Placed at the Special Meeting
of the Academic Council
held on 26.03.2018

APPENDIX – M

MADURAI KAMARAJ UNIVERSITY
(University with Potential for Excellence)

MODIFIED SYLLABUS FOR B.Sc. BIOTECHNOLOGY

CBCS SEMESTER PATTERN
(For affiliated colleges with effect from 2018-19)

1. Introduction

B.Sc. Biotechnology is an undergraduate course in a field of applied biosciences that involves the use of living organisms and their properties (products) through bioprocess technology, medicine, agriculture and food sciences. The aim of the course is to bring high quality internationally standard curriculum in biotechnology with strong vocational elements and professional skills development courses. This course also aims to nurture and culture the intellectual training, manpower development in the thrust areas of modern biotechnology including Molecular biology, Genetic Engineering, Bioprocess technology and bioinformatics. THE DURATION OF THE B.Sc. Biotechnology Programme is three years and the syllabus is divided into six semesters.

2. Eligibility for admission

A candidate who have passed higher secondary examination (10 +2) conducted by the Board of Higher Secondary Education, Govt. of Tamil Nadu or any other state board examinations accepted as Equivalent thereto by the syndicates subject to such conditions

a) Biology/Physics/Chemistry as subjects in the higher secondary education
b) Candidates should have secured at least 60% in the above subjects and above in aggregates
c) A relaxation of 10% marks in the aggregate will be given to SC/ST candidates

Duration of the course

d) The students will undergo the prescribed course of study for a period of not less than three academic years (six semesters)
e) The maximum duration for completion of the UG Programme shall not exceed twelve semesters.
f) Medium of Instruction: English

3. Objectives of the programme

The objectives of the B.Sc. Biotechnology programme is to empower the students from the basics of interdisciplinary life-sciences to the recent trends in Biotechnology and its applications for the benefit of the community.

4. **Outcome of the Programme**

The outcome of this course would be :-

- A detailed knowledge in the structure, function and applications of living organisms.
- Skill sets in handling microorganisms in the laboratory and their applications in academia and industry.
- Understanding and implementation of the applications of biotechnology in industry, health-care, environmental protection, food and agricultural research.
- Understanding the current trends in biotechnology and its applications.
- Demonstrating the ability to design, perform and interpret the experiments during the practical courses.

5. Core subject Papers

Major Subjects (Core papers)

Core-1: General Biochemistry

Core-2: Fundamentals of Microbiology

Core-3: Major Practical-1 (Lab in Analytical Biochemistry and Microbiology)

Core-4: Molecular Genetics

Core-5: Immunology & Immunotechnology

Core-6: Major Practical-2 (Lab in Molecular Genetics and Immunology & Immunotechnology)

Core-7: Recombinant DNA technology

Core-8: Animal Biotechnology

Core-9: Microbial Biotechnology

Core-10: Major Practical-3 [Recombinant DNA Technology and Genomics & Proteomics]

Core-11: Major practical-4 [Animal Biotechnology and Plant Molecular Biology]

Core-12: Major Practical-5 [Microbial Biotechnology, Evolutionary biology and Biostatistics]

Core-13: Genomics & Proteomics

Core-14: Plant Molecular Biology & Biotechnology

Core-15: Evolutionary Biology & Biostatistics

Allied Subjects

1. ALLIED CHEMISTRY [SEMESTER-1 TO SEMESTER-4]

Allied-1: Paper-1: Organic, Inorganic and Physical chemistry -1

Allied-1: Practical-1: Volumetric Analysis

Allied-1: Paper-2: Organic and Physical chemistry -1

Allied-1: Paper-3: Organic, Inorganic and Physical chemistry -2

Allied-1: Practical-2: Organic analysis

Allied-1 Paper-4: Organic and Physical chemistry -2

2. Allied Biology [Semester 3 to semester 6]

Allied -2: Paper-1: General Biology

Allied -2 Practical-1: Biology Practical-1 [General Biology and Applied Ecology]

Allied -2: Paper-2: Basic and Applied Ecology

Allied -2: Paper-3: Biodiversity and Conservation

Allied -2: Practical-2: Biology Practical 2 [Biodiversity and Conservation]

Allied -2: Paper-4: Cell Biology

Part-IV

Skill Based Subjects

Skill -1: Basics of Computer application & Bioinformatics

Skill-2: Natural Products (secondary metabolites)

Skill -3: Tissue culture techniques

Skill-4: Food Technology

Skill -5: Advanced Biotechnology & Enzyme Technology

Skill -6: Bioethics, Biosafety & IPR

7. Non-Major Elective Papers

1. Infectious diseases
2. Genes to Proteins

Part – V

1. Extension Activities

8. Unitization

Each subject paper is divided into five units. Each units should be given equal importance in terms of teaching and examination.

9. Pattern of semester exam

The theory examination would be for three hours duration for each paper at the end the semester. The candidate failing in any subject(s) will be permitted to appear in the subsequent semester examinations. The practical examinations for UG course should be conducted at the end of the every semester

Subjects of study & Scheme of Examinations: As given in Appendix A
The course of study shall comprise instruction in the following subjects (As given in

Appendix A) according to the syllabus and books prescribed from time to time.
Eligibility for the degree: Candidates will be eligible provided he/she completes the course and pass in the prescribed examinations.
Attendance, progress and conduct certificate from the head of the Institution will be required for the examination.

Course Structure:

The course is organized on semester basis with a total of six semesters. A candidate has to study 140 credits to qualify for the degree.

Transitory provision:

Transitory provision for the existing syllabus is up to May 2021.

10. Scheme of internal assessment

For the UG courses the internal assessment marks will be as follows.

Test	: 10 Marks (Average of the best two test)
Assignment	: 5 Marks
Seminar / Group Discussion	: 5 Marks
Peer-team Teaching	: 5 Marks
Total	**: 25 Marks**

11. External Exam

Guidelines for the Pass minimum:
To get a pass, a student should fulfill the following conditions:

a) Theory:
i) 40% of the aggregated (Internal +External)
ii) No separate pass minimum for Internal
iii) 27 marks out of 75 is the pass minimum for the External

b) Practical
i) 40% of the aggregated (Internal +External)
ii) No separate pass minimum for Internal
iii) 21 marks out of 60 is the pass minimum for the External
Candidates who have secured 60% and above in aggregates of the Part III will be given

First class; Candidates who have secured 60% and above but not less than 50% will be given **Second class**; Candidates who have secured 40% and above but below 50% will be given a **Third class**. Ranking will be made for the candidates who have necessarily completed the course without any arrears in each semester and scored the maximum total in the Part III be given the First Rank. Such candidates will be honoured with a Gold Medal if there is a sponsorship or an endowment.

12. Question Paper Pattern

Time : 3 Hours **Section A:** (10 x 1 = 10 marks) **Max.Marks : 75**

Question No. **1 to 10** (Multiple choice or Objective type)

1. Two questions from each unit **2**. Four Choices in each question. One mark objective questions are also acceptable. **3**. No 'none of the above' choice

Section B: (5 x 7 = 35 marks)
Answer all questions choosing either (a) or (b)
Answers not exceeding one page
(One question from each unit)

11 (a)	or	11 (b)
12 (a)	or	12 (b)
13 (a)	or	13 (b)
14 (a)	or	14 (b)
15 (a)	or	15 (b)

Section C: (3 x 10 = 30 marks)
Questions 16 – 20, Answers not exceeding four pages
Answer any three out of five (one question from each unit)

13. Scheme of evaluation

1. The pattern for internal valuation may be : two tests – 15 marks each: average 15 marks (Average of the two)
2. Group discussions/Seminar/Quiz – 5 marks
3. 2 Assignments: 5 marks each: average 5 marks
4. 3rd test may be allowed for absentees of any one of the two tests.
5. If the college opts quiz, 2 Quiz should be conducted.

14. Passing minimum

UG: Passing minimum – 40% (aggregate)

No pass minimum for internal

27/75 is the minimum in External

Internal – 30%, External – 70%

15. Model Questions

TISSUE CULTURE

(For those who joined in July 2008 and after)

Time: Three hours **Maximum : 75 marks**

SECTION A (10X1=10 marks)

Answer ALL the questions

1. Totipotency refers to
   a. The ability of a plant cell to arrest the growth of a plant
   b. The ability of a plant cell to develop disease in plant
   c. The ability of a plant cell to develop into a complete plant
   d. The ability of a plant cell develop into a callus.

