

**Under- Graduate Programme
in Biotechnology**

**Courses of study, Schemes of Examinations
& Syllabi**
(Choice Based Credit System)



DEPARTMENT OF BIOTECHNOLOGY & BIOINFORMATICS

BISHOP HEBER COLLEGE (Autonomous)
(Reaccredited with 'A' Grade (CGPA – 3.58/4.0) by the NAAC &
Identified as College of Excellence by the UGC)
DST – FIST Sponsored College &
DBT Star College
TIRUCHIRAPPALLI – 620 017
TAMIL NADU, INDIA

2016 – 2017

Under – Graduate Programme in Biotechnology

Structure of the Curriculum

Parts of the Curriculum	No. of Courses	Credits
Part – I : Language	4	12
Part – II : English	4	12
Part – III		
Major		
Core	9	49
Core Practical	6	12
Elective	3	15
Allied		
Allied (Microbiology)	3	11
Allied (Chemistry)	3	10
Group Project	1	2
Part – IV		
SBEC	3	6
NMEC	2	4
VLOC	1	2
Env. Studies	1	2
SBC	1	1
Part – V		
Extension Activities	1	1
Gender Studies	1	1
Total	43	140

B.Sc. Biotechnology – Programme Description
(For the students admitted from the year 2016 onwards)

Se m	part	Course	Course code	Course title	Pre requisites	Hrs./ week	Credits	Marks		
								CIA	ESA	Total
I	I	Tamil I/*	U15TM1L1	செய்யுள், இலக்கிய வரலாறு, உரைநடை, மொழிப்பயிற்சியும் படைப்பாக்கமும்		6	3	25	75	100
	II	English I	U16EGNL1	English Communication Skills-I		6	3	40	60	100
	III	Core I	U16BT 101	Cell Biology		4	4	25	75	100
		Core Prac. I	U16BT 1P1	Cell Biology Lab		3	2	40	60	100
		Allied I	U16BT 1Y1	Fundamentals of Microbiology		4	4	25	75	100
		Allied Prac. I	U16BT YP1	Fundamentals and Applied Microbiology Lab		3	--	--	--	--
	IV	Env. Stud	U16EST 11	Environmental studies		2	2	25	75	100
		VLOC	U14VL1:1/ U14VL1:2	Value Education (RI/MI)		2	2	25	75	100
II	I	Tamil II/*	U15TM2L2	செய்யுள், இலக்கிய வரலாறு, சிறுகதைத்திரட்டு, மொழிப்பயிற்சி & படைப்பாக்கம்		6	3	25	75	100
	II	English II	U16EGNL2	English Communication Skills –II		6	3	40	60	100
	III	Core II	U16BT 202	Biochemistry		6	6	25	75	100
		Core Prac. II	U16BT 2P1	Biochemistry Lab		3	2	40	60	100
		Allied II	U16BT 2Y2	Applied Microbiology	U16BT 1Y1	4	4	25	75	100
		Allied prac. I	U16BT YP1	Fundamentals and Applied Microbiology Lab		3	3	40	60	100
	IV	SBEC I	U16BT 2S1	Basics of Bioinformatics		2	2	25	75	100
III	I	Tamil III/*	U15TM3L3	செய்யுள் - காப்பியங்கள், இலக்கிய வரலாறு, நாவல், மொழிப்பயிற்சி		6	3	25	75	100
	II	English III	U16EGNL3	English for Competitive Examinations		6	3	40	60	100
	III	Core III	U16BT 303	Genetics		6	5	25	75	100
		Core Prac. III	U16BT 3P1	Genetics Lab		3	2	40	60	100
		Allied III	U16CHB33	Basics of Chemistry		4	4	25	75	100
		Allied Prac. II	U16CHYP2	Volumetric and Organic analysis		3	--	--	--	--
	IV	NMEC I		<i>To be selected from the courses offered by other disciplines</i>		2	2	25/ 40	75/ 60	100

Sem	part	Course	Course code	Course title	Pre requisites	Hrs./ week	Credits	Marks		
								CIA	ESA	Total
IV	I	Tamil IV/*	U15TM4L4	செய்யுள் - நாடகம், இலக்கிய வரலாறு, மொழிப்பயிற்சி		5	3	25	75	100
	II	English IV	U16EGNL4	English through Literature		5	3	40	60	100
	III	Core IV	U16BT404	Basics of Immunology		6	6	25	75	100
		Core prac. IV	U16BT4P4	Basics of ImmunologyLab		3	2	40	60	100
		Allied IV	U16CHB44	Chemistryfor Biotechnology	U16BT202	4	3	25	75	100
		Allied Prac. II	U16CHYP2	Volumetric and Organic analysis		3	3	40	60	100
	IV	NMEC II		<i>To be selected from courses offered by other departments</i>		2	2	25/40	75/60	100
		SBC	U16LFS41	Life Skills		2	1	100	--	100
V	V	Extension Activities	U16ETA41				1	-	-	-
	III	Core V	U16BT505	Molecular Biology	U16BT101	6	6	25	75	100
		Core VI	U16BT506	Genetic Engineering	U16BT303	6	6	25	75	100
		Core Prac. V	U16BT5P5	Molecular Biology & Genetic Engineering Lab		4	2	40	60	100
		Elective I	U16BT5:1/ U16BT5:2	Plant Physiology/Ecology		5	5	25	75	100
		Elective II	U16BT5:3/ U16BT5:4	Developmental Biology/Basics of evolution		5	5	25	75	100
		SBEC II	U16BT5S2	Basics of Biostatistics		2	2	25	75	100
		SBEC III	U16BT5S3	Food Biotechnology		2	2	25	75	100
VI	III	Core VII	U16BT607	Industrial Biotechnology		6	6	25	75	100
		Core VIII	U16BT608	Animal Biotechnology		6	5	25	75	100
		Core IX	U16BT609	Plant Biotechnology		6	5	25	75	100
		Core Prac. VI	U16BT6P6	Industrial, Plant & Animal Biotechnologylab		3	2	40	60	100
		Elective III	U16BT6:1 U16BT6:2	Human physiology/ Fundamentals of Biology		5	5	25	75	100
		Group Project	U16BT6PJ	Project		4	2	--	--	100
	V		U16GST61	Gender studies			1	20	80	100
Total							140			4200

SBEC- Skill Based Elective Course
VLOC- Value added Life Oriented Course
CIA- Continuous Internal Assessment

NMEC- Non Major Elective Course
SBC- Skill Based Course
ESA- End Semester Assessment

*Other Languages	Hindi	Sanskrit	French		Hindi	Sanskrit	French
Semester I	U14HD1L1	U14SK1L1	U14RR1L1	Semester III	U14HD3L3	U14SK3L3	U14RR3L3
Semester II	U14HD2L2	U14SK2L2	U14FR2L2	Semester IV	U14HD4L4	U14SK4L4	U14FR4L4

NMEC offered by the department

Sem	part	Course	Course title	Course code	Pre-requisite	Hrs./ week	Cr ed its	Marks		
								CIA	ESA	Total
III	IV	NMEC –I	Basics of Biotechnology	U16BT3E1	-	2	2	25	75	100
IV	IV	NMEC –II	Applied Biotechnology	U16BT4E2	U16BT3E1	2	2	25	75	100

CORE I : CELL BIOLOGY

Semester : I
Credits : 4

Course Code : U16BT101
Total Hours : 60

Objectives

1. To know about the basic concepts of cell and their functions.
2. To understand the structural features organelles and the cellular mechanisms.

Unit - I

Discovery of Cell -Cell theory-Prokaryotes & Eukaryotes- Cellular Organelles: Structure, Organization and Functions of Plasma membrane, Nucleus & nucleolus, Mitochondria.

Unit - II

ER-rough and smooth, Ribosomes, Golgi apparatus, Plastids, Vacuoles, Lysosomes, Peroxisomes and Microbodies.

Unit - III

Cell junction. Overview, Structure and Organization of Micro tubules and Microfilaments-Cell movement.

Unit - IV

Cell Division: Mitosis and Meiosis-Cell Cycle-Regulation of Cell Cycle- Cell signaling- (adrenalin receptors, acetylcholine receptors, insulin receptors) Programmed Cell Death.

Unit - V

Transformation, Transduction and Conjugation, Recombination - Generalized and Site specific in bacteria- Holiday model. Oncogenic cells.

Text Book

1. Gupta. P.K., Cell and Molecular Biology, Rastogi Publications, India, 2005.

References

1. Harvey Lodish, Molecular Cell Biology, Fourth Edition, W.H.Freeman & Company, New York, 2002.
2. Geoffrey M Cooper, Robert E Hausman, The Cell - A Molecular Approach, Third Edition, ASM Press, Washington, 2004.
3. Gerald Karp, Cell and Molecular Biology, Third edition, John Wiley & Sons, New York, 2001.
4. Alberts, Essential Cell Biology : An Introduction to the Molecular Biology of the Cell, Second edition, Garland Science Taylor & Francis Group, New York, 2003.
5. David Freifelder, Essentials of molecular biology, Narosa Publishing House, New Delhi, 1990.

ALLIED I : FUNDAMENTALS OF MICROBIOLOGY

Semester : I
Credits : 4

Course Code : U16BT1Y1
Total Hours : 60

Objectives

1. To understand the origin of microbes and their contribution to life.
2. To know the use of microscopes and sterilization techniques.
3. To know the contributions of great scientists towards the growth of microbiology.
4. To know the concepts and fundamentals of microbes.

