KANNUR UNIVERSITY

(Abstract)

Revised Scheme, Syllabus and Model Question Papers of the M.Sc. Molecular Biology Programme (CBCSS) - implemented in the University Department - w.e.f. 2020 Admission – Orders issued.

ACADEMIC C SECTION

Acad/C4/12616/2020 Dated: 15.03.2021

Read:-1. The Minutes of the meeting of the Syndicate held on 26.10.2019, vide item No. 2019.676

2. U.O.No.ACAD C3/22373/2019. dated 08.10.2020

3. U.O.No.Acad/C3/22373/2019, dated 12.11.2020

4. The Minutes of the meeting of the Department Council, Dept. of Molecular Biology, dated 19.02.2021

5. E.mail dated 02.03.2021, from the Head, Dept. of Molecular Biology along with revised Scheme, Syllabus and Model Question Paper of M.Sc. Molecular Biology Programme

ORDER

1.The meeting of the Syndicate held on 26.10.2019 resolved vide paper read (1) above to revise the Scheme and Syllabus of all Post Graduate Programmes under Choice Based Credit Semester System (CBCSS) in the Schools/Departments of University with effect from 2020 admission.

2.Subsequently, the Curriculum Committee was reconstituted as per paper read (2) above, to monitor and co-ordinate the working of the Choice based Credit Semester System.

3.Accordingly, the revised Regulations for P.G. Programmes under Choice Based Credit Semester System were implemented in the Schools/Departments of the University with effect from 2020 admission as per paper read (3) above.

4.Further, the Department Council, vide paper read (4) above approved the revised Scheme, Syllabus and Model Question papers of the M.Sc. Molecular Biology Programme Under Choice Based Credit Semester System, prepared in line with the revised Regulations for Choice Based Credit Semester System, for implementation w.e.f 2020 admission.

5.Subsequently, the revised Scheme, Syllabus & Model Question Paper of M.Sc. Programme, prepared in line with the revised Regulations for Choice Based Credit Semester System, was duly scrutinized by the Dean and a Subject Expert and they recommended the Syllabus for implementation.

6.Thereafter, the revised Scheme, Syllabus and Model Question Paper of M.Sc. Molecular Biology Programme was forwarded by the Head, Dept. of Molecular Biology, Dr. P.K Rajan Memorial Campus, as per paper read (5) above, for implementation with effect from 2020 admission.

7.The Vice Chancellor after considering the matter in detail and in exercise of the powers of the Academic Council conferred under section 11 (1) Chapter III of Kannur University Act 1996

M.Sc. Molecular Biology Programme under Choice Based Credit Semester System offered in the Department of Molecular Biology, Dr. P.K Rajan Memorial Campus, with effect from 2020 admission, subject to reporting to the Academic Council.

8.The revised Scheme, Syllabus and Model Question Paper of M.Sc. Molecular BiologyProgramme(CBCSS) implemented with effect from 2020 admission are uploaded in the University Website **(www.kannuruniversity.ac.in)**.

Orders are issued accordingly.

Sd/-

BALACHANDRAN V K

DEPUTY REGISTRAR (ACAD)

For REGISTRAR

To: Head, Dept. of Molecular Biology
Dr. P.K Rajan Memorial Campus, Palathadam, Nileswaram,
Kasaragod - 671314

Copy To: 1. The Examination Branch (through PA to CE)
2. PS to VC / PA to PVC / PA to R
3. DR / AR 1/ AR II (Acad)
4. The Computer Programmer (for uploading in the Website)
5. SF / DF /FC

Forwarded / By Order

SECTION OFFICER

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KANNUR UNIVERSITY

DEPARTMENT OF MOLECULAR BIOLOGY

M.Sc. MOLECULAR BIOLOGY

Scheme and Syllabus

(under Choice Based Credit Semester System -CBCSS, effective from 2020 admission onwards)

KANNUR UNIVERSITY

DEPARTMENT OF MOLECULAR BIOLOGY

Regulations, Scheme and Syllabus for
M.Sc. MOLECULAR BIOLOGY
(w.e.f. 2020 Admission)

CONTENTS

1. About the Department

The Department of Molecular Biology was established in the year 2008, at Dr. P.K. Rajan Memorial Campus, Puthariyadukkam, Nileshwaram, Kasaragod district. The Department offers Postgraduate (M.Sc.) and Doctoral (Ph.D.) programmes in Molecular Biology. The subject Molecular Biology is an emerging area of modern biology with vast potential for application in diverse areas including basic sciences, biomedical sciences and other allied applied areas. The department is well equipped with smart classrooms, MSc practical labs and research lab with the basic instruments needed for the successful conduct of this programme. The department has a bioinformatics lab with computers and internet facility, and a library with more than one thousand books and 13 journals.

2. About the Programme

The MSc Molecular Biology program envisages empowering the blended students to equip to conduct research in any area of interest in modern biology and hence is amenable to a multidisciplinary approach. The M.Sc. programme is a research oriented collaborative course comprising most of important and recent Sciences like genetic Engineering, Industrial Biotechnology, Environmental Science, genetics etc. giving the students job opportunities in various fields like Teaching, research, Industry, Medical laboratories and more. It also provides the students exposure to most important and recent techniques and information in Life science.

This program is intended for young students with high academic caliber from diverse fields and provides greater opportunity to prepare themselves for competitive examinations like UGC-CSIR JRF/NET, ICMR-JRF/NET, DBT- JRF/NET. GATE etc for those who are ambitious of becoming a teacher or a scientist. This program will prepare students to take research in Molecular Biology and allied areas as a possible career option as well as will enable generation of manpower for the emerging Molecular Biology industry. The student strength is 16. The M.Sc. Molecular Biology program is offered under the Choice based Credit and Semester System with duration of 2 years (4 Semesters), which comprises Classroom Teaching, Laboratory Practical's, Tutorials in the form of Seminars and a Dissertation (research) in the last semester.

3. Introduction to Choice Based Credit Semester System (CBCSS)

The CBCSS provides an opportunity for the students to choose courses of their interest from the prescribed courses comprising core, elective, open elective courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Grading system provides uniformity in the evaluation and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations which enables the student to move across institutions of higher learning. The uniformity in evaluation system also enable the potential employers in assessing the performance of the candidates.

3.1. Definitions

(i) **Academic Programme** means an entire course of study comprising its programme structure, course details, evaluation schemes etc. designed to be taught and evaluated in a teaching Department/Centre or jointly under more than one such Department/Centre.

(ii) **Course** means a segment of a Programme limited to one semester in a subject.

(iii) **Programme Structure** means a list of courses (Core, Elective, Open Elective) that makes up an Academic Programme, specifying the syllabus, Credits, hours of teaching, evaluation and examination schemes, minimum number of credits required for successful completion of the programme etc. prepared in conformity with University Rules,

(iv) **Core Course** means a course that a student admitted to a particular programme must successfully complete to receive the degree and which cannot be substituted by any other course.

(v) **Elective Course** means an optional course to be selected by a student out of such courses offered in the same Department/Centre.

(vi) **Open Elective Course** means an elective course which is available for students of all programmes including students of same department. Students of other Departments may opt these courses subject to fulfilling of eligibility of criteria as laid down by the Department offering the course.

(vii) **Credit** means the value assigned to a course which indicates the level of instruction; Normally, one-hour lecture per week equals 1 Credit, 2/3 hours practical class per week equals 1 credit. Credit for a practical could be proposed as part of a course or as a separate practical course.

(viii) **SGPA** means Semester Grade Point Average calculated for individual semester.

(ix) **CGPA** is Cumulative Grade Points Average calculated for all courses completed by the students in the last year of the course by clubbing together SGPA of four semesters.

3.2. Program Objectives:

The M.Sc. programme in Molecular Biology will:

(1) provide training and understanding of basic concepts as well as cutting edge advancement in the field of Molecular Biology,

(2) impart practical skills through laboratory courses and understanding of modern scientific techniques,

(3) enhance analytical, statistical and validation skills through hands on training,

(4) expose students to various aspects of research through dissertation, and

(5) introduce applications of Molecular Biology in order to prepare highly trained and skilled workforce for teaching, research and entrepreneurship.

3.3. Program Outcomes:

On successful completion of this programme students will:

(1) have an in-depth understanding of the basic and recent developments in the field of Molecular Biology,

(2) acquire skills of critical, analytical and problem solving in order to enable them to be successful in various national and international examinations,

(3) conduct independent work in a laboratory,

(4) possess skills for independent thinking and in writing scientific proposal and presentations, and

(5) capable of becoming successful academicians/researchers and/or entrepreneurs.

4. Programme details

M.Sc. Molecular Biology programme is a two-year course divided into four-semesters. A student should obtain 80 credits for the completion of this programme and the award of degree. Credit system defines the quantum of contents / syllabus prescribed for a course and determines the number of hours of instruction required per week. There shall be at least sixteen-

week schedule per semester to complete the course contents.

The Department Council will assign every student admitted to an advisor. He/She will advice the students about academic programme and counsel on the choice. The course structure encompasses: (1) Core Courses, (2) Elective Courses and (3) Open Elective Courses.

The minimum duration for completion of the M.Sc. Molecular Biology program is four semesters. The maximum period for completion is eight semesters.

No student shall register for more than 24 credits and less than 16 credits per semester.

The credit pattern is **Lecture: Tutorial: Practical (L:T:P) Pattern**.

Lecture : One hour session of theory class per week in a semester is 1 credit.

Tutorial and Practical : Two hour session of tutorial or 2 to 3 hours of practical per week in a semester is 1 credit.

One semester period is 16 weeks of teaching and learning.

Duration of semester is 20 weeks that includes semester end examinations.

A total of 80 credits shall be the minimum for the successful completion of the program.

4.1. Programme Structure

	Semester	Semester
First Year	Semester I	Semester II
Second Year	Semester III	Semester IV

4.2. Eligibility for Admission

Candidates with the degree of Bachelor of Science in any branch of Life Sciences (Zoology, Botany, Microbiology, Biotechnology, Biochemistry, Bioinformatics, Genetics, Laboratory Technology or equivalent), Medical, Veterinary and Agricultural Sciences from any recognized Indian or Foreign University, with **minimum 50% marks or equivalent grade in core course**. Candidates belonging to backward communities (OBC/OEC) with minimum eligibility cut off 45% and for SC/ST category, a pass in the qualifying examinations can also apply. Those who have appeared for the final year examinations can also apply; however, they should produce the mark lists on or before the date of admission.

Mode of Selection

The selection of the candidate is based on the marks secured in the entrance test (reservation policy applies). The entrance test will cover Molecular Biology, Biotechnology, Microbiology, Cell Biology, Genetics, Biochemistry, Botany, Zoology and related areas at the undergraduate level. Duration of the entrance test will be 2 hours with 100 objective type multiple choice questions. There will be 25% negative marks for wrong answers.

Number of Seats: 16 + 4 NRI

4.3. Assessment of student's performance and scheme of examinations

Attendance

The minimum attendance required for each Course shall be 60% of the total number of classes conducted for that semester. Those who secure the minimum attendance in a semester alone will be allowed to register for the End Semester Examination. Condonation of attendance to a maximum of 10 days in a Semester subject to a maximum of two spells within a Programme will be granted by the Vice-Chancellor. Benefit of Condonation of attendance will be granted to the students on health grounds, for participating in University Union activities, meetings of the University Bodies and participation in extra-curricular activities on production of genuine supporting documents with the recommendation of the Head of the Department concerned. A student who is not eligible for Condonation shall repeat the Course along with the subsequent batch.

Evaluation

There shall be two modes of evaluation in all the semesters- Continuous evaluation (CE) and End Semester Evaluation (ESE). The total mark for each course, including the project, shall be divided into 40% for CE and 60% for ESE.

