**Kurukshetra University Kurukshetra**

**Scheme and syllabus of Examinations for Under-graduate programme**

**under -NEP 2020 (Multiple Entry-Exit Internship)and**

 **(CBCS-LOCF)**

**w.e.f. 2022-23 (in phased manner)**

**Course: Biotechnology**

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Semester | Course | Paper | Nomenclature of paper | Credits | Contact hours | Internal marks | End term Marks | Total | Duration of exam |
| 1 | CC-I | B-BTY-N101 | Basics of Biotechnology-I | 2 | 2 | 25 | 25 | 50 | 3 |
| B-BTY-N102 | Basics of Biotechnology-II  | 2 | 2 | 25 | 25 | 50 | 3 |
| B-BTY-N103 | Practicals based on B-BTY-N101&102 | 2 | 4 | 25 | 25 | 50 | 3 |
| 2 | CC-II | B-BTY-N201 | Introduction to Microbiology  | 2 | 2 | 25 | 25 | 50 | 3 |
| B-BTY-N202 | Proteins & Enzymes | 2 | 2 | 25 | 25 | 50 | 3 |
| B-BTY-N203 | Practicals based on B-BTY-N201&202 | 2 | 4 | 25 | 25 | 50 | 3 |
| 3 | CC-III | B-BTY-N301 | Metabolism-I | 2 | 2 | 25 | 25 | 50 | 3 |
| B-BTY N302 | Metabolism-II | 2 | 2 | 25 | 25 | 50 | 3 |
| B-BTY-N303 | Practicals based on B-BTY-N301&302 | 2 | 4 | 25 | 25 | 50 | 3 |
| 4 | CC-IV | B-BTY-N401 | Molecular Biology-I | 2 | 2 | 25 | 25 | 50 | 3 |
| B-BTY-N402 | Molecular Biology-II | 2 | 2 | 25 | 25 | 50 | 3 |
| B-BTY-N403 | Molecular Biology-Practicals | 2 | 4 | 25 | 25 | 50 | 3 |
| 5 | CC-V | B-BTY-N501 | Recombinant DNA technology-I | 2 | 2 | 25 | 25 | 50 | 3 |
| B-BTY-N502 | Recombinant DNA technology-II | 2 | 2 | 25 | 25 | 50 | 3 |
|  | B-BTY-N503 | Recombinant DNA technology-Practicals | 2 | 4 | 25 | 25 | 50 | 3 |
| DSE-I | B-BTY-N504 | Animal Biotechnology | 4 | 4 | 50 | 50 | 100 | 3 |
| B-BTY-N505 | Animal Biotechnology-Practicals | 2 | 4 | 25 | 25 | 50 | 3 |
| DSE-II | B-BTY-N506 | Microbial Biotechnology | 4 | 4 | 50 | 50 | 100 | 3 |
| B-BTY-N507 | Microbial Biotechnology-Practicals | 2 | 4 | 25 | 25 | 50 | 3 |
| DSE -III | B-BTY-N508 | Plant Biotechnology | 4 | 4 | 50 | 50 | 100 | 3 |
|  | B-BTY-N509 | Plant Biotechnology-Practicals | 2 | 4 | 25 | 25 | 50 | 3 |
| DSE-IV | B-BTY-N510 | MOOC\* (From Swayam Portal) | \* |  |  |  | \* |  |
| SEC- S1 | B-BTY-N511 | Bioanalytical Techniques | 2 | 2 | 25 | 25 | 50 | 3 |
| B-BTY-N512 | Bioanalytical Techniques-Practicals | 4 | 8 | 50 | 50 | 100 | 3 |
| 6 | CC-VI | B-BTY-N601 | IPR, Bioethics & Biosafety  | 4 | 4 | 50 | 50 | 100 | 3 |
|  | B-BTY-N602 | Bioenterpreneurship | 2 | 2 | 25 | 25 | 50 | 3 |
| DSE-V | B-BTY-N603 | Food Biotechnology | 4 | 4 | 50 | 50 | 100 | 3 |
| B-BTY-N604 | Food Biotechnology-Practicals | 2 | 4 | 25 | 25 | 50 | 3 |
| DSE-VI | B-BTY-N605 | Bioprocess & Fermentation | 4 | 4 | 50 | 50 | 100 | 3 |
|  | B-BTY-N606 | Bioprocess & Fermentation-Practicals | 2 | 4 | 25 | 25 | 50 | 3 |
| DSE-VII | B-BTY-N607 | Bioinformatics | 4 | 4 | 50 | 50 | 100 | 3 |
| B-BTY-N608 | Bioinformatics-Practicals | 2 | 4 | 25 | 25 | 50 | 3 |
| DSE- VIII | B-BTY-N609 | MOOC\* (From Swayam Portal) |  |  |  |  |  |  |
| SEC- S1 | B-BTY-N611 | Bioanalytical Techniques | 2 | 2 | 25 | 25 | 50 | 3 |
|  | B-BTY-N612 | Bioanalytical Techniques-Practicals | 4 | 8 | 50 | 50 | 100 | 3 |
| 7 | RAEC-1 | B-BTY-N701 | Research Ethics  | 4 | 4 | 50 | 50 | 100 | 3 |
| RAEC-2 | B-BTY-N702 | Research Methodology | 4 | 4 | 50 | 50 | 100 | 3 |
| RAEC-3 | B-BTY-N703 | Review of literature Seminar | 4 | 4 | 50 | 50 | 100 | 1 |
| RAEC-4 | B-BTY-N704 | Synopsis writing and seminar | 4 | 4 | 50 | 50 | 100 | 1 |
| 8 | RAEC-5 | B-BTY-N800 | Research | 20 |  |  |  | 500 |  |
| RAEC-6 | B-BTY-N801 | Mid-term seminar | 2 |  |  |  | 50 | 1 |
|  | RAEC-7 | B-BTY-N802 | Pre-submission Seminar | 2 |  |  |  | 50 | 1 |