Unit - I

Definition and scope of microbiology – History of microbiology. The origin of microbial life – Theory of spontaneous generation. Contributions of Leeuwenhoek, Pasteur, Robert Koch. Characteristic features of bacteria, viruses, fungi, algae and protozoan.

Unit - II

Microscopy – Simple, compound, Dark field, Phase contrast, Fluorescence & Electron Microscopy. Microbial evolution and diversity – Binomial nomenclature of Microbes. Classification of three kingdom, five kingdom concept and domain concept.

Unit - III

Microbial growth – Growth curve measurement of microbial growth – Measurement of cell number, Measurement of cell mass. Factors affecting growth.

Unit - IV

Anatomy & Physiology of bacteria –Structure of Cell wall, Cytoplasmic membrane, Cilia, Flagella, Capsule, Sporulation and types of reproduction.

Unit - V

Sterilization – Methods of sterilization and Disinfection. Antimicrobial chemotherapy – Tests for sensitivity to Antimicrobial agents.

Text Books

1. Pelczar Jr. M.J, Chan. E.C.S and Kreig.N.R, Microbiology, 5th Edition, McGraw Hill Inc, New York, 2006.
2. Dubey, R.C. and Maheswari, D.K, A Text Book of Microbiology, S. Chand & Company Ltd., New Delhi, 2005.

References

1. Gerard J. Tortora, Berdell R. Funke, Christine & L. Case, Microbiology an Introduction. Benjamin Cummings, USA, 2001.
2. Danial Lim, Microbiology, McGraw-Hill Companies, New York, 1998.
3. Stainer, R.Y., Ingraham, J.L., Wheelis, M.L and Painter, P.R, General Microbiology, Mac Milan Education Ltd. London, 1986.

CORE PRACTICAL I : CELL BIOLOGY LAB

Semester : I
Credits : 2

Course Code : U16BT1P1
Total Hours : 45

Objectives

1. To develop skills in basics of cell biology.
 2. To analyze the structural features of cells of plants and animals.
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1. Mitosis in onion root tips.
 2. Barr body staining from buccal epithelial cells.
 3. Preparation of giant /polytene chromosomes from chironomous larvae.
 4. DNA isolation from buccal cells.
 5. Cell Staining – Cytochemical Methods for Demonstration of Cellular and sub-cellular components.

References

1. Rajan, S, Experimental Procedures in Life Sciences, Anjanaa Book House, 2010.
2. Karp, G, Cell and Molecular Biology: Concepts and Experiments, 6th Edition, John Wiley & Sons. Inc., 2010.

ALLIED PRACTICAL I : FUNDAMENTALS AND APPLIED MICROBIOLOGY LAB

Semester : I/II
Credits : 3

Course Code : U16BTYP1
Total Hours : 45

Objectives

1. To understand the basic laboratory techniques in Microbiology.
2. To know the cultivation techniques of microbial culture.
1. Sterilization principle and methods-moist heat - dry heat and filtration methods.
2. Media preparation: Liquid media, Solid media, Agar deep, Agar slants, Agar plates.
3. Pure culture technique: Streak plate, pour plate, spread plate, serial dilution.
4. Cultural characteristics of microorganisms: Growth on different media, growth characteristics and description.
5. Motility demonstration: Hanging drop preparation.
6. Simple staining.
7. Gram's staining.

APPLIED MICROBIOLOGY LAB

1. Antibiotic sensitivity testing: Disc diffusion test – Quality control with standards strains.
2. Biochemical characteristics: IMViC test.
3. Isolation of Rhizobium sp.
4. Isolation of Cellulolytic organisms.
5. Isolation of Lactobacillus sp.
6. Fungal staining.

References

1. Rajan, S, Experimental Procedures in Life Sciences, Anjanaa Book House, 2010.
2. Gunasekaran P, Lab Manual in Microbiology, New Age International Publications, 2007.

CORE II : BIOCHEMISTRY

Semester : II
Credits : 6

Course Code : U16BT202
Total Hours : 90

Objectives

1. To comprehend the structure and properties of biomolecules and their biochemical reactions.
2. To understand the basic metabolism, reaction pathway and the kinetics of chemical reaction.

Unit - I

Basic chemistry in life science: Structure and properties of water. Measurement of pH, determination of pK_a (Henderson Harselbalch equation). Buffers, buffer actions (strong & weak acids) and biological buffer systems.

Unit - II

Carbohydrates: Classification, properties, structure and biological functions of monosaccharides (glucose, fructose) Oligo saccharides (lactose, galactose) and polysaccharides (glycogen, starch, cellulose, agarose).

Unit - III

Amino acids & Proteins: Structure, classification, physical and chemical properties. Proteins: classification and Biological importance. Primary structure, Secondary, tertiary and quaternary structure- forces stabilizing the structure of proteins. Denaturation, precipitation, separation by solubility differences- isoelectric pH.

Unit - IV

Lipids and Vitamins: Nomenclature, classification and Biological significance of simple lipids (triglycerides, homolipids) compound lipids (heterolipids) derived lipids, glycerol and fatty acids. Vitamins- Source, structure, biological role, daily requirement and deficiency manifestation of vitamin A, B, C, D, E and K.

Unit - V

Nucleic acids & Enzymes: Types of DNA and RNA. Composition and structure- their biological importance hydrolysis of nucleic acids by acids, bases and enzymes. Denaturation and renaturation. Enzymes: Nomenclature and classification, enzyme activity; Factors affecting activity, enzyme kinetics –Michaelis Menton equation.

Text Book

1. Jain, J.L., Sunjay Jain and Nitin Jain, Fundamentals of Biochemistry, Fifth Edition, S. Chand and Company Ltd, New Delhi, 2010.

References

1. Berg, J.M., Tymoczko, J.L., Stryer, L., Biochemistry, 7th Edition, W.H.Freeman, USA, 2010.
2. Campbell, M.K., Farrell, S.O, Biochemistry, 6th Edition, Brooks Cole Publishing Company, USA, 2007.
3. Mathews, C. K., Van Holde, K.E., Ahern, K.G, Biochemistry, 3rd Edition, Addison Wesley, USA, 2000.
4. Voet, D., Voet, J.G. and Pratt, C.W, Principles of Biochemistry, 3rd Edition, John Wiley & Sons, USA, 2008.
5. Zubay, G.L, Biochemistry, 7th Edition, William C Brown Publishers, New York, 1995.
6. Nelson, D.L., Cox, M.M, Lehninger, Principles of Biochemistry, 5th Edition, W.H Freeman and Company, USA, 2008.

ALLIED II : APPLIED MICROBIOLOGY

Semester : II
Credits : 4

Course Code : U16BT2Y2
Total Hours : 60

Objectives

1. To know the principles of Microbiology and to understand the applications of microbes in different fields.
2. To know the concepts of employing microbes in various commercial products.

Unit – I

Isolation and purification of Enzymes from microbes – Industrial enzymes: Important Enzymes – Application in food, leather, textile, paper, detergent, pharmaceutical industries – Role of transformed microorganism in Enzyme production.

Unit - II

Pharmaceuticals: Production of ethanol, antibiotics, amino acids, organic acids, vitamins by conventional and Recombinant organisms.

Unit - III

Agriculture: Biofertilizer, Bio-control of Microbial pathogens, Biopesticides plant promoters, Secondary metabolites.

Unit - IV

Waste recycling, Industrial effluent treatment – Dairy: Importance of microbes in dairy and Dairy products.

Unit - V

Microbial Disease- Bacterial (Cholera, Typhoid), Protozoan (Malaria), Viral disease (HIV), Fungal (Candidiasis), Zoonotic and Nosocomial infections.

Text Book

1. Chan E.C.S. and Noel R.K, Microbiology (Pelczar), An Application Based Approach, Tata McGraw Hill Education Private Limited, New Delhi, 2010.

References

1. Subba Rao, N.S, Soil Microorganism and plant growth, oxford and IBH publishing co.pvt. Ltd. 1995.
2. Frazier, W.C and Westhoff, D.C, Food microbiology, 4th edition. McGraw Hill NY, 1988.
3. Adams M.M. R and Moss M.O, Food microbiology, New International (P) Ltd. Publishers, 1995.
4. Alexander, Introduction to Soil Microbiology, John Wileyand Sons, 1997.

CORE PRACTICAL II : BIOCHEMISTRY LAB

Semester : II
Credits : 2

Course Code : U16BT2P1
Total Hours : 45

Objectives

1. To know the various qualitative and quantitative methods of analysis of biomolecules
 2. To develop hands-on skills in bioanalytical techniques.
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1. Preparation of solutions: Normality, Molarity, Molality and Percentage solutions.
 2. pH metry -Determination of pH from unknown biological samples using pH paper and pH meter.
 3. Colorimetry – Preparation of standard curve and estimation of the concentration of solute in an unknown sample
 4. Estimation of biomolecules: 1.Sugars –Anthrone method 2. Proteins –Bradford method 3. Lipids- Zak's method
 5. Chromatography –Paper Chromatography - Determining the R_f value of aminoacids and its separation- Thin layer Chromatography- Separation of Plant pigments
 6. Demonstration of gel electrophoresis. (PAGE/AGE)

References

1. Arun Rastogi, Mathur, N.B.L Mathur, N.B. L, An Introduction to Practical Biochemistry, Anmol Publications, India, 2010.
2. Joshi, R.A. and Saraswat, M, A Textbook of Practical Biochemistry. Jain Publishers private limited, India, 2002.
3. Malhotra, V.K, Practical Biochemistry for Students, Jaypee Brothers Publishers, India, 2003.
4. Rajan, S, Experimental Procedures in Life Sciences, Anjanaa Book House, 2010.
5. B Sashidhar Rao and Vijay Deshpande, Experimental Biochemistry, I K International Publishing House, 2009.

