KANNUR UNIVERSITY

(Abstract)

M.Sc. Computational Biology Programme - Scheme and Syllabus (CBCSS)- implemented in the University Department w.e.f.2020 admission - Orders issued

ACADEMIC C SECTION

Acad/C4/7627/2021 Dated: 27.04.2021

Read:-1. G.O. (Ms) No.389/2020/HEDN dated 05.11.2020

2. Minutes of the meeting of the syndicate held on 17.11.2020, vide item No.2020.550

3. U.O. No.Acad.A2/5565/ND&C/2008 Vol.II dated 31.12.2020

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

5. Minutes of the meeting of the Experts Committee held on 08.02.2021

6. E-mail dated 13-4-2021 from the Programme Coordinator,[M.Sc.Computational Biology] along with the Syllabus

ORDER

1. As per paper read (1) above, sanction was accorded by the Government to start New Generation Courses in the Teaching Departments of the University during academic year 2020-21.

2. The meeting of the Syndicate as per paper read (2) above resolved to start the newly sanctioned Programmes in Govt./Aided Colleges/University Departments from the academic year 2020-21.

3. Accordingly, the Vice Chancellor, as paper read (3) above, accorded sanction for starting the New Generation Course in M.Sc. Computational Biology (CBCSS) in the Department of Bio Technology and Micro Biology at Dr. Janaki Ammal Campus, Palayad, Thalassery.

4. Further, the Expert committee constituted to draft Regulation, Curriculum, Syllabus of New Generation Course in M.Sc Computational Biology Programme under Choice Based Credit Semester System, prepared the same as per paper read (4), and approved the Scheme and Syllabus for M.Sc Computational Biology Programme w.e.f 2020 admission, after incorporation of the suggestions by the subject Expert, vide paper read (5) above.

5. Subsequently, the Programme Co-ordinator(M.Sc.Computational Biology) submitted the Scheme and Syllabus of M.Sc. Computational Biology Programme under CBCSS vide paper read (6), for implementation w.e.f 2020 admission on wards.

6. 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,

accorded sanction to implement the Scheme and Syllabus of M.Sc. Computational Biology Programme under CBCSS in the Department of Bio Technology and Micro Biology at Dr. Janaki Ammal Campus, Palayad, Thalassery w.e.f 2020 admission, subject to reporting to the Academic Council.

7. The Scheme and Syllabus of the M.Sc. Computational Biology Programme under CBCSS are uploaded on the University website, www.kannuruniversity.ac.in.

Orders are issued accordingly.

Sd/-

BALACHANDRAN V K

DEPUTY REGISTRAR (ACAD)

For REGISTRAR

To: The Head, Department of Biotechnology and Microbiology
Dr. Janaki Ammal Campus, Palayad, Thalassery

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

KANNUR UNIVERSITY
CIVIL STATION P.O.
KANNUR
Pin-670 002
THAVAKKARA

KANNUR UNIVERSITY

DEPARTMENT OF BIOTECHNOLOGY AND MICROBIOLOGY

SCHEME AND SYLLABUS

M Sc COMPUTATIONAL BIOLOGY

2020 ADMISSION ONWARDS

Scheme and Syllabus of M Sc Computational Biology Programme
Under the Choice Based Credit Semester System with
effect from 2020 Admission

SCHEME AND SYLLABUS OF M.Sc. COMPUTATIONAL BIOLOGY PROGRAMME

(Under the Choice Based Credit Semester System with effect from 2020 Admission)

About the Department

The Department of Biotechnology and Microbiology of Kannur University established in the year 2000 at Palayad, Thalassery offers M.Sc., Ph.D. and Post-doctoral programs in Biotechnology and Microbiology. The Department is a Centre of Excellence in Biosciences, receiving research funds from state, national and international agencies. Our vision is to improve quality of life through research and molding future scientists and individuals who will be a work force to make a better tomorrow.

Program Specific Outcomes (PSOs):

A post-graduate student in the frontier and multidisciplinary areas of Computational Biology upon completion of the programme is expected to gain the following attributes:

- Capability to become future scientists, teachers, and entrepreneurs.
- Competence for research and innovation in Computational Biology
- Technical skills for the betterment of planet Earth
- Critical thinking ability to review scientific literature as steppingstone to research
- Confidence for career choice.
- Ability to work independently in chosen research topics as well as be part of teamwork with collaborative skills.
- Confidence in scientific conversation and writing skills and knowing ethical behavior

DURATION AND OTHER DETAILS OF THE PROGRAMME

- The whole program is divided into four semesters (two years)
- The number of students' intake (anticipated) is 12 (Twelve)
- Fee structure of the program is same as that of M.Sc. Biotechnology and Microbiology

ELIGIBILITY FOR ADMISSION

1. The student is required to obtain at least 50% in his/her Bachelor's programme with not less than 50% marks in aggregate (excluding languages).
2. Bachelor’s degree in any branch of science/technology/medicine (with degrees such as BSc, BE, BTech, BPharm, MBBS, BDS, BVSc and BAMS)
3. The eligible subject areas include: Life sciences (botany, zoology, genetics, human biology, general life sciences, ecology, environmental biology), bioinformatics, microbiology, biotechnology, chemistry, physics, mathematics, computer science/information technology, statistics, any branch of engineering, pharmaceutical sciences, agriculture, medicine, dentistry, horticulture, forestry, and veterinary sciences.
4. Those who are awaiting final year results of their bachelor’s degree also can apply, but they must fulfill the eligibility criteria before the admission.
5. Eligible relaxation in the percentage of marks will be given to candidates belonging to SC and ST. Reservation policies of the University/State are followed for admission.

ADMISSION PROCEDURE

Admissions are notified in national newspapers inviting applications for the M.Sc. programme offered by the Department.

All the eligible applicants must appear for a written entrance test. Duration of the entrance test will be 120 minutes with 200 objective type multiple choice questions for 100 marks. Questions will be focused on thebiology, chemistry, physics, mathematics, and computer science at the basic level. There will be 25% negative marks for the wrong answers. A rank list will be prepared based on the entrance test. The admission will be as per the rank in the list and reservation policy.

CURRICULUM

The MSc curriculum of Computational Biology closely follows the level and extent as conceived by the national curricula development centers of UGC/DBT. The Choice Based Credit Semester

System (CBCSS) provides an opportunity for the students to choose courses from the prescribed courses comprising core and elective courses. The evaluation of the courses will be through grading system evaluation and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in internal and external examinations.

COURSES AND CREDITS

Definitions:

I. '**Academic Programme'** means the entire course of study including its programme structure, details of the course, evaluation methods etc. This will be carried out by teaching and evaluation process in the parent department / centre or jointly under more than one such Department/ Centre

II. **'Course'** means is a subject that is part of an Academic Programme

III. **'Programme Structure'** includes the list of courses (Core, Elective, Open Elective) that forms an Academic Programme which specifies the syllabus, credits, hours of teaching, evaluation process and examination schemes, the minimum credits required for successful completion of the programme etc. prepared in conformity to University Rules and eligibility criteria for admission

IV. **'Core Course'** means a course that a student admitted to a particular programme must successfully complete compulsorily to receive the degree and that 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 or any other Department/Centre

VI. '**Open Elective'** means an elective course which is available from recognized online resources like Swayam/ MOOCS or offered by other departments within the frame work of the subject.

VII. **'Credit'** is the value assigned to a course which indicates the level of instruction; 1 lecture per week equals 1 Credit, 3 hours practical class per week equals 1 credit.

VIII. '**SGPA'** means Grade Point Average of the semester calculated for individual semester.

IX. **'CGPA'** is Cumulative Grade Points Average calculated for all courses completed by the students at the end of the programme. A formula for conversion of CGPA into percentage marks will be given in the mark sheet.

A minimum of 80 credits are mandatory for the successful completion of the programme.

Students can opt for one elective (open elective) course relevant to Computational Biology program from online sources approved by the University (Swayam Platform or similar platforms) or other Departments during second and third semester. The choice of the student must be reported to the Head of the Department and approved by the Department Council. The minimum credits per semester is 16 and the maximum credits per semester (core and elective inclusive) cannot cross 24. All students have to opt for equal number of electives in each semester.

If the student does not earn the required credits by not appearing for the exam or due to other reasons, the course will have to be repeated along with the concurrent semester of the next batch after the approval by the DC.

PROJECT WORK

Students have to take up a research project of 5 months duration in the fourth semester for which they are encouraged to go to national research institutes. The students may also get opportunity to undergo 1-2 weeks training in industrial / research institutions in the field.

EVALUATION

The marks for Continuous Evaluation and End Semester Examination will be in the ratio 40:60. Allocation of marks for each component under continuous evaluation of theory courses shall be as given below.

Continuous Evaluation: Theory Paper (40 Marks)

Assignment	Test papers	Seminar	Total
8	16	16	40

Continuous Evaluation: Practical (40 Marks)

Mid-semester test/viva	Record	Total

30	10	40

End Semester Examination Practical: (60 Marks)

The teacher conducting the practical examination will decide the components of the exam

End Semester Examination Theory: Written examination for 60 Marks

ATTENDANCE:

The minimum attendance required for each course in a semester shall be 60% of the total number of classes conducted for the course. Only those who secure the minimum attendance requirement in the semester will be allowed to register for the End Semester Examination.

