

*Placed at the meeting of
Academic council
held on 26.03.2018*

APPENDIX-AL
MADURAI KAMARAJ UNIVERISTY
(University with Potential for Excellence)

MODIFIED SYLLABUS FOR B.Sc. BIOCHEMISTRY
CBCS SEMESTER PATTERN
(w.e.f. 2018-19)

1. Introduction of the Programme

The Bachelor of Science in Biochemistry is a full- time programme spread over 3 years and is divided into 6 semesters. The programme of study shall consist of 14 Core papers which are compulsory, 12 Allied papers, 1 Elective paper, 2 Non major Elective, 5 Skill Based papers, 2 mandatory papers under Part-IV (Value Education and Environmental Studies) and 1 under Part-V Extensive Activities. Each of these carries 100 marks. It has been developed to provide students the opportunity to be trained in recent development in Biochemistry. The course is designed to impart the students a vigorous training in Biochemistry both in theory and experiments. Our approach is a comprehensive one. It is believed that teaching students both how to ask and address questions. This Programme has been designed to expose students knowledge in Biochemistry to contemporary national and international problems. At the end of the course, students are expected to have state- of- the- art quantitative skills valued both in academia and in the corporate world. During the course time, one gets as in-depth knowledge about core subjects like Biochemistry, Molecular Biology, Microbiology and Immunology.

2. Eligibility for Admission

Candidate should have passed the higher secondary examinations conducted by the Board of higher secondary Education, Govt. of Tamilnadu or any other examination accepted by the syndicate as equivalent there to

- a) Biology/physics/ chemistry as subjects in the higher secondary education
- b) Candidates should have secured at least 50% in the above subjects and above in the aggregate
- c) A relaxation of 10% marks in the aggregate will be given to SC/ST candidates
- d) Candidates sponsored by the industrial / hospitals/clinical laboratories may also considered for admissions.

3. Objectives of the Programme

- To offer the knowledge, understanding and skills to UG students.
- To offer a balance between Theoretical and Experimental –Biochemistry.
- To improve the employability of the students
- To develop core competencies on critical thinking skills, hypothesizing and solving problems.

4. Outcome of the Programme

- It serves as a basis to build a purely academic profile for further studies and research in Masters in Biochemistry.
- On successful completion of this course, one can apply for the Masters in Biochemistry. The degree holders can opt for further higher studies and career in various specializations of Biochemistry and Biotechnology

5. Core Subject Papers

Core Subject papers shall consists of 14 papers as listed below.

1. Biomolecules
2. Enzymes
3. Biochemical Techniques
4. Major- Lab-I
5. Metabolism
6. Microbiology
7. Major- Lab -II
8. Molecular Biology
9. Immunology
10. Plant Biochemistry
11. Biotechnology
12. Clinical Biochemistry
13. Major-Lab - III
14. Major Lab - IV

6. Allied Subject Papers

Allied papers shall consists of 124 papers as listed below.

1. Chemistry- Theory I
2. Chemistry- Theory II
3. Chemistry Lab I
4. Chemistry- Theory III

5. Biology - Theory I
6. Chemistry - Theory IV
7. Chemistry - Lab II
8. Biology - Theory II
9. Biology Lab I
10. Biology - Theory III
11. Biology - Theory IV
12. Biology - Lab II

Major Elective

1. Food Technology

7. Non-major Electives

1. Health and Human Disease
2. Herbal Medicine

Skill Based Electives

Skill Based Elective shall consists of 5 papers as listed below.

1. Biostatistics
2. Nutrition
3. Medical Lab Technology
4. Bioinformatics
5. Endocrinology

Part-IV: 1. Value Education, 2. Environmental Studies

Part-V: Extension Activities

8. Unitization

Each subject Paper consist of five units. One unit (Preferably the 5th unit) will be handled by the students as a part of peer team teaching/learning process.

9. Pattern of Semester Examination

Three-year B. Sc., Biochemistry degree shall be having examinations of 14 Core papers, 12 Allied subjects, 1 Subject- Elective papers, 2 Non- Major Elective papers, 5 Skill Based Elective paper, 2 mandatory papers under Part-IV (Value Education and Environmental Studies) and 1 under Part-V Extensive Activities to be conducted in six semesters. First, third and fifth semester examinations shall be conducted in the month of November. The second, fourth and sixth semester examinations shall be held in the month of April. Each paper shall carry 100 marks of which 25 marks for internal assessment and 75 marks for external examinations for all the theory papers. For practicals, 40 marks for internal and 60 marks for external.

10. Scheme of Internal Assessment

The components of Internal Assessment marks shall be as follows, for theory.

Test	: 10 Marks (Average of the best two tests)
Assignment	: 5 Marks
Seminar/ Group Discussion/Quiz	: 5 Marks
Peer Team Teaching	: 5 Marks
Total	: 25 Marks

For practical's, 40 marks is for internal.

11.External Examinations

External examination for each Theory paper shall be conducted for 75 marks.

Section A: 10 Multiple choice questions (One question from each unit) ($10 \times 1 = 10$ marks)

Section B: 5 either/ or type questions (One question from each unit) ($5 \times 7 = 35$ marks)

Section C: 3 out of 5 questions. This may include 2 problems. ($3 \times 10 = 30$ marks)

Total : 75 Marks.

12. Question paper pattern

a) For all 3 credits and above courses

The existing pattern of question paper will be as follows:

Time : 3 Hours

Max Marks : 75

Section A : ($10 \times 1 = 10$ Marks)

Question No. 1 to 10

1. Two questions from each unit.
2. Four choices in each question.
3. Answer all questions. Choose the write answer.

Section B: ($5 \times 7 = 35$ Marks)

Answer all questions – Either or types

Answer not exceeding two pages.

(one question from each unit)

Question NOs.

11a or 11b

12a or 12b

13a or 13b

14a or 14b

15a or 15b

Section C: ($3 \times 10 = 30$ Marks)

Answers not exceeding four pages

Answer any **THREE** out of Five (one question from Each Unit)

Question Nos. 16-20

b) Practical Exams : External (Max: 60 marks)

Practical Exams: External (Max : 60 Marks)

One major experiment	= 25
One minor experiment	= 10
Two spotters	= 05
Record book	= 05
Viva voce	= 15

The pattern for **internal valuation** for 40 marks may be:

- a) Two internal tests of 25 marks each : Average = 25 marks
- b) Observation book = 10 mark
- c) One assignment = 05 marks

13. Scheme of Evaluation

Students shall be evaluated on the basis of internal tests, seminar, and assignment, peer-teaching and external examinations. Question paper setters shall be requested to prepare scheme of valuation for all the papers.

