BHARATHIDASAN UNIVERSITY, TIRUCHIRAPPALLI – 620 024.

B.Sc. Biotechnology Course Structure under CBCS

(For the candidates admitted from the academic year 2016-2017 onwards)

Semester	Part	Course	Title	Inst. Hours/ Week	Credit	Exam Hours	Marks		Total
							Int	Ext	
I	I	Language Course–I (LC) – Tamil*/Other Languages ** #		6	3	3	25	75	100
	II	English Language Course - I (ELC)		6	3	3	25	75	100
	III	Core Course–I (CC)	Cell Biology	6	4	3	25	75	100
		Core Practical – I (CP)	Cell Biology (P)	3	3	3	40	60	100
		First Allied Course–I (AC)	Basic Microbiology	4	4	3	25	75	100
		First Allied Course–II (AP)	Microbiology (P)	3	-	-	-	-	-
	IV	Value Education	Value Education	2	2	3	25	75	100
	Total			**30**	**19**				**600**
II	I	Language Course–II (LC)– Tamil*/Other Languages ** #		6	3	3	25	75	100
	II	English Language Course–II (ELC)		6	3	3	25	75	100
	III	Core Course–II (CC)	Molecular Biology	6	4	3	25	75	100
		Core Practical – II (CP)	Molecular Biology (P)	3	3	3	40	60	100
		First Allied Course–II (AP)	Microbiology (P)	4	2	3	40	60	100
		First Allied Course–III (AC)	Applied Microbiology	3	3	3	25	75	100
	IV	Environmental Studies	Environmental Studies	2	2	3	25	75	100
	Total			**30**	**20**				**700**
III	I	Language Course – III (LC)– Tamil*/Other Languages ** #		6	3	3	25	75	100
	II	English Language Course-III (ELC)		6	3	3	25	75	100
	III	Core Course – III (CC)	rDNA Technology	6	4	3	25	75	100
		Core Practical – III (CP)	rDNA Technology (P)	3	3	3	40	60	100
		Second Allied Course – I (AC)	Biomolecules	4	4	3	25	75	100
		Second Allied Course-II (AP)	Biochemistry (P)	3	-	-	-	-	-
	IV	Non Major Elective I-for those who studied Tamil under Part-I a) Basic Tamil for other language students b) Special Tamil for those who studied Tamil upto +2 but opt for other languages in degree programme	Biotechnology for Human Welfare	2	2	3	25	75	100
	Total			**30**	**19**				**600**

IV	I	Language Course –IV (LC) - Tamil*/Other Languages ** #		6	3	3	25	75	100
	II	English Language Course – IV (ELC)		6	3	3	25	75	100
	III	Core Course – IV (CC)	Immunology	5	4	3	25	75	100
		Core Practical – IV (CP)	Immunology (P)	3	3	3	40	60	100
		Second Allied Course - II (AP)	Biochemistry (P)	3	2	3	40	60	100
		Second Allied Course - III	Applied Biochemistry	3	3	3	25	75	100
	IV	Non Major Elective II-for those who studied Tamil under Part I a) Basic Tamil for other language students b) Special Tamil for those who studied Tamil upto +2 but opt for other languages in degree programme	Food Processing	2	2	3	25	75	100
		Skill Based Elective - I	Skill Based Elective - I	2	2	3	25	75	100
		Total		**30**	**22**				**800**
V	III	Core Course – V (CC)	Plant Biotechnology	5	5	3	25	75	100
		Core Course – VI (CC)	Animal Biotechnology	5	5	3	25	75	100
		Core Course – VII (CC)	Biostatistics and Biosafety	5	5	3	25	75	100
		Core Practical – V (CP)	Plant and Animal Biotechnology (P)	4	4	3	40	60	100
		Major Based Elective – I	Bioinstruments	5	5	3	25	75	100
	IV	Skill Based Elective – II	Skill Based Elective - II	2	2	3	25	75	100
		Skill Based Elective – III	Skill Based Elective – III	2	2	3	25	75	100
		Soft Skills Development	Soft Skills Development	2	2	3	25	75	100
		Total		**30**	**30**				**800**
VI	III	Core Course – VIII (CC)	Microbial Biotechnology	6	6	3	25	75	100
		Core Course – IX (CC)	IPR and Bioethics	6	6	3	25	75	100
		Core Practical – VI (CP)	Microbial Biotechnology (P)	5	4	3	40	60	100
		Major Based Elective II	Food Technology	6	6	3	25	75	100
		Major Based Elective III	Immunotechnology	6	6	3	25	75	100
	V	Extension Activities	Extension Activities	-	1	-	-	-	-
		Gender Studies	Gender Studies	1	1	3	25	75	100
	Total			**30**	**30**				**600**
Grand Total				**180**	**140**				**4100**