Continuous evaluation includes assignments, seminars, periodic written examinations etc. for each course. The component wise division of the 40% CE mark are as follows:

Theory		**Practical**	
Components	**% of marks**	**Components**	**% of marks**
Test papers	40% (16 marks)	Tests/viva	75% (30 marks)
Tutorial with viva, Seminar presentations, Discussion, Debate etc.	40% (16 marks)	Record	25% (10 marks)
Assignment	20% (8 marks)		
Total Internal marks	40	Total internal marks	40

Practical Examination: There shall be no external practical examinations. For practical courses, marks shall be awarded internally by continuous evaluation (40 marks) and end semester examination (60 marks). The teacher conducting the practical examination will decide the components of end semester examination (number of experiments and theory-written examination).

Conduct of End Semester Examination

The ESE (except for practicals) shall be made based on examinations for each course conducted by Controller of Examinations, as per the common norms under the CCSS. The question paper for ESE for Theory Examinations shall contain three sections. The Question paper should contain minimum 3 questions from each unit/module and should not contain more than 5 questions from the same unit. The distribution of the no of questions and marks are given in the following table.

Section	**Marks**	**Number of questions to be answered**	**Number of questions in the question paper**	**Types of questions (Level-Bloom's Taxonomy)**
A	15	5 (3 marks each)	6	Remembering Understanding
B	15	3 (5 marks each)	5	Creating
C	30	3 (10 marks each)	5	Applying Analysing Evaluating
Total	60	11	16	

Dissertation/Project Work: All the M.Sc. students are required to carry out a research project in the fourth semester. For this, the students are encouraged to go to National Research Institutes, in order to acquire hands-on-training and exposure to a research culture. The department/University may establish close link with such institutions for the purpose, by way of executing appropriate MoU, if required.

There shall be a board of at least two examiners (At least one external expert) for the evaluation of the project work. Each candidate has to submit a copy of the Project Report approved by the project guide before the last date fixed by the department. The candidate has to present the project before the board of examiners which will be followed by a Viva. The ESE for the project will be made jointly by the board of examiners based on the report, its presentation and Viva. The total CE and ESE marks for Project /Dissertation work shall be 150.

Scheme of evaluation of dissertation is as follows: **12** Credits

Total Marks	:	150	(90 ESE + 60 CE)
Content	:	25%	(22.5 ,, + 15 ,,)
Methodology & presentation	:	50%	(45.0 ,, + 30 ,,)
Dissertation viva-voce	:	25%	(22.5 ,, + 15 ,,)

General Viva-voce (2 credits): A comprehensive viva based on all courses offered for the M.Sc. Program will be conducted at the end of all other examinations by the same board of examiners who conducted the Project Evaluation. The total CE and ESE marks for Subject Viva shall be 100.

Total Marks : 100 (60 ESE + 40 CE)

5. Grading

Grading system and pass requirements shall be governed by the general rules and regulations of the CCSS of the PG programme framed by the University.

5.1. An alphabetical Grading System shall be adopted for the assessment of a student's performance in a Course. The grade is based on a 6 point scale.

The following table gives the range of marks %, grade points and alphabetical grade.

Range of Marks%	Grade Points	Alphabetical Grade
90-100	9	A+
80-89	8	A
70-79	7	B+
60-69	6	B
50-59	5	C
Below 50	0	F

5.2 A minimum of grade point 5 (Grade C) is needed for the successful completion of a Course. A student who has failed in a Course can reappear for the End Semester Examination of the same Course along with the next batch without taking re-admission or choose another Course in the subsequent Semesters of the same programme to acquire the minimum credits needed for the completion of the programme. There shall not be provision for improvement of CE and ESE. A student can sit the ESE again if she/he has successfully completed the CE requirements in a subsequent semester subject to the maximum durations permitted.

5.3. Performance of a student at the end of each Semester is indicated by the Semester Grade Point Average (SGPA) and is calculated by taking the weighted average of grade points of the Courses successfully completed. Following formula is used for the calculation. The average will be rounded off to two decimal places.

$$GPA = \frac{\text{Sum of (grade points in a course multiplied by its credit)}}{\text{Sum of Credits of Courses}}$$

5.4. At the end of the Programme, the overall performance of a student is indicated by the Cumulative Grade Point Average (CGPA) and is calculated using the same formula given above.

5.5. Empirical formula for calculating the percentage of marks will be

% Marks = **(CGPA x 10) + 5.**

5.6. Based on the CGPA overall letter grade of the student and classification shall be in the following way.

CGPA	**Overall Letter Grade**	**Classification**
8.5 and above	A+	First Class with Distinction
7.5 and above but less than 8.5	A	
6.5 and above but less than 7.5	B+	First Class
5.5 and above but less than 6.5	B	
5 and above but less than 5.5	C	Second Class

5.7. Appearance for Continuous Evaluation (CE) and End Semester Evaluation (ESE) are compulsory and no Grade shall be awarded to a candidate if he/she is absent for CE/ESE or both.

5.8. A student who fails to complete the Programme/Semester can repeat the full Programme/Semester once, if the Department Council permits to do so. Absence in an examination will be marked zero.

5.9. No student shall be allowed to take more than eight/twelve consecutive Semesters for completing a four/six Semester Programme from the date of enrolment.

6. Grade Card

6.1. The Controller of Examinations shall issue the grade cards of all semesters and the consolidated grade card and certificates on completion of the programme, based on the details submitted by the Heads of the Departments concerned. This will be in digital form only.

6.2. The Grade Card shall contain the following

(a) Title of the Courses taken as Core, Elective & Open Elective.

(b) The credits associated with and grades awarded for each Course.

(c) The number of credits (Core /Elective / Open Elective) separately earned by the student and the SGPA.

(d) The total credits (Core / Elective / Open Elective) separately earned by a student till that Semester.

6.3. The consolidated grade statement issued on completion of the Programme shall contain the name of the Programme, the Department/School offering the Programme, the title of the Courses taken, the credits associated with each Course, grades awarded, the total credits (Core /Elective/Open) separately earned by the student, the CGPA

and the class in which the student is placed. Rank Certificates will be issued based on CGPA calculated at the end of the last semester of that Programme.

7. SYLLABUS

The M. Sc. Molecular Biology program comprises of the following courses.

SEMESTER-I		
MSMOB01C01	Cell Biology	-3 credits
MSMOB01C02	General Microbiology	-3 credits
MSMOB01C03	Biochemistry	-3 credits
MSMOB01C04	Biophysics	-3 credits
MSMOB01P01	Lab in Cell Biology & Microbiology	-3 credits
MSMOB01P02	Lab in Biochemistry & Biophysics	-3 credits
SEMESTER-II		
MSMOB02C05	Genetics & Molecular Biology	-4 credits
MSMOB02C06	Cell Physiology	-3 credits
MSMOB02P03	Lab in Genetics & Molecular Biology	-3 credits
MSMOB02P04	Lab in Physiology & Immunology	-3 credits
MSMOB02E01	Immunology	
MSMOB02E02	Lifestyle disorders: Cancer & Cardiovascular diseases	-4 credits
MSMOB02E03	Biostatistics	
MSMOB02E04	Ecology & Biodiversity	-3 credits
SEMESTER-III		
MSMOB03C07	Advanced Molecular Biology	-4 credits
MSMOB03C08	Genetic Engineering & Biotechnology	-4 credits
MSMOB03P05	Lab in Molecular Biology, Genetic Engineering & Biotechnology	-3 credits
MSMOB03P06	Lab in Genomics & Bioinformatics	-2 credits
MSMOB03E05	Genomics & Bioinformatics	
MSMOB03E06	Forensic Biology & DNA profiling	-4 credits
MSMOB03E07	Developmental Biology	
MSMOB03E08	Molecular Evolution	-3 credits
SEMESTER-IV		
MSMOB04C09	Research Project related to Molecular Biology	-12 credits
MSMOB04C10	General Viva-voce	- 2 credits
MSMOB04E09	Industrial Biotechnology	
MSMOB04E10	Human Genetics	-4 credits
MSMOB04E11	Ethics, patency and Intellectual Property Rights	
MSMOB04E12	Environmental Biotechnology	-4 credits
MSMOB04O01	Life and Genes	

8. DETAILED SCHEME OF VALUATION

SEMESTER- I

Courses: Core-6 (Theory-4; Practical-2); Elective-0

Credits : Core-18 (Theory-12; Practical-6); Elective-0

Sl. No.	Course Code	Title of the course	Contact hours/week			Marks			Credits
			L	T/S	P	ESE	CE	Total	
1.	MSMOB01C01	Cell Biology	3	1		60	40	100	3
2.	MSMOB01C02	General Microbiology	3	1		60	40	100	3
3.	MSMOB01C03	Biochemistry	3	1		60	40	100	3
4.	MSMOB01C04	Biophysics	3	1		60	40	100	3
5.	MSMOB01P01	Lab in Cell Biology & Microbiology			5	60	40	100*	3
6.	MSMOB01P02	Lab in Biochemistry & Biophysics			5	60	40	100*	3
TOTAL			**16**	**4**	**10**	**360**	**240**	**600**	**18**

*There is no external practical examination. CE includes marks for lab record, test/practical viva.

SEMESTER- II

Courses: Core-4 (Theory-2; Practical-2); Elective-2 (Students have to choose two elective courses from 4)

Credits: Core-13 (Theory-6; Practical-6); Elective-7; TOTAL=20

Sl. No.	Course Code	Title of the course	Contact hours/week			Marks			Credits
			L	T/S	P	ESE	CE	Total	
1.	MSMOB02C05	Genetics & Molecular Biology	4	1		60	40	100	4
2.	MSMOB02C06	Cell Physiology	3	1		60	40	100	3
3.	MSMOB02P03	Lab in Genetics & Molecular Biology			5	60	40	100*	3
4.	MSMOB02P04	Lab in Physiology & Immunology			5	60	40	100*	3
5.	MSMOB02E01	Immunology	4	1		60	40	100	4
	MSMOB02E02	Lifestyle disorders: Cancer & Cardiovascular diseases							
6.	MSMOB02E03	Biostatistics	3	1		60	40	100	3
	MSMOB02E04	Ecology & Biodiversity							
TOTAL			**14**	**4**	**10**	**360**	**240**	**600**	**21**

*There is no external practical examination. CE includes marks for lab record, test/practical viva.

SEMESTER- III

Courses: Core-4 (Theory-2; Practical-2); Elective-2 (Students have to choose two elective courses from 4)

Credits: Core-13 (Theory-8; Practical-5); Elective-7; TOTAL=20

Sl. No.	Course Code	Title of the course	Contact hours/week			Marks			Credits
			L	T/S	P	ESE	CE	Total	
1.	MSMOB03C07	Advanced Molecular Biology	4	1		60	40	100	4
2.	MSMOB03C08	Genetic Engineering & Biotechnology	4	1		60	40	100	4
3.	MSMOB03P05	Lab in Molecular Biology, Genetic Engineering and Biotechnology			5	60	40	100*	3
4.	MSMOB03P06	Lab in Genomics & Bioinformatics			4	30	20	50*	2
5.	MSMOB03E05	Genomics & Bioinformatics	4	1		60	40	100	4
	MSMOB03E06	Forensic Biology & DNA profiling							
6.	MSMOB03E07	Developmental Biology	3	1		60	40	100	3
	MSMOB03E08	Molecular Evolution							
TOTAL			**15**	**4**	**9**	**330**	**220**	**550**	**20**

*There is no external practical examination. CE includes marks for lab record, test/practical viva.

