331 As per the list		2-0-4				
Total				24	180	420	600
Semester IV							
Core course 12	MSBT411	Dissertation	Minimum 03 months duration	4			100
Skill course IV[μ]	MSBTSC431		2-0-4				
Total							100

* Lecture – Tutorial -- Practical

[#]Number of Credits

[$] Continuous Comprehensive Assessment

[£] End- Semester Examination

[μ]In SEM IV, the Biotechnology student shall undertake only dissertation work. However, the students of other PG programme may opt for the skill course in the Department.

In view of the course content, the Department of Botany and Biotechnology distributed the Periods (**per paper**) for Lecture/Tutorial/Practical as under:

- 4 : 0 : 0 (four lectures only (no tutorial and no practical) per week) – For Theory
- 0 : 0 : 8 (no lecture, no tutorial, and eight practical only per week) – For Practical
- 2 : 0 : 4 (two lectures, no tutorial and four practical/field experimentations) – For Skill course

Course Evaluation:

I. Evaluation of the Students for Core/ Special (Elective) courses:

All courses (Core/ Elective) involve an evaluation system of students that has the following two components:-

A. **Continuous Comprehensive Assessment (CCA)** accounting for 30% of the final grade that a student gets in a course; and

B. **End-Semester Examination (ESE)** accounting for the remaining 70% of the final grade that the student gets in a course.

A. **Continuous Comprehensive Assessment (CCA)**:

(i) For Theory Paper:

This would have the following components:

a. **Test**: Two tests, each of 1 hour duration, having a maximum of 20 marks shall be arranged for each theory paper during the semester course period. The total of best two performances shall be taken into consideration for computation of marks. The question paper will consist of Part A, B & C. The Part B & C may have internal choice.

Types of question	Number of Questions	Marks per question	Total marks per type
Part A Very Short Answer - Definitions,	3	2	6
illustrations and short explanations (up to 30 words)	1	4	4
Part B Short Answer (up to 250 words)	1	10	10
Part C Long answer (500 words)			
Total	5		20

b. **Seminar:** A seminar having a maximum of 10 marks shall be arranged for each theory paper during the semester course period. The student will prepare slides and give presentation on topics allotted to them based on theory papers. The marks shall be awarded on the following basis:

i. Slide Presentation = 4 marks
ii. Viva Voce = 3 marks
iii. Hand written literature = 3 marks

c. **Classroom Attendance:** Each student will have to attend a minimum of 75% Lectures / Tutorials / Practical. A student having less than 75% attendance will not be allowed to appear in the End-Semester Examination (ESE). Attendance shall have 10 marks and will be awarded by following the system proposed below:

Those having greater than 75% attendance (for those participating in Co-curricular activities, 25% will be added to per cent attendance) will be awarded CCA marks as follows:-

75% to less than 80%	=	2 marks
80% to less than 85%	=	4 marks
85 to less than 90%	=	6 marks
90% to less than 95%	=	8 marks
= and > 95%	=	10 marks

II. **For Practical Paper:**

In laboratory courses (having only practical (*P*) component), the CCA marks will be awarded as follows:

a. Attendance : 10 marks
b. Others* : 20 marks

* Practical records, hands on Practical, attending educational tour, preparation and submission of tour report etc, (as applicable).

Each component marks will be added without rounding and the total thus obtained is ratio by a factor of two. This value shall be rounded.

Illustration:

Test 1	– Marks obtained = 10.5
Test 2	– Marks obtained = 15.5
Seminar	– Marks obtained = 4.5
Attendance	-- Marks obtained = 8
Total	= 38.5
Conversion	= 38.5/2 = 19.25
Award	= 19.00

B. End Semester Examination (ESE):

(i) For Theory Paper:

Part A

Ten short type questions (Definitions, illustrations, functions, short explanations, etc.; 25-50 words) for two marks each. 10 × 2= 20 marks; two questions from each Unit; no choice in this part.

Part B

Five short answer (250 words) type questions for four marks each. 5 × 4 = 20 marks; one question from each Unit with internal choice.

Part C

Five questions of long/explanatory answer (500 words) type, one drawn from each Unit; student need to answer any three; ten marks each; 3 × 10 = 30 marks.

20+20+30 = 70 marks

(ii)For Practical Paper:

Semester I & Semester II shall have Board I and Board II only. However, Semester III shall have Board I, Board II and Board III.

BOARD I:

Maximum Marks: 100 (including 30% CCA).

Duration: Six hours in a single day.

In Semester I, Semester II & Semester III, it includes course work of two theory papers (Paper I & Paper II).

BOARD II:

For Semester I & Semester II - Maximum Marks: 100 (including 30% CCA).

Duration: Six hours in a single day

It includes course work of next two theory papers (Paper III & Paper IV).

For Semester III –Maximum Marks: 50 (including 30% CCA).

Duration: Four hours in a single day

It includes course work of one theory paper (Paper III).

BOARD III:

Maximum Marks: 50 (including 30% CCA). It includes course work of special/ elective paper (Paper IV).

Duration: Four hours in a single day.

III. **Evaluation of the students for Skill Course:**

At the end of the semester, the performance of the student shall be evaluated. Each student has to submit a hand written literature on the topic assigned by the teacher. Based on his/her performance, hands - on practice and attendance (minimum 75%), the respective Department shall declare the result as "Satisfactory" or "Non-Satisfactory"; each student need to get three "Satisfactory" declaration for the course completion.

TEACHING AND EXAMINATION SCHEME

Per Semester*

Course	Periods/Week	Examination hours	CCA	ESE	Total
Core Course					
Theory Paper I	4	3	30	70	100
Theory Paper II	4	3	30	70	100
Theory Paper III	4	3	30	70	100
Theory Paper IV	4	3	30	70	100
Practical Courses In SEM I & SEM II					
Board I	8 per paper	6	30	70	100
Board II	8 per paper	6	30	70	100
Practical Courses In SEM III					
Board I	8 per paper	6	30	70	100
Board II	8 per paper	4	15	35	50
Board III	8 per paper	4	15	35	50

***Students are required to pass in Theory and Practical examination individually in each semester. However, in SEM IV, the student shall undertake only dissertation work (Maximum Marks 100).**

Qualifying for Next semester:

1. A student acquiring minimum of 40% in total of the CCA is eligible to join next semester.
2. A student who does not pass the examination (CCA+ESE) in any course(s) (or due to some reason as he/she not able to appear in the ESE, other conditions being fulfilled, and so is considered as 'Fail'), shall be permitted to appear in such failed course(s) in the subsequent ESE to be held in the following October / November or April / May, or when the course is offered next, as the case may be.
3. A student who fails in one or more papers in a semester shall get three more chances to complete the same; if he/she fails to complete the same within the prescribed time, i.e. three additional chances for each paper; the student is ineligible for the Postgraduate degree in the Subject in which he/she is admitted.

Students Failed in CCA:

Any student declared "Not Eligible" by the Department based on CCA in Semester I, II, or III and accordingly did not appear in ESE; can be readmitted as an additional student in that Semester in the following year only. Such student need to deposit the annual fee as prescribed for that academic year.

The full course is of FOUR SEMESTERS spread for TWO YEARS duration. A semester-wise list of courses to be offered is given below:

CODE & NOMENCLATURE OF PAPERS IN M.Sc. BIOTECHNOLOGY

SEMESTER I

MSBT111:	Principles of Microbiology
MSBT112:	Cell Biology, Genetics and Cytogenetics
MSBT121:	Practical- I (Covering MSBT 111& 112)
MSBT113:	Fundamentals of Immunology
MSBT114:	Basic Molecular Biology
MSBT122:	Practical –II (Covering MSBT 113 and 114)
MSBTSC131:	Skill course I (for students of M.Sc.Biotechnology only)

SEMESTER II

MSBT211:	Principles of Biochemistry
MSBT212:	Bioanalytical Techniques
MSBT221:	Practical- I (Covering MSBT 211&212)
MSBT213:	Computational Biology and Bioinformatics
MSBT214:	Genetic Engineering, Genomics and Proteomics
MSBT222:	Practical- II (Covering MSBT 213 and 214)
MSBTSC231:	Skill course II(for students of other PG programme)

SEMESTER III

MSBT311:	Environmental Biotechnology
MSBT312:	Animal Cell Culture and Applications
MSBT321:	Practical- I (Covering MSBT 311&312)
MSBT313:	Plant Biotechnology
MSBT322:	Practical- II (Covering MSBT 313)
MSBT314:	Special/ Elective Paper[¥]
MSBT323:	Practical III (Covering MSBT 314A/MSBT 314B/ MSBT314C)
MSBTSC331:	Skill course III (for students of M.Sc. Biotechnology only)

Special/ Elective paper group:

MSBT314A:	Bioprocess Engineering and Technology
MSBT314B:	IPR, Biosafety and Bioethics
MSBT314C:	Evolution &Developmental Biology

SEMESTER IV

MSBT411:	Dissertation (minimum 3 Months Duration)[£]
MSBTSC431:	Skill course IV (for students of other PG programme)

¥Number of Special/ Elective to be taught in a particular year shall be decided by the Department. Special/ Elective offered will be announced at the beginning of the academic session. Each student shall be assigned one Special/ Elective paper on merit-cum-choice basis with equal number (minimum 10) of students in each paper.

Skill Courses in Biotechnology*:

1. Biofertilizers
2. Bioremediation
3. Immunotechnology
4. Bioinformatics
5. Microbiology

*The Department shall offer two skill courses per semester from the list of skill courses that will have 2 lectures and 4 practical/field experimentations per week.

£ See academic regulations for dissertation

£ACADEMIC REGULATIONS FOR MSBT411: DISSERTATION

1. For the MSBT 411 paper, the student shall carry out a **minimum of three months** of research work/ training in a recognized laboratory of any University / Institute/ Organization/Industry.

2. After completion of work, the student shall **submit2copies** of the Dissertation report (type written and hard bound) on or before the prescribed date.

