CVM UNIVERSITY

MASTER OF SCIENCE INTEGRATED BIOTECHNOLOGY PROGRAMME

Under Choice Based Credit Scheme

Structure with Effect From: 2020-21

M. Sc. Integrated Biotechnology Programme Details

Programme Objectives (POs):

The overall aim of the integrated biotechnology programme is to provide basic understanding of the core principles and working knowledge of modern day biotechnology which will be necessary for future scientific endeavours and make our students to pursue higher education and research in the field of allied areas of biotechnology. To make our students capable in the field of biotechnology and its allied areas by means of lecture series and a research project. To provide strong fundamentals of biotechnology and its industrial application. To empower students with the comprehensive understanding of the principles and practices in the field of biotechnology to produce responsible biotechnologist that can work in the area of social welfare and as an entrepreneur with strong ethics and communication skills. To maximize the benefits of biotechnology to nation and globe to solve problems which will improve the quality of life for those suffering from health related diseases and disorders.

Programme Specific Outcomes (PSOs):

After successfully completing this course, the student should be able to understand the core principles and topics of modern day biotechnology and other allied areas. Student can implement the knowledge in domain of advanced biotechnology empowering their applications in research and industry to deliver sustainable edge to present society. Students will exhibit contemporary knowledge in biotechnology and will develop problem solving skills and critical thinking to the allied fields of biotechnology. As biotechnology is rapidly developing field, ample of opportunities are available for students with biotechnology background at national and international level in the field of academics, research, pharmaceutical companies, fertilizer industry, food processing industries, entrepreneurship ventures, chemical industry, textile industry, aquaculture industries and environment sector.

Programme Structure:

M. Sc. Integrated Biotechnology is a five years course that a student can pursue after the completion of Class12th science. M. Sc. Integrated Biotechnology is divided in to ten semesters. After completion of five years M. Sc. Integrated Biotechnology degree is awarded, however on student demand after completion of three years B. Sc. Biotechnology degree can be awarded. Direct admission to 2 years M. Sc. Integrated Biotechnology is also possible.

Course Credit Scheme

Semester I

Type of course	Course Code	Name of Course	T/ P	Credit	Exam Duration	Component of Marks		
						Internal	External	Total
						Total/ Passing	Total/ Passing	Total/ Passing
Core - 1	PS01CIGB01	Fundamentals of Chemistry	T	4	3 hrs	30/10	70/28	100/40
Core - 2	PS01CIGB02	Biochemistry -I	T	4	3 hrs	30/10	70/28	100/40
Core - 3	PS01CIGB03	Microbiology	T	4	3 hrs	30/10	70/28	100/40
Elective 1 (For B group)	PS01EIGB01	Biomathematics	T	4	3 hrs	30/10	70/28	100/40
Elective 2 (For A group)	PS01EIGB02	Plant and Animal science	T	4	3 hrs	30/10	70/28	100/40
	PS01CIGB04	Practicals based on PS01CIGB01 and PS01CIGB02	P	4	3 hrs	30/10	70/28	100/40
	PS01CIGB05	Practicals based on PS01CIGB03 and PS01EIGB01/ PS01EIGB02	P	4	3 hrs	30/10	70/28	100/40
Ability Enhancement	PS01AIGB01	English Communication	T	2	2 hrs	15/05	35/14	50/20
Viva-Voce	PS01VIGB01	Comprehensive Viva-Voce	V	1	--	--	20/50	20/50
Total Credit				27				

Course Wise Content Details for M.Sc. Integrated Biotechnology
CHARUTAR VIDYAMANDAL UNIVERSITY
VALLABH VIDHANAGAR
SEMESTER I
M.Sc. Integrated Biotechnology
SYLLABUS EFFECTIVE FROM: JUNE-2020-21

PS01CIGB01: Fundamentals of Chemistry

Course Objectives:

The main objective of the paper is to educate the students to develop the knowledge of the fundamental principles of chemistry and to enable understanding of the nomenclature, structural, isomerism, stereochemistry of organic compounds. Student will understand acid-base concept and solution behaviour. It provide the fundamental knowledge of the properties of transition metals and basics of coordination chemistry.

Learning Outcomes:

At the end of this course, the student will be able to:

1. Understand the fundamental principles of organic chemistry that include chemical bonding,
2. Learn nomenclature, structural of various classes of compounds,
3. Develop concept of isomerism, stereochemistry, Chirality.
4. Acquire concept of Acidity, Alkalinity, applications of indicator. .

UNIT I: IUPAC nomenclature

- Introduction of organic compound and their classification. Physical Properties and systemic IUPAC nomenclature of different class of organic compounds including alkanes, alkenes, alkynes, cycloalkanes, bicyclic, spiro, aromatic and heterocyclic compounds.

UNIT II: Stereochemistry

- Elements of symmetry centre, plane and axis of symmetry. Isomers and classification of isomers. Configuration, conformational isomers. Separation of enantiomers. Absolute configuration (R and S).Conversion of projection formulas.
- Stereochemistry of compounds containing two asymmetric carbon atoms. Conformations around a C-C bond in acyclic compounds.
- Structure of cycloalkanes, Cyclohexane conformations. Stereochemistry of disubstituted cyclohexanes.

UNIT III: Ionic equilibrium in aqueous solutions

- Acids & Bases, Arrhenius theory of Acids and Bases, The Lowry – Bronsted Concept, Strength of Acids and Bases, The Lewis concept, pH Scale, pH and Buffers Structure and physical properties of water, Self-Ionization of water, Hydrolysis, Buffer Solutions, Indicator, Sparingly Soluble Salts, Common ion effect, Selective Precipitation, acid-base titration and use of indicators, mathematical treatment of acid-base titrations.

UNIT IV: Fundamental concept of coordination chemistry

- Position of d-block elements in the periodic table, Electronic configuration and Classification of d-block elements in 3d, 4d, 5d and 6d series. Definition of coordination

compounds Werner's theory, Co-ordination number, Classification of ligands, Nomenclature of co-ordination compounds, Chelate, chelating ligand and Chelation, Uses of Chelates.

