KARNATAK UNIVERSITY, DHARWAD
ACADEMIC (S&T) SECTION

ಕರ್ನಾಟಕ ವಿಶ್ವವಿದ್ಯಾಲಯ, ಧಾರವಾಡ
ವಿದ್ಯಾಮಂಡಳ (ಎಸ್&ಟಿ) ವಿಭಾಗ

ಸ್ವಾತಂತ್ರ್ಯದ ಅಮೃತ ಮಹೋತ್ಸವ

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NAAC Accredited
'A' Grade 2014

website: kud.ac.in

No. KU/Aca(S&T)/JS/MGJ(Gen)/2024-25/436 Date: 11 NOV 2024

ಅಧಿಸೂಚನೆ

ವಿಷಯ: ರಾಷ್ಟ್ರೀಯ ಶಿಕ್ಷಣ ನೀತಿಯನುಸಾರ 2024-25ನೇ ಶೈಕ್ಷಣಿಕ ಸಾಲಿನಿಂದ ಎಲ್ಲ ಸ್ನಾತಕೋತ್ತರ ಪದವಿಗಳಿಗೆ / ಸ್ನಾತಕೋತ್ತರ ಡಿಪ್ಲೋಮಾಗಳಿಗೆ ಪಠ್ಯಕ್ರಮವನ್ನು ಪ್ರಕಟಣೆ ಕುರಿತು.

ಉಲ್ಲೇಖ: 1. ವಿದ್ಯಾವಿಷಯಕ ಪರಿಷತ್ ಸಭೆಯ ನಿರ್ಣಯ ಸಂಖ್ಯೆ: 2 ರಿಂದ 9, ದಿ: 08.11.2024.

2. ಮಾನ್ಯ ಕುಲಪತಿಗಳ ಅನುಮೋದನೆ ದಿನಾಂಕ: 11.11.2024.

ರಾಷ್ಟ್ರೀಯ ಶಿಕ್ಷಣ ನೀತಿಯನುಸಾರ 2024-25ನೇ ಶೈಕ್ಷಣಿಕ ಸಾಲಿನಿಂದ ಅನ್ವಯವಾಗುವಂತೆ, ಕರ್ನಾಟಕ ವಿಶ್ವವಿದ್ಯಾಲಯದ ಎಲ್ಲ ಸ್ನಾತಕೋತ್ತರ ಪದವಿಗಳಾದ M.A./ M.Sc / M.Com / MBA / M.Ed 1 ರಿಂದ 4ನೇ ಸೆಮೆಸ್ಟರ್‌ಗಳಿಗೆ ಮತ್ತು 1 & 2ನೇ ಸೆಮೆಸ್ಟರ್‌ಗಳ ಸ್ನಾತಕೋತ್ತರ ಡಿಪ್ಲೋಮಾಗಳಿಗೆ ವಿದ್ಯಾವಿಷಯಕ ಪರಿಷತ್ ಸಭೆಯ ಅನುಮೋದನೆಯೊಂದಿಗೆ ಈ ಕೆಳಗಿನಂತೆ ಪಠ್ಯಕ್ರಮಗಳನ್ನು ಅಳವಡಿಸಿಕೊಳ್ಳಲಾಗಿದೆ. ಕಾರಣ, ಸಂಬಂಧಪಟ್ಟ ಎಲ್ಲ ಸ್ನಾತಕೋತ್ತರ ವಿಭಾಗಗಳ ಅಧ್ಯಕ್ಷರು / ಸಂಯೋಜಕರು / ಆಡಳಿತಾಧಿಕಾರಿಗಳು / ಮಹಾವಿದ್ಯಾಲಯಗಳ ಪ್ರಾಚಾರ್ಯರುಗಳು / ಶಿಕ್ಷಕರು ಸದರಿ ಪಠ್ಯಕ್ರಮಗಳನ್ನು ಅನುಸರಿಸುವುದು ಮತ್ತು ಸದರಿ ಪಠ್ಯಕ್ರಮವನ್ನು ಕ.ವಿ.ವಿ. ಅಂತರ್ಜಾಲ www.kud.ac.in ದಲ್ಲಿ ಭಿತ್ತರಿಸಲಾಗಿದನ್ನು ಸಂಬಂಧಪಟ್ಟ ವಿದ್ಯಾರ್ಥಿಗಳಿಗೆ ಸೂಚಿಸುವುದು.

Arts Faculty

Sl.No	Programmes	Sl.No	Programmes
1	Kannada	8	MVA in Applied Art
2	English	9	French
3	Folklore	10	Urdu
4	Linguistics	11	Persian
5	Hindi	12	Sanskrit
6	Marathi	13	MPA Music
7	MVA in Painting		

Faculty of Science & Technology

Sl.No	Programmes	Sl.No	Programmes
1	Geography	10	M.Sc (CS)
2	Chemistry	11	MCA
3	Statistics	12	Marine Biology
4	Applied Geology	13	Criminology & Forensic Science
5	Biochemistry	14	Mathematics
6	Biotechnology	15	Psychology
7	Microbiology	16	Applied Genetics
8	Zoology	17	Physics
9	Botany	18	Anthropology

Faculty of Social Science

Sl.No	Programmes	Sl.No	Programmes
1	Political Science	8	Journalism m & Mass Commn.
2	Public Administration	9	M.Lib. Information Science
3	History & Archaeology	10	Philosophy
4	A.I.History & Epigraphy	11	Yoga Studies
5	Economics	12	MTTM
6	Sociology	13	Women's Studies
7	MSW		

Management Faculty

Sl.No	Programmes	Sl.No	Programmes
1	MBA	2	MBA (Evening)

Faculty of Commerce

Sl.No	Programmes	Sl.No	Programmes
1	M.Com	2	M.Com (CS)

Faculty of Education

Sl.No	Programmes	Sl.No	Programmes
1	M.Ed	2	M.P.Ed

OEC subject for PG

Sl.No	Programmes	Sl.No	Programmes
1	Russian	5	Veman Peetha
2	Kanaka Studies	6	Ambedkar Studies
3	Jainology	7	Chatrapati Shahu Maharaj Studies
4	Babu Jagajivan Ram	8	Vivekanand Studies

PG Diploma

Sl.No	Programmes	Sl.No	Programmes
1	PG Diploma in Chatrapati Shahu Maharaj Studies	2	P.G. Diploma in Women's Studies
3	P.G. Diploma in Entrepreneurial Finance		

ಅಡಕ: ಮೇಲಿನಂತೆ

ಕುಲಸಚಿವರು.

ಗೆ,

1. ಕ.ವಿ.ವಿ. ಸ್ನಾತಕೋತ್ತರ ಅಧ್ಯಕ್ಷರುಗಳಿಗೆ / ಸಂಯೋಜಕರುಗಳಿಗೆ / ಆಡಳಿತಾಧಿಕಾರಿಗಳಿಗೆ / ಮಹಾವಿದ್ಯಾಲಯಗಳ ಪ್ರಾಚಾರ್ಯರುಗಳಿಗೆ
2. ಎಲ್ಲ ನಿಖಾಯದ ಡೀನರು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.

ಪ್ರತಿ:

1. ಕುಲಪತಿಗಳ ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
2. ಕುಲಸಚಿವರ ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
3. ಕುಲಸಚಿವರು (ಮೌಲ್ಯಮಾಪನ) ಆಪ್ತ ಕಾರ್ಯದರ್ಶಿಗಳು, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
4. ಅಧೀಕ್ಷಕರು, ಪ್ರಶ್ನೆ ಪತ್ರಿಕೆ / ಗೌಪ್ಯ / ಜಿ.ಎ.ಡಿ. / ವಿದ್ಯಾರ್ಥಿಗಳ (ಪಿ.ಜಿ.ಪಿಎಚ್.ಡಿ) ವಿಭಾಗ/ ಸಿಸ್ಟಮ್ ಅನಾಲೆಸಿಸ್ಟ್ / ಸಂಬಂಧಿಸಿದ ಪದವಿಗಳ ವಿಭಾಗಗಳು, ಪರೀಕ್ಷಾ ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
5. ನಿರ್ದೇಶಕರು, ಕಾಲೇಜು ಅಭಿವೃದ್ಧಿ / ವಿದ್ಯಾರ್ಥಿ ಕಲ್ಯಾಣ ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ.
6. ನಿರ್ದೇಶಕರು, ಐ.ಟಿ. ವಿಭಾಗ, ಕ.ವಿ.ವಿ. ಧಾರವಾಡ ಇವರಿಗೆ ಕ.ವಿ.ವಿ. ಅಂತರ್ಜಾಲದಲ್ಲಿ ಪ್ರಕಟಿಸುವುದು.

KARNATAK UNIVERSITY, DHARWAD

Faculty of Science and Technology

Two Years PG Programme

M.Sc. Biotechnology

Programme structure and Syllabus

As per NEP-2020

With Effect from 2024-25

ABOUT THE DEPARTMENT

The Post Graduate Department of Microbiology and Biotechnology was established in the year 1999 and 2001 respectively in the beautiful campus of Karnatak University, Dharwad, Karnataka. Karnatak University is one of the premier universities catering the Microbiology and Biotechnology education to the northern Karnataka region. During the last five years the Department has made substantial progress in terms of research and generation of funds through sponsored research projects. Various funding agencies have sanctioned research projects which include three projects from DST, DBT, VGST, UGC etc. Microbiology and Biotechnology plays a pivotal role in human welfare. Realizing the scope and importance of biotechnology, Govt. of India has established Department of Biotechnology in the Ministry of Science and Technology in 1986 to promote the Research and Develop activities and commercialization of Biotechnological processes etc.

Microbiology overlaps the various other degree areas of biology like as molecular biology, genetics & immunology. Students can explore career scope in the field of Microbiology owing to its relevance in Pharmacy, Medicine, clinical research, agriculture, dairy industry, environment, fermentation & nanotechnology.

Biotechnology is one field that is closely associated with human life in many ways, from the making of bread to medicine, transgenic plants to animal. Biotechnology offers a diverse career scope for the students. One can chose the options like Microbiology, Genetic Engineering, Clinical Research, Biomedical Engineering, Immunology, Food technology etc.

In 2000, Government of Karnataka has announced the Millennium Biotech Policy. In this context, Karnatak University would provide trained manpower to biotechnology industry and the proposed M.Sc. Biotechnology and Microbiology courses intends to fulfill this objective.

Karnatak University with its life science faculty, specialized in different aspects of Biotechnology, is catering the needs in the development of the department. The staff along with the eminent biotechnologists from India is involved in designing the curriculum

The Department of Biotechnology and Microbiology is an independent department and it is an interdisciplinary course. All the formalities of establishing as separate department have been completed by getting the concurrence of appropriate university bodies and Vice Chancellor of University.

GENERAL INSTRUCTIONS

I. CREDIT, WORKLOAD AND SYLLABUS EQUIVALENCE:

1. One credit is equal to 1 hour theory teaching per week.
2. One credit is equal to 2 hour practical teaching per week.
3. One credit is equal to 15 hours theory syllabus per semester (1 Unit is equal to 15 Hours)
4. One credit is equal to 30 hours practical syllabus per semester (1 credit practical is equal to 2 hours/ week)

A. Workload for theory subjects:

1. There shall be 16 hrs/week workload for Assistant Professor
2. There shall be 14 hrs/week workload for Associate Professor/ Professor/Senior Professor.
3. There shall be 2hrs/week workload relaxation for Guiding Ph.D. students

B. Workload for practical subjects:

1. There shall be 20 hrs/week workload for Assistant Professor
2. There shall be 18 hrs/week workload for Associate Professor/ Professor/Senior Professor.
3. There shall be 2hrs/week workload relaxation for Guiding Ph.D. students

C. Workload for practical batches:

1. A batch of 10-12 students shall have 1 teacher

D. Workload for Project:

1. Students for projects / internship shall be preferably guided by permanent faculty for atleast10 students by sharing equally among the permanent faculty. If remained excess shall be allotted to other teacher's on roll on temporary basis.
2. If there are no permanent faculty, the students shall be distributed among the temporary teachers on roll.
3. There shall be maximum of 4 hrs/week workload for guiding the students for project work irrespective of number of students.

II. ALLOTMENT OF SPECIALIZATION:

While allotting specialization in 3rd and 4th semester, minimum of 10 students shall have to select the specialization.

III. **ATTENDANCE:** 75% attendance is mandatory for every course (paper). No marks are reserved for attendance. If the candidates fail to fulfill 75% attendance in any one of the course (paper) in the given semester, such candidate is not eligible to appear for examination in all the papers and candidate has to get the readmission for such semester. However, up to 20% attendance may be condoned with the supportive documents for a student who represents University /State / National level sports, cultural and other events. Monthly attendance shall be displayed on notice board.

IV. CREDIT AND MARKS EQUIVALENCE:

1. Generally, 20% weightage for Formative assessment and 80% weightage for Summative assessment.
2. Up to 2 credits equal to 50 marks (10 marks Formative assessment and 40 marks summative assessment).
3. 3-4 credits equal to 100 marks (20 marks Formative assessment and 80 marks summative assessment).
4. 5-6 credits equal to 150 marks (30 marks Formative assessment and 120 marks summative assessment).
5. Example for 100 marks out of which 20 marks for Formative assessment i.e., Formative Assessment shall be in two internal assessments i.e.: 10 marks I.A. for 8^{th} week and 10 marks for 14^{th}week of every semester.