3. The Dissertation report shall bear a **certificate** from the supervisor certifying that :

   (i) *The work has been undertaken and completed under his/her supervision and guidance and meets the requirements of the course;*

   (ii) *The Dissertation is a bonafide record of the original work carried out by the candidate and the Dissertation work has not formed the basis of award of any other degree of this or any other University;*

4. **Marks** (**out of 100**) for the Dissertation report shall be awarded on the basis of Dissertation report, presentation and viva-voce by a board consisting of an internal examiner (Mentor), external examiner and the HOD. The HOD shall also be the chairperson of the board.

5. A student, who fails in M.Sc. IV SEM end examination, shall be furnished by the Board with a clear statement of reasons for failure and suggestions for improvement. The candidate shall revise and resubmit the Dissertation report after incorporating suggestions made by the board. Such a student will have to reappear for the subsequent semester end examination of M.Sc. IV SEM.

SEMESTER – I

MSBT 111: PRINCIPLES OF MICROBIOLOGY

Unit I
History of microbiology; general account of classification, ultrastructure, nutrition, reproduction, biology and economic importance of Archaebacteria, Eubacteria, Cyanobacteria, Actinomycetes and Fungi.
Genetic recombination in bacteria: Transduction, Conjugation & Transformation.

Unit II
Microbial growth: Batch culture, methods of growth estimation, stringent response, death of a bacterial cell, growth as affected by environmental factors like temperature, acidity, alkalinity, water availability and oxygen.
Microbial physiology: Photosynthesis; Chemolithotrophy: Hydrogen and iron oxidizing bacteria; Sulfate reduction.

Unit III
General account of Viruses: Prions and Viroids; Bacterial viruses, life cycle and regulation of λ-Phage; Biology of animal (Retrovirus) and plant (CaMV, Gemini and TMV) viruses. General account of L- forms, Mycoplasma, Phytoplasma, Spiroplasma, Ureoplasma & Rickettsiae; molecular basis of host pathogen interactions in plants – HR & SAR.

Unit IV
Ecological impacts of microbes: Symbiosis (nitrogen fixation, mycorrhizal symbiosis and ruminant symbiosis), Microbes and Nutrient cycles (Nitrogen & Sulphur); Antimicrobial agents: Sulfa drugs, Penicillin and cephalosporin and their mode of action.

Unit V
Molecular methods in assessing microbial diversity: Denaturing Gradient Gel Electrophoresis (DGGE), Temperature Gradient Gel Electrophoresis (TGGE), Amplified rDNA Restriction Analysis, Terminal Restriction Fragment Length Polymorphism (T-RFLP), 16S rDNA sequencing and Ribosomal Database Project.

Suggested Readings:

1. Buchanan, BB, Gruissem, W, & Jones, RL (eds.) 2015, *Biochemistry and Molecular Biology of Plants*, American Society of Plant Physiologists, Maryland, USA and Wiley Blackwell.
2. Aneja, KR (ed.) 2017, *Crueger's Biotechnology: A Text Book of Industrial Biotechnology*, Medtech India.
3. Madigan, MT & Martinko, JM 2006, *Biology of Microorganisms*, 11th edn, Pearson Prentice Hall, USA.
4. Maloy, SR, Cronan, JE Jr., & Freifelder, D 2006, *Microbial Genetics*, Jones Bartlett Publishers, Sudbury, Massachusetts.
5. Pelczar, MJ Jr., Chan, ECS & Krieg, NR 2010, *Microbiology*: *An Application Based Approach*, Tata McGraw Hill.
6. Reed, G (Ed.) 2004, *Prescott & Dunn's Industrial Microbiology,* 4th edn, CBS Publishers & Distributors, New Delhi.
7. Tortora, GJ, Funke, BR & Case, CL 2016, *Microbiology: An Introduction*, 12th edn, Pearson.
8. Willey, JM, Sherwood, LM & Woolverton, CJ 2008, *Prescott, Harley and Klein's Microbiology,* 7thedn, McGraw Hill.

MSBT 112: CELL BIOLOGY, GENETICS AND CYTOGENETICS

Unit I

Membrane structure and function: structural models; composition and dynamics; transport of ions and macromolecules; pumps, carriers and channels; endocytosis and exocytosis; membrane carbohydrates and their significance in cellular recognition.

Unit II

Nucleus – structure and function of nuclear envelope, lamina and nucleolus; chromatin organization and packaging; cell cycle and regulatory mechanisms; mitochondria and chloroplast – origin, structure, function, genome and biogenesis; male sterility in plants.

Unit III

Structure and function of microbodies, Golgi apparatus, lysosomes and endoplasmic reticulum; organization and role of microtubules and microfilaments; actin-binding proteins and their significance; molecular motors; intermediate filaments; cellular junctions and adhesions; structure and functional significance of plasmodesmata; extra- cellular matrix in plants and animals.

Unit IV

Mendelian genetics: introduction to genetics; background and history; patterns of single gene inheritance- autosomal recessive; autosomal dominant; X linked inheritance; role of genetics in medicine; human pedigrees;
Non-Mendelian inheritance patterns: mitochondrial inheritance; polygenic inheritance - genetic and environmental variation; heritability; analysis of quantitative and qualitative traits.

Unit V

Cytogenetics: cell division and errors in cell division; non disjunction; structural and numerical chromosomal abnormalities – deletion; duplication; translocation; sex determination; role of Y chromosome; genetic recombination; disorders of sex chromosomes and autosomes.
Molecular cytogenetics - Fluorescence *in situ* Hybridization (FISH); Comparative Genomic Hybridization (CGH).

Suggested Readings:

1. Alberts, B, Bray, D, Lewis, J, Raff, M, Roberts, K & Watson, JD 2007, *Molecular Biology of the Cell*, 5th edn, Garland Publishing Inc, New York.
2. Cooper, GM & Hausman, RE 2016, *The Cell: A Molecular Approach*, 7th edn, ASM Press and Sinauer Associates Inc, USA.
3. Hardin, J, Bertoni, G & Kleinsmith, LJ 2012, *Becker's-World of Cell*, Pearson Benjamin Cummings, San Francisco, CA, USA
4. Karp, G, Iwasa, I & Marshall, W 2016, *Cell and Molecular Biology: Concepts and Experiments*, 8thedn, John Wiley & Sons Inc, USA.
5. Kleinsmith, LJ & Kish, VM 1995, *Principles of Cell and Molecular Biology*, Harper Collins College Publishers, New York, USA.
6. Lodish, H, Berk, A, Kaiser, CA, Kreiger, M, Bretscher, A, Ploegh, H, Amon, A & Martin, K 2016, *Molecular Cell Biology*, 8th edn, W.H. Freeman and Company, New York.
7. Gardner, EJ 2004, *Principles of Genetics*, 2nd edn, John Wiley & Sons, New York, USA
8. Gupta, PK 2010, *Cytology, Genetics, Evolution and Plant Breeding*, 2nd edn, Rastogi Publications, Meerut.
9. Hartl, DL & Jones, EW 1998, *Genetics: Principles and Analysis*, 4th edn, Jones and Bartlett Publishers, Boston, Massachusetts, USA.
10. Pierce, BA 2016, *Genetics: A Conceptual Approach*, 6th edn, W. H. Freeman & Company, New York, USA.
11. Snustad, DP & Simmons, MJ 2012, *Principles of Genetics*, 6th edn, John Wiley & Sons Inc, Hoboken, NJ, USA.
12. Singh, BD 2014, *Fundamentals of Genetics*, Kalyani Publishers, Ludhiana.
13. Tamarin, RH 2001, *Principles of Genetics*, 7th edn, The McGraw-Hill Companies Inc., New York, USA.
14. Verma, PS & Agarwal VK 2016, *Cell Biology (Cytology, Biomolecules and Molecular Biology)*, S. Chand & Company Ltd.

PRACTICAL I: MSBT 121 (COVERING THEORY PAPERS MSBT111 AND MSBT 112)

SUGGESTED LABORATORY EXERCISES:

1. Preparation of culture media for the growth of bacteria and fungi (Nutrient Agar, LB agar, EMB agar, MacConkey agar and PDA)
2. Separation and identification of microorganisms by streaking and spread plate method.
3. Separation of microorganisms from water and soil by serial dilution method.
4. Studying antibiotic sensitivity of microorganisms by Kirby- Bauer method.
5. Studying the effect of temperature, pH, carbon and nitrogen on growth kinetics of bacteria.
6. Staining (Gram's staining and acid fast staining) and enumeration (by Haemocytometer) of microorganisms.
7. Determination of thermal death point and thermal death time of microorganisms.
8. Studying various stages of Mitosis from onion root tip.
9. Studying various stages of Meiosis from *Phlox*/*Aloe vera* flower bud.
10. Assessment of mode of inheritance on the basis of pedigree chart.
11. Preparation of genetic maps based on data from recombination.
12. Preparation of genetic map in bacteria using data obtained from interrupted mating.
13. Preparation of genetic map in bacteria on the basis of transformation and generalized transduction.

SPOTS (Three from each paper):

1. Compound microscope
2. Conjugation
3. AIDS Virus
4. HR & SAR
5. N_2 Fixation
6. Louis Pasteur
7. Fluid mosaic model of plasma membrane
8. Receptor - mediated endocytosis
9. Microtubule
10. Cell cycle and its regulation
11. Co- dominance
12. Translocation
13. Aneuploidy
14. FISH

LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JODHPUR, RAJASTHAN
PRACTICAL EXAMINATION - I
M.Sc. BIOTECHNOLOGY
SEMESTER- I
MSBT: 121 (Covering Papers MSBT 111 &112)

Time: 6 hours **Max. Marks: 70**

1. Perform the given Microbiology experiment 18

2. Perform the given Cell biology/ Genetics/ Cytogenetics experiment 18

3. Identify and comment upon spots from 'a' to 'f' : 6x4 = 24

    a. _____

    b. _____

    c. _____

    d. _____

    e. _____

    f. _____

4. Viva-voce 10

MSBT 113: FUNDAMENTALS OF IMMUNOLOGY

Unit I
Components of innate and acquired/adaptive immunity. Haematopoiesis; Organization and structure of organs and cells of the immune system- primary and secondary lymphoid organs, lymphoid cells- B and T cells, Blood cells- granular and agranular cells, Natural killer cells; Nature and biology of antigens – immunogen and hapten.