TENURE

A student must complete the entire program within four years from the date of registration

Courses offered in the M.Sc. Computational Biology Programme
Total credits 80

Semester I

Core: 6 (Theory: 4 Practical :2) Electives: 2
Credits: Core: 16 Elective: 6 Total: 22 Credits

Sl. No	Course Code	Title of the course	Contact hours /week			Marks			Credits
			L	T/S	P	ESE	CE	Total	
	Core Courses								
1	MSCPB01C01	Biochemistry	3	2		60	40	100	3
2	MSCPB01C02	Biological database management systems	3	2		60	40	100	3
3	MSCPB01C03	Basics of computing	3	2		60	40	100	3
4	MSCPB01C04	Biostatistics	3	2		60	40	100	3
5	MSCPB01C05	Practical 1: Biochemistry andBiological Databases			3+3	60	40	100	2
6	MSCPB01C06	Practical 2: Programming lab I – Basic Computing and Application of R programming			3+3	60	40	100	2
	Elective Courses								
7	MSCPB01E01	Cell Biology and Genetics	3	2		60	40	100	3
8	MSCPB01E02	Instrumentation	3	2		60	40	100	3

Semester II

Courses: Core: 3 (Theory: 2, Practical :1) Electives: 4
(Students must choose 4 elective courses from 5)
Credits: Core: 8, Elective: 12, Total=20

Sl. No.	Course Code	Title of the course	Contact hours/week			Marks			Credits
			L	T/S	P	ESE	CE	Total	
	Core courses								
9	MSCPB02C07	Sequence Analysis	3	2		60	40	100	3
10	MSCPB02C08	Python programing and Biomolecular simulations	3	2		60	40	100	3
11	MSCPB02C09	Practical 3: Programing Lab II – Python programing and Biomolecular simulations			3+3	60	40	100	2
	Elective courses (4/5)								
12	MSCPB02E03	Structural Biology	3	2		60	40	100	3
13	MSCPB02E04	Advanced Algorithms in Computational Biology	3	2		60	40	100	3
14	MSCPB02E05	Molecular Biology	3	2		60	40	100	3
15	MSCPB02E06	Immunology	3	2		60	40	100	3

16	MSCPB02E07	Ethics, Patency and Intellectual Property Rights	3	2		60	40	100	3

Semester III
Core (Theory: 4 Practical :2) Electives: 2
Credits: Core: 16 Elective: 6 Total: 22 Credits
Students have to choose Two Electives from Four

Sl. No.	Course Code	Title of the course	Contact hours/week			Marks			Credits
			L	T/S	P	ESE	CE	Total	
	Core courses								
17	MSCPB03C10	Genomics and Proteomics	3	2		60	40	100	3
18	MSCPB03C11	Systems Biology	3	2		60	40	100	3
19	MSCPB03C12	Cheminformaticsand Computer Aided Drug Design	3	2		60	40	100	3
20	MSCPB03C13	Programming in Java andBiojava	3	2		60	40	100	3
21	MSCPB03C14	Practical 4: Genomics, Proteomics andCheminformatics			3+3	60	40	100	2
22	MSCPB03C15	Practical 5: Programming lab III–JavaandBiojava			3+3	60	40	100	2
	Elective courses (2/4)								
23	MSCPB03E08	Enzymology	3	2	0	60	40	100	3
24	MSCPB03E09	Biotechnology in Medicine, Health, Agriculture and Environment	3	2	0	60	40	100	3
25	MSCPB03E10	Recombinant DNATechnology	3	2	0	60	40	100	3
26	MSCPB03E11	Environmental Microbiology	3	2	0	60	40	100	3

Semester IV
Courses: Core: 1 Credits: 16

Sl. No.	Course Code	Title of the course	Contact hours/week			Marks			Credits
		Core	L	T/S	P	ESE	CE	Total	
27	MSCPB04C16	Research and Dissertation		5	25	60	40	100	**16**

The continuous evaluation of the project work shall be done by the research supervisor based on the performance of the student in the lab. The end semester evaluation consists of a presentation and a viva voce based on the project.

SEMESTER I

(Total Credits Required:22)

MSCPB01C01: BIOCHEMISTRY
3 CREDITS (48 Hours)

Course Objectives:

1. Understand structure and function of biological macromolecules.

2. Understand Chemical changes taking place in the living cells.

3. Understand transport across biological membranes.

4. Understand the role of small molecules in the biological system.

Course Outcome:

Upon completion of this course, students will be able to explain and demonstrate the structure, function and dispersal of the basic building blocks of life-the chemical components of living organisms

Course Content:

Module I

Introduction: Molecular logic of living system, Biological macromolecules. Importance of Biochemistry in contemporary medicine and its perspectives. Membranes: Structure and functions of different membranes and reasons for their composition. Membrane transport: Passive transport, co-transport, anti-port, active transport, secondary active transport, Pumps and channels and their significance, Membrane proteins. **(10 Hrs)**

Module II

Carbohydrates: Definition and classification, Structure, conformation and functions of monosaccharides, disaccharides, polysaccharides. Starch, glycogen, dextrin, cellulose, amino sugars, Glycoproteins, Glycolipids, Mucopolysaccharides. Lipids: Definition and classification, structure, function, physical and chemical properties –Fatty acids, Fats, Waxes, Phospholipids, Sphingolipids, Cerebrosides, Gangliosides, Sterols, lipoproteins. Eicosanoids -Formation of prostaglandins; prostacyclin and thromboxane from unsaturated fatty acids, Saponification number, acid number and iodine number of fats. **(14Hrs)**

Module III

Proteins: Properties of peptides and proteins, Amino acids, their properties, and their classification according to the polarity of their sidechains and according to the acid-base properties. Essential and non-essential amino acids, Structure of peptides and proteins, their primary structure, structures of higher order and their meaning for the function of peptides and proteins. Protein-protein interaction. Nucleic acids: Definition and classification, structure, function, physical and chemical properties -Purines and pyrimidines, base pairing, Hoogsteen base pairing. **(12Hrs)**

Module IV

Vitamins and minerals: chemistry, source and functions of water soluble and fat-soluble vitamins. Role of vitamins as cofactors. Source and functions of macro elements and trace elements, Hormones & Related Molecules: Chemistry, synthesis and functions of various hormones (Plant & Animal), pigments (Plant& Animal), Pheromones and neurotransmitters **(12Hrs)**

References

1. Lehninger's Principle of Biochemistry. Nelson L D and M M Cox.

2. Biochemistry. Jeremy M.Berg John and TymoczkoLubertStryer.

3. Biochemistry with Clinical Correlation. Thomas M Devlin. Wiley- Liss

4. Biochemistry. Donald Voet, Judith G Voet, Charlottewpratt. John Wiley

5. Biochemistry. JeoffreryZubay. Wm C Brown Pub.

6. Biochemistry. Mathews CK and KE.vanHolde. Benjamin Cumming Pub.

7. Biochemistry. Vol 1&2 David Metzler.

MSCPB01C02: BIOLOGICAL DATABASE MANAGEMENT SYSTEMS
3 Credit Course (48 hours)

Course objectives:

1. To understand basics theory and practice of database management systems
2. To understand relational model
3. To give an overview of SQL and data mining
4. Understand different biological databases

Course outcomes:

Upon completion of this curse, students will be able to understand the database management systems, collecting and retrieving data, and different biological databases.

Course content:

Module I

Introduction to databases: Traditional file system, data and need for information, database approach, data models, Database languages, Database users, Classification of database systems, Database Design - Overview of the Design Process, Entity-Relationship Model, ER Diagrams, Data Storage and Querying, Transaction Management, Database Architecture, Database Users and Administrators **(11 hrs)**

Module II

Introduction to Relational model: Basic concepts: Domains Attributes, keys, tuples, Relations, Relational database schemas, Relational Database Design: Features of Good Relational Designs, Atomic Domains and First Normal Form, Decomposition Using Functional Dependencies, Functional-Dependency Theory, Algorithms for Decomposition, Decomposition Using Multivalued Dependencies, More Normal Forms, Modeling Temporal Data. **(11 hrs)**

Module III

Structured Query Language**:** Overview of the SQL Query Language, SQL Data Definition, Basic Structure of SQL Queries, Additional Basic Operations, Set Operations, Null Values, Aggregate Functions, Nested Subqueries, Modification of the Database. Introduction to Data mining: Classification, Clustering, Data Warehousing, Applications of Data Mining. **(11 hrs)**

Module IV

Biological databases: Primary, secondary and composite databases. Types of Biological data: sequence: structure, function, literature, Nucleotide sequence databases-GenBank, EMBL, DDBJ. Genome databases, Protein Sequence Databases- UniProtKB, UniProt, TrEMBL, Swiss-Prot, UniProt, Secondary and composite databases: MMDB, SCOP, CATH, KEGG ENZYME, BRENDA, Prosite, ProDom, Pfam, InterPro; Metagenomic and Environmental Sequences-UniMES. Literature Databases- PubMed, PLos, BioMed Central. Database file formats and retrieval system: GenBank, FASTA, ALN/ClustalW2, PIR; Text-based search engines (Entrez, DBGET/LinkDB). Biological Database Management -Introduction to Biological Data Integration, challenges faced in the integration of Biological Information. **(15 hrs)**

References

1. Database System Concepts by Henry F. Korth, Abraham Silberschatz, S. Sudarshan, Tata Mac-Graw Hill.
2. An Introduction to Database Systems by C.J. Date, Addison-Wesley.
3. Introduction to Database Systems, Itl Education Solutions Limited, Pearson Education

4. Introduction to Database Management Systems, AtulKahate, Pearson Education India
5. N. Gautham; Bioinformatics: Databases and Algorithms; Alpha Science.
6. D. W. Mount; Bioinformatics Sequence and Genome Analysis; Cold Spring Laboratory Press.
7. F. J Burkowski; Structural Bioinformatics: An Algorithmic Approach; CRC Press.
8. A. M Lesk; Introduction to Bioinformatics; Oxford University Press.
9. J. Bedell, I. Korf and M. Yandell; BLAST; O'Reilly Press.
10. J. M. Keith; Bioinformatics Vol. 1, Data, sequence analysis & evolution; Humana Press.
11. R. Durbin; Biological sequence analysis; Cambridge University Press.
12. R. M. Holmes; A cell biologists' guide to modeling and bioinformatics; WileyInterscience.

