# Discipline Specific Core ( 200-299 )

**University of Kerala**

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| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK3DSCBIT200 | | | | |
| Course Title | BIOMOLECULES & METABOLISM | | | | |
| Type of Course | DSC | | | | |
| Semester | III | | | | |
| Academic Level | 200 - 299. | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 4 | 3 hours | 0 | 2 hours | 5 |
| Pre-requisites | Fundamentals of Biochemistry, cell biology | | | | |
| Course Summary | This course delves into the intricate world of biomolecules and the fundamental processes governing metabolism in living organisms. It provides an advanced understanding of the structure, function, and interplay of various biomolecules such as proteins, carbohydrates, lipids, and nucleic acids, as well as the metabolic pathways that govern energy production, biosynthesis, and cellular regulation. | | | | |
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**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| I | | **Basic constituents of Life -Overview** | **6** |
| | 1 | Chemical Constituents of Life, Importance of water and physiological buffer system | |
| | 2 | Carbohydrates : Classification,mono,di,and polysaccharides with special | |

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|---|---|---|---|
| | | emphasis on starch, glycogen, cellulose, and chitin | |
| | 3 | Glycoconjugates and its biological significance. glycosides, deoxy sugars, amino sugars, sugar alcohols and sugar acids (Lectins-CS) | |
| **II** | | **Lipids** | 8 |
| | 4 | Classification of lipids | |
| | 5 | Fatty Acids,Triglycerides ,Phospholipids ,Sphingolipids - structure, properties and reactions | |
| | 6 | Function of Steroids–cholesterol (CS) and ergosterol, phosphatidyl choline and phosphatidyl ethanolamine, cerebrosides and gangliosides | |
| **III** | | **Amino Acids and Proteins** | 10 |
| | 7 | Classification of amino acids, Physical properties, Chemical reactions of amino acids | |
| | 8 | Biological significance and classification- fibrous proteins, globular proteins, conjugated proteins(CS) | |
| | 9 | Elementary study of primary, secondary, tertiary and quaternary structure of proteins;(CS-motifs) oligopeptides- glutathione; Hemoglobin-structure and functions | |
| | 10 | Nucleic acids: Base compositions, structure of purines and pyrimidines, ribose and deoxyribose, nucleoside structure , nucleotides- nomenclature, structure of polynucleotide – DNA,RNA primary structure and inter nucleotide linkage Watson and Crick double helix model of DNA, different types of RNA. | |
| **IV** | **Metabolism of Biomolecules** | | **12** |
| | 11 | Metabolism basic concepts- Energy rich compounds-ATP, Common types of reaction in metabolism-Oxidation, reduction, phosphorylation, hydrolysis, hydroxylation, carboxylation.<br>High energy compounds with structures (ATP, ADP, Creatine phosphate, 1, 3 bisphosphoglycerate, PEP), role of high energy phosphate groups. | |
| | 12 | Metabolism of carbohydrates<br>Glycolysis. Gluconeogenesis, Glycogen metabolism- glycogenesis, glycogenolysis. Regulation (Only pathway outlines, structures not required**).** | |
| | 13 | Metabolism of Lipids.<br>Scheme of β- oxidation, ATP yield in β oxidation (stearate, palmitate as examples) and regulation. Basics of α- and ω-oxidation, ketone body formation, cytoplasmic system of fatty acid biosynthesis and regulation of the pathway, outline study of biosynthesis of cholesterol and bile acids (Only pathway outlines, structures not required**).** | |
| | 14 | Metabolism of amino acids.<br>Reactions involved in the metabolism of amino acids- deamination, transamination and decarboxylation; coenzymes involved in these reactions. Urea cycle (structure not required).<br>Metabolism of Nucleic Acids- De Novo & Salvage Pathway. | |
| **V** | **Enzymes** | | **9** |

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|---|---|---|---|
| | 15 | Enzymes - Classification<br>Units of enzyme activity, progress curve, effect of enzyme concentration, substrate concentration- (Michaelis-Menten equation- derivation not expected), Michaelis-Menten constant, enzyme affinity, temperature and pH on reaction velocity of enzyme catalyzed reactions.<br>Enzyme specificity- different types, enzyme activation. | |

**Practicals 30 hrs- Essential Experiments (15 hrs) , Group Work (15 hrs)**

**Essential Experiments**

1. Tests for amino acids: Solubility, ninhydrin reaction, xanthoproteic reaction, Millons test, Morners test, glyoxalic acid test, Ehrlich's test, nitroprusside test, lead acetate, test for methionine, aldehyde test, Sakaguchi reaction and isatintes
2. Tests for proteins: Solubility, Ninhydrin reaction, Xanthoproteic reaction, Folin's test, Lowry's test, Biuret test, Heat denaturation, TCA precipitation, Alcohol precipitation.
3. Demonstration of Kinetics of Urease / Trypsin (Effect of pH, substrate Concentration, enzyme concentration• and temperature) .
4. Progress curve of Urease/Trypsin•
5. Digestion of carbohydrates –action of salivary amylase•

**Suggested Readings:**


1. Lehninger Principles of Biochemistry, 4th Edition by David L. Nelson David L. Nelson (Author)
2. Biochemistry (2004) by Donald Voet, Judith G. Voet Publisher: John Wiley & Sons Inc
3. TextBook of Biochemistry, 5th edition by DM Vasudevan and Sreekumar S, JAYPEE Publishers, New Delhi
4. Experimental Biochemistry: A Student Companion, Beedu Sasidhar Rao & Vijay Deshpande (ed), I.K International Pvt. LTD, New Delhi .
5. Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi,
6. Standard Methods of Biochemical Analysis, S. K. Thimmaiah (Ed), Kalyani Publishers, Ludhiana.
7. ES West, WR Todd, HS Mason and JT van Bruggen. A text Book of Biochemistry, Oxford and IBH Publishing Co., New Delhi, 1974.
8. E.S. West, W.R. Todd, H.S. Mason and J.T. van Bruggen, A Text Book of Biochemistry, Oxford and IBH Publishing Co., New Delhi, 1974
9. Principles and Techniques of Practical Biochemistry by Keith M. Wilson, John M. Walker Cambridge University Press


| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | Understanding how chemical constituents of life in a biotechnological perspective | U | PSO-1,2 |

| | | | |
|---|---|---|---|
| CO-2 | Explain biomolecule modifications and biological significance of various bioconjugates | R, U,Ap | PSO3,4 |
| CO3 | Understand complex metabolic pathways in living cells | R , U | PSO3 |
| CO4 | Evaluate various tests for presence of amino acids, carbohydrates on the basis of qualitative tests | U, Ap | PSO3,4 |

**R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create**

*Note: 1 or 2 COs/module*

**Name of the Course: Metabolism and energetic Credits: 3:0:2 (Lecture:Tutorial:Practical)**

| **CO No.** | **CO** | **PO/PSO** | **Cognitive Level** | **Knowledge Category** | **Lecture (L)/Tutorial (T)** | **Practical (P)** |
|---|---|---|---|---|---|---|
| CO-1 | Understand the basic constituents of Life | PSO-1,2 | U | F, C | L | |
| CO-2 | Explain how biomolecules function and its various structural and functional modifications | PSO3,4 | R, U,Ap | P | L | |
| CO3 | Understand the basics of metabolic networks | PSO3 | R , U | F | L | |
| CO4 | Evaluate the tests for important biomolecules | PSO3,4 | U, Ap | P | L | P |

**F-Factual, C- Conceptual, P-Procedural, M-Metacognitive**

**Mapping of COs with PSOs and POs :**

| | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

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|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | 2 | - | - | - | - | | | | | | |
| **CO 2** | - | - | 3 | 3 | - | - | | | | | | |
| **CO 3** | - | - | 2 | - | - | - | | | | | | |
| **CO 4** | - | - | 2 | 3 | - | - | | | | | | |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:Continuous Comprehensive Assessment:**

**Formative :** Practical /problem/Survey/Design/Field trip based Assignment in the form of Individual or team work regarding the theory part/Follow any of the tool regarding the above practical assignment-1.Observation of practical skill/Viva/.Quiz/ In class discussions/Good Lab practices/Lab work book

**Summative:**Follow any of the tool - Written test (theory based)/.Open Book Test(theory based)/ Individual /team work report practical assignmen/Case study report /Literature survey/Individual / Team project report oral presentation/ Laboratory report

**End Semester Examination Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Observation of Practical skills | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | | | ✓ | ✓ |

UniversityofKerala

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|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK3DSCBIT201 | | | | |
| Course Title | MICROBIOLOGY | | | | |
| Typeof Course | DSC | | | | |
| Semester | III | | | | |
| Academic Level | 200 – 299 | | | | |
| Course Details | Credit | Lectureper week | Tutorial perweek | Practical perweek | Total Hours/Week |
| | 4 | 3 hours | 0 | 2 hours | 5 |
| Pre-requisites | Basicknowledge of Biology and Biochemistry | | | | |
| Course Summary | The Microbiology course delves deeply into the microbial world, covering key aspects from past discoveries to practical applications in various fields.It equips students with a strong foundation in microbiology, necessary lab skills, and a thorough understanding of microbial functions, uses, and control methods vital in scientific and industrial contexts. | | | | |

**DetailedSyllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|

| | | | |
|---|---|---|---|
| **I** | **Introductiontothemicrobialworld** | | **10** |
| | 1 | Overview of key events and discoveries in the history of microbiology.<br>Contributions of Antonvan Leeuwenhoek,Louis Pasteur and Robert Koch | |
| | 2 | Introduction to the prokaryotic world,eukaryotic microorganisms, acellular microorganisms (Viruses, Viroids, Prions, Mycoplasma) | |
| | 3 | Introduction to systems of classification: Binomial Nomenclature, Introduction to Bergey's manual | |
| | 4 | Nutritional classification of bacteria, Energy production in bacteria (Brief account) | |
| **II** | **Principles of microbial control** | | **6** |
| | 5 | General principles:Control by removal, inhibition and sterilisation. | |
| | 6 | Physical MethodsofMicrobialControl : Heat- dry and moist, filtration, radiation | |
| | 7 | Chemical Methods of MicrobialControl<br>Types and Modes of Action of chemical sterilants and disinfectants | |
| **III** | **Microbial physiology and culture** | | **12** |
| | 9 | Ultrastructure of bacteria:Cellwall (Gran positive and negative), internal organisation, spores<br>Staining techniques: Simple staining, negative staining, differential staining (Grams staining) | |
| | 10 | Motility in bacteria –structure of flagella, their distribution and patterns of motility, Hanging drop test | |
| | 11 | Nutritional requirements in bacteria<br>Culture media:components,types of culture media<br>Pure culture methods (pour plate, spread plate, streaking, culture preservation methods (Lyophilisation, deep freezing) | |
| | 12 | Bacterial growth curve,factors affecting the growth of microbes. | |
| **IV** | **Bacterial Genetics and recombination** | | **10** |
| | 13 | Bacterial Chromosome,Plasmids- types of plasmids<br>Bacterial mutation and Repair | |
| | 14 | Bacterial Recombination-Transformation,Transduction(Generalised and Specialised), Conjugation | |
| **V** | **AppliedMicrobiology** | | **7** |
| | 17 | Agricultural microbiology: Biological nitrogen fixation, Mycorrhizalassociations, | |
| | 18 | Microbesasbiofertilizer–typesandapplication | |
| | 19 | Microbes in extreme condition: role of Methanogenic bacteria, extremophiles– Thermophiles, Acidophiles, Halophiles and Alkalophiles, Applications. | |
| | 20 | Casestudyandindustrialvisit | |

**Practicals30hrs-EssentialExperiments(15hrs),GroupWork(15hrs) Essential**

**Experiments**

1. HandlingMicroscope
2. Preparation of smear on slide and focusing on microscope(low power and high power objective).
3. Sterilization and aseptic techniques-preparation andsterilization of glassware and solutions, Autoclaving, Hot air oven
4. Media Preparation-Preparation ofLuria-Bertanimedium,Nutrient agar and their sterilization (Broth and plates).
5. Serial dilution of bacterial cultures and spread plating(Lrod)to findout population density of microbes in a given sample, incubation and observation of colonies
6. Examination of microbial flora of the available soil and water samples.a)Pourplate method, b) Streak plate method - Continuous, Quadrant & T streak.
7. Stainingofbacteria-Gramstaining,Acid fast staining,Negative staining.
8. Microscopic tests for bacterial motility-Hanging Drop experiment
9. Identification of bacterial and fungal cultures microscopically.
10. Antibiotics sensitivity assays-Kirby Bauer Method

**SuggestedReadings:**


1. ATextbookofMicrobiology–P.Chakraborthy,NewcentralBookagencyPvt.Ltd, calcutta
2. ModernconceptofMicrobiology–DDKumar,SKumar;VikasPublishingHouse Pvt. Ltd. New Delhi
3. IntroductiontoGeneticEngineering&Biotechnology-A.J.Nair;Jones&Bartlett Publishers, Boston,USA.