Unit II
Basics of self –non-self recognition and discrimination; B-cell maturation, activation and differentiation; Immunoglobulins - basic structure, classes and subclasses of immunoglobulins, antigenic determinants; Multigene organization of immunoglobulin genes; Generation of antibody diversity; The Complement system: Structure, Components, Functions and biological consequences of complement activation.

Unit III
Major Histocompatibility Complex - MHC types, HLA typing; T-cell maturation, activation and differentiation and T-cell receptors, Cell-mediated immune responses. Cytokines - properties and therapeutic uses; Antigen processing and presentation - endogenous antigens, exogenous antigens, non-peptide bacterial antigens and super-antigens.

Unit IV
Active and passive immunization; Live, killed, attenuated, sub unit vaccines.; Vaccine technology - Role and properties of adjuvants, recombinant DNA and protein based vaccines, plant-based vaccines; Antibody engineering - Hybridoma Technology, chimeric and humanized monoclonal antibodies. Catalytic antibody - Abzyme; Immunotechniques: Chromatin immunoprecipitation, ELISA, RIA, immunofluorescence, FACS and ELISPOT assay

Unit V
Hypersensitivity – Type I-IV, mechanisms and diseases; Autoimmune disorders : Types - Organ specific (Hashimoto's Thyroiditis and Graves' disease) and Systemic disease (Systemic lupus erythematosus); Transplantation – Immunological basis of graft rejection; Clinical transplantation and immunosuppressive therapy; Tumor immunology –Tumor antigens; Immune response to tumors and tumor evasion of the immune system, Cancer immunotherapy.

Suggested Readings:

1. Abbas, AK, Lichtman, AH & Pillai, S 2015, *Basic Immunology: Functions and Disorders of the Immune System*, 5th edn, Elseviers' – Health Sciences Division, Philadelphia, US.
2. Chapel, H, Haeney, M, Misbah, S & Snowden, N 2013, *Essentials of Clinical Immunology*, 6thedn, Wiley – Blackwell, NJ, USA.
3. Decker, J & Reischl, U 2004, *Molecular Diagnosis of Infectious Diseases*, Humana Press, USA.
4. Delves, PJ, Martin, SJ, Burton, DR & Roitt, IM 2017 *Roitt's Essential Immunology*, 13th edn, Wiley – Blackwell, NJ, USA.
5. Goldsby, RA, Kindt, TJ, Osborne, BA & Kuby, J 2002, *Immunology*, 6th edn, W. H. Freeman & Co. NY.
6. Lydyard, P M, Whelan, A & Fanger MW 2002, *Instant Notes in Immunology*, Viva Books New Delhi
7. Paul, NC 2013, *Fundamental of Immunology*, 7th edn, Lippencott Williams & Wilkins.
8. Rao, CV 2011, *Immunology-A Text Book*, 5th edn, Narosa Publication House, New Delhi.
9. Sinha, JK & Bhattacharya, SA 2006, *Text Book of Immunology*, 2006 Academic Publishers, Kolkata.

MSBT 114: BASIC MOLECULAR BIOLOGY

Unit I
Prokaryotic and Eukaryotic genome structure and organization, Levels of eukaryotic chromatin organization – Nucleosome, Solenoid & higher - order chromatin structure; Regulation of chromatin structure - nucleosome remodeling.

Unit II
DNA Replication; Repair & Recombination: DNA Replication- initiation, elongation and termination in prokaryotes and eukaryotes, Enzymes and accessory proteins; DNA repair- enzymes; Photoreactivation; Nucleotide excision repair; Mismatch correction; SOS repair; Non-homologous end joining; Recombination: Homologous.

Unit III
Prokaryotic & Eukaryotic Transcription***:*** Prokaryotic Transcription; Prokaryotic Promoters; Mechanism-Initiation, Elongation and Termination-Rho-dependent and independent; Prokaryotic gene expression with reference to inducible and repressible operons.
Eukaryotic transcription and regulation-Initiation, Elongation and Termination; RNA polymerase structure; RNA polymerase I, II, III and IV/ V (Plant specific); Eukaryotic promoters; Transcription factors; Transcriptional and post-transcriptional gene silencing- RNA interference and CRISPR.

Unit IV
Post Transcriptional Modifications***:*** Processing of mRNA, tRNA, rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; Splicing; RNA editing; Nuclear export of mRNA; mRNA stability. Long non-coding RNA and Circular RNA.
Translation & Transport: Translation machinery; Ribosomes; Features of genetic code; Prokaryotic and eukaryotic translation, Mechanism of initiation, elongation and termination.

Unit V
Oncogenes and Tumor suppressor genes**:** Viral and cellular oncogenes; Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins; Activation of oncogenes and dominant negative effect; Suppression of tumor suppressor genes.

Suggested Readings:

1. Alberts, B, Johnson, A , Lewis, J, Raff, M, Roberts, K & Walter, P 2007, *Molecular Biology of the Cell*, 5th edn, Garland Science, New York.
2. Krebs, JE, Goldstein, ES & Kilpatrick, ST 2014, *Lewin's Gene XI*, Jones and Bartlett Publishers, Sudbury, Massachusetts.
3. Lodish, H, Berk, A, Kaiser, CA, Kreiger, M, Bretscher, A, Ploegh, H, Amon, A & Martin, K 2016, *Molecular Cell Biology*, 8th edn, W.H. Freeman and Company, New York.
4. Pierce, BA 2016, *Genetics: A Conceptual Approach*, 6th edn, W.H. Freeman and Company, NY.
5. Snustad, DP & Simmons, MJ 2012, *Principles of Genetics*, 6th edn, John Wiley & Sons Inc, Hoboken, NJ, USA.
6. Watson, JD, Baker, TA, Bell, SP, Gann, A, Levine, M & Losick, R 2013, *Molecular Biology of the Gene*, 7th edn, Pearson Education, Inc.
7. Watson, JD, Hopkins, NH, Roberts, JW, Steitz, JA & Weiner, AM 1987, *Molecular Biology of the Gene*, 6th edn, The Benjamin/ Cummings Publ. Co. Inc, California.

PRACTICAL II: MSBT 122 (Covering theory papers MSBT 113 & MSBT 114)

SUGGESTED LABORATORY EXERCISES:

1. Separation of leucocytes by dextran method.
2. Performing Immunodiagnostic test to detect diseases- typhoid and malaria.
3. Performing antibody titre by ELISA method.
4. Analysis of antigen- antibody interaction by double diffusion.
5. Analysis of antigen- antibody interaction by Immuno-electrophoresis.
6. Extraction and visualization of genomic DNA from plants by CTAB method.
7. Extraction and visualization of DNA from blood cells.
8. Extraction and visualization of RNA from plants.
9. Preparation of blood smears for identification of leucocytes by Giemsa stain.

SPOTS (Three from each paper):

1. Thymus- as an organ of immune system
2. MHC-T cell interaction
3. Superantigen
4. Monoclonal antibody
5. FACS
6. Plant- based vaccine
7. Autoimmune disorder
8. Structure of DNA
9. DNA replication
10. Eukaryotic transcription
11. Eukaryotic promoter
12. Structure of eukaryotic chromosome
13. *Lac* operon
14. Ribosome

LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)

JODHPUR, RAJASTHAN

PRACTICAL EXAMINATION - II
M.Sc. BIOTECHNOLOGY
SEMESTER- I
MSBT: 122 (Covering paper MSBT 113 and MSBT 114)

Time: 6 hours **Max. Marks: 70**

1. Perform the given Immunology experiment. 18

2. Perform the given Molecular Biology experiment. 18

3. Identify and comment upon spots from 'a' to 'f' : 4x 6= 24

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

   f. _____

4. Viva-voce 10

SEMESTER II

MSBT 211: PRINCIPLES OF BIOCHEMISTRY

Unit I

Chemical basis of life, Water – properties, pH, buffers, covalent and non covalent interactions; Laws of Thermodynamics, Concept of free energy, standard free energy, determination of ΔG for a reaction. Redox potentials. High energy phosphate compounds – introduction, phosphate group transfer, free energy of hydrolysis of ATP and sugar phosphates.

Structure and function of Saccharides, Lipids, Amino acids, Nucleic acids and Vitamins; Emergent properties of biomolecules in water, Macromolecules; Molecular assemblies;

Unit II

Peptides and covalent structure of proteins; elucidation of primary and higher order structures; Conformations of proteins (Ramachandran plot, secondary structure, domains, motif and folds). Structure-function relationships in model proteins like ribonuclease A, myoglobin, hemoglobin, chymotrypsin, ATPase and cytochromes.

Unit III

Enzyme: Historical perspective, general characteristics and structure, nomenclature, IUB enzyme classification, Concept of ES complex, active site, specificity, Michaelis-Menten equation. Different plots for the determination of Km & Vmax and their physiological significances. Collision & transition state theories. Enzyme inhibition, reversible inhibitions and their kinetics. Allosteric enzymes.

Unit IV

Primary Metabolic pathways: Glycolysis, Gluconeogenesis, Pentose Phosphate Pathway, Metabolism of Glycogen, Cori cycle, Citric acid cycle, Fatty acid oxidation, Amino acid oxidation, Urea cycle and its regulation.

Unit V

Substrate - level phosphorylation, Oxidative phosphorylation and photophosphorylation (cyclic and noncyclic), Photorespiration, Carbohydrate biosynthesis in plants, Lipid biosynthesis, Biosynthesis of amino acids, Integration and hormonal regulation of metabolism. Inborn errors of metabolism.