**Notes:**

1. Credits (C), Core Courses (CC); Discipline Specific Elective Courses (DSE); General Elective Courses (GE); Skill Enhancement Courses (SEC), Ability Enhancement Compulsory Courses (AECC), RAEC (Research Ability Enhancement Course
2. Major, Minor, Generic Elective subjects and DSE options will be offered depending upon the availability of faculty/infrastructure /timetable of the Institute/College.
3. Students can opt to exit after completing the internship after 2nd semester and earn a Certificate. Continuing students can do an internship after 4th semester.
4. CC- 5 and CC-6 are honours courses to be taken if students opt for Honours course in the third year and will have to be taken compulsorily by the students opting for 4th year of the programme (Honors and Research) if these courses are not completed earlier at level 7.
5. All the fieldwork, Internship, and dissertation/thesis will be effected through guided learning by allotting a teacher as guide to every student.
6. Each candidate shall be examined in the courses through a system of Comprehensive Continuous Assessment using a mix of Internal and End term evaluation. The Internal Assessment and End term evaluation for different courses of programme shall carry weightage of 50% each. The internal assessment shall be based on clearly defined components of class attendance and participation, mid term exam of 2 hour duration and assignments-presentations carrying 50 percent of the credit (approved by staff council) and the rest (50 %) through End term Examination.

**Programme Outcomes (POs) for UG courses of the Faculty of Life Sciences**

1. To develop skills in graduate students to be able to acquire theoretical and practical knowledge in fundamentals of biology in respective disciplines of plants, animals, microbes and environment.
2. To inculcate ability to critically evaluate problems and apply lateral thinking and analytical skills for professional development.
3. To create awareness on ethical issues, good laboratory practices and biosafety.
4. To develop ability in youth for understanding basic scientific learning and effective communication skills.
5. To prepare youth for career in teaching, industry, government organizations and self reliant entrepreneurship.
6. To make students aware of natural resources and environment and its sustainable utilization.
7. To provide learning experience in students that instills deep interest in biological science for the benefit of society.