4. IntroductiontoMicrobiology-JHeritage, EGVEvans,RAKillington;Cambridge University Press.
5. Microbiology–LMPrescott,BrownPublishers,Australia
6. AdvancesinMicrobiology–JPTewari,TNLakhanpal,ISingh,RGuptaandBP Chanola; A P H Publishing Corporation, New Delhi.
7. Microbiology:PrinciplesandExplorations–JacquelynG.Black.PrenticeHall,New Jersey.

## CourseOutcomes

| No. | Uponcompletionofthecoursethegraduatewillbe able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO- 1 | Understandingthekeyeventsinmicrobialhistory. | U | PSO-1,2 |
| CO- 2 | Explainscopeofmicrobiologyanddifferentnutritional typesof microorganisms and classification | An | POS1 |
| CO- 3 | Understandmicrobial genetics and metabolism, analyse the recombination methods in bacteria | E | PSO1 |
| CO- 4 | Understandstrategiesformicrobialcontrol.Evaluate the role ofsterilants and disinfectants. | E | POS1,PSO3 |
| CO- 5 | Differentiatebetweentypes of culturemediaand understandfactorsaffectingmicrobialgrowth. | C | POS1,PSO4 |
| CO- 6 | Gainpracticalskillsinmicrobial sampling,isolation,staining and culture methods. | C | PSO3 |

**R-Remember,U-Understand,Ap-Apply,An-Analyse,E-Evaluate,C-Create**

*Note:1or2 COs/module*

**NameoftheCourse:**MICROBIOLOGY**credits: 3:0:2 (lecture:tutorial:practical)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| CO- | Understanding the key events in microbial history. | PSO-1,2 | U | F,C | L | - |
| **CO No.** | **CO** | **PO/PSO** | **Cognitive Level** | **Knowledge Category** | **Lecture (L)/Tutorial (T)** | **Practical (P)** |
| CO-2 | Explain scope of microbiology and different nutritional types of microorganisms and classification | POS1 | An | P | L | - |
| CO-3 | Understand microbial genetics and metabolism, analyse the recombination methods in bacteria | PSO1 | E | F | L | - |
| CO-4 | Understand strategies for microbial control. Evaluate the role of sterilants and disinfectants. | POS1,PSO3 | E | F | L | |
| CO-5 | Differentiate between types of culture media and understand factors affecting microbial growth. | POS1,PSO4 | C | P | L | P |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO-6 | Gain practical skills in microbial sampling, isolation, staining and culture methods. | PSO3 | C | P | L | P |

**F-Factual,C-Conceptual,P-Procedural,M-Metacognitive Mapping of**

**COs with PSOs and POs :**

| | **PSO1** | **PSO2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 3 | - | - | - | - | - | | | | | | |
| **CO** | 3 | - | - | - | - | - | | | | | | |
| | **PSO1** | **PSO2** | **PSO 3** | **PSO 4** | **PSO 5** | **PSO 6** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
| **2** | | | | | | | | | | | | |
| **CO 3** | 3 | - | - | - | - | - | | | | | | |
| **CO 4** | 2 | - | 2 | - | - | - | | | | | | |
| **CO 5** | 2 | - | - | 3 | - | - | | | | | | |
| **CO 6** | - | - | 3 | 2 | - | - | | | | | | |

**CorrelationLevels:**

| **Level** | **Correlation** |
|---|---|

| | |
|---|---|
| - | Nil |
| 1 | Slightly/Low |
| 2 | Moderate/Medium |
| 3 | Substantial/ High |

**AssessmentRubrics:**

**ContinuousComprehensiveAssessment:**

**Formative:**

- InteractiveQuiz/GroupDiscussions/Assignment/StudentSeminar
- Observationofpracticalskills/JournalClubpresentations
- Punctualityinlab,andtimemanagementincompletingassignedlaboratory tasks

**Summative-**Internaltestpapers/Laboratorybook/report/Periodicallabtests

**MappingofCOstoAssessmentRubrics:**

| | Internal Exam | Assignment | ObservationofPractical skills | EndSemester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | ✓ | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | ✓ |

**niversity of Kerala**

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|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK3DSCBIT202 | | | | |
| Course Title | BASICS OF ENZYMOLOGY | | | | |
| Type of Course | DSC | | | | |
| Semester | III | | | | |
| Academic Level | 200 - 299 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 4 | 3 hours | 0 | 2 hours | 5 |
| Pre-requisites | Basic knowledge of Biology, Biochemistry & Cell biology | | | | |
| Course Summary | The Basics of Enzymology course provides a comprehensive introduction to the fundamental principles governing enzyme structure, function, kinetics, and regulation. Through a combination of lectures, laboratory sessions, and readings, students will gain a deep understanding of enzymatic mechanisms and their significance in biological processes. The course emphasizes on both theoretical knowledge and practical skills necessary for studying enzymes in various biochemical contexts. | | | | |

Detailed Syllabus:

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Nomenclature, Classification & Purification of Enzymes** | | **8** |
| | 1 | The Enzyme Commission's system of classification and nomenclature | |
| | 2 | Extraction and Purification of Enzymes:<br><br>Extraction of soluble and membrane bound enzymes; Overview of enzyme purification methods (Precipitation, Electrophoresis, Chromatography), Criteria of enzyme purity | |
| **II** | **Structure and General properties of enzymes** | | **10** |
| | 4 | Enzymes and Co-factors, Specificity of enzyme action -Types of specificity, the active site, Lock and key hypothesis, Induced fit hypothesis. | |
| | 5 | Mechanism of Catalysis: Acid Base catalysis, Covalent catalysis, Electrostatic catalysis, Enzyme Catalysis | |

| | | | |
|---|---|---|---|
| | 6 | Factors affecting enzyme activity (substrate concentration, temperature, pH) | |
| | 7 | Isozymes, Metalloenzymes, Multienzyme complexes, Synthetic Enzymes. | |
| **III** | **Kinetics of Enzyme-catalyzed reactions** | | **10** |
| | 8 | Kinetics of enzyme catalyzed reactions: Factors affecting enzyme kinetics, Significance of Michaelis-Menton constant, Lineweaver–Burk plot | |
| | 9 | Kinetics of multi-substrate enzyme - catalyzed reactions – Ping-pong and random order mechanisms | |
| | 10 | Enzyme inhibition: Mechanism of enzyme inhibition –Competitive, non – competitive, Uncompetitive and Irreversible Inhibition | |
| **IV** | **Regulatory mechanisms in enzyme catalysis** | | **8** |
| | 11 | Allosteric Regulation and Feedback Regulation, Important metabolic pathways regulated by allosteric enzymes (Glycolysis, Krebs Cycle) | |
| **V** | **Enzyme technology** | | **9** |
| | 14 | Introduction to Enzyme technology, Enzyme engineering, Computational enzyme design | |
| | 15 | Applications of Enzymes: Applications in medicine (diagnostic enzymes, therapeutic enzymes), Applications in Genetic Engineering (Restriction endonucleases, Ligases), Applications in Industry | |
| | 16 | Immobilization of enzymes and their applications | |

Practical 30 Hours- Essential Experiments (15 hrs) , Group Work (15 hrs)

Essential Experiments

1. Demonstration of Kinetics of Urease / Trypsin (Effect of pH, substrate Concentration, enzyme concentration and temperature).

2. Progress curve of Urease/Trypsin

3. Digestion of carbohydrates –action of salivary amylase

Suggested Readings:

1. Lehninger Principles of Biochemistry" by David L. Nelson and Michael M. Cox - This comprehensive book covers enzymology along with other fundamental concepts in biochemistry.

2. "Enzymes: Biochemistry, Biotechnology, Clinical Chemistry" by Trevor Palmer - A thorough textbook covering the principles of enzyme structure, function, kinetics, and regulation, as well as applications in biotechnology and clinical chemistry.

3. "Principles of Enzymology for the Food Sciences" by John R. Whitaker, Alphons G.J. Voragen, and Dominic W.S. Wong - Focuses on the enzymology relevant to the food industry, covering topics such as enzyme kinetics, enzyme inhibition, and enzyme applications in food processing.

4. "Introduction to Enzyme and Coenzyme Chemistry" by T. D. H. Bugg - A concise introduction to the basic principles of enzyme and coenzyme chemistry, suitable for students with a background in chemistry or biochemistry.

5. "Enzyme Kinetics: Catalysis and Control" by Daniel L. Purich - Provides an in-depth understanding of enzyme kinetics, including detailed discussions on reaction mechanisms, rate equations, and enzyme inhibition.

6. "Biochemical Calculations: How to Solve Mathematical Problems in General Biochemistry" by Irwin H. Segel - Although not solely focused on enzymology, this book provides valuable guidance on mathematical aspects of enzyme kinetics and other biochemical calculations.

7. "Practical Enzymology" by Hans Bisswanger - Offers practical guidance on experimental techniques in enzymology, including enzyme purification, assay methods, and data analysis.

Course Outcomes

Course Outcomes

| **No.** | **Upon completion of the course the graduate will be able to** | **Cognitive Level** | **PSO addressed** |
|---|---|---|---|
| CO- 1 | Understand Enzyme nomenclature, Classification, Extraction and Purification of Enzymes | U, Ap | PSO-1,2 |
| CO- 2 | Understand the Structure and General properties of enzymes and enzyme specificity | R, E | PSO1 |
| CO- 3 | Explain Kinetics of enzyme catalyzed reactions and factors affecting enzyme catalyzed reactions | U, An | PSO1, PSO3 |
| CO- 4 | Understand Regulatory Mechanisms in Enzyme Catalysis and metabolic regulations | E, C | PSO1 |
| CO- 5 | Understand enzyme technology and the applications of enzymes in various fields | Ap | PSO3,4 |

**R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create**

*Note: 1 or 2 COs/module*

Name of the Course: Basics of enzymology Credits: 3:0:2 (Lecture:Tutorial:Practical)

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| **CO- 1** | Understand Enzyme nomenclature, Classification, Extraction and | **PSO-1,2** | **U, Ap** | **F, C** | **L** | |
| **CO- 2** | Understand the Structure and General properties of enzymes and enzyme specificity | **PSO1** | **R, E** | **P** | **L** | |
| **CO- 3** | Explain Kinetics of enzyme catalyzed reactions and factors affecting enzyme catalyzed | **PSO1, PSO3** | **U, An** | **F,P** | **L** | |
| **CO- 4** | Understand Regulatory Mechanisms in Enzyme Catalysis and metabolic | **PSO1** | **E, C** | **F** | **L** | |
| **CO- 5** | Understand enzyme technology and the applications of enzymes in various | **PSO 3,4** | **Ap** | **P** | **L** | **P** |

**F-Factual, C- Conceptual, P-Procedural, M-Metacognitive Mapping of COs with PSOs and POs :**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | 3 | - | - | - | - | | | | | | |
| **CO 2** | 3 | - | - | - | - | - | | | | | | |
| | | | | | | | | | | | | |
| **CO 4** | 3 | - | - | - | - | - | | | | | | |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 5** | - | - | 3 | 2 | - | - | | | | | | |

**Correlation Levels:**

| **Level** | **Correlation** |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

**Continuous Comprehensive Assessment:**

**Formative :** Practical /problem/Survey/Design/Field trip based Assignment in the form of Individual or team work regarding the theory part/Follow any of the tool regarding the above practical assignment-1.Observation of practical skill/Viva/.Quiz/ In class discussions/Good Lab practices/Lab work book

**Summative:**Follow any of the tool - Written test (theory based)/.Open Book Test(theory based)/ Individual /team work report practical assignmen/Case study report /Literature survey/Individual / Team project report oral presentation/ Laboratory report

Mapping of COs to Assessment Rubrics :