REFERENCE BOOKS:

1. Morrison R. T. & Boyd R. N., *Organic chemistry* (6th edition).
2. IUPAC nomenclature by Robert M. Silverstein.
3. Stereochemistry by P. S. Kalsi.
4. A text book of organic chemistry by Arun Bahl & B. S. Bahl, 16th Edition
5. Principles of Physical chemistry by B. R. Puri, L. R. Sharma and M. S. Pathania, 41th Ed.
6. Biophysical chemistry, Principles and Techniques by Upadhyay, Upadhyay and Nath.
7. Cotton, F.A. & Wilkinson, G. *Basic Inorganic Chemistry,* Wiley
8. Elements of Physical Chemistry by S. Glasstone and D. Lewis

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PS01CIGB02: Biochemistry -I

Course Objectives:

The course is aimed to provide insight into fundamentals of structures and functions of biomolecules. Student will able to understand basic structure of enzymes and mechanism of action. It also helps to understand the properties of carbohydrates, proteins, lipids, cholesterol, DNA, RNA, glycoproteins and glycolipids and their importance in biological systems and to develop skills to determine amino acid and nucleotide sequences of proteins and DNA respectively.

Learning Outcomes:

At the end of this course, the student will be able to:

1. Understand chemical and physical characters of biomolecules to be known to the students.
2. Learn the structure, classification and functions of Carbohydrates, Lipid, Protein and Nucleic acid and enzyme
3. Different protein structure, their physical chemical properties

UNIT I: Introduction to Biomolecules

- Nature of biological material and general properties of biomolecules. **Carbohydrate**: Introduction, occurrence, physiological importance, classification of carbohydrates, monosaccharide, disaccharide, oligosaccharides and polysaccharides.
- Physiological properties of carbohydrates, asymmetric centre in monosaccharides, Optical isomerism, stereoisomerism, epimers, mutarotation, diasterioisomerism configuration in sugar, cyclic structure anomeric carbon atom, fisher's projection formula, Haworths representation.
- Chemical properties of carbohydrates, oxidation and reduction of sugars, action of mineral acids, hydrogen cyanide, and hydrazine on sugars due to hydroxyl groups, reducing action of sugars.
- Polysaccharides: occurrence, structure and physiological importance of starch, glycogen, cellulose, hemicellulose, dextrin, pectin, agar, hyalouronic acid, heparin and chondrotin sulphate.

UNIT II: Aminoacids and proteins

- Structure and classification of amino acids, rare aminoacids of proteins, non protein aminoacids, Essential aminoacids, amphoteric nature of protein, titration curve of glycine. Physical properties of amino acids- stereospecificity and optical activity.
- Chemical properties of amino acids, chemistry of peptide linkage. Classification of proteins, solubility criteria: salting in and out of protein. Denaturation of proteins. Structure of proteins with examples (Primary, secondary, tertiary, quaternary). Determination of sequence of proteins.

UNIT III: Lipids

- Definition, classification of lipids, fatty acids, essential fatty acids triacylglycerol, properties of triacylglycerol, phospholipids, glycolipids, sphingolipids, sterols, there properties, structures, functions. Lipoproteins.

UNIT IV: Nucleotides and nucleic acid

- Structure of nitrogen bases and sugars, structure of nucleosides and nucleotides, Ribose, Deoxyribose and their conformation. - Structure and properties of DNA, forms of DNA.
- **Enzymes:** Nomenclature and classification, chemical nature and properties of enzymes, factor affecting enzyme activity, active site, enzyme inhibition, enzyme specificity, Coenzymes.

REFERENCE BOOKS:

1. Biochemistry by Lubert Stryer, W. H. Freeman and Company. 4th /6th edition, 2000/2004 Hardback, ISBN 0716720094
2. Fundamentals of Biochemistry: Life at the Molecular Level, by D. Voet, J. G. Voet, and C. Pratt, 3rd Edition, John Wiley and Co John Wiley & Sons, Inc., New York, , 2008 ISBN **:** 0471214957; 9780471214953
3. Principles of Biochemistry by Albert Lehninger, W.H. Freeman & Company; 3rd edition (February 2000), ISBN-10: 1572591536
4. Harper's Biochemistry: Harper, 27th Edition, McGraw-Hill Publishing Co; Robert K. Murray, Daryl K. Granner, Victor W. Rodwell, 2006 ISBN-10: 0071461973
5. Outlines of Biochemistry by Conn E E , Stumps P E and and Doi, R.H., John Wiley and sons, Singapore, 5th Edition - 2001
6. Principles of Biochemistry by Horton,Morgan, Secrimgeour,Perry, Rawn , pearson International edition – 4th edition ISBN 978-1-4058-2573-3
7. Harper's Biochemistry: R. K. Murray and others. Appleton and Lange, Stanford. ISBN: 0838536905 25 edition (pb) 2000
8. Plummer, D.T. (1987). 3rd ed. An introduction of Practical Biochemistry. McGraw Hill Book Co.

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SEMESTER I
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PS01CIGB03: Microbiology

Course Objectives:

The main objective of this course is to give students comprehensive knowledge of the historical aspects and development of Microbiology. To make the students to understand the different aspects to the classification of Prokaryotes. Students will provide in-depth knowledge on the structure and functions of prokaryotic and eukaryotic cells. Student will learn properties of viruses and exhaustive knowledge of fungi. Further it gives insight into hands on training of basic microbial techniques which will give the student a strong base in scope of microbiology.

Learning Outcomes:

At the end of this course, the student will be able to:

1. Acquire knowledge about history and scope of Microbiology.
2. Understand various methods of microbial classification.
3. Differentiate prokaryotic and eukaryotic cell structure and functions.
4. Learn about viruses and nutritional requirements and modes of reproduction in fungi.

UNIT I: Historical foundation of Microbiology

- Establishment of microbiology as a discipline: Spontaneous generation *vs* biogenesis, Contributions of Anton von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming. Role of microorganisms in fermentation, Germ theory of disease, Development of various microbiological techniques and golden era of microbiology.
- Development of the field of soil microbiology: Contributions of Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A.Waksman. Establishment of fields of medical microbiology and immunology through the work of Paul Ehrlich, Elie Metchnikoff, Edward Jenner.

UNIT II: Classification and Prokaryotic cell structure

- Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. Classification in brief as per Bergey's Manual of Systematic Bacteriology.
- Overview of prokaryotic cell structure, prokaryotic cell membranes, prokaryotic cytoplasm, cytoplasmic inclusion bodies, cell wall, ribosome, and capsule. Bacterial endospores, exospores, and cyst. Bacterial motility. Bacterial chromosome, nuclear material, plasmid and episomes.

UNIT III: Eukaryotic cell structure and function

- Overview of eukaryotic cell structure, Eukaryotic membranes, Cytoplasmic matrix, Organelles of the biosynthetic-secretory and endocytic pathways, Ribosomes,

Mitochondria, Chloroplast, Nucleus, Structures external to the plasma membrane, Comparison of prokaryotic and eukaryotic cells.

