# University of Kota, Kota

## Syllabus- M. Sc. (Biotechnology) I& II Semester

**Course Structure with Distribution of Marks:**

| Year / Semester | Serial Number, Code & Nomenclature of Paper | | | Duration of Exam | Teaching Hrs/Week & Credit | | | Distribution of Marks | | | Min. Pass Marks | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number | Code | Nomenclature | | L | P | C | Conti. Assess. | Sem. Assess. | Total Marks | Conti. Assess. | Sem. Assess. |
| I Year/ I Semester | 1.1 | BTC101 | Enzyme Technology | 3 Hrs | 4 | -- | 4 | 30 | 70 | 100 | 12 | 28 |
| | 1.2 | BTC102 | Biophysics and Bioelectronics | 3 Hrs | 4 | -- | 4 | 30 | 70 | 100 | 12 | 28 |
| | 1.3 | BTC103 | Concepts of Microbiology | 3 Hrs | 4 | -- | 4 | 30 | 70 | 100 | 12 | 28 |
| | 1.4 | BTC104 | Fundamentals of Molecular Biology | 3 Hrs | 4 | -- | 4 | 30 | 70 | 100 | 12 | 28 |
| | 1.5 | BTC111 | Biotech Laboratory-I | 5 Hrs | -- | 16 | 8 | -- | 100 | 100 | -- | 50 |
| | **Total** | | | | **16** | **16** | **24** | **120** | **380** | **500** | **--** | |
| I Year II Semester | 2.1 | BTC201 | Fundamentals of Biochemistry | 3 Hrs | 4 | -- | 4 | 30 | 70 | 100 | 12 | 28 |
| | 2.2 | BTC202 | Tools and Techniques of Molecular Biology | 3 Hrs | 4 | -- | 4 | 30 | 70 | 100 | 12 | 28 |
| | 2.3 | BTC203 | Biostatistics | 3 Hrs | 4 | -- | 4 | 30 | 70 | 100 | 12 | 28 |
| | 2.4 | BTC204 | Principles of Genetic Engineering | 3 Hrs | 4 | -- | 4 | 30 | 70 | 100 | 12 | 28 |
| | 2.5 | BTC211 | Biotech Laboratory-II | 5 Hrs | -- | 16 | 8 | -- | 100 | 100 | -- | 50 |
| | **Total** | | | | **16** | **16** | **24** | **120** | **380** | **500** | **--** | |
| **II Year / III Semester** | **Serial Number, Code & Nomenclature of Paper** | | | **Duration of Exam** | **Teaching Hrs/Week & Credit** | | | **Distribution of Marks** | | | **Min. Pass Marks** | |
| | **Number** | **Code** | **Nomenclature** | | **L** | **P** | **C** | **Conti. Assess.** | **Sem. Assess.** | **Total Marks** | **Conti. Assess.** | **Sem. Asses.** |
| | 3.1 | BTC301 | Basic and Applied Plant and Animal Biotech | 3 Hrs | 4 | -- | 4 | 30 | 70 | 100 | 12 | 28 |
| | 3.2 | BTC302 | Environmental Biotechnology | 3 Hrs | 4 | -- | 4 | 30 | 70 | 100 | 12 | 28 |
| | 3.3 | BTC303 | Immunology and Immunotechnology | 3 Hrs | 4 | -- | 4 | 30 | 70 | 100 | 12 | 28 |
| | 3.4 | BTC304 | **Elective**<br>1) Recent trends in RNA Biology<br>2) Nanotechnology<br>3) Medical Biotechnology<br>4) Solid and liquid Waste Management | 3 Hrs | 4 | -- | 4 | 30 | 70 | 100 | 12 | 28 |
| | 3.5 | BTC311 | Biotech Laboratory –III | 5Hrs | -- | 16 | 8 | -- | 100 | 100 | -- | 50 |
| | **Total** | | | | **16** | **16** | **24** | **120** | **380** | **500** | **--** | |
| II Year/ IV Semester | 4.1 | BTC401 | Industrial Biotechnology | 3 Hrs | 4 | -- | 4 | 30 | 70 | 100 | 12 | 28 |
| | 4.2 | BTC402 | Computational Biology & Research Methodology | 3 Hrs | 4 | -- | 4 | 30 | 70 | 100 | 12 | 28 |
| | 4.3 | BTC403 | Biosafety, Bioethics and IPR | 3 Hrs | 4 | -- | 4 | 30 | 70 | 100 | 12 | 28 |
| | 4.5 | BTC404 | Dissertation | ---- | 4 | -- | 4 | 30 | 70 | 100 | 12 | 28 |
| | 4.6 | BTC411 | Biotech Laboratory-IV | 5 Hrs | -- | 16 | 8 | -- | 100 | 100 | -- | 50 |
| | **Total** | | | | **16** | **16** | **24** | **120** | **380** | **500** | **--** | |

**Note:**

The allotment of an elective shall reserve with the department, which depends upon the availability of faculty members, infrastructure and laboratory facility available to run the elective and an elective cannot be offered by the department if the number of students is less than the 25% of the total sanctioned strength of the programme.

The syllabus for each theory paper is divided into five independent units and each theory question paper will be divided into three sections as mentioned below:

- ***Section-A*** *shall have 01 compulsory question comprising 10 questions (maximum 20 words answer) taking two questions from each unit. Each question shall be of one mark and total marks of this section will be 10. This section will be compulsory in the paper.*
- ***Section-B*** *will carry 25 marks with equally divided into five long answer type questions (answer about in 250 words) and examiners are advised to set two questions from each unit and students are instructed to attempt five questions by selecting one question from each unit.*
- ***Section-C*** *will contain five long answer type questions. One compulsory question of 15 marks and four questions of 10 marks each. Students are instructed to attempt total three questions with one compulsory question (answer about in 500 words) of and any two more questions (answer about in 400 words) out of remaining four questions. Paper setter shall be instructed to design question paper covering from all five units.*

The pattern of question paper of internal and external shall be as follows:

**(A) Continuous or Internal Assessment:**
30% weightage of Maximum Marks (30 Marks out of 100 Maximum Marks)

**First/Second Internal Test 20…….**
**Duration of Exam: 1.00 Hr Max. Marks: 15**
**Class: M.Sc. Semester:**
**Subject: Paper:**

**Note:** The question paper contains three sections as under:
Section-A : One compulsory question with 04 parts. Please give short answers in 20 words for each part.
Section-B : 02 questions to be attempted having answers approximately in 250 words.
Section-C : 01 question to be attempted having answer in about 500 words.

**SECTION A**
Q.1(a) 1
(b) 1
(c) 1
(d) 1

**SECTION B**
3
3
3
3

**SECTION C**
5
5

**(B) Semester or External Assessment:**
70% weightage of Max. Marks (70 Marks out of 100 Max. Marks)

**Duration of Examination: 3 Hours Max. Marks: 70**

**SECTION-A: 10x1=10**

(Answer all questions)

(Two question from each unit with no internal choice)

**Q. No. 1**

(i) ……..…… **1 Mark**

(ii) ……..…… **1 Mark**

(iii) ……..…… **1 Mark**

(iv)……..…… **1 Mark**

(v)……..…… **1 Mark**

(vi)……..…… **1 Mark**

(vii)……..…… **1 Mark**

(viii)……..…… **1 Mark**

(ix)……..…… **1 Mark**

(x)……..…… **1 Mark**

**SECTION-B: 5x5=25**

(Answer all questions)

(One question from each unit with internal choice)

(Maximum two sub-divisions only)

**Q. No. 2.** . ……..……

Or

……..…….

**5 Marks**

**Q. No. 3.** ……..……

Or

……..……...

**5 Marks**

**Q. No. 4.** ……..……

Or

……..……

**5 Marks**

**Q. No. 5.** ……..……

Or

……..……...

**5 Marks**

**Q. No. 6.** ……..

Or

……..