University of Kerala

| | | | | | |
|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK3DSCBIT203 | | | | |
| Course Title | IICROBIAL METABOLISM | | | | |
| Type of Course | DSC | | | | |
| Semester | III | | | | |
| Academic Level | 200–299. | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 4 | 3 hours | 0 | 2 hours | 5 |
| Pre-requisites | Basic knowledge in Microbiology and Biochemistry | | | | |
| Course Summary | Microbial metabolism is a fundamental aspect of microbiology that explores the biochemical pathways and mechanisms by which microorganisms obtain energy, grow and interact with their environments. This graduate-level course delves into the intricate world of microbial metabolic processes, emphasizing the diversity of metabolic strategies employed by bacteria, archaea, fungi, and other microorganisms. | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Nutritional classification & Nutrient transport in microbes** | | **6** |
| | 1 | Nutritional classification of bacteria | |
| | 2 | Nutrient transport across the cell: Diffusion: Passive and facilitated; Primary active and secondary active transport | |
| | 3 | Group translocation (phosphotransferase system) electroneutral transport; transport of Iron. | |
| **II** | **Photosynthesis & Respiration in Bacteria** | | **10** |
| | 4 | Photosynthetic pigments of bacteria- chlorophyll a and bacteriochlorophyll, carotenoids, phycobiliproteins, leghaemoglobin | |
| | 5 | Oxygenic and anoxygenic photosynthesis<br>Mechanism of photosynthesis in bacteria (purple non sulphur bacteria, green sulphur bacteria) and cyanobacteria | |
| | 6 | Chemolithotrophy -– oxidation of sulphur, iron, hydrogen & nitrogen<br>Methanogenesis, Bioluminescence | |
| | 7 | Respiration in bacteria- aerobic respiration | |

| | | | |
|---|---|---|---|
| | | Glycolysis and tricarboxylic acid cycle<br>Electron transport and oxidative phosphorylation in Bacteria<br>Anaerobic respiration- Fermentation- lactic acid and alcohol fermentation, mixed acid fermentation, Lactate fermentation (homofermentative and heterofermentative pathways). | |
| | 8 | Assimilation of nitrogen,sulphur, phosphorus | |
| **III** | **Synthesis of biopolymers** | | **10** |
| | 9 | Biosynthesis of peptidoglycan, biopolymers, PHB | |
| | 10 | Biosynthesis of vitamins, amino acids and nucleotides | |
| | 11 | Regulation of metabolic pathways | |
| | 12 | Overview of Microbial metabolites-marine sources | |
| **IV** | **Biochemical characterization of bacteria** | | **10** |
| | 13 | Importance of Biochemical characterisation<br>Types: Carbohydrate fermentation test, Methyl red test, Citric acid utilization test. (D) Hydrogen sulfide production test. | |
| | 14 | Principle of Sugar utilization test, Sugar fermentation test, IMViC test | |
| | 15 | Enzyme detection – Catalase, Oxidase, Oxidative-fermentative test | |
| | 16 | Gelatinase assay | |
| **V** | **Industrial importance of Microbial metabolism** | | **9** |
| | 17 | Microorganisms of industrial importance.<br>Biology of industrial microorganisms: Isolation, Screening and Preservation. | |
| | 18 | Fermentation process, Types of fermentation and Downstream processing- recovery and purification of end products of metabolism-a basic account | |
| | 19 | Strain improvement of microbes for industrial purposes | |
| | 20 | Examples of commercial products of microbial origin- case study | |

**<u>Practicals 30 hrs-</u> Essential Experiments (15 hrs) , Group Work (15 hrs)**

**Essential Experiments**

1. Effect of temperature, pH, salt, Carbon source and Nitrogen source on the growth of bacteria
2. Study and plot growth curve of E.coli by turbidometric method
3. Demonstration of production of acid and gas during lactose fermentation
4. Urease test
5. Gelatin hydrolysis
6. Isolation and culture of photosynthetic bacteria.
7. Starch hydrolysis test by amylase producing microbes, and enzyme assay.

**Suggested Readings:**

1. Madigan MT, and Martinko JM (2014). Brock Biology of Microorganisms. 14th edition. Prentice Hall International Inc.

2. Moat AG and Foster JW. (2002). Microbial Physiology. 4th edition. John Wiley & Sons

3. Nelson David L and Cox Michael M, Lehninger, Principles of Biochemistry, Macmillan Press, Worth Publishers, New Delhi.

4. Reddy SR and Reddy SM. (2005). Microbial Physiology. Scientific Publishers India

5. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.

6. Stanier RY, Ingrahm JI, Wheelis ML and Painter PR. (1987). General Microbiology. 5th edition, MacMillan Press.

7. Willey JM, Sherwood LM, and Woolverton CJ. (2013). Prescott's Microbiology. 9th edition. McGraw Hill Higher Education.

## Course Outcomes

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | Understanding of bacterial nutritional requirements to classify bacteria & predict their growth conditions. | U, R | PSO-1,2 |
| CO-2 | Describe different mechanisms of nutrient transport across cell membranes & evaluate their significance in bacterial metabolism. | U, E | PSO1,3 |
| CO-3 | To know the process of photosynthesis in bacteria | U, R | PSO1 |
| CO-4 | Examine the environmental significance of chemolithotrophy | U, An | PSO3 |
| CO-5 | Compare the efficiency of aerobic & anaerobic respiration pathways in bacteria by comparing their energy yields. | U | PSO1 |
| CO-6 | Explain the regulatory mechanisms involved in biosynthetic pathways | U | PSO3,4 |
| CO-7 | Apply their practical skills to identify bacteria using different biochemical tests | Ap, An | PSO5 |

**R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create**



*Note: 1 or 2 COs/module*

**Name of the Course:** Microbial metabolism **Credits: 3:0:2 (Lecture:Tutorial:Practical)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| CO-1 | Understand bacterial nutrition | PSO-1,2 | U, R | F, C | L | - |
| CO-2 | Describe the nutrient uptake in bacteria | PSO1,3 | U, E | P | L | - |
| CO-3 | Know the basics of photosynthetic bacteria | PSO1 | U, R | F | L | - |
| CO-4 | Examine the environmental significance of chemolithotrophy | PSO3,5 | U, An | P | L | P |
| CO-5 | Compare the respiratory process in different kind of bacteria | PSO1 | U | F,P | L | - |
| CO-6 | Explain the regulation of metabolism in bacteria | PSO3,4 | U,R | C | L | - |
| CO7 | Identify bacteria based by biochemical tests | PSO5 | Ap, An | P | L | P |

**F-Factual, C- Conceptual, P-Procedural, M-Metacognitive**

**Mapping of COs with PSOs and POs :**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | 2 | - | - | - | - | | | | | | |
| **CO 2** | 2 | - | 3 | - | - | - | | | | | | |
| **CO 3** | 2 | - | - | - | - | - | | | | | | |
| **CO 4** | - | - | 2 | - | 2 | - | | | | | | |
| **CO 5** | 2 | - | - | - | - | - | | | | | | |
| **CO 6** | - | - | 3 | 3 | - | - | | | | | | |
| **CO7** | | | | | 1 | | | | | | | |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:Continuous Comprehensive Assessment: Formative :**

**Formative :** Practical /problem/Survey/Design/Field trip based Assignment in the form of Individual or team work regarding the theory part/Follow any of the tool regarding the above practical assignment-1.Observation of practical skill/Viva/.Quiz/ In class discussions/Good Lab practices/Lab work book

**Summative:**Follow any of the tool - Written test (theory based)/.Open Book Test(theory based)/ Individual /team work report practical assignmen/Case study report /Literature survey/Individual / Team project report oral presentation/ Laboratory report

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Observation of Practical skills | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | ✓ | | ✓ |
| CO 2 | ✓ | | | ✓ |

| | | | | |
|---|---|---|---|---|
| CO 3 | ✓ | | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | ✓ | ✓ | | ✓ |
| CO 6 | ✓ | | | ✓ |
| CO7 | | | ✓ | ✓ |

University of Kerala

| | | | | | |
|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK3DSCBIT204 | | | | |
| Course Title | PLANT PHYSIOLOGY | | | | |
| Type of Course | DSC | | | | |
| Semester | III | | | | |
| Academic Level | 200 -299. | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 4 | 3 hours | 0 | 2 | 5 |
| Pre-requisites | Basic knowledge on life science, specifically on physiological processes in plant body.Fundamentals of Biology, Biochemistry | | | | |
| Course Summary | This course gives a fundamental knowledge on the biophysical and biochemical processes that function in a plant system. The students will learn the basic mechanisms governing the life processes of plants at a cellular, molecular, and whole-organism level. | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| I | | **Introduction to plant physiology** | 8 |
| | 1 | Physiological process, their significance and other application: Water relations and Mineral nutrition in plant body | |
| **11** | | **Photosynthesis** | 12 |
| | 2 | Photosynthetic apparatus and pigment systems-chromatographic techniques for the separation of photosynthetic pigments, Raw materials of photosynthesis<br>Light perception and signal transduction | |
| | 3 | a) Light reaction i) Radiant energy and its effects on chlorophyll pigments ii) Cyclic and non-cyclic photophosphorylation iii) Source of oxygen liberated iv) Hill reaction | |
| | 4 | b) Dark reaction i) Trace the path of carbon in photosynthesis ii) Calvin cycle iii) C3 and C4 plants. CAM plants. iv) Photorespiration v) Factors affecting photosynthesis. Law of limiting factors | |

| | | | |
|---|---|---|---|
| | 5 | Definition and general equation. Significance, Respiratory substrates, Mechanism - Glycolysis, Krebs cycle, terminal oxidation. Oxidative pentose phosphate pathway, Factors affecting respiration, Anaerobic respiration | |
| III | **Growth and Development** | | 10 |
| | 6 | Seed germination and seedling establishment -Dormancy and germination of seeds.<br>Flowering and reproductive development, Differentiation, morphogenesis<br>Hormonal regulation of plant growth - Auxins, Gibberellins, Cytokinins, Abscissic acid, Ethylene and their practical applications | |
| | 7 | Senescence and programmed cell death | |
| | 8 | Signal Transduction and Plant Responses: how plants perceive and respond to internal and external signals. receptor proteins, intracellular signaling pathways, gene expression regulation, and the integration of multiple signaling inputs. | |
| IV | **Plant-biotic- abiotic Interactions** | | 6 |
| | 9 | Interactions between plants and microorganisms, beneficial symbioses (e.g., mycorrhizae, nitrogen-fixing bacteria) and pathogenic infections. | |
| | 10 | Biotic stress responses (pathogens, herbivores)- Molecular communication, defense mechanisms, and the implications for plant health and agriculture | |
| | 11 | Abiotic stress responses (drought, salinity, temperature)<br>Circadian rhythms and biological clocks | |
| V | **Biotechnological Applications** | | 9 |
| | 12 | Crop improvement through biotechnology, Biofortification and nutritional enhancement | |
| | 12 | Phytoremediation and bioremediation | |

**<u>Practicals 30 hrs-</u> Essential Experiments (15 hrs) , Group Work (15 hrs)**

**Essential Experiments**

1. Evolution of oxygen during photosynthesis

2. Necessity of chlorophyll, CO2 and light in photosynthesis



3. Measurement of photosynthesis.

4. Simple respiroscope , Respirometer of R.Q. , Anaerobic respiration

5. Geotropism and phototropism Klinostàt ,. Hydrotropism

6. Measurement of growth Arc or Lever Auxonometer

7.Plant tissue culture and transformation methods

8. Bioinformatics analysis of plant genomic data

**Suggested Reading:**


1. Devlin & Witham Plant Physiology, C B S publishers.

2. Devlin R.M. (1979) Plant Physiology.

3. Dieter Hess (1975): Plant physiology.

4. Jain V. K. (1996) Fundamentals of Plant Physiology.

5. Kochhar P. L. & Krishnamoorthy H. N. Plant Physiology. Atmaram & Sons Delhi, Lucknow.

6. Kumar & Purohit Plant Physiology - Fundamentals and Applications, Agrobotanical publishers.

7. Malik C. P. & Srivastava A. K. Text book of Plant Physiology Kalyani Publishers New Delhi.

8. Noggle G R & Fritz G J (1991) Introductory Plant physiology, Prentice Hall of India

9. Pandey S.N. & Sinha B. K. (1986) Plant physiology,Vikas publishing House- New Delhi.

10. Salisbury F.B and Ross C.W. (2006): Plant Physiology 4Edn, Wadsworth publishing company.

11. Sundara Rajan S. College Botany Vol. IV, Himalaya publishing House.


**Course Outcomes**

| | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | Understand the physiological process of plant physiological process and molecular signalling involved | R, U | PSO1 |
| CO-2 | Aware the concept of photosynthesis | R, U | PSO3 |
| CO-3 | Analyse the significance of respiration | U,An | PSO1,3 |

| | | | |
|---|---|---|---|
| CO-4 | Understand the signal transduction pathways and hormonal regulation involved in growth and development | U,Ap | PSO3,4 |
| CO-5 | Understand the application of physiological process | U,An | PSO3 |
| | | | |