14. Passing Minimum

To get a pass, a student should fulfill the following conditions:

A) Theory:

- 1. 40% of the aggregate (External + Internal).
- 2. No separate pass minimum for internal
- 3. 27 marks out of 75 is the pass minimum for the External.

B) Practicals :

- 1. 40% of the aggregate (External + Internal)
- 2. **No separate pass minimum for the internal**
- 3. 21 marks out of 60 is the pass minimum for the External

C) Project:

- 1. 40% of the aggregate (project evaluation + Viva- voce).
- 2. No separate pass minimum for viva -voce
- 3. 28 mark out of 80 is the pass minimum for the project evaluation.

15. Model Question paper

Maximum Time: 3 hrs

Maximum Marks: 75

Section A

Answer All Questions

All multiple choice Questions

(10 × 1= 10 Marks)

Two Questions from each Unit

(Questions are numbered from 1 to 10)

Section B

Answer All Questions

(Either/ or type: either (a) or (b))

(5 × 7= 35 Marks)

One question from each Unit

Questions are numbered from 11 to 15)

Section C

Answer any three Questions

One question from each Unit

(3 × 10= 30 Marks)

(Questions are numbered from 16 to 20)

16. Teaching Methodology

Methodology shall consist of stimulation of students' interest, presentation of teaching material, team formation and activities' determination, conduction of activities and discussion and assessment. For the sake of simplicity and easy understand, the methods like problem solving, discussion, lab demonstration and lecture method shall be adopted. The use of ICT shall be co- opted for the visual presentation of the lessons. One unit (mostly 5th unit will be handled by the students).

17. Text Books: The list of text books is given at the end of syllabus of each paper.

18. Reference Books: The list of reference books is given at the end of syllabus

19. Re-totaling and Revaluation Provision

Students shall be provided the facility of applying for retotaling the marks within 15 days after the publication of results on payment of a minimum fee fixed by the University and they shall be allowed to apply for revaluation of their papers within 15 days after the publication of results on payment of a fee to be fixed by the University.

20. Transitory Provision (3+3): Syllabus revision shall be done once in 3 years and afterwards 3 years shall be under transitory provision.

21. Subjects and paper related websites

The related websites for each paper shall be provided at the end of the syllabus wherever necessary.

FIRST SEMESTER

Title of the paper	Weekly content hours	No. of Credits	Examination Hours	Marks		
				Internal	External	Total
<u>Part I</u>						
Tamil	6	3	3	25	75	100
<u>Part II</u>						
English	6	3	3	25	75	100
<u>Part III</u>						
<u>Core Subjects</u>						
Biomolecules	4	4	3	25	75	100
Enzymes	4	4	3	25	75	100
Major Lab-I	2	-	-	-	-	-
<u>Allied Subjects</u>						
Chemistry Theory-I	4	4	3	25	75	100
Chemistry Lab -I	2	-	-	-	-	-
<u>Part IV</u>						
Value Education	2	2	3	25	75	100
Total	30	20				600

- Tamil and English syllabi and workload are as per the other degree courses.
- The Allied-I (Chemistry) and Allied-II (Biology) syllabi are as per other degree courses

SECOND SEMESTER

Title of the paper	Weekly cont	No. of Credits	Examination Hours	Marks		
				Internal	External	Total
<u>Part I</u>						
Tamil	6	3	3	25	75	100
<u>Part II</u>						
English	6	3	3	25	75	100
<u>Part III</u>						
<u>Core Subjects</u>						
Biochemical Techniques	4	4	3	25	75	100
Major Lab-I	2	3	3	40	60	100
<u>Allied Subjects</u>						
Chemistry Theory-II	4	4	3	25	75	100
Chemistry Lab-1	2	1	3	40	60	100
<u>Skill Based Electives</u>						
Biostatistics	2	2	3	25	75	100
Nutrition	2	2	3	25	75	100
<u>Part-IV</u>						
Environmental Studies	2	2	3	25	75	100
Total	30	24				900

THIRD SEMESTER

Title of the paper	Weekly conten	No.of Credits	Examinatio n	Marks		
				Internal	External	Total
<u>Part I</u>						
Tamil	6	3	3	25	75	100
<u>Part II</u>						
English	6	3	3	25	75	100
<u>Part III</u>						
<u>Core Subjects</u>						
Metabolism	4	5	3	25	75	100
Major Lab -II	2	-	-	-	-	-
<u>Allied Subject</u>						
Chemistry Theory –III	4	4	3	25	75	100
Chemistry Lab-II	2	-	-	-	-	-
Biology Theory – I	4	4	3	25	75	100
Biology Lab-I	2	-	-	-	-	-
Total	30	19				500

FOURTH SEMESTER

Title of the paper	Weekly conten t	No. of Credit s	Examinatio n	Marks		
				Internal	External	Total
<u>Part I</u>						
Tamil	6	3	3	25	75	100
<u>Part II</u>						
English	6	3	3	25	75	100
<u>Part III</u>						
<u>Core Subjects</u>						
Microbiology	4	4	3	25	75	100
Major Lab -II	2	3	3	40	60	100
<u>Allied Subjects</u>						
Chemistry Theory- IV	4	4	3	25	75	100
Chemistry Lab- II	2	1	3	40	60	100
Biology Theory - II	4	4	3	25	75	100
Biology Lab-I	2	1	3	40	60	100
<u>Part-V</u>						
Extension Activities	-	1	3	100		100
Total	30	24				900

FIFTH SEMESTER

Title of the paper	Weekly content hours	No. of Cred	Examination	Marks		
				Internal	External	Total
<u>Part III</u>						
<u>Core Subjects</u>						
Molecular Biology	4	4	3	25	75	100
Immunology	3	4	3	25	75	100
Plant Biochemistry	3	4	3	25	75	100
Major Lab – III	4	-	-	-	-	-
Major Lab -IV	4	-	-	-	-	-
<u>Allied</u>						
Biology Theory -III	4	4	3	25	75	100
Biology Lab-II	2	-	-	-	-	-
<u>Non-Major Elective -I</u>						
Health and Human Diseases	2	2	3	25	75	100
<u>Skill Based Electives</u>						
Medical Lab Technology	2	2	3	25	75	100
Bioinformatics	2	2	3	25	75	100
Total	30	22				700