Language Part – I	-	4
English Part –II	-	4
Core Paper	-	9
Core Practical	-	6
Allied Paper	-	4
Allied Practical	-	2
Non-Major Elective	-	2
Skill Based Elective	-	3
Major Based Elective	-	3
Environmental Studies	-	1

Value Education	-	1	
Soft Skill Development	-	1	
Gender Studies	-	1	
Extension Activities	-	1	(Credit only)

* for those who studied Tamil upto 10th +2 (Regular Stream)

+ Syllabus for other Languages should be on par with Tamil at degree level

those who studied Tamil upto 10th +2 but opt for other languages in degree level under Part I should study special Tamil in Part IV

** Extension Activities shall be out side instruction hours

Non Major Elective I & II – for those who studied Tamil under Part I

a) Basic Tamil I & II for other language students
b) Special Tamil I & II for those who studied Tamil upto 10th or +2 but opt for other languages in degree programme

Note:

	Internal Marks	External Marks
1. Theory	25	75
2. Practical	40	60

3. Separate passing minimum is prescribed for Internal and External marks

FOR THEORY

The passing minimum for CIA shall be 40% out of 25 marks [i.e. 10 marks]
The passing minimum for University Examinations shall be 40% out of 75 marks [i.e. 30 marks]

FOR PRACTICAL

The passing minimum for CIA shall be 40% out of 40 marks [i.e. 16 marks]
The passing minimum for University Examinations shall be 40% out of 60 marks [i.e. 24 marks]

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CORE COURSE I

CELL BIOLOGY

Objectives

Cell biology is the study of the 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 macromolecules such as carbohydrate, protein, lipid, DNA & RNA; membrane structure and function; bioenergetics; cellular communication; and microscopic techniques to understand the cell structure.

Unit I Fundamentals of cell structure

Discovery of cells; Basic properties of cells; Different classes of cells – Prokaryotic and eukaryotic cells. **Cell division**: Cell cycle; mitosis; meiosis, binary fission.

Unit II Cellular membranes and matrices

Chemical composition and fluidity of membranes; dynamic nature of membranes; transportation across cell membrane; membrane potentials; extracellular matrices – structure and function; cytoskeleton – structure and function.

Unit III Cellular organelles in metabolism

Endoplasmic reticulum – smooth & rough; function of endoplasmic reticulum; Golgi complex – structure and function; Ribosomes – Types, structure and function; Morphology and functions of peroxisomes and glyoxisomes; Plant cell vacuoles; endocytic pathways – endocytosis, phagocytosis; membrane trafficking.

Unit IV Cellular organelles in energy metabolism

Mitochondria – structure and function; Chloroplast – structure and function. Structure of nucleus – nuclear membrane, nucleolus, chromatin, structure of nucleic acids.

Unit V Methods in cell biology

Microscopy - Light microscope, TEM, SEM, Use of radioisotopes; Staining procedures.

Text Books

1. Freifelder D. 1985. Molecular Biology, Narosa Publishing House. New Delhi.

2. Lewin B. 2007. Genes IX. Oxford University Press, London.
3. Ajoy Paul. 2011. **Textbook of Cell and Molecular Biology.** Books and Allied Ltd.
4. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. 2008. Molecular Biology of Cell. 6th Edition. Garland Science, Taylor & Francis group Publishers.
5. Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, David Baltimore, and James Darnell. 1995. Molecular Cell Biology. 3rd Edition. W.H. Freeman Publishers.