V. **Conduct of Examination:**

1. Formative assessment examination shall be conducted for 1hr. There shall not be any provision for improvement. A special Formative assessment examination shall be conducted for a student who represents University /State / National level sports, cultural and other events if a schedule is overlapping.

2. 80 marks summative theory examination shall be conducted for 3 hrs and 40 marks for 1.5 hrs.

3. 80/ 40 marks Formative / Summative Practical examination shall be conducted for 4 hrs.

4. There shall be a single examiner for both even and odd semesters' Formative Practical examination.

5. There shall be a single examiner for odd semester Summative Practical examination and two examiners for even semester Summative Practical examination; one from internal and other shall be external examiner.

VI. Assessment:

1. **Theory papers:** There shall be a single valuation for odd semester theory papers preferably

internal examiner and double valuation for even semesters; one from internal and other shall be external examiner.

2. **Project/Internship assessment**

A) **For150 marks Project/Internship assessment:**

i. **Formative Assessment**: Project/Internship assessment carrying 30 marks out of 150 marks Candidate has to submit two Progress Reports; each carries 15 Marks. i.e. 15 x 2= 30 marks.

ii. **Summative Assessment:** Project/Internship assessment carrying 120 marks out of 150 marks

a. Project Report : 50

b. Presentation : 30

c. Viva-voce : 40

VII. Passing criteria:

1. There shall be no minimum passing marks for Formative assessment.

2. Candidate has to score minimum 40% in summative examination and fulfill 40% of the maximum marks including Formative assessment marks. For example: for 80 marks summative examination, candidate has to score minimum of 32 marks (40%) and should score cumulatively 40 marks including formative assessment in every course.

VIII. DECLARATION OF RESULT:

1. Candidate has to score 40% as above in all the courses to pass the semester end examination to declare pass.

2. **Percentage and Grading:** Result shall be declared in terms of SGPA and at the end of four semesters as CGPA. The calculation of CGPA is as under

3. If P is the percentage of marks secured (IA + semester end score) by the candidate in a course which is rounded off to the nearest integer, the grade point (GP) earned by the candidate in that course will be given as below.

Percentage (%)	Grade(GP)	Percentage (%)	Grade(GP)
40	4.0	71-75	7.5
41-45	4.5	76-80	8.0
46-50	5.0	81-85	8.5
51-55	5.5	86-90	9.0
56-60	6.0	91-95	9.5
61-65	6.5	96-100	10.0
66-70	7.0		

Grade point of less than 4 shall be considered as fail in the course, hence, GP=0 and for the absent candidate also GP=0

4. A student's level of competence shall be categorized by grade point (GP), Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA) of the programme.
5. **Semester Grade Point Average (SGPA):** The SGPA is a ratio of sum of the number of Credit Grade Points scored from all the courses (subject) of given semester to the total credits of such semester in which the candidate studied. (Credit Grade Points of each course = Credits x GP).
6. **Cumulative Grade Point Average (CGPA):** It is calculated as below for 4 semester programme.

   CGPA=($Credit_1$ x $SGPA_1$) + ($Credit_2$ x $SGPA_2$) +($Credit_3$ x $SGPA_3$) + ($Credit_4$ x $SGPA_4$) / Total credits of programme (sum of credits of 4 semesters).
7. After studying and passing, all the credits prescribed for the programme the degree shall be awarded with CGPA score after rounding off to second decimal and class distinguishing as second class, first class, and distinction along with grade letter as under:

CGPA of the programme(Degree)	Class obtained	Grade Letter
9.5 to 10.00	Outstanding	A^{++}
7.00 to 9.49	Distinction	A^{+}
6.00 to 6.99	First Class	A
5.50 to 5.99	Second class	B^{+}
5.00 to 5.49		B
4.00 to 4.99	Pass	C
Less than 4.0	Fail/ Reappear	D

8. Each semester Grade Card shall have marks and SGPA and final Grade Card shall have semester wise marks obtained in all semesters, CGPA and % of cumulative marks obtained from all semesters.
9. There shall be Revaluation / Challenge valuations provisions as per the prevailing rules and regulations.
10. Marks obtained from the OEC shall not be considered for award of CASH PRIZE / RANK / GOLD MEDAL.

i. MAXIMUM DURATION FOR COMPLETION OF THE PROGRAMME:

A candidate admitted to any P.G. Programme shall complete it within a period, which is double the duration of the programme from the date of admission.

X. ANY OTHER TERMS AND CONDITIONS:

Apart from the above, the prevailing rules and regulation are valid for any other matters which are not addressed in this regard.

M.Sc.in Biotechnology
Effective from 2024-25

Sem.	Type of Course	Theory/ Practical	Course Code	UUCMS Code	Course Title	Instruction hour/ week	Total hours /Sem	Duration of Exam	Marks			Credits
									Formative	Summative	Total	
I	DSC-1	Theory	BT CT 1.1	A1BIT001T	Biomolecules	04	60hrs	03hrs	20	80	100	04
	DSC-2	Practical	BT CP 1.5	A1BIT005P	Biomolecules	04	56hrs	04hrs	10	40	50	02
	DSC-3	Theory	BT CT 1.2	A1BIT002T	Microbiology	04	60hrs	03hrs	20	80	100	04
	DSC-4	Practical	BT CP 1.6	A1BIT006P	Microbiology	04	56hrs	04hrs	10	40	50	02
	DSC-5	Theory	BT CT 1.3	A1BIT003T	Biophysical and Biochemical Techniques	04	60hrs	03hrs	20	80	100	04
	DSC-6	Practical	BT CP 1.7	A1BIT007P	Biophysical and Biochemical Techniques	04	56hrs	04hrs	10	40	50	02
	DSC-7	Theory	BT CT 1.4	A1BIT004T	Cell Biology and Genetics	04	60hrs	03hrs	20	80	100	04
	DSC-8	Practical	BT EP 1.8	A1BIT008P	Cell Biology and Genetics	04	56hrs	04hrs	10	40	50	02
								28	**120**	**480**	**600**	**24**
II	DSC-9	Theory	BT CT 2.1	A2BIT001T	Molecular biology, Bioinformatics and Biostatistics	04	60hrs	03hrs	20	80	100	04
	DSC-10	Practical	BT CP 2.5	A2BIT004P	Molecular biology, Bioinformatics and Biostatistics	04	56hrs	04hrs	10	40	50	02
	DSC-11	Theory	BT CT 2.2	A2BIT002T	Immunology and Immunotechnology	04	60hrs	03hrs	20	80	100	04
	DSC-12	Practical	BT CP 2.7	A2BIT005P	Immunology and Immunotechnology	04	56hrs	04hrs	10	40	50	02
	DSC-13	Theory	BT CT 2.3	A2BIT003T	Enzymology and Metabolism	04	60hrs	03hrs	20	80	100	04
	DSC-14	Practical	BT CP 2.7	A2BIT006P	Enzymology and Metabolism	04	56hrs	04hrs	10	40	50	02

	OEC-1	Theory	BT ET 2.4	A2BIT203T	Molecular Cell Biology	04	60hrs	03hrs	20	80	100	04
								24	**110**	**440**	**550**	**22**
III	DSC-15	Theory	BT CT 3.1	A3BIT001T	Animal Biotechnology	04	60hrs	03hrs	20	80	100	04
	DSC-16	Practical	BT CP 3.5	A3BIT004P	Animal Biotechnology	04	56hrs	04hrs	10	40	50	02
	DSC-17	Theory	BT CT 3.2	A3BIT002T	Environmental Biotechnology and Biodiversity	04	60hrs	03hrs	20	80	100	04
	DSC-18	Practical	BT CP 3.6	A3BIT005P	Environmental Biotechnology and Biodiversity	04	56hrs	04hrs	10	40	50	02
	DSC-19	Theory	BT CT 3.3	A3BIT003T	Bioprocess Engineering and Technology	04	60hrs	03hrs	20	80	100	04
	DSC-20	Practical	BT CP 3.7	A3BIT006P	Bioprocess Engineering and Technology	04	56hrs	04hrs	10	40	50	02
	OEC-2	Theory	BT ET 3.4	A3BIT203T	Plant and Animal Tissue Culture	04	60hrs	03hrs	20	80	100	04
								24	**110**	**440**	**550**	**22**
IV	DSC-21	Theory	BT CT 4.1	A4BIT001T	Genetic Engineering	04	60hrs	03hrs	20	80	100	04
	DSC-22	Practical	BT CP 4.4	A4BIT004P	Genetic Engineering	04	56hrs	04hrs	10	40	50	02
	DSC-23	Theory	BT CT 4.2	A4BIT001T	Plant Biotechnology	04	60hrs	03hrs	20	80	100	04
	DSC-24	Practical	BT CP 4.5	A4BIT005P	Plant Biotechnology	04	56hrs	04hrs	10	40	50	02
	DSC-25	Theory	BT CT 4.3	A4BIT003T	Medical Biotechnology	04	60hrs	03hrs	20	80	100	04

	DSC-26	Practical	BT CP 4.6	A4BIT006P	Medical Biotechnology	04	56hrs	04hrs	10	40	50	02
	Project-1	Practical	BT CPJ 4.7 Project Work/ Dissertation	A4BIT007P					25	125	150	06
								21	**115**	**485**	**600**	**24**

M.Sc. Biotechnology

Program outcome:

1. Students learn the fundamental concepts of core areas like plant, animal, and industrial biotechnology, as well as allied areas like microbiology, immunology, and physiology.
2. Students will be able to apply biotechnology to solve issues in medicine, agriculture, food processing, and the environment. They will also learn how to create business ideas in various industries.
3. Students gain expertise in basic microbiology laboratory techniques, including isolation and characterization and maintenance of microbes.
4. Students gain exposure to various research fields and thrust areas.
5. Student will be able to identify scientific problem and perform different experimentations.
6. Students will able to plan and execute experiments, and how to analyze and interpret data. They will also learn how to present their project work in writing, orally and visually. Learn to collaborate and operate both autonomously.
7. Students will acquire technical skills, especially in regard to industrially important metabolites and their production.
8. Students will understand the importance of bioinformatics and computational techniques, and how to analyze and interpret sequencing data. Students gain knowledge of modern biotechnology-related computer applications, software, scientific material, and web content creation.
9. They can recognize different Intellectual Property Right (IPR) and Ethical issues related to Practical and research aspects.
10. Students with a conceptual understanding of advanced areas in Biotechnology and with the necessary subject knowledge and laboratory skills will be able to start a career in academia, Research and Industry related to Biotechnology.

M. Sc. Semester – I
Discipline Specific Course (DSC)

Course Title: BT CT 1.1 - Biomolecules

Course Code: A1BIT001T

Types of Course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/ Semesters	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course outcome:

By the end of the course the students will be able to

- CO1: Understand the Chemical foundations such as bonding, bioorganic reactions and water.
- CO2: Understand various applications of Biomolecules, their structure and function.
- CO3: To understand the importance of quantification of biomolecules.
- CO4: To identify the presence of different biomolecules in given samples**.**

Unit	Content	60 Hrs/Sem
I	**Chemical Foundations and Water:** • **Chemical Bonding**: Covalent, Ionic, Hydrogen, Co-ordinate bonds, Electrostatic forces, Vander-Waal's forces, Hydrophobic forces, Molecular orbitals, Sigma and Pi bonds, Bond length, Bond strength, Bond energy, Bond radius, Geometry of carbon compounds, Stereo-isomers, Tetrahedral structure, Conformation and Configuration of Optically active molecules, Asymmetric and chiral centers, D and L isomers, R and S configurations, Cis-trans configuration. (5 Hours) • **Water**: Structure and properties, Water as a solvent, pH and buffers, Ionization of water, Equilibrium constant, Acid-base theory, Preparation of solutions, Normality, Molarity, Molality, Henderson-Hassel Balch equation, pH scale, pK and pH relation, Buffers concept, Importance and preparation of buffers. (5 Hours) • **Bio-organic Reactions**: Acid-base, Covalent and Metal ion catalysis, Nucleophiles and electrophiles, Nucleophilic and substitution reactions (SN1 and SN2), Oxidoreduction reactions. (5 Hours)	**15**
II	**Carbohydrates and Nucleic Acids:** • **Carbohydrates**: Properties and characteristics, Derivatives of	**15**

	monosaccharides, Amino sugars, Deoxy-sugars, Glycosides, Purification and Structure of homo and hetero polysaccharides, Starch, Cellulose, Glycogen, Dextrin, Hemi-cellulose, Xylan, Pectin, Lignin, Agar-agar, Chitin, Hyaluronic acid, Heparin, Chondroitin sulphate, Peptidoglycan, Carbohydrates on cell surface. (9 Hours) • **Nucleic Acids**: Structure of nucleotides, DNA and RNA, Conformation of DNA, RNA types (mRNA, rRNA, tRNA). (6 Hours)	
III	**Amino Acids, Proteins and Lipids:** • **Amino Acids and Proteins**: Classification, Structure and Properties of amino acids, Classification of proteins, Structural organization of proteins (primary, secondary, tertiary, quaternary), Haemoglobin conformational changes, Conformational analysis, Ramachandran's plot, Techniques of isolation and purification, Protein denaturation and renaturation kinetics, Stability of proteins, Glycoproteins (N-glycan and O-glycan). (10 Hours) • **Lipids**: Classification of phospholipids, Glyco and Sphingolipids, Structure, Properties and reactions of lipids, Cholesterol and its derivatives. (5 Hours)	**15**
IV	**Vitamins, Secondary Metabolites, and Antibiotics:** • **Vitamins**: Chemistry of Fat and water soluble vitamins, Significance in metabolism. (5 Hours) • **Secondary Metabolites**: General introduction, Alkaloids, Pigments, Chemistry of medicinally and industrially important Alkaloids, Terpenoids, Carotenoids, Essential oils, Chemistry of chlorophylls, Cytochromes, Heme, Phenolics, Tannins. (5 Hours) • **Antibiotics**: Structure and Chemistry of Penicillin, Streptomycin, Chloramphenicol, Tetracyclines, Vancomycin, Peptide/antibiotics. (5 Hours)	**15**