Suggested readings:

1 Berg JM, Tymoczko JL & Stryer L 2002, *Biochemistry*, W.H. Freeman and Company.
2 Buchanan, BB, Gruissem, W, & Jones, RL (eds.) 2015, *Biochemistry and Molecular Biology of Plants*, American Society of Plant Physiologists, Maryland, USA and Wiley Blackwell.
3 Cooper, TG 2011, *The Tools of Biochemistry*, Wiley India Pvt. Ltd.
4 Freifelder D. 1983, *Physical Biochemistry: Application to Biochemistry and Molecular Biology*, W.H. Freeman & Company, San Francisco, USA.
5 Gupta, SN 2015, *A Text Book of Biochemistry*, 2nd edn, Rastogi Publications, Meerut.
6 Nelson, DL & Cox, MM 2017, *Lehninger Principles of Biochemistry*, 7th edn, W. H. Freeman, New York, USA.
7 Rao, CNR 2001, *Understanding Chemistry*, Universities Press, Hyderabad. India.
8 Voet D, Pratt CW & Voet JG 2013, *Principles of Biochemistry*, John Wiley and Sons, New York. USA.
9 Zubay, G 2014, *Biochemistry*, Addison Wesley, Menlo Park, USA.

MSBT 212: BIOANALYTICAL TECHNIQUES

Unit I

Chromatography techniques: TLC, gel permeation, ion exchange and affinity chromatography, HPLC.
Spectroscopy technique: UV-visible spectroscopy. Theory and applications of circular dichroism, fluorescence, NMR, ESR, Integrated Plasma Emission Spectroscopy (IPES) and Plasma Emission Spectroscopy.

Unit II

Electrophoretic techniques: theory and applications- Polyacrylamide gel electrophoresis, SDS-PAGE, agarose gel electrophoresis, isoelectric focusing, 2-D electrophoresis, pulsed field gel electrophoresis and capillary electrophoresis.

Unit III

Radioactivity: radioactive and stable isotopes, pattern and rate of radioactive decay, measurement of radioactivity - Geiger-Muller counter, solid and liquid scintillation counters (Basic principle, instrumentation and technique); Autoradiography and radioimmunoassay.

Unit IV

Centrifugation: basic principles, types of centrifuge - microcentrifuge, ultracentrifuge; differential gradient centrifugation and density gradient centrifugation, applications (isolation of cell components), determination of molecular weight by sedimentation velocity and sedimentation equilibrium methods

Unit V

Microscope and its modifications – Light, phase contrast and interference, Fluorescence, Confocal, Electron (TEM and SEM)
Advanced techniques: protein crystallization - theory and methods. X- ray crystallography, mass spectrometry.

***Suggested Readings*:**

1. Campbell, AM & Heyer, LJ 2007, *Discovering Genomics, Proteomics and Bioinformatics*, 2nd edn, Benjamin Cummings.
2. Freifelder, D 1983, *Physical Biochemistry - Application to Biochemistry and Molecular Biology*, 2nd edn, W. H. Freeman and Company, San Francisco.
3. Gibas, C & Jambeck, P 2001, *Developing Bioinformatics Computer Skills*, O'Reilly, Sebastopol.
4. Gupta, SN 2015, *A Text Book of Biochemistry*, 2nd edn, Rastogi Publications, Meerut.
5. Hofmann, A & Clokie, S 2018, *Wilson & Walker's Principles and Techniques of Biochemistry and Molecular Biology*, 8th edn, Cambridge University Press.
6. Holme, D & Peck, H 1998, *Analytical Biochemistry*, 3rd edn, Longman.
7. Scopes, R 1994, *Protein Purification - Principles & Practices*, 3rd edn, Springer Verlag.

PRACTICAL I: MSBT 221 (Covering Theory papers MSBT211 & MSBT212)

SUGGESTED LABORATORY EXERCISES:

1. Quantitative estimation of reducing sugar & total soluble sugar.
2. Quantitative estimation of proteins by Bradford's method.
3. Quantitative estimation of DNA by DPA reagent method.
4. Quantitative estimation of RNA by Orcinol method.
5. Separation of amino acids, sugars & plant pigments by TLC
6. Separation of biomolecules by gel permeation chromatography.
7. Study of the effect of various parameters (substrate concentration, enzyme concentration, temperature and pH) on enzyme (peroxidase/ alkaline phosphatase) activity.
8. Electrophoresis for native and denatured proteins (SDS PAGE).
9. HPLC- Handling and basic exercise.
10. Identification of bio molecules on the basis of maximum absorption spectrum.

SPOTS (Three from each paper):

1. Ramachandran plot
2. ATPase pump
3. Non- competitive inhibition
4. Cori cycle
5. Feedbak Inhibition
6. Photorespiration
7. Phenylketonuria
8. NMR spectroscopy
9. X-Ray crystallography
10. Electron microscope
11. Phase contrast microscope
12. Density gradient centrifugation
13. RIA
14. HPLC

LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JODHPUR, RAJASTHAN
PRACTICAL EXAMINATION - I
M.Sc. BIOTECHNOLOGY
SEMESTER- II
MSBT: 221 (Covering Papers MSBT 211 & MSBT212)

Time: 6 hours **Max. Marks: 70**

1	Perform the given Biochemistry Experiment	18
2	Perform the given Bioanalytical technique Experiment	18
3	Identify and comment upon spots from 'a' to 'f': a. _____ b. _____ c. _____ d. _____ e. _____ f. _____	6x 4= 24
4.	Viva-voce	10

MSBT 213: COMPUTATIONAL BIOLOGY AND BIOINFORMATICS

Unit I

Biostatistics - definition and scope. Collection of data- Population and sampling, Graphical and diagrammatic representation of data - scale diagram, histograms, pie diagrams, frequency polygon and frequency curves. Measures of central tendency - arithmetic mean, median, and mode. Measure of dispersion - standard deviation.

Unit II

Hypothesis: principle and evaluation of hypothesis, null and alternate hypothesis. Test for significance: chi-square test, student t-test (single sample mean and two sample mean), F-test. Analysis of variance (ANOVA): assumptions, techniques of analysis of variance, analysis of variance in one-way techniques.

Unit III

Introduction to bioinformatics: definition, history and principle. Database concept, Biological databases: Primary database (GENBANK, DDBJ, EMBL, SWISS-PROT), Secondary database (TrEMBL, OWL), specialized database (EcoGene, ACeDB, FlyBase, Gramene), Structural database (PDB, MMDB, SCOP). General account of Big Data and cloud computing.

Unit IV

Computation Biology: Analysis of nucleic acid and protein sequences, sequence comparison algorithms, sequence scoring schemes. Sequence and Genome analysis: Local alignment, global alignment, FASTA, BLAST (Blast P, Blast N, Blast X) and similarity searching scores and their statistical interpretation.

UnitV

Genome annotation, Computational evolutionary biology, Analysis of gene expression: Analysis of regulation, Analysis of protein expression. Analysis of mutations, Comparative genomics, Modeling systems for predicting structure of biomolecules (DNA and Protein), Molecular Interaction and Docking algorithms. High-throughput image analysis, Role of bioinformatics in genome analysis with reference to *E. coli*, *Arabidopsis* and Human.

Suggested Readings:

1. Baxevanis, AD & Ouellette BFF 2004, *Bioinformatics-A Practical Guide to the Analysis of Genes and Proteins*, Wiley Publishers.
2. Bergeron, B 2002, *Bioinformatics Computing*. Pearson Education, US.
3. Bhat, B R, Srivenkatramana, T & MadhavRao, K S 2011, *Statistics. A Beginners Text. Vol. I*. New Age International Pvt. Ltd., New Delhi.
4. Daniel, WW 2012, *Biostatistics-A Foundation for Health Sciences*, 10th edn, John Wiley, New York, USA.
5. Gupta, SC & Kapoor, VK 2014, *Fundamentals of Mathematical Statistics*. S. Chand & Sons. New Delhi.
6. Mount, DW 2004, *Bioinformatics: Sequence and Genome Analysis*, Cold Spring Harbor Laboratory.
7. Orengo, CA & Thornton, JM 2003, *Bioinformatics: Genes, Proteins and Computers*. Taylor and Francis, US.
8. Rashidi, H & Buchler, LK 2005, *Bioinformatics Basics: Application in Biological Science and Medicine*. CRC Press, USA.
9. Rastogi, VB 2011, *Fundamentals of Biostatistics*, Ane Books Pvt. Ltd. New Delhi, India.
10. Sharma, V, Munjal, A & Shankar, A 2008, *A Text Book of Bioinformatics*, Rastogi Publications, Meerut.

MSBT 214: GENETIC ENGINEERING, GENOMICS AND PROTEOMICS

Unit I

General introduction and tools of genetic engineering: restriction enzyme, homing enzyme, DNA ligase, polynucleotide kinase, alkaline phosphatase, DNA polymerase, terminal transferase, Reverse transcriptase. Cohesive and blunt end ligation: Linkers, Adaptors, Homopolymer tailing.

Cloning vector - Plasmid (pBR322 and pUC19), cosmid, lambda phage, BACs and YAC. Animal virus derived vectors- SV40, vaccinia and retroviral vectors.

Expression vectors - pMal, GST, pET-based vectors.

Unit II

Choice of hosts, Methods for transferring recombinant DNA to host cells (Transformation and Transfection).

Screening and selection for transformants - Hybridization techniques (Northern, Southern and Colony hybridization, Fluorescence *in situ* hybridization).

Construction of libraries - Isolation of mRNA and total RNA, cDNA and genomic libraries.

Expression of foreign gene in *E. coli*, Baculovirus, mammalian cell and plant. Principles in maximizing gene expression: Codon optimization, codon biasing, phage display.