MSCPB01C03: BASICS OF COMPUTING
3 Credits Course (48 hours)

Course objectives:

1. Understand the hardware organization of digital computers and operating systems
2. Understand basics of computer networking
3. Understand basics of HTML
4. Understand basics of computer programing

Course outcome:

Students shall be able to

1. Explain the functioning of computer hardware and operating system
2. Explain the functioning of networking and data communication
3. Understand the basics web designing
4. Write simple computer programs using R

Course content:

Module I

Fundamentals of Computing: Introduction to computer, Operation of processor; Number Systems and Digital Circuits; ALU; Memory Chips (ROM, RAM, DRAM), Storage Devices, Memory Hierarchy; I/O Devices; Moore's Law, Classification of computers (Notebook, Personal Computers, Workstation, Mainframes, Minicomputers, Microcomputers, Supercomputers). Introduction to operating systems: Characteristics and Types of Operating system like DOS, windows XP, Window-NT**,** LINUX. Introduction to Computer Viruses.**(10 hrs)**

Module II

Computer Networking:OSI reference model, Network Topologies, Router, Switch, Network cards, Data Communication (ISDN, Cable Modem, Wireless Modem), Concept of Wireless networking, LAN, WAN, MAN, Security of the network, Firewalls, TCP/IP family of protocols**,** Concepts of client Server Architecture, Concept of search Engine - Database search engines. Introduction to Internet, World Wide Web, Advantages of Web, Web Terminology, Concepts of Domain, Concept of Web Browser, Internet Services, Internet Tools. Telnet, FTP. **(12 hrs)**

Module III

HTML: Introduction, common tags, creating hyperlinks, incorporation of images; Tables; Frames; Formatting of text with fonts; Dynamic HTML; cascading style sheets; Creation of Background images, HTML object models; dynamic positioning; direct animation path control. **(12 hrs)**

Module IV

Introduction to programming: The basic model of computing, algorithm and flow charts, programming languages, compilation, linking, testing, debugging and documentation. Introduction to R programing.**(14 hrs)**

References

1. Gurvinder Singh, Rachhpal Singh. A Textbook on Windows Based Computer Courses, Kalyani Publishers, Jalandhar
2. Rachhpal Singh, MamtaVerma, Sonia Mahindru. A Textbook of Scripting Language and Web Designing, Kalyani Publishers, Jalandhar
3. Kapila H. PC Computing Window Based Computer System. Dinesh Publishers, Jalandhar.
4. Norton’s P. Introduction to Computing. McGraw Hill Education, New Delhi.
5. Sinha P.K. Fundamental of Computers. BPB Publication, New Delhi.
6. E. Siever; Linux in a Nutshell; O’Reilly Publication, 6th edition, 2009.
7. L. Robert; Linux System Programming; Shroff Publishers and Distributors Private Ltd, 2nd revised edition, 2014.
8. M. J. Bach; The Design of the UNIX Operating System; Pearson Education India, 1st edition, 2015.

MSCPB01C04: BIOSTATISTICS
3 Credits (48Hours)

Course objectives:

1. Understand data types and data presentations.
2. Understand the concepts of averages and dispersion of measurement values.
3. Understand the concept of probability and probability distributions.
4. Understand the method of testing statistical hypotheses.

Course outcomes:

Students shall be able to

1. Make graphical/diagrammatic representation of given statistical data.
2. Calculate measures of central tendencies and measures of dispersion of a given set of values.
3. Explain different probability distributions.
4. Test hypothesis using normal, students-t, chi square and F distributions.

Course content:

Module I

Collection, classification and diagrammatic representation of statistical data: Variables and constants, Different types of numerical data, Collection of data, Sampling techniques, Random sampling, Stratified random sampling. Classification and tabulation of data, frequency distribution. Graphical/diagrammatic representation of data: line charts, Bar charts, Pie-chart, Histograms, frequency polygons, ogives. **(12 hrs)**

Module II

Measures of central tendency: Arithmetic mean, Median, Mode, Geometric and Harmonic mean. Measures of dispersion: Range, Inter-quartile range, Variance and Standard Deviation, coefficient of variation. Correlation and Regression: Relation between two variables, scatter diagram, definition of correlations, Pearson's correlation coefficient, Spearman Rank correlation coefficient. Definition of regression: regression lines. Fitting lines using method of least squares. (**14 hrs)**

Module III

Probability and probability distributions: Permutation and combination, types of events, Definition of probability, addition and multiplication theorems of probability. Probability distributions: Binomial, Poisson and Normal distributions. Skewness and Kurtosis: Definitions, Karl Pearsons coefficients of Skewness and Kurtosis, moments. **(10 hrs)**

Module IV

Normal distribution and statistical inference: Central Limit Theorem, Concept of confidence interval: Estimation, confidence limit, level of significance, standard error. Statistical hypotheses, Tests of significance of means, difference between two means and proportion. Student's t-distribution and testing of hypothesis for small samples.Chi-square distribution, Chisquared tests for independence and for goodness of fit, F-distribution and Analysis of variance.**(12 hrs)**

References

1. Principles of Biostatistics -PaganoM. &Kimberlee G. Duxbury Press
2. Probability and Statistical Inference-Hogg R. V. Tanis E. A., Prentice Hall, New Jersey
3. Experimental Design Data Analysis for Biologists-QuinnG. P. &KeoughM. J. Cambridge University7 Press
4. Statistical Methods in Biology -3rdedition, BaileyN.T.J., Cambridge University Press
5. Biostatistical analysis -4th edition,Zar, J.H. Pearson Education.
6. Fundamentals of Biostatistics –P.HanmanthRao and K. Janardhan,I.K. International Publishing House, New Delhi.
7. Introduction to Biostatistics and Research Methods-P.S.S. SundarRaoandJ.Richard, PHI learning PvtLtd, New Delhi.

MSCPB01C05: Practical 1
Biochemistry and Biological Databases
2 Credits (96 Hours)

Biochemistry

1. Qualitative analysis of carbohydrates.
2. Qualitative analysis of proteins.
3. Qualitative analysis of lipids.
4. Estimation of protein.
5. Estimation of lipids (cholesterol, phospholipids, triacylglycerols).
6. Estimation of carbohydrates (glucose, fructose, lactose, starch).
7. Denaturation studies on proteins.
8. Extraction of total nucleic acids from plant tissue.
9. Preparation of buffers of required pH.
10. Purification of proteins using dialysis.
11. Separation of amino acids using paper chromatography.

References

1. David Plummer, An Introduction to Practical Biochemistry, McGraw Hill
2. Harold Varley, Practical Clinical Biochemistry, by Gowenlock A. H., CBS.
3. Hans Bisswanger, Practical Enzymology. Wiley VCH.
4. Robert Eisenthal, Enzyme Assays: A Practical Approach, Oxford University Press
5. Sadasivam&Manickam, Biochemical Methods, New Age International
6. DM Vasudevan&Subir Kumar Das, Practical Textbook Of Biochemistry, Jaypee Brothers
7. SK. Sawhney, Randhir Singh, Introductory Practical Biochemistry. Alpha Science International

Biological Database

1. Make list of Biological databases for DNA and protein by browsing search engines.
2. Visit NCBI, EMBL, and DDBJ. Explore them, List out the salient features of these databases. Retrieve the gene sequences by exploring and querying the nucleic acid databases, Retrieve the protein sequences by exploring and querying the protein databases, Find the chromosomal location of gene sequence and basic experiments in NCBI map viewer
3. Exercises to understand DBMS: Creating and working with databases, creating tables, dropping tables, primary and secondary keys, data validation, cursors, stored procedures. Oracle/PosGreSQL - Usage of important commands/instructions.

References

1. Database System Concepts by Henry F. Korth, Abraham Silberschatz, S. Sudarshan, Tata Mac-Graw Hill.
2. An Introduction to Database Systems by C.J. Date, Addison-Wesley.
3. Introduction to Database Systems, Itl Education Solutions Limited, Pearson Education
4. Introduction to Database Management Systems, AtulKahate, Pearson Education India
5. N. Gautham; Bioinformatics: Databases and Algorithms; Alpha Science.
6. D. W. Mount; Bioinformatics Sequence and Genome Analysis; Cold Spring Laboratory Press.
7. F. J Burkowski; Structural Bioinformatics: An Algorithmic Approach; CRC Press.
8. A. M Lesk; Introduction to Bioinformatics; Oxford University Press.
9. J. Bedell, I. Korf and M. Yandell; BLAST; O'Reilly Press.
10. J. M. Keith; Bioinformatics Vol. 1, Data, sequence analysis & evolution; Humana Press.
11. R. Durbin; Biological sequence analysis; Cambridge University Press.
12. R. M. Holmes; A cell biologists' guide to modeling and bioinformatics; Wiley Interscience.

MSCPB01C06: Practical 2
Programming lab I – Basic Computing and Application ofR Programming
2 Credits (96 hours)

Basic Computing

1. Introduction to operating systems (DOS, Windows, Linux etc) and their installation.

2. Basic DOS commands, Basic of Linux commands and Shell scripting
3. Network configuration in windows and Linux through Network Interface Card (NIC), Working with Telnet and FTP
4. Exercises on HTML - Design a simple web page using basic tags, Design a simple web page using frameset, Design a simple web page using Image tag with attributes, Design simple login page using form with attributes, Design simple registration form using all form tags, Design simple website using hyperlink

References

1. Gurvinder Singh, Rachhpal Singh. A Textbook on Windows Based Computer Courses, Kalyani Publishers, Jalandhar
2. Rachhpal Singh, MamtaVerma, Sonia Mahindru. A Textbook of Scripting Language and Web Designing, Kalyani Publishers, Jalandhar
3. Kapila H. PC Computing Window Based Computer System. Dinesh Publishers, Jalandhar.
4. Norton's P. Introduction to Computing. McGraw Hill Education, New Delhi.
5. Sinha P.K. Fundamental of Computers. BPB Publication, New Delhi.
6. E. Siever; Linux in a Nutshell; O'Reilly Publication, 6th edition, 2009.
7. L. Robert; Linux System Programming; Shroff Publishers and Distributors Private Ltd, 2nd revised edition, 2014.
8. M. J. Bach; The Design of the UNIX Operating System; Pearson Education India, 1st edition, 2015.