**Programme specific Outcomes**

After the successful completion of the programme the student will be able to

**PSO1 :** demonstrate the knowledge and understanding of biological sciences i.e. structure and function of biological molecules, biological mechanisms, such as the processes and control of bioenergetics and metabolism, as chemical reactions with engineering technologies to manipulate living organisms and biological systems to produce products that advance healthcare, medicine, agriculture, food, pharmaceuticals and environment control

**PSO2 :** critically think and correlate the biological knowledge of distribution, morphology and physiology of organisms (animals, plants and microorganisms) to techniques in aseptic procedures, isolation, identification, characterization and modifications to improve quality of life in person as well as community.

**PSO3:** demonstrate an understanding of the principles of bio- techniques, and exhibit basic professional skills pertaining to biotechnology, carry out laboratory-orientated numerical calculations and analyze biological data (e.g. in enzyme kinetics, molecular structure analysis, microbiological techniques, immunological inferences)

**PSO4: scientific** writing and authentic reporting, effective presentation skills and ability to work in a group with cooperation

**Learning Outcomes**: After the successful completion of the course the student will be able to

**Semester – I Course: Biotechnology**

**CC-1**

**Paper: B-BTY-N101**

**Basics of Biotechnology-1**

**Credits: 2**

**Total Marks: 50**

**Internal Assessment: 25**

**End term exam: 25**

**End term examination time: 3h**

101.1 Demonstrate the knowledge of chemical basis of biomolecules, Classify, define, draw structures and correlate to various properties, functions of carbohydrates.

102.2 Classify, draw structures and correlate the chemical structures of lipids, amino acids, and nucleic acids to their organization, properties and functions

**Approaches to teaching**

Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

**Requirements**

Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

**Evaluation**

The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

**Mode of paper setting**

Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each section. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each section. All questions carry equal marks.

**SECTION-A**

**Fundamentals of Bio-Organic Chemistry**

Mechanism of Organic Reactions: Curved arrow notation, drawing electron movements with arrows, half-headed and double-headed arrows, homolytic and heterolytic bond breaking. Types of reagents–electrophiles and nucleophiles.Types of organic reactions (Substitution, Addition, Elimination, Rearrangement etc.). Reactive intermediates: Carbocations, carbanions, free radicals, carbenes (structure & stability). Concept of isomerism: Types of isomerism, Optical isomerism, elements of symmetry, molecular chirality, enantiomers, stereogeniccentre, optical activity, properties of enantiomers, chiral and achiral molecules with two stereogeniccentres, diastereomers and meso compounds (tartaric acid and 2,3-dichlorobutane), R & S nomenclature. Geometric isomerism: Configuration of geometric isomers. Cis-Trans nomenclature, Conformational analysis of ethane, n-butane and cyclohexane.

**Carbohydrates**: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Glycoproteins and their biological functions.

**SECTION-B**

**Lipids**: Structure and functions: Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.

**Amino Acids:**Structure and functions: Common structural features, stereoisomerism and RS system of designating optical isomers, classification and structures of standard amino acids, Zwitter ion in aqueous solutions, essential amino acids and non protein amino acids. Biological function of amino acids

**Nucleic acids**: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines &pyrimidines,. Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA.

**Suggested Reading**

1. Lehninger: Principles of Biochemistry, 3rd edition, by David L. Nelson and M.M. Cox (2000) Maxmillan/ Worth publishers.
2. Fundamentals of Biochemistry by Donald Voet and Judith G Voet (1999). John Wiley & Sons, NY
3. Biochemistry, 2nd edition, by R.H. Garrett and C.M. Grisham (1999). Saunders College Publishing, NY.
4. Outlines of Biochemistry by E.E.Conn, P.K.Stumpf, G. Bruenimg and Ray H.Doi (1987), John Wiley
5. Biochemistry, 2nd edition, by Laurence A. Moran, K.G. Scrimgeour, H. R. Horton, R.S. Ochs and J. David Rawn (1994), Neil Patterson Publishers Prentice H.
6. Introductory Biochemistry by S.K.Singla&O.P.Chauhan (1995) Kalyani Publishers, New Delhi.
7. Biochemistry by J.L. Jain, S. Chand & Co.