**5 Marks**

**SECTION-C: 1x15 + 2x10=35**

(Answer any three questions including compulsory Q.No. 7)

(Maximum four sub-divisions only)

**Q. No. 7.** …… **15 Marks**

**Q. No. 8.** …… **10 Marks**

**Q. No. 9.** …… 1**0 Marks**

**Q. No. 10.** …… **10 Marks**

**Q. No. 11.** …… **10 Marks**

**Distribution of Marks for Practical Examinations:**

| | |
|---|---|
| **Time - 5 hrs** | **Max. Marks –100**<br>**Min. Marks -50** |
| **Major Exercise** | **25** |
| **Minor Exercise** | **15** |
| **Preparation** | **05** |
| **Spotting** | **10** |
| **Seminar/Project** | **20** |
| **Record** | **10** |
| **Viva-voce** | **15** |
| **Total** | **100** |

## SEMESTER-I

### BTC101 - Enzyme Technology

**Min. Pass Marks: 28** **Duration: 3 Hours** **Max. Marks: 70**

### Unit- I

Introduction to enzyme and enzyme technology: History of enzyme and enzyme technology. Enzymes: -Classification, Nomenclature and general properties of enzymes. Effects of substrate, temperature, pH and inhibitors of enzyme activity.

### Unit- II

Enzyme isolation, purification and large scale Production: Source and screening strategies for novel enzymes. Isolation methods of enzyme. Purification methods and concentration of intracellular and extracellular enzymes. Factors affecting enzyme stability. Media and large scale production of enzyme. Large scale use of enzymes in different fields.

### Unit- III

Steady state kinetics: Methods of estimation of rate of enzyme catalyzed reaction with special reference to Michaelis-menton kinetics. Mechanism of enzyme action and regulation: Active and regulatory sites, chemical modification. General mechanistic principles, feedback inhibition. Isozymes, enzyme activation, zymogens, multi-enzymes complexes and multifunctional enzymes.

### Unit- IV

Preparation of kinetics of immobilized enzymes: Methods of immobilization, physical adsorption, covalent binding, entrapment, kinetics of immobilized enzymes and factors effecting. Immobilized enzyme processes: production of high fructose corn syrup, production of antibiotics, production of acrylamide.

### Unit-V

Advancement in enzyme technology: Enzyme reactions in biphasic liquid system proteases, glycosidases, lipases in synthetic reactions, inter-estrification of lipids, artificial enzymes, unnatural substrate enzyme engineering, extremophilic enzyme.

**Reference Books:**


1. Enzyme Technology- M F Chaplin and D C Bucks
2. Industrial Enzymology- Godfrey and West
3. Enzyme – Copeland
4. Enzyme in Industry – W. Gerhartz
5. Principles of Biochemistry. Ed Lehninger, Nelson and Cox. CBS publishers and distributors.
6. Biochemistry. Ed Donald Voet and Judith G. Voet. John Wiley & sons, Inc
7. Plant enzymology and plant histoenzymology- Malick CP singh MB, Kalyani Publishers, New Delhi

**SEMESTER-I**
**BTC102 - Biophysics and Bioelectronics**

**Min. Pass Marks: 28** **Duration: 3 Hours** **Max. Marks: 70**

**Unit- I**

Bioenergetics: Basic bioenergetics. Cellular bioenergetics, whole body bioenergetics. Entropy. Gibbs free energy. Bioenergetic pathways. Bioenergetics and biocommunication. Control of bioenergetics.

**Unit- II**

Molecular interactions: Molecular interactions of primary importance. Strong and weak interactions. Biomolecular interactions- DNA protein interactions, Elementary account of DNA drug interactions. Molecular interaction forces-intermolecular and intramolecular forces. Attractive and repulsive forces generated within molecules and their overall effect on molecular interactions.

**Unit- III**

Radiation Biophysics**:** Interaction of radiation with matter- ionizing radiation, non-ionizing radiation, ion pairs, radiation units and dosimetry, dose effect graphs and target theory, direct and indirect radiation action, radiation on proteins, nucleic acids, carbohydrates, cell and whole organism, genetic effects of radiation, repair of radiation induced damage, radiation in diagnosis and therapeutics, protection from radiation.

**Unit- IV**

Nucleic Acids Biophysics**:** Basis of Watson Cricks original model Different, base- pairing schemes Unsatisfactory nature of Hoogsteen and other base pairing schemes, biological implication of Watson Crick base pairing scheme refinement of Watson-Crick model by linked-atom least squares, fiber X- ray diffraction studies, single crystal X-ray diffraction, and NMR studies on mono- and oligo- nucleotides, spectroscopic study of DNA polymorphism.

**Unit-V**

Biochip and Biocomputers: Biochip principle, micro fluidic chips, silicon chips and molecular chips. Eye chip vision sensors and Dobelle artificial vision system. Biocomputers. Genetic discrimination and biocomputing. Sound and image processing with optical bio computers. Future of Biocomputers.

**Text/Reference books:**


1. Introduction to Electron Microscopy - S. Wischnitzer.
2. Electron Microscopy in Biology - J.R.Harris (ed.).
3. Biophysics by R.N.ROY
4. Biophysics - V. Pattabhi & N. Gautham (Narosa, New Delhi).
5. Fundamentals of Molecular Spectroscopy - C.N. Banwell, (Tata-McGraw Hill)
6. Radiation Biophysics-Edward L. Alpen

**SEMESTER-I**

**BTC103- Concepts of Microbiology**

**Min. Pass Marks: 28** **Duration: 3 Hours** **Max. Marks: 70**

## UNIT I

History and Scope of microbiology. Classification up to class level and distinctive characters of major groups: Bacteria, Fungi, Algae and Protozoa.
Classification of microorganisms – Haeckel's three kingdom concept, Whittaker's five kingdom concept, Classification and salient features of bacteria according to the Bergey's manual of determinative bacteriology.

## UNIT II

Principles, Function & application of Microscopy: Bright field, Dark field, Phase contrast, confocal. Fluorescence and Electron (Transmission and Scanning) microscopy.
Staining techniques: Stains and Dyes, Simple, Gram, Negative, Capsule, Endospore, Acid fast.

## UNIT III

Sterilization and Disinfection (Physical and Chemical methods): Heat, Temperature, Filteration Pasteurization, Dehydration, Radiation, Alcohol, Surface active agents, Aldehyde, Halogen, Gases.
Isolation Techniques: Serial Dilution, Streak plate, Pour plate and Spread plate method.
Culture Media: Types of Media.

## UNIT IV

Bacterial morphology- size, shape, cell wall, cell Membrane, capsule, flagella, fimbriae and pili, nucleoid, ribosomes, mesosomes and reserve Food.
Bacterial Growth– Growth curve and its kinetics and growth yield, growth synchronization. Determination of biomass, Environmental factors affecting growth.

## Unit V

Biological nitrogen fixation
Geochemical cycles (nitrogen, carbon, phosphorus, sulphur)
Study of Viruses: General structure and properties of viruses, Taxonomy, reproduction, cultivation, Purification and assay.
Bacteriophage - Structure and reproduction, Prions and Viriods.

**Text/Reference books:**


1. Prescott, L.M., J.P Harley and D.AKlein, 2007. Microbiology VII Ed.Mc Grow Hill,
2. Davis R.Y. E.A. Adeberg and J.L. Ingram,1991 General Microbiology
3. Stainer .General Microbiology, V Ed., Printice Hall of India Pvt,Ltd. New Delhi
4. Ronald M. Atlas 1997. Principles of Microbiology. II Ed. Mc Graw Hill Pub.
5. Alexopoulos CJ et al, Introductory Mycology 4th Edition
6. Woese,.C,R 1981 Archeabacteria , Sci. Am. 244:98-122

**SEMESTER-I**

**BTC104 – Fundamentals of Molecular Biology**

**Min. Pass Marks: 28** **Duration: 3 Hours** **Max. Marks: 70**

**UNIT- I**

Genetic Material: Structure, chemical composition and organization of DNA. Difference between euchromatin and heterochromatin. DNA super coiling, Different forms of DNA. Repetitive DNA and satellite DNA. Experimental proof of DNA as genetic material.

**UNIT- II**

DNA replication in prokaryptes and eukaryotes-Initiation, elongation, termination, fidelity of replication, enzymology of replication. Regulation at replication level. Chromosome walking extrachromosomal replicons, DNA damage and repair mechanisms. Mutation- Types and various mutagens. repair and recombination repair.

**UNIT- III**

Transcription: transcription in prokaryotes and eukaryotes- Initiation, elongation and termination. Transcription factors and machinery, transcription activator and repressor. RNA processing-RNA editing, splicing and polyadenylation, Structure and function of different types of RNA, RNA transport. Ribozymes

**UNIT- IV**

Proteins Synthesis: Mechanism of translation in Prokaryotes and Eukaryotes–initiation, elongation, termination. DNA Recombination- Holliday model, Site specific Recombination. Transposons – Transposable Elements, Classification of Transposons, Types in Eukaryotes.