Reference Books

1. Watson JD, Gilman M, Witkowski J and Zoller M. 1992. Recombinant DNA. Scientific American Books. 2nd Edition. New York.
2. Blackburn GM and Gait MJ. 1996. Nucleic Acids in Chemistry and Biology. Oxford University Press.
3. Lodish H, Baltimore D, Beck A, Zipursky SL, Matsudaria P and Darnell J. 1995. Molecular Cell Biology. Scientific American Books.
4. Cooper M 1995. The Cell Molecular Approach. 2nd Edition. ASM Press.
5. Lewis J Kleinsmith and Valerie M Kish. 1980. Principle of Cell and Molecular Biology 2nd Edition. Benjamin-Cummings Publishing Company.
6. De Robertis, EDP and E.M.F Robertis. 1980. Cell and Molecular Biology. 7th Edition. Saunders Company.
7. T.A. Brown. 2011. Introduction to genetics: A molecular approach. 1st Edition. Garland Science.
8. J.D.Watson, Tania A. Baker, Stephen P. Bell, Michael Levine and Richard Losick. 2013. Molecular Biology of the Gene. 7th Edition. Benjamin/Cummings Publ. Co., Inc., California.
9. Benjamin Lewin. 2008. Genes XI. 9th Edition. Jones & Bartlett Learning.
10. R.A. Meyers. 1995. Molecular Biology and Biotechnology. A comprehensive desk reference. (Ed) Wiley-Blackwell Publishers.

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CORE PRACTICAL I

CELL BIOLOGY (P)

Objectives

The students will learn, understand & develop skill and hands on training in basics of cell biology

1. Microscope – Bright field and Dark field
2. Micrometry
3. Structure observation - Prokaryotic & Eukaryotic cell
4. Cell count - Prokaryotic & Eukaryotic cell
5. Observation – Different types of cells – parenchyma, collenchymas, sclerenchyma, epithelium
6. Size and shape of an organism (prokaryote) – simple staining, use of ocular micrometer
7. Motility of an organism – Hanging drop
8. Cell Staining – Cytochemical methods - Demonstration of Cellular and sub-cellular components
9. Sub cellular fractionation
10. Osmosis and tonicity
11. Cell division - Mitotic stages - Preparation of Onion Root Tip
12. Cell division - Meiotic stages - Preparation of Tradescantia Flower bud
13. Cell division – Binary fission of yeast
14. Polytene and diplotene chromosome – Chirinamous larva
15. Microtome – Temporary & permanent slide preparation.

Reference Books

1. David A. Thompson. 2011. Cell and Molecular Biology Lab. Manual.
2. P.Gunasekaran. 2007. Laboratory Mannual in Microbiology. New Age International.
3. D O Hall, S E Hawkins. 1974. Laboratory Manual of Cell Biology. British Society for Cell Biology, Published by Crane, Russia.
4. Mary L. Ledbetter. 1993. Cell Biology: Laboratory Manual. Edition: 2. Published by RonJon Publishing. Incorporated.

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FIRST ALLIED COURSE I

BASIC MICROBIOLOGY

Objectives

This course is aimed give an understanding about the basics of microbiology dealing types of microbes, classification & characterization.

Unit I History of development of Microbiology

Development of microbiology as a discipline. Spontaneous generation *vs*. biogenesis. Development of various microbiological techniques. Concept of fermentation. Establishment of fields of medical microbiology, immunology and environmental microbiology with special reference to the work of following scientists: Anton von Leeuwenhoek, Joseph Lister, Paul Ehrlich, Edward Jenner, Louis Pasteur, Robert Koch, Martinus W. Beijerinck, Sergei N. Winogradsky, Alexander Fleming, Selman A. Waksman, Elie Metchnikoff, Norman Pace, Carl Woese and Ananda M. Chakraborty. Nobel prize winners in the field of Medicine.

Unit II Diversity of Microbial world

Systems of classification - Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems and their utility. General characteristics of different groups of microbes. Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Algae, Fungi and Protozoa) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.

Bacteria: A very precise account of typical eubacteria, chlamydiae & rickettsiae (obligate intracellular parasites), mycoplasma, and archaebacteria (extremophiles).

Unit III Algae

History of phycology with emphasis on contributions of Indian scientists. General characteristics of algae including occurrence, thallus organization, algae cell ultra structure, pigments, flagella, eyespot, food reserves and vegetative, asexual and sexual reproduction. Different types of life cycles in algae: Haplobiontic, Haplontic, Diplontic, Diplobiontic and Diplohaplontic life cycles. Detailed life cycle of *Chlamydomonas* and *Spirogyra*.