UNIT IV: Viruses, Other Acellular Agents and Fungi

- Introduction to viruses, General properties of viruses, Viral reproduction, Cultivation of viruses, Virus purification and assays, Principles of virus taxonomy, Viroids and Virusoids, Prions. Lytic and lysogenic cycles.
- Introduction of fungi, Distribution, Structure, Nutrition and metabolism, Reproduction, Characteristics of fungal divisions and Economic significance.

REFERENCE BOOKS:

1. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
2. Willey JM, Sherwood LM, and Woolverton CJ. (2008). Prescott, Harley and Klein's Microbiology. 7th edition. McGraw Hill Higher Education.
3. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9th edition. Pearson Education.
4. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers. 3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition.
5. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
6. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education limited.
7. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms. 12th edition. Pearson/Benjamin Cummings.
8. Dubey RC and Maheswari DK. A Text book of Microbiology. (2005).S. Chand & Company Ltd., New Delhi.

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SEMESTER I
M.Sc. Integrated Biotechnology
SYLLABUS EFFECTIVE FROM: JUNE-2020-21

PS01EIGB01 (for B group): Biomathematics

Course Objectives:

As the study of biological systems becomes more quantitative, the part that biomathematical analysis plays increases. This extends from the macroscopic, such as modelling the spread of a disease through a community, to the microscopic, such as determining the three-dimensional structure of proteins from knowledge of their sequence of amino acids. Understanding Equations and spectroscopy data analysis are to be very beneficial. Hands on module on various tools for Biomathematics especially excel is the key for future work as Statistical part is everywhere in research.

Learning Outcomes:

At the end of this course, the student will be able to:

1. Understand mathematical modelling and applications of applied mathematics.
2. Extend the range of usage of mathematical models in biology, ecology and evolution problems.
3. Learn application of multivariable calculus, ordinary differential equations, stochastic models and partial differential equations.

UNIT I:

- **Scientific Notation, Powers and Prefixes** To write large and small numbers in scientific notation Convert between decimals and scientific notation Add, subtract, multiply and divide in scientific notation know all of the standard prefixes and use them in calculations, Convert between units and prefixes.
- **Amount and Concentration: Making and Diluting Solutions**. Calculate concentration from amount in g and volume in L and express in g/L, % w/v, % w/w, % v/v Convert amounts from g to mol and vice versa. Calculate concentration from amount in mol and volume in L and express in M with an appropriate prefix Convert between concentration in g/Land M Calculate amount/volume required to make a solution of a certain concentration (in g/L and M) Calculate volumes required to make a dilution and the concentration of the resulting solution

UNIT II:

- **Understanding Equations: Using, Rearranging and Manipulating Equations** To add, subtract, multiply and divide fractions using numbers and symbols, To carry out calculations with numbers and symbols using the correct order of operations
- **Spectrophotometry**: Describe the basic principles of spectrophotometry; State the Beer-Lambert Law and define the Molar Absorbance Coefficient, Calculate the Molar Absorbance Coefficient
- **Michaelis-Menten Equation**: sketch the shape of a curve from the equation; understand the difference between variable and parameter; understand the effect that changing the parameters has on the shape of the curve, how to derive the equation,

Rearrange an equation for a rectangular hyperbola into that of a straight line (eg the Lineweaver-Burke plot)

UNIT III:

- **Introduction to logarithms.** Rationale: What are logs for? Writing numbers in logarithmic notation Using a calculator to get the log and anti-log Using logs - understanding the pH scale
- **Manipulating logs.** Multiply and divide with logs Power of a power Using the rules of logs to derive the Henderson-Hasselbalch Equation Using the rules of logs to calculate the likelihood of a drug **crossing** a cell membrane from the stomach to the blood
- **Logs with different bases.** Sketching exponential growth and decay**,** Logs to the base 2**,** Changing the base What is "e"? What are "natural logs"? Using natural logs - calculating half-time**,** Using log graph paper

UNIT IV:

- **Statistics for Biology made simple using Excel**
  Descriptive statistics mean, median, mode, standard deviation, standard error, confidence interval Graphing data scatter graphs, bar, graphs, error bars, lines. Association statistics Pearson coefficient, Spearman coefficient, linear regression. Comparative statistics paired and unpaired, t-test, ANOVA. Frequency statistics χ^2-test.

REFERENCE BOOKS:

1. Mathematics for Biological Science by Jagdish Arya and Ladner.
2. Practical Skills in Biomolecular Sciences (4th eds.) By: Rob Reed, David Holmes, Jonathan Weyers, Allan Jones, British Library Cataloguing-in-Publication, 2013. ISBN 978-1-4082-4552-1.
3. Introduction to Mathematics for Life-Sciences by P. Batschelet – Springer - Verlag.
4. Biostatistics by P. N. Arora and P.K.Malhan.
5. Fundamentals of Biostatistics by Khan and Khanum.
6. https://camtools.cam.ac.uk/access/content/group/6041b37a-7fa4-4a47-808b-b20db3a36122/Module%202/Practice%20Questions/mod2/index.htm

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PS01EIGB02 (for A group): Plant and Animal sciences

Course Objectives:

The major objective of this paper is to develop clear understanding of various aspects of Plants and animal science which includes identification of species based on classification, importance of individual phylum, importance of medicinal plants and economically important families, plant and animal diversity, histology etc. Students will gain an interest in learning about plants and animals by understanding the similarities in survival needs among all living things.

Learning Outcomes:

At the end of this course, the student will be able to:

1. Identify the major groups of organisms with an emphasis on plants and be able to classify them within a phylogenetic framework.
2. Understand the importance of Bryophytes, Pteridophytes, Gymnosperms and Angiosperms and familiarize the traditionally useful medicinal plants.
3. Get a concrete idea of the evolution, hierarchy and classification of fascinating world of Animal kingdom.
4. Predict and understand organ behavior and function as tissues are the building blocks of virtually everything in the body.

UNIT I: Cryptogams

- Eichler's system of Classification. Algae: Introduction, Distribution and habitat, Morphology, Reproduction and Life Cycle of Spirogyra and Economic importance of Algae. Fungi: Introduction, Distribution and habitat, Morphology, Reproduction and Life cycle in Mucor.
- Lichens: Introduction and General account of Lichens. Bryophyta: Introduction, Distribution and habitat, Morphology, Reproduction and Life cycle in *Riccia*. Pteridophyta: Introduction, Distribution and habitat, Morphology, Reproduction and Life Cycle in Fern.

UNIT II: Phaenerogams

- Gymnosperms: Introduction, Distribution and habitat, Morphology, Reproduction and Life cycle in *Cycas*. Introduction, Classification (Bentham & Hooker), Morphology and Life Cycle of Maize and Sunflower.