2. Who is the father of tissue culture?
   a) Bonner b) Haberlandt
   c) Laibach d) Gautheret

3. Haploid plants can be obtained through
   a. Meristem culture b. Embryo culture
   c. Endosperm culture d. Embryo developed by ovules.

4. Synthetic seed is produced by encapsulating somatic embryo with
   a) sodium chloride b) sodium alginate
   c) sodium acetate d) sodium nitrate

5. A clone is a group of organisms produced by
   a. Asexual method and genetically similar

b. Asexual method and genetically dissimilar
c. Sexual method and genetically similar
d. Sexual method and genetically dissimilar

6. DMSO (Dimethyl sulfoxide) is used as
   a) Gelling agent b) alkaylating agent
   c) Chelating agent d) Cryoprotectant

7. Cybrids are produced by
   a) Fusion of two different nuclei from two different species
   b) Fusion of two same nuclei from same species
   c) Nucleus of one species but cytoplasm from both the parent species
   d) Nucleus of two species but cytoplasm from same parent species.

8. Which of the following is used to obtain virus free culture?
   a. Haploid culture b. Embryo culture
   c. Protoplast fusion d. Stem meristem culture

9. Part of plant used for culturing is called
   a) Scion b) Explant
   c) Stock d) Callus

10. When the cell wall of a plant cell is removed it is called ----------
   a. Protoplast b. Plant cell
   c. Changed cell d. Transgenic cell

SECTION B --- (5 x 7 = 35 marks)
Answer ALL questions choosing either (a) or (b).
Answer not exceeding 2 pages

11. a. Write a short note on the composition and preparation of culture medium for plant tissue culture
   Or
   b. What is the significance of Bio safety.
12. a. What is 'organogenesis'? What are it's applications?
   Or
   b. Give five applications of Transgenic plants.
13. a. What is Golden Rice? In what way it is different from the normal rice?
   Or
   b. Write short notes on cybrid and hybrid
14. a. Describe how the technique of micropropagation has been applied in the area of horticulture and forestry?
   Or
   b. Write short notes on agroinfection.
15. a. Give detailed account on transgenics for herbicide tolerance in crop plants.

Or

b. Discuss commercial tissue culture units in India.

SECTION C---- (3x10=30 marks)
Answer any THREE out of Five
Answer not exceeding 4 pages.

16 . What is micropropogation? How is it different from vegetative propogation.?
17. Discuss in detail about Agro bacterium and genetic engineering in plants.
18. Write the procedure of isolation of protoplasts from plant cells. What are the application of protoplast culture.
19. Write essay on protocol for commercial production of Banana.
20. Explain in detail about the application of plant tissue culture in production of plant secondary metabolites.

16. Teaching methodology

A teaching method comprises the principles and methods used by teachers to enable student **learning.** These strategies are determined partly on subject matter to be taught and partly by the nature of the learner. For a particular **teaching** method to be appropriate and efficient it has to be in relation with the characteristic of the learner and the type of learning it is supposed to bring about. Suggestions are there to design and selection of teaching methods must take into account not only the nature of the subject matter but also how students learn. In today's school the trend is that it encourages a lot of **creativity**. It is a known fact that human advancement comes through **reasoning.** This reasoning and original thought enhances creativity.

1. Lecture Method.
2. The Discussion Method.
3. The Demonstration Lesson.
4. Brainstorming.
5.Peer team teaching method

17. Text Books

1. Principles of Biochemistry, Author: AlbertL. Lehninger, Pub: CBS
2. Biochemistry, Author: Lubert Stryer, Pub: Freeman International Edition
3. Fundamentals of Biochemistry, Author: J.L.Jain, Pub: S. Chand and Company
4. Biochemistry, Author: Keshav Trehan, Pub: Wiley Eastern
5. Principles of Biochemistry, Author: Jeffory Zubey.
6. Veer Bala Rastogi, Cell biology, Genetics
7. Mol. Biology, P.S.Verma & V.K. Agrawal,
8. Mol. Biology of cell , Albert et al, The Cell Coope

18.Reference Books

Reference books are given ibelow in each paper.

19. Retotalling and revaluation provision

Revaluation means to re evaluate the paper of a particular subject completely. Under this, Student has to surrender his/her original marks of particular paper and accept the final marks when declared by the University as a result of Revaluation. Application form available at Examination Section and University Website. Fee Structure Rs. 500/ per subject for Revaluation Rs. 250/ per subject for Retotalling.

Condition- Application for Revaluation is to be made within 15 days from the date of publication of result on University website. Application form is to be completely filled and signed by the student (concerned) only. Select the paper carefully in which you wish to seek revaluation. No second application for additional papers shall be accepted. The fees once paid shall not be refunded.The application is to be made by the student in his/her own handwriting and under his/her own signature and not by anyone else on his/her behalf.

Rules for Revaluation - Revaluation shall be available only for the paper of end term examination. Revaluation for the paper of end term examination shall be sent to two external evaluators for evaluation. The average of the marks awarded by two external evaluators shall be taken as final marks and the original marks obtained by the student shall have no value.

20. Transitory provision 3+3

UG syllabus revision once in 3 years and afterwards 3 years under transitory provision)

21. Subjects and paper related websites.

Science Books Online lists , free science e-books, textbooks, lecture notes, monographs, and other science related documents. All texts are available for free reading online, downloading in various formats.

COURSE OF STUDY

Sl.No	Study Component	No. of Papers	Hours	Credit per paper	Total hour per course	Total Credit
1	Part - I Tamil/Other Languages	4	6	3	24	12
2	Part - II English	4	6	3	24	12
3	Part – III					
	Core subjects***	10 +[5]	4 + [2-3]	4 + [2 & 5]	72	59
	Allied Subjects***	8 +[4]	4 + [2]	4 + [1]	40	36
4	Part – IV					
	Non-Major Elective Courses	2	2	2	4	4
	Skill Based Subjects (Elective)*	6	2	2	12	12
	Environmental Studies	1	2	2	2	2
	Value Education/ Values of Religion and society /Professional values & Role of Social institutions in Value formation/ Constitutional values & fundamental rights/ Directive principles of State policy and Fundamental duties	1	2	2	2	2
5	Part- V					
	Extension Activities**	1	-	1	-	1
	Total	**46**			**180**	**140**

*Skill based subjects include General Knowledge
** NSS/NCC/Physical Education/Science Forum/Science club/Eco club
*** Numbers in [] mentioned the respective practical's.

CBCS – B.Sc. Degree Course in Biotechnology
First Year - Semester-1

PART	S.No.	Subjects	Hours	Credits	Int	Ext	Total
I	1	Part-I	6	3	25	75	100
II	2	Part II	6	3	25	75	100
III	3	Core-1: **General Biochemistry**	4	4	25	75	100
		Core-3: Major Practical-1 (Lab in Analytical Biochemistry and Microbiology)	2	-			
	4	Allied-1: **Organic, Inorganic and Physical chemistry -1**	4	4	25	75	100
		Allied Practical: Volumetric Analysis	2	-			
IV	5	Skill -1: **Basics of Computer application & Bioinformatics**	2	2	25	75	100
	6	Skill-2: **Natural Products (Secondary metabolites**)	2	2	25	75	100
	7	Non Major Elective - 1	2	2	25	75	100
Total			30	20			700

First Year - Semester-II

PART	S.No.	Subjects	Hours	Credits	Int	Ext	Total
I	1	Part-I	6	3	25	75	100
II	2	Part II	6	3	25	75	100
III	3	Core-2: **Fundamentals of Microbiology**	4	4	25	75	100
	4	Core-3: Major Practical-1 (Lab in Analytical Biochemistry and Microbiology)	2	2	25	75	100
	5	Allied-1: **Organic and Physical chemistry -1**	4	4	25	75	100
	6	Allied 1 Practical-1: **Volumetric Analysis**	2	1	25	75	100
IV	7	Skill -3: **Tissue Culture techniques**	2	2	25	75	100
	8	Skill-4: **Food Technology**	2	2	25	75	100
	9	Non Major Elective – 2:	2	2	25	75	100
Total			30	23			900