**UNIT- V**

Gene Regulation: Prokaryotic Gene Regulatory Mechanism; Operon concept: Lac and Trp operons. Gene Regulation in Eukaryotes – Attenuation control, Regulation by DNA Methylation, Transcription Factors, Enhancer Element.
Genetic Code – Salient Features and Wobble Hypothesis, Initiation and Termination Codon.

**Text/Reference books:**


1. Molecular Biology of the Gene :Watson-Baker-Bell-Gann-Levine-Losick, 5 th Edn., Pearson Education
2. Molecular Biology: D. Freifelder, Narosa Publishing House, New Delhi
3. Genome: T.A. Brown, John Wiley & Sons
4. Microbial Genetics:. Freifelder, Narosa Publishing House, New Delhi
5. Gene VII: Lewin Benjamin (Oxford)
6. Molecular Cell Biology: J.Darnell, H.Lodhis & D.Baltimore (W.H.Freeman & Co.)
7. DNA Repair & Mutagenesis: E.C.Friedberg, G.C.Walker and W. Seide (ASM Publisher)
8. Molecular biotechnology: S.B. Primrose
9. Molecular biotechnology: Glick

**BTC 111 BIOTECH LAB I**

1. Quantitative assays – (i) Enzyme assays (ii) DNA, RNA & proteins
2. Enzymology – purification of enzyme & its kinetics
3. Enzyme assays (LDH, beta galactosidase, acid phosphatase, arginase, succinic dehydrogenase): Time, Temperature, Protein concentration, cofactors. LDH: $K_m$ and $V_{max}$ various kinetic plots.
4. Microscopy: simple, compound, Dark Field, phase contrast
5. Micrometry: Calibration of stage and Occular micrometer and measurement of the given biological sample
6. Spectrophotometry: To find out absorption spectrum of given chromophore and /or oxidised and reduced forms (sodium nitrate and borohydrate).
7. Haemoglobin and Methemoglobin (b) NAD and NADH
8. Colorimetry: To determine the association constant of given indicator colorimetrically and to prepare the buffer solutions in pH range of 2.2 to 8.0.
9. Cleanliness, media preparation, sterilization, culture methods, dilution techniques in microbiology.
10. Staining techniques in microbiology i) Flagella staining ii) Negative staining iii) Differential staining iv) Spore staining v) Capsule staining.
11. Isolation of pure culture- Serial Dilution, Pour, Spread, Streak.
12. Identification of unknown bacteria by biochemical tests.
13. Bacterial growth curve-serial dilution, plating and turbidity measurement.
14. Standard qualitative analysis of water (microorganisms).
15. Competent cell preparation. Replica plating, Isolation of auxotrophic mutants in bacteria, recombination in bacteria.
16. Extracellular enzymatic activities of microbes.
17. Immobilization of *Saccharomyces cerevisiae*.
18. DNA: a) Isolation of DNA (nuclear and Mt)
    b) Agarose gel electrophoresis
    c) Demonstration of DNA modifications
    d) Restriction endonuclease digestions and separation of fragments by gel chromatography
19. Thermal melting of DNA.
20. 2-D gel electrophoresis of proteins.
21. Isolation of plasmid DNA - i) minipreparation ii) large scale isolation.
22. DNA ligation, transformation of E.coli.
23. Immobilization of Enzyme.
24. Gel Filtration Chromatography.

## SEMESTER-II

## BTC201- Fundamentals of Biochemistry

**Min. Pass Marks: 28** **Duration: 3 Hours** **Max. Marks: 70**

### UNIT- I

High energy phosphate compounds: Introduction, Phosphate group transfer free energy of hydrolysis of ATP and sugar Phosphate. pH, buffer and water in reaction to biological system . Dissociation of water and its ion product. Henderson Hasselbalch equation, Clinical applications of Biochemistry.

### UNIT- II

Amino Acid Metabolism- Overview of amino acid metabolism, Biodegradation of amino acids – deamination, transamination, decarboxylation, glutamine and glutamic acid pathway, urea cycle, uric acid biosynthesis. Protein structure (primary, secondary, tertiary and quaternary). Ramachandran plot. Protein degradation and Targeting.

### UNIT-III

Carbohydrates: Classification, characteristics and functions. Reactions of carbohydrates, Isomerism of carbohydrates, Fischer projections, Haworth structures. Structure and functions of homo and heteropolysaccharides, glycoconjugates,

Carbohydrate Metabolism: Introduction, Aerobic and anaerobic pathways: Glycolysis, Gluconeogenesis.TCA cycle, Reductive TCA cycle, Glyoxylate cycle, amphibolic & anaplerotic reactions. Electron Transport chain, Oxidative phosphorylation, Pentose phosphate pathway (HMP shunt), Oxidative Pentose Pathway, Glycogen metabolism.

### UNIT-IV

Lipids-Introduction, sources, Nomenclature, Classification. Properties & Functions. Steroids: Structure of steroid nucleus, biological role of cholesterol

Lipid Metabolism- Biodegradation of fatty acids, beta – oxidations of saturated & unsaturated fatty acids. Ketone bodies production during starving and diabetes

Biosynthesis of fatty acids – Acetyl-CoA carboxylase reaction, Fatty acid synthase complex, biosynthesis of palmitate. Biosynthesis of triacylglycerols, Biosynthesis of cholesterol, Prostaglandins .

### UNIT- V

Nucleic Acid: Biosynthesis and degradation of Purines and Pyrimidines.

Coenzymes and cofactors: Role and mechanisms of action of $NAD^+$/$NADP^+$, FAD, lipoic acid, thiamine, Pyrophosphate, Biotin, Pyridoxal Phosphate, $B_{12}$ co-enzymes and Metal ions with specific examples.

**Text/Reference books:**


1. Biochemistry Ed Lubert Stryer. W.H. Freeman and Company, New York.
2. Principles of Biochemistry. Ed Lehninger, Nelson and Cox. CBS publishers and distributors.

3. Harper's Biochemistry. Ed. R.K. Murray, D.K. Granner, P.A. Mayes and V.W. Rodwell. Appleton and Lange, Stanford, Connecticut.
4. Textbook of Biochemistry with Clinical Correlations. Ed. Thomas M. Devlin.Wiley-Liss Publishers
5. Principles and techniques of practical biochemistry. Ed Keith Wilson and John Walker. Cambridge University Press.
6. Biochemistry. Ed Donald Voet and Judith G. Voet. John Wiley & sons, Inc
7. Cell and Molecular Biology : deRobertis and deRobertis
8. Principle of Biochemistry: Leninger , A. L.
9. Fundamental of Biochemistry J. L. jain

**SEMESTER-II**
**BTC202 - Tools and Techniques of Molecular Biology**

**Min. Pass Marks: 28** **Duration: 3 Hours** **Max. Marks: 70**

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**UNIT- I**

Microscopy: Microscopes types, use of techniques of preparing specimens, resolving power, optical microscope-Basic idea of light microscopy, Types- bright field, dark field, ultra-violet, fluorescence and phase-contrast microscopes, confocal microscopy Electron microscope. TEM, SEM.

**UNIT – II**

Centrifugation techniques: - Differential, gradient, zonal or band and isopycnic density gradient centrifugation. Chromatography: principle and procedure of absorption, column, thin layer (TLC), partition, and gas-liquid ion-exchange chromatography.

**UNIT – III**

Electrophoresis: Principle, equipment and procedure of various types (vertical & horizontal) electrophoresis, SDS-PAGE electrophoresis.
Nucleic acid hybridizations Technique: colony, plaque, dot blot, southern, northern and western blotting.

**UNIT- IV**

DNA sequencing techniques: Sanger-Coulson method, Maxam Gilbert method and next generation sequencing.
Polymerized Chain Reaction: PCR -steps, Types of PCR and its applications.
Radio autography (autoradiography): principles and procedure of radio autography.

**UNIT- V**

Mass Spectroscopy (LC-MS, GC-MS). Fluorescent spectroscopy. Applications of different Spectroscopic techniques in Biology. GM counter, Scintillation counter, Flow cytometry. RIA, ELISA, DNA Fingerprinting.