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create

*Note: 1 or 2 COs/module*

Name of the Course: Plant physiology Credits: 3:0:2 (Lecture:Tutorial:Practical)

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| CO-1 | Understand the physiological process of plant physiological process and molecular signalling involved | PSO1 | R, U | F, C | L | |
| CO-2 | Aware the concept of photosynthesis | PSO3 | R, U | P | L | |
| CO-3 | Analyse the significance of respiration | PSO1,3 | U,An | C | L | P |
| CO-4 | Understand the signal transduction pathways and hormonal regulation involved in growth and development | PSO-3,4 | U,Ap | C | L | |
| CO-5 | Understand the application of physiological process | PSO3 | U,An | P | L | |

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 2 | - | - | - | - | - | | | | | | |
| CO 2 | - | - | 3 | - | - | - | | | | | | |
| CO 3 | 2 | - | 3 | - | - | - | | | | | | |
| CO 4 | - | - | 2 | 2 | - | - | | | | | | |
| CO 5 | - | - | 3 | - | - | - | | | | | | |

Correlation Levels:

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

Assessment Rubrics: **Continuous Comprehensive Assessment:**

**Formative :** Practical /problem/Survey/Design/Field trip based Assignment in the form of Individual or team work regarding the theory part/Follow any of the tool regarding the above practical assignment-1.Observation of practical skill/Viva/.Quiz/ In class discussions/Good Lab practices/Lab work book

**Summative:**Follow any of the tool - Written test (theory based)/.Open Book Test(theory based)/ Individual /team work report practical assignmen/Case study report /Literature survey/Individual / Team project report oral presentation/ Laboratory reportMapping of COs to Assessment Rubrics :

| | Internal Exam | Assignment | Observation of Practical skills | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| CO 5 | | ✓ | | ✓ |

**University of Kerala**

| | | | | | |
|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK3DSCBIT205 | | | | |
| Course Title | ANIMAL PHYSIOLOGY | | | | |
| Type of Course | DSC | | | | |
| Semester | III | | | | |
| Academic Level | 200 - 299. | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 4 | 3 hours | 0 | 2 hours | 5 |
| Pre-requisites | Fundamental Biology, Basic Cell biology | | | | |
| Course Summary | This course provides an in-depth exploration of the fundamental principles governing the function of the human body, and will answer how our body functions. It examines the intricate mechanisms underlying various physiological processes, ranging from cellular functions to integration of organ systems. Through a combination of lectures, and discussions, students delve into the complex interplay of molecular, cellular, and systemic processes that maintain homeostasis and regulate bodily functions. | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | | **Nutrition and Respiration** | **6** |
| | 1 | Nutrition: Types of nutrition; Mechanical and chemical digestion of carbohydrates, proteins and fats; hormonal control of digestion; absorption mechanism; BMR Vitamin deficiency diseases. | |
| | 2 | Respiration: respiratory pigments and their role; gas transport – oxygen and $CO_2$ transport; Oxyhaemoglobin curve; Bohr effect; Carbon monoxide poisoning. Physiological effects of smoking | |
| **II** | | **Circulatory system** | **10** |
| | 3 | Circulation: Body fluids – importance and types; closed and open types of circulatory system; blood– composition and functions; blood groups – ABO and Rh systems, MN, Lewis and Bombay groups; blood clotting – intrinsic and extrinsic mechanisms and their factors; anticoagulants. | |
| | 4 | Heart: Detailed structure and types of heart – tubular and chambered; neurogenic and myogenic; pacemakers and conducting system of human heart; cardiac rhythm; blood pressure; electrocardiogram. Common cardiovascular diseases (hypertension, arteriosclerosis, myocardial infarction), Adaptations for different metabolic demands | |
| **III** | | **Physiology of excretion and muscle movement** | **10** |

| | | | |
|---|---|---|---|
| | 5 | Excretion: nitrogenous wastes; ammonotelic, ureotelic and uricotelic modes of excretion; structure of human nephron; urine formation in man – detailed account with countercurrent system; normal and abnormal constituents of urine; hormonal regulation of renal function; Dialysis and artificial kidney | |
| | 6 | Muscle Physiology: types of muscles; ultrastructure of striated muscle fibre; muscle contraction ,Skeletal adaptations for locomotion and support, Biomechanics of movement; chemistry of contraction; neuromuscular junction; fatigue; muscle twitch; latent and refractory periods; rigor mortis | |
| **IV** | **Nerve Physiology** | | **10** |
| | 7 | Nerve Physiology: Sense organs-eyes, (physiology of vision), ear (structure and functions- hearing and balancing), olfactory organs and taste receptors; | |
| | 8 | Structure of a typical neuron; types of neurons; myelinated and nonmyelinated nerve fibres; structure and types of synapse; initiation and conduction of nerve impulse; | |
| | 9 | EEG; Nervous disorders - epilepsy, Alzheimer's disease, Parkinson's disease. | |
| | | Action potentials and neurotransmission- neurotransmitters; synaptic transmission; reflex action and reflex arc<br>Hormonal regulation and signaling pathways, Integration of neural and endocrine control systems | |
| **V** | **Endocrinology** | | **9** |
| | 10 | Endocrinology: hormones – definition and types of hormones; mechanism of hormone action-at the levels of cell membrane, organelles and genes; positive and negative feedback regulation | |
| | 11 | Structure and functions of endocrine glands – thyroid, parathyroid, thymus, islets of Langerhans, adrenal, pituitary, hypothalamus, pineal body, gonads and placenta; brief account of prostaglandins | |
| | 12 | Hormonal disorders | |

**Practicals 30 hrs- Essential Experiments (15 hrs) , Group Work (15 hrs)**

**Essential Experiments**

1.Paper partition chromatography of amino acids (3 amino acids and a mixture)
2.Blood smear preparation – identification of leukocytes
3.Determination of human blood group – A, B, AB and O, and Rh+ and Rh-
4.Osmotic properties of RBCs – effect of isotonic, hypotonic and hypertonic solutions.
5.Activity of human salivary amylase on starch
6. Detection of Abnormal constituents of urine (glucose and albumin).
7. Estimate the butterfat content of raw milk, collected fresh from different animal sources
8. Working in groups, chart out physiological adaptations in animals
9. Subject students groups to animal physiology simulations illustrating hierarchies in organisation

10. Separation of serum proteins by gel filtration.

**Suggested Readings**


1.Arora, Mohan P. Animal Physiology. Himalaya Publishing House
2.Mariakuttikan and Arumugam, N. Animal Physiology. Saras Publication
3.Nagabhushanam, R. et al. Textbook of Animal Physiology. Oxford & IBHS
4.Rastogi, S.C. Essentials of Animal Physiology. Wiley Eastern Ltd.
5.Sebastian, M.M. Animal Physiology. Madonna Books, Kottayam
6.Verma, P.S. Tyagi, B.S. and Agarwal, V.K. Animal Physiology. S.Chand & Co.
7.Berry, A.K. A Text book of Animal Physiology, Emkay Publications.
8.Best and Taylor's Physiological Basis of Medical Practice. West, J.B. (Ed.) B.I. Waverly.


## Course Outcomes

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | Understand importance of nutrition and associated disorders | U | PSO-1,2 |
| CO-2 | Understand physiology of important vital organs and mechanism of function various parts | R, U | PSO1 |
| CO3 | Understand various physiological disorders associated with important organs and diagnosis | R, U | PSO3,4 |
| CO4 | Describe the effect of hormone action- at cellular level and structure and functions of endocrine glands | R, U | PSO3 |

**R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create**
*Note: 1 or 2 COs/module*
**Name of the Course: Animal physiology**
**Credits: 3:0:2 (Lecture:Tutorial:Practical)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| CO-1 | Understand importance of nutrition physiological functions | PSO-1,2 | U | F, C | L | |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO-2 | Understand animal physiology | PSO1 | R, U | P | L | |
| CO3 | Understand various physiological disorders | PSO3,4 | R, U | F | L | |
| CO4 | Understand How hormones controls the physiological functions | PSO3 | R, U | C | L | |

**F-Factual, C- Conceptual, P-Procedural, M-Metacognitive**

**Mapping of COs with PSOs and POs :**

| | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 1 | 3 | - | - | - | - | | | | | | |
| **CO 2** | 3 | - | - | - | - | - | | | | | | |
| **CO 3** | - | - | 2 | 2 | - | - | | | | | | |
| **CO 4** | - | - | 2 | - | - | - | | | | | | |

**Correlation Levels:**

| **Level** | **Correlation** |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |



**Assessment Rubrics:Continuous Continuous Comprehensive Assessment:**

**Formative :** Practical /problem/Survey/Design/Field trip based Assignment in the form of Individual or team work regarding the theory part/Follow any of the tool regarding the above practical assignment-1.Observation of practical skill/Viva/.Quiz/ In class discussions/Good Lab practices/Lab work book

**Summative:**Follow any of the tool - Written test (theory based)/.Open Book Test(theory based)/ Individual /team work report practical assignmen/Case study report /Literature survey/Individual / Team project report oral presentation/ Laboratory report

| | Internal Exam | Assignment | Observation of Practical skills | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | ✓ | | ✓ |
| CO 4 | | ✓ | | ✓ |

**University of Kerala**

| | | | | | |
|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK3DSCBIT206 | | | | |
| Course Title | CELL & MOLECULAR BIOLOGY | | | | |
| Type of Course | DSC | | | | |
| Semester | III | | | | |
| Academic Level | 200 - 299 | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 4 | 3 hours | 0 | 2 hours | 5 |
| Pre-requisites | Basic understanding of cell structure and function, genetics and regulation | | | | |
| Course Summary | At the graduate level, a course in Cell Biology and Genetics typically delves deep into the intricate mechanisms underlying cellular function, molecular genetics, and their profound implications in various biological processes | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| I | | **Cell organelles and functions** | **12** |
| | 1 | History and scope of Cell Biology | |
| | 2 | Structure and functions of cell organelles (A brief account only) – Nucleus, Mitochondria, Chloroplast, Ribosomes,Endoplasmic Reticulum, Golgi Bodies, Lysosomes,Centrioles | |
| | 3 | Structure, function and components of cell membranes, Fluid mosaic model (A brief account) | |
| | 4 | Introduction to cell signalling pathways(Basics of G protein coupled receptors, enzyme linked receptors, ion transporters) | |
| II | | **Cell division** | **4** |
| | 5 | Mitosis and meiosis | |
| | 6 | Cell cycle phases and checkpoints (G1, G2/M, spindle checkpoint), importance of cyclins and cyclin dependant kinases | |
| III | | **Replication** | **8** |
| | 7 | Organization of DNA in chromosomes, Nucleosome model, Organisation of prokaryotic and eukaryotic gene | |
| | 8 | Mechanism of Replication of DNA(prokaryotic and eukaryotic), | |

| | | | |
|---|---|---|---|
| | | Enzymes involved in DNA replication | |
| **IV** | **Gene expression** | | **12** |
| | 9 | Genetic code, codon, Transcription(Prokaryotic and eukaryotic)– mechanism, Post-transcriptional modification of mRNA (importance of 5' cap and 3'tail), Types of RNA-mRNA, tRNA, rRNA and snRNA, mi RNA. | |
| | 10 | Splicing mechanism, self-splicing RNA (Group II Introns) | |
| | 11 | Translation- mechanism of translation in prokaryotes and eukaryotes. | |
| | 12 | Operon concept (lac and trp operon), catabolicrepression, attenuation, control of gene expression and post translational modifications (basics only) | |
| **V** | **Genetics and Case Studies** | | **9** |
| | 13 | Mendelian genetics and basics of gene interactions<br>Case study- Classic experiments demonstrating DNA as the genetic material<br>Case Study: Tay-Sachs Disease -Lysosomal Storage Inclusion<br>Case Study - protein misfolding Disease- Misfolded Amyloid-β Protein<br>Case Study-colour variation in pepper,<br>Case study- lethal alleles multiple alleles-ABO Blood group.<br>Case study- PAX6 transcription factorMutation – Eye Development Disorder (Aniridia)) | |