Second Year - Semester-III

PART	S.No.	Subjects	Hours	Credits	Int	Ext	Total
I	1	Part-I	6	3	25	75	100
II	2	Part II	6	3	25	75	100
III	3	Core-4: **Molecular Genetics**	4	4	25	75	100
		Core-6: Major Practical-2 (Lab in Molecular Genetics and Immunology & Immunotechnology)	2	-			
	4	Allied-1: **Organic, Inorganic and Physical chemistry -2**	4	4	25	75	100
		Allied 1 Practical-2: Organic analysis	2				
	5	Allied -2: **General Biology**	4	4	25	75	100
		Allied -2 Biology Practical-1	2				
Total			30	18			500

Second Year - Semester-IV

PART	S.No.	Subjects	Hours	Credits	Int	Ext	Total
I	1	Part-I	6	3	25	75	100
II	2	Part II	6	3	25	75	100
III	3	Core-5: **Immunology & Immunotechnology**	4	4	25	75	100
	4	Core-6: **Major Practical-2** (Lab in Molecular Genetics and Immunology & Immunotechnology)	2	2	25	75	100
	5	Allied-1: **Organic and Physical chemistry -1**	4	4	25	75	100
	6	Allied 1 Practical-2: **Organic analysis**	2	1	25	75	100
	7	Allied -2: **Basic and Applied Ecology**	4	4	25	75	100
	8	Allied -2 Biology Practical-1	2	1	25	75	100
V	9	Extensions activities	0	1			-
Total			30	23			800

Third Year - Semester-V

PART	S.No.	Subjects	Hours	Credits	Int	Ext	Total
III	1	Core-7: **Recombinant DNA Technology**	4	4	25	75	100
	2	Core-8: **Animal Biotechnology**	4	4	25	75	100
	3	Core-9: **Microbial Biotechnology**	4	4	25	75	100
		Core-10: Major Practical-3 [Recombinant DNA Technology and Genomics & Proteomics]	3				
		Core-11: Major practical-4 [Animal Biotechnology and Plant Molecular Biology]	3				
		Core-12: Major Practical-5 [Microbial Biotechnology and Evolutionary biology]	2				
	4	Allied-2: **Biodiversity and Conservation**	4	4	25	75	100
		Allied 2 Biology Practical 2	2				
	5	Skill -5: **Advanced Biotechnology**	2	2	25	75	100
IV	6	**Environmental Studies**	2	2	25	75	100
Total			30	20			600

Third Year - Semester-VI

PART	S.No.	Subjects	Hours	Credits	Int	Ext	Total
III	1	Core-13: **Genomics & Proteomics**	4	4	25	75	100
	2	Core-14: **Plant Molecular Biology & Biotechnology**	4	4	25	75	100
	3	Core-15: : **Evolutionary Biology & Biostatistics**	4	4	25	75	100
	4	Core-10: **Major Practical-3** [Recombinant DNA Technology and Genomics & Proteomics]	3	5	25	75	100
	5	Core-11: **Major practical-4** [Animal Biotechnology and Plant Molecular Biology& Biotechnology]	3	5	25	75	100
	6	Core-12: **Major Practical-5** [Microbial Biotechnology, Evolutionary biology and Biostatistics]	2	5	25	75	100
	7	Allied-2: **Cell Biology**	4	4	25	75	100
	8	Allied 2 Biology Practical- 2	2	1	25	75	100
	9	Skill -6: **Bioethics, Biosafety and IPR**	2	2	25	75	100
IV	10	**Value Education**	2	2	25	75	100
Total			30	36	25	75	100

CBCS SYLLABUS FOR

B.Sc. Biotechnology (From the academic year 2018-2019)

Part III: Core Papers

1. GENERAL BIOCHEMISTRY

Objectives
To facilitate the students to

- To know the basics of bio-molecules, structure, complexity and properties.
- To understand the biochemical process of life.
- To gain the thorough knowledge about the major biomolecules like carbohydrates, Proteins and lipids.
- To enriching the analytical and research knowledge in the biomolecules and life

Unit I: Carbohydrates: Definition, classification, structure and biological functions of mono, di, oligo and polysaccharides (starch, glycogen, cellulose, dextrin, hyaluronic acid, keratin sulphate, heparin and chondroitin sulphate).

Unit II: Amino acids: structure, classification, physical and chemical properties. Proteins: Biological importance, classification, general properties. Primary structure, secondary, tertiary and quaternary structure of proteins. Enzymes – properties, classes of enzymes, enzyme reaction, theories of enzyme reaction, MM equation, LB plot, factors affecting enzyme reaction, enzyme units, enzyme assay, coenzyme, Co-factors.

Unit III: Lipids: Biological significance, nomenclature and classification. Simple lipids; Fatty acids and their properties, triglycerides, waxes, steroids and prostaglandins. Compound lipids: Phospholipids, sphingolipids and glycolipids. Lipoproteins. B-oxidation of lipids, Biosynthesis of lipids.

Unit IV: Nucleic acids: DNA and RNA. Composition, structure, types and Biological importance. Denovo synthesis of Nucleic acids. Vitamins – water soluble and ft soluble, importance of vitamins in life.

Unit V: Metabolism: Catabolism & Anabolism. Energy metabolic pathways – Glycolysis, Krebs cycle, ED-pathway, Gluconeogenesis, pentose phosphate pathway. C3, C4 cycle of CO_2 reduction, Photo phosphorylation & Oxidative phosphorylation. Urea cycle. Denovo synthesis of nucleotide biosynthesis.

REFERENCES:

1. Fundamentals of Biochemistry – O.P. Agarwal

2. Essentials of Biochemistry – M.C.Pant
3. Essentials of Biochemistry – J. I.Jain
4. Nelson, D.L. and Cox, M.M.Lehiner – Principles of Biochemistry, Worth Publishers (2003)
5. Textbook of Biochemistry – West & Todd.
6. Harper's Biochemistry 25th edn, Mc Graw Hill – 2000
7. Harper's review of Biochemistry – David W. Martin
8. Jeremy M. Berg, John L.Tymoczko and Lubert stryer (2002) Biochemistry. WH Freeman & Co.,
9. A. White, D.Handlu, E.L. Smith(8th edition). International student Edn. 1973.
10. General Biochemistry – Well (Wiley Eastern, India)
11. Biochemistry – Mathews. C.K. 2000

2. FUNDAMENTALS OF MICROBIOLOGY

Objectives
To facilitate the students to

- Enrich their knowledge in basic & fundamentals of microbiology
- To know the basic features and functions of microscope and its importance
- To familiar with the taxonomic positions and key identification features of microbes
- To understand the biology and physiology of most important microbes, industries, environment, agriculture & medicine

Unit I: Introduction to Microbiology – Historical perspectives, scope, definition of microbiology.
Microscopy: Light Microscope: Simple; Compound Microscopes – Dark field, light field, phase contrast, fluorescent Microscopes. Preparation of slides: staining – simple, Gram., acid fast, flagella, capsular staining. Electron Microscopes: TEM, SEM, Preparation of specimen for electron microscopes: Shadow casting, ultra microtome, freeze etching, autoradiography. Definition, transmission, reflection, refraction, absorption, fluorescence, magnification, refractive index, resolution.

Unit II: Classification of Microbes: Numerical and molecular taxonomy, Fundamental characteristics employed in classification of : Bacteria – up to Order (with one example). Fungi, slime molds and water molds – up to Division (with one example). Algae – up to Division (with one example). Viruses – upto Family (with one example).

Unit III: Microbial nutrition, growth and control: Nutrients, nutritional types of microorganisms, Bacterial growth - bacterial growth curve, limitation of microbial growth.

Methods of sterilization of media, reagents and, control of microbes (Physics and chemical methods).

Unit IV: Microbial physiology: Energy production: aerobic and anaerobic process. Glycolysis. Kreb's cycle, pentose pathway, Entner Duodoroff (ED) pathway. Role of ATP in energy production, Redox reactions, electron transport chain. Photosynthetic microorganisms - Photosynthetic pigments and light and dark reactions, chemosynthesis and chemosynthetic microorganisms .

Unit V: Life cycle and interaction between microorganisms: Life cycle of *Leucothrix mucor* (Purble sulfer bacteria), Bdellovibrio. Life cycle of fungi – Rhizopus and yeast (*Saccharomyces cerevisiae*), Life cycle of algae – *Chylamydamonas*., Life cycle of viruses – Plant, animal and bacteria viruses (each with one example). Interaction between microorganisms – mutualism, commensalism, antagonism, exploitation etc. Plant microbe interaction – symbiosis, mycorrhizae.