SBEC I : BASICS OF BIOINFORMATICS

Semester : II
Credits : 2

Course Code : U16BT2S1
Total Hours : 30

Objectives

1. To understand the basic concepts and applications of Bioinformatics.
2. To comprehend the Bioinformatics databases and their applications.
3. To know the applications of genomics and proteomics.

Unit - I

Introduction to Bioinformatics - History, scope and applications. Research areas of Bioinformatics, Bioinformatics industries and Institutions in India & Worldwide.

Unit - II

Introduction of Biological Databases; Nucleic acid databases (NCBI, DDBJ, and EMBL). Protein databases (Primary, Composite, and Secondary). Specialized Genome databases: (SGD, TIGR, and ACeDB). Structure databases (CATH, SCOP, and PDBsum).

Unit - III

Introduction of sequence alignment; Pairwise Alignment, Local and Global Alignment concept, Needleman wunch method and Smith waterman method, Fasta and Blast, Multiple Sequence Alignment-Clustal W.

Unit - IV

Basics of Proteins- Different types of protein structures: Primary, Secondary, Tertiary. Protein structure visualization tools – Rasmol, SPDBv, PyMol,. Tools and Server for protein structure prediction – Phyre2, I-TASSER, SWISS-Model, Modeller.

Unit - V

Basics and parameters of drug – ADMET properties; Need for developing new drugs: Molecular modification of lead compounds; Active site determination of enzymes; Basics of Docking studies; Types, Steps and tools used for drug designing.

Text Books

1. Harshawardhan, P, Bioinformatics principles and application, Tata McGraw Hill Publishers, New Delhi, 2005.
2. Lesk, A.M, Introduction to Bioinformatics, Oxford University Press, New Delhi, 2003.
3. Sundarajan. S. and Balaji, R, Introduction of Bioinformatics, Himalaya Publishing House, Mumbai, 2005.

References

1. Attwood, T.K. and Parry Smith, D.J, Introduction to Bioinformatics, Pearson Education Ltd., New Delhi, 2004.
2. Manikand Vijayaraj, Bioinformatics for beginners, Kalaikathir Achchagam, Coimbatore, 2002.
3. Mount, D.W, Bioinformatics Sequence and Genome Analysis, Second Edition, CBS Publishers, New Delhi, 2005.
4. Westhead, D.R, Parish, H.J. and Twyman, R.M, Bioinformatics, Viva Books Private Ltd., New Delhi, 2003.
5. Pennigton & Dunn, Proteomics, Viva books Publishers, New Delhi, 2002.
6. Andreas Baxevanis and Francis Ouellette, Bioinformatics - A practical guide to the analysis of genes & protein, Third Edition, Wiley-Blackwell, 2004

CORE III : GENETICS

Semester : III
Credits : 5

Course Code : U16BT303
Total Hours : 90

Objectives

1. To understand the concept of genes and their behavior.
2. To know the basics of genetics and Gene interaction and Chromosomal variation.

Unit - I

History of Genetics - Mendelian Principles, Segregation, Independent Assortment, Dominance relations, Multiple alleles, Incomplete dominance, Over dominance.

Unit - II

Gene interaction, Epistasis, lethality and lethal genes, Sex determination and sex linkage in diploids, linkage and crossing over, gene mapping. Chromosomal theory of inheritance, maternal effects.

Unit - III

Chromosomal variation in number, Changes in Chromosomal structure, Chromosomal aberrations, Genetics of Hemoglobin, Transposable elements in prokaryotes and eukaryotes.

Unit - IV

Fine structure of Gene, cistron and recon, Structure of Eukaryotic gene, Experimental evidence for DNA as the genetic material, cytoplasmic genetic systems- mitochondria and chloroplast DNA, Plasmids- F, R and Col plasmids. Relationship between genes and polypeptides.

Unit - V

Population genetics, calculating gene frequency, factors affecting gene frequency. Genetic control of development in Drosophila and Arabidopsis - Genetic drift, Shift, Pedigree analysis and genetic counseling.

Text Book

1. Sambamurty, A.V.S.S, Molecular Genetics, First edition, Alpha Science International Ltd, 2007.

References

1. Hancock, J.T, Molecular Genetics, Viva Books Private Limited, 2008.
2. Klug, W.S., Cummings, M.R., Spencer, C.A., Palladino, M.A, Concepts of Genetics, Pearson Education, 2011.
3. Griffiths, A.J.F, Introduction to Genetic Analysis, W.H. Freeman, 2008.
4. Hartl D, L. Jones E.W, Genetics Analysis of Genes and Genomes, Seventh edition, Jones and Bartlett Publishers, 2009.

CORE PRACTICAL III : GENETICS LAB

Semester : III
Credits : 2

Course Code : U16BT3P1
Total Hours : 45

Objectives

1. To identify chromosomes.
2. To understand the laws of genetics.

1. Drosophila – Morphology, Section culture and maintenance.
2. Identification of Mutants—Physical and Chemical Methods.
3. Experiments to determine Mendel's law.
4. Monohybrid and dihybrid cross using plants.
5. Human karyotype - demonstration.
6. Sex chromatin (buccal smear) identification.

References

1. Sambrook, J., Russell, D.W, Molecular Cloning: A Laboratory Manual, Third Edition, Cold Spring Harbor Laboratory Press, 2001.
2. Bisen, P.S, Laboratory Protocols in Applied Life Sciences, CRC Press, 2014.

ALLIED III : BASICS OF CHEMISTRY

Semester : III
Credits : 4

Course Code : U16CHB33
Total Hours : 75

Objectives

1. To understand the basics concepts of bonding in chemical compounds.
2. To know about the types and characteristics of reactions in organic chemistry.
3. To understand the mole concept and their applications to solutions.

UNIT – I

Chemical bonding: Ionic bond- Nature of Ionic bond Covalent bond , Coordinate Bond – Nature of coordinate bond, Hydrogen bonding-Theory of Hydrogen bonding- one example for inter and intra molecular hydrogen bonding- consequences of hydrogen bonding. Vander Waals forces of interaction.

UNIT - II

Introduction to organic chemistry: types of reactions-addition reactions, substitution and elimination reactions. Aliphatic compounds-inductive effect; aromatic compounds-Resonance effect. Acidic character of phenols; basic character of aniline. Heterocyclic-five membered and six membered ring. Preparation, Structure, acidic and basic character of pyrrole, furan and pyridine.

UNIT - III

Solutions: Mole Concept -Normality – Molarity – parts per million - Simple problems on concentration terms Primary and secondary standards and preparation of standard solutions and simple problems. Acids and bases: Arrhenius, Lowry- Bronsted, Lewis concepts- strong and weak acids and Bases.-pH, pK_a, pK_b of buffer solutions. Henderson – Hassel Balch equation.

UNIT - IV

Chemical kinetics: rate of reaction, order, molecularity, first order rate law, half lifeperiod And derivation of the first order equation – Catalysis – homogeneous and heterogeneous catalysis, promoters and poisons, applications.

UNIT - V

Colloids :(Colloids – Types with examples – classification based on affinity (lyophilic & Lyophobic). Optical and Kinetic properties of colloids – electrophoresis- electroosmosis – peptization – Coagulation. Applications of colloids.

References

1. B.K. Sharma, Industrial Chemistry, Goel Publishing Co, 1997.
2. Puri B.R., Sharma L. R., Kalia K.K, Principles of Inorganic Chemistry, 23rd edition, ShobanLal Nagin Chand & Co, New Delhi, 1993.
3. S. Lakshmi, Pharmaceutical Chemistry, Goel Publishing Co, 1997.
4. Bahl B. S and ArunBahl, Organic Chemistry, 12th edition, Sultan Chand and Co., New Delhi, 1997.
5. United States Pharmacopeia Dispensing Information's, USPDI, Rockvilla, Maryland, 1981.
6. The Indian pharmacopoeia, 3rd edition, Volume 2, Quality Specifications, World Health Organization, 1981.
7. Thiagarajan V, Pharmaceutical Chemistry, KC S. Desikan and Co., Chennai, 1986.
8. Jayashree Gosh, Text Book of Pharmaceutical Chemistry, S.Chand, New Delhi, 2008.