**Practicals 30 hrs- Essential Experiments (15 hrs), Group Work (15 hrs)**

**Essential Experiments**

1. Study of different types of cells (prokaryotes and eukaryotes) using slides/models/charts.
2. Study of cytoplasmic organelles and cell inclusions (through permanent slides, models and charts)
3. Study of stages of mitosis – squash preparation of onion root tip.
4. Preparation of solutions and buffers for DNA isolation
5. Isolation of Genomic DNA from a suitable source- bacteria, plant or animal tissue
6. Examination of the purity of DNA by agarose gel electrophoresis.
7. Quantification of DNA by UV-spectrophotometer
8. Isolation and purification of plasmid DNA
9. Agarose gel analysis of plasmid DNA

**Suggested Readings**


1. Powar,C.B.CellBiology.HimalayaPublishingHouse.
2. Verma,P.S.&Agarwal,V.K.Cytology,S.Chand&Co.
3. Alberts,B.etal.Molecular Biology of the Cell.GarlandScience.
4. DeRobertis,E.D.P.andDeRobertis,E.M.F.CellandMolecularBiology,LippincottWilliamsand Wilkins
5. Karp,Gerald.CellandMolecularBiology.JohnWileyandSons

6. Lodish,Harveyetal.MolecularCellBiology.ScientificAmericanBooks
7. Burns, G. W. &Bottino, P. J. The Science of Genetics. Maxwell McMillan
8. Curt Stein. Principles of Human Genetics. Euresia Publishing House
9. Gardner, E. J. et al. Principles of Genetics. John Wiley & Sons.
10. Goodenough, U. Genetics. Halt, Reinharts& Winston
11. Gupta, P.K. Cytogenetics. Rastogi & Co.
12. Sinnott, W.E., Dunn, L.C. and Dobzhansky, T. Principles of Genetics, TMH
13. Verma, P.S. and Agarwal V.K. Genetics. S.Chand and Co.
14. Applied Molecular Genetics – R L Miesfeld; Wiley.Liss, New Delhi.
15. Essential molecular Biology- A practical Approach, T. A. Brown; Oxford, New York
16. Gene VIII- Benjamin Lewin; Oxford University Press.

## Course Outcomes

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | Analyse the **cooperationamong cellular organelles ensures proper cellular function**, including metabolism, communication, division, and survival | An | PSO-1,2 |
| CO-2 | Evaluate the role of cell cycle and its checkpoints controlling optimum cellular functions and Consequences of Checkpoint Failure | E | PSO1 |
| CO-3 | Analyse therole of gene interactions affecting **phenotypes** and Decode the various Chromosomal Anomaliesin human genetic disoders | C, E | PSO1 |
| CO-4 | Understand the concept of gene, its structure and expression | Ap | PSO1,PSO3 |
| CO-5 | Understand the gene regulation mechanisms in a living cell | An | PSO3,4 |

**R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create**

*Note: 1 or 2 COs/module*

**Name of the Course: C**ell biology & Genetics **Credits: 3:0:2 (Lecture:Tutorial:Practical)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| CO-1 | Analyse the **cooperationamong cellular organelles ensures proper cellular function**, including metabolism, communication, division, and survival | An | An | F, C | L | |
| CO-2 | Evaluate the role of cell cycle and its checkpoints controlling optimum cellular functions and Consequences of Checkpoint Failure | | E | F C | L | P |
| CO-3 | Analyse therole of gene interactions affecting **phenotypes** and Decode the various Chromosomal Anomaliesin human genetic disoders | PSO1 | C | P | L | |
| CO-4 | Understand the concept of gene, its structure and expression | PSO1 | Ap | C | L | |
| CO-5 | Understand the gene regulation mechanisms in a living cell | PSO1, PSO3 | An | | L | |

**F-Factual, C- Conceptual, P-Procedural, M-Metacognitive**

**Mapping of COs with PSOs and POs :**

| | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | 3 | - | - | - | - | | | | | | |
| **CO 2** | 2 | - | - | - | - | - | | | | | | |
| **CO 3** | 2 | - | - | - | - | - | | | | | | |
| **CO 4** | 2 | - | 2 | - | - | - | | | | | | |
| **CO 5** | - | - | 2 | 3 | - | - | | | | | | |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics: Continuous Comprehensive Assessment: Formative :**

- Interactive Quiz ,Group Discussions,Assignment,Student Seminar
- Observation of practical skills,Journal Club presentations
- Punctuality in lab, and time management in completing assigned laboratory tasks

**Summative** Internal test papers,Laboratory book/ report,Periodical lab tests

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | ✓ | ✓ | | ✓ |
| CO 5 | ✓ | ✓ | | ✓ |

University of Kerala

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|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK3DSCBIT207 | | | | |
| Course Title | MOLECULAR BIOLOGY | | | | |
| Type of Course | DSC | | | | |
| Semester | III | | | | |
| Academic Level | 200 - 299. | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 4 | 3 hours | 0 | 2 hours | 5 |
| Pre-requisites | Essentials of Biotechnology<br>Basic understanding on Genetics and DNAstructure | | | | |
| Course Summary | This core-course imparts an essential foundation for understanding of mechanisms and regulations of gene expression at molecular level. Understanding the molecular basis of life is very important to apply manipulation strategies in the future for genetic engineering and genome editing. | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | | **Molecular basis of life** | **8** |
| | 1 | History and significant discoveries in molecular biology, Classicexperiments demonstrating DNA as the genetic material | |
| | 2 | Central dogma of molecular biology<br>Eukaryotic chromosomes – molecular organization, nucleosomes, telomeres. | |
| | 3 | Structure of DNA and types of DNA. | |
| | 4 | Replication of DNA(prokaryotic and eukaryotic), enzymes involved in DNA replication. | |
| **II** | | **Genes,Genetic code and Cytoplasmic Genome** | 8 |
| | 5 | Organisation of prokaryotic and eukaryotic gene- split genes, introns and exons, reading frame, enhancers and silencers | |
| | 6 | Genetic code - properties of genetic code, Codons, codon assignment, redundancy and wobble concept | |
| | 7 | Molecular organization of transposons in prokaryotes and eukaryotes | |
| | 8 | Mitochondrial DNA and chloroplast DNA | |

| | | | |
|---|---|---|---|
| **III** | **Gene expression** | | **10** |
| | 9 | Transcription(Prokaryotic and Eukaryotic)- mechanism. RNA Polymerase, promoter, transcription factors. | |
| | 10 | Types of RNA-mRNA, tRNA, rRNA and small nuclear RNA (snRNA), mi RNA. | |
| | 11 | Post-transcriptional modification of mRNA in eukaryotes-capping, tailing and splicing mechanisms. | |
| | 12 | Translation- mechanism of translation in prokaryotes and eukaryotes | |
| | 13 | Post translational modification of proteins | |
| **IV** | **Gene regulation** | | 10 |
| | 13 | Prokaryotic gene regulation, operon, (lac and trp operon), catabolic repression, attenuation and anti-termination | |
| | 14 | Eukaryotic gene regulation; levels of control of gene expression | |
| | 15 | mRNA degradation and protein degradation control, | |
| | 16 | RNA interference, microRNAs and siRNA | |
| | 17 | Translational regulation | |
| **V** | **Tools and Techniques in Molecular Biology** | | **9** |
| | 18 | DNA isolation: Principle and Protocol, Purification and quantification Beer-Lambert law, Colorimeter, Spectrophotometer | |
| | 19 | Electrophoresis: Principle of electrophoresis, Native Gel Electrophoresis, SDS-PAGE, Agarose gel electrophoresis. | |
| | 20 | PCR, Blotting techniques, Microarray, Flow cytometry | |
| | 21 | CRISPR-Cas9 system: mechanism and applications | |

**Practicals 30 hrs- (Essential Experiments (15 hrs), Group Work (15 hrs)**

**Essential Experiments**

1. Familiarisation of instruments and equipment's used in molecular biology laboratory
2. Preparation of solutions and buffers for DNA isolation
3. Isolation of Genomic DNA from a suitable source- bacteria, plant or animal tissue
4. Examination of the purity of DNA by agarose gel electrophoresis.
5. Quantification of DNA by spectrophotometer
6. Visit a molecular biology laboratory within the entire course tenure

**Suggested Reading:**


1. Applied Molecular genetics – R L Miesfeld; Wiley.Liss, New Delhi.
2. Essential molecular Biology- A practical Approach, T A Brown; Oxford, New York
3. Gene VIII- Benjamin Lewin; Oxford University Press.
4. Molecular Biology, PS Verma and VK Agarwal, S.Chand& Company pvt Ltd, New Delhi
5. Introduction to Molecular biology- P. Paolella; McGraw Hill, New York

6. Molecular Biology of the gene – Watson, Baker, Bell Gann, Lewinw, Losick; Pearson Education Pvt.Ltd, New Delhi
7. Molecular cell biology, H S Bhamrah; Anmol Publications Pvt. Ltd., New Delhi.
8. PCR 3 - Practical Approach – C. Simon Hearington& John J O'Leary; Oxford, New York
9. Principles of Gene manipulation- R.W.Old& S.B. Primrose; Blackwell Scientific Publications
10. M. R. Green, J. Sambrook. Molecular Cloning: A Laboratory Manual (Cold Spring Harbor, ed. 4, 2012).
11. M. M. Burell. Enzymes of Molecular Biology (Humana Press, 1993).

## Course Outcomes

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | Understand the concept of geneand its structure | R, U | PSO-1,2 |
| CO-2 | Analyse the genome organization up to chromosome level | U, An | PSO-1 |
| CO-3 | Illustratehow genetic code determines the amino acid sequence of proteins. | R, U, Ap | PSO1,PSO3 |
| CO-4 | Differentiate the mechanism of DNA replication in prokaryotes with eukaryotes | U, An | PSO-2,3 |
| CO-5 | Compare & contrast Prokaryotic and Eukaryotic Transcription and transaltion mechanism | U, E | PSO-3,4 |
| CO-6 | Generalise the various gene regulation mechanisms in both prokaryotes and eukaryotes | E, C | PSO-4 |

**R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create**

*Note: 1 or 2 COs/module*

**Name of the Course:** Molecular Biology **Credits: 3:0:2 (Lecture:Tutorial:Practical)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| CO-1 | Understand the concept of | PSO-1,2 | R, U | F, C | L | |

| | | | | | | |
|---|---|---|---|---|---|---|
| | gene | | | | | |
| CO-2 | Analyse the genome organization up to chromosome level | PSO1 | U, An | C, P | L | |
| CO-3 | Illustratehow genetic code determines the amino acid sequence of proteins. | PSO1,PSO3 | R, U, Ap | F,C | L | |
| C0-4 | Differentiate the mechanism of DNA replication in prokaryotes with eukaryotes. | PSO-2,3 | U, An | P | | P |
| CO-5 | Compare & contrast Prokaryotic and Eukaryotic Transcription and translation mechanism | PSO-3,4 | E | F,C | L, T | |
| CO-6 | Generalise the various gene regulation mechanisms in both prokaryotes and eukaryotes | PSO-4 | E, C | C, P | | P |

**F-Factual, C- Conceptual, P-Procedural, M-Metacognitive**

**Mapping of COs with PSOs and POs :**

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 1 | 3 | - | - | - | - | | | | | | |
| **CO 2** | 2 | - | - | - | - | - | | | | | | |
| **CO 3** | 2 | - | 3 | - | - | - | | | | | | |
| **CO 4** | - | - | 2 | 3 | - | - | | | | | | |
| **CO 5** | - | - | 3 | 3 | - | - | | | | | | |
| **CO 6** | - | - | 3 | - | - | - | | | | | | |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics:**

**Continuous Comprehensive Assessment:**

**Formative :** Practical /problem/Survey/Design/Field trip based Assignment in the form of Individual or team work regarding the theory part/Follow any of the tool regarding the above practical assignment-1.Observation of practical skill/Viva/.Quiz/ In class discussions/Good Lab practices/Lab work book

**Summative:**Follow any of the tool - Written test (theory based)/.Open Book Test(theory based)/ Individual /team work report practical assignmen/Case study report /Literature survey/Individual / Team project report oral presentation/ Laboratory report