Applications of R Programming

1. R software installation and basic R usage
2. Mathematical operations and string manipulation
3. Basic data structures: Vectors, data frames, lists and matrices
4. Logical statements and loops: IF-else statements, for and while loops, break
5. Writing user defined functions and packages
6. Reading and writing tables and files
7. R graphics library: Line plots, histograms, pie charts, bar plots and other plots
8. Computation of statistical parameters

References

1. Bioinformatics with R Cookbook. Paurush Praveen Sinha, Packt Publishing. 2014
2. Andrie de Vries, JorisMeys. R For Dummies. Wiley. 2015
3. John Verzani. Using R for Introductory Statistics. CRC Press 2018
4. Robert Gentleman. R Programming for Bioinformatics. CRC Press 2018
5. Edward Curry. Introduction to Bioinformatics with R - A Practical Guide for Biologists. CRC Press 2020
6. Dr. Mark Gardener: Beginning R- The Statistical Programming Language. Wiley 2012
7. Dan MacLean. R Bioinformatics Cookbook. Packt Publishing 2019

MSCPB01E01: CELL BIOLOGY AND GENETICS

3 Credit Course(48 hours)

Course objectives:
1. Understand the organization of living cells and its organelles
2. Understand the structure and replication of DNA
3. Understand the flow of genetic information through generations
4. Understand the function of genes

Course outcomes:
1. Students will understand the molecular mechanisms in a cell
2.Students will appreciate the genetic basis of existence and evolution

Course content:

Module I
General organization of prokaryotic and eukaryotic cells.Differentiation of the cell surface, Constituents of the Extra-cellular matrix.Cell junctions.Cytoskeleton. Cell communication: general principles, signaling pathways. Cellular Organelles, processing and trafficking of biomolecules, posttranslational modification of proteins. (**10 Hrs)**

Module II
Nucleus: Nuclear envelope, nuclear matrix. Organization of chromatin: nucleosomes, higher order folding of chromatin. Replication of prokaryotic, eukaryotic DNA.Enzymes and proteins of replication.DNA repair. Cell cycle: Phases of cell cycle. Apoptosis and Introduction to Cancer biology. (**14 Hrs)**

Module III
Introduction, concepts and theories of Mendelian genetics.Multiple alleles.Gene interactions.Essential and lethal genes.Environmental impact on gene.chromosome theory of inheritance,
Non -Mendelian Inheritance, Genetic linkage.Chromosomal exchange.Genetic maps.Tetrad analysis, Mitotic recombination.Chromosomal and gene mutations. Mitosis & Meiosis – an overview. Chromosome theory of inheritance.Sex determination.Analysis of sex-linked traits in humans**. (8 Hrs)**

Module IV
Cellular basis of differentiation, Genetic basis of cell differentiation.Gene expression control.Oncogenes and tumor suppressor genes.Mapping of genes in bacteria.Mapping of genes in bacteriophages.Bacterial transposons.Eukaryotic Transposable elements Cytosomic inheritance, Inheritance through mitochondria and chloroplasts and their mapping.Genetic variation in populations and measuring.Hardy -Weinberg Equilibrium, Inbreeding.Genetic Drift.Gene flow.Natural selection.Molecular evolution.**(16 Hrs)**

References

1. Molecular Cell Biology Gerald Karp 9th Edition Wiley 2020
2. Molecular Biology of The Cell Alberts 6th Edition 2014 Garland Science

3. Molecular Cell Biology Lodish 8[th Edition]. W.H. Freeman 2016
4. Genes XI Benjamin Lewin Jones and Bartlett Learning2014
5. Molecular Biology of the Gene Watson 7thEdition Pearson India 2017.
6. Genetics by Strick Berger
7. Plant breeding by B D Singh
8. A textbook of Genetics by Veer BalaRastogi
9. Genetics by Gardner, Simmons and Snustad
10. Genetics by Ursula Goodenough
11. Basic Genetics. Robert F. Weaver II edn. Philip W.C. B 1995.
12. An Introduction to genetic Analysis Griffith *et al.*

MSCPB01E02: INSTRUMENTATION
3 Credits (48 Hours)

Course objectives:

8. Understand basic principles and applications of biomolecular separation techniques.
9. Understand basic principles and applications of spectrophotometric, colorimetric and radioactivity based analytical techniques.
10. Understand spectroscopic techniques for characterization of biological molecules.
11. Understand various analytical techniques based on intermolecular interactions

Course outcomes:

Students shall be able to

1. Explain working principles and applications of biomolecular separation techniques such as chromatography, electrophoresis, centrifugation and density gradient sedimentation.
2. Explain the principles and applications of colorimetry, fluorometry, flame photometry, radioimmunoassay and autoradiography.
3. Explain the principles and applications of UV, IR, ORD, CD, NMR, ESR, Microwave, Raman and Mass spectroscopic techniques.
4. Explain the principles and applications of Surface Plasmon Resonance, Isothermal Titration Calorimetry, Differential Scanning Calorimetry, Atomic force microscopy, ELISA and ion selective electrodes.

Course content:

Module I

Centrifugation and density gradient sedimentation: Basic principles and applications. Chromatography: Basic principles and applications, partition coefficient and relative mobility, Types of chromatography: paper, thin layer, size exclusion, ion exchange, affinity, GLC, HPLC, HPTLC. Electrophoresis: Basic principles and application. Various types of electrophoresis, PAGE, Specialized electrophoresis techniques, Isoelectric focusing, Capillary electrophoresis. Immunoelectrophoresis, PFGE. (**14 hrs)**

Module II

Spectrophotometry and colourimetry: Absorption and emission spectrum, Beer-Lambert law, qualitative and quantitative spectrophotometric assays, Fluorescence and fluorometry, flame photometry, Radioimmunoassay and Autoradiography. **(10 hrs)**

Module III

Spectroscopic techniques: Basic principles and biological applications of UV, IR, ORD, CD, NMR, ESR, Microwave and Raman spectroscopies. Mass spectrometric techniques: various modes of ionization principles and applications. GCMS, LCMS, MALDI. (**12 hrs)**

Module IV

Principles and applications of Surface Plasmon Resonance, Isothermal Titration Calorimetry, Differential Scanning Calorimetry, Atomic force microscopy, ELISA, Light scattering experiments. Ion selective electrodes and pH meter. **(12 hrs)**

References

1. Physical biochemistry - David Seeshan
2. Chromatography-Brown D.R., Ivy Publishing House, Delhi.
3. Encyclopedia of Separation Technology -Ruthren D. M. (Ed), John Wiley & Sons
4. Experimental Biochemistry-3rd edition, Switzer, R. L. &Garrity, L. F. W.H. Freeman & Company
5. Foundations of Spectroscopy - Duckett, S. & Gilbert, B., Oxford University Press.

SEMESTER II
(Total Credits Required:20)

MSCPB02C07: SEQUENCE ANALYSIS
3 Credit Course(48 hours)

Course objectives:

1. Understand different formats of DNA and protein sequences, their submission and retrieval
2. Understand the theory and applications of dynamic programming
3. Understand the method of sequence alignments
4. Understand the gene and protein prediction from DNA sequences

Course outcomes:
On successful completion of the course, the students shall be able to
1. Explain different sequences and their formats, search and align using online tools.
2. Explain the method of Dynamic Programming
3. Explain principle of different sequence alignment methods
4. Use different multiple sequence alignment tools for analysis of sequences.

Course content:

Module I
Collecting and Storing Sequence Data: Genomic Sequencing; Sequence assembly; Submission of Sequences; Sequence accuracy; Sequence databases; Sequence formats; Conversion between formats; Database browsers; EST databases; SNP databases; Annotation and Archival, Database Searching- FASTA, BLAST.**(11 hrs)**

Module II
Dynamic Programming - Overview and structure, examples, shortest path, Dynamic Programming in Computational Biology applications – longest common sub-sequence, Pairwise sequence alignment: Identity and Similarity, Basic concepts of sequence alignment, local and global alignment, Needleman and Wunsch, Smith and Waterman algorithms for pairwise alignments. Methods of alignment.Dot plot, scoring alignment, gap penalty. Substitution

matrices: PAM and BLOSUM series, matrix derivation methods and principles. **(13 hrs)**

Module III

Multiple sequence alignments (MSA) –The need for MSA, basic concepts of various approaches for MSA (e.g. progressive, hierarchical etc.).Algorithm of CLUSTALW and PileUp and application, concept of dendrogram and its interpretation, Use of HMM-based Algorithm for MSA (e.g. SAM method). Applications of MSA in Genome sequencing, phylogenetic analysis, pattern identification, motif and domain prediction, SNP analysis, gene prediction: statistical and similarity based, ORF and codon usage analysis, translational and transcriptional signals; splice site identification. **(13 hrs)**

Module IV

Nucleic Acid Sequence Analysis: Reading frames; Codon Usage analysis; Translational and transcriptional signals; Splice site identification; Gene prediction methods; RNA fold analysis. Protein Sequence Analysis: Compositional analysis; Hydrophobicity profiles; Amphiphilicity detection; Moment analysis; Transmembrane prediction methods; Secondary structure prediction methods**. (11 hrs)**

References

1. Bioinformatics: Sequence and Genome Analysis by Mount D., Cold Spring Harbor Laboratory Press, New York. 2004
2. Bioinformatics- A Practical Guide to the Analysis of Genes and Proteins by Baxevanis, A.D. and Francis Ouellellette, B.F., Wiley India Pvt Ltd. 2009
3. Introduction to Bioinformatics by Teresa K. Attwood, David J. Parry-Smith. Pearson Education. 1999

MSCPB02C08: PYTHON PROGRAMMING AND BIOMOLECULAR SIMULATIONS

3 Credits (48 hours)

Course objectives:

1. Understand programming using Python and Biopython and its applications.
2. Understand the parameters determining the structure and stability molecules.
3. Understand dynamics of molecular systems and energy minimization techniques.