**Text/Reference books:**


1. Nuclear Magnetic Resonance: Williams
2. A Biologist Guide to Principle and Techniques: Willson K. and Gounding K.H.
3. Biochemical Techniques theory and practice : White R
4. Molecular biotechnology- Glick
5. An Introduction to Practical Biochemistry: Plummer D. T.
6. Life Science in tools and Techniques: P. S. Bisen and Shruti Mathur.

**SEMESTER-II**

**BTC203 – Biostatistics**

**Min. Pass Marks: 28** **Duration: 3 Hours** **Max. Marks: 70**

**Unit-I**

Introduction to statistics: Aim, Need and Scope of statistics, Sampling & sampling design- Census method, sample method, random and non-random sampling. Size of sample . Tabulation and graphics representation. Measure of central tendency: Mean, Median and Mode. Measure of dispersion: Range, Standard deviation, Lorenz curve.

**Unit-II**

Skewness and kurtosis: Objectives and measures of skewness. Karl Pearson's coefficient of skewness. Bowley's coefficient of skewness. Kelly's measure of skewness. Kurtosis.

Correlation analysis: Types of correlation- Partial and Negative correlation, Linear and non-linear correlation, Methods of studying correlation- scatter diagram, graphic method, Karl Pearson's coefficient of correlation. Correlation of grouped data, Rank correlation, Concurrent deviation method, Partial and multiple correlation.

Regression analysis: Regression Line, regression equations- of X on Y and Y on X. regression in a bivariate grouped frequency distribution. Multiple regression.

**Unit-III**

Probability theory: Types of probability- Mathematical, posterior and axiomatic probability. Theorems of probability- Addition and multiple theorem. Theorems of probability- Addition and multiple theorem. Theoretical distributions: Binomial, Poission and Normal distribution. Software packages for statistical analysis: SAS, MINITAB, BMDP, SPSS, S-plus, MATLAB. Academic and research software- XGobi, Xlisp-Start, ExplorN, MANET. Pitfalls of data analysis by employing statistics

**Unit-IV**

Sampling and test of significance: Steps in tests of hypothesis. Sampling distribution. Standard error. Test of significance for attributes. Test for number of success and proportion of success. Test of significance for variables (Large samples)- tests of differences between means of two samples and between two standard deviations.

**Unit-V**

Tests of significance for variables (Small samples)- Students t-distribution to test the difference between means of two samples, and test the significance of an observed correlation coefficient. Variance ratio test (F-Test). Chi-square test and goodness of fit: Characteristics of $X^2$ test, use of X-test, Analysis of variance: One way and two way classification. Multi variate analysis.

**Text/Reference books:**


1. Biostatistics: P.N.Arora, P.K.Malha
2. Introductory statistics for Biology : Mahajan , S. K.
3. Statistical Methods : Mishra and Mishra
4. Fundamental of Computers : P.K.Sinha
5. Statistical Methods : S.P. Gupta

**SEMESTER-II**
**BTC204 – Principles of Genetic Engineering**

**Min. Pass Marks: 28** **Duration: 3 Hours** **Max. Marks: 70**

**UNIT- I**

Genetic engineering tools and their applications: Restriction-modification system & different enzymes, Gene Cloning Vectors- Plasmids, bacteriophages, phagemids, cosmids. Artificial chromosome vectors (YAC, BAC, HAC), virus derived vectors-SV40, M13, retroviral vectors.

**UNIT- II**

Gene manipulation: cDNA Synthesis and its Cloning; mRNA enrichment, DNA primers, linkers and adaptors, Library (cDNA and Genomic) construction and screening. Alternative Strategies of Gene Cloning- Two and three hybrid systems, cloning of genes in expression vectors and regulation, DNA microarrays.

**UNIT-III**

Protein Engineering & Processing of Recombinant proteins - Directed Mutagenesis- Oligo-nucleotide with M13 DNA, PCR amplified oligo-nucleotide and Random mutagenesis. Protein Engineering: adding disulfide bonds, reducing number of free sulfhydril residues, changing amino-acids, increasing and modifying enzymatic activity.

**UNIT- IV**

Processing of Recombinant proteins: Purification and refolding. Characterization of recombinant proteins, stabilization of proteins. DNA markers. Molecular marker: RAPD, RFLP, AFLP, ISR, SNP. Protein markers.

**UNIT- IV**

Genome analysis: Intoduction, DNA typing, human genome project, single nucleotide polymorphism

Genetically modified organisms: Introduction, Transgenic animals, Transgenic Technology. Tools for analyzing gene expression: Antisense technology.

**Text/Reference books:**


1. Molecular Biology of the Gene: Watson-Baker-Bell-Gann-Levine-Losick, 5 th Edn., Pearson education
2. Molecular Biology: D. Freifelder, Narosa Publishing House, New Delhi
3. Genome: T.A. Brown, John Wiley & Sons
4. Microbial Genetics: D. Freifelder, Narosa Publishing House, New Delhi
5. Gene VII: Lewin Benjamin (Oxford)
6. Molecular Cell Biology: J.Darnell, H.Lodhis & D.Baltimore (W.H.Freeman & Co.)
7. DNA Repair & Mutagenesis: E.C.Friedberg, G.C.Walker and W. Seide (ASM Publisher)
8. Molecular biotechnology

**BTC 211 BIOTECH LAB II**

1. pH meter: Buffering capacity of a buffer, indicators. To determine the pKa value and hence the dissociation constant of a given acid by using pH meter.
2. Potentiometry: Redox potential of $Fe^{+2}$ and $Fe^{+3}$.
3. Estimation of protein: Lowry, Biuret and Bradford methods, standard curves, linear regression and assessment of ranges and reliability.
4. Protein purification: Ammonium sulphate, acetone, TCA pptn. dialysis, concentration.
5. Thin layer chromatography: lipids, mixture of dyes.
6. Chlorophyll estimation: spectrum and turbidity correction in chloroplasts.
7. Polyacrylamide gel electrophoresis of proteins.
8. cDNA synthesis and cloning.
9. Sequencing and computer analysis.
10. PCR/RFLP technique.
11. Characterization of transformants: DNA gel electrophoresis, blotting and hybridization with labeled DNA probes (Southern Blot) Techniques.
    a) DNA blotting technique b) DNA hybridization.
12. Descriptive statistics: systematic tabular summarization of data (before analysis), measures of central tendency, measures of dispersion. measures of skewness (using calculators).
13. Correlations (product-moment coefficient, Spearman's rank coefficient) and regression (linear regression, curve fitting).
14. Statistical distributions: fitting discrete uniform, binomial, Poisson and Normal probability distribution of given data.
15. Testing of hypotheses -Tests of significance (Mean, Standard Deviation, and Correlation coefficient), Chi-square test for good-ness-of-lit, test for independence of attributes, non-parametric tests (run test) using calculators and printed tables, and using Minitab.
16. Sampling (drawing random samples using random number, tables, computer programs for random number generation), Design of experiments, ANOVA (one-way and two-way).
17. To study the production of transgenic crops for disease resistance.
18. To study the genetically modified crop plants production & their usefulness.
19. To study the Production of transgenic crops for disease resistance.
20. To study the genetically modified crop plants production & their usefulness.

**SEMESTER-III**

**BTC301 - Basic and Applied Plant and Animal Biotechnology**

**Min. Pass Marks: 28 Duration: 3 Hours Max. Marks: 70**

UNIT- I

Plant tissue culture: History of plants tissue culture. Principle of tissue culture: Totipotency, cytodifferentiation. Culture media, PGR's and their *in vitro* roles. Embryo culture, Callus culture, suspension culture, single cell culture. Somaclonal variation. Shoot morphogenesis and organogenesis, rooting, hardening and field transfer.

UNIT-II

Application of plants tissue culture in plant pathology (virus free plants, Growth of obligate parasites in culture, disease resistance plants), Production of haploids, male sterile plant and novel plants.

Application of somaclonal variation in disease resistant cell lines. Production of synthetic seeds. Crop preservation and germplasm conservation. Protoplast culture and fusion, somatic hybridization, identification of hybrids, Cybrids.

UNIT-III

Transgenic plants and Gene transfer methods. Selection of clones, marker and reporter genes in screening methods. RFLP, RAPD and other molecular markers in plant breeding applications.

Production, optimization, extraction of alkaloids using plant tissue culture techniques. Biotransformation, immobilization, elicitors and hairy root culture for production of useful metabolites. Antisense RNA technology and its application.