Unit IV Fungi

Historical developments in the field of Mycology including significant contributions of eminent mycologists. General characteristics of fungi including habitat, distribution, nutritional requirements. Fungal cell ultra-structure,

thallus organization and aggregation. Fungal wall structure and synthesis. Sexual and asexual reproduction. Heterokaryosis, heterothallism and parasexual mechanism. Detailed life cycle of *Aspergillus* and *Rhizopus*.

Unit V Protozoa, Viruses, Viroids and Prions

Protozoa: General characteristics with special reference to *Amoeba, Paramecium* and *Giardia*

Viruses, viroids and prions: A general introduction with special reference to the structure of the following: TMV, poliovirus, T4 and λphage, lytic and lysogenic cycles, one step multiplication curve.

Text Books

1. Prescott, Harley, Klein. 2003. Microbiology. 5th Edition. McGraw Hill Publ.
2. Bernard R. Glick & Jack J. Pasternak. 2002. Molecular Biotechnology. Indian edition. Panima Publishing Corporation.
3. Pelzer, Chan and Kreig. 1986. Microbiology. 5th Edition. McGraw-Hill.

Reference Books.

1. Tortora, G.J., Funke, B.R. and Case, C.L. 2012. Microbiology - An Introduction. 11th Edition. Pearson Education.
2. Stainer, Ingharam, Wheelis and Painter. 1987. General Microbiology. 5th Edition. Macmillan Education, London.
3. A.J. Salle. 1974. Fundamental Principles of Bacteriology. Tata McGraw – Hill Edition.
4. AH Rose. 1977. Chemical Microbiology – An introduction to microbial physiology. Butterworth, London.
5. S. Meenakumari. 2006. Microbial Physiology. MJP Publishers.
6. MT Madigan, JM Martinko and Jack Parker. Brock Biology of Microorganisms. 10th Edition. Pearson and Education Inc., New Jersey.
7. David Freifelder, David M. Freifelder and John E. Cronan. 1994. Microbial genetics. 2nd Edition. Jones & Bartlett Publishers.
8. R.W. Old and S.B. Primrose. 1985. Principles of gene manipulation. Blackwell Scientific Publications.
9. Benjamin Lewin. 2006. Genes IX. 9th Edition. Jones and Bartlett publishers.
10. R.A. Atlas. 1998. Microbiology, Fundamental and Applications. 2nd Edition. McMillan Publishers.
11. Powar and Daginawala. 2010. General Microbiology. Volume – I. Himalaya Publishing House.

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FIRST ALLIED COURSE II

MICROBIOLOGY (P)

Objective

This practical is designed to give an understanding about the basic techniques in Microbiology

1. Cleaning and Preparation of glassware
2. Preparation of Microbiological media
3. Sterilization – glassware & media – wet, dry & filtration
4. Isolation of microorganisms from various samples
5. Counting of microbes – Use of haemocytometer, colony counting
6. Identification of microbes – Microscopy & Macroscopy
7. Biochemical identification of bacteria.
8. Staining of bacteria – Simple & differentia staining - Gram, spore, capsule, flagella
9. Culture Techniques - Pure culture - slant, stab, streak etc.
10. Maintenance and storage of bacterial strains.
11. Staining of fungi
12. Identification of algae, fungi, lichens & yeast
13. Identification of protozoa & nematodes

Reference Books

1. Gunasekaran, P. 2009. Laboratory Manual in Microbiology. 1st Edition. New Age International Publishers. Reprint 2009.
2. Dr. T. Sundararaj. Microbiology Laboratory Manual. Dr.A.L. MPGIBMS, University of Madras, Taramani, Chennai – 600 113.
3. James G. Cappuccino and Natalie Sherman. 2013. Microbiology: A laboratory Manual. 10th Edition. Benjamin Cummings.
4. Arnold L. Demain & Julian E. Davies. 1999. Manual of Industrial Microbiology and Biotechnology. 2nd Edition. ASM press.

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CORE COURSE II

MOLECULAR BIOLOGY

Objectives

This course is designed to given an understanding about the basics of molecular biology – classical genetics & molecular aspects.

Unit I Nucleus & Chromosomes

Cytoskeleton: Microtubules, microfilaments & associated proteins – actin, myosin and intermediate filaments. 3 dimensional organization of cytoskeleton.

Nucleus: Nucleus, nuclear envelops, nucleoplasam, chromatin and chromosomes, allele, loci, gene. Nuclear division.

Unit II Classical genetics.