M. Sc. Semester – I

Discipline Specific Course (DSC)

Course Title: BTCP1.5 based on BTCT 1.1 Biomolecules

Course Code: A1BIT001T

Types of Course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/ Semesters	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**04**	**04**	**60 hrs.**	**4 hrs.**	**20**	**80**	**100**

Practicals

1. Safety in Laboratory – Biosafety and Safety Guidelines.
2. Preparation of buffers: Citrate, Phosphate, Tris-HCl Buffer.
3. Chromatography techniques:
   a. Separation of Plant Pigments and Amino acids by paper chromatography (Ascending and Descending).
   b. Separation of Lipids by Thin Layer Chromatography.
4. Qualitative analysis of Carbohydrates, Amino acids and Lipids.
5. Estimation of Carbohydrates by Anthrone method.
6. Estimation of Reducing sugars by DNS method.
7. Estimation of Protein by Biuret and FCR method.
8. Estimation of Vitamins- Vitamin C, Thiamine and Riboflavin.
9. Estimation of Blood cholesterol.
10. Estimation of DNA by DPA method.
11. Estimation of RNA by Orcinol method.
12. Determination of Saponification values of fats.

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M. Sc. Semester – I

Discipline Specific Course (DSC)

Course Title: BT CT 1.2 - Microbiology

Course Code: A1BIT002T

Types of Course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/ Semesters	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course outcome:

By the end of the course the students will be able to

- CO1: Explain the basic concept of aseptic microbiological procedures.
- CO2: Get familiarity with the diverse types of microbes, methods to classify them and their food habits.
- CO3: Appreciate the functioning and applications of various techniques to growth microbes in laboratory & industry.
- CO4: Have familiarization with the structural details of bacteria and viruses as well as with the metabolic diversity.

Unit	Content	60 Hrs/Sem
I	**Introduction to Microbiology:** • **Rerview and history of Microbiology**: Fundamentals, history and evolution of Microbiology. Distribution and characterization of prokaryotic and eukaryotic cells. Morphology of cell. (5 Hours) • **Classification of Microorganisms**: Three domain system of classification and code for bacterial nomenclature and taxonomy. Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, microbial phylogeny and current classification of bacteria. Numerical taxonomy, Chemotaxonomy and Classification of bacteria according to Bergey's Manual of Systematic Bacteriology. Fungal classification system, Viral classification (ICTU, Baltimore). (10 Hours)	**15**

II	**Microbial Techniques:** • **Methods of sterilization**: Physical methods: Dry and moist heat, Filtration, Radiation. Chemical methods: Phenols, Alcohols, Halogens, Heavy metals, Aldehydes, Quaternary ammonium compounds, disinfectants and gases. (3 Hours) • **Microbiological media and Pure culture techniques:** Microbiological Media: Components, Preparations and Types-Basal, Special, Differential, Indicator, Enriched and Transport media. Pure culture techniques: Isolation of different microorganisms from different environments. Sample collection, preservation and enrichment. Different methods of isolation-pour plate, spread plate, serial dilution. (6 Hours) • **Staining techniques and Preservation of microbial cultures:** Types and nature of Stains: Simple, Differential-Gram's staining, Acid fast stating Maintenance and preservation of microbial cultures: Slant culture, stab-culture, soil culture, mineral oil overlaying and glycerol preservation and Lyophilization. Type culture collection centers-Indian and global-ATCC, MTCC and NCIM etc. Safety measures of microbiological laboratory, Levels of laboratory and good laboratory practices. (6 Hours)	**15**
III	**Microbes Growth and Environment:** • **Microbial growth:** The definition of growth, mathematical expression of growth, Growth curve, Measurement of growth and growth yield, synchronous growth, continuous culture, Chemostat and Turbidostat. (4 hours) • **icrobes and Environment:** Role of microorganisms in natural system and artificial system; Influence of Microbes on the Earth's Environment and Inhabitants; Ecological impacts of microbes; Symbiosis (Nitrogen fixation and ruminant symbiosis); Microbes and Nutrient cycles; Microbial communication system; Quorum sensing; Microbial fuel cells; Prebiotics and Probiotics; Vaccines. (11 Hours)	**15**
IV	**Study of Microbes:** • **Viruses:** Salient features and Structure of viruses, Multiplication of viruses (Lytic and Lysogenic cycles), viroids and prions. (4 Hours) • **Bacteria**: General characters, classification, morphology and ultrastructure of bacteria. Bacterial multiplication, Spirochetes, Rickettsia, Chlamydia, Mycoplasma, Cyanobacteria, Actinomycetes and Extremophiles, Importance of bacteria in biotechnology. (5 Hours) • **Fungi:** General characters, Structure and Classification of fungi. Importance of fungi and antibiotic production. (3 Hours) • **Algae**: General characters, Structure and Classification of Algae. Economic importance of Algae. (3 Hours)	**15**

M. Sc. Semester – I

Discipline Specific Course (DSC)

Course Title: BTCP1.6 based on BTCT 1.2 Microbiology

Course Code: A1BIT006P

Types of Course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/ Semesters	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**04**	**04**	**60 hrs.**	**4 hrs.**	**20**	**80**	**100**

Practicals

1. Safety Measures in Microbiology Laboratory
2. Preparation of media and stains for microbial work
3. Study of Instruments-Autoclave, Hot air Oven, Incubator, Laminar air flow, Centrifuge, pH Meter, Colorimeter.
4. Microbial techniques for culturing Bacteria: Streak Plate, Pour plate, Spread plate and standard plate.
5. Staining methods: Simple staining, Gram staining, Endospore staining, Negative-staining, Acid fast staining.
6. Isolation of microorganisms from Air, Water and Soil sample.
7. Biochemical tests: IMVIC Test, Catalase, Starch hydrolysis, Citrate utilization, Fermentation of carbohydrates, Gelatin liquefaction test and, Oxidase test
8. Observation of Bacterial motility by hanging drop method.
9. Methods of microbial culture preservations.
10. Study of Antibiotic sensitivity test of bacteria: Disc/well diffusion method.

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M. Sc. Semester – I

Discipline Specific Course (DSC)

Course Title: BTCT 1.3- Biophysical and Biochemical Techniques

Course Code: A1BIT003T

Types of Course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/ Semesters	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course outcome:

By the end of the course the students will be able to

- CO1: Understand the basic concept associated with separation of molecule based upon their size, shape and Conformation.
- CO2: Develop basic understanding about the Spectroscopic, chromatography, centrifugation techniques and be able to describe the separation using these techniques.
- CO3: Explain the basic concept of ELISA, RIA, Western blotting and flow cytometry. Students get familiarity with PAGE, SDS-PAGE, 2-D, Pulse-field, Capillary and Isoelectrofocussing.
- CO4: Appreciate the functioning and applications of Gas liquid chromatography, High pressure liquid chromatography (HPLC).
- CO5: Have familiarization with UV/visible, fluorescence, circular dichroism, NMR and ESR spectroscopy, Radioisotope techniques.
- CO6: Understand and distinguish different nanoparticles - Differentiate various physical, chemical, electrical and other properties between macro, micro and nano scale particles.

Unit	Content	60 Hrs/Sem
I	**Introduction to Biophysics and Microscopy:** • Scope of Biophysics, Molecular Interactions (Strong/Weak interactions), Bonds between atom and molecules, Ionic, Covalent, Hydrogen, Electrostatic, Disulphide and Peptide bonds, and Vander Waal's forces, Bond energies, Bond angles, Thermodynamic principles related to biophysics (brief overview to understand how these interactions are related to biological processes). (5 Hours) • Acids and Bases, Mole and Normality, Weak acids, Amphoteric electrolytes, pH, Calculation of pH from H and OH Concentration, measurements of pH, Henderson Haselbatch equation, Titration curve and pK values, Buffers and Stability of their pH, Biological buffers (Eg: - TBS-Tris buffered Saline, PBS-Phosphate-buffered saline), Numerical problems. (5 Hours) • **Microscopy:** Light Microscopy – Design and working of Compound, Phase contrast, Interference, Dark field Polarizing and Fluorescence microscope, Electron microscopy– Design and working of Scanning Electron Microscope (SEM), Transmission Electron Microscope (TEM), Preparation of the Specimen for Electron Microscopy, AFM. Confocal Microscopy, optical tweezers or laser trapping microscopy (for manipulating molecules or cells), Super resolved fluorescence microscopy, Cryo-electron microscopy. (5 Hours)	15
II	**Biophysical techniques:** • **Centrifugation:** Basic principles, Forces involved, RCF Centrifugation, techniques- principles, types and applications. Centrifuges and Ultra-centrifuges types and Application, Isopycnic centrifugation, optical methods used and applications of preparative (Differential, Density Gradient) and analytical (sedimentation velocity, sedimentation equilibrium) ultra-centrifugation. (5 Hours) • **Spectroscopic techniques:** Spectroscopy, Beer-Lambert's law, types of detectors, UV-Visible spectroscopy, Infrared spectroscopy, FTIR, Raman spectroscopy, Fluorescent spectroscopy, Flame photometry, Atomic absorption, Plasma emission mass, Mass Spectroscopy (use of MS in combination with other spectroscopic techniques for identifying and quantifying biomolecules).ESR and NMR spectroscopy, ORD andCircular Dichroism (CD)-For evaluating secondary structure of proteins and nucleic acids. X-Ray Diffraction, X-Ray crystallography, Biological importance of Lasers, Microwaves and Radiations. (5 Hours) • **X-ray crystallography:** Unit cell, cell content, crystal symmetry, crystal systems, Bravais lattices, symmetry elements and operations, point groups and space groups, Protein crystallization techniques (vapor diffusion, batch crystallization, etc), Bragg's law. Diffraction of x-rays by crystals, Atomic scattering factors and structure factors, amplitude	15

	and phase, Fourier transformation. (5 Hours)	
III	**Biochemical techniques:** • **Chromatography techniques:** Basic Concepts of adsorption and partition Chromatography, Principle Experimental set-up, Methodology and Applications of all types of Adsorption and Partition Chromatography methods-chromatography using paper, thin layer, HPTLC column (gel filtration, ion exchange, affinity), gas (GC,GLC), LCMS, HPLC: types of HPLC, Mobile phase elution , normal phase and reverse-phase HPLC, column packing material, efficiency of column, types of HPLC – principles of methodologies, HPLC pumps -efficiency and suitability, Different injectors and Detectors; Ion Chromatography; Membrane Techniques - Criteria of protein purity, equilibrium dialysis, ultra filtration and various membrane techniques.(10 Hours) • **Electrophoretic techniques:** Principle, Electrophoretic mobility (EPM) estimation, factors affecting EPM, Instrument design and set-up, Methodology and Applications of Free and Zone (Paper, Cellulose acetate, Agarose and Starch gel, Pulsed-field, PAGE, SDS-PAGE, Capillary) Electrophoresis techniques, Principle, Experimental set-up, Methodology and Applications isoelectric focusing, 2D electrophoresis, Zymography (Technique used to visualize and quantify the activity of proteolytic enzymes). (5 Hours)	**15**
IV	**Radioisotope techniques and Synthesis of Nanomaterials:** • **Radioisotope technique:** Nature of radioactivity, detection and measurement. GM counter and Scintillation counter, Auto radiography, Safety aspects and applications, Effects of radioactivity on matter, biological effects of radiation, applications of radio isotopes. (5 Hours) • **Nanomaterial synthesis:** • **Physical methods:** Methods based on evaporation, sputter deposition, chemical vapour deposition (CVD), electric arc deposition. Chemical Methods: colloids and colloids in solution, synthesis of nanoparticles by colloidal routes, micro emulsions, Sol-Gel method. (7 Hours) • **Biological Methods:** Introduction to biomaterials, Synthesis using microorganisms and plant extracts, Nanomaterial characterization and functionalization (Drug delivery, Sensors). (3 Hours)	**15**

M. Sc. Semester – I

Discipline Specific Course (DSC)

Course Title:BTCP 1.7 Based on BTCT 1.3Biophysical and Biochemical techniques

Course Code: A1BIT007P

Types of Course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/ Semesters	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**04**	**04**	**60 hrs.**	**4 hrs.**	**20**	**80**	**100**

Practicals

1. Instrumentation: Spectrophotometer, Electrophoresis, Centrifuges, Micropipettes, Chromatographic techniques: Column, HPLC, GLC, GC-MS and NMR.
2. Demonstration of Beer-Lambert's Law.
3. Titration of strong acid with strong base.
4. Titration of weak acid and weak base.
5. Titration of mixture of strong and weak acids.
6. Titration curves of amino acids.
7. Colorimetric estimation of Inorganic phosphate.
8. Agarose gel electrophoresis for separation of Nucleic acids.
9. Separation of proteins by SDS-PAGE and Native PAGE.
10. Density Gradient centrifugation and separation of blood components.
11. Determination of acid value of fats.
12. Synthesis and characterization of Nanoparticles from plants and microbial extracts.