SEMESTER- IV

Courses: Core-2 (Theory-2; Practical-0); Elective-2 (Students have to choose two elective courses from 5)

Credits: Core-14 (Theory-14; Practical-0); Elective-8; TOTAL=22

Sl. No.	Course Code	Title of the course	Contact hours/week			Marks			Credits
			L	T/S	P	ESE	CE	Total	
1.	MSMOB04C09	RESEARCH PROJECT related to Molecular Biology		5	20	90	60	150	12
2.	MSMOB04C10	General Viva-voce				60	40	100	2
3.	MSMOB04E09	Industrial Biotechnology	4	1		60	40	100	4
	MSMOB04E10	Human Genetics							
4.	MSMOB04E11	Ethics, Patency & Intellectual Property Rights	4	1		60	40	100	4
	MSMOB04E12	Environmental Biotechnology							
	MSMOB04O01	Life and Genes							
TOTAL			**8**	**7**	**20**	**270**	**180**	**450**	**22**

SEMESTER -I

MSMOB01C01: Cell Biology

60 hours **3 Credits**

Course Objectives:
The objective of this course is to offer detailed knowledge about cell biology, various cellular organelles and the signal transduction pathways associated with the cellular processes of the cells. The course also aims to provide into the insights of how classical cellular pathways were experimentally discovered.

Course Learning Outcomes:
Upon completion of this course, students will

- learn about cell theory, cell cycle mechanisms, various cellular organelles and their structure and function.
- acquire insight into the processes of transport across cell membranes, process of endocytosis and protein sorting/translocation to various organelles.
- gain knowledge about the concepts of various cellular signal transduction pathways.
- acquire insight into the mechanisms of cellular responses under varying conditions.
- learn the association of the defects in the signalling processes to various diseases.

MODULE-1

Introduction to Cell Biology- Cell theory-Basic properties of cells- different classes-Cellular dimension-Size of cells and their composition-Cell origin and Evolution (Endosymbiotic theory)– Molecules of the Cell.

MODULE-2

Cell Membrane-Proteins and Lipids-Organisation-Lipid bilayer: Composition and properties (Hydropathic plot)-Membrane permeability and transport-Principles of membrane transport-Pores and Channels-Pumps-Differentiation of cell membrane– microvilli – tight junction – belt and spot desmosomes - intercellular communications and gap junctions – cell coat and cell recognition.

MODULE-3

Synthesis, sorting and trafficking of proteins: site of synthesis of organelle and membrane proteins – transport of secretory and membrane proteins across ER – post-translational modification in RER – transport to mitochondria, nucleus, chloroplast and peroxisome - protein glycosylation – mechanism and regulation of vesicular transport – golgi and post-golgi sorting and processing – receptor mediated endocytosis; Synthesis of membrane lipids.

Ribosomes: Specific association rRNA and r-proteins –Nucleolus- ribosome biogenesis – in-vitro assembly experiments to understand ribosome formation and also for understanding the functions of various ribosomal components – active centers of ribosomes.

MODULE-4

Nucleus: Nuclear envelope – Nuclear pore complexes-nuclear matrix – organization of chromatin – supercoiling, linking number, twist - nucleosome and high order of folding and organization of chromosome (Solenoid and Zigzag model)-Global structure of chromosome –(Lamp brush and polytene chromosomes). Cell cycle and its regulation (Cyclin and kinases)-Experiments (Fission Yeast, Xenopus, Sea Urchin) -Check points-mitosis and

meiosis. Cell Death: Apoptosis versus necrosis-Apoptotic pathways – autophagy – ageing.

References:

1. Lodish *et al*., Molecular Cell Biology. W H Freeman & Co.
2. Becker W M *et al*., The World of the Cell. Pearson.
3. DeRobertis E D F and DeRobertis E MF, Cell and Molecular Biology. Saunders
4. Karp and Gerald, Cell and Molecular Biology. John Wiley.
5. Polland Thomas D, Cell Biology. Saunders.
6. Standzinski George P Editor, Cell growth, differentiation and senescence. Oxford University Press.
7. Alberts B, Molecular Cell Biology.
8. Casimeris *et al*., Lewin's cells. Jones and Bartlett.
9. Plopper, Principles of cell Biology. Jones and Bartlett.
10. Gartner, Cell Biology and Histology. LWW.
11. Pollard et al., Cell Biology. Sounders.
12. Copper, The Cell a Molecular approach. Sinauer.

MSMOB01C02: General Microbiology

60 Hours **3 Credits**

Course Objectives:
The objective of this course is to offer detailed knowledge about the history and diversity of microorganisms; benefits of microorganisms and the various mechanisms of disease, cause, transmission, detection, treatment and prevention.

Course Learning Outcomes:
Upon completion of this course, students will

- learn in detail the adaptations of microorganisms that help them to invade the host cell, how they evade the host immune system and colonise the host cell causing diseases.
- gain overall knowledge about the mechanisms of disease cause, transmission, detection, treatment and prevention.
- develop the ability to relate to any existing or emerging infection as well as will learn about drug resistance and its mechanisms.
- have the know-how to research and develop new tools in the field of microbial science.

MODULE-1

History and scope of Microbiology. Microbial Diversity: Place of microorganisms in the living world – criteria used in microbial taxonomy; Classification of bacteria – past and present status – classification based on morphology- gram's staining and culture characteristics – classification based on Bergey's manual of systematic bacteriology (details of sections not expected); Classification of viruses – classification based on host, viral morphology and nucleic characteristics.

MODULE-2

Structural organization of bacteria, fungi and viruses: Ultra structure of bacterial cell wall – cell membrane – flagella – pili – capsule and genome; Structure and architecture of bacteriophages. Fungi-Molds and Yeasts. Bacterial culturing: Physical and chemical methods of sterilization – growth media – mixed microbial population – selection of pure culture – physical conditions of growth – growth curve – storage and transport of microbes.

MODULE-3

Microbial toxins: Exotoxins – endotoxin and other virulence factors. Disinfectants and antibiotics: Methods of testing antimicrobial substances – mechanism and action of important classes of disinfectants and antibiotics – drug resistance of antibiotics.

MODULE-4

Benefits of microbes in various fields: Microbes in fermentation – microbial biogas from biological wastes – microbes in value addition of fish and meat – microbial bioremediation. Microbes and diseases: Bacterial diseases – Streptococcal diseases – Tuberculosis –Plague – Anthrax – Syphilis – Cholera – Tetanus – Leprosy; Viral diseases – Chicken pox – Small pox – Influenza – Rabies – AIDS-SARS and Ebola.

References:

1. Prescott, Harley and Klein, Microbiology. McGraw-Hill
2. Jacquelyn G Black, Microbiology: Principles and Exploration. John Wiley & Sons.
3. Nester et al., Microbiology: A human perspective. McGraw Hill.

4. Albert G Moat et al., Microbial Physiology. John Wiley & Sons.
5. Kathleen Park Talaro, Arthur Talaro, Foundations in Microbiology. Mc Graw Hill.
6. Alcamo, Foundations of Microbiology. Jones and Bartlett Publishers.
7. Cappuceino James, Microbiology: A Laboratory Manual. Pearson Education
8. Toratora Gerad, Microbiology: An Introduction. Pearson Education.
9. Edward A I, Microbiology. Tata McGraw Hill.
10. Lim Daniel, Microbiology. Mc Graw Hill.
11. Pelczar M J Jr, Chan E C S Krieg, Microbiology.
12. Wheelis, Principles of Modern Microbiology. Jones and Barttlett.
13. C.J.Alexopoulos. Introducing Mycology. Wiley.
14. Basman. Microbiology with diseases by holy systems. Pearson.
15. Madigan et al. Biology of Microorganisms. Pearson.

MSMOB01C03: Biochemistry

60 Hours **3 Credits**

Course Objectives:
The objective of this course is to offer advanced knowledge of the core principles and topics of biochemistry and their experimental basis. This course provides details about the biomolecules and cellular metabolism.

Course Learning Outcomes:
Upon completion of this course, the students will

- be able to explain/describe the synthesis of proteins, lipids, nucleic acids, and carbohydrates and their role in metabolic pathways along with their regulation including protein folding, modification, and degradation.
- learn the use of current biochemical and molecular techniques to plan and carry out experiments.

MODULE-1

Atomic bond and molecular interaction: Covalent bonds – ionic interactions – hydrogen bonds – Vander Waal's interactions – hydrophobic effect – binding of biomolecules. Biomolecules: Carbohydrates – classification, structure and properties – carbohydrate derivatives – sugar alcohols, sugar acids, amino sugars etc. – biological function of carbohydrates; Proteins – classification of amino acids, structure and properties – classification of proteins and biological functions – levels of organization – primary, secondary, tertiary, quaternary and quinary – sequencing of proteins; Lipids – classification, structure and properties – biological application; Nucleic acids – structure of nitrogen bases – nucleosides – structure of DNA and RNA.

MODULE-2

Enzymes: IUB classification, nomenclature and specificity – mechanism of enzyme action – Michaeli's-Menten equation – derivation, double reciprocal plot – Line-Weaver-Burk-method – significance of K_m and V_{max} values – factors effecting enzyme action – regulation of enzymatic activity – enzyme inhibition – allosteric enzymes – positive and negative modulation – vitamin as co-enzymes – and RNA as enzymes.

Bioenergetics: Enthalpy – entropy – free energy concepts – living body as thermodynamic system – energy of activation – standard free energy – energy rich compounds – ATP – creatine phosphate and pyrophosphate.

MODULE-3

Cellular metabolism: Carbohydrate metabolism – Glycolysis – Kreb's cycle – glycogenolysis – glycogenesis – glucogenesis – gluconeogenesis – pentose phosphate pathway – glyoxylic acid cycle; Amino acid metabolism - Biosynthesis and degradation of amino acids – deamination and transamination (metabolism of glutamic acid, phenyl alanine, methionine, tryptophan, isoleucine and histidine to be given emphasis). Fat metabolism – Biosynthesis and oxidation of fatty acids (beta oxidation) – biosynthesis of phospholipids sphingolipids – glycolipid and cholesterol metabolism; Nucleic acid metabolism – Biosynthesis and degradation of purines and pyrimidines

MODULE-4

Biological oxidation – electron transport system in mitochondria – redox potential – mechanism of oxidative phosphorylation – chemiosmotic coupling hypothesis.

Photosynthesis: Chloroplast as photosynthetic unit –Hill reaction–photosynthesis I and II – Calvin cycle.

References:

1. Smith E L et al., Principles of Biochemistry. Vol. I and Vol.II.
2. Lubert Stryer, Biochemistry. W H Freeman & Co.
3. Lehninger A L, Principles of Biochemistry. CBS publishers.
4. Conn and Stumpf, Concepts in Biochemistry.
5. Mahler H R & Cordes E H, Basic Biological Chemistry. Harper & Row.
6. Awapara J, Introduction to Biological Chemistry. Prentice-Hall of India.
7. Cohn E E & Stumpf P K, Outlines of Biochemistry. Wiley Eastern.
8. Wilson J & Walker K Practical Biochemistry: Principles and Techniques, Cambridge.
9. Sadasivan S & Manikam A, Biochemical methods. New Age International.
10. Patabhiraman T N Laboratory Manual in Biochemistry. All India Publishers.
11. Nelson David L, Principles of Biochemistry. McMillan.
12. Chatterji M N & Rana Shindo, Text Book of Medical Biochemistry. J P Brothers.
13. Das Debjyoti , Biochemistry. Academic Publishers.
14. Voet Donald & Voet Judith, Biochemistry.
15. Garrot Reginald H, Biochemistry, Thomson Publishers.
16. Elliot Willim H & Eliot C Daphne, Biochemistry and Molecular Biology.
17. Camphell Peter N, Biochemistry Illustrated. Churchill Living Stone.
18. Kamal Ritu, Biochemistry of Biomolecules. Paragon International.
19. Metzier David E, Biochemistry: the chemical reactions of living cells. Academic Press.
20. McKee Trudy, Biochemistry: the molecular basis of life. McGraw Hill.
21. Sheehan. Physical Biochemistry. Willy Blackwell.
22. Perasena. Enzymology. Oxford.
23. Heldt et al. Plans Biochemistry. Academic press.