- Study of the families and their Economic importance: Malvaceae, Cucurbitaceae, Solanaceae and Apocynaceae. Medicinal Plants: *Ocimum sanctum*, *Adhatoda vasica*, *Azadirachta indica*, *Calotropis procera*, and *Withania somnifera*.

UNIT III: Animal Diversity – Systematics (Non-chordates)

- Salient features and outline classification up-to classes with suitable examples (excluding minor Phyla). Phylum – Protozoa, Porifera, Coelenterata, Platyhelminthes, Nemathelminthes, Annelida, Arthropoda, Mollusca, Echinodermata and Hemichordata Animal Diversity – Systematics (Protochordates and Chordates).
- Salient features and outline classification upto classes with suitable examples. Protochordates –Urochordata, Cephalochordata. Chordates – Cyclostomata, Pisces, Amphibia, Reptilia, Aves, Mammalia.

UNIT IV: Histology

- Structure and functions of animal tissues (in detail with types and suitable examples). Epithelial tissue: Simple (Squamous, Columnar, Ciliated, Glandular, Sensory, Germinal, Psuedo-stratified) and Compound (Stratified, Transitional).
- Connective tissue: Connective tissue proper (Areolar, White fibrous, Yellow fibrous, Adipose), Skeletal (Cartilage – Hyaline, Fibro-cartilage, Elastic cartilage, Calcified cartilage, Mammalian bone), Fluid (Blood, Lymph).
- Muscular tissue: Smooth, Striated, Cardiac Nervous tissue: Structure and types of neuron and nerve fibers.

REFERENCE BOOKS:

1. Botany for degree students by A. C. Dutta,(18th Ed. 2005), Oxford University Press. ISBN: 13:978-0-19-563748-9, ISBN: 10:0-19-563748-8.
2. University Botany-I, Algae, Fungi, Bryophyta and Pteridophyta by S. M. Reddy, Publishers: New Age International (P) Limited, Mumbai. ISBN: 81-224-0840-0.
3. University Botany- II- Gymnosperm, Angiosperms by S. M. Reddy, Publishers: New Age International (P) Limited, Mumbai.
4. A Textbook of Zoology by PN Pandey & RD Vidyarthi, S Chand Publications, New Delhi.
5. Invertebrates by RL Kotpal, Rastogi Publications, Meerut.
6. Vertebrates by RL Kotpal, Rastogi Publications, Meerut

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PS01AIGB01: English Communication

Course Objectives:

English is now used almost exclusively as the language of science. The adoption of a de facto universal language of science has had an extraordinary effect on scientific communication: by learning a single language, scientists around the world gain access to the vast scientific literature and can communicate with other scientists anywhere in the world. Students will learn about various scientific terms and will be able to enhance skills. Verbal and Non-verbal communication, writing skills, reviewing will be remedy for the students to get better and better subjectively.

Learning Outcomes:

At the end of this course, the student will be able to:

1. Understand the preparation of Well-organized presentation slides
2. Improve presenting skill
3. Learn biological, and Chemical vocabulary and Terminology
4. Understand verbal and Non-Verbal communication

UNIT I: Vocabulary and Presentation Skill Development

- Listening Skills, Speaking Skills, Reading Skills and Writing Skills (LSRW)
- Defining the Purpose & how to make an effective presentation (MS PowerPoint)
- Outline preparation
- Review / Content / Précis writing

UNIT II: Introduction and Language of Communication

- Theory of Communication, Types and Modes of Communication
- Verbal and Non-verbal (Spoken and Written)
- Personal, Social and Business Barriers and Strategies; Intra-personal, Inter-personal and Group communication, Expressing opinions

REFERENCE BOOKS:

1. Fluency in English - Part II, Oxford University Press, 2006.
2. Business English, Pearson, 2008.
3. Language, Literature and Creativity, Orient Blackswan, 2013.
4. Language through Literature (forthcoming) ed. Dr. Gauri Mishra, Dr Ranjana Kaul, Dr Brati Biswas

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PS01CIGB04: Practicals based on PS01CIGB01 and PS01CIGB02

PRACTICALS:

1. Volumetric analysis: Determination of concentration of Strong acid [HCl] and weak acids [oxalic acid/Acetic acid] by titrating against strong base [NaOH].
2. Volumetric analysis: Determination of concentration of transition metal salts (Cu, Ni, Zn) by titrating against EDTA.
3. Qualitative Analysis : Identification of Organic substance:
    - Salicylic acid
    - Cinnamic acid
    - Benzoic acid
    - α-Naphthol
    - β-Naphthol
    - o-nitroaniline
    - m-nitroaniline
    - p-nitroaniline
    - Naphthalene
    - m-dinitrobenzene
    - Anthracene.
4. Identification of biomolecules: Carbohydrate (Molisch's test), Protein (Biuret) & lipid (Saponification).
5. Qualitative analysis of carbohydrates: Molisch's test, Iodine test, Benedict's test, Fehling's test, Cole's test, Barfoed's test, Saliwanoff's test, Rapid furfural test, Osazone test, Mucic acid test, Inversion test.
6. Qualitative analysis of proteins: Precipitation test, Mercuric nitrate test, Lead acetate test, Sulphosalicyllic test, Potassium ferricyanide test, Tannic acid test, Alcohol test, Heller's test, Ammonium sulphate test.
7. Qualitative analysis of amino acids: Colour reactions, Biuret test, Ninhydrin test, Millon's test, Arginine test (Sakaguchi test), Xanthoproteic test, Hopkin's Cole test, Ehrlich test, Nitroprusside test.
8. Qualitative analysis of fat: Test for oil, Solubility test, Dichromate test, Emulsion test, Absorption test, Glycerol test, Acid value of oil, Saponofication test, Iodine test, Borax test, and Liebermann-Burchard test.
9. Estimation of protein by Biuret method.
10. Estimation of carbohydrate by DNS method.
11. Estimation of DNA by DPA method.