Unit III

Techniques in Genetic Engineering: PCR- Primer design, fidelity of thermo-stable enzymes, proof reading enzymes. Types of PCR- LA- PCR, nested, RT - PCR, real time PCR. PCR based site - directed mutagenesis

DNA sequencing- Sanger's Method; Deep sequencing, High throughput Sequencing;

Analysis of DNA-Protein Interactions- Yeast- two hybrid system, S1 Mapping, DNaseI footprinting, Methyl interference assay.

Unit IV

Introduction to Genomics - Structural, Functional, Comparative and evolutionary genomics. Tools for genome analysis - RFLP, DNA fingerprinting, AFLP, RAPD.

Nature of genome in prokaryotes and eukaryotes; Importance of genome projects - human genome project; *Haemophilus influenzae* genome; *Caenorhabditis elegans* genome; Plant genomes; Indian initiatives in genome sequencing with special reference to Mycobacterium, Rice, Neem, Chick pea and Tomato.

Unit V

Proteome: definitions and conceptualization; Proteomics: Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Peptide fingerprinting; MALDI-TOF; Differential display proteomics; Protein-protein interactions.

Functional genomics and proteomics: Microarrays; Protein and peptide microarray-based technology; PCR-directed protein *in situ* arrays; Concept of Transcriptomics, Metabolomics, Epigenomics and Metagenomics.

Suggested Readings:

1. Brown, TA 2010, *Gene Cloning and DNA Analysis: An Introduction*, 6th edn, Wiley-Blackwell publishing, UK.
2. Campbell, AM & Heyer, LJ 2007, *Discovering Genomics, Proteomics and Bioinformatics*, 2nd edn, Benjamin Cummings Publ. Co., San Francisco, California, USA.
3. Dale, JW, Schantz, M & Plant, N 2011, *From Genes to Genomes: Concepts and Applications of DNA Technology*, 3rd edn, Wiley-Blackwell publishing, UK
4. Gibson, G & Muse, SV 2004, *A Primer of Genome Science*, 2nd edn, Sinauer Associates, USA.
5. Glick, BR & Patten, CL 2017, *Molecular Biotechnology: Principles & Applications of Recombinant DNA*, 5th edn, Taylor & Francis.
6. Gupta, PK 2012 *Biotechnology and Genomics*, 1st edn, Rastogi publications, Meerut.
7. Joshi, P 2007, *Genetic Engineering and Its Applications*, 2nd edn, Agrobios- India, Jodhpur.
8. Primrose, S & Twyman R, 2001, *Principles of Gene Manipulation and Genomics*, 6th edn, Blackwell Science, USA.
9. Sambrook, J, & Russell, DW 2001, *Molecular Cloning: A Laboratory Manual*, 3rd edn, Cold Spring Harbor Laboratory Press, New York.
10. Mitra, S 2000, *Genetic Engineering-Principles and Practice*. Macmillan India Limited, New Delhi.
11. Satyanarayana, U 2005, *Biotechnology*, 1st edn, Books and Allied Publishers, Kolkata.
12. Singh, BD 2012, *Biotechnology- Expanding Horizons*, 4th edn, Kalyani Publishers.
13. Veenstra ,TD & Yates, JR 2006, *Proteomics for Biological Discovery*, Wiley-Liss

PRACTICAL- II: MSBT 222 (Covering theory papers MSBT 213 & MSBT 214)

SUGGESTED LABORATORY EXERCISES:

1. Introduction to NCBI, NCBI data bases, BLAST, BLASTn, BLASTp, PSI-BLAST.
2. Biological databases: EMBL, GenBank, DDBJ, TrEMBL, SWISS-PROT, PIR; primary and secondary composite databases; SCOP, CATH.
3. Sequence manipulation Suite, Sequence alignment.
4. Primer designing through bioinformatics tools- Primer3.
5. Phylogenetic Analysis through PHYLIP/CLUSTAL- W.
6. Statistical analysis - Mean, mode, Median, Standard Deviation and Chi-Square Test.
7. Validating Mendelian and non Mendelian ratio using chi- square test.
8. Plasmid DNA isolation from bacteria.
9. Quantitative estimation of plasmid isolated from bacteria.
10. Restriction and digestion of lambda phage DNA (kit- based)
11. DNA ligation of restricted lambda DNA (kit- based)
12. Construction of restriction map of DNA
13. Preparation of competent cells of bacteria (kit- based)
14. Transformation of *E. coli* cells with standard plasmids (kit -based)
15. Calculation of transformation efficiency in bacteria.
16. Amplification of nucleic acid through polymerase chain reaction (demonstration).
17. DNA sequencing from the given data / photograph by Sanger's / Maxam Gilbert's method.
18. Determination of the effect of different concentrations of agarose on banding pattern of DNA.

SPOTS (Three from each paper):

1. Sequence alignment tool- BLAST
2. Comparative genomics
3. SWISS-PROT
4. Phylogenetic tree
5. SCOP
6. Sampling of Biological Data
7. Histogram
8. DNA fingerprinting
9. 2-D PAGE
10. Microarray
11. Cosmid
12. Southern blotting
13. c-DNA library
14. Microinjection

LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JODHPUR, RAJASTHAN
PRACTICAL EXAMINATION - II
M.Sc. BIOTECHNOLOGY
SEMESTER- II
MSBT: 222 (Covering Papers MSBT 213 & MSBT214)

Time: 6 hours **Max. Marks: 70**

1. Perform the given Computational Biology/ Bioinformatics Experiment 18

2. Perform the given Genetic Engineering/ Genomics and Proteomics Experiment 18

3. Identify and comment upon spots from 'a' to 'f': 6x 4= 24

   a. _____

   b. _____

   c. _____

   d. _____

   e. _____

   f. _____

4. Viva-voce 10

SEMESTER - III

MSBT 311: ENVIRONMENTAL BIOTECHNOLOGY

Unit-I

Pollution (Air, Soil, Water) - its causes and consequences. Waste water- its types and sources. Methods of waste water treatment. Eutrophication and algal blooms. Solid waste- sources, types and characterization. Methods of solid waste management. Biomedical waste and its disposal. Incineration, composting, vermi-composting and vermi-culture.

Unit-II

Sustainable development - concept and strategies. Concept of clean technology. Green technologies and their applications. Microbial biofertilizers- types, sources and their commercial production. Mycorrizhae (VM) and their significance in an ecosystem and crop productivity. *Rhizobia* and other symbiotic and non-symbiotic nitrogen fixing microbes and their role in crop productivity. *Azolla* as biofertilizer and its commercial production. Significance and application of Phosphate Solubilizing Bacteria (PSB) and Plant Growth Promoting Rhizobacteria (PGPR).

Unit-III

Bioremediation – definition, concept and applications. Application of microbes in biodegradation of cellulose, lignin, pesticides, xenobiotics and other recalcitrant chemicals, petroleum and hydrocarbons. Ecological significance of bioremediation. Biomagnification and bioaccumulation of heavy metals from industrial affluents. Use of genetically modified microbes in degradation of environmental pollutants.

Unit-IV

Phytoremediation- Concept and applications. Tailing Dams and tailing dam stabilization by plants. Indicator plants. Biomining, biometallurgy and biohydrometallurgy for extraction and recovery of useful metals. Bio-oxidation- direct and indirect mechanisms, bacterial oxidation of sphalerite, chalcopyrite and pyrite. Microbes in petroleum extraction. Biotransformation, biodeterioration and its control.

Unit-V

Biopesticides- definition, significance, types, sources, commercial production, use and mode of action. Entomopathogenic fungi and viral insecticides. Significance of *Bacillus thuringienesis* as biocontrol agent. Microbes as biological weapons. Role of microbes in production of biofuels. Biogas production and factors affecting methane formation. Biosensors- principle and working. Types of Biosensors. Applications of biosensors in environmental monitoring. Application of microbes as biosensors.

Suggested Readings:

1. Abbasi, SA & Abbasi, N 2005, *Renewable Energy Sources and their Environmental Impact*, Prentice Hall of India, Pvt. Ltd.
2. Chatterji, AK 2011, *Introduction to Environmental Biotechnology*, Prentice Hall of India Pvt. Ltd.
3. De, AK 2017, *Environmental Chemistry*, 8th edn, New Age International.
4. Jogdand, SN 2015, *Environmental Biotechnology*, Himalaya Publishing House Pvt. Ltd.
5. Metcalf & Eddy 2002, *Waste Water Engineering Treatment and Reuse.* McGraw Hill.
6. Mohapatra, PK, 2010, *Text Book of Environmental Biotechnology*, I. K. International Pvt. Ltd, New Delhi.
7. Young, M (Ed.) 2011, *Comprehensive Biotechnology* (Vol I-VI) Elsevier.
8. Mukerji, KG, Chamola, BP & Upadhyay, RK 1999, *Biotechnological Approaches in Biocontrol of Plant Pathogens*, Kluwer Academic/Plenum Publishers, Harbound.
9. Prasad, MNV & Strzalka, K 2002, *Physiology and Biochemistry of Metal Toxicity and Tolerance in Plants*, Kluwer Academic Publishers, Dordrecht, Harbound.
9. Rittman, B & McCarty, PL 2000, *Environmental Biotechnology: Principles and Applications*, 2nd edn, McGraw-Hill, New York.
10. Scragg, A 2005, *Environmental Biotechnology*, Oxford University Press.
11. Thakur, IS 2011, *Environmental Biotechnology: Basic Concepts and Applications*, I. K. International, New Delhi.

MSBT 312: ANIMAL CELL CULTURE AND APPLICATIONS

Unit I

Structure and organization of animal cell. Equipments and materials for animal cell culture technology. Balance salt solution and simple growth medium. Role of carbon dioxide, serum and other supplements in medium. Serum - free defined media and their applications.

Concept of stem cell, totipotency, pluripotency and induced pluripotency. Epigenetics and stem cell.