MSMOB01C04: Biophysics

60 Hours **3 Credits**

Course Objectives:
The objective of this course is to offer knowledge on Biophysics, an interdisciplinary science that employs and develops theories and methods of the physical sciences for the investigation of biological systems. Currently, protein physics is one of the fastest growing physics research areas that is vital to many other fields, including medicine, bioengineering, and biology.

Course Learning Outcomes:
Upon completion of this course, students will

- be able to describe how various chromatographic methods can be used to separate various macromolecules
- be able to appraise the importance of various biophysical techniques
- be able to understand the biophysical principles of interaction of light with living systems and their significance in biosphere sustenance.
- understand various kinds of radiations in the environment and their sources, the effects of various radiations on living systems etc.

MODULE-1

Principles and applications of Biophysical Methods: microscopy – light, phase, contrast, fluorescence, confocal, Atomic force, Tunnelling, scanning and transmission electron microscopy; Cytophotometry – flow cytometry; chromatography: Basic principles and Types- gel filtration; Ion exchange and affinity chromatography – thin layer and gas chromatography – high pressure liquid chromatography (HPLC); Electrophoresis; PAGE, agarose, IEF, 2D; Centrifugation – Svedberg Unit-gradient and differential – ultracentrifugation-Types of Centrifuges; X-ray Crystallography; Spectroscopy – fluorescence, UV, ORD/CD, visible, NMR, ESR – Atomic absorption – Plasma emission spectroscopy – mass spectroscopy-GCMS.

MODULE-2

Physics of photobiological system: Photodynamic sensitation – photoelectric effects – electron displacement by light quantum theory – Biophysics of photosynthesis; Laser and its application in biology – use of laser as a tool in surgery and therapy. Biophysics of vision: Light and its attenuation for vision – eye as optical instrument – formation of image.

MODULE-3

Biomagnetism and Bioacoustics: Generation and nature of biomagnetic fields. Sound and its characteristics – physical basis of hearing – limit of intensity of sound – audible sound frequency – physical organization of the ear – physical aspects of transmission of sound in the ear – traveling waves – electrical response of cochlea – pitch reception and theories – physical basis of voice – infra or sub sonic sounds and ultrasonic sounds – echolocation – echocardiography – Doppler ultrasonography – lithotripsy.

MODULE-4

Radiation Biology: Principles and applications of tracer techniques in biology – radiation dosimetry – sources of ionizing radiations - use of x-ray in biomedical application – radioisotopes – half-life of isotopes – effect of radiation in biological system; autoradiography – liquid scintillation – G M Counter-gamma counter.
Bioelectricity and bioluminescence.

References:

1. Chatwal G R, Biophysics, Himalaya Publishing House.
2. Cotterill Rodney M J Biophysics: An Introduction. John Wiley.
3. Pattabhi Vasantha & Gautham M, Biophysics. Narosa.
4. Subramanyan M A, Biophysics. MJP
5. Roy K N, A Text Book of Biophysics, New Central Book Agency.
6. Ackerman E, Biophysical Science. Prentice-Hall Inc.
7. Kane J W & Steinhein M M , Life Science Physics. John Wiley.
8. Thiravia Raj S, Biophysics. Saras Publications.
9. Glaser. Biophysics. Springer.
10. Pranab Kumar Banerjee, Introduction to biophysics, S Chand
11. Tuszynski et al., Introduction to molecular Biophysics, CRC Press
12. Nolting, Methods in Modern Biophysics, Springer

MSMOB01P01: Lab in Cell Biology & Microbiology

3 Credits

Course Objectives:
The objective of this practical course is to demonstrate significant cell biological and microbiological principles, quantitative and analytical approaches that enable the students to translate the theoretical foundation in cell biology and microbiology to be translated into practical understanding.

Course Learning Outcomes:
Upon completion of this practical course, students will

- be able to differentiate the cells of various living organisms and get awareness of physiological processes of cell e.g. cell divisions.
- be able to observe and correctly identify different cell types, cellular structures using different microscopic techniques.
- attain skills in microscopy and their handling techniques and staining procedures.
- be able to understand the basic microbial structure and microbial growth

Contents:

1. Study of meiosis in grasshopper testis squash and determination of chiasma frequency.
2. Preparation of chromosome spread from rat bone marrow and analysis of metaphase chromosome by means of G and C banding.
3. Preparation of Human karyotype from photographs of chromosome spreads – normal and abnormal.
4. Staining of buccal epithelial smear to demonstrate Barr body.
5. Preparation of human blood smears to demonstrate drumsticks in neutrophils.
6. Induction of chromosome aberration in onion root tips by a suitable clastogenic agent and its demonstration by means of root tip squashes.
7. Cell fractionation and isolation of nuclei and mitochondria from any suitable material (Rat liver).
8. Preparation and sterilization of culture media.
9. Pure culture technique: Streak plates, spread plate, and pour plate methods.
10. Staining methods: Simple, negative, Acid fast, Gram staining, spore staining, capsule staining, lactophenol cotton blue staining.
11. Measurement of growth – Direct haemocytometer count, viable count, growth curve, determination of growth rate and generation time.
12. Effect of pH, temperature and antibiotics on growth of bacteria.

MSMOB01P02: Lab in Biochemistry & Biophysics

3 Credits

Course Objectives:
The objective of this practical course is to provide a basic familiarity with the most common techniques used in biochemistry and biophysics and their applications to challenging problems in biology.

Course Learning Outcomes:
Upon completion of this practical course, students will

- critically evaluate data and design experiments to test hypothesis relevant to the practice of Biochemistry and Biophysics.
- be able to understand the strengths and limitations of various experimental and computational approaches for studying macromolecular structure and function.

Contents:

1. Qualitative analysis of monosaccharide (glucose & fructose), disaccharide (lactose, maltose and sucrose), and polysaccharide (dextrin and starch).
2. Qualitative analysis of protein (albumin, casein, peptone and gelatin).
3. Qualitative analysis of lipids.
4. Estimation of glucose.
5. Estimation of protein.
6. Estimation of amino acid.
7. Estimation of triglycerol / phospholipids / cholesterol.
8. Enzyme kinetics – assay of alkaline phosphatase.
9. Preparation of buffer and measurement of pH (Tris, Phosphate, Acetate buffer).
10. Practical aspects of microscopy, micrometry and camera lucida.
11. Demonstration of diffusion using dialysis tubing.
12. Separation of amino acids by paper, thin layer chromatography and identification of amino acids.
13. Ion exchange chromatography and Molecular sieve chromatography.
14. Separation of proteins by polyacrylamide gel electrophoresis and determination of molecular weight of unknown protein.

SEMESTER II

MSMOB02C05: Genetics & Molecular Biology

60 Hours **4 Credits**

Course Objectives:

The objective of this course is to offer knowledge in the field of Genetics and Molecular biology, which help them to understand and apply the principles and techniques helping them for further education and/or employment in teaching and/or basic research.

Course Learning Outcomes:

Upon completion of this course, students will

- be able to explain the mechanisms of DNA replication and repair, RNA synthesis and processing, and protein synthesis.
- be able to describe how gene expression is regulated at the transcriptional and post-transcriptional level.
- be able to apply the principles of genetics to produce a family pedigree from a family history,
- be able to display a broad understanding of core molecular genetics concepts.

MODULE-1

Overview of Genetics – Mendelian inheritance – non-Mendelian inheritance - Linkage, crossing over and chromosome mapping – polygenic inheritance. Chromosomal aberrations – deficiency – duplication – inversion – and translocation; Ploidy – aneuploidy – euploidy; Chromosomal aberrations in human; Mutation – molecular basis of mutation – radiation induced mutation – chemically induced mutation – mutation frequency. Restriction, modification and repair of DNA: Direct and Indirect repair, excision repair pathways – error prone repair – recombination repair – SOS system.

MODULE-2

Genetic material: Experiments, which proves DNA as genetic material and RNA as genetic material in RNA viruses. Genetic transfer in bacteria - Transformation, transduction and conjugation-Temporal mapping in *E. coli*. Genetic basis of Cancer: Characteristic features of cancer cells-carcinogen- chemical and physical carcinogen; Oncogenes-viral oncogenes -cellular oncogenes-chromosome rearrangement and cancer-tumor suppressor genes-inherited cancers.

MODULE-3

Introduction to 3D structure of DNA and RNA; Synthesis of DNA – semi conservative – experiments of Meselson and Stahl – Cairn's Experiment – Replicon – Semi-discontinuous synthesis – rolling circles – D-loop model – enzymes involved in replication; Triplex DNA – Types of DNA: A, B, Z, P and G DNA.

Transcription: Biosynthesis of RNA in prokaryotes - enzymatic machinery - promoter selection and role of RNA polymerase and ancillary factors; Transcription in eukaryotes - eukaryotic RNA polymerase - promoter and enhancer – rho factor mediated termination – antitermination - inhibition of termination. Biosynthesis of ribosomal, transfer and messenger RNA - RNA splicing and processing – post transcriptional modification in transfer and messenger RNA.

MODULE-4

Protein Synthesis: Genetic code – t RNA –rRNA and r-proteins - translation in prokaryotes

and eukaryotes – factors of protein synthesis and their role – inhibitors of protein synthesis – post translational modification.

Population Genetics: Gene pool-Genotypic frequency-allelic frequency-Hardy Weinberg Law-Factors affecting allelic frequency; Speciation-Allopatric and sympatric

References:

1. Rober J Brooker, Genetics: Analysis and Principles. Addison Wesley Longman
2. Klug W S & Cummings W S, Concepts of Genetics. Prentice Hall.
3. Gardnerand Simmon, Principles of Genetics. John wiley & Sons.
4. Strickberger , Genetics. Monroe w.
5. Bhasin M K & Walter H , Genetics of Castes and Tribes in India. Kamala Raj Ent.
6. Hartwell Leland H, Genetics from Genes to Genome.
7. Stent G, Molecular Genetics. Freeman.
8. Burns G W & Hottins P J, The science of Genetics.Mapwell –Macmillan.
9. Strickberger M W, Experiments in Genetics with Drosophila. John Wiley.
10. Hartl, David L, Genetics. Jones and Bartlett.
11. King William S & M R Qummings. Genetics. Prentice Hall.
12. Benjamin Lewin, Genes IX. John Wiley.
13. Benjamin Lewin , Gene Expression Vol1 -3. John Wiley.
14. Watson J D et al., Molecular Biology of the Gene. The Benjamin / Cummings.
15. Lodish H et al., Molecular Cell Biology. Scientific American Books. W H Freeman.
16. David Freidfelder, Molecular Biology. Narosa.
17. Brown T A, Genomes. Bioscientific.
18. Winnackeer Ernst L, From genes to Clones. Panima.
19. Dale J W and von Schantz, From genes Genomes. John Wiley.
20. Micklos D A et al, DNA Science. Cold Spring Harbor.
21. Weaver Robert F, Molecular Biology. Mc Graw Hill.
22. Turner P C, Molecular Biology. Viva Books.
23. Kreuzer Helen, Molecular Biology and Biotechnology: A Guide for Teachers.
24. Alber Bruce, Molecular Biology of the Cell. Garland Science.
25. Calladine, Horace Drew, Ben Luisi, Understanding DNA. Elsevier.
26. Benjamin A Pierce,Genetics A Conceptual approach,w.Freeman
27. Simmons et al., Principles of Genetics

MSMOB02C06: Cell Physiology

60 Hours **3 Credits**

Course Objectives:
The objective of this course is to offer knowledge to the Physiological concepts of homeostasis and control mechanisms and to study the functions of body systems. A brief introduction to plant physiology will also be dealt in this course.