SIXTH SEMESTER

Title of the paper	Weekly content	No. of Credits	Examination Hours	Marks		
				Internal	External	Total
<u>Part III</u>						
<u>Core Subjects</u>						
Biotechnology	4	4	3	25	75	100
Clinical Biochemistry	4	4	3	25	75	100
Major Lab – III	4	5	3	40	60	100
Major Lab-IV	4	5	3	40	60	100
<u>Elective</u>						
Food Technology	4	4	3	25	75	100
<u>Allied</u>						
Biology Theory - IV	4	4	3	25	75	100
Biology Lab - II	2	1	3	40	60	100
<u>Skill Based Electives</u>						
Endocrinology	2	2	3	25	75	100
<u>Non-Major Elective-II</u>						
Herbal Medicine	2	2	3	25	75	100
Total	30	31				900

FIRST SEMESTER - MAJOR BIOCHEMISTRY- THEORY

Core Subjects: BIOMOLECULES

Unit I

Carbohydrates and polysaccharides- occurrence and general importance of carbohydrates- Basic structure of glucose, its isomer and epimers and linkages- Biologically important disaccharides like lactose, maltose and sucrose. Polysaccharides- energy storage polysaccharides, starch and glycogen- structural polysaccharide- cellulose.

Unit II

Lipids- Fatty acids- Classification of some naturally occurring Fatty acids into saturated acids, unsaturated acids into, branched chain acids, hydroxyl and keto derivatives and cyclic acids- Physical properties of fatty acids- Polymorphism, solubility, boiling point, absorption, spectrochemical properties of fatty acids- Salt detergents and wetting agents, esters- reactions of unsaturated fatty acids- hydrogenation, halogenations and oxidation. –Fats- Chemical composition, Physical and chemical properties of fats- Waxes- phospholipids- Classification- non phospholipids- steroids.

Unit III

Amino acids and proteins- Common amino acids of proteins- Physical properties of amino acids- solubility, electrical properties, fundamental role of proteins in life- Composition of proteins- General properties of proteins- Rudimentary treatment of structure, classification of the proteins on the basis of their biological functions-.

Unit IV

Nucleic acids- fundamental role of nucleic acids in life processes- DNA and RNA- Structure of bases, nucleotides and nucleotides- bonds linking the various bases, primary, secondary and three-dimensional structures.

Unit V

Vitamins- Historical development to the discovery of vitamins- C- Brief mention of source and physiological role of- Fat soluble vitamins- Vitamin A, D, E, and K- Water soluble vitamins- Vitamin B complex, Vitamin C

References:

1. Biochemistry, Lehninger, A.L Nelson, Cox
2. Biochemistry, Lubert Stryer et al., Fifth edition, W.H. Freeman and company, New York, 2003.
3. Outlines of Biochemistry E.E.Conn and Stump, Fourth edition, Wiley Eastern Limited, 1989.
4. Fundamentals of Biochemistry by J.L.Jain.
5. Biochemistry, Donald Voet & Judith Voet, Wiley International Edition, 2004.

ENZYMES

Unit I

Nomenclature and Classification, Function, isolation, purification and Characterization of Enzymes.

Unit II

Enzyme specificity- Enzyme reactions oxidation, and reduction, isomerisation, phosphorylation, acetylation and methylation, dehydration, decarboxylation, transamination.

Unit III

Enzyme substrate complexes- Michaelis and Menten kinetics: Determination of K_m and V_{max} - line Weaver Burk plot- Factors influencing Enzyme reactions, Enzyme inhibition.

Unit IV

Mechanism of Enzyme actions, Role of coenzymes in Enzyme reactions -

Eg: CoenzymeA, NAD, FAD only -Zymogens.

Unit V

A brief account of clinical and industrial application of Enzymes-Enzyme immobilization and its application- Biosensors and their applications.

References:

1. Enzymes- Nicholas Price.
2. Enzyme structure and Mechanism by Allan Fersht.
4. Biochemistry, Lehninger, A.L Nelson, Cox
5. Biochemistry, Donald Voet & Judith Voet, Wiley International Edition, 2004.

Allied Subject

CHEMISTRY - I

CHEMISTRY LAB - I

Part IV: VALUE EDUCATION

SECOND SEMESTER

Core Subject : BIOCHEMICAL TECHNIQUES

Unit I

Chromatography: Column, Paper and Thin layer chromatography, Adsorption Partition, Ion exchange, Gas chromatography and HPLC, Gelfiltration. Dialysis

Unit II

Electrophoresis – Principles – Instrumentation, Application of different types of Electrophoresis – Agarose, SDS PAGE. Principles and application of PCR.

Unit III

Centrifugation - Theory, relation between RPM and g- Differential centrifugation- other types- Different centrifuges. Measurement of Gases: Manometry.

Unit IV

Colorimetry: Light spectrum and its wavelength regions- Complementary colours. Molar Extinction co- efficient. Beer lambert's law and its application.

Unit V

Radioisotopes in Biochemistry: Radioactivity, Elementary units, Deduction and confirmation- Auto radiography, fluorography, Isotopic tracer technique, Isotope dilution method.

References:

1. Tools in Biochemistry. Terrance G.Cooper
2. Separation methods in Biochemistry. CJOR Morris and Maris
3. Spectroscopy in Biology and Chemistry. Sow Hsinchem and Siney YI
4. The use of radioactive isotopes in the life sciences. Chapman and Aecrey
5. Manometric and Biochemical techniques. Umbrit and Burris
6. Practical Biochemistry, Wilson and Walker
7. Modern Experimental Biochemistry 3rd edition, Rodney Boyer, Pearson education, 2004.

Major Lab - I

1. Qualitative analysis of bioorganic compounds
 - a. Analysis of carbohydrates
 - b. Analysis of aminoacids
 - c. Test for proteins
 - d. Test for lipids - Test for cholesterol
 - e. Qualitative tests for DNA and RNA
2. Biochemical preparation
 - a. starch from potato
 - b. Lactose from milk
 - c. Casein from milk
 - d. Caffeine from coffee seeds

3. Use of pH meter for the preparation of buffer
4. Verification of Beer –Lambert’s law using colorimeter
 - i) Determining the concentration of any given coloured compounds using a standard graph.

Allied Subject: CHEMISTRY – II

Note: Chemistry practical syllabus will be as per the existing Syllabus.