Unit II

Biology of cultured cells: the culture environment, cell adhesion, cell proliferation. Primary culture: primary explant, isolation of the tissue. Cell line: nomenclature, subculture and propagation, immortalization of cell lines, cell line designations. Maintenance of cell culture: cell morphology, replacement of medium, surface area, holding medium and use of antibiotics.

Methods for measurement of growth: cell quantification, biochemical determinations, viability assay.

Unit III

Cell characterization: requirement and methods. Cell cloning: monolayer cloning, suspension cloning.

Organotypic culture: introduction, types- organ and histotypic culture, applications.

Scaling-up of animal cell culture: scale- up in suspension (Air lift fermentor, Rotating chamber & NASA bioreactor) and scale- up in monolayer (Nunc cell factory, Roller culture & Microcarrier).

Unit IV

Cell transformation: introduction, properties and causative factors-genetic instability, immortalization, aberrant growth control and tumorigenicity.

Three dimensional culture: introduction, multicellular tumour spheroids (MCTS) monoculture .

Tissue engineering: introduction and examples (skin, urothelium and peripheral nerve implants).

Safety measures, hazards and ethics of animal cell culture.

Unit V

Applications of animal cell culture: Cell culture based vaccines, Production of special secondary metabolites/ products (insulin, somatotropin, interferon, tPA, factor VIII etc.), Growth factors for promoting proliferation of animal cells (EGF, FGF, PDGF, IL-1, IL-2, NGF, erythropoietin), Transgenic animals: importance and applications.

Suggested Readings:

1. Butler. M 2014, *Animal Cell Biotechnology-Methods & Protocol* (Portner, R ed.) Springer.
2. Freshney, RI 2010, *Culture of Animal Cells: A Manual of Basic Techniques and Specialized Applications*, 6th edn, John Wiley& Sons.
3. Jennie, P & Barnes, D 1998, *Methods in Cell Biology*, Volume 57, *Animal Cell Culture Methods*, Academic Press.
4. Masters, JRW 2000, *Animal Cell Culture – Practical Approach*, 3rd edn, Oxford University Press.
5. Ranga, MM 2007, *Animal Biotechnology*, 3rd edn, Agrobios, India.
6. Satyanarayana, U 2013, *Biotechnology*, Books and Allied (P) Ltd.

PRACTICAL I- MSBT 321 (Covering theory papers MSBT 311 and MSBT 312)

SUGGESTED LABORATORY EXERCISES:

1. Quantification of filterable solid wastes.
2. Water quality assessment for polluted water bodies:
   a. Physical- pH and conductivity.
   b. Chemical- nitrate, chloride, Dissolved oxygen, Chemical oxygen demand and alkalnity.
3. Quantification of inorganic ions (sodium, potassium and calcium) in water sample using flame photometer.
4. Studying cell death and cytotoxicity by staining methods
5. Differentiation of the viable and nonviable cell by staining methods.
6. Introduction to culture environment, medium and culture vessels for animal cell culture.
7. Preparation of culture media and concept of sterilization in animal cell culture.
8. Demonstration of establishment of primary cell culture by trypsinization.

SPOTS (Three from each paper):

1. Biogas production
2. *P. putida* as Superbug
3. Bioaugmentation
4. Biomagnification
5. Vermiculture
6. Bioleaching
7. Plant Growth Promoting Rhizobacteria (PGPR)
8. Stem cell
9. Cell Characterization
10. Histotypic Culture
11. Growth Factors for Animal Cell Culture
12. Air lift Fermenter
13. Continuous cell line
14. Supermouse

LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JODHPUR, RAJASTHAN
PRACTICAL EXAMINATION - I
M.Sc. BIOTECHNOLOGY
SEMESTER- III
MSBT: 321 (Covering Papers MSBT 311 & MSBT312)

Time: 6 hours **Max. Marks: 70**

1. Perform the given Environmental Biotechnology Experiment 18

2. Perform / comment on the given Animal cell culture Experiment 18

3. Identify and comment upon spots from 'a' to 'f': 6x 4= 24

   a._____

   b._____

   c._____

   d._____

   e._____

   f._____

4. Viva-voce 10

MSBT 313: PLANT BIOTECHNOLOGY

Unit I

Plant Tissue Culture: General Introduction; Concept of Totipotency, Historical Background; Concept of asepsis and methods of sterilization. Laboratory planning and design. Basic tools and techniques of *in vitro* culture, Explant selection and surface sterilization, Composition and preparation of tissue culture media.

Unit II

Micropropagation: Pathways (Axillary bud proliferation, adventitious shoot bud differentiation, callus organogenesis and somatic embryogenesis), meristem tip culture and production of virus - free plants-Thermotherapy, chemotherapy, virus indexing, Applications and limitations.

Anther, pollen and ovule culture for haploid production, *in vitro* fertilization and ovary culture; Somaclonal Variations-Isolation of somaclonal variants, molecular basis, Applications and Limitations.

Unit III

Germplasm conservation and cryopreservation: Importance, methods of conservation: *In situ* and *ex situ* conservation; *In vitro* conservation, cryopreservation technique – importance of cryopreservation, pretreatment, freezing methods, cryoprotectants, vitrification.

Protoplast Culture: Isolation, purification and regeneration of protoplast; Testing of viability of isolated protoplast; Somatic hybridization and methods of protoplast fusion; Selection of hybrids, Practical applications of somatic hybridization (hybrids/cybrids).

Unit IV

Plant Transformation Technology: Features of Ti and Ri plasmid; The basis of tumour formation, mechanisms of DNA transfer , role of virulence genes; Vectors engineered from Ti plasmid; Use of 35S and other promoters; Methods of nuclear transformation, Direct DNA transfer: particle bombardment, electroporation, microinjection; Transgene stability and gene silencing.

Unit V

Application of plant transformation for productivity and performance: herbicide resistance , insect resistance with special reference to Bt genes, virus resistance, Use of antisense technology to prevent post-harvest losses and prolonging shelf-life of fruits and flowers, Production of vaccines/ plantibodies in GM plants, Terminator gene technology, Transplastomics , cis-genics, Applications of genome editing.

Suggested Readings:

1. Barbara, MR 2007, *Plant Cryopreservation: A Practical Guide*. Springer Verlag, Berlin, Heidelberg.
2. Bhojwani, SS & Razdan, MK 1996, *Plant Tissue Culture: Theory and Practice (revised edition)*, Elsevier Science, Netherlands.
3. Davey, MR & Anthony, P 2010, *Plant Cell Culture: Essential Methods*, Wiley-Blackwell Ltd.
4. De, KK 2013, *An Introduction to Plant Tissue Culture*, New Central Book Agency, Kolkatta.
5. Endress, R 2014, *Plant Cell Biotechnology*, Springer India Pvt. Ltd.
6. Pauline, MD 1997, *Hairy Roots: Culture and Applications*, Harwood Academic Publishers.
7. Purohit, SD 2013, *Introduction to Plant Cell, Tissue and Organ Culture*, PHI Learning Private Limited, Delhi.
8. Razdan, MK 2012, *An Introduction to Plant Tissue Culture*, Oxford & IBH Publ. Ltd., New Delhi.
9. Singh, BD & Shekhawat, NS 2017, *Molecular Plant Breeding*, Scientific Publishers, Jodhpur.
10. Slater, A, Scott, N & Fowler, M 2003, *Plant Biotechnology: The Genetic Manipulation of Plants*, Oxford University Press, UK.
11. Thorpe, TA & Edward CY (eds.) 2011, *Plant Embryo Culture: Methods and Protocols*, Springer Verlag, Berlin, Heidelberg.
12. Vasil, IK & Thorpe, TA (eds.) 2005, *Plant Cell and Tissue Culture*, Springer India Pvt. Limited, New Delhi.

MSBT 322: PRACTICAL –II (Covering Paper MSBT313)

SUGGESTED LABORATORY EXERCISES:

1. Preparation of stock solutions of MS medium.
2. Preparation of MS medium from stock solutions.
3. Harvesting, preparation, surface sterilization and inoculation of different explants.
4. Effect of auxins and cytokinins on callus growth and organogenesis.
5. Effect of auxins and cytokinins on shoot multiplication.
6. Experiments on multiple shoot induction from mature nodal shoot segments.
7. Differentiation of tissues through organogenesis/somatic embryogenesis.
8. Experiments on in vitro and ex vitro rooting.
9. Establishment of suspension culture.
10. Preparation of synthetic seeds.
11. Demonstration of anther culture of *Datura*.

SPOTS:

1. Gottlieb Haberlandt
2. Multiple shoot proliferation
3. Somatic embryogenesis
4. Cryopreservation
5. *Agrobacterium tumefaciens*
6. Electroporation
7. Gene silencing

LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JODHPUR, RAJASTHAN
PRACTICAL EXAMINATION - II
M.Sc. BIOTECHNOLOGY
SEMESTER- III
MSBT: 322 (Covering Paper MSBT313)

Time: 4 hours **Max. Marks: 35**

1. Perform the given Plant Biotechnology Experiment 18

2. Identify and comment upon spots from 'a' to 'c': 3x 4= 12

a._____

b._____

c._____

3. Viva-voce 05

Semester III
MSBT314: Special/ Elective Paper

MSBT314A: BIOPROCESS ENGINEERING AND TECHNOLOGY

Unit I
Introduction to bioprocess engineering and technology, Material balance in biological systems, energy balance in biological system, kinetics of cell growth and death. Batch, fed-batch and continuous cultures (definition and kinetics). Product formation kinetics, heat transfer and mass transfer. Measurement and control of bioprocess parameter: Feedback control, controller characteristics. Cell as a factory, Cell cytotoxicity.

Unit II
Concepts of basic mode of fermentation processes**:** Bioreactor designs; Types of fermenters; Concepts of basic modes of fermentation - Batch, fed batch and continuous; Conventional fermentation v/s biotransformation; Solid substrate, surface and submerged fermentation; Fermentation economics; Fermentation media. Upstream processing: Media formulation; Sterilization. Measurement and control of bioprocess parameters.