Course Learning Outcomes:
Upon completion of this course, students will

- have an enhanced knowledge and appreciation of both human and plant physiology
- be able to use physiological and anatomical knowledge to enhance their personal lives.
- be able to synthesize ideas to make a connection between knowledge of anatomy and physiology and real-world situations, including healthy lifestyle decisions and homeostatic imbalances.
- be able to perform, analyse and report on experiments and observations in physiology

MODULE-1

Homeostasis: Basic mechanisms – Regulation – factors regulating homeostasis .Cell Differentiation: General Characteristics–Nucleocytoplasmic interactions – molecular mechanisms of cell differentiation. Intercellular communications and signal transduction.

MODULE-2

Cellular and Molecular Neurobiology: General organization and function of nerve fibers - synaptic transmission and structure of synapse – synaptic vesicle and release of neurotransmitter – synaptic receptors and physiologic response.

Sensory physiology – photoreception – eyes and vision – mechanoreceptor: touch and pressure – mechanoreceptors of motion and position – proprioceptor – chemoreceptor – mechanism of hearing, olfaction, gustatory receptors

MODULE-3

Cellular and Molecular Biology of the Muscle: structure of striated muscle fiber – smooth muscle – molecular organization of contractile system – molecular mechanism of muscle contraction – energetics of muscle contraction – regulation.

Cellular and Molecular Biology of endocrine system: Cellular secretions – mammalian endocrine glands – peptide and proteins, amines and steroid hormones – synthesis, storage and secretion of hormones – cellular mechanism of hormone action – hormone receptors – endocrine disorders – pheromones and its role behavior and reproduction – biological clocks.

MODULE-4

Plant Physiology: Autotrophy-heterotrophy-intake of water and nutrients-transpiration-Growth and Reproduction: Hormones and growth regulators-auxins, gibberlins, kinins, ethylene and other compounds.

References:

1. Sherwool L, Klandorf H and Yancy P H, Animal Physiology: From Genes to Organisms Thompson Brooks/Cole.

2. David Randall, Burggren W and Frech K, Eckert Animal Physiology: Mechanisms and Adaptations. W H Freeman & Co.
3. Guyton A C. Text Book of Medical Physiology. W B Saunders Co.
4. Hancock John T, Cell Signalling. Oxford University Press.
5. DeRobertis E D P and DeRobertis E M F, Cell and Molecular Biology. Holt Saunders.
6. Taiz and Zeiger,Plant Physiology,Sinauer
7. S.Mukherji et al.,Plant Physiology,Central
8. Hopkins et al.,Introduction to plant physiology
9. Negi,Introduction to Endocrinology,PHI

MSMOB02P03: Lab in Genetics & Molecular Biology

3 Credits

Course Objectives:
The objective of this practical course is to introduce students to most of the common techniques used in genetic analyses, with an emphasis on basic molecular biology techniques.

Course Learning Outcomes:
Upon completion of this practical course, students will

- be able to demonstrate an understanding of modern genetics by conducting studies on Drosophila
- be able to demonstrate practical knowledge of DNA technologies by extracting and estimating DNA, RNA and protein.

Contents:

1. Maintenance of *Drosophila melanogaster* culture and demonstration of sex linked inheritance of any suitable gene by means of crosses.
2. Gene mapping of *Drosophila melanogaster*, using text book problems
3. Preparation and analysis of salivary gland chromosomes of *Drosophila.*
4. Extraction and estimation of chromosomal DNA from animal tissues (by diphenylamine test).
5. Extraction and estimation of total RNA from any suitable material (by Orcinol test).
6. Extraction and estimation of protein from any suitable material (by Lowry test).
7. Agarose gel electrophoretic separation and visualization of DNA using UV transilluminator.
8. Leucocyte culture and chromosome study.
9. Melting temperature of DNA - Tm analysis.

MSMOB02P04: Lab in Physiology & Immunology

3 Credits

Course Objectives:
The objective of this practical course is to develop a working knowledge of the principles and procedures of physiology and immunology.

Course Learning Outcomes:
Upon completion of this practical course, students will attain hands on training for various physiological and immunological techniques.

Contents:

1. Determination of vertebrate haemoglobin using calorimeter.
2. Enumeration of WBC, RBC; Blood grouping and Rh typing.
3. Total and differential count of WBC.
4. Determination of vertebrate serum chloride, calcium and fibrinogen.
5. Demonstration of osmotic hemolysis.
6. Preparation of antigen; immunization protocol - preparation of serum & complement.
7. Haemoagglutination test.
8. Immunodiffusion test
9. Immunoelectrophoresis – preparation of immunoglobulin-lymphocyte migration inhibition test.
10. ELISA - Widal test - VDRL tests.

SEMESTER III

MSMOB03C07: Advanced Molecular Biology

60 Hours **4 Credits**

Course Objectives:
The objective of this course is to introduce the student to the advanced concepts in molecular biology. Students will gain an understanding of molecular mechanisms involved in recombination, gene regulation in prokaryotic and eukaryotic organisms. They will also study the techniques and experiments used to understand these mechanisms.

Course Learning Outcomes:
Upon completion of this course, students will

- be able to acquire knowledge on various molecular mechanism involved in the regulation of gene expression in prokaryotes and eukaryotes.
- be able to interpret the outcome of various molecular biology experiments.

MODULE-I

Molecular mechanisms involved in recombination of DNA: Holliday intermediate – Reciprocal recombination-patch recombination-heteroduplex DNA – gene conversion – Rec A protein ant its role in recombination.

Eukaryotic genome: C-value paradox –Gene numbers– unique, moderately repetitive and highly repetitive DNA sequences – reassociation kinetics – Cot value and complexity of genome-Interrupted genes – satellite – Rot value.

MODULE-II

Regulation of gene expression in Prokaryotes: various models - operon - details of lac operon-negative and positive control lac operon – catabolite repression-basic features of tryptophan, arabinose, and galactose operon. Gene regulation in bacteriophage.

Regulation gene expression in eukaryotes: Regulation of transcription-regulation of RNA processing and translation.

MODULE-III

Developmental Genetics: Induction and competence – maternal effects of genes – homeotic genes. Transposon in bacteria and eukaryotes: retroviruses and transposition – phage Mu as transposable elements. Microarray and gene expression analysis.

MODULE-IV

DNA sequencing: Maxam Gilbert chemical method - Sanger's enzymatic chain termination method- foot printing. Molecular probes – cDNA probes – RNA probes – nick translated probes; Restriction mapping – RFLP. Blotting techniques: Northern blotting – western blotting – dot blots- Southern blotting. PCR technology – gene amplification – primer designing – variation in PCR – real time PCR, RACE, inverse, nested etc-Applications of PCR

References:

1. Walker J M and Gringold EB, Molecular Biology and Biotechnology. Panima.
2. Benjamin Lewin.Genes 1X. John Wiley.
3. Sambrook J, Fritsch E F and Maniatis T, Molecular cloning: A laboratory Manual.

Cold Spring Harbor Laboratory.
4. Hartwell L H et al., Genetics: From Genes to Genome. Mc Graw Hill.
5. Watson J D et al., Molecular Biology of the Gene. The Benjamin / Cummings.
6. Lodish H et al., Molecular Cell Biology. Scientific American Books. W H Freeman.
7. David Freidfelder, Molecular Biology. Narosa.
8. Adrin J Harwood, Methods in Molecular Biology,Vol.58, Basic DNA and RNA protocols. Humana Press.
9. Chris R Calladine et al., Understanding DNA. Elsevier.
10. Micklos D A et al., DNA Science. Cold Spring Harbour.
11. Cox et al, Molecular Biology, Principles and Practice, Freeman
12. Tropp, Molecular Biology, Genes to proteins, Jones and Bartlett
13. Allison, Fundamental Molecular Biology, Wiley.
14. Ernst L Winnacker, From genes to clones, Panima.

MSMOB03C08: Genetic Engineering & Biotechnology

60 Hours **4 Credits**

Course Objectives:
The objective of this course is to introduce the student to the advanced concepts in genetic engineering and biotechnology. It encompasses ways to analyze, alter and recombine virtually any DNA sequences. The student will also study the techniques and experiments used in genetic engineering and biotechnology.

Course Learning Outcomes:
Upon completion of this course, students will

- be able to learn the basics of gene cloning, construction of various libraries and gene identification.
- be able to familiarize with the various techniques to engineer and express recombinant proteins.
- be able to appreciate the importance and application of recombinant DNA technology in biology.

MODULE-I

Fundamentals of biotechnology: History – emergence of molecular biotechnology– revolution. Tissue culture: Plant tissue culture – principle and methodology – callus culture – tissue and organ culture – whole embryo culture; Animal tissue culture – primary, secondary and established cell lines

MODULE-II

Genetic Engineering: (a) Enzymes in genetic engineering – restriction enzymes type I, II & III, ligases, enzymes to modify the ends of DNA molecules; alkaline phosphatase, polynucleotide kinase, terminal transferase, polymerases, reverse transcriptase etc. (b) Gene cloning vectors: plasmids – pBR 322, pUC, Ti plasmids – bacteriophages – lambda phage, M13, – cosmids – phagemids – BAC, PAC - special vectors – shuttle vectors, expression vectors, yeast artificial chromosomes, MAC etc. (c) Gene isolation, identification and synthesis; Construction of chimeric DNA – cohesive end ligation – use of linkers – blunt end ligation; construction and screening of cDNA and genomic libraries– colony hybridization – plaque hybridization – chromosome walking, chromosome jumping, subtractive cDNA hybridization, differential mRNA display; Studying cloned gene expression and function.

MODULE-III

Protoplast fusion – techniques of protoplast fusion – enzymes involved in cell wall digestion – factors effecting protoplast fusion – fate of products of protoplast fusion.

Gene transfer in animals and plants: Gene transfer method (transfection) – direct gene transfer – Ti plasmid – electroporation – uptake by protoplast –microinjection – liposome mediated DNA delivery – Transgenic animals and plants. Gene Knockout, animal pharming, nanoparticles for labeling, delivery of drugs and DNA and RNA.

MODULE-IV

DNA finger printing – Variable number of tandem repeats (VNTR) – applications; Gene therapy – somatic and germ line gene therapy – *ex-vivo* and *in-vivo* gene therapy – antisense therapy – application of gene therapy in the correction of adenosine deaminase (ADA) – future prospects of gene therapy; RNAi and gene silencing; gene targeting and embryonic

stem cells; Terminator genes.

References:

1. Brown T A, Gene Cloning and DNA Analysis Blackwell Science.
2. B R and Pasternack J J, Molecular Biotechnology: Principles and Applications of Recombinant DNA. Panima.
3. James D Watson et al., Recombinant DNA: A Short Course. Scientific American Books, W H Freeman & Co.
4. Old R W & Primrose S B, Principles of Gene Manipulations. Black Well Science
5. Winnaker E L, From Genes to Clones: Introduction to Gene Technology. VCH Publications.
6. Purohit S S & Mathur S K, Biotechnology: Fundamentals and Applications. Agrobios.
7. Eric Grace, Biotechnology Unzipped: Promises and Realities. University Press.
8. Fumento Michael, Biotechnology: How it is changing our Life. Jaico Publishing.
9. Bourgaize David, Biotechnology demystifying the concepts.
10. Meyers Robert A, Molecular Biology Biotechnology. John Wiley.
11. Sambrook J, Fritsch E F and Maniatis T, Molecular cloning: A laboratory Manual. Cold Spring Harbor Laboratory.
12. Howe, Gene cloning and Manipulation, Cambridge
13. Lodge et al., Gene cloning, Taylor and Francis.
14. Rastogi, Genetic Engineering, Oxford.