ALLIED CHEMISTRY PRACTICAL – II : VOLUMETRIC AND ORGANIC ANALYSIS

Semester : III & IV
Credits : 3

Course Code : U16CHYP2
Total Hours : 60

Objectives

1. To understand the basic principles and different types of volumetric analysis.
2. To identify the organic compounds.
3. To know the difference between qualitative and quantitative analysis

I. VOLUMETRIC ANALYSIS

- a) Acidimetry and Alkalimetry
 - i) Estimation of hydrochloric acid
 - ii) Estimation of sodium hydroxide
- b) Permanganometry
 - iii) Estimation of oxalic acid using KMnO_4
 - iv) Estimation of ferrous sulphate using KMnO_4
- c. Demonstrative Experiments
 - i) Estimation of acid content in citrus fruits
 - ii) Determination of total hardness of water
 - iii) Determination of calcium in commercial milk powder by EDTA method
 - iv) Determination of dissolved oxygen in water (Winkler's Method)

II. ORGANIC ANALYSIS

- a) Analysis of organic compounds with the following
 - (i) tests for Aromatic/ Aliphatic,
 - (ii) saturated/ unsaturated
 - (iii) solubility in common solvents, and
 - (iv) presence of nitrogen

Test for Functional groups

- i) Carbohydrate
- ii) Diamide
- iii) Aldehyde
- iv) Ketone
- v) Acid
- vi) Amine

b) Demonstration

4. Preparation of Buffer solution
5. Determination of pH using pH meter
6. Preparation of standard solution (Molar, ppm & Normal)

Reference

1. V.Venkateswaran, R.Veerasamy , A.R. Kulandaivelu, Basic Principles of Practical Chemistry, Sultan Chand & Sons , New Delhi, 1997.

CORE IV : BASICS OF IMMUNOLOGY

Semester : IV
Credits : 6

Course Code : U16BT404
Total Hours : 90

Objectives

1. To understand the immune system and their significance.
2. To know the mechanism of immune cells and organs.
3. To understand pathology and clinical aspects of Immunology.

Unit - I

History and scope of Immunology: Historical perspective of Immunology, Early theories of Immunology, Types of Immunity Innate, Adaptive (cell mediated and humoral). Passive: Artificial and Natural Immunity, Active: Artificial and Natural Immunity

Unit - II

Immune system and its mechanism: Primary and Secondary organs of immune system –structure and function ,Hematopoiesis- Significance -Origin and differentiation of lymphocytes: T-cells, B-cells, myeloid cells, antigen presenting cells, cell mediated subset of T-Cells, helper and suppressor cells, natural killer cells.

Unit - III

Cellular and molecular interactions: Antigens: Structure and properties - Immunogenicity vs antigenicity, factors affecting antigenicity, epitopes, haptens, adjuvants and vaccines – Types and vaccination schedule. Immunoglobulins: Structure, types, distribution and biological functions. Antigen antibody interactions: principle, methods and applications of precipitation and agglutination.

Unit - IV

Immune response: Recognition of antigen: MHC, antigen processing and presentation, T-cell and B - cell activation Cell mediated-Mechanism and target cell lysis , Humoral response, antibody dependent cell mediated cytotoxicity, Complements - Classical and Alternative pathways, role in immunity.

Unit - V

Clinical Immunology:Organ transplantation- types of graft, mechanism of allograft rejection,Immunosuppression,Allergic reactions- Immunology & types of hypersensitivity. Auto antibodies – Autoimmune diseases and examples.Immunological Techniques in Clinical Diagnosis: Widaltest, Pregnancytest, ELISA

Text Books

1. Kuby, J, Immunology, Sixth edition, W.H.Freeman and Company, New York, 2007.

2. Abbas AK, Lichtman AH, Pillai S, Cellular and Molecular Immunology, 6th edition, Saunders Publication, Philadelphia, 2007.

References

1. E. Riet, Essential Immunology 12th Edition, Wiley & Blackwell, 2011.
2. Richard M. Hyde, Microbiology and Immunology, 3rd Edition, Springer Science & Business Media, 2012.
3. Brostoff J, Seaddin JK, Male D, Roitt IM, Clinical Immunology, 6th Edition, Gower Medical Publishing, 2002.
4. Paul, Fundamental of Immunology, 4th Edition, Lippencott Raven, 1999.
5. Janeway, Immunobiology, 4th Edition, J Current Biology publications, 1999.
6. D. M. Weir, John Stewart, Immunology, 8th Edition, Churchill Livingstone, 1997.
7. P.J.Delves, I S.J.Arfin, I D.R.Burton and I I.M.Roitt, Essential Immunotechnology, 12th Edition, Wiley & Blackwell, 2006.

ALLIED IV : CHEMISTRY FOR BIOTECHNOLOGY

Semester: IV
Credits: 3

Course Code : U16CHB44
Total Hours : 60

Objectives

1. To understand the role of chemistry in biological system
2. To know the impact of chemical processes and the direction of cellular reactions governed by thermodynamics.
3. To distinguish the mechanisms of transport of organic and inorganic chemical moiety in biological system

Unit - I

Adjustment of cells to diverse environments: water, salts, acidity, alkalinity, buffers, temperature (heat, cold, freezing) and pressure, radiation – adaptability of prokaryotic and eukaryotic cells.

Unit - II

Release of energy to cells: introduction to metabolism- oxidation, and reduction, reactions pathways, group transfer reactions ,pathways of oxidoreductions -glycolysis, krebs cycle, pentose shunt pathway, oxidative phosphorylation- Electron transport chain.

Unit - III

Direction of cellular reactions: Thermodynamics, free energy, second law of thermodynamics, energy storage, enzymes involved in cellular metabolism (hydrolases, oxidoreductase, NAD, FAD) and exchange role of enzymes.

Unit - IV

Kinectics and mechanisms of Transport : glucose transport, ATP –driven active transport(sodium potassium pump),ion- gradient driven active transport (sodium-glucose transport)transport across all membrane- pinocytosis, phagocytosis, Autophagy, permeability of water and salts, salt antagonism.

Unit - V

Metals of biological importance :Heme proteins -Binding of Oxygen by Myoglobin, Binding of Oxygen by Hemoglobin Iron – sulfur proteins-Rubredoxin and Ferredoxin. Magnesium in photosynthesis – Magnesium binding to ATP - Cobalt in vitamin B12 – Molybdenum in Nitrogen fixation.

Text Books

1. Berg, J.M., Tymoczko, J.L., Stryer, L, Biochemistry, 7th Edition, W.H.Freeman, USA, 2010.
2. Arthur C.Giese, Cell Physiology, 5th edition, Saunders company, 1979.

References

1. Campbell, M.K., Farrell, S.O, Biochemistry, 6th Edition, Brooks Cole Publishing Company, USA, 2007.
2. Mathews, C. K., Van Holde, K.E., Ahern, K.G, Biochemistry, 3rd Edition, Addison Wesley, USA, 2000.
3. Voet, D., Voet, J.G. and Pratt, C.W, Principles of Biochemistry, 3rd Edition, John Wiley & Sons, USA, 2008.
4. Zubay, G.L, Biochemistry, 7th Edition, William C Brown Publishers, New York, 1995.
5. Nelson, D.L., Cox, M.M, Lehninger, Principles of Biochemistry, 5th Edition, W.H Freeman and Company, USA, 2008.

CORE PRACTICAL IV: BASICS OF IMMUNOLOGY LAB

Semester : IV
Credits : 2

Course Code : U16BT4P4
Total Hours : 45

Objective

1. To understand the basic immunological techniques.
1. Preparation of serum from blood
2. To perform total WBC and RBC counting
3. Differential Leukocyte count
4. Agglutination reactions : blood grouping
5. Immunodiffusion. (Rocket)
6. Dot Elisa Assay
7. Demonstration: Preparation of Antibodies.
8. Demonstration: A preface to Immunization and bleeding techniques

References

1. Lesile Hudson, Frank C.Hay, Practical Immunology, 3rd edition, Blackwell Scientific Publication, 1989.
2. Peakman M, and Vergani D, Basic and Clinical Immunology, 2nd edition, Churchill Livingstone Publishers, Edinberg, 2009.
3. Richard C and Geiffrey S, Immunology, 6th edition, Wiley Blackwell Publications, 2009.
4. Murphy K, Travers P, Walport M, Janeway's Immunobiology, 7th edition, Garland Science Publishers, New York, 2008.

CORE V : MOLECULAR BIOLOGY

Semester : **V**
Credits : **6**

Course Code : **U16BT505**
Total Hours : **90**

Objectives

1. To understand the basic molecular concepts, Gene expression and regulation.
2. To know the general principles of gene organization and expression in both prokaryotic and eukaryotic organisms.

Unit - I

Structure of DNA and RNA- Composition, Types and Functions, Replication. Mechanisms - Enzymes involved in replication.

Unit - II

Mutation: Origin and Classification - Types- Molecular Mechanism of Mutation- Detection of DNA damage at molecular level, Ames test, cytogenetic analysis in mammalian cells- in vitro and in vivo- Host mediated assay-

Unit - III

DNA repair and recombination mechanisms. Transposons and transposable elements- Mechanism of transposition. Transcription and RNA processing: Transcription in Prokaryotes and Eukaryotes -Post transcriptional modifications.

Unit - IV

Genetic code and Translation: Features of genetic code -Deciphering of the codon- Translation in Prokaryotes and Eukaryotes- Post translation modifications- Protein targeting.

Unit - V

Cistron, muton and recon -exons and introns. Regulation of Gene expression: Regulation of gene expression in prokaryotes and eukaryotes -positive and negative control in prokaryotes- Operon models- Spatial and Temporal regulation of eukaryotic genes, mi RNA, siRNA, Micro-satellites.