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M. Sc. Semester – I

Discipline Specific Course (DSC)

Course Title: BT CT 1.4 - Cell Biology and Genetics

Course Code: A1BIT004T

Course outcome:

Types of Course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/ Semesters	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Theory**	**04**	**04**	**60 hrs.**	**3 hrs.**	**20**	**80**	**100**

Course outcome:

By the end of the course the students will be able to

- CO1: Understand the cell organelles, their structure and functions.
- CO2: Differentiate between meiosis and mitosis and will be able to learn about different factors control cell cycle progression.
- CO3: Students will be able to explain role of different protein/ enzymes involved in cell signaling.
- CO4: They will be able to understand genetics, mechanism of genetic damage caused by mutation and role of various repair system in neglecting the effect of these mutation.

Unit	Content	60 Hrs/Sem
I	**Cell Theory and Cell Components:** • **Cell Theory and Cell Organization:** Overview of cell theory, organization of prokaryotic and eukaryotic cells, structure and functions of the plasma membrane, present models, and mechanisms of membrane transport. (4 Hours) • **Cell Organelles:** Structure and functions of chloroplasts, endoplasmic reticulum, Golgi complex, mitochondria, ribosomes, lysosomes, and peroxisomes. (4 Hours) • **Nucleus:** Microscopic and sub-microscopic organization; structure and functions of the nuclear membrane; ultrastructure of the nucleolus. (2 Hours) • **Eukaryotic Chromosomes:** Chromatin structure, nucleosome model, centromeric DNA organization, telomere structure, laws of DNA consistency, C-value paradox, heterochromatin significance, special types of chromosomes (B chromosomes, polytene chromosomes, lamp brush chromosomes), sex chromosomes and sex determination, karyotyping. (5 Hours)	15
II	**Cell Division and Numerical Changes in Chromosomes:** • **Mitotic and Meiotic Processes:** Overview of the mitotic apparatus, cytokinesis, chromosome movement; regulation of the eukaryotic cell cycle including cyclins and cyclin-dependent kinases; molecular mechanisms regulating mitotic events; cell cycle control in mammalian cells; mutations causing loss of cell cycle control; stages of meiosis including chromosome pairing, chiasma formation, molecular mechanisms of recombination (synaptonemal complex, recombination nodules, holiday junction), models of recombination. (10 Hours) • **Chromosomal Changes:** Fundamentals and practical significance of euploidy and haploidy; types and genetic significance of polyploidy; types and genetic significance of aneuploidy. (5 Hours)	15
III	**Genetics:** • **Principles of Heredity:** Introduction to concepts and theories of Mendelian genetics; chromosomal theory of inheritance; extra-chromosomal inheritance; interaction of genes. (3 Hours) • **Linkage and Crossing Over:** Introduction to genetic linkage; gene mapping in eukaryotes; sex-linked inheritance; genetic control of chromosome pairing; molecular mechanisms of crossing over; gene conversion. (4 Hours) Sex Determination and Dosage Compensation: Sex determination mechanisms in Drosophila and mammals; secondary sex determination in mammals; dosage compensation mechanisms in Drosophila and mammals. (3 Hours) • **Population Genetics:** Concepts of gene pools, allele frequencies; Hardy-Weinberg equation; non-random mating; genetic drift; gene flow; selection processes; speciation. (2 Hours) • **Quantitative Genetics**: Introduction to quantitative traits, heritability,	15

	and the genetic basis of complex traits. (3 Hours)	
IV	**Genome Organization, Structural Analysis of Genes, and Mutation:** • **Genome Organization and Structural Analysis:** Organization of the *E.coli* genome including functional classes of predicted genes; common features in the genomes of Archaea and Eukaryotes; Genome size and Organization in yeast, Arabidopsis, *C.elegans*, and Drosophila; bar-locus complex loci; pseudo alleles complementation; fine structure analysis of the rII locus; split genes and overlapping genes. (7 Hours) • **Mutation Types:** Base pair mutations vs. frameshift mutations; genetic suppression mechanisms; Luria-Delbruck fluctuation test; use of base analogs, alkylating agents, and ionizing radiation to induce mutagenesis along with their mechanisms. (4 Hours) • **Molecular Basis of Mutation**: Spontaneous vs. Induced mutations and their roles in evolution; detection methods for mutations including Ames test. (2 Hours) • **Chloroplast and Mitochondrial Mutations:**Chloroplast mutations in Chlamydomonas; variations in Mirabilis; mitochondrial mutations in yeast and Neurospora; human diseases caused by mutations in mitochondrial genomes. (2 Hours)	**15**

M. Sc. Semester – I

Discipline Specific Course (DSC)

Course Title: BTCP 1.8 Based on BTCT 1.4 Cell Biology and Genetics

Course Code: A1BIT008P

Types of Course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/ Semesters	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**04**	**04**	**60 hrs.**	**4 hrs.**	**20**	**80**	**100**

Practicals

1. Micrometry: Calibration and measurement of Onion epidermal cells yeast and spores.
2. Study of Mitosis using onion root tips.
3. Study of Meiosis using grasshopper testis or Onion flower buds.
4. Buccal epithelial smear for study of Barr bodies.
5. Differential counting of WBC's using blood smear.
6. Culture and maintenance of *Drosophila melanogaster* cultures.
7. Mounting of Salivary gland chromosomes form *Drosophila* larvae.
8. Study of Auxotrophic mutants using replica plate technique.
9. Isolation and vital Staining of Mitochondria.
10. Isolation of Chloroplast by density gradient method.
11. Isolation of protoplasts by osmotic/enzymatic method.
12. Karyotype analysis in humans: Normal: Male and Female, Abnormal: Down syndrome, Turner, Cri Du chat and Klinefelter's Syndrome.

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M. Sc. Semester – II

Discipline Specific Course (DSC)

Course Title: BT CT 2.1 -Molecular Biology, Bioinformatics and Biostastics

Course Code: A2BIT001T

Course outcome:

After the completion of the topics, Students will be able to

- CO1: Understand the basic structure of DNA, RNA.
- CO2: Explain mechanism of DNA replication, transcription, translation and other related processes. Understand Genomic organization.
- CO3: Basic understanding about computer and molecular Biology.
- CO4: Understand the basic concept associated with protein structure, conformation properties and co-ordinate files.
- CO5: Know Protein and Nucleotide sequence analysis to find out homology, Different primary, secondary and derived database analysis and interpretation using tools available on them.
- CO6: Understand the Evolutionary relationship analysis using different Phylogenetic analysis tools, Various Biological database available.
- CO7: Analysis of DNA, RNA and protein as required for scientific studies using various online/offline tools and techniques.
- CO8: Conduct and planning independent experimentation for In Silico analysis and prediction of homologus sequences.
- CO9: Know how drugs are designed by computational means.
- CO10: Learn about basic concept of statistics, interpret the scientific results and explain concept of hypothesis testing.
- CO11: Make use of appropriate test statistics according to need of data.

Unit	Content	60 Hrs/Sem
I	**Replication, Transcription, Translation:** • **Replication:** Rolling circle replication, semi-conservative replication, replication fork-leading and lagging strands, enzymes involved at different steps of replication. Folded fiber model of *E. coli* chromosome, split genes, over-lapping genes, DNA amplification, the law of DNA constancy and C-value paradox. Structure, types and replication of RNA virus. (3 Hours) • **Transcription:** Classes of RNA Molecules and RNA Polymerases, Prokaryotic and Eukaryotic transcription, Post transcription modification – mRNA processing, 5-capping, 3-polyadenylation, Splicing Mechanisms, rRNA and tRNA processing. (3 Hours) • **Translation:** Genetic code and wobble hypothesis, tRNA and the Aminoacyl-tRNAsynthetases, Clover leaf structure of tRNA prokaryotic and Eukaryotic translation machinery, Ribosomes, Mechanism of prokaryotic and eukaryotic transcription, Post translational modification of proteins, inhibitors of protein translation. (2 Hours) • **Organization of genetic material:** Genome organization in viruses, bacteria and eukaryotes. Interrupted genes, gene clusters, structure of nucleosome, chromatin and chromosome. (2 Hours) • **Structural Polymorphism of DNA**: DNA Structure A, Band Z DNA, Super coiled DNA and DNA Binding Proteins. (2 Hours) • **DNA viruses:** Double stranded (Pox virus and SV40 virus) and single stranded DNA viruses. (2 Hours) • **Gene as a Unit of Mutation:** Mutation, mutagens and types of Mutations, Molecular basis of spontaneous and induced mutations and their role in evolution. Transposon and site directed mutagenesis, environmental mutagenesis and toxicity testing**,** Hot spots, AME's Test, Comet Assay. (4 Hours)	**15**
II	**Introduction to Computer Science and Bioinformatics:** • **Computer Science:** Parts and types of computers-Basic components and essential details of digital computers and peripherals devises and their maintenance functions. Mainframes, mini and micro (PC, PC-XT, PC-AT) Computer Architecture, Internal and External devices, servers, computer software and super, 4iyne/ computers. (3 hours) • **Operating system:** Windows, UNIX (Ubuntu), CRAN/ LINUX, Macintosh, application software's like word processor, formatting the document, tables, mail merge and spell check. Spreadsheets basics with MS Excel, labels, MS Power point, MS access. (2hours) • **Computer Viruses:** Overview and prevention. (1 hours) • **Computer network:** Advantages of Networks, Types of Networks (LAN and WAN) WIFI. Internet protocol (TCP/IP) File transfer protocols (FTP) WWW, HTTP. Etc.), Cloud Computing, Mobile	**15**

	Applications. (3 hours) • **Programming:** Introduction to HTML and Python, C, C++ and R-Programming. (3 hours) • **Bioinformatics:** An Overview- Introduction to Computational Biology and Bioinformatics, scope, and applications, Multomics Technologies - Genomics, Proteomics, Transcriptomics, Metabolomics. Emergence of Bioinformatics as a separate discipline. (3 hours)	
III	**Sequence alignment, phylogenetics, Structural biology:** • **Biological databases** Types of databases, literature databases, sequence databases, structure database, functional databases and chemical databases. Nucleotide Sequence Database – GenBank, EMBL-EBI, DDBJ and INSDC. Protein sequence data – TrEMBL, UniProt KB, PIR. Structure Databases (PDB, MMDB) Genome databases – Bacterial genome database – GOLD, MBGD, Viral genome databases – ICTVDB, VirGen, Human genome databases – MapViewer, Ensembl, UCSC, Vista-genome Browser, OMIM/OMIA. Organisms Specific Databases (Wormbase, Ecogene, SGD,TAIR,Flybaseetc).(6 hours) • **Sequence alignments** Pairwise sequence alignment and multiple sequence alignments – Basic concepts of sequence alignment, gap penalties. Sequence similarity search tools - BLAST and FASTA. Algorithm of CLUSTAL Omega. • **Molecular Phylogenetics** – phylogenetics basics: molecular evolution and molecular phylogenetics, gene phylogeny versus species phylogeny, forms of tree representation; phylogenetic tree construction methods and programs: distance-based methods, character-based methods, phylogenetic tree evaluation, phylogenetic programs – PHYLIP, MEGA and PileUp. (5 hours) • **Primer designing:** Primer 3, applied biosystems, • **Structural biology and Drug Design** Protein structure prediction prediction, Homology Modeling, Concept of lead, lead identification and lead optimization, Computer Aided Drug Design (CADD) Structure based drug design (SBDD) and Ligand Based Drug Design (LBDD); Specific activity relationship (SAR), Quantitative Structure Activity Relationship (QSAR) methods and applications. Combinatorial chemistry and virtual screening. Drug designing softwares: Autodock, GOLD, Schrodinger, Discovery Studio. (4 hours)	**15**
IV	**Biostatistics:** • Organization, description and graphical representation of data. (3 Hours) • Summary measures of – Central tendency (mean, mode, median), dispersion (Standard Deviation, Standard error) correlation (2-D, 3-D, Pearson, R value, Heatmap) and regression Chi square tests, tests of	**15**

	significance (t test, P-value, F, ANOVA. (7 Hours) • Statistical softwares: MS Excel, MS access, Statistic, SPSS, Graph pad. (5 Hours)	

M. Sc. Semester – II

Discipline Specific Course (DSC)

Course Title: BT CP 2.5 Based on BT CT 2.1 Molecular Biology, Bioinformatics and Biostatistics

Course Code: A2BIT004P

Types of Course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/ Semesters	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**04**	**04**	**60 hrs.**	**4 hrs.**	**20**	**80**	**100**

Practicals

1. Inheritance and pedigree analysis of simple Mendelian traits.
2. Induction and study of physical and chemical mutagens in bacteria/fungi
3. RFLP and RAPD analysis.
4. Demonstration of Southern blotting / Northern blotting/Western blot.
5. Basic computer operations, Internet and its applications.
6. Programming in 'C'.
7. Virtual library – Bibliographic searches.
8. Sequence retrieval from nucleic acid and protein database.
9. Pair-wise comparison of sequences. (BLAST and FASTA).
10. Multiple sequence alignment.
11. Phylogenetic analysis.
12. Primer designing.
13. Measures of Mean, Mode, Median, Central Tendency, Chi, Square Tests, t-test.
14. Organization, description and graphical representation of data.
15. Mandatory visit to research institute/ Biotech industries.