CHEMISTRY LAB-I

Skill Based Elective

BIOSTATISTICS

Unit I:

Introduction: Basis of Statistics- Definition- Statistical Methods- Kinds of Biological Data Collection, organization and Representation of Data:

1. Collection of Data - Types of data: primary Data, Secondary Data- Methods of Collecting Data.
2. Sampling and Sampling Designs- Meaning and definitions- Random and Non random sampling.
3. Editing the Data: Definition for editing, Objectives of Editing, Problems of Accuracy, Problems of approximation and errors.
4. Classification of Data: Meaning, Definition, Objectives of classification of Data.
 - a. Ungrouped raw data- continuous- discrete variation.
 - b. Univariate frequency distribution, Continuous frequency distribution, discrete frequency distribution.
 - c. Cumulative frequency distribution.

Unit II:

Tabulation: Meaning and definition - of parts of table - advantages.

Representation of the Data:

Diagrammatic: simple bar diagram, Rectangles, squares, circles or Pie diagram - Graphic representation: Histogram, Frequency- Polygon frequency curve, cumulative frequency curve or O give curve.

Measures of central Tendency:

Explanation, Types of averages: 1. Arithmetic mean 2. Median 3. Mode Explanation problems related to: ungrouped data, Simple grouped data: continuous, discrete series.

Measures of Dispersion

Explanation, Types of dispersion: 1. Range, 2. Mean deviation 3. Standard deviation and Variance. Problems related to the above mentioned dispersion taking ungrouped data.

Unit III:**Measures of Symmetry:**

Explanation and definition, Explanation for Skewness, Kurtosis of different types moments, Tests of Skewness, Measures of Skewness, Measures of Kurtosis (problems not necessary).

Unit IV**Probability:**

Definition and Explanation:

1. Theorem and probability: addition theorem and multiplication theorem.
2. Types of theoretical distribution: Binomial distribution (simple problems, Poisson distribution and Normal distribution (explanation problems not necessary)).

Unit V:**Correlation and Regression****Correlation Explanation**

1. Types of Correlation: Positive and negative correlation- simple partial and multiple correlation- linear and non-linear correlation.
2. A method of studying correlation using Karl Pearson's co-efficient of correlation (simple problems related to correlation).

Regression analysis:

Explanation: Regression line - Regression equation: regression equation of X on Y, regression equation of Y on X.

References

1. Statistical methods- S.P. Gupta
2. Biostatistics - A foundation for analysis in health science – Daniel
3. Biostatistical Analysis, Jerrold H. Zar, Fourth edition, Pearson Education, 2004
4. Research methodology- R.C.Kothari
5. Biostatistics – Palanisamy
6. Biostatistics - Arumugam

NUTRITION

Unit I:

Food groups, food habits, food fads and fallacies, changing food habits. Carbohydrates: Kinds, Functions, food sources- Fats: Kinds, Functions, food sources, essential fatty acids and cholesterol

Unit II:

Proteins: Kinds, Functions, food sources, complete and incomplete proteins- Energy: Basal metabolism, measurement of BMR, factors affecting BMR, regulation of body temperature, energy needs, total energy requirement and energy value of foods.

Unit III:

Protein nutritional Nitrogen balance, Quality of food proteins and requirements, Protein nutrition abnormalities, Protein deficiency disorder, PEM- Balanced diet formulation- Assessment of nutritional status

Unit IV:

Nutrition at various stages of growth and development- Diets for infants, children, adolescents, pregnant women, lactating mothers and older persons.

Unit V:

Nutritional challenges of the future: Food production and food storages, future foods, new protein foods.

References:

1. Principles of Nutrition Determination Dietetics- Dr.M.Swaminathan
2. Advanced Textbook on Food and Nutrition- Vol-I&II, Dr.M.Swaminathan, second edition.
3. Normal and Therapeutic Nutrition- Corine Robinson.

PART IV : ENVIRONMENTAL STUDIES: COMMON SYLLABUS

THIRD SEMESTER

Core Subject : METABOLISM

Unit I:

Bioenergetics: High energy and low energy phosphates; Electron Transport chain, Oxidative phosphorylation.

Unit II:

Carbohydrate metabolism: Conversion of simple sugars into glucose, Glycolysis, TCA cycle, Energetics of TCA cycle, HMP shunt, Glyconeogenesis, Glycogenolysis, Gluconeogenesis.

Unit III:

Lipid metabolism: Oxidation of Fatty acid, energetics of oxidation, ketone body metabolism, Glycerol metabolism, Biosynthesis of Triglycerides, phospholipids, Cholesterol metabolism (Structure is not needed)

Unit IV:

Amino acid metabolism: A brief account of amino acid metabolism of Glycine, Cysteine, Proline, Homoserine, Phenylalanine only.

Unit V:

Nucleic acid metabolism - Purine and pyrimidine bases – Biosynthesis of purine, pyrimidine – biosynthesis of DNA and RNA –

References:

1. Harper's Illustrated Biochemistry- 26th edition, Robert K.Murray, Peter A.Meyes, Victor W.Rodwell. 2003
2. Principles of Biochemistry- Albert L.Lehninger. 2003
3. Bender, David, A, Amino acid Metabolism, Willey (1985).
4. Biochemistry by Devlin
5. Biochemistry, Donald Voet & Judith Voet, Wiley International Edition, 2004.
6. Biochemistry, Lubert Stryer et al., Fifth edition, W.H. Freeman and company, New York, 2003.

Major Lab II

Analysis of Lipids:

- a. Determination of iodine number
- b. Determination of saponification number.
- c. Estimation of total cholesterol.

Analysis of Carbohydrates:

- i. Estimation of glucose by (any two methods)
 - a. Phenol sulphuric acid method.
 - b. Anthrone method.
 - c. Benedict's method
 - d. Copper reduction method.
- ii. Estimation of pentose by Bial's method.
- iii. Estimation of fructose by Selivanoff's method.
- iv. Estimation of reducing sugar in a fruit.
- v. Estimation of lactose in milk.

Proteins:

- a. Protein determination- Lowry's method
- b. Protein determination - Biuret method.

Vitamins:

- a. Determination of ascorbic acid (Colorimetry)
- b. Determination of Nicotinic acid.

Allied Subject: Chemistry-III

Chemistry Lab-II Common Syllabus

Allied Subject: Biology-I

Biology Lab.-I Common Syllabus

Fourth Semester

Core Subject: MICROBIOLOGY

Unit I:

Organization and structure of microorganisms: General classification of microorganisms and their characteristics. Prokaryotic organization- cytoplasmic membrane and their functions- mesosomes. Cell wall- gram positive and gram negative reactions, capsules and slime layers- Flagella and cilia- bacterial chromosomes, Plasmids, ribosomes, reserved food endospore.