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Observation of practical skills | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | ✓ | | ✓ | ✓ |
| CO 5 | | ✓ | | ✓ |
| CO 6 | | | ✓ | |

# Discipline Specific Elective courses (200-299)

University of Kerala

| | | | | | |
|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK3DSEBIT200 | | | | |
| Course Title | BIOPHYSICS AND INSTRUMENTATION | | | | |
| Type of Course | DSE | | | | |
| Semester | III | | | | |
| Academic Level | 200 - 299. | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 4 | 3 hours | 0 | 2 hours | 5 |
| Pre-requisites | Basic Physiology, Basic Biochemistry, Fundamentals of Chemistry | | | | |
| Course Summary | Biophysics and Instrumentation is an advanced graduate-level course that explores the interdisciplinary field where physics principles are applied to biological systems. The course integrates concepts from physics, biology, chemistry, and engineering to understand the physical properties of biological molecules and systems. Emphasis is placed on the development and application of various instrumentation techniques to study biological processes at molecular, cellular, and organismal levels. | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | | **Principles of thermodynamics** | **6** |
| | 1 | Overview of thermodynamics of biological processes –Law of thermodynamics,Gibbs free energy, energy changes in the biochemical reactions | |
| | 2. | Electrical properties of biological compartments:-membrane potential, electrochemical gradients, ATP synthesis.<br>(Case Study Report: 1.rotenone- proton gradient disruptor from plants<br>2. non-shivering thermogenesis -Thermogenin (UCP1)) | |
| **II** | | **Biophysics of physiological events** | **8** |
| | 3. | Biophysics of Photosynthesis - Light reception in plants, microbes and animals. (case study:Photoreception in Bacteria: The Role of | |

| | | | |
|---|---|---|---|
| | | Bacteriorhodopsin in Halobacterium salinarum )<br>Resonance Energy Transfer in photosynthesis<br>Fluorescence and phosphorescence (case study: From Glowing Jellyfish to a Revolution in Biotechnology: The Story of GFP) | |
| | 4. | Biophysics of Vision, Muscle movements and Hearing, (case study: Ototoxicity-Induced Hearing Loss from Aminoglycoside Antibiotics), correction of vision faults, hearing aids. | |
| | 5. | Intra and inter molecular interactions in the biological system | |
| **III** | **Basic Instrumentation in Biology** | | **19** |
| | 6. | Electrophoresis: Principle of electrophoresis, types of electrophoresis, 2-D gel electrophoresis | |
| | 7. | Microscopy: Principle of Microscopy, various types of Microscopy - Simple, Phase contrast, Fluorescence and electron microscopy (TEM and SEM).<br>Overview of -cryo-electron microscopy, Scanning probe microscopy and Confocal microscopy<br>Overview of single-molecule techniques - Atomic force microscopy (AFM) (case study:Studying RNA Polymerase Transcription Using Optical Tweezers) | |
| | 8. | Basic principles and working of: pHmeter, centrifuge, chromatography | |
| | 9 | Spectrophotometer(UV and Visible) and colorimeter - Beer-Lambert law, atomic absorption spectroscopy, IR, NMR and X-ray Crystallography and Mass Spectrometry. | |
| **IV** | **Isotopes and radioisotopes** | | **3** |
| | 10. | Application of isotopes and radioisotopes in biological research | |
| **V** | **Applications of Biophysics and Instrumentation** | | **9** |
| | 11 | Drug discovery and development.<br>Biomedical imaging and diagnostics. Biophysical approaches to understanding disease mechanisms.<br>Emerging trends and future directions in biophysics research. Case study reports for radiotracer techniques | |
| | 12. | Overview: computational modelling and simulation methods in biophysics.Molecular dynamics simulations for studying biomolecular structure and dynamics | |

**Practicals. - 30 Hrs -Essential Experiments (15 hrs), Group work (15 hrs)**

**Essential Experiments**

1. pH Meter–Use of pH Meter, Familiarization of the instrument and Preparation Phosphate buffers and determination of pH.
2. Spectrophotometer–Familiarization of the working of the instrument, Quantitative estimation of Sugars by Dinitrosalysilic acid and Proteins by Lowry's Method
3. Development of absorption spectra of chlorophyll or any other biological sample

4. Electrophoresis–demonstration of PAGE and Agarose Gel Electrophoresis

**Suggested Readings**


1. Nelson, D. L., & Cox, M. M. (Year). *Lehninger's Biochemistry*. New York, NY: Worth Publishers.
2. Voet, D., & Voet, J. G. (Year). *Biochemistry*. Boston, MA: Jones & Bartlett
3. Roy, R. N. (Year). *A Textbook of Biophysics*. Calcutta, India: New Central Book Agency Pvt. Ltd.
4. Nair, A. J. (Year). *Introduction to Genetic Engineering & Biotechnology*. Boston, MA: Jones & Bartlett Publishers.
5. Volkenstein, M. V. (Year). *Biophysics*.
6. Cantor, C. R., & Schimmel, P. R. (Year). *Biophysical Chemistry*.
7. Phillips, R., Kondev, J., Theriot, J., & Garcia, H. (Year). *Physical Biology of the Cell*.
8. Lakowicz, J. R. (Year). *Principles of Fluorescence Spectroscopy*.


**Course Outcomes**

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | Analyse how energy changes and conservation in the biochemical reactions is maintained | An | PSO 1, 2 |
| CO-2 | Understand the functioning of physiological events like vision, muscle movement and hearing and various types of biological interactions. | E | PSO 1 |
| CO3 | Understand basic instrumentation to analyse, elucidate and interpret a biomolecule | C | PSO 3, 4 |
| CO4 | Analyse the use of labelling of molcules in understanding the biochemical and physiological events in biology. | C | PSO 3 |

**R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create**

*Note: 1 or 2 COs/module*

**Name of the Course: Biophysics and instrumentation Credits: 3:0:2 (Lecture:Tutorial:Practical)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| CO-1 | Understand the concepts of energy conservation and changes in biological system | PSO-1,2 | An | F, C | L | |
| CO-2 | Understand the biophysics of basic physiological system | PSO1 | E | P | L | |
| CO3 | Understand Basic instrumentation to elucidate the structure of molecules | PSO3,PSO4 | C | F, P | L | P |
| CO4 | Analyse the use of labelling of molcules in understanding the biochemical and physiological events in biology. | PSO3 | C | P | L | - |

**F-Factual, C- Conceptual, P-Procedural, M-Metacognitive**

**Mapping of COs with PSOs and POs :**

| | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 2 | 3 | - | - | - | - | | | | | | |
| **CO 2** | 3 | - | - | - | - | - | | | | | | |
| **CO 3** | - | - | 3 | 4 | - | - | | | | | | |
| **CO 4** | - | - | 2 | - | - | - | | | | | | |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

**Assessment Rubrics: Continuous Comprehensive Assessment:**

**Formative :** Practical /problem/Survey/Design/Field trip based Assignment in the form of Individual or team work regarding the theory part/Follow any of the tool regarding the above practical assignment-1.Observation of practical skill/Viva/.Quiz/ In class discussions/Good Lab practices/Lab work book

**Summative:**Follow any of the tool - Written test (theory based)/.Open Book Test(theory based)/ Individual /team work report practical assignmen/Case study report /Literature survey/Individual / Team project report oral presentation/ Laboratory report

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |
| | | | | |

**University of Kerala**

| | | | | | |
|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK3DSEBIT201 | | | | |
| Course Title | ENZYME ENGINEERING | | | | |
| Type of Course | DSE | | | | |
| Semester | III | | | | |
| Academic Level | 200-299. | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 4 | 3 hours | 0 | 2 hours | 5 |
| Pre-requisites | Biochemistry and metabolism | | | | |
| Course Summary | Enzyme engineering is a multidisciplinary field that integrates principles from biology, chemistry, biochemistry, and engineering to modify enzymes for diverse applications. This course provides students with a comprehensive understanding of the basics of enzyme structure, function, and engineering methodologies. Students will explore the fundamental principles behind enzyme catalysis, techniques for enzyme characterization, and approaches for optimizing and modifying enzymes. Additionally, the course will showcase how engineered enzymes are applied in various industries including pharmaceuticals, food production, biofuels, and bioremediation. | | | | |

**Detailed Syllabus:**

| Module | Unit | Content | Hrs |
|---|---|---|---|
| **I** | **Introduction to enzymes** | | **6** |
| | 1. | Enzymes, Extraction, purification, and characterization of enzymes from natural sources. | |
| | 2. | Comparison of chemical and enzyme catalysts | |
| | 3. | Mechanisms of enzyme action– concept of active site and energetics of enzyme-substrate complex formation, specificity of enzyme action | |
| **II** | **Preparation and properties of enzymes** | | **10** |
| | 4. | Media for enzyme production, Preparation of enzymes. | |

| | | | |
|---|---|---|---|
| | 5. | Screening of for novel enzymes – Colorimetric, Fluorometric and biochemical assays<br>Enzyme stabilization - stability of enzyme in various conditions, Strategies for stabilization.<br>Enzyme specificity – level of specificity and factors affecting specificity | |
| | 6. | Enzyme immobilization- Techniques, Benefits and applications | |
| **III** | | **Enzyme engineering- objectives and Methods** | **10** |
| | 7. | History and background of enzyme engineering, Fundamentals of protein chemistry, Objectives and Method of enzyme engineering. | |
| | 8. | Methods- Rational design (overlap extension and whole plasmid single round PCR) and directed evolution, other methods include De novo enzyme engineering, site directed mutagenesis, random mutagenesis, DNA shuffling, phage display and mRNA display and computational methods. | |
| **IV** | | **Enzyme engineering applications** | **10** |
| | 9. | Industrial applications, such as enzyme catalysis in biocatalysis, food processing, and detergent manufacturing | |
| | 10. | Application of enzymes in analysis -Biomedical applications, including enzyme-based therapeutics and diagnostics. | |
| | 11. | Environmental applications, such as bioremediation and biofuel production. | |
| **V** | | Computational Approaches in Enzyme Engineering<br>Lecture Topics: | |
| | 12. | Molecular dynamics simulations for enzyme dynamics and flexibility.<br>Enzyme-substrate docking and binding affinity prediction.<br>Machine learning and AI in enzyme engineering.<br>Case studies: Computational enzyme design projects (e.g., Rosetta, FoldX). | |

**Practicals. - 30 Hrs -Essential Experiments (15 hrs), Group work (15 hrs)**

**Essential Experiments**

1. Immobilize a model enzyme using different techniques.
2. Test enzyme activity before and after immobilization.
3. Evaluate factors affecting immobilization efficiency.
4. Design mutations using computational tools to improve enzyme properties (e.g., activity, specificity, stability

5. Analyze industrial enzyme formulations and their applications.

**Suggested readings**


1. Palmer, T. (2008). *Enzymes: Biochemistry, Biotechnology, Clinical Chemistry* (2nd ed.). Affiliated East-West Press Pvt. Ltd.
2. Shukla, A. (2009). *Elements of Enzymology*. Discovery Publishing House Pvt. Ltd.
3. Bailey, J. E., & Ollis, D. F. (1988). *Biochemical Engineering Fundamentals* (2nd ed.). McGraw-Hill.
4. Shuler, M. L., & Kargi, F. *Bioprocess Engineering Basic Concepts* (3rd ed.).