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M. Sc. Semester – II
Discipline Specific Course (DSC)

Course Title: BT CT 2.2 - Immunology and Immunotechnology

Course Code: A2BIT002T

Course outcome:

After the completion of the topics, Students will be able to

- CO1: Have understanding about concepts of immunology.
- CO2: Learn the basic techniques essential in immunological experimentation.
- CO3: Understand the mechanism of immune system of the body build up against various diseases and the protection offered lifetime.
- CO4: Use of immunological techniques in laboratory, in research and development areas.
- CO5: Understand the antigen antibody interaction.
- CO6: Hands on performing practically used techniques.

Unit	Content	60 Hrs/Sem
I	**Immunology:** • **Introduction to Immunology:** Fundamental concepts and anatomy of the immune system, History and scope of immunology. (2 Hours) • **Cells involved in immune system**–Haematopoetic system, T-lymphocytes, B-lymphocytes, Monocytes, Macrophages, APC, Neutrophils, Mast cells. (3 Hours) • **Organs of the immune system**- primary and secondary lymphoid organs, Lymphatic system, Lymphocyte circulation, Mucosal and Cutaneous associated Lymphoid tissue (MALT and CALT). (6 Hours) • **Types of immunity**- Innate immunity, Adaptive immunity, Components of Innate and Acquired immunity. Phagocytosis, Complement and Inflammatory responses. (4 Hours)	15
II	**Antigen- Antibody and their interactions, Hypersensitivity reactions:** • **Antigen:** Identification and measurement of antigen, conditions of antigenicity, antigens and immunogenicity, super-antigen. Self and non-self-recognition, epitopes mapping, paratopes, nature of B-cell and T – cell epitopes, Concept of haptens carbohydrate antigens, blood group antigens, synthetic peptides as antigens. (3 Hours) • **Immunoglobulin:** Structure and properties of immunoglobulin classes, Isotypes, Idiotypes and Allotypes, Genetics of antibody diversity, Polyclonal antibodies and Monoclonal antibodies. (3 Hours) • **Antigen-antibody Interaction:** Agglutination, Precipitation, Affinity,	15

	avidity and cross reactivity, Haemagglutination and Complement fixation. (2 Hours) • **Hypersensitivity reactions:** Allergies, Type I- Anaphylaxis, Type II- Antibody dependent cell cytotoxicity and Type III- Immune complex mediated reactions, Type IV- delayed type hypersensitivity, Symptoms and Immunological methods of diagnosis of hypersensitive reactions, Lymphokines, and cytokines–Assay methods, Immunological tolerance and modulation. (7 Hours)	
III	**Immunodiagnostics, Immunotechniques and applications, Immunization and Vaccine technology:** • **Anti-microbial immunity:** Defense against bacteria, viruses, fungi, protozoa and parasites. (4 Hours) • **Immunodiagnostics in virology** – Serological methods for detection and quantitation of viruses including Hepatitis, Influenza, HIV and others. (2 Hours) • **Immuno-assays:** Immuno double- diffusion, single radial immunodiffusion (SRID), ELISA, ELISA-PCR, RIA, Western Blotting, Immunofluorescence and their application. Immune deficiencies and autoimmunity, Immunoelectrophoresis, Flow cytometry, Complement fixation test (CFT), Montaux test, Applications of these methods in diagnosis of Microbial infections. (4 Hours) • **Vaccines:** Types of vaccines and its application, edible vaccines, conventional vaccines, viral vaccines, bacterial vaccines, peptide vaccines, genetically engineered vaccines, Hybridoma technology, immunization of animals Isolation of stimulated spleen cells, myeloma cell lines used and fusion partners, Fusion method production, detection and applications of monoclonal and polyclonal antibodies, production and application of Lymphokines. (5 Hours)	**15**
IV	**Expressions and Regulation of Immune Response, Transplantation and Tumour immunology:** • Regulation of immune response, Antigen processing and presentation, generation of humoral and cell mediated immune response, activation of B and T lymphocytes, cytokines and their role in Immune regulation, T cell regulation, MHC complex restriction, Immunological tolerance. (5 Hours) • **Cytokines:** Structure and receptors, signal transduction, modulation of immune response cytokine profile of diseases. (2 Hours) • **Transplantation Immunology:** Organ transplantation, types of grafts, Structure and functions of MHC and the HLA systems, grafts rejection, mechanism of graft rejection and prevention of graft rejection, GVH reactions. **HLA and tissue transplantation**: Tissue typing methods for transplantations in humans; Xeno-transplantation, (inter species, intra Species, Intra Genus) immunosuppressive therapy. (5 Hours) • **Tumor Immunology:** Immune response to tumors, Tumor specific antigens, Theory of surveillance, Immunodiagnosis of tumors – detection of tumor markers – Alpha-fetoprotein, Carcino-embryonic antigen, Cancer therapeutics. (3 Hours)	**15**

M. Sc. Semester – II

Discipline Specific Course (DSC)

Course Title: BT CP 2.6 Based on BT CT 2.2 Immunology and Immunotechnology

Course Code: A2BIT005P

Types of Course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/ Semesters	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**04**	**04**	**60 hrs.**	**4 hrs.**	**20**	**80**	**100**

Practicals

1. Blood film preparation and identification of cells, WBC and RBC count.
2. Determination of Blood groups and Rh factor.
3. Estimation of Hemoglobin.
4. Demonstration of antigen administration to animals Mice / Rat. (Intra-muscular, Intra-veinal, Intra-peritoneal)
5. Determination of Bleeding Time (BT) and Clotting Time (CT).
6. Separation of Serum / Plasma from whole blood, Electrophoretic separation of serum proteins/plasma.
7. Precipitation of Immunoglobulins from serum by Ammonium sulphate precipitation.
8. Agglutination tests (Haemagglutination, Latex agglutination, Bacterial agglutination).
9. Immunoprecipitation tests – Radial Immunodiffusion test / Ochterlony double diffusion test.
10. Demonstration of ELISA.
11. Demonstration of Western blot.
12. Determination of antibody titer of the serum.
13. Immunoelectrophoresis – Rocket Immunoelectrophoresis.

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M. Sc. Semester – II

Discipline Specific Course (DSC)

Course Title: BTCT - 2.3 Enzymology and Metabolism

Course Code: A2BIT003T

Course outcome:

After the completion of the topics, Students will be able to

- CO1: To understand the role of various metabolic pathways and their importance.
- CO2: Understand the concept of photosynthesis, biochemistry of hormones.
- CO3: Knowledge of Electron-Transfer Reactions in Mitochondria. ATP Synthesis, Regulation of Oxidative Phosphorylation.
- CO4: Basic understanding of enzymes.
- CO5: learn about Classification, nomenclature of enzymes.
- CO6: Understand the detailed mechanism of enzyme specificity and action, unit of enzyme activity, kinetics of single and multisubstarte reactions.
- CO7: Role of inducers, inhibitors, covalent modifications, pH & temperature in the course describe their indispensable role in regulating enzyme activity.
- CO8: Estimation of absolute and specific activity of enzymes and Effect of activators and inhibitors on enzyme activity.

Unit	Content	60 Hrs/Sem
I	**Bioenergetics and Enzymes:** • Thermodynamics– laws of thermodynamics, Gibbs free energy, endergonic (photosynthesis) and exergonic (cellular metabolism) reactions . ATP-structure, function, energy transfer, and sources. Organization of respiratory electron transport system, mechanism of oxidative phosphorylation biological energy transducers, chemo-osmotic generation of ATP, high energy compounds. (5 Hours) • Introduction to Metabolism- Catabolism, anabolism, catabolic, anabolic and amphibolic pathways. (2 Hours) • Definition, structure, properties and classification of enzymes, Co-factors and Co-enzymes, Kinetics of enzyme catalyzed reactions. Michaelis–Menten equation, K_M and V_{max}, single substrate and double substrate reactions. Lineweaver and Burke modification, enzyme kinetics and enzyme inhibitory kinetics (competitive, uncompetitive, noncompetitive and mixed inhibitions and determination of Ki).(4 Hours)	15

	• Mechanism of enzyme action: Induced fit hypothesis nature of catalysis, mechanism of lysozyme action. (2Hours) • Enzyme regulation: Covalent and allosteric regulation activation and inhibition of enzyme activity and isoenzymes, ribozymes and abzymes. (2 Hours)	
II	**Carbohydrate and lipids metabolism:** • Sources of carbohydrates, enzymatic conversion of metabolites as glucose and fructose, Introduction, aerobic and anaerobic pathways, brief account of glycolysis, Kreb's cycle, Glyoxylate cycle, Gluconeogenesis, Pentose phosphate pathway (HMP shunt) and its regulation, Glycogenolysis and Glycogenesis, substrate level phosphorylation, rate controlling steps and regulation of the metabolic pathways. (7 Hours) • Beta–oxidation of saturated, unsaturated and branched chain fatty acids. Peroxisomal beta– oxidation, alpha and omega oxidation Biosynthesis of fatty acids, biosynthesis of long chain fatty acids and branched chain fatty acids, desaturation. Biosynthesis of phospholipids De novo pathway and inter conversion, cholesterol biosynthesis and regulation. (8 Hours)	**15**
III	**Amino acids -proteins and Nucleotide Metabolism:** • Synthesis of amino acid and their catabolism (deamination, decarboxylation, trans-amination and reductive trans-amination), hydrolysis of proteins, proteases and re-purposing of amino acids. Co-ordinated control of amino acid metabolism, formation of ammonia and urea. (8 Hours) • Pathway for degradation of purines and pyrimidines, de-novo biosynthetic pathway of ribonucleotides, Salvage pathways and related disorders, biosynthesis of deoxyribonucleotides. Regulation of degradation and biosynthesis. (7 Hours)	**15**
IV	**Photosynthesis, Signal transduction, Biochemistry of Hormones:** • Chemistry and components of photosystems, absorption spectrum and active spectrum, Cyt-b, Cyt-f complex, ATP synthesis, pigments involved in photosynthesis, chlorophyll a, chlorophyll b, bacterio-chlorophyll, bacterio-rhodopsin, mechanism of light reaction and carbon fixation, C3, C4 and CAM pathways, photorespiration and its impact in bacterial photosynthesis. (5 Hours) • Inter- and Intra- cellular signaling, signaling molecules–proteins and non- protein signals, signal synthesis, release and transport. Target cells and tissues, signal receptors, distribution and interaction between the signal transduction and the mechanism of transduction, Role of secondary messengers, such as calcium, cAMP, cGMP, phosphotidyl inositol, phosphates. A general view of plant signals, phytohormones and their mechanisms. (6 Hours) • Biosynthesis and regulation of hormones, mechanisms of hormone transduction, Cell-cell transport of hormones, hormone receptors, signal component receptors. (4 Hours)	**15**

M. Sc. Semester – II

Discipline Specific Course (DSC)

Course Title:BT CP 2.7 Based on BT CT 2.3 Enzymology and Metabolism

Course Code: A2BIT006P

Types of Course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/ Semesters	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**04**	**04**	**60 hrs.**	**4 hrs.**	**20**	**80**	**100**

Practicals

1. Qualitative and quantitative analysis of carbohydrates / proteins / amino acids / lipids.
2. Estimation of Chlorophyll/ Carotenoids from microorganism or plants.
3. Determination of pKa of proteins and amino acids.
4. Purification of enzymes/proteins using ammonium sulphate, pH precipitation and organic solvent methods.
5. Isolation of enzymes from different biological sources (bacterial / fungal / plant / animal cells).
6. Effect of different substrate concentration, temperature and pH on enzyme activity.
7. Study of enzyme kinetics–effect of inhibitors, Determination of Km, Vmax and Ki of competitive and noncompetitive inhibitors.
8. Isolation of α-amylase from sweet potato, assay of enzyme activity and specific activity.
9. Isolation of protease from papaya, assay of enzyme activity and specific activity
10. Enzyme assay- using standard Trypsin, Urease and Phosphatase.
11. Immobilization of enzymes by calcium alginate method and assay.
12. Estimation of urea, creatine and creatinine in biological samples.

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M. Sc. Semester – II

Discipline Specific Course (DSC)

Course Title: BT ET 2.4 - Molecular cell biology

Course Code: A2BIT204T

Course outcome:

After the completion of the course, students will be able to

- CO1: Understand the cell organelles, their structure and functions.
- CO2: Differentiate between meiosis and mitosis and will be able to learn about different factors controlling cell cycle progression.
- CO3: Explain the mechanism of DNA replication, transcription, translation and other related processes.
- CO4: Understand chromosomal organization.
- CO5: Explain the role of different protein/ enzymes involved in cell fertilization and differentiation.
- CO6: Understand the detailed biology of cancer.