Unit II:

Bacterial nutrition: Growth and reproduction- autotrophic and heterotrophic nutrition- bacterial photosynthesis- Bacterial metabolism- fermentation: homo fermentative and hetero fermentative types- Binary fission- other modes of reproduction- Conjugation- Transformation- transduction- sporulation- kinetics of bacterial growth - normal growth curve.

Unit III

Microscopy: Simple, compound microscope, light and dark field microscope, parts and their functions, resolving power, aperture, electron, phase contrast microscope and their applications.

Unit IV

Applied microbiology: Food microbiology - food spoilage, food poisoning, food borne infection. Industrial microbiology - use of microbes in industries - ethanol, organic acid (lactic and citric), antibiotics (Penicillin and Streptomycin) production. Microorganism and milk - fermentation of milk, milk souring, proteolysis, alkali production, sweet curding, butyric acid fermentation.

Unit V

Medical Microbiology: Pathogenesis and prevention of air and water borne diseases – Typhoid, Cholera, Dysentery, Diarrhea, hepatitis, amoebiosis, tuberculosis, pox diseases, diphtheria and poliomyelitis.

References:

1. Microbiology – A Human perspective, Nester, Roberts, Nester
2. Microbiology, Pelezar, Tata McGraw Hill company
3. Microbiology, 6/e Prescott, Harley and Klein, Tata McGraw Hill company 2006.
4. The Microbial world, Stanier, Prentice Hall
5. Microbiology, Tortora

Allied Subject

Chemistry Theory-IV Common Syllabus

Chemistry Lab.-II Common Syllabus

Biology Theory-II

Biology Lab.- I Syllabus will be as per the existing syllabus

Part-V –Extension Activities

FIFTH SEMESTER
MOLECULAR BIOLOGY

Unit I:

Origin of Molecular Biology- Prebiotic origin of Biomolecules- Self replicating Biomolecules- Advantages of compartmentalization of Biomolecules.

Unit II:

Chemical basis of hereditary- Nucleic acid as the genetic material - Chromatin structure and composition.

Unit III:

Fundamentals of DNA structure and its replication – Types of DNA A, B and Z DNA- DNA damage-DNA repair-Introduction to Genetic code - molecular changes associated with Gene mutation

Unit IV:

Transcription of RNA – Post transcriptional modification -Modulation of gene expression - Concepts of Operons-Inducers and repressors-Lac operon only.

Unit V:

Translation process - tRNA, rRNA, mRNA and their roles-Post translational regulation -. Ways of gene transfer, transformation, transduction, conjugation.

References:

1. The Biochemistry of the Nucleic acids, 9th edition, 1981, R.L.P.Adams, R.H.Burdon, A.M.Campbell, D.P.Leader, R.M.S. Smith Chapman and Hall.
2. Freifelder, D. Physical Biochemistry: Applications to Biochemistry and Molecular Biology (2nd ed) Freeman (1982).
3. Molecular Biology- Freifelder.
4. The cell & Molecular biology Geoffrey M. Cooper, 2nd Edition, 2000

Core subject : IMMUNOLOGY

Unit I

Definition: Immunity, host resistance, antigen, antibody, Leucocytes, lymphocytes etc., Principles of Innate and acquired immunity, Memory specificity - self/non self diversity - introduction to cells and organs of the immune system.

Unit II

Types of immunoglobulins - Ig M, Ig G, IgA, and Ig D, Ig E- structure of antibody molecule - IgG only .The nature of antigens- immunogen and haptens - T dependent and T independent antigens.

Unit III

Antigen antibody interaction- agglutination-precipitation-immunodiffusion-immunoelectrophoresis-radioimmunoassay-immunofluorescence-complement fixation - ELISA- production of antisera- production of monoclonal antibodies..

Unit IV

Blood group antigen- Rhesus-incompatibility-major histocompatibility complex-autoimmune disease-vaccines-immunodiagnostics.

Unit V

Hyper sensitivity- types-mechanism-transplantation-graft rejection, tissue typing, immunosuppression, tumor antigen, cancer immunotherapy.

References

1. Roitt, I M, 2005. Essential of Immunology, ELBS, Blackwell Scientific Publication.
2. Kuby, J.2004. Immunology V Edition.W.H.Freeman and company, NY.
3. Immunology-Tizard
4. Immunology- Eli Benjamin

Core Subject: PLANT BIOCHEMISTRY

Unit I

Introduction: Occurrence, classification, structure and function of naturally occurring pigments, Carotenoids, flavones, flavanols and chlorophylls.

Unit II

Photosynthesis: Photosynthetic apparatus and photosynthesis pigments, Light and dark reactions of photosynthesis, C3, C4 and CAM plants - factors affecting photosynthesis, photorespiration.

Unit III

Plant Nutrition: Essential mineral nutrients - function, effects of toxicity and deficiency, N₂ cycle, N₂ fixation - symbiotic and asymbiotic Nitrogen Fixation - Nitrogenase, nitrate assimilation - sulphur as a mineral nutrient, sulphate assimilation.

Unit IV

Plant growth regulators: Normal growth hormones- Auxins, GA, Cytokinins, Ethylene and ABA - Synthetic growth hormones.

Unit V

Physiology and reproduction: Brief account on physiology of germination- Dormancy- Photoperiodism- Vernalization. Plant tissue culture.

References:

1. Plant Biochemistry by Devlin and Witham.
2. Plant Biochemistry by Ross and Salisbury
3. Plant Biochemistry by Bonner and Varner, 3rd edition, Academic press.
4. Plant Physiology by Hopkins.
5. Plant Physiology, Noggle Fritz

Allied : Biology Theory-III Common Syllabus

Non-Major Elective-I: HEALTH AND HUMAN DISEASES

Unit 1:

Introduction- importance of being healthy- nutrition- exercise causes of disease- environment – age – living conditions – Life style – obesity- BMI.

Unit 2:

Diseases – causes – symptoms- treatment of – heart diseases- jaundice- cancer-

Unit 3

AIDS- Nosocomial diseases- traveling disease- children and old age diseases – T.B- leprosy- Dengue- Bird Flu.

Unit 4:

Diseases prevention – healthy habits, disease prevention awareness- vaccination- immunization schedule-

Unit 5:

First aid measures- accident Care- Bleeding and Wound Care – Fractures and dislocations, electric shock burns – breathing emergency – Allergies- Pregnancy care.