Text Book

1. Gupta. P.K, Cell and Molecular biology, Rastogi Publications, India, 2005.

References

1. Alberts, B., Bray, D., Hopkin, K., Johnson, A. D., Johnson, A., Lewis, J., Raff, M., Roberts, K., Walter, P, Essential Cell Biology, 3rd Edition, Garland Science, USA, 2009.
2. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., Walter, P, Molecular Biology of the Cell, 5th Edition, Garland Science, USA, 2008.
3. Lodish, H. Berk, A., Matsudaira, P., Kaiser, C. A., Krieger, M., Scott, M.P. Lawrence Z., Darnell, J, Molecular Cell Biology, 5th Edition, W. H. Freeman, USA, 2003.
4. Rastogi, S.C, Cell and Molecular Biology, 3rd Edition, New Age International Publishers, India, 2012.
5. Sathyanarayana U, Biochemistry, 3rd Edition, New Central Book Agency(p) Ltd, 1999.
6. Karp, G, Cell and Molecular Biology: Concepts and Experiments, 5th Edition, John Wiley and Sons, USA, 2007.
7. Cooper, G.M., Hausman, R.E, The cell Molecular Approach, 5th Edition, American Society of Microbiology Press, USA, 2009.

CORE VI : GENETIC ENGINEERING

Semester : V
Credits : 6

Course Code : U16BT506
Total Hours : 90

Objectives

1. To understand the modern concept of Genetic Engineering and their applications.
2. To know about different areas of rDNA technology including DNA modifying enzymes, cloning strategies, analysis of expression and various modern techniques.

Unit – I

Enzymes in Recombinant Technology: Enzymes in Genetic engineering - Restriction endonucleases Type I & II, DNA polymerase, Polynucleotide kinase, Alkaline phosphatase, T4 DNA ligase, Terminal deoxynucleotidyl transferase, Reverse transcriptase.

Unit – II

Vector: Different kinds of vector- Cloning and expression vectors. Cloning vectors for E. coli-Bacterial artificial chromosome (BAC), Cloning vectors for Eukaryotes- Yeast shuttle vector, Yeast artificial chromosome, Phage life cycle- Viral vector, phage vector, phagemids, cosmids.

Unit – III

Molecular cloning: Cloning strategies. Cloning System for amplifying different sized fragments, Cloning System for producing single-stranded and mutagenized DNA. Methods of introduction DNA into the cell - Microinjection, lipofection, electroporation, calcium precipitation, DEAE and biolistic.

Unit – IV

Recombinant selection and screening - Construction of genomic libraries and cDNA Libraries. Principle of Nucleic acid hybridization assays, and microarrays.

Unit – V

Polymerase chain Reaction and DNA sequencing: Polymerase chain reaction (PCR): key concepts, Applications of PCR: Ligase chain reaction. DNA Finger printing, RFLP and RAPD. Sequencing (chemical degradation; chain termination and automated sequence).

Text Books

1. Brown, T.A, Gene Cloning and DNA analysis: An Introduction, 6th Edition, Wiley-Blackwell, USA, 2010.
2. Primrose, S.B. Twyman, R.M, Principles of Gene Manipulation, 7th Edition, Wiley-Blackwell, USA, 2006.
3. Jogdand, S.N, Gene biotechnology, Himalaya Publishing House, 2009.

References

1. Old, R.W and S.B. Primrose, Principles of Gene Manipulation: An Introduction to Genetic Engineering, Blackwell Scientific Publications, Oxford, 1996.
2. Glover, DM. and BD. Hames, DNA Cloning: A Practical Approach, IRL Press, Oxford, 1995.
3. Innis, M.A., D.H. Gelfand and J.J. Sninsky, PCR Strategies, Academic Press, San Diego, 1995.
4. Persing, D.H., K T.F Smith, F.C. Tenover and T.J.While, Diagnostic Molecular Microbiology, ASM Press, Washington D.C., 1993.
5. Watson J.D., Gilman M., Witkowski, J., and Zoller M, Recombinant DNA, Scientific American Books, New York, 1992.
6. Tvan R.S, Recombinant Gene Expression Protocols, Humana Press Inc., Tokowa, 1997.

CORE PRACTICAL V : MOLECULAR BIOLOGY AND GENETIC ENGINEERING LAB

Semester : V
Credits : 2

Course Code : U16BT5P5
Total Hours : 60

Objective

1. To learn Molecular Biology Techniques.
1. Isolation of plasmid DNA from *E.coli*.
2. Isolation of genomic DNA from animal tissue.
3. Isolation of buccal cell DNA.
4. Agarose gel electrophoresis of plasmid and genomic DNA.
5. Restriction digestion of DNA. - Single and double digestion*.
6. PCR amplification, RFLP*.
7. Southern blotting*
8. Ligation*.
9. Transformation of *E. coli* with plasmid DNA using CaCl₂ *.

* Practical by demonstration only.

References

1. Bisen, P.S, Laboratory Protocols in Applied Life Sciences, CRC Press, 2014.
2. Sambrook, J., Russell, D.W, Molecular Cloning: A Laboratory Manual, Third Edition Cold Spring Harbor Laboratory Press, 2001.

ELECTIVE I : PLANT PHYSIOLOGY

Semester : V
Credits : 5

Course Code : U16BT5:1
Total Hours : 75

Objectives

1. To know the functioning of plants.
2. To understand the plant metabolism.

Unit - I

Photosynthesis : Light harvesting complexes; mechanisms of electron transport; photoprotective mechanisms; CO₂ fixation-C₃, C₄ and CAM pathways.

Unit - II

Respiration and photorespiration : Citric acid cycle; plant mitochondrial electron transport and ATP synthesis; alternate oxidase; photorespiratory pathway.

Unit - III

Nitrogen metabolism: Nitrate and ammonium assimilation; amino acid biosynthesis.

Unit - IV

Solute transport and photo assimilate translocation: Uptake, transport and translocation of water, ions, solutes and macromolecules from soil, through cells, across membranes, through xylem and phloem; transpiration; mechanisms of loading and unloading of photo assimilates.

Unit - V

Stress physiology : Responses of plants to biotic (pathogen and insects) and abiotic (water, temperature and salt) stresses; mechanisms of resistance to biotic stress and tolerance to abiotic stress.

Text Books

1. Jain V.K, Fundamentals of Plant Physiology, 5th edition, S Chand & Co Ltd, New Delhi, 2000.
2. Salisbury, F. B. and Ross. E, Plant Physiology, Wadsworth, Belmont, California, USA, 1992.
3. Verma, S. K, Plant Physiology, S. Chand & Co., New Delhi, 1999.

References

1. Devlin, R. M. and Baker, Photosynthesis, Reinhold Affiliated East-West Press Pvt.Ltd, New Delhi, 1973.
2. Harold, F.M, The vital force; A study of bioenergetics, Freeman & Co., New York, 1986.
3. Hewitt, E.J. and Cutting, C.V, Nitrogen metabolism of plants, Academic Press, 1979.
4. Leopold, A. C, Plant Growth and Development, Tata McGraw Hill Publishing Co. Ltd., New Delhi, 1973.
5. Meyer, Anderson and Bonning, Introduction to Plant Physiology, D. VanNostrand, 1965.
6. Noggle, R. and Fritz, G. I, Introductory Plant Physiology, 2nd edition, Prentice Hall, New Delhi, 1989.

ELECTIVE I : ECOLOGY

Semester : V
Credits : 5

Course Code : U16BT5:2
Total Hours : 75

Objectives

1. To understand the dynamics of our surroundings and to take proper measures to conserve it.
2. To know structural adaptations and functional adjustments of organisms to their physical environment.
3. To comprehend the inter-relationship between organisms in population and communities.

Unit – I

Concept of an Ecosystem: Definition: Characteristics of an Ecosystem, Complete Nature of Ecosystem; Components of Ecosystems: Biotic and Abiotic Components.

Unit - II

Ecosystems: Introduction, types and characteristic features of the Forest, Grassland, Desert and Aquatic (Pond, Ocean) ecosystems.

Unit - III

Population and Community Ecology: Basic concepts, Population characteristics, Population dynamics, Characteristics of a community, Community structure, Community dynamics (ecological succession), Concept of Habitat and Niche.

Unit - IV

Environmental Pollution: Cause, effects and control measures of: Air (CO₂, SO₂, NO_x, O₃ CFC, PAN, Green house effect), Water (Cd, Hg, Pb, F, As, BOD), Noise and Radiation (Strontium and Cesium) pollution., Solid waste management, Biomagnification, Methalmoglobinemia , Global warming and Climate change (cause and consequences).

Unit - V

Environmental Laws: Environmental Impact Assessment, Environmental planning and National Environment Policy

Text Book

1. Misra S.P. and S.N. Pandey, Essential Environmental Studies, Anne Books Pvt. Ltd., New Delhi, 2008.

References

1. Sharma P.D, Environmental Biology and Toxicology, Rastogi Publications, 2005.
2. Chapman, J.L. and M.J. Reiss, Ecology - Principle and Applications, Cambridge University Press, 1995.
3. De, A.K., Environmental Chemistry, Wiley Eastern Ltd., 1993.
4. Kormondy, E.J, Concept of Ecology, Prentice-Hall of India Pvt. Ltd., 1989.
5. Abbasi, S.A. and Abbasi, N, Renewable Energy Sources and their Environmental Impact, Prentice-Hall of India Pvt. Ltd., New Delhi, 2002.
6. Biotechnology of Biofertilizers, Edited by Sadasivam Kannaiyan, Kluwer Academic Publishers, 2002.