Unit	Content	60 Hrs/Sem
I	**Basics of Cell Biology, Cell Organelles and Cell Architecture:** • Cell theory, Structure of Prokaryotic and Eukaryotic cells, Differences between Plant and Animal Cells. Ultrastructure of Plasma Membrane, Different models of Plasma membrane structure. Ultrastructure and functions of cellular organelles: Nucleus, Chloroplast, Mitochondria, Endoplasmic Reticulum, Golgi bodies, Ribosomes, Lysosomes, Vacuoles and Centrosomes. Structure of microtubules, cilia, flagella and centrioles, Intermediate Filaments Actin and Myosin, functional role of actin filaments and motor proteins. Role of microtubules in intracellular movements.	15
II	**Membrane Transport:** • **Transport across membrane**- passive diffusion, osmosis, active transport, Ion Channels, A B C transporter, Na+ and K+ pump, Ca^{2+} ATPase pump, co-transport, symport, antiport, endocytosis and exocytosis. Membrane vesicular traffic. (8 Hours) • **Cell Signaling:** Cell to cell interactions, Cell adhesion-integrins, selectins, cadherins. Cell Junction- Tight and gap junctions, Desmosomes, plasmodesmata. General principles of cell signaling, signaling via G-protein coupled receptors, kinase receptors, role of secondary messengers. (7 Hours)	15
III	**Chromosomal organization and Cell Cycle:**	15

	• Molecular organization of eukaryotic chromosomes, Molecular features of telomeres, centromere, kinetochore, chromatin and heterochromatin. Mechanism and causes of chromosomal condensation and relaxation. Mutations, Chromosomal aberrations- deletions, duplications, translocation and inversion. Euploidy and Polyploidy. (8 Hours) • Cell cycle and division - mitosis, mitosis and meiosis, phases of the cell cycle, DNA Replication, Transcription and Translation. Control system of Cell cycle and Checkpoints in cell cycle regulation**.** (7 Hours)	
IV	**Apoptosis, Molecular biology of Cancer:** • Phenomenon of Apoptosis, Programmed cell death, Caspases, Apoptotic protease activating factor (APAF) mechanism of apoptosis at biochemical, cellular and gene level, Necrosis, factors regulating apoptotic death in normal cells and tumorous cells. (8 Hours) • Characteristics of Cancer cells, The Genetic Basis of Cancer, Proto-onco genes and its regulation, Oncogenes, Viral Oncogenes, Regulation of gene expression and signal transduction in cancerous cells, cancer treatment. (7 Hours)	**15**

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M. Sc. Semester – III

Discipline Specific Course (DSC)

Course Title: BT CT 3.1 - Animal Biotechnology

Course Code: A3BIT001T

Course outcome:

After the completion of the topics, Students will be able to

- CO1: Examine and analyze the theoretical and practical principles of cell culture. Examine animal and human cell lines for various biological assays.
- CO2: Take out primary cells from animal or human tissues and can grow them outside environments for long period of time and perform various experiments on these.
- CO3: Understand the Stem cells biology, therapy and Tissue Engineering concepts
- CO4: Get practical skills in the field of manipulation of animal cell and tissue cultures.
- CO5: Explain the main advantages and disadvantages of cell and tissue culture in biomedical research and its applications.
- CO6: Understand the applications of Biomaterials and Ethics in Biotechnology.
- CO7: Explain about the different types of bio safety levels, their set up and need.

Unit	Content	60 Hrs/Sem
I	**Introduction to Tissue Culture, Types, and Techniques of Animal Cell Culture:** • **Overview of Tissue Culture**: Definition, principles, and significance of tissue culture, equipment and materials for animal cell culture technology, maintenance of sterility, use of antibiotics, detection of mycoplasma and viral contaminants, tissue culture media (natural, synthetic media, and sera), sterilization of cell culture media and reagents, role of carbon dioxide in animal cell culture. (5 Hours) • **Cell Culture Techniques:** Primary and secondary cell cultures, development of cell lines or established cultures, biological characterization of cell cultures, contact inhibition, cell transformation, cancer cells, indefinite cell lines. Measurement of cell viability and cytotoxicity, screening of cytotoxic compounds and their importance. (5 Hours) • ***In Vitro*** **Techniques:** Disaggregation of tissue and primary culture, subculture and establishment of cell lines, cloning and selection, cell separation, characterization, differentiation, transformation and	15

	immortalization, quantification of cell culture, scale-up techniques and cell synchronization. (5 Hours)	
II	**Stem Cells and Tissue Engineering:** • **Stem Cell Biology:** Overview of stem cells, self-renewal potential, differentiation versus stem cell renewal, trans-differentiation, and cell cycle dynamics of different stem cells. Stem cell assays and protocols: isolation of defined stem cell populations, progenitor cell assays, sources of progenitor cells, cytokine and chemotherapy approaches to mobilization of progenitor cells. (5 Hours) • **Stem Cell Therapy:** Clinical applications of stem cell therapy in neurodegenerative diseases (e.g., Parkinson's disease, Alzheimer's disease), spinal cord injury, tissue system failures (e.g., diabetes, cardiomyopathy, kidney failure, liver failure, hemophilia), lymphoma, and leukemic malignancies requiring stem cell therapy. (5 Hours) • **Tissue Engineering:** Basic concepts in cell biology, cell-matrix interactions, receptor biology, engineering angiogenesis and vascularization, material-based immune therapy, applications in skin, bone, liver, and muscle tissue engineering. (3 Hours) • **Gene Therapy:** Types of genetic diseases targeted for gene therapy, overview of the Human Genome Project and its applications. (2 Hours)	**15**
III	**Hybridoma Technology, Antibody Engineering, and Biomaterials:** • **Monoclonal Antibody Production:** Production strategies for murine monoclonal antibodies (MAbs) including fusion strategies and HAT selection. Strategies for the production of human MAbs: humanization and antigenization techniques (chimeric, CDR-grafted, SDR-grafted, veneered MAbs). (5 Hours) • **Antibody Engineering:** Antibody fragments, antibody gene cloning, expression of recombinant antibody genes, next-generation display technologies for *in vitro* antibody production, combinatorial libraries and phage display libraries, bio-specific and bi-functional antibodies, immuno-conjugates, catalytic antibodies. (3 Hours) • **Polymeric Biomaterials:** Overview of polymeric biomaterials including polyolefins, polyamides, acrylic polymers, fluorocarbon polymers, rubbers, thermoplastics. Physiochemical characteristics of biopolymers, biodegradable polymers for medical purposes, synthetic polymeric membranes and their biological applications (e.g., controlled release systems, artificial skin). (5 Hours) • **Composite Biomaterials:** Properties, classification, and applications of composite biomaterials in the fabrication of bio-devices and implants, applications in drug delivery systems. (2 Hours)	**15**
IV	**Animal Reproductive Systems with Reference to Insects and Mammals and Ethics in Biotechnology:** • **Animal Reproductive Systems:** Organization, function, hormonal regulation of growth and reproduction in insects and mammals. Hormonal regulation during the estrous cycle, menstrual cycle, pregnancy, IVF techniques including embryo transfer technology in humans and livestock. Mechanisms of protein and steroid hormone	**15**

	action, importance of hormones as biotechnological products. (10 Hours) • **Ethics in Biotechnology:** Legal and socio-economic impacts of biotechnology at national and international levels, public awareness initiatives, biosafety regulations, guidelines for research involving transgenic animals, public understanding of the processes involved in producing transgenic organisms. (5 Hours)	

M. Sc. Semester – III

Discipline Specific Course (DSC)

Course Title: BT CP 3.5 Based on BT CT 3.1 Animal Biotechnology

Course Code: A3BIT004P

Types of Course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/ Semesters	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**04**	**04**	**60 hrs.**	**4 hrs.**	**20**	**80**	**100**

Practicals

1. Rearing, Maintenance and Safety of laboratory animals – Rat/ Mouse/ Silkworm.
2. Preparation of animal cell culture media (Natural and Synthetic).
3. Viability test and Cell counting (Trypan Blue Staining).
4. Disaggregation of animal tissue by trypsinization.
5. Studies on the Estrous cycle.
6. Sperm counting and Sperm viability.
7. Demonstration of techniques involved in Ovariectomy, Orchiectomy, Adrenalectomy and Hysterectomy in rats.
8. Isolation of DNA from animal tissues.
9. Demonstration of Cryo-preservation of animal cells.
10. Estimation of Cholesterol.
11. Comet assay of blood sample.
12. MTT assay for Cytotoxicity.
13. Developmental stages of chick embryo.
14. Initiation of primary culture from chick embryo.
15. Visit Research institute veterinary institute and IVF center.

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M. Sc. Semester – III

Discipline Specific Course (DSC)

Course Title: BT CT 3.2 - Environmental Biotechnology and Biodiversity

Course Code: A3BIT002T

Course outcome:

After the completion of the topics, Students will be able to

- CO1: Gain basic understanding about environment and its pollution.
- CO2: Learn about various effects of pollution and its controlling methods.
- CO3: Get acquainted to the methods of waste water treatment and solid waste management.
- CO4: Students will gain knowledge about biomass production and biofuels.
- CO5: Use of Biotechnology in environmental pollution control.
- CO6: Recent trends in biofuel research.
- CO7: Industrial applications and future prospects.

Unit	Content	60 Hrs/Sem
I	**Environment and Environmental pollution, Aerobiology and Soil biology:** • Meaning, Scope and Concept of Environment and Environmental pollution. (2 Hours) • **Aerobiology**: Air sampling techniques, Identification of airborne Bio-particles, Sources and characteristics of air pollutants, health hazards due to air pollution. Air borne diseases and controlling measures of air pollution. (3 Hours) • **Soil biology**: Classification of soil based on physical and chemical characteristics, Microorganisms in various soil types. Soil pollution – sources and characteristics of soil pollutants, health hazards due to soil pollution, control measures of soil pollution, Interaction among soil microbes-mutualism, commensalisms, amensalism, parasitism, predation, competition, antibiosis and their significance Interrelationship between microbes, plant and soil Brief account on rhizosphere, Phyllosphere and Sphermoshere, Symbiotic and non-symbiotic association with higher plants, role of enzymes of microbial origin in the release of plant nutrients. (10 Hours)	15
II	**Water ecosystem and Water treatment:** • **Water Ecosystem**: Fresh water and marine water ecosystems, Zonation of water ecosystem, water pollution-sources, and characteristics of water	15

	pollution and health hazards due to water pollution, eutrophication. Biological indicators of water pollution - Chemical, Microbiological and Biotechnological indicators Water purifications. Brief account on water borne diseases and control measures. (6 Hour) • **Waste Treatment**: Solid and Liquids wastes and their Characterization Physical, chemical and biological methods of solid waste treatment Saccharification, Gasification, Composting and wastewater recycling-chlorination, Ozonization, radiation, filtrations, reverse osmosis. Effluent treatment - (Dairy, Distillery, Tannery, Textile, Paper and sugar industries) Physical, chemical and biological sewage treatment-Trickling filters, oxidation pond, ditch and activated sludge treatment. Advanced waste water treatment-Rotating Biological Contactors (RBC), submerged aerobic filters, fluidized bed reactors, biological aerated flooded system and combination of anaerobic, denitrification and aerobic treatment of wastewater. Advanced activated sludge process. (9 Hours)	
III	**Bioremediation**, **Bioenergy:** • Concepts and principles, *Insitu* and *Exsitu* Bioremediation, Phycoremediation, Mycoremediation, Phytoremediation. Biodegradation of pesticides and Xenobiotics (Halocarbons, C-1 compounds, aliphatic hydrocarbons, acyclic hydrocarbons, Aromatic hydrocarbons, polycyclic Hydrocarbons, Halogenated compounds) in soil and their influence on soil micro flora. Biodegradation of natural polymers-Cellulose, Lignin, Pectin, Chitin Detergents, Soaps and Plastics. Bio-deterioration of paper, Leather, Wood, Textiles. Mode of Deterioration and organisms involved. Bio-leaching, Bio-mining, and Production of Oils and fuels from wooden-waste.(12 Hours) • Biofuels, bio-ethanol, biodiesel, biogas, bio-hydrogen, Algal Biotechnology for Bio-energy, byproducts of sugar industries, Bioethanol. (3 Hours)	**15**
IV	**Biodiversity and its conservation, Environmental Education:** • Current levels of biodiversity, extinction and endangered species, reasons of concern for loss of biodiversity, steps to preserve biodiversity, *In-situ* and *Ex-situ* conservation, gene banks, convention on biological diversity, Species conservation. (8 Hours) • Agrochemicals, Global Warming, Ozone depletion, Greenhouse effect, Acid rain their impact and biotechnological approaches in the environment. (4 Hours) • Biological control and Integrated Pest Management (IPM). (3 Hours)	**15**

M. Sc. Semester – III

Discipline Specific Course (DSC)

Course Title:BT CP 3.6 Based on BT CT 3.2 Environmental Biotechnology and Biodiversity

Course Code: A3BIT005P

Types of Course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/ Semesters	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**04**	**04**	**60 hrs.**	**4 hrs.**	**20**	**80**	**100**

Practicals

1. Detection of coliforms for determination of purity of potable water samples by MPN method.
2. Determination of DO, BOD, COD and TDS of water samples.
3. Isolation of Bacteriophages from sewage water samples.
4. Study of microflora of industrial waste and effluents.
5. Selective enrichment of auxotrophic and antibiotic (Tet^R/Ref^R) mutants.
6. Isolation of DNA from environmental samples.
7. Isolation of Xenobiotic degrading bacteria by selective enrichment technique.
8. Estimation of Phosphate, sulphates, Nitrates, major cat ions (Na^+, K^+, Mg^{++} and Ca^{++}) and heavy metals in water samples.
9. Effect of industrial effluents/ heavy metals on seed germination and seedling growth.
10. Field excursion to an industrial area to assess environmental impact.