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PS01CIGB05: Practicals based on PS01CIGB03 and PS01EIGB01/PS01EIGB02

PRACTICALS:

1. Preparation and sterilization of culture media for bacterial cultivation
2. Study of different shapes of bacteria using permanent slides/ pictographs
3. Simple staining: Monochrome staining and Differential: Gram's staining
4. Endospore staining
5. Capsule staining
6. Determination of motility of bacteria by (i) hanging drop method (ii) Agar stab method
7. Isolation of bacteria [Streak plate, spread plate, pour plate, serial dilution]
8. Determination of CFU count.
9. Study of the following fungi by preparing temporary mounts: *Rhizopus* and *Aspergillus*.
10. To apply the concept of function in biosciences.
11. Use the concept of exponential & logarithmic function in the field of biosciences.
12. To make use of log function in some complex calculation of mathematics.
13. Problem related to Beer – Lambert Law.
14. Problem related Michaelis – Menten Equation.
15. To convert ungrouped data in to grouped data using Sturge's formula.
16. To study how to calculate descriptive statistics for the given data. (Mean mode, median, standard deviation and mean deviation).
17. Study of algae, fungi (mount preparations) and Lichen.
18. T.S. of cycas leaf and fern rachis.
19. Study of the families – *Malvaceae, Cucurbitaceae, Solanaceae & Apocynaceae.*
20. Study of grafting techniques.
21. Study of specimens of protozoa, Porifera, Coelenterata, Platyhelminthes, Nemathelminthes, Annelida, Arthropoda, Mollusca and Echinodermata.
22. Study of specimens of Protochordata and Vertebrata (Pisces, Amphibia, Reptilia, Aves and Mammalia)
23. Study of Histological slides of Mammalian tissues / Organs (Permanent): T.S. of Stomach, Small Intestine, Liver, Pancreas, Lung, Kidney, Testis, Ovary, Spinal cord and V.S. of Skin.

REFERENCE BOOKS:

1. Mendham, J., Denney, R. C., Barnes, J. D., Thomas, M. J. K., *Vogel's textbook of quantitative chemical analysis*, 6th Edition.
2. Pandey, O. P., Bajpai, D. N.,Giri, S., *Practical Chemistry*.
3. Ghoshal, Mahapatra ,Nad , *An Advanced course in Practical Chemistry*.

Course Credit Scheme

Semester II

Type of course	Course Code	Name of Course	T/ P	Credit	Exam Duration	Component of Marks		
						Internal	**External**	**Total**
						Total/ Passing	**Total/ Passing**	**Total/ Passing**
Core – 1	PS02CIGB01	Cell Biology	T	4	3 hrs	30/10	70/28	100/40
Core – 2	PS02CIGB02	Biochemistry -II	T	4	3 hrs	30/10	70/28	100/40
Core – 3	PS02CIGB03	Microbial Physiology	T	4	3 hrs	30/10	70/28	100/40
Elective 1	PS02EIGB01	Biophysics	T	4	3 hrs	30/10	70/28	100/40
	PS02CIGB04	Practicals based on PS02CIGB01 and PS02CIGB02	P	4	3 hrs	30/10	70/28	100/40
	PS02CIGB05	Practicals based on PS02CIGB03 and PS02EIGB01	P	4	3 hrs	30/10	70/28	100/40
Ability Enhancement	PS02AIGB01	Environmental Science	T	2	2 hrs	15/05	35/14	50/20
Viva-Voce	PS02VIGB01	Comprehensive Viva-Voce	V	1			20/50	20/50
	Total Credit			**27**				

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PS02CIGB01: Cell Biology

Course Objectives:

Cell biology is the study of structure and function of prokaryotic and eukaryotic cells. In this course the students will learn different areas of cellular biology including the structure and functions of cell, its organelles, synthesis and function of proteins, membrane structure and function; bioenergetics; cellular communication, division of cell and chromosomal separation in different stages of cell cycle.

Learning Outcomes:

At the end of this course, the student will be able to:

1. Understand the structures and purposes of basic components of plant cell, Animal cells, prokaryotic and eukaryotic cells, especially macromolecules, membranes, and different cell organelles.
2. Learn how these cellular components are used to generate and utilize energy in cells.
3. Understand the cytoskeleton structure, protein sorting, Cell cycle, programme cell death and the cellular components underlying mitotic cell division.

UNIT I: Cell Structure and Function:

- Discovery, Origin of Cell and Cell theory, Cell as basic unit of life (Plant and Animal Cell structure, Comparison between plant and animal cells), Cell Wall, Differences between Prokaryotic and Eukaryotic cells, Structure and its function of Plasma membrane (Three dimensional), Chemical composition of Biological membranes, Membrane models, Fluid mosaic membrane model, Transport across membrane (Active and Passive transport, Facilitated diffusion, Gated channels, Na+ K+ Pump). Cell junction's structure and its types.

UNIT II: Cytoskeleton structure and functions:

- Overview of the Major Functions of Cytoskeleton. Microtubules: Structure, Composition and functions, Composition, Assembly and Disassembly, Structure, composition and functions of Centrioles and Basal bodies, Microtubules in Cilia and Flagella. Microfilaments and Intermediate filaments: Structure and Composition; Endoplasmic reticulum: Structure, function including role in protein segregation. Golgi complex: Structure, biogenesis and functions including role in protein secretion.

UNIT III: Structure of Nucleus

- Nuclear membrane, nuclear pore, nucleolus, chromatin, structure of nucleic acids. Mitochondria – Ultra structure and function; Biogenesis of mitochondrial Genomes,

Chloroplast – Ultra structure and function, Genome biogenesis. Ribosomes detailed structure and its function with involvement in protein synthesis. Vacuoles, Lysosomes structure and functions.

UNIT IV: Cell cycle and Cell division

- The key roles of mitosis and meiosis during the life cycle. Types of cell divisions. Different Stages of mitosis and meiosis, highlighting similarities and differences. Significance of Mitosis and Meiosis.
- Overview of the Cell cycle and its control. Programmed Cell Death: Difference between necrosis and apoptosis.

REFERENCE BOOKS:

1. Cell Biology by C.B. Powar. (Reprinted-2004)Himalaya Publishing House, Mumbai.
2. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology by P.S. Verma and V.K. Agarwal (Reprinted -2007) Pub.S.Chand & Company Ltd.Ram Nagar, New Delhi-110055.
3. Cytology by P.S. Verma and V.K. Agarwal (Reprinted -2006) Pub:S.Chand & Company Ltd.Ram Nagar, New Delhi-110055.ISBN: 81-219-0814-0.
4. Molecular Biology of the cell by Albert et al.4th Edition, 2002, Garland Science, Taylor & Francis Group. ISBN: 0-8153-3218-1.
5. The Cell – A Molecular Approach By Geoffrey M. Cooper And Robert E. Hassman. 3rd Edition, 2004, ASM Press, Sinauer Associates, Inc.ISBN:0-87893-214-3.