REFERENCES:

1. L. Prescott, J.Harley and D.Klein, 1999. Microbiology 4th edition. McGraw Hill.
2. H.G. Schlegel, 1993. General Microbiology, 7th edition. Cambridge University Press, New York
3. A.J. Salle, Fundamental Principles of Bacteriology 7th edition. Tata McGram Hill.
4. M.T. Madigan, J.M. Martinko, J.Parker, Brock's Biology of Mircroorganisms, 10th ed, Prentice Hall – 2002.
5. Moat Albert. G, Foster. John. W, Speetor, Michel P, Microbial Physicology, 4th ed.
6. Wiley Liss Publishers – 2002.
7. C.J. Alexopoulus, Mims, Blackwell. Introductory Mycology. 4th ed. WSE, Wiley- 1996.
8. Microbiological methods – 7th ed. Collins C.H & Lyne's P.M. 1995
9. Das, H.K. 2004, Text Book of Biotechnology. Wiley Dreamtech India Pvt. Ltd.

3. LAB IN ANALYTICAL BIOCHEMISTRY & MICROBIOLOGY

Objectives

To facilitate the students to

- To learn the basic principles of laboratory practice, handling the equipments etc.
- Learn the experimental principles of calorimeter, pH meter.
- To develop a skill to evaluate enzymes.
- Carryout the bioassay and analytical principles to quantify the biomolecules.

Analytical Biochemistry

1. Colorimeter and spectrophotometer (principle & use)
2. Estimation of proteins
3. Estimation of aminoacids
4. Estimation of glucose (Dinitrosalicylic acid method)
5. pH meter – principles and applications
6. Preparation of phosphate and acetate buffers.
7. Enzyme assay (Invertase & amylase)
8. Chromatography method – Principles and applications
9. Paper chromatography, Thin-Layer chromatography.

Microbiology

1. Microbiological techniques – Sterilization techniques, Media preparation
2. Isolation and enumeration of microbes (bacteria & fungi) from soil.
3. Single colony preparation – streak plte methods
4. Identification of Bacteria: Staining methods – simple, Grams and Spore staining; Biochemical Identification – IMViC – test, Oxidase, Catalase, TSI –test, Hydrolysis of starch, casein, and lipids.
5. Growth curve of bacteria.
6. Antimicrobial sensitivity test – Disk diffusion test.
7. Preservation of microbes: slant culture, Mineral oil stocks
8. Fungal identification: Slide culture method & lactophenol cotton blue staining (morphology)

References:

1. Laboratory manual of Biochemistry by J.Jayaraman (1988) Wiely East
2. Principles and Techniques of practical biochemistry, Keith Willson, Jo (2000), 5th Edi. Cambridge University Press.
3. Lab in analytical Biochemistry, P.Palanivelu (2013), Twenty first Centaury publications.
4. Ronalds M. Atlas et al., Experimental Microbiology – Benhjamin & Cummings Publication.
5. Cappucino, Sherman, 2005. Microbiology - A Laboratory Manual, 6th Edition. Pearson Education.
6. Anitha Rozgar, Practical methods for environmental Microbiology and Biotechnology, Krishna Prakash Ltd.m Meerut.
7. Kannan, N. Lab manual in Microbiology, Panima Publication, New Delhi.

4. MOLECULAR GENETICS

Objectives

To facilitate the students to

- To understand the basic principles of genetic materials & its inheritance.

- To know the importance of molecular biology and genetics in life
- To enriching the knowledge in basics of RNA biology and gene families.
- To become familiar with the principles gene regulations.

Unit I : Structure of chromosomes, chromatin structure and composition, packaging of DNA into chromosomes – melting, dissociation and cot curve. Replication: Biochemistry of replication: DNA polymerase structure, mechanism of replication, initiation, elongation and termination. Types of replication such as semi-conservative replication. Replication of Eukaryotic DNA and Mitochondrial DNA.

Unit II: Transcription: RNA polymerase structure, mechanism of transcription, initiation, elongation and termination. Processing of RNAs: mRNA, tRNA and rRNA. Genetic code - codon, properties. Translation: promoter structure and functions, protein synthesis Initiation, elongation, termination (prokaryotes & eukaryotes) and post translational modification. Concepts of operons and their regulations - *Lac* operon and trp operon - Attenuation.

Unit III: Mutation and genetic analysis of mutants: Mutation definition, types – insertion, deletion, addition, rearrangement: genetic analysis. Mutagenesis: Types: Site directed mutagenesis, base analogue mutants, tautomerization. DNA damage and repair mechanism: Photo reactivation, direct repair of nicks, excision repair, mismatch repair, recombination repair, SOS repair mechanisms.

Unit IV: Recombination: genetic crossing over, models for recombination – homologous, heterologous. Gene rearrangements and gene loss. Regulation of synthesis of primary transcripts in eukaryotes - transcriptional control by hormones. Regulation of gene expression in plant cells by light. Transposons and insertion elements: Structure of Tn3, Tn5, Tn9 and Tn10 transposition. P elements in Drosophila: Introduction, types of *P* elements.

Unit V: Gene transfer in microbes: general introduction to gene transfer. Conjugation: Definition, types, F-mediated conjugation, Hfr mediated mechanism, sexduction, F-mediated sexduction. Transformation: Definition, Griffith experiment, process, mechanism. Transduction: Introduction, types, generalized transduction. Specialized transduction. Transfection: Introduction, process, Transfection of phage DNA.

REFERENCES:

1. D. Freifelder, Molecular Biology, 1987,2nd Edition, Jones & Bartlett Publishers, International.

2. B. Alberts, A. Johnson, J. Lewis, M. RaH, K. Roberts, P. Walter. Molecular, Biology of the cell, 4th Edition.2002, Garland Science.
3. J.D. Watson, T. A. Basker, S.P. Bell, A. Gann, M. Levine, R. Losick, Molecular, Biology of the Gene, 2004. 5th Edition. Benjamin Cummings.
4. An introduction to Genetic Analysis, Anthony, J.F., Griffiths, Jeffrey H.Miller. David T.Suzuki, Richard C.Lewontin, William M.Gelbart, 2000. W.H. Freeman & Co.
5. Genetics: A Beginner's Guide. T.Cullis, Burton, S.GuHman, Antony Griffiths, David Suzuki, 2003. One world publication Limited.
6. Microbial Genetics, David Freifelder, 1998, Jones and Bartlett Publishers International.

5. IMMUOLOGY AND IMMUNOTECHNOLOGY

Objectives

To facilitate the students to

- Understand the basics of immunology
- Widen their knowledge in classical and molecular immunology
- Become familiar with immunization practices and their importance
- Enabling their knowledge in techniques of immunology

Unit I: History and scope of immunology – Overview of the immune system – Immunity, types, factors and mechanisms.

Unit II: Lymphoidal organs, primary and secondary lymphoid organs- Immune cells, antigen presenting cells and their importance in antigen recognition. Innate immunity.

Unit III: Antigens and antigenecity – structure, properties. Types and functions of immunoglobulins. Development and differentiation of B and T lymphocytes – antigen recongnition of B & T cells.

Unit IV: Anitgen – Antibody interactions: Antibody affinity, antibody avidity, precipitation reactions – radian immune diffusion, double immune diffusion, immune electrophoresis. Agglutination reactions – hemagglutination, bacterial agglutination, passive agglutination.

Radio immune fluorescence. Immuno diagnosis – monoclonal antibodies, principles and construction of monoclonal antibodies and their applications.

Unit V: Antigen processing and presentation by Class I and Class II MHC molecules. HLA and their relevance in medicine, vaccine and vaccine development, Immunity to infectious agents – bacteria, viruses and parasites. Immune reaction against host – allergy, autoimmunity, transplantation, Tumor immunology, hypersensitive reactions.

REFERENCES:

1. Kuby Immunology, Richard A.Goldsby, Thomas J.Kindt, Barbara A Osborne, 2000, 4th Edi. W.H. Freeman & Co.
2. Immunology: An Introduction, lan Tizard, 1995, Thomson Learning.
3. Hybridoma technology in the Biosciences and Medicine – Timothy Springer (1985) Plenum Press.
4. Essentials of Infectious Diseases by Lionel A. Mandell, Edward D. Ralph (1985) Black Well Science Inc.
5. Vaccines 86 : New approaches to immunization : Developing vaccines against Parasitic, bacterial & viral diseases, Robert M. Chanock, Fred Brown, Richard A. Lerner, 1986, Cold Spring Lab. Press.