**UNIT-IV**

Brief discussion on the chemical, physical and metabolic functions of balanced salt solutions and simple growth medium. Biology of the cultured cells, Basic technique of mammalian cell cultures *in vitro*. Microcarrier culture, cell synchronization and cell culture and Stem cell culture. Gene transfer: Vaccinia and Baculoviruses as a vector, Mice as the experimental material.

**UNIT-V**

Application of animal cell and recombinant DNA technology: Cell culture based vaccines. Somatic cell genetics. Organ and histotypic cultures. Development of transgenic animals and their uses. DNA based diagnosis of genetic disease. Hybridoma technology. Human somatic cell. Gene therapy for single gene disorders.

**Reference books:**


1. Freshney, Culture of Animal Cells, 5th Edition, Wiley-Liss, 2005
2. Ed. John R.W. Masters, Animal Cell Culture - Practical Approach, 3rd Edition, Oxford University Press, 2000.
3. Plant Tissue Culture by MK Razdan
4. Plant Tissue Culture by MK Razdan & SS Bhojwani (1996) Elsevier
5. Plant Physiology by L Taiz & E Zeiger 4th Edition (2006) Sinauer Associates Inc, Publishers
6. Plant Biotechnology by H.S. chawla.
7. Plant Biotechnology and Transgenic Plants, Edited by Kirsi Marja Oksman-Caldentey, Wolfgang Barz Marcel Dekker 2002
8. Plant Tissue Culture Concepts and Laboratory Exercises, Second Edition, Robert N Trigiano, Dennis J Gray, CRC Press November 1999
9. Jenni, Mathur P. and Barnes, D (Eds.). Methods in cell biology, Vol 57, Animal cell culture methods, Acedamics press.
10 . Martin Clynes. M. (Ed). Animal Cell Techniques. Springer.
11. Mesters , JRW(Ed) Animal cell culture- Practical Approaches, Oxford.
12. Glick BR. And Pasterrnek , JJ. (1994). Molecular Biotechnology principles and Applications

of Recombinant DNA. Panima Publishing Crop, New Delhi
13. Kumar HD. (1998)Modern concept of Biotechnology, Vikas Publishing Hpuse, New Delhi

## SEMESTER-III

### BTC302 – Environment Biotechnology

**Min. Pass Marks: 28** **Duration: 3 Hours** **Max. Marks: 70**

UNIT-I

Environmental biotechnology: Current status of biotechnology in environmental protection. Cleaner technology. Biotechnology for pollution abatement: Bioscrubbers and biofilters; Biotechnology for air and water pollution abatement. Aerobic and anaerobic biological treatment. Use of immobilized enzymes and microbial cells for effluent treatment.

**UNIT- II**

Bioremediation Introduction, Methods of Bioremediation (In Situ and Ex Situ Methods). Applications of Bioremediation. Phytoremedation: Concept and Types. Microbes and their genetic engineering for degradation of environmental pollutants. Degradation of pesticides, oil spills and other xenobiotics

UNIT-III

Biomineralization: Modes ,Organisms. Bioleaching-direct and indirect. Biomineralization of metals-iron, zinc, copper, gold.

Bioaccumulation: Bioaccumulation process-uptake, storage, elimination, state of dynamic equilibirium.Factors affecting bioaccumulation.

Biomagnification of pesticides and heavy metals. Consequences of biomagnification.

**UNIT-IV**

Biofertilizers: Application of microbes as biofertilizers and microbial insecticides (Bt insecticides, Neem insecticides) for productivity improvement and crop protection. Composting and Vermicomposting. Biofertilizers v/s fertilizers, pesticides v/s biopesticides, plastic v/s bioplastics.

UNIT-V

Biomonitoring: Objectives, Parameters for biomonitoring. Micro-organisms, lower plants, higher plants, chromosome and human system as indicator of pollution. Applications of bioindicators.

Spiderwort strategy for detection of low level atomic radiation : Increase of somatic mutation. Significance of concentration of radiation.

**Reference Books:**

1. Environmental Biotechnology: Concepts and Applications Hans-Joachim Jördening, Josef Winter John Wiley & Sons,
2. Advanced Environmental Biotechnology By S.K.Agarwal APH Publishing,
3. Environmental Biotechnology By S.N Jogdand Himalaya Publishing
4. Textbook of Environmental Biotechnology By Mohapatra I. K. International Pvt Ltd
5. Environmental Biotechnology: Basic Concepts and Applications By Indu Shekhar Thakur
6. Environmental Biotechnology: Theory and Application By Gareth G. Evans , Judy Furlong
7. Introduction to Environmental Microbiology; R. Mitchell.
8. Milton Wainwright. An Introduction to Environmental Biotechnology.
9. Kluwer Academic Publishers, Boston. Hardbound, ISBN 0-7923-8569-1. July 1999, 192.

10. Bruce Rittman, Perry L. McCarty. Environmental Biotechnology: Principles and Applications. McGraw-Hill 2nd edition (July 25, 2000) ISBN: 0072345535.
11. Martin Alexander. Biodegradation and Bioremediation. Academic Press; 2nd edition (April 15, 1999) ISBN: 0120498618.
12. Ecotechnology for pollution control & environmental management - By R.K. Trivedi & Arvind Kr.
13. Basic Environmental Technology - J.A. Nathanso

## SEMESTER-III
## BTC303 – Immunology and Immunotechnology

**Min. pass marks: 28** **Duration: 3 hours** **Max. Marks: 70**

**UNIT-I**

Cells and organs of immune system,Immunity - Innate and adaptive, Humoral and cell-mediated, Clonal selection theory.

Antigens: Structure and properties, Types– Iso and allo – haptens, adjuvants, antigen specificity, antigenic determinants. vaccines and toxoids.

Antigen processing and presentation.

**UNIT-II**

Immunoglobulins-basic structure, classes and subclasses of immunoglobulins, Multigene organization of immunoglobulin genes, Generation of antibody diversity.

Complement system: Structure, complement pathways and biological consequence of complement activation. Hybridoma Technology.

**UNIT-III**

Antigen- Antibody interaction -Precipitation, agglutination ,complement fixation, Radial Immunodiffusion, Enzyme Linked absorbent assay, Western blotting, ELISPOT assay, immunofluorescence, flow cytometry and immunoelectrophoresis, Mixed lymphocyte reaction, Apoptosis, Microarrays, Cell cytotoxic assay.

**UNIT-IV**

Major Histocompatibility Complex: Structure and functions of MHC and HLA system. HLA and tissue transplantation. Graft versus host reaction and rejection. Tissue typing methods for organ and tissue transplantations in humans.

Tumor Immunology :Tumor specific antigens. Immune response to tumors. Immunodiagnosis of tumors. Detection of tumor markers.

**UNIT-V**

Hypersensitivity reactions- Type I- Anaphylaxis. Type II- Antibody dependent cell cytotoxicity. Type III- Immune complex mediated reactions. Type IV-Cell mediated hypersensitivity reactions.

Autoimmune diseases- Addison’s disease, Grave’s disease, Hashimoto’s thyroidites, goodpasture’s disease,rheumatoid arthristis.

Immune deficiencies- B cell deficiencies.

**Text/Reference books:**


1. Essentials of Immunology, Author- Roitt, I.M., ELBS. Blackwell Scientific Publishers, London.
2. Immunology II Edition, Author- Kuby, J. WH., Freemanand Company, New York.
3. Immunology. Author- Klaus D. Elgert ,Wiley-Liss. NY.
4. Text Book on Principles of Bacteriology, Virology and Immunology, IX Edition (5 volumes). Authors- Topley and Wilson's, Edward Arnold, London.
5. The Experimental Foundations of Modern Immunology. Authors- Clark, V.R., John Willey and Sons, Incl.
6. Fundamental Immunology. Author – W.E. Paul, Raven Press, New York.
7. Fundamentals of Immunology. Authors – R.M. Coleman, M.F. Lombord and R.E. Sicard 2nded. C. Brown publishers.
8. Immunology. Authors – D.M. Weir and J. Steward 7thEd. (1993).