Organization of Chromosomes: Specialized chromosomes, chromosomal abnormalities and qualitative inheritance. Population genetics and developmental genetics using *Drosophila melanogaster* as model system. Somatic cell genetics.
Mundelein inheritance, Law's of inheritance – single & dihybrid ratio. Linkage analysis.

Unit III Central dogma of Molecular Biology.

Characteristics of genetic code.

Transcription – Prokaryotic & Eukaryotic Transcription. Enzymes involved in Transcription - RNA polymerase. Post transcriptional processing in mRNA (5' cap), 3' – end polyadenylation, splicing.

Translation - Factors involved in translation – Mechanism of translation in Prokaryotes and Eukaryotes – initiation – elongation – termination. Translational inhibitors. Post-translational modification of Proteins. Importance of Glycosylation and Phosphorylation.

Unit IV DNA Replication & repair

Prokaryotic and Eukaryotic DNA replication. Mechanism of DNA replication. Enzymes & proteins involved in DNA replication. Models of replication - Semi-conservative, unidirectional, bidirectional, rolling circle mechanism. Inhibitors of DNA replication. DNA repair.

Unit V Regulation of gene expression

In prokaryotes: lac operon, ara operon and trp operon & attenuation. In eukaryotes: gene loss, gene amplification, gene rearrangement. Regulation of synthesis of primary transcripts, transcriptional control by hormones.

Text Books

1. Ajoy Paul. 2011. **Textbook of Cell and Molecular Biology.** Books and Allied Ltd.
2. Benjamin Lewin. 2007. Gene IX. 9th Edition, Jones and Barlett Publishers.
3. J.D.Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz & A.M. Weiner. 2007. Molecular Biology of the Gene. 6th Edition. Benjamin Cummings Publishing Company Inc.
4. Watson JD, Gilman M, Witkowski J, Zoller M. 1992. Recombinant DNA. Scientific American Books.

References

1. Bruce Alberts, Alexander Johnson. Julian Lewis, David Morgan, Martin Raff, Keith Roberts, Peter Walter. 2014. Molecular Biology of Cell. Garland Science publication.
2. Burton E. Tropp. 2012. Molecular Biology – Genes to Proteins. Jones and Bartlett Publishers.
3. George M. Malacinski. 2013. Freifeder's Essentials of Molecular Biology. Norosa Publishing House.
4. Stanely R. Maloy, Jhon E Cornan Jr, David Freifelder. 1994.Microbial genetics. 2nd Edition. Jones and Bartlett publisher.
5. Uldis N. Streips and Ronalad E. Yasbin. 2002. Modern Microbial Genetics. 2nd Edition. Wiley-Blackwell.
6. Sandy B. Primrose, Richard M. Twyman and Robert W. Old. 2008. Principles of Gene Manipulation. 6th Edition. Blackwell Science.

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CORE PRACTICAL II

MOLECULAR BIOLOGY (P)

Objectives

In this course the students will get hands on experience in Molecular Biology Techniques.

1. Isolation and purification of genomic DNA from prokaryotes.
2. Isolation and purification of genomic DNA from eukaryotes.
3. Isolation and purification of plasmid DNA.
4. Observation of DNA - Agarose gel electrophoresis.
5. Quantification of nucleic acids – DNA & RNA – Chemical and UV method.
6. Separation of protein by SDS PAGE
7. Staining of proteins - Amido black, coomosie brilliant blue & $AgNO_3$.
8. Bacterial mutagenesis – physical & chemical.
9. Preparation of *E. coli* competent cells.
10. Transformation of bacteria – $CaCl_2$ method.
11. Bacterial conjugation.
12. Transduction.

Reference Books

1. M. Mooyoung. 1985. Comprehensive Biotechnology. Vol. 2, 3 & 4. Pergamon press.
2. Dr. David A Thompson. 2011. Cell and Molecular Biology Lab Manual.
3. George M. Malacinski. 2013. Freifeder's Essentials of Molecular Biology. Norosa Publishing House.
4. Stanely R. Maloy, Jhon E Cornan Jr, David Freifelder. 1994.Microbial genetics. 2nd Edition. Jones and Bartlett publisher.

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FIRST ALLIED COURSE III

APPLIED MICROBIOLOGY

Objective

This course is designed to give knowledge on the applied aspects of microbiology.