ELECTIVE II : DEVELOPMENTAL BIOLOGY

Semester : **V**
Credits : **5**

Course Code : **U16BT5:3**
Total Hours : **75**

Objectives

1. To understand the cell development and their stages.
2. To comprehend the links of basic aspects of the cell with the advances in stem cell biology.

Unit - I

Origin of developmental patterns: History, Anatomical tradition, Principles of development -life cycles, Developmental patterns and evolution of differentiation, Experimental embryology, Role of genes in development, Amniocentesis.

Unit - II

Early Embryonic Development: Gametogenesis- Spermatogenesis and oogenesis, Types of eggs, Fertilization changes in gametes, mono and polyspermy; the early development of *C. elegans* -The early development of *Xenopus* cleavage, Gastrulation, Embryonic induction and organizers; the early development of chick cleavage, Gastrulation.

Unit - III

Later Embryonic Development: Differentiation of germ layers-Formation of neural tube (development of CNS and eye), skin, notochord, somites, coelom and digestive tube (upto rudiments), Extraembryonic membranes in birds and human, Implantation of embryo, Placentation – structure, types and physiology of placenta.

Unit - IV

Post-Embryonic Development: Metamorphosis changes and hormonal regulation of metamorphosis in insects and amphibians, Regeneration modes of regeneration epimorphosis, Morphallaxis and compensatory regeneration (with one example), Ageing3 concepts and model (*C. elegans*)

Unit - V

Implications of Developmental Biology: Medical implications: Infertility –Diagnosing Infertility, IVF, Teratogenesis – teratogenic agents and effect of teratogens on embryonic development; Embryonic stem cells –A new generation stem cells in biomedical field

Text Book

1. Agarwal, V.K and Verma, P.S, Chordate Embryology, S. Chand Publishing, New Delhi, 1995.

References

1. Scott F Gilbert, *Developmental Biology*, X Edition, Sinauer Associates, Inc. Publishers, Sunderland, Massachusetts, USA, 2013.
2. Balinsky, B.I, *An introduction to Embryology*, International Thomson Computer Press, London, UK, 2008.
3. Jonathan M. W. Slack, *Essential Developmental Biology*, Wiley-Blackwell, Hoboken, New Jersey, United States, 2012.
4. Kalthoff, *Analysis of Biological Development*, II Edition, McGraw Hill Publishers, New York, USA, 2000.

ELECTIVE II : BASICS OF EVOLUTION

Semester : V
Credits : 5

Course Code : U16BT5:4
Total Hours : 75

Objective

1. To understand the concepts of population genetics and product of evolution and their evidences.

Unit - I

Life's Beginnings: Chemogeny, Biogeny, Historical review of evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism

Unit - II

Evidences of Evolution: Fossil record, Sources of variations: Heritable variations and their role in evolution

Unit - III

Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population Evolutionary forces upsetting H-W equilibrium. Natural selection and Genetic Drift (mechanism, founder's effect, bottleneck phenomenon; Role of Migration and Mutation in changing allele frequencies

Unit - IV

Product of evolution: Micro evolutionary changes (inter-population variations, clines, races, Species concept, Isolating mechanisms, modes of speciation—allopatric, sympatric, Adaptive radiation / macroevolution (exemplified by Galapagos finches)

Unit - V

Origin and evolution of man, Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from *Dryopithecus* leading to *Homo sapiens*, molecular analysis of human origin.

Text Book

1. Agarwal, V.K and Verma, P.S., Basis of Evolution, S.Chand Publishing, New Delhi, 1995.

References

1. Ridley M, Evolution, II Edition, Oxford University Press, 2004.
2. Hall, B.K. and Hallgrimson, B, Evolution, IV Edition, Jones and Barlett Publishers, 2008.
3. Reece J.B, Urry L.A, Cain, M.L, Campbell Biology, IX Edition, Benjamin Cummings, 2011.
4. Douglas, J. Futuyma, Evolutionary Biology, Sinauer Associates, 1997.
5. Pevsner, J, Bioinformatics and Functional Genomics, II Edition Wiley- Blackwell, 2009.
6. Minkoff, E, Evolutionary Biology, Addison-Wesley, 1983.

SBEC II : BASICS OF BIOSTATISTICS

Semester : V
Credits : 2

Course Code : U16BT5S2
Total Hours : 30

Objective

1. To know the statistical approaches available to probe biological data, from DNA to biological processes of healthcare systems.

Unit - I

Biostatistics -definition -statistical methods-basic principles. Variables-measurements, functions, limitations and uses of statistics.

Unit - II

Collection of data primary and secondary -types and methods of data collection procedures -merits and demerits. Classification -tabulation and presentation of data -sampling methods.

Unit - III

Measures of central tendency -mean, median, mode, geometric mean -merits & demerits. Measures of dispersion -range, standard deviation, mean deviation, quartile deviation -merits and demerits; Co-efficient of variations.

Unit - IV

Correlation-types and methods of correlation, regression, simple regression equation, fitting prediction, similarities and dissimilarities of correlation and regression.

Unit - V

Statistical inference -hypothesis -simple hypothesis -student 't' test -chi square test.

Text Books

1. Panner Selvam R, Research Methodology, Prentice- Hall of India Private Limited, New Delhi, 2006.
2. Pillai RSN and Bhavathy V, Statistics, S.Chand Company Ltd, 2005.

References

1. S. Palanisamy and M. Manoharan, Statistical Methods for Biologists, Palani Paramount Publication, Palani, Tamil Nadu, 2002.
2. S.C. Gupta and K. Kapoor, Fundamentals of Applied Statistics, 3rd Edition, Sultan Sons Educational Publisher, N.D, 2002.
3. N. Gurumani, An introduction to Biostatistics, MJP Publishers, Chennai, 2002.
4. P.R. Vittal and V. Malini, Statistical and Numerical Methods, Margham Publications, Chennai, 2002.
5. Thomas Clover and Kevin Mitchell, An introduction to Biostatistics, McGraw Hill Higher Education, 2002.
6. Daniel, W.W, Biostatistics, John Wiley Sons, New York, 1987.

SBEC III : FOOD BIOTECHNOLOGY

Semester : V
Credits : 2

Course Code : U16BT5S3
Total Hours : 30

Objectives

1. To understand the effects of biotechnology on production, processing, and quality food products.
2. To know the integration between molecular biology and biochemical pathways for food technology.
3. To know the fermentation biotechnology of modern and traditional foods worldwide, including the bioprocessing of food waste.

Unit - I

Fermentation and Bioprocess Engineering in Food

Fermentation Biotechnology of Traditional Foods, Fermentation Technology and Bioreactor Design, Technologies Used for Microbial Production of Food Ingredients, Process Developments in Solid-State Fermentation and submerged fermentation for Food Applications, Production of Amino Acids: Physiological and Genetic Approaches, Enzymatic Bioprocessing of food Wastes, Cold Active Enzymes in Food Processing, Enzyme Technology for the Dairy Industry, Enzymatic Synthesis of Oligosaccharides: Progress and Recent Trends.

Unit - II

Molecular Biology and Genetic Engineering

Principles of Biochemistry and Molecular Biology, Metabolic Engineering of microorganisms for Food Ingredients, Application of Microbial Molecular Techniques to Food Systems, Application of ELISA Assays for Detection and Quantification of Toxins in Foods, Biochemical Markers for Antioxidant Functionality, Genetics of Dairy Starter Cultures, Genetic Engineering of Baker's Yeast: Challenges and Outlook, Application of Transgenic Fish Technology in Sea Food Production

Unit - III

Microbial Biotechnology in Food

Microbial Biotechnology of Microbial metabolites and Food products Production, Biotechnology in Wine Yeast. Applications : Biotechnological Approaches to Improve Nutritional Quality and Shelf Life of Fruits and Vegetables, Solid-State Bioprocessing for Functional Food Ingredients and Food Waste Remediation.

Unit - IV

Microbial Production of Oils and Fats, Production of Pectinases and Utilization in Food Processing, Biotechnology of Citric Acid Production, Potential Uses of Cyanobacterial Polysaccharides in the Food Industry, Food Applications of Algae, Bioprocessing of Starch Using Enzyme Technology, Biotechnology in Wine Industry, Biotechnology of Nonnutritive Sweeteners.

Unit - V

Biosensors for Food Quality Assessment: International Aspects of the Quality and Safety Assessment of Foods Derived by Modern Biotechnology.

References

1. Kalidas Shetty, Gopinadhan Paliyath, Anthony Pometto and Robert E. Levin, Food Biotechnology, CRC Press, 2005.
2. Sinosh Skariyachan, Abhilash M, Introduction to Food Biotechnology, CBS Publisher & Distributors P Ltd, 1st edition, 2012.
3. Byong H. Lee, Fundamentals of Food Biotechnology, 2nd Edition, Wiley-Blackwell, 2014.
4. Gustavo F. Gutierrez-Lopez, Food Science and Food Biotechnology, CRC Press, 2003.
5. Vinod K. Joshi and R. S. Singh, Food Biotechnology, I K International Publishing House, First Edition, 2012.
6. Watson, K. Industrial Biotechnology, Volume 1, CBS Publisher & Distributors P Ltd, 2016.