**Course Outcomes**

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | Demonstrate the comprehensive understanding of enzyme characterisation and purification including mechanism of enzyme action. | U | PSO-1,PSO3 |
| CO-2 | Analyse the preparation and screening of enzymes<br>Evaluate enzyme immobilization | An, E | PSO3 |
| CO3 | Demonstrate historical background and objectives of enzyme engineering<br>Investigate the methods through rational design and denovo enzyme engineering | R, An | PSO3,4 |
| CO4 | Explore the knowledge of enzyme engineering in<br>Industry, biomedical and environmental fields | Ap | PSO4 |

**R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create**

*Note: 1 or 2 COs/module*

**Name of the Course:** Enzyme engineering **Credits: 3:0:2(Lecture:Tutorial:Practical)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|

| | | | | | | |
|---|---|---|---|---|---|---|
| CO-1 | Evaluate the application of enzymes in various fields | PSO-1,PSO3 | U | F, C | L | |
| CO-2 | Understand the methods to improve the enzymes functions | PSO3 | An, E | P | L | |
| CO3 | Understand to preserve the structure and functions of the enzymes for long term | PSO3,4 | R, An | P | L | P |
| CO4 | Understand the application of engineered enzymes in various field | PSO4 | Ap | F | L | |

**F-Factual, C- Conceptual, P-Procedural, M-Metacognitive**

**Mapping of COs with PSOs and POs :**

| | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO 1** | 1 | - | 2 | - | - | - | | | | | | |
| **CO 2** | - | - | 3 | - | - | - | | | | | | |
| **CO 3** | - | - | 2 | 2 | - | - | | | | | | |
| **CO 4** | - | - | - | 3 | - | - | | | | | | |

**Correlation Levels:**

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

Assessment Rubrics:

- **Continuous Comprehensive Assessment:**
- **Formative :** Practical /problem/Survey/Design/Field trip based Assignment in the form of Individual or team work regarding the theory part/Follow any of the tool regarding the above practical assignment-1.Observation of practical skill/Viva/.Quiz/ In class discussions/Good Lab practices/Lab work book
- **Summative:**Follow any of the tool - Written test (theory based)/.Open Book Test(theory based)/ Individual /team work report practical assignmen/Case study report /Literature survey/Individual / Team project report oral presentation/ Laboratory report
    - Final Exam

**Mapping of COs to Assessment Rubrics :**

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |

University of Kerala

| | | | | | |
|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK3DSEBIT202 | | | | |
| Course Title | INTRODUCTION TO MARINE BIOTECHNOLOGY | | | | |
| Type of Course | DSE | | | | |
| Semester | III | | | | |
| Academic Level | 200 - 299. | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 4 | 3 hours | 0 | 2 hours | 5 |
| Pre-requisites | Basic Biotechnology, Microbiology | | | | |
| Course Summary | Marine Biotechnology is an interdisciplinary field at the forefront of scientific research, harnessing the vast potential of marine organisms and ecosystems for various applications in biomedicine, aquaculture, environmental management, and beyond. This graduate-level course delves into the principles, methodologies, and applications of marine biotechnology, equipping students with the knowledge and skills necessary to navigate the complexities of this dynamic field. | | | | |

Detailed Syllabus:

| Module | Unit | Content | Hrs |
|---|---|---|---|
| I | | **Marine Microbial environment** | 6 |
| | 1 | Classification of the marine environment. | |
| | 2 | Marine microbial habitats , Diversity of Marine microorganism. | |
| | 3 | Characteristics of marine microorganisms. Specialized microorganisms: Extremophiles: barophiles, thermophiles, psychrophiles, , halophiles, actinomycetes, polyextremophiles, anaerobes | |
| II | | **Techniques in Marine microbiology:** | 10 |
| | 4 | Techniques in Marine microbiology: Sampling: Water, Sediments. | |
| | 5 | Culture based methods for isolation and, identification of microbes. define, selective and differential culture media. | |
| III | | **Bioactive molecules from marine sources** | 10 |
| | 6 | Microbial nutrition: i) autotrophic & heterotrophic modes | |
| | 7 | Antibacterial and anti biofilm molecules produced by marine bacteria, Chitin from poriferan | |

| | | | |
|---|---|---|---|
| | 8 | Chemotaxis, Phototaxis, Bioluminescence and indicator species and Biological Rhythms | |
| IV | **Marine bio resources** | | 10 |
| | 9 | Marine bio resources.<br>Brief introduction - Marine microbes (viruses, bacteria, archaea, protists, fungi)<br>Marine algae and plants (seaweeds, sea grasses, mangrove, plants)<br>Invertebrates: sponges, cnidarians, polychaetes,<br>crustaceans, marine worms, molluscs, echinoderms, arthropods, Non-craniate (non-vertebrate) chordates, | |
| | 10 | Molecular Adaptations in Marine Organisms:<br>Mechanisms of adaptation to extreme environments | |
| V | **Ecosystem functioning in marine environment** | | 9 |
| | 11 | Food web dynamics and ecosystem functioning, Microbial loop - Role of microbes in marine food web dynamics, - Biogeochemical processes: Nutrient cycling, carbon cycle, Nitrogen cycle, Sulphur cycle, Iron cycling, Phosphorus cycling and other cycles | |

**Practicals. - 30 Hrs -Essential Experiments (15 hrs), Group work (15 hrs)**

**Essential Experiments**

1.Demonstrate Marine Sampling Technique- sampling marine environments (e.g., plankton nets, sediment cores, water column sampling).

2.Collection of water samples from different marine habitats (coastal, pelagic, deep-sea).

3.Isolation and characterization of marine microorganisms using culture-dependent and culture-independent techniques (e.g., metagenomics).

4.Field trip to marine ecosystems such as coral reefs, mangroves, or hydrothermal vents.

5.Identification and collection of marine organisms with potential biotechnological application

**Suggested Reading**


1. Blue iotechnology: production and Use of Marine Biomolecules. Stephane La Barre, Stephen S Bates. 2018. Wiley

2. Munn, C.B. , (2004) Marine Microbiology: Ecology and Applications, BIOS Scientific Publisher.

3. Krichman, D.L.,(2000), Microbial Ecology of the Oceans. Wiley-Liss, New York.

4. Paul,J.,(2001) Methods in Microbiology : marine Microbiology, Academic Press.

5. Gram, L., (2009) Microbial Spolage of Fish and Seafood, Springer





6. Pelczar M.J. Jr., ChanE.C.S. and Kreig N.R. (2001) Microbiology, (5th Edition) CBS Publishers.

7. Josep M Gasol and David L Kirchman (2018) Marine ecology of the oceans, (3rd edition), John Wiley and Sons. Inc

8. Surajit Das Hirak Dash (2018) Microbial Diversity in the Genomic Era, Elsevier

9. Horikoshi K, Antranikian G, Bull A T, Robb F T and Stetter, K O (2011) Extremophiles Handbook, Springer

10. Madigan, Martinko, Bender, Buckley & Stahl and Thomas Brock (2017) Brock Biology of Microorganisms, Pearson

**Course Outcomes**

| No. | Upon completion of the course the graduate will be able to | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO-1 | Discuss about Marine Microbial environment and its economic impact by biomaterial synthesis | U | PSO-1 |
| CO-2 | Identify the methods for biological and pharmaceutical investigation of crude extract, isolation , identification of active substances and synthesis of biomaterials | R, U,Ap | PSO3 |
| CO3 | Awareness of different bio-resources in marine environments and overview of different bioactive compounds | U,E | PSO1 |
| CO4 | Analyse different marine environments that affect overall productivity | R,U | PSO3,4 |

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create*Note: 1 or 2 COs/module***Name of the Course: Introduction to marine biotechnology Credits: 3:0:2 ecture:Tutorial:Practical)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| CO-1 | Discuss about Marine Microbial environment | PSO-1 | U | F, C | L | |
| CO-2 | Identify the methods investigation of active substances | PSO3 | R, U, Ap | P | L | P |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO3 | Awareness of different bio - resources in marine environment | PSO1 | U, E | U | L | |
| CO4 | Analyse different marine environment that affect overall productivity | PSO3,4 | R, U | F | L | |

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive Mapping of COs with PSOs and POs :

| | PSO1 | PSO 2 | PSO 3 | PSO 4 | PSO 5 | PSO 6 | PO 1 | PO 2 | PO 3 | PO 4 | PO 5 | PO 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 2 | - | - | - | - | - | | | | | | |
| CO 2 | - | - | 3 | - | - | - | | | | | | |
| CO 3 | - | - | 1 | - | - | - | | | | | | |
| CO 4 | - | - | 2 | 3 | - | - | | | | | | |

| Correlation Levels:Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

Assessment Rubrics: **Continuous Comprehensive Assessment:**

**Formative :** Practical /problem/Survey/Design/Field trip based Assignment in the form of Individual or team work regarding the theory part/Follow any of the tool regarding the above practical assignment-1.Observation of practical skill/Viva/.Quiz/ In class discussions/Good Lab practices/Lab work book

**Summative:**Follow any of the tool - Written test (theory based)/.Open Book Test(theory based)/ Individual /team work report practical assignmen/Case study report /Literature survey/Individual / Team project report oral presentation/ Laboratory report

Mapping of COs to Assessment Rubrics :

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | | ✓ |
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |

University of Kerala

| | | | | | |
|---|---|---|---|---|---|
| Discipline | BIOTECHNOLOGY | | | | |
| Course Code | UK3DSEBIT203 | | | | |
| Course Title | BIOMOLECULAR INTERACTIONS & CELL SIGNALLING | | | | |
| Type of Course | DSC | | | | |
| Semester | III | | | | |
| Academic Level | 200 - 299. | | | | |
| Course Details | Credit | Lecture per week | Tutorial per week | Practical per week | Total Hours/Week |
| | 4 | 3 hours | 0 | 2 hours | 5 |
| Pre-requisites | Cell biology & molecular biology | | | | |
| Course Summary | This course covers a wide range of topics related to host-parasite interaction, cellular communication, and signalling regulation, providing students with a comprehensive understanding of these complex biological processes | | | | |

Detailed Syllabus:

| Module | Unit | Content | Hrs |
|---|---|---|---|
| I | | **Introduction to Biomolecular Interactions** | 6 |
| | 1 | Overview of biomolecules: proteins, nucleic acids, carbohydrates, and lipids<br>Forces governing biomolecular interactions: electrostatic, hydrophobic, hydrogen bonding<br>Techniques for studying biomolecular interactions: spectroscopy, chromatography, mass spectrometry | |
| | 2 | Cellular interactions: Extracellular matrix molecular interaction, matrix proteins, integrins, focal adhesions and hemidesmosomes; Cell-cell interactions and cellular junctions | |
| II | | **General principles of cell communication** | 10 |
| | 3 | Basics of cell signaling: autocrine, paracrine, endocrine signaling<br>Signal transduction pathways: receptor activation, intracellular signaling cascades- Hormones and their receptors,<br>cell surface receptor, Ser/Thr protein kinases and phosphatises, Tyr phosphorylation signaling receptor and non-receptor TKs,<br>Protein Kinase (PKC) Signaling, cytokine receptors and the JAK-STAT Pathway<br>signaling through Gprotein coupled receptors,Toll like Receptors,<br>Inflammasomes , Role of NO as an Intercellular Messenger ,<br>Regulation of cell signaling: feedback mechanisms, cross-talk between | |

| | | | |
|---|---|---|---|
| | | pathways | |
| | 4 | general principles of cell communication - cell adhesion and roles of different adhesion molecules, gap junctions, extracellular malrix, integrins, neurotransmission and its regulation | |
| | 5 | Host parasite interaction: Recognition and entry processes of different pathogens like bacteria, viruses into host cel1s, alteration of host ce11 behaviour by pathogens ,bacterial signalling systems, bacterial chemotaxis and quorum sensing. | |
| III | | **Protein-Protein Interactions** | 10 |
| | 6 | Structural basis of protein-protein interactions | |
| | 7 | Methods for studying protein-protein interactions: yeast two-hybrid, co-immunoprecipitation, surface plasmon resonance | |
| | 8 | Applications in drug discovery and protein engineering,<br>Post-translational modifications and their impact on protein function<br>Membrane protein interactions and their significance in cellular processes | |
| IV | | **Protein-DNA Interactions** | 10 |
| | 9 | Mechanisms of protein-DNA recognition and binding | |
| | 10 | DNA-binding domains and transcription factors | |
| | 11 | Genome-wide approaches for studying protein-DNA interactions: ChIP-seq, DNase-seq | |
| V | | **Cell Signaling in Disease** | 9 |
| | 12 | Aberrant signaling in cancer, neurodegenerative diseases, and metabolic disorders<br>Targeting signaling pathways for therapeutic interventions<br>Case studies illustrating the role of biomolecular interactions in disease progression and treatment | |

**Practicals. - 30 Hrs -Essential Experiments (15 hrs), Group work (15 hrs)**

**Essential Experiments**

1. Stimulate cells with a signaling molecule (e.g., growth factor or hormone).
2. Monitor the activation of downstream signaling components using techniques like immunoblotting, immunofluorescence, or ELISA.
3. Examine the effect of signaling pathways on gene expression.
4. Treat cells with pathway activators or inhibitors.
5. Measure changes in mRNA expression using qRT-PCR, RNA-seq, or microarray analysis.