Unit I Fermentation

Isolation, preservation and improvement of strains. Handling and development of inoculum for various fermentation process. Upstream process. Media for industrial fermentation - formulation and sterilization.

Unit II Microbial Energetic

Energy from inorganic compounds - ET in chemolithotrophs, production of reducing power in chemolithotrophs; Energy from visible radiation – photosynthesis in eukaryotes, blue-green algae, bacteria. Energy from aromatic compounds – two carbon compounds, one carbon compounds, endogenous reserve polymers. Energy from hydrocarbons – alkanes, alkenes, acyclic aromatic hydrocarbons.

Unit III Food Microbiology

Food poisoning – Food borne diseases - Bacterial and Non- Bacterial. Microbial quality and safety – Determination of microorganisms in food - culture, microscopy and sampling methods – Chemical and immunological methods. Principles of food preservations: Asepsis, Preservation by use of High temperature, Low temperature, Canning, Drying, Radiation and Food additives.

Unit IV Medical Microbiology

Infectious Diseases – viral, bacterial, fungal & protozoan. Host pathogen interaction & establishment of disease. Diagnosis – sample collection, transport and examinations of the specimens. Antibiogram.

Bacterial diseases: Morphology, cultural characteristics, pathogenicity and laboratory diagnosis of Gram positive organisms - *Staphylococcus aureus, Mycoplasma*; Gram negative organisms: *E.coli.*

Viral diseases: Basic concepts of virology. General properties of Human viruses. Approaches to viral diagnosis - Serological and Molecular techniques of viral infections - Hepatitis, Polio. **Fungal diseases**: General properties and approaches to laboratory diagnosis. Mycosis – Superficial, Subcutaneous and Systemic infections – *Candida allbicans*.

Parasitic infections: Pathogenicity and laboratory diagnosis of *Entamoeba histolytica, Plasmodium vivax.*

Unit V Environmental and Agricultural Microbiology

Waste management - waste water treatment, organic compost, biogas production, biodegradation of petroleum & xenobiotic products microbial leaching. Production of biofertilizer and biopesticides.

Text Books

1. Prescott, Harley, Klein. 2003. Microbiology. 5th Edition. McGraw Hill Publ.
2. Bernard R. Glick & Jack J. Pasternak. 2002. Molecular Biotechnology. Indian edition. Panima Publishing Corporation.
3. Pelzer, Chan and Kreig. 1986. Microbiology. 5th Edition. McGraw-Hill.
4. S. Meenakumari. 2009. Microbial Physiology. MJP Publishers.

References Books

1. AH Rose. 1976. Chemical Microbiology – An introduction to microbial physiology –Butterworth, London.
2. MT Madigan, JM Martinko & Jack Parker. 2002. Brock Biology of Microorganisms – 10th Edition – Pearson and Education Inc., New Jersey.

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CORE COURSE III

rDNA TECHNOLOGY

Objectives

This course is planned to give basic knowledge on rDNA technology.

Unit I Introduction to rDNA Technology

Introduction to genetic engineering and recombinant DNA technology. Various steps involved in rDNA technology. Isolation of genes. Enzymes of rDNA technology - Restriction endonucleases, exonuclease, DNA modifying enzymes - Polymerase, Transferase, Kinase and Ligase.

Unit II Different types of Vectors

Plasmids, Phage vectors, Cosmids, Phagemids, Virus vectors, Shuttle vectors and expression vectors- YAC, BAC- *S. cerevisiae* system as a model.

Unit III Cloning Strategies

Cloning vectors for *E. coli.*, Cloning vectors for Eukaryotes. Methods of transformation. Construction of genomic libraries and cDNA Libraries. Probe construction, recombinant selection and screening,

DNA amplification using polymerase chain reaction (PCR): key concepts, Analysis of amplified products. Applications of PCR: Ligase chain reaction. RFLP, RAPD, DNA Finger printing.. Principles of Southern, Northern and Western blotting techniques.

Unit IV Selection & Screening of rDNA products and Gene Sequencing

Analysis of recombinant DNA - Selection methods – antibiotics, expression basis, GUS expression. Sequencing - chemical degradation; chain termination and automated sequence. Altered expression and engineering genes. Site-directed mutagenesis.