Reference:

1. Microbiology – Alcamo.
2. Biochemistry – Thomas Devlin.
3. Fundamentals of Biochemistry – A.C. Deb.
4. Clinical biochemistry- Chatterjee.
5. Kavanagh James “ Emergency First Aid” – Waterford Publisher
6. Kathen Handal- The American Red Cross First Aid and Safety Handbook

Skill Based Elective: MEDICAL LAB TECHNOLOGY

Theory

Unit I:

Blood of urine analysis: Blood analysis – collection and preservation of blood- anticoagulants- normal haematological values – prevention of clotting. Blood banking urine analysis- collection and preservation of urine. Macroscopic and microscopic examination of urine culture- chemical examination of urinary calculi.

Unit II

Mycology and Immunology: Mycology - Introduction to common fungal disease – Investigation of fungal infections candidosis, Mycetomosis, Cryptococcus.

Unit III

Immunology – Collection and preservation of serum- Measurement of Antibodies, Agglutinations reaction, widal's test, serological tests for syphilis- VDRL slide flocculation test, ELISA.

Unit IV

Molecular Biology Techniques: Plasmid Analysis- polymerase chain reaction for detection of diseases – sample processing for DNA extraction – DNA fingerprinting.

Unit V

Complete haemogram - grouping & “Rb” typing- Blood Bank Set up- Blood Collection Screening, Storage, Cross matching & Blood Transfusion

Reference:

1. Clinical chemistry – Teetz.
2. Practical chemistry – Varley.
3. Medical lab technology – M. Muckerjee.
4. Immunology – Roit
5. Molecular biology – David frifelder.

BIOINFORMATICS**Unit I**

Internet basics – Browsing – web – pictures-Videolinks- search tips and tricks-On line journals- Literature database- Pubmed- Agricola

Unit II

Basic codes in Computing, computer networking and computer analysis, database management systems (DBMS) and it's applications.

Unit III

Information networks: Internet, Web, HTTP, HTML and VRLS, EMB net, NCBI and virtual library.

Unit IV

Commercial databases and software packages specializing in DNA analysis, internet packages BLAST & FASTA. Homology and diversity – evolutionary basis of sequence alignment-searching for similarity.

Unit V

Sequence analysis; Sequence databases, biological databases and protein & nucleic acid sequence analysis. GCG – Genetic Computation Group – Wisconsin package. Analysis Packages

References:

1. Attwood, T.K and Parry –Smith, D.J. Introduction to Bioinformatics, Pearson Education Private Ltd., Singapore 2002.
2. Gribshow, Sequence Analysis, University Press. 2000
3. Introduction to Bioinformatics 2002. S.Sundarrajan & R. Balaji. Himalaya Publishing House, Mumbai.
4. Bioinformatics 2003. D.R.West Head. J.H.Parish and R.M.Twyman. VIVA Books Pvt. Ltd Chennai.
5. Bioinformatics – a beginners guide, Jean-Michel Claverie, Wiley, 2004.

SIXTH SEMESTER

Core Subject: BIOTECHNOLOGY

Unit I

Genetic Engineering – Introduction to gene cloning, restriction enzymes and mode of action, Types of cloning vectors, plasmid, cosmid, M13 phage.

Unit II

Plant Biotechnology – vector for gene transfer using Agrobacterium only, Transgenic plants, crop improvement.

Unit III

Animal Biotechnology – Genetic engineering in animals, Viral vector and Yeast vectors. Transgenic animals.

Unit IV

Microbial biotechnology – Bioprocess – Basic principles of microbial growth, types, design and operation of Fermentors, Oil spill clean by microbes, biodegradable plastics.

Unit V

Production of Novel proteins – Insulin – Interferons- vaccines- Gene therapy- Treatment of Various human disorders.

References

1. Biotechnology by P.K.Gupta.
2. Text Book of Biotechnology by R.C.Dubey, 4th edition, 2006
3. Recombinant DNA technology by Watson.
4. Biotechnology – B.D.Singh, 3rd edition, 2008
5. Principles of gene manipulation. An introduction to genetic engineering by Old and Primrose, 6th edition, 2004.
6. Biotechnology – S.S.Purohit, 3rd edition, 2008
7. Principles of Fermentation Technology – P.F.Stanbury, A.Whitaker & S.J.Hall, 2nd edition, 2007
8. Biotechnology by V.Kumaresan 6th edition,2015.

CLINICAL BIOCHEMISTRY

Unit I:

Introduction: scope of clinical biochemistry- Development of clinical biochemistry. Laboratory investigation in Clinical Biochemistry - Evaluation of laboratory test - Normal range- system of international units- Techniques used in clinical assays.

Unit II:

Disorders of Carbohydrate metabolism: sugar level in normal blood- Hypo and Hyperglycemia, glycosuria, obesity and Galactosemia. Glucose tolerance test- Inborn errors of carbohydrate metabolism.

Unit III:

Disorders of lipid metabolism: hypo and hyper Lipoproteinemias, disorders of Triglycerides, Phospholipids and Cholesterol metabolism- Inborn errors of lipid metabolism.

Unit IV:

Disorders of amino acid and protein metabolism: amino acid metabolism in starvation- disorders of Plasma proteins, urea, Uric acid, Creatinine, ammonia, Uremia, Uremia and Porphyria- Inborn errors of amino acid metabolism.

Unit V:

Disorders of Nucleic acid metabolism: Purine and Pyrimidine metabolism- Gout, LNS, Orotic aciduria, Xanthinuria.

References:

1. Physiological Chemistry- Hawk's
2. Practical Clinical Biochemistry- Harold Varley, Fourth edition.
3. Clinical Biochemistry- Tietz
4. Biochemistry- Chatterjee.
5. Physiological basis for medical practice, Best & Taylor
6. Human Physiology, Guyton

Major LAB III

1. Blood Analysis:

1. Blood sugar - Folin Wu method
2. Blood urea - Urease method
3. Blood cholesterol- Ferric chloride method
4. Blood uric acid - Molybdate method
5. Creatinine- Picric acid method

6. Serum phosphorus
7. Estimation of haemoglobin
8. Blood Grouping ABO
9. Urine Deposits
10. Bleeding Time
11. Clotting Time
12. Prothrombin test

2. Urine analysis

- a. Qualitative analysis for urine (sugar, urea, uric acid & Creatinine)

3. Estimation of Any two enzymes

- a. LDH
- b. Acid phosphatase
- c. Alkaline phosphatase
- d. SGOT
- e. SGPT
- f. Amylase
- g. Urease

Major Lab-IV

1. Cleaning of glass wares
2. Preparation of simple culture media
3. Selection of suitable culture medium
4. Gram's staining, motility - Hanging drop
5. Isolation of microbes - serial dilution, streak plate technique
6. RBC, WBC count
7. ESR- Erythrocyte Sedimentation rate
8. Enumeration of E.coli in milk and ice cream
9. Water Quality analysis

Demonstration only

1. Separation of aminoacids by Paper chromatography, TLC
2. Separation of proteins by SDS – PAGE
3. Identification of nucleic acids by Agarose Gel Electrophoresis
4. Haemagglutination
5. Immunodiffusion

ELECTIVE: FOOD TECHNOLOGY

Unit I

Cereals and Pulses: Grain characteristics and plants products – wheat milling process – pasta – noodles- baking process. Rice processing- quick cooking dals- fermentation and germination.