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M. Sc. Semester – III

Discipline Specific Course (DSC)

Course Title: BT CT 3.3 - Bioprocess Engineering and Technology

Course Code: A3BIT003T

Course outcome:

After the completion of the course, Students will be able to

- CO1: Learn the basic components of fermenter. Basic understanding about different types of fermenters used for microbial, plant and animal cell.
- CO2: Basic understanding about concept of microbial growth and growth curve.
- CO3: Understand the necessary concept coupled with design of fermenter and instrumentation involved in control of various parameters in fermenter.
- CO4: Gain knowledge in areas relating to sterilization cycle for batch and continuous mode of operation.
- CO5: Learn the concept of transport in fermenter and product formation.
- CO6: Analyse the use and application of fermenter.
- CO7: Master the standardization of probes and various factors involved in fermenter.
- CO9: Understand the methods of enzyme cell immobilization, and their applications.
- CO10: Medical applications of enzymes in the course describe their indispensable use at large scale.
- CO11: Students will be able to identify basic differences between different forms of IPR like patent, copyright, trademarks etc.

Unit	Content	60 Hrs/Sem
I	**Bioprocess Engineering, Immobilization and Entrepreneurship:** • Chronological development of bioprocess engineering and fermentation industry, Industrial processes-Microbial biomass, microbial metabolites, transformation process and recombinant products. Isolation, screening, selection, preservation and maintenance of industrial important microorganisms. (5 Hours) • **Immobilization**: Definition and concepts of immobilization, enzyme and whole cell immobilization. Immobilization techniques – Adsorption, Cross-linking, Ionic bonding, Entrapment and Encapsulation. Advantages and industrial applications of immobilized enzymes and cells. (5 Hours) • **Entrepreneurship:** Potential entrepreneurship opportunities in bioprocess technology. Economics of product development, product licensing, marketing, resources, research and training units, Industrial licensing and venture capital, Biotech parks, Biotechnology industries in India, contract research (CRO) and Intellectual property rights (IPRs). (5 Hours)	15
II	**Fermentation Technology:** • **Bioreactors**: Basic design and function of a Bioreactor, body construction, aeration and agitation, attainment and maintenance of aseptic conditions, sterilization of bioreactor. Ports for nutrients and inoculum, sampling, types of valves, Types of bioreactors: Specialized bioreactors–Tubular bioreactors, membrane bioreactors, tower bioreactors, fluidized bed reactor, packed bed reactor and photo-bioreactors. (7 Hours) • **Types of fermentation process**: Solid state fermentation-principle, methodology and applications. Liquid state fermentation- principle, methodology and applications. Analysis of batch, fed batch and continuous fermentations. Stability of microbial reactors, analysis of mixed microbial population, Measurement and control of bio-process parameters and Response surface methodology (RSM).(8 Hours)	15
III	**Upstream and Downstream processing:** • **Sterilization and Fermentation Process controls**: Sterilization of fermentor, Media, feeds, air and filter sterilization, method of batch sterilization and continuous sterilization process. Methods of measuring process variables. Online analysis and Control systems. Computer applications in fermentation technology. (4 Hours) • **Upstream processing**-Media Natural media, synthetic media and typical media. Media formulation strategies, sources of carbon, nitrogen, vitamins and minerals.Role of buffers, precursors, inhibitors, inducers and antifoam agents. Microbial growth kinetics, specific growth rate. monod equation, strain improvement, inoculum development for bacterial and fungal processes. (5 Hours) • **Downstream Processing**: Objectives and criteria, removal of microbial cells and solid matter, cell disruptions, foam precipitation, filtration,	15

	centrifugation, liquid-liquid extraction, chromatography, TFF membrane process, drying, crystallization, packaging. Quality control and quality assurance, effluent treatment, DOC, COD and disposal. (6 Hours)	
IV	**Industrial Production and Food process Technology:** • **Industrial Production:** of Agar – Agar, Alginate, Alcohol (Ethanol), Organic acids (Citric, Acetic acid, Solvents. (Glycerol and Acetone), Antibiotics (Penicillin and Streptomycin), Amino acids (Lysine and Glutamic acid), Single cell proteins (SCP), Vitamins (Riboflavin), Enzymes (Amylase, Lactase and Protease), Hydrocarbons – Biodegradable plastic or PHA and PHB, and recombinant protein (HCG, hepatitis – B vaccine), metabolic engineering of microbes for production of fine chemicals (biofuels, nano-particle based drugs, functional nutrients). (8 Hours) • **Food processing**: Food spoilage-Microbiological spoilage, Chemical spoilage, Physical spoilage and spoilage by insects, rodents, and parasites. Food preservation-Principles and general methods (chemical and physical), shelf life, elementary idea of canning, freezing, dehydration, packing sterilization and pasteurization, irradiation of food products. (5 Hours) • **Food fermentation technology** – Sausages, olives, bread, Idli and acidophilus milk Hazard analysis and critical control point (HACCP) concepts. (2 Hours)	**15**

M. Sc. Semester – III

Discipline Specific Course (DSC)

Course Title: BT CP 3.7 Based on BT CT 3.3 Bioprocess Engineering and Technology

Course Code: A3BIT006P

Types of Course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/ Semesters	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**04**	**04**	**60 hrs.**	**4 hrs.**	**20**	**80**	**100**

Practicals

1. Study of fermentor and bioreactor-its parts, types and functioning.
2. Isolation and screening for industrially important microorganisms by crowd plate technique using different media and conditions (aerobic and anaerobic).
3. Study of antibiotic producing microorganisms in liquid culture process and activity analysis.
4. Study of alcohol fermentation – alcohol production from different substrates (molass, sugar beet juice and processed wood waste products).
5. Lab production of wine, estimation of percentage of alcohol, total acidity and volatile acidity in wine
6. Estimation of alcohol by potassium dichromate method.
7. Production of α-amylase/ protease from *Bacillus* spp., *Aspergillus*spp., and *Streptomyces* spp. by using wheat bran, coffee pulp through small scale smf/ ssf fermentation process and its assay.
8. Production of citric acid by *Aspergillusniger, Pencilliumcitrinum*and its estimation.
9. Partial purification of microbial α-amylase/ protease by salt/ solvent precipitation, its activity and immobilisation
10. Microbial production of yoghurt, acidophilus milk and temph.
11. Rapid platform test for milk- (MBRT, clot on boiling-COB, alcohol test, specific gravity test, two-minute resazurin test)
12. Estimation (nutritive value) of fat, protein, sugars and minerals in milk and milk products
13. Detection and quantification of siderophores produced by *Pseudomonas* spp.

14. Mandatory visit to research Institutes / industries and submission of report.

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M. Sc. Semester – III

Discipline Specific Course (DSC)

Course Title: BT ET 3.4 - Plant and Animal Tissue Culture

Course Code: A3BIT203T

Course outcome:

After the completion of the course, students will be able to

- CO1: Gain an insight into the concepts and techniques of plant and animal tissue culture and its applications.
- CO2: Prepare plant culture medium and establish *invitro* cultures from primary and secondary explants.
- CO3: Understand the culturing of specialized cells, cell separation, characterization and tissue engineering.

Unit	Content	60 Hrs/Sem
I	**Plant Tissue Culture:** • Introduction to Cell and Tissue culture. Tissue culture as a technique to produce novel plants and hybrids, plant tissue culture lab setup, tissue culture media(Composition and Preparation).Initiation, maintenance of callus and suspension culture and single cell clones. (7 Hours) • **Cell and Organogenesis**: Somatic embryogenesis, transfer and establishment of whole plants in soil. Shoot tip culture, rapid clonal propagation and production of virus-free plants. Embryo culture and Embryo rescue. Anther, pollen and ovary culture for production of haploid plants and homozygous lines. (8 Hours)	15
II	**Techniques in Plant Tissue Culture:** • Selection of hybrid cells and regeneration of hybrid plants, Symmetric and asymmetric hybrids and cybrids. Cryopreservation and DNA banking for germplasm conservation. (7 Hours) • **Metabolic engineering of plants**: Plant tissue culture for the production of useful chemicals and secondary metabolites (Hairy root culture, Biotransformation, Elicitation) - pigments, flavanoids, alkaloids, mechanism and manipulation of shikimate pathway.(8 Hours)	15
III	**Animal cell culture:** • Historical perspectives, development and scope. (1 Hours) • Requirements for animal cell, tissue and organ culture – Equipment and materials for animal cell culture technology, advantages and limitations	15

	of tissue culture, aseptic handling, facilities required, Cell culture media- Serum containing media, Serum free media and synthetic media and cell lines. (3 Hours) • **Organ and embryo culture:** Choice of models, organ culture and histotypic culture Filter – well inserts, neuronal aggregates, whole embryo culture eggs, chick and mammalian embryos. (4 Hours) • **Primary culture**: Primary culture: Isolation of mouse and chick embryos, human biopsies, methods for primary culture, nomenclature of cell lines, Sub culture and propagation, immortalization of cell lines, cell line designation, selection of cell line and routine maintenance. Cultivation of animal cell in mass using bioreactors, biology of cell culture, evaluation of culture dynamics and maintenance of cell lines. (7 Hours)	
IV	**Cell and Tissue Engineering:** • **Culture of Specialized Cells:** Epithelial, mesenchymal, neural, ectodermal, hematopoietic, gonad and tumor cell Lymphocyte preparation and culture of amniocytes, fish cells and confocal microscopy, Stem cell culture and its applications. (3 Hours) • **Cell Sorting**: Density-based, antibody based, magnetic and fluorescence-based cell sorting. Characterization of cells based on morphology, chromosome analysis, DNA content, RNA and protein, enzyme activity, antigenic markers, cytotoxicity assays, Cell quantitation and cell culture contamination, monitoring and eradication, and Cryopreservation. (5 Hours) • **Tissue Engineering:** Growth factors for *in-situ* tissue regeneration, biomaterials in tissue engineering, approaches for tissue engineering of skin bone grafts, nerve grafts, Hemoglobin based blood substitutes, bioartificial or bio-hybrid organs, Limitations and possibilities of tissue engineering. (7Hours)	**15**

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M. Sc. Semester – IV

Discipline Specific Course (DSC)

Course Title: BT CT 4.1 - Genetic Engineering

Course Code: A4BIT001T

Course outcome:

After the completion of the topics, Students will be able to

- CO1: Have basic understanding about concepts of genetic engineering.
- CO2: Learn the basic techniques essential in genetic engineering experimentation. Understanding the mechanism of different genetically engineered products. Studying vector and its role, identifying the transformed cells.
- CO3: Have basic understanding about Whole genome sequencing, genomic and cDNA library preparation. Understanding the basic concept associated with microarray, design, synthesis and analysis.
- CO4: Learn the basic concept of probe labelling and be able to describe their application in various analysis and diagnostic procedures.
- CO5: Explain about different technique and its implication in creating genetically engineered organisms.

Unit	Content	60 Hrs/Sem
I	**Tools of Genetic Engineering:** • **Introduction to Genetic Engineering**: Scope and importance of Genetic engineering. (1 Hours) • **Restriction endonucleases**- Nomenclature and types, recognition sequences and mechanism of action. DNA Modification enzymes (nucleases, kinases, Alkaline phosphatase, Klenow-Fragment polymerase, Lambda-Exonuclease and Exonuclease-III) and ligases-types and mechanism of action. (6 Hours) • **Vectors**: Brief account of naturally occurring plasmids (Conjugative and Non-conjugative plasmids, Degradative plasmids, Resistance plasmids, Fertility plasmids, Col-Plasmids), artificial plasmids (pBR322, pUC vectors, Ti and Ri plasmids), Bacteriophages, Phagemids, Cosmids, Fosmids, Artificial chromosomes (BAC's, YAC's), Shuttle vectors, expression vectors, M13 derived vectors and Viral vectors (SV40 and Bovine Papilloma Virus). (8 Hours)	15
II	**Gene Libraries and Selection of Recombinants:** • **cDNA library**- Isolation and purification of mRNA, synthesis of cDNA, cloning of cDNA in to plasmids and phage vectors. (2 Hours) • **Genomic DNA Library**: Isolation and purification of genomic and plasmid DNA, preparation of DNA fragments for cloning, construction of genomic DNA library with different vectors and screening techniques. (3 Hours) • **Chemical synthesis of Genes:** Methods (Phosphodiester, phosphotriester and phosphite ester methods principle and strategies). Oligonucleotide synthesis and application, synthesis of complete gene. (5 Hours) • **Labeling and Detection Techniques**: Labeling of DNA, RNA and Proteins (Radioactive and non-radioactive isotopes). DNA Sequencing (Chemical and Enzymatic method). (5 Hours)	15
III	**Techniques in Genetic Engineering:** • **Transformation and Transfection techniques**: Preparation of competent cells of bacteria, chemical methods- calcium phosphate precipitation method and liposome mediated method. Physical methods-Electroporation and gene gun method. Biological methods-*Agrobacterium* mediated transformation, Co-cultivation methods, Chloroplast transformation, method of DNA transfer to yeast, mammalian and plant cells**.** (5 Hours) • **Gene Editing:** CRISPR-Cas-9, **PCR:** Methodology, types and applications. (2 Hours) • **Blotting Techniques**- Southern Blotting, Northern Blotting, Western Blotting and DOT Blot, Nucleic Acid hybridization (Colony Hybridization and Plaque Hybridization), Immunological methods and *Invitro*-translation.Chromosome walking. (5 Hours) • **Gel Electrophoresis**: Agarose gel Electrophoresis, PAGE and PFGE (3 Hours)	15