Unit V Application of rDNA Technology in Plants & Animals and Gene therapy

Transgenic plants with reference to virus and pest resistances, herbicide tolerance and stress tolerance (cold, heat and salt); cytoplasmic male sterility; delay of fruit ripening; resistance to fungi and bacteria, Biopharmaceuticals and secondary metabolite production.

Transgenic animals – Pharmaceutical products - insulin. Farm animal production.

Gene therapy – Haemopoietic cells, genetically engineered bone marrow cells, skin fibroblasts, hepatocytes, myoblast and genetically modified lymphocytes – Recombinant DNA Technology in the production of vaccines.

Text Books

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter. 2002. Molecular Biology of the Cell, 4th Edition. Garland Sciences.
2. Stanley Maloy 1994. Microbial genetics. 2nd Edition. Jones and Bartlett publisher.
3. Uldis N. Streips and Ronalad E. Yasbin. 2002. Modern Microbial Genetics. 2nd Edition. Wiley-Blackwell.
4. Sandy B. Primrose, Richard M. Twyman, Robert W. Old. 2008. Principles of Gene Manipulation. 6th Edition. Blackwell Science.
5. *Brown TA. 2008. Genomes. 3rd Edition.* New York: Garland Publishing Co. New York: *Garland Science.*

Reference Books

1. Old, R.W and S.B. Primrose. 1996. Principles of Gene Manipulation: An Introduction to Genetic Engineering. 2nd Edition. Blackwell Scientific Publications, Oxford.
2. Glover, DM. and BD. Hames. 1995. DNA Cloning: A Practical Approach. 2nd Edition. IRL Press, Oxford.
3. Innis, M.A., D.H. Gelfand and J.J. Sninskey. 1995. PCR Strategies. Academic Press, San Diego.
4. Persing, D.H., K T.F Smith, F.C. Teower and T. J. While. 1993. Diagnostic Molecular Microbiology. 2nd Edition. ASM Press, Washington D.C.
5. Watson J.D., Gilman M., Witkowski, J. and Zoller M. 1992. Recombinant DNA. 2nd Edition. Scientific American Books, New York.
6. Daniel L.Hartl. 2011. Analysis of Genes and Genomes. 8th edition. Maryellen Ruvolo. Laxmi Publications.
7. Keya Chaudhuri. 2012. Recombinant DNA Technology. The Energy and Resources Institute, TERI.
8. J.F. *Sambrook* and *D.W. Russell*. 2011. *Molecular Cloning*: A *Laboratory Manual*. 3rd Edition. Volume 1, 2 and 3. Cold Spring Harbor Laboratory Press.
9. Tvan R.S. 1997. Recombinant Gene Expression Protocols. Humana Press Inc., Tokowa.

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CORE PRACTICAL III

rDNA TECHNOLOGY (P)

Objectives

This course is planned to give hands on training in recombinant DNA technology

1. Isolation of genomic DNA from plant, animal cells & from bacteria
2. Isolation of plasmid DNA – small & large scale
3. Size analysis of plasmids by agarose gel electrophoresis
4. Restriction digestion – single & double digestion.
5. Ligation.
6. Preparation of competent *E.coli* cells
7. Transformation of *E.coli* with recombinant DNA.
8. Selection & screening of rDNA products – Antibiotic resistance, Blue white colony.
9. PCR amplification
10. Southern blot and northern blot.
11. RAPD
12. RFLP

Reference Books

1. J. Sambrook and D.W. Russel. 2001. Molecular Cloning: A Laboratory Manual, Vols 1-3. CSHL.
2. T.A. Springer. 1985. Hybridoma Technology in the Biosciences and Medicine. Plenum Press New York.
3. *Judith W. Zyskind and Sanford I. Bernstein. 1989.* Recombinant DNA Laboratory Manual.Academic press.

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SECOND ALLIED COURSE I

BIOMOLECULES

Objectives:

To ensure students to gain knowledge about the structure, properties and functions of biomolecules.

Unit I Carbohydrates

Definition and classification: Isomerism, anomeric form and mutarotation. classification of monosaccharides - Structure, occurrence, chemistry and functions of glucose, galactose, ribose and fructose. Disaccharides - Structure, occurrence, chemistry and functions of sucrose, lactose and maltose. Homopolysachrides - Occurrence, structure, chemistry and functions of cellulose, starch, glycogen, chitin, dextrin and inulin. Heteropolysacchrides - Occurrence, types, composition and functions of peptidoglycan, agarose and hyaluronate.