Course outcomes:

On successful completion of the course students shall be able to

1. Write small programs in Python
2. Do different bioinformatic operations using Biopython scripts
3. Explain biomolecular simulation techniques

Module I
Introduction to Python, Print and Variables, Simple data types, Collections: Lists, Strings, Sets and Dictionaries, Functions, Conditional execution, Loops, Files, Delimited Files, Modules and Packages.

Module II
Object Oriented Programming Concepts, Exception Handling, Regular Expression, Biopython: Introduction, Bio.Seq and Bio.SeqRecord modules, Using Seq class, Sequences reading and Writing, Bioclasses for sequences, Bio.SwissProt.SProt and Bio.WWW.ExPASy, Reading Entries, Regular expressions in Python, Prosite, Bio.GenBank, Reading entries, Running Blast and Clustalw, Running other bioinformatics programs under Pise

Module III
Introduction - theoretical approaches to biomolecular structures. QM foundations (an overview), Born-Oppenheimer approximation, Molecular Mechanics: Force fields – Introduction, Normal Modes, Potentials – bond stretching, Angle bending, Torsional terms – improper torsions, Non-bonded - Lennard-Jones, Coulomb, Hydrogen-bonding in MM, United atom force fields and reduced representation. Force field- GROMOS87, OPLS, AMBER, CHARMM

Module IV
Energy minimization –Steepest Descent and Conjugate Gradient. Molecular Dynamics (MD) Simulation: Introduction, Phase Space, Periodic boundary conditions, Minimum image convention, Newtonian dynamics, Time Integrators- Leapfrog and Verlet algorithm, Water models, Constraint dynamics, Various MD ensembles, Simulated annealing

References

1. Mark Lutz, David Ascher (2003) Learning Python. O'Reilly & Associates
2. Alan Gauld (2000) Learn To program Using Python Addison –Wesley
3. AlexMartelli (2003) Python in a Nutshell, O'Reilly
4. URL: http://www.python.org
5. URL: http://www.biopython.org
6. Molecular Modeling Principles and Applications (2nd Ed.) by Andrew R. Leach, Prentice Hall, USA. 2001
7. Molecular Modelling for Beginners, (2nd Edition) by Alan Hinchliffe, John Wiley & Sons Ltd. 2008
8. Molecular Modeling and Simulation – An interdisciplinary Guide by Tamar Schlick, Springerverlag. 2000

MSCPB02C09: Practical 3
Programming Lab II- Python programming and Biomolecular simulations
2 Credits (96 Hours)

Pythonprograming

1. Print and Variables

2. Simple data types, Arithmetic and Saving code in files
3. Collections: Lists and Strings
4. Collections: Sets and Dictionaries
5. Conditional execution
6. Loops
7. Files and Delimited Files
8. Modules
9. Object Oriented Programming Concepts
10. Exception Handling
11. Regular Expression
12. Biopython - Handling Sequences with BioPython, Sequence Alignment, Difference Between Sequence Similarity and Sequence Identity, BLAST, Example with sequence analysis of viral DNA/RNA

References

1. Mark Lutz, David Ascher (2003) Learning Python. O'Reilly & Associates
2. Alan Gauld (2000) Learn To program Using Python Addison –Wesley
3. AlexMartelli (2003) Python in a Nutshell, O'Reilly
4. URL: http://www.python.org
5. URL: http://www.biopython.org

Biomolecularsimulations

1. Molecular Visualization: Pymol and VMD
2. Structure preparation
3. Energy minimization
4. Molecular dynamics (MD) simulation – restrained and unrestrained MD
5. Analysis of MD trajectories

References

1. Molecular Modeling Principles and Applications (2nd Ed.) by Andrew R. Leach, Prentice Hall, USA. 2001
2. URL: http://www.mdtutorials.com/gmx/

MSCPB02E03: STRUCTURAL BIOLOGY
3 Credits (48 hours)

Course objectives:

1. Understand the structure and conformations of DNA
2. Understand the Protein structure and folding
3. Understand theory and methodology of protein crystallography
4. Understand different methods of protein structure prediction.

Course outcomes:

On successful completion of the course students shall be able to

1. Explain the structure and conformation of different forms of DNA
2. Explain different levels of protein structure and protein folding pathways
3. Explain different steps used to elucidate the structure of protein using crystallography
4. Explain the principle of protein structure prediction

Course content:

Module I

Nucleic acid structures: Conformation of nucleotides, Watson-Crick model of DNA, base pairing and base stacking interactions. DNA polymorphism- ADNA, BDNA and ZDNA.t-RNA structure. **(12 hrs)**

Module II

Protein Structure: Primary structure, peptide bonds, Secondary structure; Alpha helices, Beta sheets and turns, Ramachandran plot, motifs and domains, tertiary and quaternary structures, Membrane proteins, Virus structure. Protein folding: Forces stabilizing macromolecular structures, Thermodynamics of folding, driving forces, folding pathways, Molten globular structures. Folding accessory proteins.**(12 hrs)**

Module III

Protein Crystallization: Principles of protein crystallization, Crystallization techniques: vapour diffusion method, liquid-liquid diffusion method, batch method, dialysis. Elementary crystallography: Unit cells, symmetry elements and operations, point groups and space groups, crystal systems, Bravais lattices, Bragg's law, Atomic scattering factor, structure factor, Fourier Transform. Crystal diffraction and data collection Steps in crystal structure determination: Data collection- x-ray sources, detectors. Structure solution-Phase Problem, Patterson function, Direct methods, Molecular replacement method, heavy atom method. Refinement and validation of structures **(12 hrs)**

Module IV

Protein structure prediction: Chou Fasman method, GOR method, Threading, Homology modeling, Ab initio prediction, Visualization and related bioinformatics tools: Swiss PDB Viewer, Pymol. AA CompIdent, MultiDent, Peptide Mass. **(12 hrs)**

References

1. Biological thermodynamics - Donald T. Haynie, Cambridge University Press, Cambridge.
2. Biopolymers - A. G. Walson and J. Blackwell, Associated Press.
3. Essentials of Biophysics - P. Narayanan, New Age International publishers
4. Introduction to Protein Structure - C. Branden and I. Tooz. , Garland Press, New York
5. Principles of Protein Structure - G.E.Schulz&R.H.Schirmer, Springer Verlag, Berlin.
6. Principles of Nucleic Acid Structure - W. Saenger,

7. Protein Folding - Thomas E. Creighton (Ed),
8. Structure and Mechanism in Protein Science - Alan Fersht
9. Biophysical Chemistry- Part I, II, III - Charles R. Cantor and Paul R. Schimmel, W.H. Freeman & Company, New York.

MSCPB02E04: ADVANCED ALGORITHMS IN COMPUTATIONAL BIOLOGY
3 Credits (48 hours)

Course objectives:
1. Understand various algorithms used in computational biology
2. Understand the basics of Hidden Markov Model and its application in sequence alignment
3. Understand the basics of Support Vector Machines and its application in bioinformatics
4. To introduce the basics of machine learning techniques

Course outcomes:
On successful completion of the course, students shall be able to

1. Explain the concepts of various computing algorithms
2. Detail the Hidden Markov Model, Support Vector Machines, and their applications
3. Explain the concepts of Artificial Neuron Networks and other concepts in machine learning techniques

Course content

Module I
Algorithms in Computing: Biological and Computer algorithm, Fibonacci problem, Dynamic Programming, Time and space complexity of algorithms, Laplace's Rule. Search Algorithms: Random walk, Hill climbing, simulated annealing. Genetic Algorithm: Basic Concepts, Reproduction, Cross over, Mutation, Fitness Value, Optimization using GAs; Applications of GA in bioinformatics. Combinatorial Pattern Matching: Hash Tables, Repeat Finding, Exact Pattern Matching

Module II
Hidden Markov Model: Markov processes and Markov Models, Hidden Markov Models.Forward and Backward Algorithms. Most probable state path: Viterbi algorithm, Parameter Estimation for HMMs: Baum-Welch Algorithm, Applications of profile HMMs for multiple alignment of proteins and for finding genes in the DNA.

Module III

Support Vector Machines: Introduction, hyperplane separation (maximum and soft margin hyperplanes), linear classifier, Kernel functions, Large Margin Classification, Optimization problem with SVM, Applications of SVM in bioinformatics. Bayesian network: Bayes Theorem, Inference and learning of Bayesian network, BN and Other Probabilistic Models.

Module IV

Introduction to machine learning techniques: Artificial Neural Network concepts, Perceptron, characteristics of neural networks terminology, models of McCulloch – Pitts neuron model, Perceptron, Adaline model, Basic learning laws, Topology of neural network architecture, single layer ANN, multilayer perceptron, back propagation learning, input-, hidden-, and output- layer computation, back propagation algorithm, Applications of ANN -secondary structure prediction

References

1. An introduction to bioinformatics algorithms by Neil C. Jones, PavelPevzner. MIT Press.2004
2. Biological sequence analysis: Probabilistic models of proteins and nucleic acids by Richard Durbin, Eddy, Anders Krogh, 1998
3. Algorithms for Molecular Biology by Ron Shamir Lecture, Fall Semester, 2001
4. Neural Networks: A Systematic Introduction by Raul Rojas. Springer. 1996
5. Bioinformatics: the machine learning approach by Pierre Baldi, SørenBrunak. MIT Press.2001
6. Benson G. and Page R. D.M. (2003). Algorithms in Bioinformatics. *Springer.*
7. Michael Waterman, Chapwan& Hall/CRC, (2000). Introduction to Computational Biology-Maps, sequences and genomes.
8. PavelA.Pevzner (2000), Computational Molecular Biology- An Algorithmic Approach, *MIT Press.*

MSCPB02E05: MOLECULAR BIOLOGY
(3 Credits) (48Hours)

Course Objectives:

1. Understand the organization of genome.
2. Familiarize with cellular processes like transcription and translation
3. Study the methods to measure the level of expression of RNA and protein.
4. Understand regulation of gene expression

Course Outcome:

Familiarize the student with the mechanisms and components involved inexpression of genes in prokaryotic and eukaryotic systems.