MSMOB03P05: Lab in Molecular Biology, Genetic Engineering & Biotechnology

3 Credits

Course Objectives:
The objective of this practical course is to develop a working knowledge of the principles and procedures of molecular biology techniques.

Course Learning Outcomes:
Upon completion of this practical course,
- Students will attain hands on training for various molecular biology techniques.
- Students will be able to explain the principles of cloning and genetic manipulation and their applications.

Contents:
1. Isolation of genomic DNA.
2. Isolation of plasmid DNA from *E.coli* – Separation by agarose gel electrophoresis.
3. Restriction digestion of plasmid – single, double digestion – determination of molecular weight – physical mapping.
4. Cloning of fragment in pBR 322/pUC – insertional inactivation - Bluewhite selection.
5. Re-isolation of plasmid from recombinant clone – restriction digestion and agarose gel electrophoresis – confirmation of size of insert.
6. PCR amplification of DNA, RFLP – gel electrophoresis – analysis of fragments.
7. Genomic and cDNA library construction.
8. Blotting technique – Southern, Northern and Western blotting.
9. DNA sequencing.

MSMOB03P06: Lab in Genomics & Bioinformatics

2 Credits

Course Objectives:
The objective of this practical course is to provide training in the application of programs used for database searching, protein and DNA sequence analysis, and prediction of protein structures.

Course Learning Outcomes:
Upon completion of this practical course,

- Students will acquire training in different areas of bioinformatics related to various biological databases such as protein databases, nucleic acid databases, metabolic pathway databases, etc.
- With training in multiple sequence alignments, they will be in a position to perform in-silico experiments and will predict structures of proteins.

Contents:

1. Internet search for literature.

2. Genome Database services – Search against genes and genomes (BLAST / FASTA) – Gene annotation; DNA–Protein interactions, protein-protein interactions, similarity searches.

3. Use of software for sequence alignment (BLAST , FASTA , CLUSTAL W)

4. Phylogenetic analysis using bioinformatics software.

5. Alignment of protein sequence using Bioinformatics software

ELECTIVE COURSES

MSMOB02E01: Immunology

60 Hours **4 Credits**

Course Objectives:
The objective of this course is to offer knowledge in basic immunology including cellular and molecular processes that represents the human immune system. It includes studies on cells and organs of the immune system, antigen, immunoglobulins and antibody diversity, molecular mechanisms of innate and adaptive immunity, the complement system, antigen presentation, cell-mediated effector responses and techniques used in immunological studies.

Course Learning Outcomes:
Upon completion of this course, students will

- be able to conceptualize cellular and molecular basis of the immune system.
- be able to understand how the innate and adaptive immune responses coordinate to fight against invading pathogens.
- be able to appreciate and understand the complement system, its activation and biological consequences of complement activation.
- be able to understand and identify the genetic defects that lead to immunodeficiency diseases

MODULE-1

Introduction to immunology – types of immunity – innate and acquired – passive and active – lymphoid organ – autoimmunity – physiology of immune response – humoral and cell mediated immunity – immunohaematology.

MODULE-2

Antigen: Basis of specificity – epitopes – hapten – characteristic features of immunogen - pathways of antigen processing and presentation of intracellular and extra cellular antigens – synthetic and recombinant antigens – complement activation pathways.

Antibody: Structure of immunoglobulin – different classes of immunoglobulin – hybridoma technique – monoclonal antibodies and polyclonal antibodies – chimeric antibodies - applications – Genetic basis of immune diversity.

MODULE-3

Regulation of immune system: Immunologic tolerance – immunopathology – T-cell derived lymphokines – macrophages mediated regulation – interleukin 1 –tumor necrosis factor – interleukin 6– interferon and related cytokines.

Immunogenetics: Molecular genetics of human related diseases – transplantation immunology – rejection – graft Vs host reaction – transplantation – antigen-HLA tissue typing and MHC – tumor immunology – tumor antigens - immunotherapy of malignancy – autoimmune diseases – hypersensitive immune responses.

MODULE-4

Principles and methods of precipitation techniques – immunodiffusion - immunoelectrophoresis – agglutination isoelectric focusing – ELISA – RIA – cytotoxic assay labeled antibody technique in light and electron microscopy – immunohistochemistry – Vaccines - techniques of immunization – use of adjuvants – separation of lymphocytes – flow cytometry – elispot.

References:

1. Ivan Roitt, Essential Immunology, Blackwell Science.
2. Goldsby R A,Kindt T J,Osbor R A. Kuby Immunology. W H Freeman.
3. Hue Devis. Introductory Immunology. Chapman & Hall publishers.
4. Roitt J M, Brostaff J J and Male D K, Immunology C V Mosby Publisher.
5. Bellanti J A Immunology. W B Saunders Co.
6. Talwar G P and Gupta S K. A Hand Book of Practical Immunology (Vol. & 11).
7. Elgert,Immunology,Understanding the Immune System,Wiley Blackwell
8. Tizard,Immunology an Introduction,Cengage learning.
9. Mak et al.,Primer to immune response,Academic cell.

MSMOB02E02: Lifestyle Disorders: Cancer & Cardiovascular Diseases

60 Hours **4 Credits**

Course Objectives:
The objective is to provide knowledge about common life style disorders with detailed insight into two major killers: Cancer and Cardiovascular diseases.

Course Learning Outcomes:
Upon completion of this course, students will

- learn about the various life style associated disorders.
- gain detailed insight into Cancer and Cardiovascular diseases with regards to the molecular mechanisms, causes, symptoms, stages, diagnosis and treatments.
- learn about alternative medicines; current research status, various ethical, social and regulatory issues.

MODULE-I

Introduction: Life style associated disorders like obesity, diabetes, chronic obstructive pulmonary diseases (COPD), cancer and cardiovascular diseases (CVDs); Causes, symptoms, complications, diagnosis, intervention and management of disease; Two major killers: Cancer and Cardiovascular diseases.

MODULE-II

Cancer: History of cancer; Characteristics of normal and transformed cells; Hallmarks of cancer; Causes and symptoms; Pathophysiology; Stages of cancer; Molecular basis of neoplastic growth and metastasis, Key oncogenic pathways; Proto-oncogenesis and Tumor suppressor genes; Cancer causing mutations; Tumor viruses, Overview of important techniques related to cancer research.

MODULE-III

Cardiovascular diseases: Definition; The origin of cardiovascular diseases (electrical, structural and circulatory) and types of CVDs; Defining the broad spectrum of ailments; Understanding the underlying factors; Stages of CVDs; Molecular basis of CVDs like hypertension, coronary heart (artery) disease, cerebrovascular disease, cardiomyopathy, cardiac hypertrophy, atherosclerosis, myocardial infarction.

MODULE-IV

Diagnosis and Treatment strategies : Biochemical analysis of cancer and screening methods; Current treatment modalities and their disadvantages, major side effects; Molecular approaches to cancer treatment; Factors affecting prognosis of cancer; Challenges of treatment and disease control strategies. Diagnosis and biomarkers for CVDs; Treatment strategies and management of the condition; Drugs and their discovery; Model systems and animals for CVDs. Recent Advances: Introduction to alternative medicines; Case studies; Research status and scope; Ethical, social and regulatory issues.

References:

1. Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.

2. Introduction to Human Physiology (2012) 8th edition; Lauralee Sherwood. Brooks/Cole, Cengage Learning. ISBN-13: 978-1133104544 ISBN-10: 1133104541
3. The Cell: A Molecular Approach (2009) 5th ed., Cooper, G.M. and Hausman, R.E., ASM Press & Sunderland (Washington DC), Sinauer Associates, MA, ISBN:978-0-87893-300-6.
4. The World of the cell, 7th edition (2009). Lewis J. Kleinsmith, Jeff Hardin, Gr Wayne M.Becker. ISBN-13: 978-0805393934 ISBN-10: 0805393935.
5. Life style disorders, National health portal of India (https://www.nhp.gov.in/lifestyledisorder_mtl)

MSMOB02E03: Biostatistics

45 Hours **3 Credits**

Course Objectives:
The objective of this elective course is to provide an introduction to selected important topics in biostatistical concepts and reasoning

Course Learning Outcomes:
Upon completion of this course, students will

- be able to recognize the importance of data collection and its role in determining scope of inference.
- be able to interpret statistical results correctly, effectively, and in context.
- be able to appreciate the power of data.

MODULE-I

Nature and scope of Biostatistics and its applications in biology: Discrete and continuous variables – collection and classification and tabulation of data frequency table – diagrammatic and graphic presentation of data – bar diagram - pie diagram – histogram – frequency polygon and frequency curve.

MODULE-II

Measures of central tendency: Arithmetic mean – median – mode. Measures of dispersion: Range – quartile deviation – mean deviation and standard deviation. Analysis of variance: ANOVA – one way and two way classification.

MODULE-III

Probability theory: Basic concepts and definition of probability – relative frequency definition – probability distributions – binomial, Poisson and normal distributions and their applications.

Testing hypothesis; level of significance – critical region , type 1 and type 11 error – tests based on normal distribution – t-test, F-test, Z-transformation and chi-square test.

MODULE-IV

Correlation and regression analysis: positive correlation – negative correlation coefficient of correlation, regression equation and its application in computing X or Y. Applications of computer in biostatistics.

References:

1. Jasra P K & Raj G, Biostatistics. Krishna Prakasan Media Pvt. Ltd.
2. Dixon W J & Massey F J Jr, Introduction to Statistical Analysis.
3. Khan I A & Khanum a, Fundamentals of Biostatistics. Ukaaz Publications.
4. Sokal R R & Rohif F J, Introduction to Biostatistics. W H Freeman & Co.
5. Lewis A I, Biostatistics. Reinhold Publications.
6. Snedecor G W & Cochran W G, Statistical Methods. Oxford & IBH.
7. Zar, Jerrold H, Biostatistical Analysis. Morgan Kaufman.
8. Hannagan T J, Mastering Statistics. Mac Millan Master Series.
9. Milton Susan J, Statistical Methods in the Biology & Health Sciences. McGraw Hill.
10. Arora P N, Biostatistics. Himalaya Publishing House.

MSMOB02E04: Ecology & Biodiversity

45 Hours **3 Credits**

Course Objectives:
The objective of this elective course is to convey the principles of ecology and the importance of biodiversity and its conservation

Course Learning Outcomes:
Upon completion of this course, students will

- be able to understand the physical aspects of the environment.
- be able to understand the structure and function of ecosystems.
- be able to appreciate the role of ethics, values and norms in producing culturally attuned and effective conservation interventions.

MODULE-I

Concept of ecosystem: Introduction – Various components of ecosystem – functions – Concept of habitat and niche– energy in ecosystem – nutrient cycling.
Population growth – Characteristics – population growth curves- r and k selection-dispersion – dynamics – species diversity indices – species and the individual in ecosystem.

MODULE-II

Ecological Succession: Types-Mechanisms-changes involved in succession-concept of climax. Biogeography; Major terrestrial biomes-Theory of Island biogeography-biogeographical zones in India.

MODULE-III

Concept and Scope of Biodiversity – species loss – social concept – biodiversity conservation in protected area – biodiversity and agriculture – grazing – forestry – human dimension of biodiversity.

MODULE-IV

Hotspots – conservation strategies – challenges to the preservation of biodiversity– conservation and management – Indian case studies on conservation (Project Tiger/Biosphere reserves).