CORE VII : INDUSTRIAL BIOTECHNOLOGY

Semester : VI
Credits : 6

Course Code : U16BT607
Total Hours : 90

Objectives

1. To know the overall industrial bioprocess in order to manipulate the process to the requirement of the industrial needs.
2. To understand the production of commercially important industrial enzymes, plant and animal cell cultures.

Unit - I

Exploitation of microorganisms and their products, screening, strain development strategies, immobilization methods, fermentation media, raw material used in media production, antifoaming agents, buffers, downstream processing.

Unit - II

Fermentation equipment and its uses, fermentor design, Types of fermentors and fermentations - single, batch, continuous, multiple, surface, submerged and solid state.

Unit - III

Industrial products from microorganisms- antibiotics: production of penicillin, streptomycin. Interferons, vaccines, hormones, vitamins.

Unit - IV

Enzymes from microbes: amylase, protease. Organic acids: citric acid, acetic acid, amino acids: glutamic acid, lysine.

Unit - V

Production of alcoholic beverages: beer and wine, biofuels: ethanol, methane, biogas.

Text Books

1. Dubey, R.C. and Maheswari, D.K, A Text Book of Microbiology, S. Chand & Company Ltd., New Delhi, 2005.
2. A.H. Patel, Industrial Microbiology, Macmillan, 2011.

References

1. Stanbury, P.F., Whitakar, A., Principles of Fermentation Technology, Pergamon Press, 1984.
2. Mansi. E.MT.El., C.F.A.Bryce, Fermentation Microbiology and Biotechnology, 3rd edition, CRC Press, 2011.
3. Bailey and Ollis, Biochemical Engineering Fundamentals, McGraw Hill, New York, 1986.
4. Casida L.E.Jr., Industrial Microbiology, New Age International Publishers, 2007.

CORE VIII : ANIMAL BIOTECHNOLOGY

Semester : VI
Credits : 5

Course Code : U16BT608
Total Hours : 90

Objectives

1. To understand the applications of biotechnology in animal products.
2. To know about the basics of animal tissue culture, animal products, production and improvement of them.

Unit - I

Basic techniques in animal cell culture and organ culture: Cell lines- types and isolation, culture media- types and supplements, cell fusion, cell differentiation, maintenance and preservation of cell lines.

Unit - II

Gene transfer: Gene transfer methods-mechanical, chemical, biological-viral-Adenovirus, Herpes simplex, Retrovirus

Unit - III

Transgenesis: Transgenic animals production, applications of transgenic in agriculture and medicine, In-vitro fertilization and embryo transfer

Unit - IV

Applications: Development of recombinant vaccines, monoclonal antibody their applications, human genome project and gene therapy.

Unit - V

Secondary metabolites: Bioreactors for large scale culture of cells, Production of secondary metabolites/products: Insulin, growth hormones, interferon etc.

Text Books

1. Ramadass. P., Animal Biotechnology: Recent Concepts and Developments, MJP Publishers, India, 2008.
2. Singh. B., Gautam, S.K., Chauhan, M.S, Text Book of Animal Biotechnology, The Energy and Resources Institute, TERI, 2013.

References

1. Ian Freshney, R., Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications, 6th edition, Wiley Publications.
2. Mather, J.P and Barnes, D, Animal cell culture methods - Methods in cell biology, Volume 57, Academic Press, London, 1998.
3. Mehta, V, Animal Biotechnology, Campus Books International, New Delhi, 2006.
4. Sasidhara. S, Animal Biotechnology, MJP Publishers, India, 2009.
5. Holland, A.J., Johnson, A, Animal Biotechnology and Ethics, Springer, 1998.

CORE IX: PLANT BIOTECHNOLOGY

Semester : VI
Credits : 5

Course Code : U16BT609
Total Hours : 90

Objectives

1. To learn the basic principles and techniques involved in plant cell culture.
2. To understand the concepts of transformation and achievements of biotechnology in plants.
3. To know the molecular concepts in different areas of plant biotechnology including plant tissue culture, genetic engineering and transformation.

Unit - I

Introductory history - Laboratory organization - sterilization techniques – nutrition for plant cells, types of media – MS – Nitsch&Nitsch media, Gamborg's media, White's Media. Structure and function of Growth regulators – Auxins, Cytokinins and Gibberellins. Establishment and maintenance of callus and suspension cultures. Somatic embryogenesis, cytology of callus. Green house effect.

Unit - II

Haploid production, Anther and microspore culture. Gynogenesis, embryo culture and rescue in agricultural and horticultural crops. In vitro pollination and fertilization.

Unit - III

Protoplast isolation, Culture regeneration, fusion. Somatic hybrids, cybrids, cryopreservation, Synthetic seeds – Terminator seed concept. Gene transfer techniques in plants. Applications of transgenic plants.

Unit - IV

Plant micro propagation – micro grafting – *in vitro* clonal multiplication – clonal orchards – meristem culture and virus elimination shoot tip culture. Edible vaccines from plants – Banana, Watermelon.

Unit - V

Somaclonal and Gametoclonal variation in vitro cultures, Secondary metabolites in plants - production – screening - applications. Role of tissue culture in agriculture, forestry. Biodiversity and conservation.

Text Books

1. Bhojwani, S.S., Razdon. R, Plant Tissue Culture: Theory and Practice, Elsevier, 2010.
2. Chawla, H.S, Plant Biotechnology, Oxford and IBH, New Delhi, 2000.
3. Glick, B.R, Pasternak, J.J, Molecular Biotechnology - Principle and Applications of Recombinant DNA, ASM Press, Washington, 2002.

References

1. Gupta, P.K, Plant Biotechnology, Rastogi Publications, India, 2010.
2. Mahipal Singh Shekhawat and Vikrant. S, Plant Biotechnology: In Vitro Principles, Techniques and Applications, MJP Publishers, 2010.
3. Near Stewart, C, Plant Biotechnology and Genetics: Principles, Techniques and Applications, Wiley India Private Limited, 2013.
4. Singh, B.D, Plant Biotechnology, Kalyani Publishers, India, 2010.
5. Slater, A., Scott, N., Fowler, M, Plant Biotechnology – The genetic manipulation of plants, 2nd Edition, Oxford University press, USA, 2008.

CORE PRACTICAL VI : INDUSTRIAL, PLANT AND ANIMAL BIOTECHNOLOGY LAB

Semester : VI
Credits : 2

Course Code : U16BT6P6
Total Hours : 45

Objectives

1. To understand isolation and screening of industrially important organisms.
2. To know plant & animal tissue culture.

INDUSTRIAL BIOTECHNOLOGY LAB

1. Bacteriological analysis of food products.
2. Determining the quality of milk by MBRT.
3. Antibiotic sensitivity testing-Well and Disc methods.
4. Screening of cellulolytic organisms
5. Isolation and identification of major bacterial pathogens such as *Staphylococcus*, *Streptococcus* etc.
6. Isolation of lactobacillus from fermented foods

PLANT BIOTECHNOLOGY LAB

1. Micropropagation and indirect organogenesis
2. Induction and culture of Somatic Embryos
3. Measurement of plant cell growth (PCV, cell number, Wet and Dry Weights)
4. Seed culture technique; Production of Synthetic seeds.

ANIMAL BIOTECHNOLOGY LAB

1. Preparation of culture media and sterilization
2. Cell counting by haemocytometer
3. Viability testing by trypan blue
4. Giemsa staining
5. Isolation of cells from organ
6. Preparation of serum

References

1. Chawala, H.S, Plant Biotechnology: Laboratory Manual for Plant Biotechnology, Oxford and IBM Publishing Co. Pvt. Ltd., 2008.
2. Gunasekaran, P, Lab Manual in Microbiology, New Age International Publications, 2007.
3. Ian Freshney, R, Culture of Animal Cells: A Manual of Basic Technique and Specialized Application, Sixth Edition, Wiley –Blackwell, 2011.
4. Purohit, S.S, Plant Biotechnology a Laboratory Manua, Agro-Bios, 2002.
5. Rajan, S, Experimental Procedures in Life Sciences, Anjanaa Book House, 2010.

ELECTIVE III : HUMAN PHYSIOLOGY

Semester : VI
Credits : 5

Course Code : U16BT6:1
Total Hours : 75

Objectives

1. To know about the anatomy and physiological systems of human beings.
2. To understand the functioning of human organ systems.

Unit - I

Digestive system: Anatomy of the digestive system, Salivary, Gastric and Biliary Secretions functions. Digestion and absorption of carbohydrates, Lipids and proteins.

Unit - II

Body fluids: Plasma, Lymph & Blood. Blood- cells, Haemoglobin, blood coagulation.

Unit - III

Circulation: Structure of Heart and blood vessels, Functions of heart. Respiration: Anatomy, and physiology of respiration.

Unit - IV

Excretory system: Structure and functions of kidney. Urine- composition and formation. Renal regulation of acid-base balance.

Unit - V

Central nervous system: General organization. Conduction of nerve impulse. Synaptic transmission. Brain chemical composition, neurotransmitters and Camp. Biochemical aspects of learning and memory.

Text Book

1. Martini, Frederick, Human Anatomy and Physiology, 9th edition, Pearson, Benjamin Cummings, 2012.

References

1. Chatterjee, Human Physiology, Volumes I & II, CBS Publishing, 11th edition, 2016.
2. Guyton A.C, Functions of the Human Body, Saunders W.B. Co Ltd, 4th edition, 1974.
3. Best C.H, Taylor N.B, The Living Body, Chapman & Hall Publishing, 1954.
4. Swaminathan, Human Nutrition and Dietetics, Bangalore Printing and Pulv. Co. Ltd, 1996.
5. Barrett K, Ganong's, Review of Medical Physiology, 24th edition, McGraw Hill Education, 2012.