Course Content

Module I

The genome: Content, Mapping (Linkage, Restriction cleavage, Sequencing), Variations, Repetitive and Non-repetitive sequences, Organelle DNA – Mitochondrial and Chloroplast. Genome sequences and Gene numbers. Transcription in Prokaryotes -Biosynthesis of RNA, Enzymatic machinery, Promoter selection and role of RNA Polymerase and ancillary factors. **(12Hrs)**

Module II

Transcription in eukaryotes: RNA polymerases, Eukaryotic promoter structure, enhancer elements and transcription factors, transcriptionally active chromatin, biosynthesis of ribosomal, transfer and messenger RNAs. Post transcriptional modifications, transfer and messenger RNAs, antibiotic inhibitors of transcription. Gene silencing. **(12Hrs)**

Module III

Protein synthesis: Genetic code and gene protein relationships, nonsense and missense mutations and suppressers, ribosome structure (prokaryotic and eukaryotic) mRNA structure, polycistronic v/s monocistronic, specificity of aminoacyltRNAsynthetases, polypeptide chain elongation and termination, factors of protein synthesis (pro & eukaryotic) and their role, inhibitors of protein synthesis and their mechanism of action, translational regulation, post-translational modification, biosynthesis of secretory proteins. **(12Hrs)**

Module IV

Regulation of gene expression, bacterialoperons (lac, gal, ara, trp, hut, etc) and viral models (T4 and T7), stringent and relaxed control, regulation in eukaryotes, chromatin activity and gene regulation. Methods, measurements of RNA synthesis and protein synthesis, complementary sequence analysis by nucleic acid hybridization including southern blotting, isolation methods for eukaryotic mRNA, identification of translation products (flurography, western blotting). Genome sequencing -chemical.Next generation sequencing.**(12Hrs)**

References

1. Lodish, H., Baltimore, D. Berk, A., Zipursky, S. L. Matsudaira, P. and Darnell. J. 1995 molecular Cell Biology, 3rd ed, W H. Freeman & Co.
2. Stent, G. S. and Calender, R. Molecular Genetics1986. An Introductive Narrative, CBS Publishers and Distributors, New Delhi.
3. Weaver, R E& Hedrick, PW.1985 Basic Genetics, WMC. Brown Publishers.
4. Alberts, B., Bray,D. Lewis, Julian, Raffn M. Roberts, K. and J. D. Watson,
5. J.D. 1994. Molecular Biology of the Cell, 3rd edn, Garland Publishing Inc..
6. Hayes, W., 1994. Genetics of Bacteria and their viruses. 2nd Edn, CBS Publishers and Distributors, New Delhi.
7. Genes XII Benjamin Lewin

MSCPB02E06: IMMUNOLOGY
3 Credits (48 Hours)

Course Objectives:

1. Understand the components and functioning of the immune system.
2. Determine the deficiencies arising out of the immune system.
3. Analyze the overreaction of the immune system.
4. Understand the methods of exploiting the specificity of the immune system for quantification, diagnosis, and immunization protocols.

Course Outcome:

1. Evaluate usefulness of immunology at the application level.
2. Apply their knowledge and design immunological experiments
3. Understand the role of immune responses in the setting of infection (viral or bacterial).

Course Content

Module I

History of the Immune system, Cells of the Immune system, Innate immune mechanisms**,** TLR, PRR, PAMP Phagocytosis, classical and alternative pathways of complement activation, regulation and functions of complement. Adaptive immunity: Properties of immunogens and antigens. Pathways of antigen processing and presentation**.** (**10Hours)**

Module II

Primary and secondary lymphoid organs, structure and cellular organization**.**Structure of immunoglobulins.Antigen binding site of antibody. Forces involved in antigen -antibody complex formation. Receptors, co-receptors and CD antigen on B cells, Generation of receptor diversity.B cell development in activation and differentiation.**(15Hrs)**

Module III

T cell development, activation and differentiation to helper, cytotoxic T cells. Signal transduction in B&T cell. Role of cytokines.Humoral and cytotoxic response, MHC complex and MHC restriction.

Introduction to Immunology of infectious diseases, Hypersensitivity and immunology of transplantation, Immuno-deficiencies, autoimmunity, immune suppression, tolerance.Tumor immunology.**(15Hrs)**

Module IV

Factors governing immunogenicity, haptens and its applications, epitopes, adjuvants.Principle and applications of Antigen-antibody interactions. Agglutination, immunodiffusion, immunoelectrophoresis, immunofluorescence, RIA and ELISA and assays for cytotoxic responses. Monoclonal Antibodies.Vaccines.**(8Hrs)**

References

1. Immunology Kuby 2019 Eighth Edition| 2019 Jenni Punt; Sharon Stranford; Patricia Jones; Judy Owen Macmillan Learning Eighth Edition
2. ImmunobiologyJaneway 2017 9thEdition Garland Science.
3. Essential Immunology. Roitt 2017 13thEdition. Wiley Blackwell

MSCPB02E07

ETHICS, PATENCY AND INTELLECTUAL PROPERTY RIGHTS

3 CREDITS (48 Hours)

Course objectives:

1. To understand how precious each life forms are, the risks associated with altering the genetic makeup of an organism and their ethical aspects.
2. To study the importance of maintaining the biosafety measures while handling with dangerous microorganism.
3. To learn the importance of maintaining the guidelines while handling the rDNA products. The essential steps to be followed to get an invention patented.

Course Outcome:
Importance of individual life forms, understanding biosafety levels, patents and patent procedures.

Course Content:

Module I
Ethical aspects of interfering in natural process, Hidden dangers in altering genetic make-up.**(3hrs**)

Module II
Patent, Objectives of Patent system and general requirement of Patent law, Patent office, Patent Office Practices, Infringement problems, Harmonization of Patent laws, International treaties on IPR, International convention for the protection of new varieties- Strasbourg convention, UPOV convention. **(15hrs)**

Module III
Patentability of micro-organism- Claims, characterization and repeatability, Deposition of Culture collection, Legal protection plants and animals, Transfer of Technology, TRIPS, FDA. **(15hrs)**

Module IV
Biosafety, Definition, Objectives, Biological Containment (BC) and Physical Containment (PC), Biosafety levels, Biosafety level1, Biosafety level 2, Biosafety level 3, Biosafety level 4.The containment laboratory design and facilities. Guidelines for rDNA research, Quality control of biologicals produced by rDNA technology. **(15hrs)**

References
1. Beir, F.K, Crespi, R.S and Straus J: 1982 Biotechnology and patent protection-Oxford and IBH Publishing Co. New Delhi.
2. Chowdhary, N. K and Aggarwal J. C: Dunkal's Proposals I. Implications for India and the third world.
3. Chowdhary, N. K and Aggarwal J. C: Dunkal's Proposals II. The Final Act. Significance for India and World trade.
4. Department of Biotechnology (1990) Recombinant DNA Safety guidelines. Govt. of India, New Delhi.
5. Krattinger, A. F Lesser, W and Mudge G: Implementation of Biosafety Regulatory Mechanisms under the Biodiversity Convention.
6. NarayanaswamiK: 1994 Safety and regulatory arrangements in Biotechnology in

Sohal and Srivastava (eds) Environment and Biotechnology.

SEMESTER III
Total Credits Required:22

MSCPB03C10: GENOMICS AND PROTEOMICS
3Credits (48 hours)

Course objectives:

1. To understand the genome sequencing and transcriptomics techniques
2. To understand the functional genomics and Pharmacogenomics
3. To understand the concepts of proteome analysis

Course outcomes:

Student will be able to explain the vital concepts of technologies pertinent to genomics and proteomics, and their applications

Course content:

Module I
Genomics: History, Genome projects, Large scale genome sequencing strategies. Basic principles, prokaryotic and eukaryotic genomes and interpretation of results. Reference genome sequence, integrated genomic maps, gene expression profiling.**(10 hrs)**

Module II
Types of RNAs and the respective roles in cells.Concept of Transcriptome and techniques used for transcriptomics; microarray, detecting differential gene expression, correlation of gene expression data to biological process. RNA databases, RNA interference, RNA structure prediction tools, RNA sequence analysis, RNA regulatory networks, Comparativetranscriptomics. **(12 hrs)**

Module III

Functional genomics: Application of sequence based and structure-based approaches to assignment of gene functions – e.g., sequence comparison, structure analysis (especially active sites, binding sites) and comparison, pattern identification, etc. Use of various derived databases in function assignment, use of SNPs for identification of genetic traits. Pharmacogenomics: identification of SNPs, SNP database (DbSNP). Role of SNP in Pharmacogenomics.**(14 hrs)**

Module IV

Proteomics: Proteome profiling methods, 2D electrophoresis image comparisons; yeast two hybrid system, MALDI, Tandem mass spectroscopy, peptide mass fingerprinting, Protein micro arrays, protein expression analysis, pathway analysis and identifying protein-protein interactions with mass scale expression data. **(12 hrs)**

References

1. Discovering Genomics, Proteomics and Bioinformatics 2nd edition - by A. Malcolm Campbell and Laurie J. Heyer. by Cold Spring Harbor Laboratory Press 2006.
2. Principles of Genome Analysis and Genomics (3rd Ed.) by Primrose, S.B. and Twyman, R.M., Blackwell Publishing Company, Oxford, UK. 2003
3. Introduction to Proteomics – Tools for the new biology (1st Ed.) by Liebler, D.C., Humana Press Inc., New Jersey, USA. 2002
4. Bioinformatics and Functional Genomics by Pevsner, J., John Wiley and Sons, New Jersey, USA. 2003
5. Bioinformatics: Sequence and Genome Analysis by Mount, D., Cold Spring Harbor Laboratory Press, New York. 2004

MSCPB03C11: SYSTEMS BIOLOGY
3 Credits(48 hours)

Course objectives:

1. Understand the systems level modelling of biological systems
2. Understand the modelling and simulation of whole cell
3. Understand the concepts of metabolic pathway modelling

Course outcomes:

Familiarize the students with approaches in computational modelling of various biological systems

Course content

Module I

System Biology: Towards System level Understanding of Biological Systems, Properties of models-Robustness, Redundancy, Control, Modular Design, StructureStabilty. Impacts of System Biology. Rapid Pole-to-pole Oscillations in E. coli, Models for Eukaryotic Gradient Sensing.