6. LAB IN MOLECULAR GENETICS & IMMUNOLOGY

Objectives
To facilitate the students to

- To perform and lean the microbial culture practices and identification methods
- Learn the basic genetic experiments to understand the complexity of genetic process.
- Perform an experiment to know the gene mutation.
- Develop the skill to learn the gene transfer methods etc.

Molecular Genetics

1. Protein characterization: isolation, purification by Ammonium salt precipitation, dialysis, ion-exchange chromatography
2. Drosophila – male and female identification, Mutant forms (from pictures),Genetic importance
3. Observation of simple Mendelian traits in man.
4. Human Karyotypes : normal, Down's, Klinefelters and Turner, is syndrome.

5. Recording of Mendelian traits in humans.
6. Isolation of genomic DNA from Bacteria and plants
7. Agarose gel electrophoresis
8. Isolation of Plasmid DNA
9. Demonstration of Conjugation, transformation and Transduction
10. Ames test
11. Bacteriophage isolation & enumeration.
12. Demonstration of Lytic & lysogenic phages.

Immunology

1. Properties of antigen and antibody
2. ABO blood grouping
3. RH factor determination
4. Widal test, Syphilis Fast Latex Agglutination Test
5. Immune precipitation test: single radial immunodiffusion, Double immune diffusion
6. Immune electrophoresis.
7. Make a differential count and subset population in lymphocyte (B & T lymphocytes)
8. Total RBC and WBC count
9. ELISA test

References

1. Jeffery H. Miller 1977. Experiments in Molecular Genetics, Cold springHarbor Press.
2. N.Sivakumar (2010), Methods in Molecular Genetics, Nanjil Book stall, Nagercoil.
3. P. Oelkers, 2016. Molecular Biology Laboratory Manual
4. Immunology: A Laboratory Manual, Richard L. Myers, 1989
5. Diagnostic Immunology Laboratory Manual, Ronald J. Harbeck, 1991
6. Practical Immunology- A Laboratory Manual, Senthilkumar Balakrishnan, Kaliaperumal Karthik, Senbagam Duraisamy, 2015 DOI: 10.13140/RG.2.1.4075.4728

7. RECOMBINANT DNA TECHNOLOGY

Objectives
To facilitate the students to

- Understand the basics techniques in rDNA technology
- Become familiar with basic techniques of vectors & its biology
- Updating the knowledge in basic DNA cloning methods & their applications
- Enabling their knowledge in techniques of hybridization.

Unit I: DNA modifying enzymes and their uses in molecular biology: Restriction enzymes. DNA Polymerases, DNA dependent RNA polymerases. DNA ligase and Taq DNA polymerases and the new temperature resistant enzymes.

Unit II: Cloning vectors and their applications : Plasmids – high and low copy number of plasmids and their copy number regulation. Cosmids, Phagemids. Expression vector for prokaryotes and eukaryotes.

Unit III: YAC, BAC – construction, principles and use, specialized features of cloning hosts like *E.coli*, yeast, animal cells and plants.

Unit IV: DNA cloning a) sticky ends b) blunt ends. Construction of genomic and cDNA libraries. PCR based cloning approaches. Site directed mutagenesis.

Unit V: Analysis of cloned genes. Southern hybridization – Preparation of radiolabelled/non radiolabelled DNA & RNA probes, hybridization and autoradiography. Production of commercially useful products in lab scale. Affinity tags and their uses.

REFERENCES:

1. Principles of Gene Manipulation. Blackwell Science Inc., 2002. 6th Edition. Sandy B. Primrose, Richard Twyman, R W. Old.
2. Molecular Cloning: A Laboratory Manual (3 Volumes) Joseph Sambrook, David W. Russell, Joe Sambrook, 2001, 3rd Edition, Cold Spring Harbor Laboratory.

8. ANIMAL BIOTECHNOLOGY

Objectives

To facilitate the students to

- Know the basics of animal biotechnology
- Know the basic requirements of animal tissue culture
- Learn the basics of animal tissue culture methods
- Understand the needs of animal biotechnology for human welfare.

Unit I: Introduction to animal tissue culture – washing, sterilization of animal tissue culture glasswares and media preparation – primary culture and subculture – cell strain, cell lines - Transformation of animal cells.

Unit II: Basic tools for animal tissue culture – Fibroblast cell lines. Hela cell line – Significance of animal tissue culture. Electroporation, transfection methods.

Unit III: Biology of viral vectors. Eg. SV40, adenovirus, retrovirus, vaccinia virus vectors and its applications. Baculovirus vectors and its use for biocontrol.

Unit IV: Genetic engineering as applied to production of regulatory proteins, blood, products, vaccines and hormones.

Unit V: Production of transgenic animals. Transgenic in animal biotechnology research. Gene knockout and mice model for human genetic disorder. Gene therapy. Introduction to Human genome project.

REFERENCES:

1. Gene transfer and expression protocols. Methods in Molecular Biology. C.Don Murray & Walter, E.Wiest, 1991. Humana Press.
2. Recombinant DNA. James D. Watson, Michael Gilman. Jan Witkowski: Mark Zoller, Gilman Witkowski, 1993, 2nd Edition. WH Freeman & Co.
3. Genetic Engineering in Animals. A Puller (ed). VCH Publishes.
4. Molecular Biotechnology. Bernard R Glick and Jack. J. Pasternhack. 2003. American Society for Microbiology.

9. MICROBIAL BIOTECHNOLOGY

Objectives

To facilitate the students to

- Introduction about of microbial Biotechnology
- Understand the importance of microbes in an industrial uses
- Widen their knowledge in basic process of microbial biotechnology
- Become familiar with microbe mediated pollution control.
- Know the applications of microbes as SCP.
-

Unit I: Gene cloning of industrial microorganisms: Gene cloning – strategies in gene cloning – Importance, advantage and methods of gene cloning in Bacillus, Pseudomonus, Streptomyces and yeast.

Unit II: Pollution and waste control: Industrial wastes – Waste management using Pseudomonus- Microbial based environmental applications of biotechnology.

Unit III: Selection of industrial strains and media formulation: Isolation and screening of industrially important microbes, strain improvement, media formulation and sterilization.

Unit IV: Bioreactors: Bioreactor design, parts and their functions. Bioprocess control and monitoring variables such as temperature, agitation, pressure and pH. Computers in bioprocess control system, its types. Introduction to large scale production of recombinant proteins (insulin, Biopolymer) using bioreactors.

Unit V: Application of Bioprocess technology: Production of microbial biomass - SCP (Spirulina, yeast); extracellular enzymes: primary and secondary metabolites including vitamins (riboflavin production), amino acids (glutamate production) and other commercial products (L-ascorbate, llactate, vinegar), antibiotic production (penicillin & bacterial toxoids). Introductory concepts to downstream processing.

REFERENCES:

1. Comprehensive Biotechnology – Vol. 1,2, 3 and 4 by Murray Moo Young (1985) Elsevier Science.

2. Fundamentals of Biotechnology by Paul Prave, Uwe Faust, Wolfgang sitting (1987) VCH publishing.

3. Principles of fermentation technology by Stephen J.Hall, Peter Stanbury and Allan Whittakker (1999) 2nd ed. Butterworth – Heinemann Publication.

10. Lab in Recombinant DNA Technology and Genomics & Proteomics]

Objectives
To facilitate the students to

- Know the basic techniques of rDAN technology& genomics
- Developing the skill for handling laboratory important bacteria & microbes.
- Developing the basic skills to search of DNA, Protein data bases.
- Predict the structure of DNA & proteins.

Recombinant DNA Technology

1. Isolation of plasmid DNA from Bacteria
2. Analysis of plasmid DNA in Agarose Gel electrophoresis
3. Isolation of DNA from animal tissues.
4. Restriction fragment analysis of DNA
5. Preparation of Competent cells
6. Simple DNA ligation and transformation experiments.

7. Recombinant selection (Blue – white Screening), antibiotic selection
8. Polymerase Chain Reaction
9. Demonstration of Southern Hybridization, Synthesis of cDNA.