References:

1. Eugene P Odum, Fundamentals of Ecology. W B Saunders.
2. Subramanyam N S & Sambamurthy AVSS, Ecology. Narosa.
3. Wilson E O, Biodiversity. National Academy Press.
4. Jeffrey A, McNeely & R Miller, Conserving the Worlds Biological Biodiversity.
5. Vitousek P M & DV Hooper, Biodiversity and Ecosystem Function.
6. Cain et al,. Ecology, Sinauer.
7. Dr.V.K.Gupta, Animal diversity, natural history and conservation vol.1.,Daya publications.

MSMOB03E05: Genomics & Bioinformatics

60 Hours **4 Credits**

Course Objectives:
The objective of this course is to teach genomics and bioinformatics, with a brief introduction to transcriptomics, proteomics and metabolomics. The course will cover recent developments in genomics- genome mapping, pharmacogenomics, human genome project and its future etc. This course will outline the brief historical context of sequencing, provide an introduction to what bioinformatics is and why it is important, along with an overview of the application areas of bioinformatics,

Course Learning Outcomes:
Upon completion of this course, students will

- be able to describe recent advances in genomics, transcriptomics, proteomics and metabolomics.
- be able to explain some of the current genomics technologies and illustrate how these can be used to study gene function.
- be exposed to available bioinformatics tools and databases
- get trained in the application of programs used for database searching, protein and DNA sequence analysis, and prediction of protein structures.
- be able to locate and evaluate current scientific literature and discuss the important findings of these publications in writing.

MODULE-I

The Human genome: Organization of genes and related sequences – pseudo genes and microsatellites. Organellar genomes: Special features of yeast mitochondria and human mitochondrial genome – petite mutants of yeast. Mapping genomes: Genetic mapping – physical mapping – restriction mapping – Fluorescent *in situ* hybridization (FISH) – sequence tagged site (STS) mapping.

MODULE-II

Sequencing genomes: pyrosequencing-Next generation sequencing- assembly of contiguous DNA sequence – sequence assembly by shot gun approach – sequence assembly by clone contig approach – whole genome shot gun sequence – Human genome project – sequencing the human genome – future of the human genome project (hapmap, 1000 genome project). Understanding a genome sequence: Locating the genes in a genome sequence – determining the function of individual genes – computer analysis of gene function – assigning gene function by experimental analysis.

MODULE-III

Pharmacogenomics and its applications: Historical perspectives and current status – Genetic polymorphism – SNPs – personalized medicine. Genome evolution and phylogenetics: Origin of genome – acquisition of new genes – non coding DNA – genome evolution -phylogenetic tree as a tool in the study of human prehistory – origin and migration of modern human.

MODULE-IV

Bioinformatics: Introduction – genomics – transcriptomic – proteomic-metabolomics. Biological databases: Generalized and specialized databases – DNA, protein and carbohydrate databases – nucleic acid sequence databases – premier institutes for databases

– nucleic acid codes used in database formats; Collection and down loading of information from databases – literature search. Sequence alignment and its evolutionary basis: Simple alignment and multiple sequence alignment - searching the database for sequence similarity – search programmes with special reference to FASTA, BLAST, CLUSTAL W. Application of bioinformatics in phylogenetic analysis.

References:

1. Dale J W and Schantz M V, From Genes to Genome. Wiley.
2. Brown T A, Gene Cloning and DNA Analysis. Blackwell Science.
3. Winnacker E L, From Genes to Clones: Introduction to Gene Technology. Panima.
4. Benjamin Lewin, Genes IX. Jones and Bartlett.
5. Daniel L Hartl and Elizabath W Jones, Gentics: Analysis of Genes and Genome. Jones and Bartlett
6. Young, Computerized Data Acquisition and Analysis For Life Sciences. Cambridge University Press.
7. Xiong, Essential Bioinformatics. Cambridge University Press.
8. Marketa J Zvelebil, Understanding Bioinformatics. Garland Science.
9. Shui Quing Ye, Bioinformatics: A practical Approach.
10. Anna Tramontano, Introduction to Bioinformatics
11. David W Mount, Bioinformatics. CBS
12. Mani K and Vijayaraj N, Bioinformatics. Kalaikathir Achchagam.
13. Augen Jeff, Bioinformatics in the post genomic era. Addison Wesley.
14. Cohen Nadine, Pharmacogenomics and personalized medicine
15. Lesk, Introduction to Genomics, Oxford
16. Ruvinsky et al., Mammalian Genomics, Oxford
17. Faridi, Genetics and Genomics, Pearson
18. Bosu et al, Bioinformatics, Oxford
19. Rastogi et al,. Bioinformatics, Oxford.

MSMOB03E06: Forensic Biology & DNA Profiling

60 Hours **4 Credits**

Course Objectives:
The objective of this course is to discuss the principles of serology and immunology and to explain the bloodstains investigations techniques. It also aims at informing the students about various protected and endangered species of animals and plants and introduction of wildlife (protection) act 1972. The student would be able to understand the forensic DNA profiling and its application in criminal and civil investigations.

Course Learning Outcome
Upon completion of this course, students will

- to learn about various serological techniques used to analyse blood samples for criminal investigation.
- be able to analyse microscopic and macroscopic examination of biological samples like plant, hair recovered from crime scene.
- learn the techniques used in DNA Profiling.
- understand the Concept of gene and sequence variation.

MODULE-I

Cell structure and functions. Structure and function of carbohydrates, fats and proteins, serum proteins, haemoglobin and its variants, haptoglobins, HLA, polymorphic enzymes, blood groups-history, biochemistry and genetics of ABO, Rh, Mn and other systems, Methods of ABO blood grouping from fresh blood and biological stains, body fluids, determination of secretor status, polymorphic enzyme typing, serogenetic markers, determination of origin of species, immunology, immune response, antigens, haptens and antibodies, function and rising of antisera, lectins. Bloodstains investigations: Blood pattern analysis, ageing of bloodstains, difference between human and animal bloodstains, spectroscopic analysis.

MODULE-II

General plant classification schemes. Sub specialisation of forensic botany- plant morphology, plant anatomy, plant systematic, palynology, plant ecology. Wood and timber analysis. Diatoms and their forensic importance. Study and identification of various diatoms. Paper and pulp identification. Introduction and importance of wild life. Protected and endangered species of animals and plants. Sanctuaries and their importance. Introduction to Wildlife (Protection) Act 1972 and CITES, Relevant provision of wild life and environmental act. Types of wildlife crimes, different methods of killing and poaching of wildlife animals. Collection and preservation of hair samples. Morphological and microscopic examination of human and animal hair. Hair growth and development, determination of origin, race, sex, site from hair. Comparison between human and non-human hair. Macroscopic and microscopic features of hair.

MODULE-III

Double helical structure of DNA, alternate forms of DNA double helix, denaturation and renaturation of DNA, DNA binding proteins, factors affecting DNA stability, types and structure of RNA. Chemical nature of DNA and RNA. Nature and structure of human genome and its diversity.mt-DNA, Y-Chromosomes and the peopling, migration, of modern humans, Forensic DNA profiling and its application in criminal and civil investigations.

MODULE-IV

Concept of gene – Conventional and modern views. Concept of sequence variation - VNTRs, STRs, Mini STRs , SNPs. Detection techniques - RFLP, PCR amplifications, Amp-FLP, sequence polymorphism, Y-STR, Mitochondrial DNA. Disputed paternity cases. Missing person identity, population genetics and legal admissibility of DNA evidence. Concepts of length and sequence DNA polymorphism, DNA markers (VNTRs, Stars, SNPs, Y-STRs, mt DNA)- their importance and detection. DNA extraction, it's qualitative and quantitative assessment, Polymerase chain reaction (PCR), Generation and assessment of DNA profiles, Statistical interpretation of DNA profiles, evaluation and presentation of DNA evidence, Kinship testing and lineage markers DNA databanks and their utility in various criminal investigations.

References:

1. Brown, T; Gene cloning and DNA analysis: An Introduction , 5th ed. Blackwellpublishing, London, 2006 .
2. Butler, J; Advanced Topics in Forensic DNA Typing: Methodology, 1st Ed., Academic Press, London, 2009.
3. Easteal, S. McLeod, N. & Reed, K; DNA Profiling: Principles, Pitfalls and Potential, Harwood Academic Publishers, New Jersey, 1991.
4. Primorac, D.&Schanfield, M; Forensic DNA Applications: An Interdisciplinary Perspective, CRC Press, New York, 2014.
5. Rudin, N. & Inman, K; An Introduction to Forensic DNA Analysis, Second Ed.,CRC press, New York, 2001.
6. Spencer, C; Genetic testimony: a guide to forensic DNA profiling, Pearson, New Delhi, 2004.

MSMOB03E07: Developmental Biology

45 Hours **3 Credits**

Course Objectives:
The objective of this elective course is to provide a comprehensive understanding of the concepts of early development in animals and plants.

Course Learning Outcomes:
Upon completion of this course, students will

- be able to understand the main developmental biology concepts
- be able to explain the molecular mechanisms that underlie animal and plant development

MODULE-I

Basic concepts of development: Potency-commitment, specification, induction-competence-determination and differentiation-morphogenetic gradients-cell fate and cell lineages-stem cells.

MODULE-II

Gametogenesis, fertilization and early development: Production of gametes-cell surface molecules in sperm egg recognition in animals-Embryo sac development and double fertilization in plants-zygote formation-cleavage-blastula formation-embryonic fields-gastrulation and formation of germ layers in animals-Embryogenesis.

MODULE-III

Morphogenesis and organogenesis in animals: Cell aggregation and differentiation in Dictyostelium-Axes and pattern formation in Amphibia and chick-vulva formation in *Caenorhabditis elegans*, eye lens induction, limb development and regeneration in vertebrates - Post embryonic development - larval formation – metamorphosis - sex determination

MODULE-IV

Morphogenesis and organogenesis in plants: Organization of shoot and root apical meristem-Shoot and root development-leaf development and phyllotaxy-Transition to flowering.

References:

1. Scott F Gilbert, Developmental Biology, Sinauer Associates, Inc.,Sunderland.
2. Werner A Muller, Developmental Biology, Springer.
3. B.I.Balinsky & B.C.Fabian, An Introduction to Embryology
4. Abhilash Jain, Advanced Developmental Biology.
5. Geoffrey M Cooper, Robert E Hausman, The cell-A molecular Approach.
6. Elena Notarianni, Martin J Evans, Embryonic stem cells.

MSMOB03E08: Molecular Evolution

45 Hours **3 Credits**

Course Objectives:
The objective of this elective course is to provide a comprehensive overview of the concepts of evolution at molecular level. This will also provide adequate knowledge about microevolution, origin of life and evolution of man.

Course Learning Outcomes:
Upon completion of this course, students will

- be able to understand the concepts of molecular evolution
- be able to learn most of the essential aspects of evolution in detail, which will help them in acquiring better understanding of the subject.

MODULE-I

Molecules and Origin of life: Origin of basic biomolecules - origin of organized structures (coacervates, microspheres); RNA world, evolution of protein synthesis, evolution of genetic code, prokaryotes and eukaryotes - evolution of eukaryotic organelle, genetic constancy and variability – chromosomal variation – gene mutation - gene duplication-evolutionary history of haemoglobin, cytochrome C, pseudogene, genetic polymorphism, evolutionary clock.

MODULE-II

Speciation: Isolating mechanisms – Founder principle – bottleneck effect – genetic drift – and gene flow.

MODULE-III

Microevolution – Macroevolution and punctuated equilibrium – anagenesis and cladogenesis.

MODULE-IV

Culture and human evolution; learning, society and culture – cultural and biological evolution – Social Darwinism, sociobiology, biological limitations, deleterious genes, eugenics.