Module II

Systems Microbiology - The Cell as a Well-stirred Bioreactor: Michaelis-Menten Kinetics, A Genetic Switch in Lamba Phage, Synthetic genetic switches, Stability analysis, Modeling Escherichia coli chemotaxis, Genetic Oscillators

Module III

Developmental Systems Biology: Whole cell simulation, Computer Simulation of the Cell: Human erythrocyte model & its applications Quorum Sensing, Minimal gene set concept. Emerging Areas in System Biology: such as From Neurons to Brains, Complex Diseases, Organisms and their interactions with environment.

Module IV

Regulation of Metabolic Pathways at Enzyme Level: Regulation of enzyme activity, overview of enzyme kinetics, allosteric enzymes, feedback inhibition. Metabolic Pathway databases: - KEGG,

EMP, EcoCyc and MetaCyc, BioCyc. Enzymes, Compounds and Reactions databases; LIGAND - Biochemical Compounds and Reactions, ENZYME – Enzymes, BRENDA - Comprehensive Enzyme Information System; Full Genome Annotation through knowledge of Metabolic Pathways, Organism Specific Metabolic Pathways, Comparison of Metabolic Pathways, Engineering of Metabolic Pathways.

References

1. Foundation of System Biology by Hiroaki Kitano.
2. A First Course in System Biology by Eberhard O. Voit.
3. Alberts Bruce *et al,* (2002), Molecular Biology of the Cell. *Garland Science, New York.*
4. Masaru Tomita, (2001). Whole cell simulation: a grand challenge of the 21st century.

MSCPB03C12: CHEMINFORMATICS AND COMPUTER AIDED DRUG DESIGN
3 Credits (48 hours)

Course objectives:

1. Understand different methods of molecular docking
2. Understand steps involved structure-based and ligand-based drug designs
3. Understand structure-activity relationships

Course outcomes:

Students shall be able to

1. Explain the theoretical aspects of molecular docking
2. Explain different steps in computer-based drug design
3. Explain the QSAR and its applications

Module I

Molecular docking: Intermolecular interactions, different methods of docking: shape complementary methods, fragment-based methods, Distance geometry methods, scoring functions, rigid and flexible docking, applications, algorithms used. **(14hrs)**

Module II

Drug design: Drugs and their targets, theories of drug-target interactions, affinity and efficacy, pharmacokinetics, ADME and its prediction. Structure based drug design: steps in SBDD,lead discovery, HTVS, de novo design, optimization of ligand geometries.**(12hrs)**

Module III

Ligand based drug design - Chemoinformatics, analysis of large database of ligands using similarity, rule of five, rule of three and sub-structure based methods. Pharmacophore generation.**(12 hrs)**

Module IV

Introduction to QSAR, descriptors used in QSAR study, model building: regression Analysis, Partial Least Squares, Principle Components Analysis, model validation methods and applications of QSAR.**(10 hrs)**

References

1. Chemoinformatics (Methods in Molecular Biology Vol. 275 Ed. By Jurgenbajorath. Humana Press 2004
2. Structural Bioinformatics. Ed. By P. E. Bourne and H. Weissig. Wiley-Liss 2003
3. J. Gasteiger “Chemoinformatics: A text book” John Wiley and Sons 2003
4. Molecular Modeling: Basic principles and applications. Holtje HD, sippl W, Rognan D and Folkers G. Wiley-VFH 2nd Edition (2003)
5. Molecular modelling and drug design. Andrew Vinter and Mark Gardner and Boca Raton, CRC Press, 1994

MSCPB03C13: PROGRAMMING IN JAVA AND BIOJAVA
3 Credits (48 hours)

Course objectives:

1. Understand the fundamentals of java language constructs
2. Understand multithread programming in java
3. Understand the use of biojava in bioinformatics

Course outcomes:

After completion of the course, students are expected to understand the following:

1. Structure of java programming and creating Datatypes
2. The way various expressions and data types are assembled in packages
3. Implementation of multithreading in JAVA.
4. Application of biojava tools in bioinformatics

Course content

Module I

Introduction to Java:Compilation of java programs – Java Development kit – virtual machine – byte code – data types (int, long, char, and Boolean) – operators (arithmetic, relational, bitwise and assignment) – arrays – operator precedence – type conversion – control statements and loops. **(10 hrs)**

Module II

Working with java classes:Declaring classes – super and sub classes – constructors – instances of classes – inheritance (simple, multiple and multilevel) – overriding and overloading – exception handling – file handling. **(10 hrs)**

Module III

Multi-thread programming:Life cycle of a thread – creating a thread (extension of thread class and implementing runnable) – thread priorities – synchronization – deadlock. Event handling and applets:Event handling mechanisms – delegation event model – event classes – event listener interfaces – mouse and keyboard events – adapter classes and inner classes. Applet basics – passing parameters to applets – applet display methods – drawing lines, ovals, rectangles and polygons – threads and animation. **(14 hrs)**

Module IV

Biojava: Installing BioJava, Symbols, Basic Sequence Manipulation (DNA to RNA, Reverse Complement, motif as regular expression), Translation (DNA to Protein, Codon to amino acid, Six frame translation), Proteomics (Calculate the mass and pI of a peptide), Sequence I/O (File Formats conversions), Locations and Features (Point Location, Range Location, Feature modifications), BLAST and FASTA (Blast and FastA Parser, extract information from parsed results), Counts and Distributions, Weight Matrices and Dynamic Programming, User Interfaces. **(14 hrs)**

References

1. Java: The complete Reference. (7th Ed.) by Herbert Schildt, TMH. 2012
2. K. Arnold, J. Gosling, D. Holmes; The Java Programming Language; Addison Wesley, 4th edition, 2005.
3. Anonymous; Core and Advanced Java Black Book; Dreamtech Press, 2016.
4. U. K. Roy. Advanced Java Programming; Oxford University Press, 2015.
5. Dr. Kaladhar. Bio Java – A Programming Guide; LAP LAMBERT Academic Publishing, 2012.

MSCPB03C14: Practical 4
2 Credits (96 Hours)
GENOMICS, PROTEOMICS AND CHEMINFORMATICS

1. Genome comparison, Genome rearrangements, Gene prediction with bioinformatics tools
2. Translation the sequences and ORF finding
3. Phylogenetic Reconstruction
4. Practicals with MultiDent, AACompIdent, Protparam
5. Databases PDB, SCOP, CATH, Pfam
6. Secondary structure Prediction-GOR, SOPMA

7. Protein Identification and Analysis Tools on the ExPASy Server
8. Structure based Drug Design - Molecular Docking, De Novo Ligand Design, Virtual Screening
9. Ligand based Drug Design - Pharmacophore Identification, QSAR

References

1. G. P. Quinn and M. J. Keough; Experimental design and data analysis for biologists; Cambridge University Press, 2002.
2. A J. Link and J LaBaer; Proteomics: A Cold Spring Harbor Laboratory Course Manual; Cold Spring Harbor Laboratory Press; 2009.
3. Chemoinformatics (Methods in Molecular Biology Vol. 275 Ed. By Jurgenbajorath. Humana Press 2004
4. Molecular Modeling: Basic principles and applications. Holtje HD, sippl W, Rognan D and Folkers G. Wiley-VFH 2nd Edition (2003)
5. Molecular modelling and drug design. Andrew Vinter and Mark Gardner and Boca Raton, CRC Press, 1994

MSCPB03C15: Practical 5
2 Credits (96 Hours)
PROGRAMMING LAB III – JAVA AND BIOJAVA

1. Simple java programs to demonstrate decision making, and loops.
2. Handling of arrays and working with matrices.
3. Working with classes and objects in java.
4. Use of constructors and demonstration of overloading of constructors.
5. Demonstration of simple, multiple and multilevel inheritances.
6. Exception handling.
7. Creation of multiple threads.
8. Reading and writing files.
9. Applets.
10. Animation and Threads.
11. Managing Simple Events and Interactivity.
12. Alignment of sequences (biojava)

References

1. Java: The complete Reference. (7th Ed.) by Herbert Schildt, TMH. 2012
2. K. Arnold, J. Gosling, D. Holmes; The Java Programming Language; Addison Wesley, 4th
   edition, 2005.
3. Anonymous; Core and Advanced Java Black Book; Dreamtech Press, 2016.
4. U. K. Roy. Advanced Java Programming; Oxford University Press, 2015.
5. Dr. Kaladhar. Bio Java – A Programming Guide; LAP LAMBERT Academic Publishing, 2012.

MSCPB03E08: ENZYMOLOGY
(3 Credits) (48 Hours)

Course objectives:

1. Understand the nomenclature, methods of isolation and purification, activity and uses of enzymes.
2. Understand the structure and function of enzymes.
3. Understand enzyme kinetics and kinetic parameters
4. Understand the mechanism of enzyme inhibition

Course outcomes:

The students shall be able to

1. Explain the methods of isolation and purification, measurement of activity and uses of enzymes.
2. Explain the structure and function of enzymes.
3. Explain the kinetics of enzyme-substrate interactions.
4. Explain the mechanism of enzyme inhibition.