**Semester I -- CC-BIOTECHNOLOGY-1**

**Paper B-BTY-N102**

**BASICS OF BIOTECHNOLOGY-II**

**Credits: 2**

**Total Marks: 50**

**Internal Assessment: 25**

**End term exam: 25**

**End term examination time: 3h**

**Learning Outcomes**: On successful completion of the course the students will be able to

102.1 Demonstrate the knowledge of the concept and applications of biotechnology in animals and plants

102.2 give an insight of the scope and applications of biotechnology in agriculture, environment, food and chemical industries

**Approaches to teaching**

Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

**Requirements**

Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

**Evaluation**

The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

**Mode of paper setting**

Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each section. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each section. All questions carry equal marks.

**SECTION-A**

Definition and scope of Biotechnology; introduction of genetic engineering; plant and animal tissue culture; Animal Biotechnology; Plant Biotechnology; fermentation technology; immobilized enzymes; monoclonal antibodies and hybridoma technology; embryo transfer technology; preservation techniques; introduction to gene and genomes, Proteins and proteome, history of genetic manipulations; recombinant DNA technology, DNA fingerprinting and forensic analysis.

**SECTION-B**

Application of biotechnology in agriculture; animal and veterinary sciences, Environment biotechnology; pharmaceutical industry, food industry and chemical industry. Bioremediation and waste treatment biotechnology. Biotechnology research in India. Biotechnology in context of developing world. Brief account of safety guidelines and risk assessment in biotechnology. Ethics in Biotechnology, Intellectual property rights.

**Suggested Reading**

1. Elements of Biotechnology - PK Gupta
2. Gene Biotechnology - S.N. Jogdand
3. Biotechnology 5th Edition (Cambridge) - John E. Smith
4. Biotechnology for beginners – Reinhard Renneberg  Academic Press

**Semester I**

**CC-BIOTECHNOLOGY-I**

**Paper B-BTY-N103**

 **PRACTICALS BASED ON B-BTY-N101&102**

**Credits: 2**

**Total Marks: 50**

**Internal Assessment: 25**

**End term exam: 25**

**End term examination (one session): 3h**

103.1 Prepare various types of solutions used in qualitative and quantitative biochemical estimations; verify and apply the basic principles of spectroscopy

103.2 Analyse the unknown samples qualitatively for the presence of various biomolecules

**Approaches to teaching**

Instructions, Chalk and board teaching, demonstrations, models, practical and practice

**Requirements**

Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals

**Evaluation**

The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

**Practicals:**

1. Study of instruments: Autoclave, Hot air oven, pH meter, Laminar airflow and centrifuge
2. Preparation of normal, molar, percent solutions, buffer solutions and determination of their pH.
3. Qualitative tests for Carbohydrates
4. Qualitative tests for lipids
5. Qualitative tests for amino acids and Proteins
6. Verification of Beer- Lambert’s Law

**Suggested Reading:**

1. Elements of Biotechnology; Gupta PK, Rastogi Publications, Meerut.
2. Gene Biotechnology - S.N. Jogdand
3. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
4. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants.American Society of Plant Biologists.
5. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA

**Semester – II**

**CC-BIOTECHNOLOGY-2**

**Paper: B-BTY-N201**

 **INTRODUCTION TO MICROBIOLOGY**

**Credits: 2**

**Total Marks: 50**

**Internal Assessment: 25**

**End term exam: 25**

**End term examination time: 3h**

**Learning Outcomes**: On successful completion of the course the student will be able to

201.1 Illustrate the knowledge of history, scope, classification, various approaches of study and microbial diversity, Compare and characterize prokaryotic and eukaryotic cells based on morphology; different groups of microorganisms based on their structures.

201.2 Give an account of microbial growth, reproduction and metabolism and identify the microorganisms in water and food along with methods to control them

**Approaches to teaching**

Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

**Requirements**

Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

**Evaluation**

The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

**Mode of paper setting**

Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each section. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each section. All questions carry equal marks.

**SECTION- A**

**Microbial Taxonomy and classification**: Fundamentals, History and Evolution of Microbiology. Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria. Microbial Diversity:

**Distribution and characterization**: Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

**Cultivation and Maintenance of microorganisms**: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.

**SECTION-B**

**Microbial growth:** Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria. Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.

**Control of Microorganisms:** By physical, chemical and chemotherapeutic Agents

**Food and Water Microbiology:** Bacterial pollutants of water, coliforms and non coliforms.Sewage composition and its disposal. Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major food born infections and intoxications, Preservation of various types of foods.Fermented Foods.