**SEMESTER-III**

**BTC304 – (1) Recent trends in RNA Biology**

**Min. Pass Marks: 28** **Duration: 3 Hours** **Max. Marks: 70**

**UNIT-I**

Introduction to RNA Biology, Properties of ribonucleic acids. Types of RNAs found in cells. RNA world hypothesis, RNA structure and folding, analytical techniques for studying RNA biology, Function of the RNA molecule is regulated by proteins and small ligands.

**UNIT II**

m-RNA processing- Capping, Tailing and splicing and Alternative splicing.
r-RNA splicing. t-RNA formation and splicing. RNase P recognition, modifications, editing, tRNA mimics, charging and proofreading.

**UNIT III**

Discovery of RNA interference , Post transcriptional Processing of microRNA.
RNA dependent protein complex: target Pairing and RISC Function, microRNA Target Genomics (with introduction to bioinformatic tools). Harnessing RNAi as a tool. RNAs as enzymes.

**UNIT IV**

Long Noncoding RNA: Genome Organization and Mechanism of Action. From Heterochromatin to Long Noncoding RNAs in Drosophila: Expanding the Arena of Gene Function and Regulation. Long Noncoding RNAs in the Yeast (*S. cerevisiae* ) and Plants. RNA biology of disease-associated microsatellite repeat expansions

**UNIT V**

microRNA Function in Vertebrate Development. miRNAs in cancer: tumor suppressors and oncogenes. Small Bacterial RNAs –CRISPR , piRNAs , SnoRNAs , lincRNAs , miRNAs and diseases. A case study of miRNA function in human disease

RNA Science and its Applications.

**Reference Books:**


1. MicroRNAs -From Basic Science to Disease - Krishnarao Appasani- Cambridge University Press
2. RNAi: A Guide to Gene Silencing - Gregory J. Hannon - Cold Spring Harbor Laboratory Press.
3. RNA Biology: Gunter Meister,
4. Goyal A. et al. (2017). Challenges of CRISPR / Cas9 applications for long non-coding RNA genes. Nucleic Acids Research 45: e12
5. utschner T. et al. (2013). The non-coding RNA MALAT1 is a critical regulator of the metastasis phenotype of lung cancer cells. Cancer Res, 73(3), 1180–1189.
6. A Simple Laboratory Practical to Illustrate RNA Mediated Gene Interference Using Drosophila Cell Culture Received for publication, April 15, 2009, and in revised in 2010


**Practicals:**

1. A Simple Laboratory Practical to Illustrate RNA Mediated Gene Interference Using Drosophila Cell Culture.
2. Staining of RNA

3. Targets and functions of miRNAs encoded by the human herpesvirus Kaposi's sarcoma-associated herpesvirus (KSHV)
4. Molecular machinery for histone modifications in yeast, Drosophila and human cells

**SEMESTER-III**

**BTC304 – (2) Nanotechnology**

**Min. Pass Marks: 28 Duration: 3 Hours Max. Marks: 70**

**UNIT -I**

Overview of Nanotechnology: definition, history the new technological revolution, industrial and economic impact. Introduction of Nanoscale physics: quantum mechanics, infinite potential well, energy, quantization. Low Dimensional Systems: Quantum Wells, Quantum Wires, and Quantum Dots, and their applications

**UNIT –II**

Properties of individual nanoparticles: optical properties, electronic Properties. Carbon Nanostrucutres : Carbon Nanotubes and Buckey balls, their fabrication and applications Magnetic. Nanoparticles : properties and applications, spin valves, spintronics.

**UNIT –III**

Synthesis of Nanomaterials: Chemical precipitation and coprecipitation; Metal nanocrystals by reduction, Sol-gel synthesis; Microemulsions or reverse micelles, myle formation; Solvothermal synthesis; Thermolysis routes, Microwave heating synthesis; Sonochemical synthesis; Electrochemical synthesis; , Photochemical synthesis, Synthesis in supercritical fluids.

**UNIT – IV**

Bionanomaterial: Use Preparation and Characterization of Bionanomaterials, Medical Applications of Nanobiotechnology: Nanoparticles' Cytotoxicity, Green nanoparticle production and characterization, Biocompatbility.

**UNIT -V**

Nanotechnology in drug delivery, cosmetics, tissue engineering, bioinformatics, information technology, agriculture , food industry, environment, Health risk , Nanotechnology: Ethics, Regulation of Nanotechnology.

**Reference Books**


1. Chemistry of nanomaterials : Synthesis, properties and applications by CNR Rao et.al.
2. Nanoparticles: From theory to applications – G. Schmidt, Wiley Weinheim 2004.
3. Instrument E L Principe, P Gnauck and P Hoffrogge, Microscopy and Microanalysis (2005), 11: 830-831,Cambridge University Press.
4. Processing & properties of structural naonmaterials - Leon L. Shaw Nanochemistry: A Chemical Approach to Nanomaterials, Royal Society of Chemistry, Cambridge UK 2005.
5. A.W. Adamson and A.P.Gast, Physical Chemistry of surfaces, Wiley Interscience, NY 2004.
6. W. Gaddand, D.Brenner, S.Lysherski and G.J.Infrate (Eds), Handbook of nanoscience, Engg and Technology, CRC Press,2002.
7. G.Cao, Naostructures and Nanomaterials: Synthesis, properties and applications, Imperical College Press, 2004.

8. J.George, Preparation of thin films, Marcel Dekker, InC., New York, 2005.

**Practicals:**

1. Synthesis of nanoparticles.
2. Biosynthesis of nanoparticles.
3. Use to nanobiotechnology in Bioinformatics
4. Use to nanobiotechnology in Drug delivery
5. Use to nanobiotechnology in pollution abetment
6. Use of nanobiotechnology as an antimicrobial agents

**SEMESTER-III**

**BTC304 – (3) Medical Biotechnology**

**Min. Pass Marks: 28 Duration: 3 Hours Max. Marks: 70**

**UNIT I**

Disease diagnosis: probes, detection of genetic diseases. Uses of products of non recombinant and recombinant organisms for disease treatment. Drug manufacturing process. Drug design: ligand based, structure based, active site identification, ligand fragment link, scoring method.

**UNIT II**

Drug metabolism: Non Synthetic-oxidation, reduction, hydrolysis etc., conjugation reactions methylation, sulphation etc. Factors affecting drug metabolism, Drug development process: Pharmacological, microbial, recombinant, biochemical and molecular level screening system.

**UNIT III**

Drug delivery-theory of controlled release drug delivery systems: zero order kinetics, theory of diffusion: release and diffusion of drug polymers. Types of drug delivery- Targeted, Thin film, self microemulsifying, acoustic, neural, drug carrier, liposomes, microspheres, nanofibers etc.

**UNIT IV**

Antibiotics- mechanism, side effects, metabolisms, bioavailability, representative member, resistance, uses of β lactam (penicillin), aminoglycosides (Streptomycin), tetracycline, metronidazole, rifampicin, daptomycin, sulphonamides, multiple drug resistance. Need for III/IV generation of antibiotics.

**UNIT V**

Production of Biopharmaceuticals- Insulin, Interferon. Vaccines-Live vaccines, killed vaccines-Subunit vaccines-Recombinant vaccines-DNA vaccines, Applications of biotechnology in forensics. Microencapsulation in medicine, Biosensors and their application in medicine. Detection of genetic diseases: amniocentesis, carrier detection.

**Suggested Readings:**

1 Christopher, H. Gene cloning and Manipulation. Cambridge University, Press.
2 Nicholl, D.S.T. An introduction to genetic engineering. Cambridge University Press.
3 Sambrook, Russell and Maniatis. Molecular Cloning : A Laboratory Manual (Vol. I, II and III).Cold Spring Harber Laboratory.
4 Glover, D.M. and Hames, B.D. DNA Cloning : A (Practical) approach. IRL Press. Oxford.
5 Brown, T.A. Gene cloning. Blackwell Publisher.
6 Kreuzar, H. and Massey, A. Recombinant DNA technology. A.S.M. Press, Washington.
7 Primrose, S.B. Molecular Biotechnology. Panima.
8 Watson and Zoller. Recombinant DNA. Panima.
9 Boylan, M. Genetic engineering – science and ethics on new frontier. Pearson Edu.
10 Old and Primrose. Principles of Gene Manipulation.
11 Glick and Pasternak. Molecular Biotechnology. ASM Press Washington, USA.