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PS02CIGB02: Biochemistry -II

Course Objectives:

The aim of this course is to associate concepts in the areas of bioenergetics and metabolism. The focus is on the main metabolic pathways involved in carbohydrate, lipid, and protein metabolism, how these pathways are regulated and disrupted in disease and how energy is obtained to meet the cell's needs. Other objectives are to engage students in discussions on topics of Bioenergetics and Metabolism, have them think and raise questions, train their critical reading of scientific literature in this field, and develop skills in presentation and scientific discussion

Learning Outcomes:

At the end of this course, the student will be able to:

1. Understand basics of bioenergetics to be known to the students.
2. Learn metabolism of carbohydrate.
3. Understand metabolism of amino acid and protein.
4. Acquire knowledge of metabolism of Nucleic acid and lipid.

UNIT I: Basic of Bioenergetics

- Energy transformation, Laws of thermodynamics, entropy, free energy of reaction, Biological oxidation-reduction reactions, standard redox potentials, Hydrolysis of energy rich intermediates and ATP ,Respiratory transport, Electron Transport and Proton pump, Oxidative Phosphorylation and ATP synthesis, conformational changes and chemiosmotic theory, central dogma of energy transduction.

UNIT II: Metabolism of Carbohydrate

- Glycolysis, Gluconeogenesis, Regulation of glycolysis and Gluconeogenesis, Pentose Phosphate Pathway, TCA cycle, ATP Stoichiometry of the TCA Cycle, Regulation of TCA Cycle Activity, Glyoxylate Cycle.

UNIT III: Amino acid metabolism

- Source of amino acid, Protein turn over, Transamination and deamination reaction, metabolism of ammonia, urea cycle and its regulation, link between urea cycle and TCA cycle,. Overall anabolic and catabolic pathways of pyruvate family, aspartate family, aromatic family.

UNIT IV: Metabolism of Nucleic acid and Lipid

- Metabolism of Nucleic acid: - Biosynthesis of purines and pyrimidines, Degradation of purines and pyrimidines, Regulation of purines and pyrimidines biosynthesis.
- Metabolism of lipid: Overall pathways and regulation of fatty acid synthesis and breakdown. Regulation of complex lipid.

REFERENCE BOOKS:

1. Biochemistry by Lubert Stryer, W. H. Freeman and Company. 4th /6th edition, 2000/2004 Hardback, ISBN 0716720094.
2. Fundamentals of biochemistry: Life at the Molecular Level, by D. Voet, J. G. Voet, and C. Pratt, 3rd Edition, John Wiley and Co John Wiley & Sons, Inc., New York, , 2008 ISBN : 0471214957; 9780471214953.
3. Principles of Biochemistry by Albert Lehninger, W.H. Freeman & Company; 3rd edition (February 2000), ISBN-10: 1572591536.
4. Harper's Biochemistry: Harper, 27th Edition, McGraw-Hill Publishing Co; Robert K. Murray, Daryl K. Granner, Victor W. Rodwell, 2006 ISBN-10: 0071461973
5. Outlines of Biochemistry by Conn E E , Stumps P E and and Doi, R.H., John Wiley and sons, Singapore, 5th Edition – 2001.
6. Principles of Biochemistry by Horton,Morgan, Secrimgeour,Perry, Rawn , pearson International edition – 4th edition ISBN 978-1-4058-2573-3.
7. Harper's Biochemistry: R. K. Murray and others. Appleton and Lange, Stanford. Mcgraw-hill book company ISBN: 0838536905 25 edition (pb) 2000.

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PS02CIGB03: Microbial Physiology

Course Objectives:

The major objective of this course is to educate the students to develop a clear understanding of the fundamental concepts of microbial physiology and metabolism occurring inside microbes. The students will understand nutritional classification of microbes. Students will understand pure culture techniques and methods of culturing, preservation and maintenance of microorganisms. This course will aid students to acquire skills and competence in microbiological laboratory practices.

Learning Outcomes:

At the end of this course, the student will be able to:

1. Design synthetic media for screening of specific culture.
2. Describe and differentiate type of growth requirement for specific microbial culture.
3. Describe and evaluate the growth of microorganisms and factors affecting it.
4. Describe the microbial photosynthesis and depict the role of pigments associated with microbes.

UNIT I: Microbial Nutrition

- Nutritional types: Requirement of nutrients for microbes and classification of microorganisms based on carbon, energy and electron sources viz. Autotroph/Phototroph, heterotrophy, Chemolithoautotroph, Chemolithoheterotroph, Chemoheterotroph, Chemolithotroph, photolithoautotroph, Photoorganoheterotroph. Primary and secondary active transport; Passive and facilitated diffusion. Effect of oxygen on growth, classification on the basis of oxygen requirement and tolerance (aerobic, anaerobic, microaerophilic, facultative aerobe, facultative anaerobe).

UNIT II: Media type, control and Preservation

- Role of macro and micro-nutrients. Components of media: Natural, Synthetic, Complex, Selective media, Differential Media, Enriched and enrichment media. Methods for culturing aerobic and anaerobic bacteria; Colony and broth culture characteristics.
- Physical methods of microbial control: heat, low temperature, high pressure, filtration, desiccation, osmotic pressure, radiation. Chemical methods of microbial control: disinfectants, types and mode of action. Maintenance and preservation techniques for microorganisms (Sub culturing, Oil overlay, Sand cultures, Storage at low temperature, Lyophilisation, Liquid Nitrogen).

UNIT III: Microbial Growth

- Growth in Microbes (growth phases, generation time, growth curve and specific growth rate). Measurement of cell mass and cell number; Factors affecting microbial growth;

Continuous and batch cultures; details of synchronous and Diauxic growth curve. Physical factors influencing growth: Temperature; pH; Atmospheric Pressure; Salt Concentration. Chemical factors: heavy metal (copper), surfactants. Control of Microorganisms: patterns of microbial death, control of microorganism growth by antiseptics.

UNIT IV: Microbial Photosynthesis

- Concept of photosynthesis and associated pigments in microbes; photosynthetic apparatus in pro and eukaryotes; anoxygenic and oxygenic photosynthesis; light and dark reaction; photorespiration and its significance; Effect of light, temperature; pH and CO_2 concentration on photosynthesis; measurement of net photosynthetic yield. Electron transport chain in photosynthetic bacteria.