**SUGGESTED READING**

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996).Introductory Mycology. 4 th edition. John and Sons, Inc.
2. Jay JM, Loessner MJ and Golden DA.(2005). Modern Food Microbiology.7thedition, CBS Publishers and Distributors, Delhi, India.
3. Kumar HD. (1990). Introductory Phycology.2nd edition.Affiliated East Western Press.
4. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms.12th edition.Pearson/Benjamin Cummings.
5. Pelczar MJ, Chan ECS and Krieg NR.(1993). Microbiology.5th edition. McGraw Hill Book Company.
6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.

**Semester – II**

**CC-BIOTECHNOLOGY-2**

**Paper: B-BTY-N202**

**PROTEINS AND ENZYMES**

**Credits: 2**

**Total Marks: 50**

**Internal Assessment: 25**

**End term exam: 25**

**End term examination time: 3h**

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**Outcomes:** After successful completion students will be able to

202.1 Describe different classes of proteins and explain different levels of structural organization in protein architecture; define various characteristics of enzymes and classify them

202.2 Elaborate the role of cofactors in enzyme catalysis and correlate the structure of enzymes to their functions and mechanism of enzyme catalysis

**Approaches to teaching**

Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

**Requirements**

Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

**Evaluation**

The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

**Mode of paper setting**

Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each section. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each section. All questions carry equal marks.

**SECTION - A**

### Peptides: structure of peptide bond, Protein structure: levels of structure in protein architecture (Primary, secondary, tertiary and quaternary structures of proteins), Ramachandran plot and forces stabilizing these structures. Denaturation and renaturation of proteins. Salting-in and salting-out of proteins. Biological functions of polypeptides and proteins

Enzymes: Historical perspectives, general characteristics, nomenclature & classification, significance of numbering system, holoenzyme, apoenzyme, coenzymes, cofactors, activators, inhibitors, active site, metallo-enzymes, isoenzymes, monomeric enzymes, oligomeric enzymes, multifunctional enzyme and multi-enzyme complexes. Enzyme specificity (absolute, group and optical specificity), Three point attachment theory of enzyme specificity, Measurement and expression of enzyme activity: Enzyme assay, enzyme units, enzyme turn over number and specific activity

**SECTION - B**

Role of cofactors in enzyme catalysis: NAD/NADP, FMN/FAD, coenzyme A, biocytin, Vitamin B12 Coenzyme, lipoamide, TPP, pyridoxal phosphate, tetrahydrofolate and metal ions with special emphasis on coenzyme functions.

Enzyme catalysis: Reaction co-ordinate diagram, transition state, Acid-base catalysis, covalent catalysis, proximity and orientation effects, strain and distortion theory. Mechanism of action of chymotrypsin and carboxypeptidase

**Suggested reading**

1. Structure and mechanism in Protein Science, by Alan Fersht (2017). World Scientific
2. Fundamentals of Enzymology, 3rd edition, by Nicholas C. Price and Lewis Stevens (2009) Oxford U.
3. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry by Trevor Palmer, Philip Bonner (2008) East West Publishing.
4. The Chemical Kinetics of Enzyme action by K.J. Laidler and P.S. Bunting, Oxford University Press London.

**Semester – II -- CC-BIOTECHNOLOGY-2**

**Paper: B-BTY-N203**

**PRACTICALS BASED ON B-BTY-N-201&202**

**Credits: 2**

**Total Marks: 50**

**Internal Assessment: 25**

**End term exam: 25**

**End term examination(one session): 3h**

**Learning Outcomes:** After successful completion students will be able to

203.1 Exhibit skills in preparation of media and staining, Isolate bacteria from different sources and determine their count and cell size

203.2 estimate the enzyme activity and protein content of the samples

**Approaches to teaching**

Instructions, Chalk and board teaching, demonstrations, models, practical and practice

**Requirements**

Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals

**Evaluation**

The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

 **PRACTICALS**

1. Isolation of bacteria from different sources
2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.
3. Determination of bacterial cell size by micrometry and Enumeration of microorganism - total & viable count.
4. Protein estimation by biuret / Lowry’s method
5. Assay of acid phosphatase activity from germinating mungbean seeds and calculation of its specific activity.
6. Effect of substrate concentration on acid phosphatase activity and determination of its Km value.