Unit III
Downstream processing**:** Bioseparation - filtration, centrifugation, sedimentation, flocculation; Cell disruption; Liquid-liquid extraction; Purification by chromatographic techniques; Reverse osmosis and ultra filtration; Drying; Crystallization; Storage and packaging.

Unit IV
Applications of enzymes in food processing: Mechanism of enzyme function and reactions in process techniques; Enzymatic bioconversions e.g. starch and sugar conversion processes; High-Fructose Corn Syrup; Inter-esterified fat; Hydrolyzed protein etc. and their downstream processing.

Unit V
Applications of Microbes in food processing and Pharmaceutical products**:** Food ingredients and additives prepared by fermentation and their purification; Microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products; Biofuels. Bacteriocins from lactic acid bacteria – Microbial products - Antibiotics (penicillin, streptomycin, tetracycline), vitamins, pre- and probiotics; Biotechnology industries in India.

Suggested Readings:

1. Demain, AL & Davies, J 2010, *Manual of Industrial Microbiology and Biotechnology*, ASM press, Washington DC, USA.
2. El-Mansi, M & Bryce, C 2002, *Fermentation Microbiology and Biotechnology*. Taylor and Francis Ltd., London.
3. Nakra, BC & Chaudhry, KK 2004, *Instrumentation, Measurement and Analysis*. Tata McGraw Hill Publishing Co. Ltd., New Delhi, India.
4. Paul, JK 1982, *Genetic Engineering Applications for Industry*, Noyes Publications, New Jersey, US.
5. Reed, G (ed.) 2004, *Prescott & Dunn's Industrial Microbiology,* 4th edn, CBS Publishers & Distributors, New Delhi.
6. Rehm, HJ & Reed, G 1983, *Biotechnology*, *VI-VIII*, Wiley- VCH.
7. Stanbury, PF & Whitaker, A 1984, *Principles of Fermentation Technology*, Pergamon Press, Oxford, UK.

MSBT323A: Practical II1 (Covering MSBT314A)

SUGGESTED LABORATORY EXERCISES:

1. Designing of bioreactor prototype.
2. Studying the synthesis of alcohol by molasses.
3. Studying cell immobilization and growth of immobilized cell.
4. Differentiation of the viable and nonviable cell by staining methods.
5. Studying the pure and mixed cell culture of plant/animal/microbial cell by staining method.

SPOTS:

1. Probiotics
2. Bacteriocins
3. Alcoholic beverages
4. Downstream processing
5. High fructose corn syrup
6. Reverse osmosis
7. *Jatropha* as Biofuel

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JODHPUR, RAJASTHAN
PRACTICAL EXAMINATION - III
M.Sc. BIOTECHNOLOGY
SEMESTER- III
MSBT323A (Covering Paper MSBT314A)

Time: 4 hours **Max. Marks: 35**

1. Perform the given experiment 18

2. Identify and comment upon spots from 'a' to 'c': 3x4= 12

a._____

b._____

c._____

3. Viva-voce 05

MSBT314B: IPR, BIOSAFETY AND BIOETHICS

Unit I

Introduction to Intellectual Property**:** Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indicators- importance of IPR – patentable and non patentables – patenting life – legal protection of biotechnological inventions. – World intellectual property rights organization (WIPO).

Unit II

Agreements and Treaties**:** History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act . TIFAC and its role in India.

Unit III

Biosafety: Introduction; biosafety issues in biotechnology-historical background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels, Biomedical waste management.

Biosafety guidelines and regulations (National and International) – operation of biosafety guidelines and regulations of Government of India.

Unit IV

Roles of Institutional Biosafety Committee**:** RCGM, GEAC, Definition of GMOs; applications of GMO in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol, Biopiracy.

Unit V

Bioethics: Introduction to ethics/bioethics – framework for ethical decision making; biotechnology and ethics – benefits and risks of genetic engineering – ethical aspects of genetic testing – ethical aspects relating to use of genetic information – genetic engineering and biowarfare; Ethical implications of cloning: Reproductive cloning, therapeutic cloning; Ethical, legal and socio-economic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research and GMO's.

Suggested Readings:

1. Acharya, NK 2001, *Text Book on Intellectual Property Rights,* Asia Law House.
2. Arthur, RP & Michael, HD 2000, *Intellectual Property: Patents, Trademarks and Copyrights in a Nutshell,* West Group Publishers.
3. Cibelli, J, Wilmut, IS, Jaenisch, R, Gurdon, J, Lanza, R, Michael, W & Campbell, KHS 2013, *Principles of Cloning*, Academic Press, San Diego, Gurdon.
4. Das, HK 2010, *Text Book of Biotechnology*, 4th edn., Wiley India.
5. Erbisch, FH & Maredia, K 1998 *Intellectual Property Rights in Agricultural Biotechnology,* CABI.
6. Ganguly, P 2001, *Intellectual Property Rights: Unleashintg Knowledge Economy*, McGraw- Hill.
7. Kankanala, KC 2007, *Genetic Patent Law & Strategy*, Manupatra Information Solution Pvt. Ltd., Noida, India.
8. Sadhasivam, SK & Jaabir, M 2008, *IPR, Biosafety and Biotechnology Management*, Jasen Publications, Tiruchirapalli, India.
9. Saha, R (ed.) 2006 *Intellectual Property Rights in NAM and Other Developing Countries: A Compendium on Law and Policies.* Daya Publishing House.
10. Singh, BD 2012, *Biotechnology- Expanding Horizons*, 4th edn. Kalyani Publishers.
11. Singh, BD & Shekhawat, NS 2017, *Molecular Plant Breeding*, Scientific Publishers, Jodhpur.
12. Wadhera, BL 2007, *Law Relating to Intellectual Property.* Universal Law Publishing.

MSBT323B: Practical II1 (Covering MSBT314B)

SUGGESTED LABORATORY EXERCISES:

1. Indian Patent Act: Important cases.
2. Process of patenting in India:
3. Filing of patent: Process of patenting, Product patenting

SPOTS:

1. GATT
2. Patent
3. Biosafety levels
4. Genetically modified organisms
5. Bioweapons
6. Biopiracy
7. Monarch Butterfly

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JODHPUR, RAJASTHAN
PRACTICAL EXAMINATION - III
M.Sc. BIOTECHNOLOGY
SEMESTER- III
MSBT323B (Covering Paper MSBT314B)

Time: 4 hours **Max. Marks: 35**

1. Perform the given experiment 18

2. Identify and comment upon spots from 'a' to 'c': 3x4= 12

a._____

b._____

c._____

3. Viva-voce 05

MSBT314C: EVOLUTION AND DEVELOPMENTAL BIOLOGY

Unit I

Emergence of evolutionary thoughts: Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection.

Origin of cells and unicellular evolution: Origin of basic biological molecules and polymers; Concept of Oparin and Haldane; Experiment of Miller; The first cell; Evolution of prokaryotes; Origin of eukaryotic cells.

Molecular Evolution: Concepts of neutral evolution, molecular divergence and molecular clocks; Origin of new genes and proteins; Gene duplication and divergence.

Unit II

Genetic variation: Agents of genetic polymorphism; genome polymorphism; uses of polymorphism and molecular markers.

Population genetics and evolution: Phenotype; Genotype; Gene frequency; Hardy-Weinberg law; Factors distinguishing Hardy-Weinberg equilibrium; Mutation selection; Migration; Gene flow; Gene drive, Genetic drift.

Unit III

Basic concepts of development: Potency, commitment, specification, induction, competence, determination and differentiation; morphogenetic gradients; cell fate and cell lineages; stem cells; genomic equivalence and the cytoplasmic determinants.

Developmental genetics: Genes in early development; maternal effect genes; Pattern formation genes; Homeotic genes; Signaling and adhesion molecules.

Unit IV

Gametogenesis, fertilization and early development in Angiosperms: Production of gamete, Pollination and Self-incompatibility and molecular interactions, fertilization, embryo sac development and double fertilization in plants; seed formation and germination.

Gametogenesis, fertilization and early development in Animals: Production of gametes, cell surface molecules in sperm-egg recognition in animals; zygote formation, cleavage, blastula formation, gastrulation and formation of germ layers in animals; embryogenesis.

Unit V

Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in *Dictyostelium*; axes and pattern formation in *Drosophila*; Organogenesis- vulva formation in *Caenorhabditis elegans*; post embryonic development-larval formation, metamorphosis; environmental regulation of normal development.

Suggested Readings:

1. Ayala, FJ & Avise, JC 2014, *Essential Readings in Evolutionary Biology*, Johns Hopkins University Press, Baltimore, Maryland.
2. Futuyma, DJ & Kirkpatrick, M 2017, *Evolution*, 6th edn, Oxford University Press, UK.
3. Futuyma, DJ 1998, *Evolutionary Biology*, 3rd edn, Sinauer Associates Inc, Sunderland, MA.
4. Gilbert, SF 2013, *Developmental Biology*, 10th edn, Sinauer Associates, Sunderland, MA, USA
5. Ridley, M 2003, *Evolution*, 3rd edn, Blackwell Publishing, Hoboken, NJ, USA
6. Slack, JMW 2012, *Essential Developmental Biology*, 3rd edn, Wiley-Blackwell, UK.
7. Wolpert, L & Tickle, C 2010, *Principles of Development*, Oxford University Press, UK.

MSBT323C: Practical II1 (Covering MSBT314C)

SUGGESTED LABORATORY EXERCISES:

1. Study of developmental stages of larvae of *Drosophilla*
2. Study of different types of embryo in plants.
3. Validation of Hardy-Weinberg equilibrium.