Unit II

Fruits and vegetables: Structure, composition , physiological and biochemical changes during ripening, handling and storage.

Unit III

Processing of vegetables. Fruit processing- citrus juices, apple juices, slices. Grape juice and raisins. Squashes jams, ketchups.

Unit IV

Milk and Milk products: Milk processing – pasturisation, homogenization, packing – fortified milk, skim milk- cream, butter, cheese, ice creams, khoa, paneer, yoghurt.

Unit V

Meat, fish, and eggs: Aging, tenderizing, freezing- storage Fish preservation and processing- Dehydrated egg powder, frozen egg – egg storage.

Reference:

1. Hand book on food biotechnology by NIIR Board, New Delhi.
2. Food processing and preservation- B. Sivasankar , Anna University, Chennai
3. Food and Nutrition- Swaminathan.

Allied

Biology Theory-IV Common Syllabus

Biology Lab-II Common Syllabus

SKILL BASED ELECTIVE: ENDOCRINOLOGY

Unit I:

Introduction to endocrine system, Hormones- definition, classification, Mechanism of action of hormones, Class I and Class II hormone, role of second messengers in hormone action.

Unit II:

Hypothalamus and pituitary hormones- Hypothalamic releasing factors, vasopressin and oxytocin. Biosynthesis, secretion, transport, regulation and biological effects of growth hormone.

Unit III:

Biosynthesis, secretion, transport, regulation and biological effect of thyroid and parathyroid hormones, hormones of pancreas, mechanism of action insulin and glucagons.

Unit IV:

Gastrointestinal hormones – Pepsin, gastrin, Secretin and Cholecystokinin.

Unit V:

Adrenal anatomy, Adrenal Steroids - Glucocorticoids and mineralo corticoids, Sex Steroids- Progesterone, Estrogens and Androgens

Reference:

1. Harpers biochemistry – Murray et al.,
2. Principles of Biochemistry – Smith et al.
3. William textbook of endocrinology – Wilson and foster 8th edition.
4. Human Biochemistry – Frisell.

NON MAJOR ELECTIVE-II: HERBAL MEDICINE

Unit 1

Introduction : Scope - Alternative systems of medicine – advantages – human system – herbals for human system – definition.

Unit 2

Secondary metabolites : Source- different types – action – medicinal plants – pharmacological action – toxicity.

Unit 3

Herbal cultivation : Plant – types - Methodology – marketing – economic potential – pharmacological companies – manufacture – patency – GATT- TRIPS- WTO.

Unit 4

Herbal gardening : Types – methodologies – applications – home gardens – types – methodologies – application – home made remedies – herbal formulations- herbal physiotherapy.

Unit 5

Plant propagation : Definition – types – grafting – endangered plants- need for conservation– techniques – tissue culture – requirements - techniques - Micro propagation.

Reference:

1. Biotechnology of Secondary metabolites – K.G.Ramawat, J. M. Muritton.
2. Indian medicinal plants Vol-I to Vol – V :- A compendium of 500 Species – Orient Longman
3. Introduction to spices, plantation crops, Medicinal aromatic plants – N.Kumar *et. al.*,

*Placed at the meeting of
Academic Council
held on 26.03.2018*

APPENDIX – CE
MADURAI KAMARAJ UNIVERSITY
(University with Potential for Excellence)

B.Sc. Ancillary Biology (Semester)
(for Biochemistry, Microbiology and Biotechnology Majors)

CBCS

(With effect from 2018-19 onwards)

Paper I

GENERAL BIOLOGY

Unit I

Basics of classification: species, genus, family-Nomenclature-binomial system. Systems of classification-artificial, natural and phylogenetic; Bentham and Hooker system of classification of plants (Cohort level only). General classification of animals up to class level with examples as mentioned in practical syllabus-description for example is not required.

Unit II

General characters and classification up to class level for the plant groups algae, fungi and Bryophytes. Type study (Development of sex organs need not be discussed).

Algae: *Sargassum*, Fungi: Yeast, Bryophytes: *Funaria*

Unit III

General characters and classification up to class level for the plant groups Pteridophytes and Gymnosperms. Type study (Development of sex organs and anatomical aspects need not be discussed). Pteridophytes: *Selaginella*, Gymnosperms: *Pinus* – economic importance of gymnosperms. Angiosperms: description of a typical monocot and dicot flowers.

Unit IV

Digestive, respiratory, excretory and reproductive systems in cockroach and frog.

Unit V

Digestive, respiratory, excretory and reproductive systems in pigeon and man.

References:

1. A.C. Dutta: **Botany for Degree Students**, Oxford University Press.
2. G.M. Smith: **Cryptogamic Botany, Vol. I & II**, Tata McGraw Hill.
3. W.T. Tailor and R.J. Wehe: **General Biology**, East West Press Pvt. Ltd.

4. E.L. Jordon and P.S. Verma (1995) **Invertebrate Zoology**, S. Chandra & Co., New Delhi
5. E.L. Jordon and P.S. Verma (1995) **Chordate Zoology**, S. Chandra & Co., New Delhi

**Practical
Botany -1**

1. Vegetative structure and reproductive structure in Sargassum, Yeast, Funaria, Seleginella and Pinus (section cutting of Sargassum and Sleginella, Pinus stem and needles)
2. Dissection and study of any available Monocot flower
3. Dissection and study of any available of Dicot flower

Zoology

1. Cockroach – external and digestive system and reproductive system
2. Frog – external, digestive system, and urogenital system
- a. Morphology of the following (spotters only) – amoeba, Euglena, Hydra, Planaria, Liver Fluke, Tania, Ascaris, earthworm, Prawn, Pila Starfish, Shark, Calotes, Pigeon and rat
3. A. Blood cells of man
4. B. Different types of muscles

Paper II Basic and Applied Ecology

UNIT – I

Ecosystem concept and flow of energy and nutrients:

Ecosystem concept – Biosphere and different ecosystems components of ecosystems- biotic and abiotic factors – Productivity – Primary and secondary – food chain and food web – Trophic relations within and between ecosystems – Ecological pyramids – energy flow through ecosystems – Biogeochemical cycles – Nitrogen and Carbon cycle. Water cycle in the biosphere.