REFERENCE BOOKS:

1. Moat A.G. and Foster S.W. Microbial Physiology (4th Ed.) (2004). John Wiley and Sons, New York.
2. Gerald Karp. Cell Biology (3rd Ed.) (2003). McGraw Hill Book Company, New York.
3. Stanier R. Y, Ingrahm J. I, Wheelis M. L and Painter P. R. General Microbiology. (5th Ed.) (1987). McMillan Press. UK.
4. Dubey R. C and Maheswari D. K. A Text book of Microbiology. (2005).S. Chand & Company Ltd., New Delhi.
5. Nelson D. L. & Cox M. M. Lehninger's Principles of Biochemistry, 4th edition. (2005). W. H. Freeman & Co. NY.
6. Pelczar Jr, M. J, Chan E. C. S., Krieg N R, Microbiology, (5th Ed.), (2001). McGraw Hill Book Company, NY.
7. Madigan M. T, Martinko J. M and Parker J. (2003). Brock Biology of Microorganisms. 10th edition. Pearson/Benjamin Cummings.
8. Reddy S. R. and Reddy S. M. (2005). Microbial Physiology. Scientific Publishers India.

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PS02EIGB01: Biophysics

Course Objectives:

The main objective of this course is to give a comprehensive insight into various aspects of physics in biological sciences. This includes nature of electromagnetic waves and its interaction with biological compounds which provides information about biological molecules. Students will also understand how spectroscopy techniques will be helpful gathering qualitative and quantification information about bio molecules. Further, it gives insight in to role of electromagnetic information and X rays in the field of biological sciences.

Learning Outcomes:

At the end of this course, the student will be able to:

1. Understand the integration of applying physical principles and techniques of physics with modern biology.
2. Enhance the critical knowledge as well as perspective on modern biophysics research to integrate physical concepts with biological phenomena.

UNIT I: Light and Microscopy

- The electromagnetic spectrum, Principles of superposition, Constructive and destructive Interference, Type of Interference, Newton's rings, Diffraction-Types of diffraction, Diffraction grating, Rayleigh's criterion, Resolving power of microscope and telescope, Polarization of light waves, Polaroid, Optical activity, Types of lenses, Cardinal points, Huygens eyepiece, Ramsden eyepiece, Introduction to microscopy-Light microscopy, Bright and Dark Field microscopy, Phase contrast microscopy.

UNIT II: Spectroscopy techniques

- Basic principles of electromagnetic radiation, energy, wavelength, wavenumbers and frequency. Review of the electronic structure of molecules (Molecular orbital theory), absorption and emission spectra, Beer-Lambert law, light absorption and its transmittance. UV and visible spectrophotometry-principles, instrumentation and applications, fluorescence spectroscopy, static and dynamic quenching, energy transfer, fluorescent probes in the study of protein, nucleic acids, Infra-red spectroscopy, Light scattering in biology, circular dichroism, optical rotator dispersion, magnetic resonance spectroscopy.

UNIT III: Electricity and Magnetism

- Coulomb's law, Electric field-Electric field lines, electric potential, Energy of a point charge distribution, Energy of a continuous charge distribution, Magnetic force of moving charge, Hall effect, Three types of magnetic substances, Magnetization M, Hysteresis, the B-H curve, electromagnet, NMR, CD, ORD.

UNIT IV: Advanced Physics

- Introduction to X-Rays: Introduction, Production of X-rays, X-ray diffraction (XRD) and its biological applications. Introduction to the crystal structure, Unit cell, seven crystal systems.
- Plank's Quantum Theory, Properties of Photon, Photoelectric effect, de Broglie's hypothesis, Heisenberg's Uncertainty principle. Fabrication of organic solar cell.

REFERENCE BOOKS:

1. Physical biochemistry, David Freifelder, Application to biochemistry and molecular Biology, 2nd Edition, W.H. Freeman.
2. Engineering physics by R.K. Gaur and S.L.Gupta, Dhanpat Rai Publication.
3. Element of spectroscopy by S.L.L Gupta, V. Kumar.
4. Instrumental method of chemical analysis by Gurdeep R. Catwal and And Shyam Anand, Himaliya Publishing House.
5. Physical Biochemistry Wilson and Walker.
6. Microcopy and Micro techniques, R. Marimuthu.
7. Optics by Ajoy Gathok, Tata McGraw-Hill Education India.
8. Principles of Instrumental Analysis by Douglas A Skoog.
9. Biophysical Chemistry (Principles and Techniques) by Upadhaya, Upadhaya and Nath.

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PS02AIGB01: Environmental Science

Course Objectives:

The major objective of this paper is to develop clear understanding of various aspects of environment which includes ecosystem, biodiversity, conservation of biodiversity, Indian hotspots, endangered flora and fauna of India. It also develops an attitude of concern for the environment and acquiring skills to help the concerned individuals in identifying and solving environmental problems.

Learning Outcomes:

At the end of this course, the student will be able to:

1. Explain the ecological interconnectedness of life on earth by tracing energy and nutrient flow through the environment.
2. Understand biodiversity, threats to it and modern environmental concept like how to conserve biodiversity.
3. Understand the importance of environmental issues and problems at local, national and international levels.

UNIT I: Introduction to environmental studies and Ecosystems

- Scope and importance of environmental science.
- What is an ecosystem? Structure and function of ecosystem; Ecological pyramids.
- Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems: (a) Forest ecosystem (b) Grassland ecosystem (c) Desert ecosystem (d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

UNIT II: Biodiversity and Conservation

- Levels of biological diversity: genetic, species and ecosystem diversity
- Biogeographic zones of India; Biodiversity patterns and global biodiversity hot spots
- India as a mega-biodiversity nation;
- Endangered and endemic species of India
- Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions
- Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity.

REFERENCE BOOKS:

1. Ecology - Principles and Applications by J.L. Chapman & M.J. Reiss. (2008) (2nd Ed.) Cambridge University Press, U.K. (ISBN: 978-0-521-68920-5)
2. Ecology and Environment by P.D. Sharma. (2010). (10th Ed.) Rastogi Publications, Meerut (India). (ISBN: 978-81-7133-905-1)
3. Elements of Ecology by Thomas Smith & Robert Smith. (2007) (6th Ed.) Dorling Kindersley Press. (South Asia). (ISBN: 81-317-1557-4)
4. Fundamentals of Ecology by Eugene Odum & Gray Barrett. (2009) (5th Ed.) Cengage Learning & Nelson Education Press. (ISBN: 978-81-315-0020-0)
5. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. Principles of Conservation Biology. Sunderland: Sinauer Associates, 2006.
6. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. Environment. 8th edition. John Wiley & Sons.
7. Rosencranz, A., Divan, S., & Noble, M. L. 2001. Environmental law and policy in India. Tripathi 1992.
8. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.