Practicals

1. Identification of human blood groups.
2. Estimation of blood haemoglobin.
3. Perform Total Leukocyte Count of the given blood sample.
4. Perform Differential Leukocyte Count of the given blood sample
5. Separate serum from the blood sample.
6. Perform antibacterial sensitivity by Kirby-Bauer method
7. Drug designing using bioinformatics tools.

**SEMESTER-III**

**BTC304 – (4) Solid and Liquid Waste Management**

**Min. Pass Marks: 28** **Duration: 3 Hours** **Max. Marks: 70**

**UNIT I**

Solid waste: Concept and Current scenario, Sources and Classification of Solid waste,Factors affecting the generation of Solid waste, Evolutionary concept of legislative measures: Related to Environment and solid waste management.

Source reduction of wastes - Recycling and reuse.

**UNIT II**

Handling and segregation of Solid Waste at source and methods of separation, Solid Waste Reduction techniques, Collection of Solid Waste, Transfer and transportation of Solid Waste, Solid waste processing methods, Solid waste disposal methods

Disposal in landfills - Landfill Classification, types and methods - site selection - design and operation of sanitary landfills.

**UNIT III**

Liquid waste management: Classification of liquid waste/sewage, wastewater/ sewage composition , Sewage disposable techniques.

Wastewater treatment: flow variations, characteristics, analysis of BOD, COD, solids and volatile solids & their significance.

Physicochemical treatment: Chemical treatment processes for MSW (combustion, stabilization and solidification of hazardous wastes); physicochemical processes for hazardous wastes (soil vapour extraction, air stripping, chemical oxidation); ground water contamination and remediation .

**UNIT IV**

Biological treatment: Composting; bioreactors; anaerobic decomposition of solid waste;principles of biodegradation of toxic waste; inhibition; co-metabolism; oxidative and reductive processes; slurry phase bioreactor; in-situ remediation.

Advanced water treatment: Ion exchange, electro-dialysis, Reverse Osmosis, Ultra filtration

Nitrification and Denitrification Processes, Phosphorous removal. Wastewater disinfection.

**UNIT V**

Contaminated Waste Management : Introduction ,collection and disposal of contaminated waste. Methods to dispose solid and liquid contaminated wastes, methods to dispose contaminated sharps. Management of organic waste, management of E-waste.

**REFERENCES:**

1. Peavy, H.S., Rowe and Tchobonoglous,G., (1985), "Environmental Engineering", McGraw Hill
2. Metcalf and Eddy Inc., (2003), **"Wastewater Engineering - Treatment and Reuse",** 4th Edition, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
3. Benefield R.D., and Randal C.W., (1980), **"Biological Process Design for Wastewater Treatment"**, Prentice Hall, Englewood Chiffs, New Jersey.
4. Anonymous (2014).Waste to resources- A waste management Handbook. The Energy and Resources Institute (TERI) New Delhi.www.teriin.org.
5. Bhatia S.C.(2007), Solid and hazardous waste management ,Atlantic Publishers and

Distributions(P). New Delhi
6. Khan, I. H. and Ahsan, N.(2011) Textbook of Solid Waste Mangement.CBS Publishers, New Delhi
7. Mishra, S.G. and Mani D.(1993). Pollution through solid waste. Ashok Publishing House, New Delhi.

**Practicals:**

1. Qualitative and Quantitative estimation of solid waste from Household/commercial /Institutional areas.
2. Cost estimation of recyclable waste generated from households /commercial /Institutional areas.
3. Estimate energy content of household solid waste.
4. Making recycled paper/paper items from used newspapers/paper.
5. Preparation and collection of items from recycled/reused material.
6. Laboratory demonstration of Vermi –composting
7. Laboratory demonstration of Aerobic Composting
8. Field visits to waste dumping/disposal site
9. Field visits to Solid Liquid Resource Management (SLRM)
10. Field visit to various Industries
11. Field visit to paper recycling unit or any other recycling unit
12. Field visit to plastic recycling unit or any other recycling unit.
13. Construction and working of Incinerators/biogas plants
14. Site selection and sitting criteria for sanitary landfills in your area.

## BTC311-Biotechnology Laboratory –III

1. Selection of animals, Preparation of antigens, Immunization and methods of bleeding, Serum separation, Storage.
2. Antibody titre by ELISA method.
3. Double diffusion, Immuno-electrophoresis and Radial Immuno diffusion.
4. SDS-PAGE, Immunoblotting, Dot Elisa assays
5. Blood smear identification of leucocytes by Giemsa stain
6. Separation of leucocytes
7. Immunodiagnostics using commercial kits
8. Blood group typing
9. Blood film preparation and identification of cells.
10. MIC assay – Kirby Bauer method
11. Sterilization techniques: Washing of glassware, dry and steam sterilization.
12. Preparation of culture Media. Stock solutions for MS media..
13. Micro propagation techniques. Hardening and transfer of plants to soil
14. Surface sterilization and Organ culture. Ovary culture

15. Callus induction.
16. Study of somatic embryogenesis.
17. Anther culture, production of Haploids.
18. Demonstration of protoplast fusion employing PEG
19. Isolation & identification of secondary metabolites from plant cell
20. Synthetic seeds.
21. To study the development and maintenance of animal cell line.
22. Chick developmental stages
23. Identification of cell types by maceration method.
24. Role of serum in cell culture.
25. Preparation of metaphase chromosome from cultured cells.
26. To study of transplantations -tumors, organs, cells.
27. Western- blotting.
28. To estimate total hardness of water
29. To estimate Calcium hardness of water
30. To estimate the total solids (Ts), total dissolved solids (TDS) and suspended solids (SS) in the given water sample
31. To estimate dissolved oxygen content of wastewater.(DO)
32. To estimate chemical oxygen demand of the given sample(COD)
33. To estimate Biological Oxygen Demand (BOD)
34. To measure the concentration of chloride in it the given sample
35. To measure the Sulfite ($SO_3^{-2}$) content in the given sample by iodometric titration.
36. Practical on soil bioremediations
37. Visit to waste water treatment plant.
38. Practicals based on Elective.

## SEMESTER-IV

### BTC 401 Industrial Biotechnology

**Min. Pass Marks: 28** **Duration: 3 Hours** **Max. Marks: 70**

Unit-I

Isolation, preservation and maintenance of industrial microorganisms, strain improvement Microbial growth and death kinetics, media for industrial fermentation air and media sterilization,

Types of Fermentations: batch, continuous, fed-batch, solid state, sub-merged, aerobic and anaerobic, dual and multiple fermentations, their advantages and disadvantages. Fermentor: Basic design and Types, environmental control ,analysis of mixed microbial populations.

**Unit-II**

Down stream processing: Biomass separation by centrifugation, filtration, flocculation and other recent developments.

Cell disintegration: Physical, chemical and enzymatic methods.

Extraction: Solvent, two phase, liquid extraction, whole broth, aqueous multiphase extraction. Purification by different methods. Concentration by precipitation, ultra-filtration, reverse osmosis. Drying and crystallization.

**Unit-III**

Industrial production of alcohol (ethanol), acids (citric acid and gluconic) solvents (glycerol, acetone butanol), antibiotics (Penicillin, Streptomycin, Tetracycline), amino acids (Lysine, Glutamic acid), steroids transformation, hormones vaccines : types and production. Whole cell immobilization and industrial applications

**Unit-IV**

Introduction to food technology -elementary idea of Canning and packing, Sterilization and pasteurization of food products, Production of mushroom. cheese, single cell protein, single cell oil .

Synthetic seeds-Progress and potentials. Mass scale plant production facilities: design and planning clean area transfer and examination and control. Sericulture. Silkworm- Improvement through biotechnology.

**Unit-V**

Engineering industrial products: Alkaloids, Industrial enzymes, Bioplastics, Biopolymers, PHB, therapeutic proteins.

Green-house management and operations. Quality control, Packaging and shipment, cost benefit analysis. Global market, commercial opportunities in plant tissue culture with special reference to plant tissue culture industries in India.