Course Content:

Module I

Enzymes: basic definitions, nomenclature (EC recommended and classical), enzyme isolation and purification, measurement of enzyme activity, specific activity, molar activity (turn over number), criteria for purity. Coenzymes.Synthetic enzymes, abzymes, isoenzymes and ribozymes.Use of enzymes in medicine and industry.Immobilized enzymes.**(12 hrs)**

Module II

Enzyme structure and function: folding of the polypeptide chain, active site and its location, binding site. Allosteric enzymes: Subunit Interactions, regulation of enzyme activity, Jacob and Monod model of allosteric enzymes, Koshland model, detailed discussion using haemoglobin, ATPase (Effects of ATP and CTP) as examples. K class and V class allosteric enzymes. Structure and their function in metabolism.**(12 hrs)**

Module III

Enzyme kinetics: Single substrate –single intermediate, Michaelis –Menten and Briggs –Haldane kinetics, graphical analysis of kinetic data, progress curves and linear plots, determination of Vmax and Km –experimental aspects. Importance of Km andVmax.**(12 hrs)**

Module IV

Enzyme inhibition: Mechanisms and rate studies, degree of inhibition, competitive, non-competitive and uncompetitive inhibition, activation, graphical analysis (primary and secondary kinetic plots), two substrate reactions, sequential and Ping –Pong mechanisms, nature of rate equations, examples. Irreversible inhibition.Alteration of Km and Vmax in various types of inhibition.Feedback inhibition.**(12 hrs)**

References

1. Enzymes-Dixon and Webb
2. Enzyme Kinetics-Bowden and Wharton
3. Immobilised Enzymes-Trevan
4. Hand bookof Enzyme Technology-Alan Weisman-3 rded Prentice-Hall
5. Enzyme Technology-Chapline and Bucke –Cambridge University Press
6. Biochemistry –Donald Voet& Judith Voet 1995. John Wileyand Sons, In

MSCPB03E09:
BIOTECHNOLOGY IN MEDICINE, HEALTH, AGRICULTURE AND ENVIRONMENT
3Credits (48 Hours)

Course Objectives:

Understand the latest application of biotechnology in the field of Medicine, Health, Agriculture and Environment for improvement in quality of life.

Course Outcome:

Ability to understand the use of Biotechnology for better living

Module I

Developments in gene therapy. Molecular basis, identification, and cure of genetic disorders: like Immunodeficiencies, Diabetes mellitus, Coronary artery disease, Neurogenetic disorders, cancer, Muscular Dystrophy, mitochondrial disease. Diagnosis based on genomic and cDNA microarray. Therapies based on RNA and stem cells. **(15Hrs)**

Module II

Bioreactors in plant production and scale up.Plants as bioreactors.Engineering for secondary metabolites, herbicide resistance and improvement of food quality.Biofertilizers, Types of biofertilizers, Biopesticides**(10 Hrs)**

Module III

Biotechnological monitoring of air water and soil pollution.Biosensors.Biological indicators.Strategies for waste management and control.**(10Hrs)**

Module IV

Biotechnologically produced clinical products.Nanomedicine: Nanodevices medical microbots, nanorobotics, nanomedicine, nanosurgery for cancers and neurological disorders. Nanoparticles for biological assays as drug delivery vehicles.Applications of Biotechnology in aquaculture, forestry, wildlife and veterinary sciences.**(13Hrs)**

References

1. Molecular Biotechnology 5thEditionBernard R. Glick, Jack J. Pasternak, Cheryl L. Pattern ASM Press 2017
2. Gene cloning and DNA analysis: An Introduction 6thEdition T.A. Brown, Wiley Blackwell 2013

3. Modern Biotechnology: Connecting Innovations In Microbiology and Biochemistry to Engineering Fundamentals, Nathan S. Mosier, Michael R. Ladisch, Wiley 2009

4. Nanomedicine -Design and Application of Magnetic Nanomaterials, Nanosensors and Nanosystems.,(2008)Vijay Varadan, Linfeng Chen and JiningXie
5. Techniques for Wildlife Investigation and Management, 6thEd., C. Braun ,2005., The Wildlife Society, Bethesda, MD.
6. Introduction to Forest Science., (2006) 2ndEdition byRaymond A. Young,Ronald L. Giese(Editor)
7. Introduction to Veterinary Science (2003) byJamesLawhead,MeeCee Baker
8. Biotechnology in Agriculture and Forestry 66: Editors: Jack M.WidholmandToshiyuki Nagata : Springer 2012
9. Environmental Biotechnology: New Approaches and Prospective Application: Marian Petre (Editor) 2013

MSCPB03E10: RECOMBINANT DNA TECHNOLOGY
3 CREDITS (48 Hours)

Course Objectives:
To familiarize with the advanced genetic engineering techniques.Appropriate application of genetic engineering technique for the mass production of protein of interest.The technology behind transgenic microorganisms, plants and animals.

Course Outcomes:
Complete understanding of genetic engineering tools such as RFLP, AFLP, RAPD, PCR, DNA fingerprinting etc.

Course Content:

Module I
Historical events that led to the methods of recombinant DNA technology, Gene cloning, Steps of gene cloning, enzymes involved in recombinant DNA technology- Polymerases, Klenow fragment, Nucleases, Restriction endonucleases, Ligases, Poly nucleotide kinases, Terminal deoxynucleotidyltransferases, Alkaline phosphatases. (**10Hrs)**

Module II
Vectors used in Recombinant DNA technology, Plasmids, Cosmids, Phagemids, Artificial chromosomes, Shuttle vectors, Viral vectors, Expression vectors. Linkers, Adapters, Homopolymer tailing. Transformation, Transfection, Transient transfection, Selectable marker gene to identify the transfer of genes in cells. (**14Hrs**)

Module III

Preparation of Gene libraries, cDNA libraries, Expression libraries, Storage of libraries and Screening of libraries, Screening by DNA hybridization, Screening by Immunological Assay, Screening by protein activity, Screening by Genetic complementation, Hybrid Arrest Translational systems. (**10Hrs**)

Module IV

RFLP, AFLP, RAPD Analysis, PCR, Various types of PCR and its applications, Fluorescent in-situ hybridization, Chromosome micro dissection and micro cloning. Genetic engineering of animals and generation of transgenic animals. Knock out Technology and Knock-in technology, Anti-sense RNA technology and its Application. (**14Hrs**)

References

1. Principles of gene manipulation-An Introduction to Genetic Engineering. Old, RW & Primrose, S.B –19945th Edn. Blackwell Sci Pub.
2. Molecular Cloning-A Laboratory Manuel Sambrook, J., Fritsch, E. F.andManiatis, T. 1989.. Second Edition. Cold Spring Harbor Laboratory Press.
3. Recombinant DNA technology-Concepts and Biomedical Applications Steinberg, M., Guyden, J., Calhann, D, Staiano-Coico, L.,Coico,R,1993. Ellice Horwood Prentice Hall.
4. Recombinant DNA Watson, J. D., Gilman, M., Witkowski, J.andZoller, M. 1992. Second Edition. Scientific American Books, WH Freeman & Co.
5. From Genesto Clones: Introduction to Gene -Winnacker, E. L. 1987.

MSCPB03E11: ENVIRONMENTAL MICROBIOLOGY
(3Credits) (48 Hours)

Course objectives:

Objectives of this course are to study and understand

1. Microbial biodiversity in different environments and factors affecting microbial population
2. Environmental, agricultural, medical, and industrial applications of microorganisms.

Course outcome:

Upon completion of this course, students will be able to explain and demonstrate the dispersal and adaptability of diverse microorganisms in different environments and their beneficial roles in environment, agriculture, health and industry.

Course Content:

Module I

Microbial behavior in ecosystems: Microbial biodiversity, Interactions among microbial populations. Animal-microbe and plant-microbe interactions. Microbiology of soil: Soil as habitat for microorganisms. Soil microflora, Decomposition of organic matter -Soil as source of industrial strains.Biodegradation of recalcitrants by soil microbes.Geocycles of C, N, S, P. iron and sulphur oxidation.N2 fixation.**(11Hrs)**

Module II

Microbiology of water: Microbial communities in aquatic environments, factors affecting microbial population in natural waters, Air water interface, Microbial Corrosion, Bacteriological analysis of drinking water. Water purification and various steps involved. Microbiology of air: Composition of air microflora, Significance of air microflora, Airborne diseases, Hazards of laboratory techniques, Air sanitation. Biological weapons, their regulation and precautions. Microorganisms in extreme environments: Environmental Determinants that Govern Extreme environments, Extremes of pH & temperature, salinity, Hydrostatic pressure, Nutrient limitation. **(15Hrs)**

Module III

Pollution and environment, Biosensors and Biological indicators, Waste water management and sewage treatment, BOD concepts, Solid waste management and land filling, Degradation of xenobiotics, Microbes and bioremediation. Microbial Biofilms: Physiology, Morphology and Biochemistry of microbial biofilms **(11Hrs)**

Module IV

Production of microbial biofertilizers –cyanobacteria, Rhizobium, Azotobacter, Azospirillum, Phosphobacteria and VAM, Biopesticides, Microbes as a health food (SCP)-Spirulina and its production methods. Probiotics -use of Lactobacilli and Bifidobacterium-therapeutic and nutritional value, Microbial enhanced oil recovery, Microbial production of fuels. Microbial leaching of ores and biomining, Biopolymers and biosurfactants.**(13Hrs)**

References

1. R.M.Atlas and R. Bartha (1998) Microbial Ecology-Fundamentals and Applications. Addison Wesley Longman, Inc.
2. Buckley R G, Environmental Microbiology by, CBS
3. N.S. Subbarao, Biological Nitrogen Fixation
4. Alexander and Martin , Microbiology of Soil
5. Soil Microbiology. Mark Coyne Thompson Learning
6. Ivanov, Environmental Microbiology for Engineers, Taylor & Francis Exclusive (Cbs)

SEMESTER IV

MSCPB04C16
Total Credits:16 Period:5Months

Research & Dissertation