References:

1. Strickberger M W, Evolution. Jones Barllett.
2. Volpe E P, Understanding Evolution. Universal Book Stall.
3. Li.W H, Molecular Evolution. Sinaur Associates.
4. Edwin H McConkey, Human Genetics: The Molecular Evolution. Jones and Bartlette.
5. Masatoshi Nei and Sudhir Kumar, Molecular Evolution and Phylogenetics. Oxford University Press.

MSMOB04E09: Industrial Biotechnology

60 Hours **4 Credits**

Course Objectives:
The objective of this elective course is to provide a comprehensive overview on the instruments used in bioprocess and methods to improve modern biotechnology.

Course Learning Outcomes:
Upon completion of this course, students will

- be able to understand the need for sustainable innovation and how biotechnology and biobased production can contribute to this.
- be able to integrate scientific and technological knowledge on the use of bioprocesses for industrial products on the cell and process level.

MODULE-I

Fermentation Types – surface, submerged, solid state, adhesive, batch, continuous, fed batch, immobilized and anaerobic. Media sterilization; development of inocula; assay of fermentation products.

MODULE-II

Bioreactor – batch, chemostat and turbidostat, mode of operation, ideal reactors, mass transfer, heat transfer and mass balance. Optimization conditions – aeration agitation, foam control, process control equipment, biosensors.

MODULE-III

Bioproduct technology- production of microbial biomass, enzymes, vaccines, vitamins, microbial transformation of steroid, fermentation economics, market potential, process cost, recovery cost future of bioprocess technology.

MODULE-IV

Bioproduct processing – downstream processing, concentration and finishing. Anaerobic fermentation - Wine, beer, industrial alcohol, acetone, butanol, lactic acid and glycerol production. Aerobic fermentation –vinegar, citric acid, glucomic acid, fermanic acid, Kojic acid, amino acids and antibiotics (Penicillin and streptomycin) production.

References:

1. Michael J Waites, et al., Industrial Microbiology: An introduction. Blackwell Science.
2. EI-Mansi, E.M.T and Bryce, C.F.A. Fermentation Microbiology and Biotechnology.
3. L.E. Casida, J.R Industrial Microbiology. New international (p) Ltd. Publishers.
4. DR.Kavita, Industrial Biotechnology, AITBS publishers
5. Domain and Davies, Manual of industrial Microbiology and Biotechnology, Panima.
6. P.F.Stanburry, Principles of fermentation technology

MSMOB04E10: Human Genetics

45 Hours **4 Credits**

Course Objectives:
The objective of this elective course is to provide an overview of basics of Human Genetics and makes familiar with the common genetic disorders.

Course Learning Outcomes:
Upon completion of this course, students will

- be able to explain the genetic mechanisms and their role in human inherited disease.
- be able to appreciate the importance of genetic counselling and prenatal diagnosis in real life.

MODULE-I

Human chromosomes: Karyotype and different types of banding techniques and its significance. Human pedigree and various modes of inheritance: Pedigree construction, autosomal abnormalities, sex chromosomal abnormalities, autosomal recessive inheritance, X-linked inheritance, Y-linked inheritance, multifactorial inheritance.

MODULE-II

Genetics of reproduction and development: prenatal development, errors in sexual development – defects of androgen target cells, congenital adrenal hyperplasia, sex reversal; genetics of embryonic development – maternal effect genes, segmentation and pattern forming genes.

MODULE-III

Inborn errors of metabolism: Concept of metabolic diseases, detection of metabolic diseases in new born, taysachs disease, disorders of phenyl alanine metabolism, Lesh-Nyhan syndrome. Genetic diseases and gene therapy: Types of gene therapy – germ line, zygotic and somatic cell gene therapy; treatable genetic diseases – cystic fibrosis, sickle cell anemia; future of gene therapy, early detection of genetic diseases.

MODULE-IV

Genetic counselling and prenatal diagnosis: Methods of genetic counseling, amniocentesis, chorionic villi sampling, fetoscopy, ultrasound sonography; prenatal sexing and legislation. Human population genetics: Genetic drift – gene flow – consanguineous marriages, inbreeding, sampling, demographic analysis.

References:

1. Gardner and Simmon, Principles of Genetics. John Wiley & Sons.
2. Strickberger Genetics, Monroe W.
3. Robert J Brooker, Genetics: Analysis and Principles. Addison Wesley Longman.
4. Edwin H McConkey, Human Genetics: The Molecular Evolution. Jones and Bartlett Publishers.

MSMOB04E11: Ethics, Patency & Intellectual Property rights

45 Hours **4 Credits**

Course Objectives:
The objective of this elective course is to introduce fundamental aspects of Intellectual property Rights to students who are going to play a major role in development and management of innovative projects in industries. This course will also provide knowledge about the ethical issues and patent rights.

Course Learning Outcomes:
Upon completion of this course, students will

- be able to apply intellectual property law principles (including copyright, patents, designs and trademarks) to real problems and analyse the social impact of intellectual property law and policy.
- be able to analyse ethical and professional issues which arise in the intellectual property law context.

MODULE-I

Ethical aspects of interfering in natural process – hidden dangers in altering genetic makeup. Objectives of the patent system, basic principles and general requirements of patent law, technological inventions and patent law, legal development, patentable subjects and protection in biotechnology, international convention for the protection of new varieties – Strasbourg convention, UPOV convention.

MODULE-II

The patentability of microorganisms – claims, characterization and repeatability – deposition in culture collections, legal protection – for plants and other higher organisms – tissue culture protocols – transfer of technology. Patentability of inanimate products of nature – vectors, FDA, FPA, patent office practice – trade secrets, copyrights, infringement problems – harmonization patent laws – IPR and Plant genetic sources, GATT and TRIPS.

MODULE-III

Biosafety: Objectives, definition, recombinant DNA safety – classification of pathogenic microorganisms – Biological containment (BC) and physical containment (PC) – biosafety levels.

MODULE-IV

Guidelines for rDNA research activities: Large scale experiments, release to the environment, import and shipment, quality control of biologicals produced by rDNA technology, mechanism of implementation.

References:

1. Erice Grace, Biotechnology Unzipped: Promises and realities.
2. Glick B R & Pasternak J J, Molecular Biotechnology. Panima.
3. Purohit S S & Mathur S K, Biotechnology: Fundamentals and Applications. Agrobios.
4. Brown T A, Gene Cloning and DNA Analysis. Blackwell Science.

MSMOB04E12: Environmental Biotechnology

45 Hours **4 Credits**

Course Objectives:
The objective of this elective course is to introduce fundamental knowledge about the different types of biotechnological processes that exist in the field of environmental applications. This also introduce students to the various types of environmental pollutants and their effects

Course Learning Outcomes:
Upon completion of this course, students will

- be able to describe the scientific basis that are applied by environmental biotechnology.
- be able to describe the properties of microorganisms with potential application to processes of environmental biotechnology.
- be able to explain the technologies, tools and techniques in the field of environmental biotechnology.

MODULE-I

Introduction to Environmental Biotechnology – scope and importance. Biological Treatment of waste water: Aerobic – Biological process for domestic and industrial waste water treatment ; aerobic systems – activated sludge processes– trickling filters – biological filters – rotating biological contractors (RBC) ; fluidized bed reactors (FBR) , expanded bed reactor, inverse fluidized bed biofilm reactor (IFBBR) ; sparged reaction. Anaerobic: Contact digestion - packed column reaction-UASB reactor.

MODULE-II

Bioremediation: Introduction – constraints and priorities of bioremediation; biostimulation of naturally occurring microbial activities; bioaugmentation; solid phase bioremediation; phytoremediation – composting, bioventing, biosparging; liquid phase bioremediation. Mining and Metal Biotechnology: Microbial transformation – accumulation and concentration of metals – metal leaching – extraction and future prospects.

MODULE-III

Biofuels: Microorganisms and energy requirements of mankind. Production of non-conventional fuels. – Methane (biogas); hydrogen, alcohols, hydrocarbon, use of microorganisms in petroleum augmentation and recovery.

MODULE-IV

Major pollution problems – pathogens – microbial toxins – oxygen depletion-biodeterioration - eutrophication – hazardous transformation – Management of pollution problems using microorganisms.

References:

1. Agarwal SK, Enviornmental Biotechnology.
2. Martin Alexander , Biodegradation and Bioremediation . Academic Press
3. Stanier R Yetal , General Microbiology. McMillan Publications
4. Foster C F. & John Ware D A, Environmental Biotechnology. Ellish Horwood Ltd.
5. Chattergy A K, Environmental Biotechnology.
6. Jogdant S N, Environmental Biotechnology, Himalaya Publications.

OPEN ELECTIVE COURSE

MSMOB04O01: Life & Genes

45 Hours **4 Credits**

Course Objectives:
This basic course is intended for those students, who are interested to know the living world around us, their diversity and finally to know they themselves through living technology.

Course Learning Outcomes:
Upon completion of this course, students will

- be able to understand how life originated in this earth.
- be able to appreciate the concept of genes and living cells.

MODULE-I

Life: appearance of life – experimental studies for the origin of life – spontaneous generation, Pasteur experiment, Oparin's experiment, Miller's experiment.

MODULE-II

Biodiversity: Concept and scope of biodiversity – species biodiversity, ecosystem biodiversity, genetic biodiversity – biodiversity and health.

MODULE-III

Cell: General organization – Cell architecture – Biomolecules – cell cycle. Genome: Genetic material – central dogma of modern biology – DNA, RNA– genetic code – gene expression and regulation – Human genome.

MODULE-IV

Living Technology: Biotechnology – basic steps in genetic engineering - applications – Hazards and impacts on society.

References:

1. Biology. Raven *et.al.*
2. Biodiversity: Concept, conservation and biofuture. Mandal and Nandi.
3. Ecology. Subramanyan and Sambamurthy.
4. Fundamentals of Ecology. Odum and Barrett.
5. Cell and Molecular Biology. DeRobertis and DeRobertis.
6. The thread of life. Susan Aldridge
7. Biotechnology. John.E.Smith.
8. Gene cloning and DNA Analysis. T.A.Brown
9. Molecular Biotechnology, Principles and Application of Recombinant DNA. Glick & Pasternak.
10. DNA Science. Micklos & Freger

Reg.No…….

Name…….

First Semester M.Sc. Degree (CBCSS-Reg./Sup.)

Examination, November 2020

MOLECULAR BIOLOGY

MSMOB01C02 – General Microbiology

Time: 3 Hours Max. Marks : 60

SECTION A

Answer **any five** of the following: (5 x 3 = 15)

1) Explain how biogas is produced from biological wastes.
2) Give an account on the virulence factors associated with Streptococcal diseases.
3) Write a short note on Whittaker's five kingdom classification.
4) Briefly describe the structure and life cycle of bacteriophage.
5) Write a note on endotoxins.
6) Discuss the classification of viruses based on their morphology.

SECTION B

Answer **any three** of the following: (3 x 5= 15)

7) Microbes are used in value addition of fish and meat. Substantiate.
8) Write a short essay on microbial virulence factors and the role they play in humans.
9) What are the reasons that lead to the evolution of drug resistance in bacteria? How can they be prevented?
10) Write an essay on methods of sterilization in a microbiology laboratory.
11) Discuss the role played by microbes in bioremediation.

SECTION C

Answer **any three** of the following: (3 x 10= 30)

12) Discuss in detail the various types of exotoxins, and its mode of action inside host cell.
13) With a neat diagram explain growth curve. How does knowledge about growth curve help in applied microbiology?
14) Describe the processes involved in obtaining a pure culture of bacteria.
15) Sketch and describe the ultra structure of Gram negative and Gram positive cell wall.
16) Describe the pathogenesis and aetiology of any three viral diseases