IV	**Applications of Genetic Engineering:** • Transgenic plants (disease resistant, weedicide resistant, frost resistant, halo-tolerant and pest resistant) production of growth hormones, interferon, insulin, recombinant vaccines, gene therapy, RNA, requirement of recombinant molecules in health, pharmaceuticals, agriculture and industrial sectors, research labs. (5 Hours) • **Antisense and Ribozyme technology:** Molecular mechanism of antisense molecules, inhibition of splicing poly-adenylation and translation, disruption of RNA structure and capping Biochemistry of Ribozyme, hammerhead, hairpin and other Ribozymes, strategies for designing Ribozymes, application of antisense and Ribozymes technologies.(8 Hours) • **Forensic Sciences:** DNA microarrays – principle, types, construction and applications. (2 Hours)	**15**

M. Sc. Semester – IV

Discipline Specific Course (DSC)

Course Title:BT CP 4.4 Based on BTCT 4.1 Genetic Engineering

Course Code: A4BIT004P

Types of Course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/ Semesters	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**04**	**04**	**60 hrs.**	**4 hrs.**	**20**	**80**	**100**

Practicals

1. Isolation of genomic DNA from Bacteria, Plant and Animal tissues.
2. Electrophoretic separation of genomic DNA from Bacteria, Plant and Animal tissues.
3. Gel elution and purification of DNA fragment.
4. Isolation and electrophoretic separation of RNA from bacteria/plant/animal tissues.
5. Quantification and purity check of Isolated DNA using UV spectrophotometer.
6. Isolation, purification and electrophoretic separation of plasmid DNA from Bacteria.
7. Restriction Digestion of Genomic DNA and Plasmid DNA with Restriction endonucleases and separation of digested products in Agarose gel.
8. DNA Ligation using T4 DNA Ligase and *E.coli* DNA ligase.
9. Preparation of Competent cells using Calcium Chloride Method.
10. Transformation of Bacterial cells (blue white Selection).
11. Blotting techniques: Southern, Northern and Western Blotting.
12. Amplification of DNA using Polymerase chain Reaction.

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M. Sc. Semester – IV

Discipline Specific Course (DSC)

Course Title:BT CT 4.2 - Plant Biotechnology

Course Code: A4BIT002T

Course outcome:

The students will be able to

- CO1: Gain an insight into the concepts and techniques of plant tissue culture and its application to crop in crop yielding plantlets.
- CO2: Adapt and apply PTC techniques to resolve problems in plant biology.
- CO3: Be able to prepare culture medium and establish *in vitro* plant cultures from primary and secondary explants.
- CO4: Perform the observations and biometric and physiological measurements with techniques used in the laboratory.
- CO5: Able to work independently in plant tissue culture laboratory.
- CO6: Get knowledge on setting-up and operating a plant tissue culture laboratory.

Unit	Content	60 Hrs/Sem
I	**Plant tissue culture:** • **Plant tissue culture and media**: Introduction to Cell and Tissue culture. Tissue culture as a technique to produce novel plants and hybrids, Tissue culture media: (Composition and preparation). Initiation and maintenance of callus and suspension culture and single cell clones. (5Hours) • **Cell and Organogenesis**: Somatic embryogenesis, transfer and establishment of whole plants in soil. Shoot tip culture, rapid clonal propagation and production of virus free plants. Embryo culture and Embryo rescue. Anther, pollen and ovary culture for production of haploid plants and homozygous lines. (5 Hours) • **Protoplast isolation, fusion and cryopreservation**: Selection of hybrid cells and regeneration of hybrid plants, Symmetric and asymmetric hybrid and cybrids. Cryopreservation, slow growth and DNA banking for germ plasm conservation.(5 Hours)	15
II	**Basic techniques in r-DNA and Plants transformation technology:** • Biolistics (Particle bombardment) Electroporation, microinjection and *Agrobacterium* mediated gene transfer. T-plasmid derived vector systems, structure and restriction site Mechanism of T-DNA transfer	15

	from Agrobacterium to plant cells. Marker and reporter genes used in plant system. Manipulation of gene expression in plants Isolation and uses of different promoters, production of marker free transgenic plants. (8Hours). • Basis of tumor formation, hairy root, features of Ti and Ri plasmids, mechanisms of DNA transfer, role of virulence genes, use of Ti and Ri as vectors, Binary vectors, use of 35S and other promoters. Genetic markers, use of reporter gene with introns, use of scaffold attachment regions, methods of nuclear transformation, viral vectors and their applications multiple gene transfers, vector-less or direct DNA transfer. Transformation of monocots, Trans gene stability and gene silencing. (7 Hours).	
III	**Application of plant transformation in plant productivity and performance:** • Herbicide resistance, phosphoinothricin, Glyphosate, sulfonyl urea, atrazine, insect resistance/ Bt genes, Non Bt like protease inhibitors, alpha amylase inhibitor, virus resistance coat protein mediated, nucleo capsid gene disease resistance, chitinase, 1-3 B gluconase, RJP antifungal proteins, thionins, PR proteins, nematode resistance, Abiotic stress, post-harvest losses, long self-life of fruits and flowers use of ACC synthase, polygalactouranase and ACC oxidase.(8Hours). • Male sterile lines, bar and barnase systems, carbohydrate composition and storage ADP glucose pyrophosphates. (**7** Hours**)**	**15**
IV	**Plant Genomics:** • **Molecular marker aided breeding**: RFLP maps linkage analysis, RAPD markers. STS micro satellites SCAR (Sequence Characterized Amplified Regions) SSCP (Single strand conformational polymorphism) AFLP, QTL, map-based cloning, molecular markers assisted selection, Molecular characterization of homozygous and heterozygous for plant breeding. (8Hours**)** • **Plant genomics**: Arabidopsis thaliana (Mad–Box gene) as a model for plant genomics and Plant proteomics, Rice genome project, Genetic diversity and phylogenetic studies, Comparative genomics and analysis for selection of best species. (7 Hours**)**	**15**

M. Sc. Semester – IV

Discipline Specific Course (DSC)

Course Title:BT CP 4.5. Based on BTCT-4.2-Plant Biotechnology

Course code: A4BIT005P

Types of Course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/ Semesters	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**04**	**04**	**60 hrs.**	**4 hrs.**	**20**	**80**	**100**

Practicals

1. Aseptic culture techniques for establishment and maintenance of cultures.
2. Preparation of stock solutions of MS basal medium and plant growth regulator stocks.
3. Isolation of Explant and maintenance of culture. Sub culture of callus, Organogenesis and Transfer of plants to soil.
4. Micropropagation by Proliferation of Auxiliary buds and by adventitious shoot proliferation.
5. Initiation and establishment of cell suspension cultures.
6. Anther and Microspore culture for Haploid production.
7. Protoplast/ embryo isolation and culture.
8. Embryogenesis in cultured cells.
9. Preparation of Synthetic seeds.
10. *In vitro* fertilization and cultures of ovary/ovule.
11. Extraction and quantification of secondary metabolites from callus.
12. Histological preparation by Squash preparation of tissues to trace the path of differentiation.
13. Isolation of plant genomic DNA (C-TAB method) and Agarose electrophoresis.
14. PCR amplification of genomic DNA.

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M. Sc. Semester – IV

Discipline Specific Course (DSC)

Course Title:BT CT 4.3 - Medical Biotechnology

Course Code: A4BIT003T

Course outcome:

Students will be able to

- CO1: Explain the etiology, epidomology, clinical conditions and diagnosis of microbial diseases.
- CO2: Familiarization with vaccines and antimicrobial drugs.
- CO3: Aware about Human genome project.
- CO4:Explain how tumor stem cells give rise to metastases and treatment-resistant remnant cells that cause relapse, and how these impacts on the development of future cancer treatment strategies.
- CO5: Elaborate on the use of various nanoparticles for their application in the areas of drug discovery, drug delivery.
- CO6: Understand influence of ethical and other related issues related to cloning/stem cellresearch.

Unit	Content	60 Hrs/Sem
I	**Introduction to Medical Biotechnology, Microbial Diseases in Humans, and Diagnostics:** • **Overview of Medical Biotechnology:** Scope and importance, the Indian scenario in medical biotechnology. (2 Hours) • **Microbial Diseases:** Mode of infection, symptoms, epidemiology, and control measures of diseases caused by: Viruses: HIV, Hepatitis B, Rabies, HSV-1, H1N1 Bacteria: Gonorrhea, Tuberculosis, Anthrax, Plague Fungi: Aspergillosis, Histoplasmosis, Cryptococcosis Protozoa: Malaria, Amoebiasis. (8 Hours) • **Diagnostics**: Immunological diagnostics (RIA, ELISA, fluorescence immune assays, immune-electrophoresis, hemagglutination assay), molecular diagnostic methods (PCR, DNA fingerprinting, DNA microarray in forensic science and disease diagnosis). (5 Hours)	15
II	**Cancer Biology, Stem Cells, and Ethical Issues:** • **Cancer Biology:** Types of tumors, predisposing factors, cellular	15

	changes involved in tumor formation, genes associated with cancer (oncogenes and tumor suppressor genes), tumor formation, promotion and progression, prevention of cancer, carcinogens (airborne, foodborne, human papillomavirus), methods of tumor detection, tumor markers, treatment options (chemotherapy, radiotherapy, immunotherapy, gene therapy). (7 Hours) • **Stem Cells:** Types and sources of stem cells, properties of induced pluripotent stem cells (iPSCs), applications in tissue repair, tissue engineering, organ printing, and regenerative medicine, preservation of embryonic stem cells. (5 Hours) • **Ethical Issues:** Ethical concerns in stem cell research, use of cell cultures as alternatives to animal models, testing drugs on human volunteers, animal cloning, human cloning, organ transplantation and xenotransplantation issues. (3 Hours)	
III	**Human Genome Project and Its Applications, Gene Therapy:** • **Human Genome Project:** Examples of genes identified with various human diseases, molecular detection of pre-symptomatic genetic diseases,importance in healthcare, prenatal diagnosis, genetic manipulation and ethical implications. (6 Hours) • **Gene Therapy:** Human diseases targeted for gene therapy, types of vectors used, nanotechnology-based gene therapy and other delivery systems,*ex vivo* vs. *in vivo* gene therapy, tissue of choice for gene therapy,*in vitro* gene therapy applications for genetic diseases (e.g., neurological disorders, metabolic disorders like cystic fibrosis), gene therapy for acquired diseases (ADA gene in SCID), cardiovascular diseases, cancer. Importance of humanized antibodies and plasminogen activating factor in treating thrombosis. (9 Hours)	**15**
IV	**Nano-biotechnology and Pharmaco-biotechnology:** • **Nano-biotechnology:** Introduction to types and synthesis of nanomaterials,nanobiosensors, nanoparticles in drug delivery and gene delivery systems, quantum dots, nanoparticles for real-time monitoring and disease diagnostics, cancer therapy risks associated with nanomaterials. (8 Hours) • **Pharmaco-biotechnology:** The role of biotechnology in the production of pharmaceutical products, drug targeting strategies, monoclonal antibodies and their applications in medicine. (7 Hours)	**15**

M. Sc. Semester – IV

Discipline Specific Course (DSC)

Course Title:BT CP 4.6 Based on BT CT 4.3 Medical Biotechnology

Course Code: A4BIT006P

Types of Course	Theory/ Practical	Credits	Instruction hour per week	Total No. of Lectures/Hours/ Semesters	Duration of Exam	Formative Assessment Marks	Summative Assessment Marks	Total Marks
DSC	**Practical**	**04**	**04**	**60 hrs.**	**4 hrs.**	**20**	**80**	**100**

Practicals

1. Detection of malarial parasites from human blood samples.
2. Anaerobic culture methods for clinically important anaerobes.
3. Presumptive identification of pathogens using colony morphology on selective/differential/enrichment media.
4. Drug susceptibility testing by various methods as per NCCLS guidelines. (Paper disc and Agar cup plate method)
5. Determination of MIC for selected antibiotics (Kirby-Bauer method and checkerboard method).
6. Lymphocyte viability test in rat/mice (Trypan blue dye exclusion test).
7. Study microbial flora of the mouth and commensal flora of the human body.
8. Bacteriological examination of urine, blood, pus samples from hospitals.
9. Estimation of urine bacteria by calibrated loop direct streak method.
10. Study stem cells from embryonic fluids.
11. Study different cancer cell lines.
12. Mandatory visit to hospitals and medical research centers.

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Project work

- Students will be identifying the research area for the project.
- Critically search the scientific literature for information.
- Develop teamwork to assign project duties ensuring efficiency and quality of the project outcome.
- Develop observational skills and make discoveries in the laboratory.
- Design templates using spreadsheets for evaluation of data.
- Prepare professional scientific reports of the project.
- Student will able to get opportunity to publish their work in National/International peer reviewed journals.