SPOTS:

1. Gametogenesis
2. Gastrulation
3. *C .elegans* - as a model organism
4. Double fertilization
5. Miller's experiment
6. Darwin
7. Speciation

LACHOO MEMORIAL COLLEGE OF SCIENCE & TECHNOLOGY (AUTONOMOUS)
JODHPUR, RAJASTHAN
PRACTICAL EXAMINATION - III
M.Sc. BIOTECHNOLOGY
SEMESTER- III
MSBT323C (Covering Paper MSBT314C)

Time: 4 hours **Max. Marks: 35**

1. Perform the given experiment 18

2. Identify and comment upon spots from 'a' to 'c':
3x4= 12

a._____

b._____

c._____

3. Viva-voce 05

MSBT411: DISSERTATION (Minimum 3 months duration)

ACADEMIC REGULATIONS FOR MSBT411: DISSERTATION

1. For the MSBT 411 paper, the student shall carry out a **minimum of three months** of research work/ training in a recognized laboratory of any University / Institute/ Organization/Industry.

2. After completion of work, the student shall **submit 2 copies** of the Dissertation report (type written and hard bound) on or before the prescribed date.

3. The Dissertation report shall bear a **certificate** from the supervisor certifying that:

(i) The work has been undertaken and completed under his/her supervision and guidance and meets the requirements of the course;

(ii) The Dissertation is a bonafide record of the original work carried out by the candidate and the Dissertation work has not formed the basis of award of any other degree of this or any other University;

4. **Marks** (**out of 100**) for the Dissertation report shall be awarded on the basis of Dissertation report, presentation and viva-voce by a board consisting of an internal examiner (Mentor), external examiner and the HOD. The HOD shall also be the chairperson of the board.

5. A student, who fails in M.Sc. IV SEM end examination, shall be furnished by the Board with a clear statement of reasons for failure and suggestions for improvement. The candidate shall revise and resubmit the Dissertation report after incorporating suggestions made by the board. Such a student will have to reappear for the subsequent semester end examination of M.Sc. IV SEM.

SKILL COURSES:

1: BIOFERTILIZERS

General account about the microbes used as biofertilizer – *Rhizobium*, *Azospirillum*, *Azotobacter*, *Cyanobacteria*, Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

Suggested lab exercises:

1. Isolation, identification, mass multiplication, of *Rhizobium*, *Azospirillum*, *Azotobacter*, *Cyanobacteria* and VAM.

Suggested Readings:

1. Dubey, RC 2005, *A Text book of Biotechnology*, S. Chand & Co, New Delhi.
2. John, JPE 2004, *Outlines of Plant Biotechnology*, Emkay Publication, New Delhi.
3. Kumaresan, V 2005, *Biotechnology*, Saras Publications, New Delhi.
4. Sathe, TV 2004, *Vermiculture and Organic Farming*, Daya publishers.
5. SubhaRao, NS 2000, *Soil Microbiology*, Oxford & IBH Publishers, New Delhi.
6. Vyas, SC, Vyas, S & Modi, HA 1998, *Introduction to Bio-fertilizers and Organic Farming*, Ekta Prakashan, Nadiad.

2: BIOREMEDIATION

Principles and degradation of common pesticides, organic and inorganic pollutants. Bioremediation of soil, water, contaminated with oil spills, heavy metals and detergents. Degradation of lignin and cellulose using microbes.

Suggested lab exercises:

Study the presence of microbial activity by detecting (qualitatively) enzymes (dehydrogenase, amylase, urease) in soil.

Suggested Readings:

1. Agarwal, KC 2005, *Environmental Biotechnology*, Nidhi publishers, New Delhi.
2. Conningham, WP & Conningham, MA 2003 *Principles of Environmental Science*, Tata McGraw-Hill publishing company. Tokyo.
3. Jordening, HJ & Winter, J 2005 *Environmental Biotechnology: Concepts & Applications*, Wiley- VCH.
4. Olugin, EJ 2000 *Environmental Biotechnology and Cleaner Bioprocesses*, Taylor and Francis India
5. Sharma, PD 1994 *Environmental Biology*, Rastogi publications New Delhi.
6. Satyanarayana, U 2005 *Biotechnology*, Books and Allied Pvt. Ltd.

3. IMMUNOTECHNOLOGY:

History of Immunology, Edward Jenner, Eli Metchnikoff, Louis Pasteur, Robert Koch; Innate immunity – barriers; acquired immunity-cells involved; humoral and cellular immunity; lymphoid organs-primary & secondary – Hematopoiesis; immunogens and antigens – characteristics of ideal antigens; classes of antigens, cross reactivity, haptens and adjuvants.

Principles, methodology and application of LTT, Hybridoma technology and antibody engineering, ELISA; ELISPOT; RIST; RAST and Immunoblotting; FACSCAN, Immunoflourescence and RIA; Immuno-informatics and vaccine designing: Cloning strategies for vaccine production. T cell cloning and stem cell technology.

Suggested lab exercises:

1. Agglutination reaction
2. Single and Double immunodiffusion
3. ELISA :
   i) Capture ELISA ii) Direct ELISA
4. Western blot
5. Identification and separation of Blood cells.
6. Rocket immunoelectrophoresis
7. Purification of Immunoglobulin from serum albumin

Suggested Readings:

1. Brown, F, Chanock, RM & Lerner RA (eds) 1986, *Vaccines 86; New approaches to Immunization.*
2. Coico, R & Sunshine, G 2000, *Immunology: A Short Course*, 6th edn. Wiley – Blackwell.
3. Delves, PJ, Martin, SJ, Burton, DR & Roitt, IM 2017, *Roitt's Essential Immunology*, 13th edn, Wiley – Blackwell, NJ, USA.
4. Fathman, CG & Fitch FW 1982, *Isolation, Characterization and Utilization of T Iymphocytes clones*, Academic Press, London
5. Goding, J.W. 1998, *Monoclonal antibodies: Principles and Practice*, Academic Press, London
6. Goldsby, RA, Kindt, TI & Osborne, BA 2000, *Kuby Immunology*, 4th edn, WH Freeman & Co. NY.
7. Janeway, CA, Travers, P, Wolport, M & Capra, JD 1999, *Immunology*, 4th edn, Current Biology, NY
8. Springer, TA (ed) 1985, *Hybridoma Technology in Biosciences and Medicine*, Plenum Press, New York.

4. BIOINFORMATICS

1. Introduction to Bioinformatics and its applications
2. Bioinformatics databases
3. Database searching
4. Sequence Alignments and Visualization
5. Structural Bioinformatics
6. Genomics: Genome Annotation, Genome Assembly, Structural and Functional Genomics.
7. Comparative Genomics
8. Metabolomics
9. Chemoinformatics
10. Molecular phylogeny and evolution
11. Biodiversity informatics

Suggested lab exercises:

1. Demonstration of Molecular Biology Laboratory equipments
2. Demonstration of various Next-generation sequencing technologies
3. Introduction of National Center for Biotechnology Information (NCBI) and biological databases
4. Analysis of sequences using BIOEDIT software.
5. Assembly of sequences using GENETOOL software
6. Similarity search using the Blast and interpretation of the results.
7. Multiple Sequence alignment using Clustal W
8. Phylogenetic analysis using MEGA.
9. Submission of nucleotide sequences at NCBI-GenBank using Sequin

***Suggested Readings**:*

1. Baxevanis, AD & Ouellette, BFF 2004, *Bioinformatics- A Practical Guide to the Analysis of Genes and Proteins*, Wiley Publishers
2. Bergeron, B 2002, *Bioinformatics Computing*, Pearson Education, US.
3. Mount, DW 2004, *Bioinformatics: Sequence and Genome Analysis*, Cold Spring Harbor Laboratory.
4. Orengo, CA & Thornton, JM 2003, *Bioinformatics: Genes, Proteins and Computers*, Taylor and Francis, US.
5. Rashidi, H & Buchler, LK 2005, *Bioinformatics Basics: Application in Biological Science and Medicine*, CRC Press, USA.

5. MICROBIOLOGY:

Sterilization and disinfection: Definitions, Principles, Methods of sterilization- Physical methods (Heat, Filtration), Radiation and Chemical methods. Testing of sterility. Microscopy – General account. Measurement of Microorganisms - Micrometry. Staining - Simple, Gram staining, Negative staining.
Microbiological media, composition and types: selective and differential media. Growth curve and growth kinetics. Influence of environmental factors on microbial growth. Estimation of Microbes- Direct Microscopic count, Turbidimetric assay, TVC- Indirect Method- CO_2 liberation.

Suggested lab exercises:

1: Media Preparation (Basal, Selective, Differential, Enriched).
2: Sterilization (Wet heat- based, Dry heat- based, filter and disinfectant).
3: Techniques for isolation of pure culture (streak, pour and spread-plate).
4: Enumeration Methods – Serial Dilution.
5: Preservation (slant) and Sterility Testing (open funnel method).
6: Microbial Identification – Staining Methods (Gram's, cotton blue and negative).
7: Study of Growth Kinetics of Bacterial Population by Turbidimetry method.

Suggested readings:

1. Banerjee, AK & Banerjee, N 2006, *Fundamentals of Microbiology and Immunology,* New Central Book Agency (P) Ltd, India.
2. Cappuccino, JG & Sherman, N 2009, *Microbiology, A Laboratory Manual*, 7th edn, Pearson
3. Dubey, RC & Maheshwari, DK 1999, *A Text Book of Microbiology,* S. Chand & Company Ltd., New Delhi.
4. Madigan, MT & Martinko, JM 2006, *Brock's Biology of Microorganisms*, 11th edn, Pearson Prentice Hall, USA.
5. Pelczar, MJ Jr., Chan, ECS & Krieg, NR 2010, *Microbiology*: *An Application Based Approach*, Tata McGraw Hill.
6. Powar, CB and Daginawala, HF 2008, *General Microbiology*, Vol II, Himalaya Publishing House, Mumbai, India.
7. Willey, JM, Sherwood, LM & Woolverton, CJ 2008, *Prescott, Harley and Klein's Microbiology,* 7th edn, McGraw Hill, New York.