ELECTIVE III : FUNDAMENTALS OF BIOLOGY

Semester : VI
Credits : 5

Course Code : U16BT6:2
Total Hours : 75

Objectives

1. To understand the basic science of life.
2. To learn about the different components of eco-system.
3. To know about the life forms and their mechanism of existence.
4. To apply fundamentals of life science to biotechnology.

Unit - I

Evolution and systematic: Origin of life (Chemical) Adaptation biology- xeric adaptation in camel; Coloration and mimicry, Concept of evolution: Emergence of evolutionary thoughts and variation in population. Hardy-Weinberg equilibrium, mutation, migration, genetic drift and natural selection.

Unit - II

Ecology and Environmental Biology: Components of ecosystems: Abiotic and Biotic associations, Energy flow, Population ecology- natality, mortality, growth forms, age pyramids dispersal, distribution types, regulation of population density. Community ecology - habitat & niche concept, Ecological succession and concept of climax

Unit - III

Animal diversity :Classification of Nonchordate, (structure,organization and anatomical representation, Organ structures and mechanism) sub-kingdom Protozoa and Phylum Porifera, Cnidaria, Platyhelminthis, Annelida, Arthropoda, Mollusca and Echinodermata. Animal classification for Chordate (Comparative anatomy & structural organization)

Unit - IV

Plant diversity: Classification of plant phyla: Algae, Fungi, Bryophytes, Pteridophytes and gymnosperms and Angiosperms) Catalogue of medicinal plants and their applications

Unit - V

Application of Bioscience : Sericulture - characteristics of sericulture industry and its scope; Aquaculture: Principles, definition and scope. Fisheries resources of India, Pest Management, Apiculture- Management of apiary, Lac culture and its uses.

Text Book

1. Agarwal, K.C., Environmental Biology, Nidi Publ. Ltd., Bikaner, 2001.

References

1. Parker and Haswell, Text Book of Zoology, Volume 1, Arkose Press, 2015.
2. Raven, Johnson, Losos, Mason and Singer, Biology, 9th edition, McGraw-Hill Publications, 2010.

PROJECT

Semester : VI
Credits : 2

Course Code : U16BT6PJ
Total Hours : 60

UG – Skill Based Courses (SBC)

Sem.	Course	Code	Title	Hrs.	Credits	Marks		
						CIA	ESA	TOTAL
IV	SBC– I	U16LFS41	Life Skills	2	1	100	-	100

LIFE SKILLS

Semester IV
Total Hrs : 30

Course code: U16LFS41
Credit 1

General Objectives :

1. To acquire skills and abilities for adaptive and positive behavior that helps to deal effectively with the demands and challenges of everyday life.
2. To develop creative, communicative and critical thinking skills necessary for employability

Unit I Basics of Communication skills & Effective Communication

Features of Communication – Process of Communication Verbal, nonverbal, Body Language – Postures & Etiquette – Listening & speaking Skills- Communication Barriers – Listening & speaking Skills.

Unit II Personal Effectiveness

Maslow's theory – Self-esteem- Role Conflict – Intra & Inter personal Skills – Efficiency Vs effectiveness – Team Building – Emotional Intelligence & Quotient

Unit III Interview Skills

Types of Interviews – Resume Formats & preparation - Cover letters – Simple rules to face interviews – Dos & Don'ts in an Interview – Telephonic Interview and Etiquette - Group Discussions – Types – Methods – Ingredients and Tips for a Successful Group Discussion.

Unit IV Test of Reasoning & Numerical Ability

- A. Numerical Ability: Problems related to Average – Percentage – Profit /Loss – Simple & Compound Interest- Time & Work – Boats & Streams etc.
- B. Logical reasoning: Logical Detection – Nonverbal reasoning – Problems related to seating arrangements – Relationship model – Assertion & Reasoning etc.
- C. Online Tests: Aptitude – Logical Reasoning – Problem Solving – Time management in Online tests- Online tests on Language skills- Aptitude and technical rounds

Unit V Outbound Learning

Physical, Mental, and emotional exercises

Texts for Reference:

1. Barun.K.Mitra, Personality Development and Soft Skills, 6th edition, Oxford University press Noida 2012.
2. M.Sarada, The complete Guide to Resume Writing, Sterling Publishers Pvt Ltd, New Delhi 2012.
3. Gloria J.Galances & Katherine Adams, Effective Group Discussions, Theory & practice, 12th Edition, Tata McGrawHill Pvt Ltd 2012.
4. Francis Soundararaj, Basics of Communication in English, SoftSkills for Listening Speaking, Reading & Writing, Macmillan Publishers India Ltd. 2013.

Scheme of Evaluation

1.	EQ test	10 Marks
2.	Resume	10 Marks
3.	Numerical Ability Test	10 Marks
4.	Online test 1(aptitude)	10 Marks
5.	Group Discussion	10 Marks
6.	Team Work	10 Marks
7.	OBL Observation / Work book	40 Marks
Total		100 Marks

UG - Non Major Elective Courses (NMEC)
(Offered to Students of other Disciplines)

Sem.	Course	Code	Title	Hrs./ week	Credits	Marks		
						CIA	ESA	TOTAL
III	NMEC– I	U16BT3E1	Basics of Biotechnology	2	2	25	75	100
IV	NMEC - II	U16BT4E2	Applied Biotechnology	2	2	40	60	100

NMEC I : BASICS OF BIOTECHNOLOGY

Semester : III
Credits : 2

Course Code : U16BT3E1
Total Hours : 30

Objectives

1. To know the basics and scope of biotechnology.
2. To understand the information about DNA and genes and how it influences the functioning of an organism as a whole.

Unit - I

Scope of Biotechnology. History of Biotechnology. Biotechnology Tree – Roots and Branches. Strategies of gene cloning.

Unit - II

Tools used in gene cloning – Restriction endonucleases – Types – Features. Ligases – Linkers & adaptors. Modifying enzymes – Nucleotide kinase, Alkaline phosphates. Gene amplification by PCR.

Unit - III

Vectors – Properties of good Vector .Constructed plasmids- pBR322. Cosmid vectors, Animal vectors- SV40. Plant vectors- Ti derivatives.

Unit - IV

Introduction of genes – Vector mode – transformation and transfection. Vector less mode –Biolistics, Electroporation, Microinjection.

Unit - V

Properties of *E.coli* as good hosts. Selection of recombinants – Reporter genes, Colony hybridization.

Text Book

1. Dubey, R. C, A Text Book of Biotechnology, S.Chand & Company Ltd., New Delhi, 2007.

References

1. Old and Primrose, Principles of Gene Manipulation, 3rd edition, Blackwell Scientific Publications, Oxford, 1989.
2. Satyanarayana. U, Biotechnology, Books and Allied (p) Ltd, 2008.
3. Gupta P.K, Biotechnology and Genomics, Rastogi Publication, 2004.
4. Brown, T.A, Gene Cloning and DNA Analysis, Blackwell Science, Osney Mead, Oxford, 1996.
5. Singh, B. D, Biotechnology, Kalyani Publishers, New Delhi, 2004.

NMEC II : APPLIED BIOTECHNOLOGY

Semester : IV
Credits : 2

Course Code : U16BT4E2
Total Hours : 30

Objectives

1. To understand the various applications of biotechnology for the human welfare.
2. To know about the field of biopharmaceutical products.

Unit - I

Plant biotechnology-Role of tissue culture in agriculture, horticulture and forestry, Edible Vaccines from plants – Banana, Watermelon.

Unit - II

Animal biotechnology-Production of Vaccines in animal Cells, Transgenic Animals – cloning, Applications of Transgenic mice and sheep.

Unit - III

Medical biotechnology-Gene therapy, Production and Applications of monoclonal antibodies, Somatic and Germ line Engineering, molecular diagnosis.

Unit - IV

Industrial biotechnology-Production of Microbial products- Alcoholic Beverage – Beer, Antibiotic – Penicillin Industrial uses of enzymes – Detergents, Leather, food and Pharmaceutical.

Unit - V

Environmental biotechnology-Microorganisms as Bio indicators, Genetic engineered microorganisms to degrade xenobiotics, Biological weapons and bioterrorism.

Text Book

1. Dubey R. C, A Text Book of Biotechnology, Rajendra Printer, New Delhi, 2001.

References

1. Old and Primrose, Principles of Gene Manipulation, Blackwell Scientific Publications, Oxford, 1989.
2. Ranga M. M, Animal Biotechnology, Agrobios, India, 2000.
3. Ian Freshney R, Culture of Animal Cells, 6th Revised edition, Wiley-Blackwell, 2010.
4. Hawla, Introduction to Plant Biotechnology, 2nd edition, Oxford and IBH publishers, 2003.
5. Patel A.H, Industrial Microbiology, Second edition, Laxmi Publications, 2011.
6. Gupta P.K, Biotechnology and Genomics, 6th reprint, Rastogi Publication, 2013.
7. T.A Brown, Gene Cloning and DNA Analysis, Blackwell Science, Osney Mead, Oxford, 1996.