**Suggested Reading**

1.G. Karp, Cell and Molecular Biology, 5th Edn., Wiley, 2007
2. D. L. Wheeler, Y. Yarden, Receptor Tyrosine Kinases: Structure, Functions and Role in Human Disease, Springer, 2014

3. Q. A. Acton, Receptor Protein-Tyrosine Kinases: Advances in Research and Application, ScholarlyEditions, 2012
4. B. Alberts, A. Johnson, J. Lewis, and M. Raff, Molecular Biology of the Cell, 5th Edn., Garland Science, 2008.
5. H. Lodish, A.Berk, C.A. Kaiser, and M. Krieger, Molecular Cell Biology, 6th Edn., W. H. Freeman,2007.

Course Outcomes

| **No.** | **Upon completion of the course the graduate will be able to** | **Cognitive Level** | **PSO addressed** |
|---|---|---|---|
| CO-1 | Explore the role of biomolecular interactions in cellular processes and disease mechanisms. | U | PSO-1,2 |
| CO-2 | Explain the fundamental principles of cell communication, including signaling pathways, signal transduction, and cellular responses to extracellular stimuli. | R, U | PSO1 |
| CO-3 | Analyze various cell signaling pathways, including those mediated by hormones, growth factors, and cytokines, and their corresponding receptors. | U,AN | PSO1,PSO3,4 |
| CO-4 | Explore the role of biomolecular interactions in cellular processes and disease mechanisms.. | U,AN | PSO4 |

R-Remember, U-Understand, Ap-Apply, An-Analyse, E-Evaluate, C-Create*Note: 1 or 2 COs/module*

**Name of the Course: Biomolecular interactions & cell signalling Credits: 3:0:2 cture:Tutorial:Practical)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| CO-1 | Understand basics of host –pathogen interaction | PSO-1,2 | U | F, C | L | - |
| CO-2 | Explain fundamentals of cell signalling | PSO1 | R, U | P | L | - |
| CO-3 | Discuss various receptors and signalling molecules | PSO1,PSO3,4 | U,AN | F | L | - |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO-4 | Analyse the cell signalling regulation | PSO4 | U,AN | C | L | - |

F-Factual, C- Conceptual, P-Procedural, M-Metacognitive

Mapping of COs with PSOs and POs :

| | PSO1 | PSO2 | PSO3 | PSO4 | PSO5 | PSO6 | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| CO 1 | 2 | 2 | - | - | - | - | | | | | | |
| CO 2 | 2 | - | - | - | - | - | | | | | | |
| CO 3 | 2 | - | 2 | 3 | - | - | | | | | | |
| CO 4 | - | - | - | 3 | - | - | | | | | | |

Correlation Levels:

| Level | Correlation |
|---|---|
| - | Nil |
| 1 | Slightly / Low |
| 2 | Moderate / Medium |
| 3 | Substantial / High |

Assessment Rubrics: **Continuous Comprehensive Assessment:**

**Formative :** Practical /problem/Survey/Design/Field trip based Assignment in the form of Individual or team work regarding the theory part/Follow any of the tool regarding the above practical assignment-1.Observation of practical skill/Viva/.Quiz/ In class discussions/Good Lab practices/Lab work book

**Summative:**Follow any of the tool - Written test (theory based)/.Open Book Test(theory based)/ Individual /team work report practical assignmen/Case study report /Literature survey/Individual / Team project report oral presentation/ Laboratory report

Mapping of COs to Assessment Rubrics :

| | Internal Exam | Assignment | Project Evaluation | End Semester Examinations |
|---|---|---|---|---|
| CO 1 | ✓ | | 64 | ✓ |

| | | | | |
|---|---|---|---|---|
| CO 2 | ✓ | | | ✓ |
| CO 3 | ✓ | | | ✓ |
| CO 4 | | ✓ | | ✓ |

# Value Added Courses (200-299)

| | | | | | |
|---|---|---|---|---|---|
| Course Title | IPR,BIOETHICS AND BIOSAFETY | | | | |
| Typeof Course | VAC | | | | |
| Semester | III | | | | |
| Academic Level | 200 - 299 . | | | | |
| Course Details | Credit | Lectureper week | Tutorial perweek | Practical perweek | TotalHours/Week |
| | 3 | 2 hours | 1 | | 3 |
| Pre-requisites | EssentialsofBiotechnology | | | | |
| Course Summary | This course provides an in-depth exploration of thei ntersection of intellectual propertyrights,bioethics,and biosafety withinthecontextofmodernscientific research and biotechnology. It aims to equip students with a comprehensive understandingofthelegal,ethical,andsafetyconsiderationsinherentinthe development,dissemination,andregulationofbiotechnologicalinnovations. | | | | |

## DetailedSyllabus:

| Module | Unit | Content | Hrs |
|---|---|---|---|
| I | | **Basics of Intellectual Property Rights** | **9** |
| | 1 | Types of IPR- Industrial – Patent (Patentable and Non-patentable, Types of Patent, Patenting life), Design, Trademark, Trade secret, Geographical Indication; Non industrial – Copyright(Types, exclusions),Rights of traditional knowledge holders,Peoples biodiversity register | |
| | 2 | Legal protection of BiotechnologicalI nventions,Pros&Cons ofI PR; World Intellectual Property Right Organization(WIPO), TRIPS agreement, UPOV Convention; Patent Infringement(CaseStudy),Plagiarism,Plagiarism Detection Softwares and ways to avoid plagiarism | |
| II | | **Biosafety** | **9** |
| | 3 | Biosafetyl ssues in Biotechnology,<br><br>Biosafety-Different levels of Biosafety,Biosafety levels of specific Microorganisms(e.g. Non-pathogenic E. coli, HIV, Staphylococcus aureus, West Nile virus, Tuberculosis, Ebola);<br><br>Biological Safety Cabinets; Biocontainment – Definition and Types (Biological and Physical) | |

| | | | |
|---|---|---|---|
| | 4 | Principles and practices of biosafetyin laboratoryand industrial settings; Risk assessment methodologies and strategies for mitigating biological hazards(A brief account of the steps involved) | |
| **III** | | **Guidelines of Biosafety** | **9** |
| | 5 | Biosafety guidelines and regulations(NationalandInternational) – Brief account on the guidelines of WHO, DBT GoI, Cartagena Protocol;GMOs and LMOs – Definition | |
| | 6 | InstitutionalBiosafetyCommittee (IBSC),Review Committee on Genetic Manipulation (RCGM),Genetic Engineering Appraisal Committee (GEAC),forGMOapplications | |
| | 7 | Assessment and management of risks associatedwith GMO (Overview) | |
| **IV** | | **Bioethics** | **9** |
| | 8 | Bioethics-Introduction,Key Conceptsand Principles of Bioethics - Autonomy,Beneficence,Nonmal eficence,Justice.<br>Concepts of Animal Ethics, Animal ethical theories - Animal Rights (Deontology) and Utilitarianism | |
| | 9 | Biotechnology and Ethics;<br>Ethical issues related to research in embryonic stemc ells and cloning;<br>Ethical,Legal and Social Implications(ELSI) of Human Genome Project;<br>Ethical issues related to animal experiments | |
| **V** | | **Essentials of scientific experiments** | **9** |
| | 10 | Values in science,Misconduct ins cience,Negligence and error, Conflict of interest | |
| | 11 | Analyze case studies and real-world examples –to understand the practical application of IPR in biotechnology,<br>Protection of Plant Varieties and Farmer's Rights | |
| | 12 | Debate contemporary bioethical issues such as gene editing,and access to healthcare | |

**Suggested Reading**


1. IntellectualPropertyRights:APracticalGuidetoContent,Protection,and Exploitation" by Stephen Johnson
2. "IntellectualProperty:A VeryShortIntroduction" bySivaVaidhyanathan
3. "IntellectualPropertyintheNewTechnologicalAge" byRobertP.Merges andPeter S.Menell
4. Bioethics:Principles,Issues,andCases"byLewisVaughn
5. "PrinciplesofBiomedicalEthics"byTomL.BeauchampandJamesF. Childress
6. "Bioethics:AnIntroduction"byMarianneTalbot
7. BiosafetyinMicrobiologicalandBiomedicalLaboratories"byCentersforDisease Control and Prevention (CDC) and National Institutes of Health (NIH)
8. "BiosafetyinIndustrialBiotechnology"byPreetiJainandRakeshSingh
9. "HandbookofLaboratoryHealthandSafety"byRobertH.HillJr.andDavid W. Smith


**Course Outcomes**

| No. | Uponcompletionofthecoursethegraduatewillbeableto | Cognitive Level | PSO addressed |
|---|---|---|---|
| CO1 | Able to recognize the importance of IntellectualPropertyRightsanddistinguish various forms of IPR | An | PSO-2,5 |
| CO2 | AwarenessaboutlegalprotectionofIntellectualProperty and empower students to protect their IntellectualProperty | C | PSO-2,5 |
| CO3 | Gain knowledge ofBiosafety, associated risks and containment strategies | An | PSO -5 |
| CO4 | Get an insight into Biosafety guidelines and regulations with specific emphasis to Genetically Modified Organisms | E | PSO -5 |
| CO5 | Understandthe basics of Bioethics and relevance of Ethicalissuesrelatedtoresearchindifferentareas of Biotechnology and present arguments related to bioethical issues in a logical manner | C | PSO-2 |

**R-Remember,U-Understand,Ap-Apply,An-Analyse,E-Evaluate,C-Create**

*Note: 1 or2 COs/module*

**Nameofthe Course:IPR,bioethics andbiosafetyCredits: 2:1:0(Lecture:Tutorial:Practical)**

| CO No. | CO | PO/PSO | Cognitive Level | Knowledge Category | Lecture (L)/Tutorial (T) | Practical (P) |
|---|---|---|---|---|---|---|
| CO1 | Able to recognize the importance of IntellectualProperty Rightsanddistinguis h various forms of IPR | PSO - 2, 5 | An | F,C | L | |
| CO2 | Awarenessaboutle galprotectionofInt ellectualProperty and empower students to protect their IntellectualPropert y | PSO - 2, 5 | C | P, M | L | |
| CO3 | Gain knowledge ofBiosafety, associated risks and containment strategies | PSO - 5 | An | F | L | |

| | | | | | | |
|---|---|---|---|---|---|---|
| CO4 | Get an insight into Biosafety guidelines and regulations with specific emphasis to Genetically Modified Organisms | PSO - 5 | E | C | L | |
| CO5 | Understand the basics of Bioethics and relevance of Ethicalissuesrelate dtoresearchindiffe rentareas of Biotechnology and present arguments related to bioethical issues in a logical manner | PSO - 2 | C | C, M | L | |

**F-Factual,C-Conceptual,P-Procedural,M-Metacognitive**

**Mapping of COs with PSOs and POs :**

| | **PSO1** | **PSO2** | **PSO3** | **PSO4** | **PSO5** | **PSO6** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | - | 2 | - | - | 3 | - | | | | | | |
| **CO2** | - | 3 | - | - | 3 | - | | | | | | |
| **CO3** | - | - | - | - | 2 | - | | | | | | |
| **CO4** | - | - | - | - | **3** | - | | | | | | |
| **CO5** | - | **3** | - | - | - | - | | | | | | |

**Correlation Levels:**

| **Level** | **Correlation** |
|---|---|
| - | Nil |
| 1 | Slightly/Low |

| | |
|---|---|
| 2 | Moderate/ Medium |
| 3 | Substantial/High |

AssessmentRubrics: **Continuous Comprehensive Assessment:**

**Formative :** Practical /problem/Survey/Design/Field trip based Assignment in the form of Individual or team work regarding the theory part/Follow any of the tool regarding the above practical assignment-1.Observation of practical skill/Viva/.Quiz/ In class discussions/Good Lab practices/Lab work book

**Summative:**Follow any of the tool - Written test (theory based)/.Open Book Test(theory based)/ Individual /team work report practical assignmen/Case study report /Literature survey/Individual / Team project report oral presentation/ Laboratory report

# FinalExam

**MappingofCOstoAssessmentRubrics:**

| | InternalExam | Assignment | ProjectEvaluation | EndSemester Examinations |
|---|---|---|---|---|
| CO1 | ✓ | ✓ | | ✓ |
| CO2 | ✓ | | | ✓ |
| CO3 | ✓ | | | ✓ |
| CO4 | ✓ | ✓ | | ✓ |
| CO 5 | ✓ | ✓ | | ✓ |