### **Suggested reading:**

1. Pelczar MJ, Chan ECS and Krieg NR.(1993). Microbiology.5th edition. McGraw Hill Book Company.
2. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
3. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
4. introduction to Practical Biochemistry, 3rd Edition, by David Plummer (2017). Tata Mc-Graw Hill
5. Introductory Practical Biochemistry by S.K.Sawhney& R. Singh (2014). Narosa Publishers

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| **CORE COURSE - BIOTECHNOLOGY-1****BASICS OF BIOTECHNOLOGY** |
| **CO#** | After the successful completion of the course the student will be able to  |
| **101.1** | Demonstrate the knowledge of the chemical basis of biomolecules, Classify, define, draw structures and correlate to various properties, functions of carbohydrates |
| **101.2** | Classify, draw structures and correlate the chemical structures of lipids, amino acids, and nucleic acids to their organization, properties and functions. |
| **102.1** | Demonstrate the knowledge of the concept and applications of biotechnology in animals and plants. |
| **102.2** | Give an insight of scope and applications of biotechnology in agriculture, environment, food and chemical industries |
| **103.1** | Prepare various types of solutions used in qualitative and quantitative biochemical estimations; verify and apply the basic principles of spectroscopy |
| **103.2** | Analyse the unknown samples qualitatively for the presence of various biomolecules |

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| CORE COURSE- **BASICS OF BIOTECHNOLOGY** |
| **CO#** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PSO1** | **PSO2** | **PSO3** | **PSO4** |
| **101.1** | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| **101.2** | 3 | 3 | 1 | 3 | 3 | 3 | 3 | 3 | 3 | 2 | 3 |
| **102.1** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **102.2** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **103.1** | 3 | 3 | 3 | 3 | 3 | 2 | 2 |  | 3 | 3 | 3 |
| **103.2** | 3 | 3 | 3 | 3 | 3 | 2 | 2 | 3 | 3 | 3 | 3 |
| **Average** | 3 | 3 | 2.33 | 3 | 3 | 2.66 | 2.66 | 2.5 | 3 | 2.66 | 3 |

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| **CORE COURSE - BIOTECHNOLOGY-2****INTRODUCTION TO MICROBIOLOGY: PROTEINS AND ENZYMES** |
| **CO#** | After the successful completion of the course the student will be able to |
| **201.1** | Illustrate the knowledge of history, scope, classification, various approaches of study and microbial diversity, Compare and characterize prokaryotic and eukaryotic cells based on morphology; different groups of microorganisms based on their structures |
| **202.2** | Give an account of microbial growth, reproduction and metabolism and identify the microorganisms in water and food along with methods to control them |
| **202.1** | Describe different classes of proteins and explain different levels of structural organization in protein architecture; define various characteristics of enzymes and classify them  |
| **201.2** | Elaborate the role of cofactors in enzyme catalysis and correlate the structure of enzymes to their functions and mechanism of enzyme catalysis  |
| **203.1** | Exhibit skills in preparation of media and staining, Isolate bacteria from different sources and determine their count and cell size |
| **203.2** | Estimate the enzyme activity and protein content of the samples |

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| **CORE COURSE- INTRODUCTION TO MICROBIOLOGY: PROTEINS AND ENZYMES** |
| **CO#** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PSO1** | **PSO2** | **PSO3** | **PSO4** |
| **201.1** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **202.2** | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 | 3 |
| **202.1** | 3 | 3 | 2 | 3 | 3 | 1 | 3 | 3 | 3 | 2 | 3 |
| **202.2** | 3 | 3 | 2 | 3 | 3 | 1 | 3 | 3 | 3 | 2 | 3 |
| **203.1** | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| **203.2** | 3 | 3 | 3 | 3 | 3 | 2 | 3 | 3 | 3 | 3 | 3 |
| Average | 3 | 3 | 2.66 | 3 | 3 | 2.00 | 3 | 3 | 3 | 2.66 | 3 |