UNIT – II

Resource conservation:

Renewable and non-renewable energy resources solar and wind energy and their utilization. Aquatic resources: Fresh water and marine fish resources and their conservation. Terrestrial resources: forests and agriculture. Wildlife conservation: role of Sanctuaries and National parks. Resources and rural development: Science and Technology for human welfare.

UNIT – III

Environmental pollution and management:

Causes and consequences of air, water, noise and radiation pollution. Pollution indicators – environmental pollution management - legislation – environmental education.

UNIT – IV

Population Biology

Population parameters and their estimation – reproductive effort – Population growth models – species interaction and competition – population – regulation – density dependent and independent.

UNIT V

Environmental Biology and its relevance to human civilization – Population explosion of man and its consequences – Man's interference with nature and its impacts – Deforestation and consequences – silent Valley project and Narmada projects as examples

References:

1. Dasamann, R., Environmental Conservation – III ed
2. Kormondy, J. 1976. Concepts of Ecology – III ed. Prentice – Hall, Engelwood cliffs.
3. Odum, E.P. 1971. Fundamentals of Ecology, W.B. Sanders, Toppan Co.Ltd, Tokyo, Japan.
4. Ehrlich, P.R., J.P Holdreh and R.W. Holm, Man and the Ecosphere, 1989
5. Southwick, C.H. 1976. Ecology and Quality of our Environment, D.Van Nostrand Co. New York.
6. Verma. P.S., and V.K. Agarwal., 1995. Environmental Biology, s. Chand & Co., New Delhi.
7. Sharma, P.D. 2005. Environmental Sciences and Toxicology, Rastogi Publications Meerut.

Practicals:

1. Study of vegetation by quadrat method
2. Estimation of dissolved oxygen in different examples
3. Estimation of salinity oxygen in different examples
4. Estimation of alkalinity oxygen in different examples
5. Soil testing for pH, alkalinity, nitrates and phosphates
6. Study of plant and animal adaptations Plants – Hydrophytic adaptations and xerophytic adaptations Animals – Camouflage in animals (Chameleon, Stick insect, leaf insect, industrial melanism in moths etc.)

Paper III – Biodiversity and Conservation

UNIT I

Biodiversity – introduction concept and scope of Biodiversity. Organization of Biodiversity research in India and in world.

UNIT II

Levels of Biodiversity, Genetic, species and Ecosystem biodiversity Alpha, Beta and Gamma Biodiversity.

UNIT III

Threats to Biodiversity; Loss of Biodiversity – causes and consequences: Hot spots; Mega diversity centers. Role of CITES and ICUN. Red data book categories.

UNIT IV

Measures of Biodiversity – Diversity indices. Dominance and Evenness. Methods of studying Biodiversity (Brief account).

UNIT V

Conservation of Biodiversity – Need for conservation – Methods of conservation in situ and Ex situ conservation. Cryopreservation and germ plasm conservation. Biosphere reserves National parks, Sanctuaries and sacred grooves.

References:

1. An advanced book on Biodiversity – Principles and Practice by K.V. Kirshnamurthy, 2003 – Oxford SIBH publishing co, pvt. Ltd., New Delhi
2. Biodiversity – CPR – Environmental Education center 2003, Chennai.

Practical:

1. By using world and Indian map mark Biodiversity important regions countries and centers.
2. Measuring Biodiversity – Quadrat method using various indices and calculate dominance and evenness.
3. Collection of endemic plants and animals photos with information by using websites, journals, newspapers etc.

Paper IV – Cell Biology

UNIT I :

Cell structure prokaryotic and eukaryotic plant and animal cells – structural features – a brief comparative account. Plasma membrane – Chemistry and ultra structure – Fluid Mosaic model: functions (Brief account only). Protoplasm – Chemistry and organization – microtubules and microfilaments.

UNIT II:

Organelles in Eukaryotes:

Lysosomes – Ultrastructure and functions, types – lysosomal enzymes, Ribosomes – ultrastructure and functions, chloroplast, ultra structure and chemistry, function mechanism of photosynthesis and generation of ATP to be explained briefly.

Mitochondria – ultra structure and functions (brief account) semiautonomy of cell organelles.

UNIT III:

Membrane systems in eukaryotes:

Endoplasmic reticulum and Golgi complex – structure, chemistry, origin and functions to be dealt with briefly. Nucleus – Nuclear envelope-structure chromatin Eu and Hetero chromatin, nucleosomes, chromosomes –Kinds, structure polytene chromosomes – Nucleolus structure and functions.

UNIT IV:

Cell cycle mitosis and meiosis – stages and significance. Cell growth normal and cancerous.

UNIT V

Microscopy:

Light and Electron microscope – a brief account, Subcellular fractionations, ultra centrifugation, differential and density and density centrifugation.Histochemical staining. Protein –mercuric bromophenol blue method (Maziaetal 1953, Ruthmann 1970). Lipid and lipoproteins – Sudan black B method Ruthmann 1970)

References:

1. B. Albert, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson (1983) Molecular biology of the cell. New York. Garland.
2. E.E.P De Robertis F.A Saez and E.M.P De Robertis (1990) Cell and Biology.
3. K.V, Krishnamuthy (1988) Methods in plant histochemistry S. Viswanathan printers and publishers
4. P.S. Verma and V.K Agarwal (1995) Text book of Cytology. S chand & Co. New Delhi.
5. P.S Verma and V.K. Agarwal (1995) Text book of cell Biology Genetics, Evolution and Ecology, S. Chand & Co., New Delhi.

Practicals:

1. Parts and functions of compound microscope
2. Study of cell inclusions: Starch grains – Smear of potato, banana and rice, *Cystolits* – sections of *Fucus jeaves*, *Sclereids* – Sections of pothos leaves, petioles of *Aracase plants*
3. Study of cell organelles by photomicrographs
4. Study of mitosis by smear technique using *Allium cepa* roots
5. Study of mitosis by using *Rhoco* flower buds
6. Histochemical staining methods – techniques as given in the theory syllabus.