Genomics & Proteomics

1. DNA isolation from blood/liver and electrophoresis
2. Estimation of cellular DNA by standard method (Burton's)
3. Studies on Serum proteins by electrophoresis
4. Native PAGE, 2-D electrophoresis.
5. Two dimensional liquid chromatography
6. DNA data bases searching – BLAST analysis & Phylogenetic analysis of microbes & plants
7. Protein data bases – Protein primary sequence analysis, homology analysis and secondary structure prediction.
8. Pairwise alignment of Protein and DNA sequences & data interpretation.
9. Local and global alignment of sequence data and comparing both results.

References

1. READ, T D. -- NELSON, K E. -- FRASER, C M. *Microbial Genomes* . USA: Humana Press, Inc., 2004. 536 p. ISBN 1-58829-189-8.
2. HEYER, L. -- CAMPBELL, A. *Discovering Genomics, Proteomics and Bioinformatics.* USA: Cold Spring Harbor Lab. Press, 2006. 352 p. ISBN 0-8053-4722-4
3. R. Simpson, Proteins and Proteomics: A Laboratory Manual, Cold Spring Harbor Laboratory Press, 2003, 926 pp.
4. Reiner Westermeier, Tom Naven, Proteomics in Practice: A Laboratory Manual of Proteome Analysis, 2002, Wiley-Blackwell

11. Lab in Animal Biotechnology and Plant Molecular Biology

Objectives

To facilitate the students to

- Know the basic techniques of animal tissue culture
- Developing the skill for handling tissue culture media and cultured cells.
- Developing the basic skills to differentiation of cells and cell lines.
- Developing the plants from explants.

Animal Biotechnology

1. Basic laboratory practical in animal cell culture, introduction, sterilization and washing of glassware media preparation

2. Preparation of chick embryo 24 hrs, 48 hrs, 72 hrs and 96 hrs cell viability testing using trypan blue
3. Primary and sub culturing techniques.
4. Handling of lab animals (mice)
5. Preparation of antigens: erythrocytes, bacterial proteins
6. Immunization and bleeding techniques

Plant Molecular Biology & Biotechnology

1. Basic laboratory practical in plant tissue culture, introduction, sterilization and washing of glassware media preparation
2. Multiplication plan for in vitro plantlets for greenhouses
3. Tissue culture techniques
4. Micropropagation (node cuttings, leaflets)
5. Germplasm maintenance.
6. Mitosis and meiosis analysis
7. Tissue typing

12.Lab in Microbial Biotechnology, Evolutionary biology and Biostatistics

Objectives
To facilitate the students to

- Know the basic techniques of microbial biotechnology.
- Developing the skill for handling industrially important microbes and maintenance..
- Developing the basic skills to understand the evolution of life forms.
- Developing the pedigree chart and know the genetic disorders.

Microbial Biotechnology

1. Maintenance of pure cultures of industrially important microbes
2. Fermentor, Production media - Principles & applications
3. Screening of Extracellular enzyme producing microbes (amylase & protease) & assay of enzyme
4. Screening of antibiotic producing microbes from soil.
5. Alcohol fermentation by yeast, and quantification of ethanol.
6. Citric acid fermentation by *Aspergillus niger* and quantification.
7. Microbial fermentation of curd.

Evolutionary Biology & Biostatistics

1. Biometry analysis: Rationale, collection of data, statistical analysis, and interpretation.
2. Population Genetics: Techniques, genotype analysis, heterozygosity, polymorphism.

3. Natural Selection: Experiments that simulate the effects of natural selection and adaptation in changing environments.
4. Phylogeny Reconstruction: Application of phenetic and cladistic methods to a group of mock "organisms."
5. The Evolution of *Homo sapiens:* Discussion of human origins and our relationship to the evolutionary process
6. Data collection – processing – dendrogram, bar diagram
7. ONEWAY ANOVA test
8. Student-t test
9. Chi square test to prove Nul hypothesis.

13.Genomics & Proteomics

Unit I: Structure and organization of prokaryotic and eukaryotic genomes. Definition of genomics and proteomics. Nucleotide sequencing methods, automated sequencing, Approaches to whole genome sequencing.

Unit II: Transcriptomics – transcript analysis – global gene expression analysis, micro arrays – differential gene expression. Non array based whole transcriptome analysis, differential display, serial analysis of gene expression (SAGE).

Unit III: Proteomics – Protein analysis – Proteome – 2D analysis of proteins – differential display proteomics, protein – protein interactions, yeast two – hybrid system and phage display. Computational approaches to protein interaction. Liquid chromatography – Mass spectrometry based high throughput proteome analysis.

Unit IV: Human genome and science after genome era, pharmacogenomics – high throughput screening for discovery and identification of drugs. Drug targets and development. SNP analysis.

Unit V: Metabalomics and networks Systems biology principles. Computational approaches to phenomics. Phylogenomics.

REFERENCES:

1. Proteomics Research: New Frontiers in Functional Genomics (Principles and Practice) (1997). Edited by M.R. Wilkins. K.L. Williams, R.D. Apel and D.F. Hochstrasser, Springer Verlag, New York.

2. Expression Genetics : Accelerated and High Throughput Methods (1999) Edition by M.McClelland and Arthur Pardee, Biotechniques Press, Eaton Publishing.
3. 2-D Proteome Analysis Protocols Edited by Andrew J.Link, 1998. Humana Press.
4. DNA microarrays: A practical approach (1999). Edited by Mark Schena, Oxford University Press, Oxford, England.
5. Reviews and articles from Journals such as Nature, Sciences, PNAS (USA), Nuclei Acids Research, Trends Series & Current Opinion Series.

14.Plant Molecular Biology & Biotechnology

Objectives
To facilitate the students to

- Understand the basics of plant Molecular biology
- Widen their knowledge in classical plant Biotechnology
- Become familiar with plant tissue culture methods
- Enabling their knowledge in plant biotechnology

Unit I: Plant genome organization: Introduction, structural features of a representative higher plant gene. Gene families in plants. Regulation of gene expression in plant development.

Unit II: Organelle genetics: organization of chloroplast genome, nucleus encoded and chloroplast encoded genes for chloroplast proteins, targeting of proteins to chloroplast. Organisation of mitochondrial genome, nuclear and mitochondria encoded genes for mitochondrial proteins, targeting protein into mitochondria. Cytoplasmic male sterility and its role in plant breeding.

Unit III: Plant – Microbe interactions: Symbiotic nitrogen fixation in legumes by Rhizobia – biochemistry and molecular biology. Agrobacterium and crown gall tumours. Mechanisms of T-DNA transfer to plants. Ti-plasmid vectors for plant transformation – agroinfection.

Unit IV: Plant tissue culture: Plant cell, tissue and organ culture and its applications. Totipotency, de-differentiation and re-differentiation. Types of cultures – callus, cell suspension, protoplast, anther, microspore etc., Somatic embryogenesis and organogenesis. Culture media – types, role of hormones. Somaclonal variation and its application.

Unit V: Genetic engineering in plants: Introduction and applications. Methods of transformation, selectable markers, reporter genes and promoters used in plant vectors. Genetic engineering of plants for virus resistance, pest resistance, herbicide tolerance, resistance to fungi and bacteria, delay of fruit ripening. Molecular biology of plants stress response: engineering plants against abiotic stress. Management aspects of plant genetic engineering.

REFERENCES:

1. Plant Molecular Biology by Grierson and S. Covey (1988) Blackie.
2. Plant Biochemistry and Molecular Biology by P.J. Lea and R.C. Leegood (1993) John Wiley & Sons.
3. Plants, Genes and Agriculture by M.J. Chrispeels and D.F. Sadava (1994) Jones Jones and Barlett.
4. Molecular Genetics of Photosynthesis by B. Anderson, H.Slater and J.Barber (1996), IRL Press, Oxford.
5. Biochemistry and Molecular Biology of Plants by Buchanan, B.B., W. Gruissen and And R.L.Jones (2000), American Society of Plant Biology, Rockilled, Md, USA.
6. Plant Biotechnology Vol.1: Plant genetic engineering by Grierson, D., (Ed) (1994) Blackie.
7. DNA finger printing in Plants and Fungi by Weising, K., Nybom, H., Wolff, K., and Meyer, W., (1994) CRC press.
8. Applied Plant Biotechnology by Ignacimuthu, S., (1996) Tata McGrawhill.
9. Agricultural Biotechnology by Purohit, S.S., (2003) Agrobios India.
10. Plant Molecular Biology and Biotechnology, A.Slater, N.Scott and M.Flower (2003) and Oxford University Press, Oxford.