**Reference Books**

1. Sullia S. B& Shantharam S: (1998) General Microbiology, Oxford & IBH Publishing Co. Pvt.Ltd.
2. Glaser A.N & Nilaido.H (1995) Microbial Biotechnology,W.H Freeman & Co.
3. Prescott & Dunn (1987) Industrial Microbiology 4th Edition, CBS Publishers & Distributors.
4. Prescott & Dunn (2002) Industrial Microbiology, Agrobios (India) Publishers.
5. Crueger W. & Crueger A. (2000) A text of Industrial Microbiology, 2nd Edition, PanimaPublishing Corp.
6. Stanbury P.F, Ehitaker H, Hall S.J (1997) Priciples of Fermentation Technology., Aditya Books (P) Ltd.
7. S.N.Jogdan (2006) Industrial Biotechnology, Himalaya Publishing House

## SEMESTER-IV

## BTC402 Computational Biology & Research Methodology

**Min. pass marks: 28** **Duration: 3 hours** **Max. Marks: 70**

**UNIT-I**

Introduction of computers, Microsoft Office ( Excel, word, and PPT) – Data Entry – graphs – aggregate functions – formula and functions. Different number systems and BIT, BYTE, WORD, secondary storage media. data representation and storage binary codes, binary system and its relationship to Boolean Operations. Biological databases: Primary and secondary databases Nucleic acids (DNA/RNA), Metabolic pathways, Microbial and Cellular data bases,

**UNIT-II**

Tools for DNA sequence analysis, protein sequence analysis; Usage of sequence alignment and searching tools for Gene Identification. Sequence Aligenment: Comparisons of Nucleic acids & Proteins. Sequence and structural, global and local, pairwise and multiple alignment techniques. Using Biological databases; Structure visualization and Building; Protein Sequence Analysis; Genome Analysis; Protein Secondary and Tertiary structure prediction; Homology Modeling; Phylogenetic Analysis Software and Tools.

**UNIT–III**

Computational approaches to protein structure prediction: Threading and Homology based approaches, Experimental techniques for 3-D structure elucidation: X-ray crystallography, Gene prediction: Interpolated Markov Model, Hidden Markov Model, Dynamic programming, Significance of computational approaches in studying protein & DNA structure and function. Introduction to ab-initio, semi-empirical & molecular mechanical methods, Methods to model Nucleic Acids (DNA & RNA).

**UNIT-IV**

Disease / disorder and Drug targets. Concept of receptor / target site. Concepts in molecular recognition. Drug-like properties and associated empirical rules. structure based drug design; Applications of QM methods; Molecular descriptors in QSAR studies, Small molecule force field parameters (charges), potentials, Active site identification, ligand docking , Drug stability, synthesizability and drug delivery.Steps and software of drug designing. Phylogenetic analysis, MEGA, Phylip**.**

**Unit-V**

Research Methodology : Introduction-Basic research, applied research, need based research. Identification of the problem, defining the problem Research Project planning. Literature search-information sources, library resources-books, abstracts hand books, procedure manuals, enoyclopedias, annual report, data banks, CDROMS, online literature search- internet access, websites, directories of information resources.

Progress of research- evaluation of results, statistical approach, comparison with existing methodologies, validation of findings, research communication, impact factor of journals, plagiarism.

**Reference Book:**


1. Principles of Technical Writing by Robert Hays. Addison-Wesley, 1965 2.
2. Rastogi. S. C, Mendiratta. N and Rastogi. P. Bioinformatics Methods and Applications: Genomics, Proteomics and Drug Discovery. Prentice-Hall of India Pvt. Ltd.3rd edition.
3. Zhumur Ghosh & Bibekanand Mallick, Bioinformatics: Principles and Applications, Oxford University Press, Second Edition
4. Teresa K. Attwood and David J. Parry – Smith. 2005. Introduction to Bioinformatics. Pearson education, Singapore.
5. A.R. Leach, Molecular Modeling- Principles and Applications, Second Edition, Pearson.
6. David W. Mount. 2003. Bioinformatics: Sequence & Genome Analysis.CBS Publishers and Distributors. New Delhi.
7. Westhead. D. R, Parish. J. H and Twyman. R. M, 2003. Bioinformatics. Viva Books Private Limited, New Delhi.
8. C.R., Kothari,Research methodology.

**SEMESTER-IV**

**BTC 403 Biosafety, Bioethics & IPR.**

**Min. Pass Marks: 28** **Duration: 3 Hours** **Max. Marks: 70**

**UNIT I**

Introduction to biosafety: Biosafety issues in biotechnology – risk assessment and risk management – safety protocols: risk groups – biosafety levels – biosafety guidelines and regulations (National and International), types of biosafety containment. The cartagena protocol on biosafety.

**UNIT II**

Introduction to ethics and bioethics. Personal ethics: Profession and professionalism , Moral Reasoning , Ethical theories.

Biotechnology and ethics: Biotechnology in agriculture and environment: benefits and risks, benefits and risks of genetic engineering, ethical aspects of genetic testing, ethical aspects relating to use of genetic information , genetic engineering and biowarfare.

**UNIT III**

Ethical implications of cloning: Reproductive cloning , therapeutic cloning .Ethical, legal and socio-economic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research. GM crops and GMO's ,biotechnology and biopiracy , ELSI of human genome project.

**UNIT IV**

Introduction to intellectual property and intellectual property rights: Types, patents, copy rights, trade secrets and trade marks, design rights, geographical indications, Importance of IPR.

Patent claims, the legal decision-making process. Basic requirement of patentability, patentable subject matter, novely & the public domain, patent litigation : substantive and procedural aspects.

**UNIT V**

Special issues in Biotechnology Patent: Disclosure Recruitment, Ethical issues, Plant Biotechnology-UPOV and Plant breeder's rights, case studies/experiences from developing and developed countries, IPR issues in the Indian context.

IT Act 2000: Aims & objectives, overview the Act; Jurdisction ; Role of certifying authority; Regulation under IT Act; cyber crime- offences and contraventions; grey areas on IT Act.

**Suggested Readings**


1. Intellectual Property Right in the Global Economy. Maskus, K.E. (2000), Peterson Institute, ISBN 0881322822, pp. 1-266.
2. Intellectual Property: Patent , copyright , trade mark and allied rights, Cornish, W.R. (2003). Universal Law Publishing , New Delhi. ISBN-10: 0421781203, pp. 1-895
3. Intellectual Property Rights: Infringement and Remedies, Padmanabha A. (2012). Publisher: Lexis Butterworth Wadhwa Inc. ISBN: 9788180387937.pp. 1-638.
4. Assess to Knowledge in the , Age of Intellectual Property. Krikorian G,


**Practicals**

1. Searching of India Patent databases
2. Drafting and filing of Indian Patent databases
3. Searching of International Patent application
4. Drafting and filing of International Patent application

## BTC 404 Dissertation work

**Max. Marks: 100**

- The candidate is required to show article to faculty in/before interpreting his/her experimental work
- Three computerized bound copies of the Dissertation shall be submitted to the college during the final M.Sc. practical examination.

**BTC 411-Biotech Laboratory-IV**

1. Batch fermentation in conical flask
2. Solid state fermentation
3. Screening of microbes for production of industrially important enzymes.
4. Optimization of conditions for optimal production of enzyme: - Media composition, Incubation temperature, Aeration, Incubation time.
5. Purification of antimicrobial metabolites from a microbe.
6. Immobilization of cells and enzymes.
7. Instrumentation of fermentor. Design of various types of fomenters & bioreactors
8. Production of Beer / wine.
   Determination of MIC of antibiotics
9. Determination of microbial population in water by filter disc method
10. Study different parts of fermenter.
11. Microbial fermentations for the production and estimation (qualitative and quantitative) of:
    (a) Enzymes: Amylase and Protease and cellulase.
    (b) Amino acid: Glutamic acid.
    (c) Organic acid: lactic acid/ Acetic Acid
    (d) Alcohol: Ethanol (yeast / wheat flour)
12. A visit to any educational institute/industry to see an industrial fermenter, and other downstream processing operations.
13. Working on Biological databases, NCBI, DDBJ, EMBL.
    Visualizing and Retrieving protein and nucleic acid sequences, structures, EST sequences, SNP data using database browsers and genome browsers.
14. Converting sequences between different formats. Nucleic acid sequence analysis by using detecting ORF's, identification of translational and transcriptional signals, gene predictions, codon usage, RNA fold analysis.
15. Sequence alignment and applications: pairwise alignment-dot matrix comparisons, global and local alignment, Database searching-different pairwise methods. Use of scoring matrices and gap penalities.
16. MSA, Progressive alignment and iterative alignment approaches. Use of profile methods for motif detection. Phylogeny approaches. BLAST and FASTA.
17. Protein Sequence analysis and structure predication working on docking and visualizing software.