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PS02CIGB04: Practicals based on PS02CIGB01 and PS02CIGB02

PRACTICALS:

1. Structure and working of microscopes (Simple microscope, Compound microscope)
2. Structure of a plant cell (through chart/model)
3. Structure of animal cell (through chart/model)
4. Observation of Prokaryotic and Eukaryotic cells (plant and animal cells)
5. Preparation of Buccal smear and Identification of Barr Body
6. Localization of chloroplast
7. Localization of lipids
8. Structure of cell organelles adopting preparations/charts/models
    - Mitochondria
    - Chloroplast
    - Ribosomes
    - Endoplasmic reticulum
    - Nucleus

8. Mitosis–Squash preparation of Onion root-tip
9. Meiosis-Squash preparation of anther lobes
10. Estimation of protein by Folin-Lowry method.
11. Estimation of RNA by orcinol method.
12. Estimation of total sugar by Cole’s method.
13. Estimation of reducing sugar by Benedict’s method.
14. Estimation of SGOT by enzymatic method.
15. Estimation of SGPT by enzymatic method.
16. Separation of amino acid by TLC method

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PS02CIBS05: Practicals based on PS02CIGB03 and PS02EIGB01

PRACTICALS:

1. Introduction of media and its constituents for microbial growth.
2. Different methods for isolation and maintenance of microorganisms.
3. Isolation of microbes using differential media.
4. To study and plot the growth curve of *E. coli* using spectrophotometric method and to calculate specific growth rate and generation time.
5. To study and plot the growth curve of *Aspergillus niger* by radial growth measurements.
6. To study the effect of temperature of *Aspergillus niger* by dry weight method.
7. Demonstration of the thermal death time and decimal reduction time of *E. coli*.
8. Isolation of Photosynthetic bacteria.
9. Preservation of bacterial cultures.
10. Dispersive power of the prism.
11. Resolving power of prism'
12. Newton's ring
13. Michelson's interferometer
14. Wavelength of sodium light using a plane diffracting grating.
15. Resolving power of grating
16. Cardinal points of a given optical system\
17. M_1 and M_2 by vibration magnetometer.
18. B_H and M by deflection and vibration magnetometer.
19. Determination of λmax of given dye.

Course Credit Scheme

Semester III

Type of course	Course Code	Name of Course	T/P	Credit	Exam Duration	Component of Marks		
						Internal	**External**	**Total**
						Total/Passing	**Total/Passing**	**Total/Passing**
Core -1	PS03CIGB01	Plant Physiology	T	4	3 hrs	30/10	70/28	100/40
Core -2	PS03CIGB02	Genetics	T	4	3 hrs	30/10	70/28	100/40
Core -3	PS03CIGB03	DNA structure function and repair	T	4	3 hrs	30/10	70/28	100/40
Elective -1	PS03EIGB01	Bioinstrumentation	T	4	3 hrs	30/10	70/28	100/40
	PS03CIGB04	Practicals based on PS03CIGB01 and PS03CIGB02	P	4	3 hrs	30/10	70/28	100/40
	PS03CIGB05	Practicals based on PS03CIGB03 and PS03EIGB01	P	4	3 hrs	30/10	70/28	100/40
Skill Enhancement	PS03SIGB01	Introduction to Computers	T	2	2 hrs	15/05	35/14	50/20
Viva-Voce	PS03VIGB01	Comprehensive Viva-Voce	V	1			20/50	20/50
	Total Credit			**27**				

Course Credit Scheme

Semester IV

Type of course	Course Code	Name of Course	T/P	Credit	Exam Duration	Component of Marks		
						Internal	**External**	**Total**
						Total/Passing	**Total/Passing**	**Total/Passing**
Core -1	PS04CIGB01	Gene expression and regulation	T	4	3 hrs	30/10	70/28	100/40
Core -2	PS04CIGB02	Animal Physiology	T	4	3 hrs	30/10	70/28	100/40
Core -3	PS04CIGB03	Medical Genetics	T	4	3 hrs	30/10	70/28	100/40
Elective -1	PS04EIGB01	Developmental Biology	T	4	3 hrs	30/10	70/28	100/40
	PS04CIGB04	Practicals based on PS04CIGB01 and PS04CIGB02	P	4	3 hrs	30/10	70/28	100/40
	PS04CIGB05	Practicals based on PS04CIGB03 and PS04EIGB01	P	4	3 hrs	30/10	70/28	100/40
Skill Enhancement	PS04SIGB01	Basic Bioinformatics	T	2	2 hrs	15/05	35/14	50/20
Viva-Voce	PS04VIGB01	Comprehensive Viva-Voce	V	1			20/50	20/50
	Total Credit			**27**				

Course Credit Scheme

Semester V

Type of course	Course Code	Name of Course	T/P	Credit	Exam Duration	Component of Marks		
						Internal	**External**	**Total**
						Total/Passing	**Total/Passing**	**Total/Passing**
Core -1	PS05CIGB01	Immunology	T	4	3 hrs	30/10	70/28	100/40
Core -2	PS05CIGB02	Genetic Engineering	T	4	3 hrs	30/10	70/28	100/40
Core -3	PS05EIGB03	Fermentation Technology	T	4	3 hrs	30/10	70/28	100/40
Elective -1	PS05EIGB01	Biostatistics	T	4	3 hrs	15/05	35/14	50/20
	PS05CIGB04	Practicals based on PS05CIGB01 and PS05CIGB02	P	4	3 hrs	30/10	70/28	100/40
	PS05CIGB05	Practicals based on PS05EIGB03 and PS05EIGB01	P	4	3 hrs	30/10	70/28	100/40
Viva-Voce	PS05VIGB01	Comprehensive Viva-Voce	V	1			20/50	20/50
	Total Credit			**25**				

Course Credit Scheme

Semester VI

Type of course	Course Code	Name of Course	T/P	Credit	Exam Duration	Component of Marks		
						Internal	**External**	**Total**
						Total/Passing	**Total/Passing**	**Total/Passing**
Core -1	PS06CIGB01	rDNA Technology	T	3	3 hrs	30/10	70/28	100/40
Core -2	PS06CIGB02	Enzymology	T	3	3 hrs	30/10	70/28	100/40
Core -3	PS06EIGB03	Animal Cell Culture	T	3	3 hrs	30/10	70/28	100/40
Elective -1	PS06EIGB01	Plant Tissue Culture	T	3	3 hrs	15/05	35/14	50/20
	PS06CIGB04	Practicals based on PS06CIGB01 and PS06CIGB02	P	3	3 hrs	30/10	70/28	100/40
	PS06CIGB05	Practicals based on PS06CIGB03 and PS06EIGB01	P	3	3 hrs	30/10	70/28	100/40
Viva-Voce	PS06VIGB01	Comprehensive Viva-Voce	V	1			20/50	20/50
	Total Credit			**25**				