15. : Evolutionary Biology & Biostatistics

Unit-1: Chemical origin of life; for information about DNA, Introduction to evolution, Theories of evolution – Lamarckism – Darwinism - de Vries theory of mutation; Modern synthetic theory of evolution. Mimicry and animal colouration.

Unit-2: Population Genetics Speciation - concept, Isolating mechanisms, Extinction. Population Characteristics- Population Growth - Population Regulation - Human Impact. Community Structure, Disturbance & Nonequilibrium. Trophic structure & Energy - Nutrient Cycles.

Unit-3: Introduction to Biostatistics; Data - Types of Data, Presentations - Tables , Frequency Distributions , Relative Frequency, Graphs, Bar Charts , Histograms, Frequency Polygons, One-Way Scatter Plots , Two-Way Scatter Plots, Line Graphs.

Unit-4: Numerical Measures - Measures of Central Tendency – Mean, Median, Mode; Measures of Dispersion – Range, Variance and Standard Deviation, Coefficient of Variation.

Unit-5: Testing of hypothesis**:** i) One and two tailed tests. ii) Z-test. iii) Students t-test. iv) F-test. v) Chi-square test, One Way ANOVA, Correlation & Regression analysis

References

1. Marcello Pagano, Kimberlee Gauvreau, Principles of Biostatistics, Second Edition**.** 2018 by Chapman and Hall/CRC
2. Marcello Pagano, Kimberlee Gauvreau, Principles of Biostatistics (with CD-ROM) 2nd Edition. 2010.
3. B.Annadurai, Biostatistice, 2007, New Age Publishers.
4. Introduction of biostatistics& computer science-Y.I.Parakar & M.G Dhanyagude NiraliPrakasahan publishers,pune
5. Biostatistics by K.S.Negi AITBS publications& distributors, New Delhi Bishop O.N.statistics for Biology. Boston, Hollghtan, Mifflin.
6. Introduction to Biostatistics by pranabkumar, S.Chand company Ltd.New Delhi.
7. Arumugam, N. 1989. Organic Evolution –. Saras publication, Nagercoil.
8. Strickberger, M.W. 2000. Evolution. Jones and Bartlett Publishers.

SKILL BASED SUBJECTS

1. BASICS OF COMPUTER APPLICATION & BIOINFORMATICS

Unit-1: Introduction to Computer: History of development of computers - Computer system concepts - Capabilities and limitations. Basic components of a computer system – Control Unit, ALU, I/ O Devices, memory – RAM, ROM, EPROM, PROM, Flash Memory and other types of memory. Storage Devices - Primary Vs Secondary, Data Storage and Retrieval methods – Sequential, Direct and Index Sequential

Unit – II Computer Software: Types of Software – System software, Application software, Utility Software, Demoware, Shareware, Freeware, Firmware, Free Software. Operating Systems –

Functions, Types – Batch Processing, Single User, Multi User, Multiprogramming, Multi-Tasking. Programming languages – Machine, Assembly, High Level, 4 GL.

Unit III: Databases: Concepts, architecture, features – management- security – Collection and Storage. Biological databases – sequence, structure – genomics, pathways, biodiversity, formats; access; annotation.

Unit IV: Nucleic acid sequence analysis: DNA sequencing, assembly, restriction mapping, primer design, ORF prediction, transcriptional and translational signals, gene identification. Protein sequence analysis: composition, molecular weight, Pl, extinction coefficient, peptide mapping, hydrophobicity analysis of protein secondary structure, motifs.

Unit V: Sequence comparison and database searching: Scoring matrices: pairwise alignment – dot plot, global, local, multiple sequence alignment: BLAST and FASTA searches: statistical and functional significance.

REFERENCES:

1. Claverie J.M. and Notredome C (2003) Bioinformatics – a beginners guide. Wiley Publishers Inc.
2. Hogwins D and Taylor (2000). Bioinformatics: sequence, structure and databanks - a practical approach, Oxford University Press.
3. Gautham N (2005), Bioinformtaics, Norasa Publishers.
4. Altwood, TK and Parry-smith, DJ (2001), Introduction to Bioinformatics. Prentice Hall.
5. Sinha, P.K.(2007). *Computer Fundamentals*. New Delhi: BPB Publications.
6. Mukhi, Vijay (2008).*Working with UNIX*. New Delhi: BPB Publications.
7. Rajaraman, V. (2014). *Fundamental of Computer*. New Delhi: Prentice Hall India Pvt. Limited.
8. Rajoriya, Sheetanshu (2013). *Computer Fundamentals*. Indore: Kamal Prakashan.

2. NATURAL PRODUCTS (SECONDARY METABOLITES)

Unit I: Primary and secondary metabolites, terpenoids, synthesis of IPP, prenyltransferace and terpene synthase reactions, modification of terpenoid skeletons, transgenic terpenoid production.

Unit II: Alkaloids, alkaloid biosynthesis, biotechnological applications of alkaloid biosynthesis – medically important alkaloids from plants and microbes, Commercial alkaloid drugs from natural sources.

Unit III: Phenylpropanoid and phenypropanoid pathway- matabolites and biosynthesis. Diketopiperazines – bio synthesis and uses. Lantibiotics – sources, types and applications.

Unit IV: Biosynthesis of lignans, lignins and suberization. Flavonoids, Coumarines, Stilbenes, Styrylpyrones and Arylpyrones - medicinal values. Carotenoids – types and its commercial uses.

Unit V: Metabolic engineering of phenylpropanoid production-enhanced fibers, pigments, pharmaceuticals and flavouring agents.

References:

1. Biochemistry and Molecular Biology of Plants. 2000. B.B. Buchanan. W. Gruissem and R.L. Jones (Eds) I.K. International Press Pvt Ltd, New Delhi.
2. James Ralph Hanson, Natural Products: The Secondary Metabolites. Royal Society of Chemistry, 2003
3. Alan Crozier, Michael N. Clifford and Hiroshi Ashihara, Plant Secondary Metabolites: Occurrence, Structure and Role in the Human Diet. 2006 by Blackwell Publishing Ltd
4. Jun-ichiNagao, Properties and Applications of Lantibiotics, a Class of Bacteriocins Produced by Gram-positive Bacteria. Journal of Oral Biosciences. Volume 51, Issue 3, 2009, Pages 158-164
5. Champak Chatterjee, Moushumi Paul, Lili Xie, and Wilfred A. van der Donk, Biosynthesis and Mode of Action of Lantibiotics. *Chem. Rev.*, 2005, 105 (2), pp 633–684.
6. Reinhold Carle and Ralf M. Schweiggert Handbook on Natural Pigments in Food and Beverages. Industrial Applications for Improving Food Color, 2016 Elsevier Ltd..

3. TISSUE CULTURE TECHNIQUES

Unit I : Totipotency, macro and micro nutrients, tissue culture media, sterilization methods, tissue culture room, greenhouse.

Unit II: Plant hormones and morphogenesis, direct and indirect organogenesis, direct and indirect embryogenesis, cell suspension culture.

Unit III: Micropropagation – shoot tip culture, somatic embryogenesis, artificial seeds. Commercial applications of micropropagation.

Unit IV : Virus elimination by shoot tip culture, wide hybridization and embryo culture, embryo culture and advancement of breeding cycles, anther culture and homozygous plants.

Unit V: Large-scale cell suspension culture, production of alkaloids and other secondary metabolites, protoplasts, somatic fusion – somatic hybrids and cybrids.

REFERENCES:

1. Plant Tissue Culture: Techniques and Experiments. 1992. R.H.Smith Academic Press, San Diego.
2. Experiments in Plant Tissue Culture, Third Edition. 1995. J.H. Dodds and L.W. Roberts. Cambridge Press, Cambridge.
3. Concepts in Biotechnology, 1996. D. Balasubramanian et al (Eds). COSTED-IBN – University Press, Hyderabad.
4. Text Book of Biotechnology, 2004. H.K. Das (Ed). Wiley Dream Tech India Pvt. Ltd., New Delhi.

4. FOOD TECHNOLOGY

Unit-1: Introduction to food technology – scope and applications. Nutrition – types of Nutrition, Food used in different ages – infants, children, school age, adult. Factors determine the quality of food – intrinsic and extrinsic factors.

Unit-2: Microbial fermentation of food: Curd, yogurt and sauerkraut, Bread, Beer, Cheese, Pickle, Kefir, Kimchi, Soy sauce, rice wine, malt whisky- process and uses.

Unit-3: Common Food borne Bacteria, & illus: Molds and yeasts, Role, Significance of Microorganisms in Foods. Food borne pathogens - Campylobacter, Bacillus, Yersinia, Clostridium, Enterobacter, Listeria, Salmonella, Shigella, Legionella, Vibrio, Staphyloccus, E.coli. Hepatitis, Amoebiosis and Mycotoxins.

Unit-4: Food Preservation & Principles: Physical Chemicals, Antibiotics, Bacteriocins. Applications of Probiotics and prebiotics,

Unit-5: Food quality assessment: Standards of food Quality. Pathogens test & Spoilage indicators. Chemical test – pesticides, antibiotics, heavy metals & adulterants. Nutritional tests-quality indicators, and labeling. Processed Food Audits - Good Manufacturing Practice (GMP)-Quality Management System & ethics.

References

1. Frazier and Westhoff, DC. 1988. Food Microbiology. TATA McGraw Hill Publishing Company LTD., New Delhi
2. Adams, M.R and Moss, MO. 1995. Food Microniology. The Royal Society of Chemistry, Cambridge
3. Maheshwary. Nutrition and dietetic. New Delhi

5. ADVANCED BIOTECHNOLOGY & ENZYME TECHNOLOGY

Unit-1: Metabolic engineering: Introduction, definition & scope. Metabolic flux analysis: Setting up a metabolic pathway for analysis, Analyzing a metabolic pathway, Determining the optimal genetic manipulations, Experimental measurements.

Unit-2: Applications of Nano-botechnology: Scope and Potential for Crop Improvement, Plant Disease Management, Medicine and Environment.

Unit-3: Biofuel technology: Importance and scope. Algal biodiesel – production, extraction and quality assessment. Hydrogen fuels, Bioethanol ffom agricultural waste. Future energy.

Unit-4: Applications of enzymes in food processing: Mechanism of enzyme function and reactions in process techniques; Enzymic bioconversions e.g. starch and sugar conversion processes; High - Fructose Corn Syrup; Interesterified fat; Hydrolyzed protein etc. baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing; cheese making by proteases and various other enzyme catalytic actions in food processing.

Unit-5: Enzyme Biosensors and their Biomedical Applications. Biosensors for Environmental Monitoring. Hybrid enzymes - RNAzymes and ABzymes.

References

1. Md Fakruddin, Zakir Hossain and Hafsa Afroz, Prospects and applications of nanobiotechnology: a medical perspective. Journal of Nanobiotechnology 2012, 10:31
2. Faheem Ahmed, Nishat Arshi, Shalendra Kumar, Sarvajeet Singh Gill, Ritu Gill, Narendra Tuteja and Bon Heun Koo. 2013. Nanobiotechnology: Scope and Potential for Crop Improvement. N. Tuteja, S. S. Gill (eds.), *Crop Improvement Under Adverse Conditions*, Springer Science+Business Media New York .
3. Mujeebur Rahman Khan and Tanveer Fatima Rizvi. Nanotechnology: Scope and Application in Plant Disease Management. Plant Pathology Journal. 2014. 13 (3): 214-231
4. Parikha Mehrotra. Biosensors and their applications – A review. J Oral Biol Craniofac Res. 2016 May-Aug; 6(2): 153–159.
5. Gaia Rocchitta,* Angela Spanu, Sergio Babudieri, Gavinella Latte, Giordano Madeddu, Grazia Galleri, Susanna Nuvoli, Paola Bagella, Maria Ilaria Demartis, Vito Fiore, Roberto Manetti, and Pier Andrea Serra. Enzyme Biosensors for Biomedical Applications: Strategies for Safeguarding Analytical Performances in Biological Fluids. Sensors (Basel). 2016 Jun; 16(6): 780.

6. Celine I. L. Justino, Armando C. DuarteIand Teresa A. P. Rocha-Santos, Recent Progress in Biosensors for Environmental Monitoring: A Review. Sensors 2017, 17, 2918; doi:10.3390/s17122918

6. Bioethics, Biosafety and IPR

Unit-1: Bioethics: Ethical conflicts in biological sciences - bioethics in health care, Artificial reproductive technologies, Ethics in transplantation and stem cell research. Animal rights/welfare, Agricultural biotechnology - Genetically engineered food, environmental risk. Protection of environment and biodiversity – biopiracy.

Unit-2: Biosafety: Ethical issues concerning biotechnology, Primary containment for biohazards, Recommended biosafety levels for specific microorganisms, Biosafety guidelines for industrial operations with GMOs, Field trial of GM crops.

Unit-3: Food safety issues: Environmental risk assessment and food and feed safety assessment, Balance of genetically altered and natural population in an ecosystem, Safety of modified crops, Livestock as food and their nutritional values, Social and economic effects.

Unit-4: IPR: Different forms of IPR; General concept of patenting; Indian Patent Act 1970; Current Indian patent law, rules and regulation. Basics of patents: types of patents; recent amendments; WIPO Treaties; Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; procedure for filing a PCT application.

Unit-5: Role of a Country Patent Office; filing of a patent application. Examples for any plant, microbe, animal patents, Patenting of drugs, Food products, new inventions.

References

1. Rajmohan Joshi, Biosafety And Bioethics 01 Edition, 2006. Isha Books.
2. M.K. Sateesh, Bioethics and Biosafety 2008 . I K International Publishing House.
3. Goel And Parashar, IPR, Biosafety and Bioethics, 1e Paperback – 2013, Pearson.

Part III Allied Subjects -1

Please refer B.Sc. Chemistry Syllabus vide Appendix - BH (Page No. 2043 to 2050)

(Part III Allied Subjects -2

Please refer B.Sc. Ancillary Biology Syllabus vide APPENDIX – CE (Page No.2687 to 2692)
(for Biochemistry, Microbiology and Biotechnology Majors)

PART-IV: Non-Major Electives

1. INFECTIOUS DISEASES

Unit I: Distribution of pathogenic microorganisms and ubiquitous nature of pathogens, history of infectious and their invasiveness. Interaction between host and infection agent.

Unit II: Mycobacterium, Corynebacterium and leptospirosis and Streptococcal infections, laboratory identification, epidemiology and control measures.

Unit III: Pathogenesis, occurrence, epidemiology and treatment of histoplasmosis, aspergillosis and candidiasis.

Unit IV: Pathogenesis, distribution and diagnostic measures of malaria, amebiasis and ascariasis.

Unit V : Nosocomial infections, Salmonellosis, botulisom, history of viral diseases, smallpox, AIDS, Antiviral drugs and prevention.

REFERNCES:

1. Sheehan, C.(1997) Clinical Immunology. Principles and Laboratory diagnosis, second Edn. Lipincott Williams and Wilkins, New York.
2. Boyd, RF. And Hoer, BG. (1991) Basic Medical Microbiology. 4th Edn. Little Brown and Co. New York.

2. GENES TO PROTEINS

Unit I: Introduction to cell, nucleus, chromosome, chromatin, mitosis and meiosis, Mendelian laws of inheritance, monohybrid ratio.

Unit II: Discovery of DNA as genetic material, one gene one enzyme hypothesis. DNA double helix, DNA replication, mutation.

Unit III: Protein is made up of amino acids, genetic code, mRNA, tRNA ribosomes and rRNA, codon (mRNA) – anticodon (tRNA) – amino acid relationship.

Unit IV: Transcription, RNA polymerase, Escherichia coli gene, promoter, coding sequence, regulation of transcription in lac operon, oncogenes and cancer.

Unit V: Translation – intiation, elongation and termination. Mutations alter amino acids. Recombinant DNA, plasmid vector, restriction enzyme and ligation. Expression of human insulin in E.coli.

REFERNCES:

1. Molecular biology of the gene. Sixth Edition. 2007. J.D. Watson et al (ed). Benjamin Cummings Publishing Company Inc., New York
2. Molecular Biology of the Cell. Fourth Edition. 2002. Albert et al (ed). Garland Publishing Inc., New York.
3. Genes. VIII Edition 2004. B. Lewin and C. Jones. Barlett Publisher. Boston 2008.