Unit II Amino Acids and Proteins

Amino acids: Classification of amino acids based on charge and polarity. Essential and non- essential amino acids. Stereoisomerism, zwitter-ion in aqueous solutions, physical and chemical properties, titration of amino acids, Isoelectric pH. Peptides, Peptide bond.

Proteins: Introduction, classification based on solubility, shape, composition and function. Structure of proteins - Primary, secondary, tertiary and quaternary. Behaviour of proteins in solutions, salting in and salting out of proteins. Denaturation and renaturation of proteins.

Unit III Lipids

Definition, basic ideas about the biochemical functions of lipids. Classification of lipids with examples, classification of fatty acids, physical and chemical properties of fatty acids - saponification number, acid number and iodine number, hydrolysis, halogenation, acetyl number, rancidity of fats, Reichert-Meissel number. Essential and non essential fatty acids. Compound lipids: storage and membrane lipids. Structure and functions of phospholipids and glycolipids, Steroids: Structure of steroid nucleus, cholesterol, ergosterol, stigmasterol, calciferol.

Unit IV Nucleic acids

Structure of purine and pyrimidine base, structure of nucleoside and nucleotide. DNA: Watson and Crick model and forms of DNA. Properties of DNA. RNA- Structure and types of RNA: t-RNA, r-RNA and m-RNA.

Unit IV Vitamins and Minerals

Vitamins - Source, structure, biological role, daily requirement and deficiency manifestation of vitamin A, B, C, D, E and K.

Minerals: Requirements, macro and micro minerals - source and functions.

Texts Books

1. L. Lehninger. 2004. Principles of Biochemistry, 4th Edition. W.H Freeman and Company.
2. Stryer. 2002. Biochemistry. 5th Edition. W.H. Freeman and Company.
3. M.N. Chattergea Rana Shinde. 2011. Text book of Medical Biochemistry. 8th Edition. J.P. Medical Ltd.
4. J.L. Jain, Sunjay Jain, Nitin Jain. 2005. Fundamentals of Biochemistry. S. Chand and Company, New Delhi.

References Books

1. Donald Voet and Judith G.Voet. 2004. Biochemistry. 3rd Edition. John Wiley, New York.
2. Allan Fershi. 1984. Enzyme structure and mechanism. 2nd Edition. W.H.Freeman & Co. Ltd., USA.
3. Trevor Palmer. 1985. Understanding Enzymes. 2nd Edition. Ellis, Horwood Limited.
4. Victor W. Rodwell, David A Bender, Kathleen M. Botham, Peter J. Kennelly and Anthony P. Weli. 2015. Harper's Illustrated Biochemistry. 30th Edition. Mc Graw Hill Lange Medical Books.

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SECOND ALLIED COURSE II

BIOCHEMISTRY (P)

Objectives

This course in planned to impart knowledge on the application Bioinstrumentation

1. All basic instruments – Principle & SOP (Demo)
2. Isolation of Mitochondria from rat liver.
3. Isolation of chloroplasts from spinach leaves.
4. Preparation of the sub-cellular fractions of rat liver cells.
5. Separation of amino acids/sugars/nucleic acids/pigments using paper and thin layer chromatography.
6. Separation of Amino acids by Ion- Exchange Chromatography
7. SDS-PAGE analysis of proteins (Demo).
8. Gel Filtration Chromatography (Demo).
9. Separation of Blood, plasma and serum.
10. Extraction of Proteins from biological materials
11. Protein separation methods : Precipitation, chromatographic, electrophoretic

Reference Books

1. Arun Rastogi, Mathur, N.B.L Mathur, N.B. L. 2010. An Introduction to Practical Biochemistry. Anmol Publications, India.
2. Joshi, R.A. and Saraswat, M. 2002. A textbook of practical Biochemistry. Jain Publishers private limited, India.
3. Malhotra, V.K. 2003. Practical Biochemistry for students- Jaypee Brothers Publishers, India.
4. Rajan, S. 2010. Experimental Procedures in Life Sciences. Anjanaa Book House.
5. Jayaraman. 2011. Laboratory manual in Biochemistry. New age International private limited.
6. P.Palanivelu and M.Salihu. 2009. Analytical biochemistry and separation techniques. 4th Edition, MKU, Madurai.
7. Sadasivam .S and Manickam A. 2009. Introduction to Practical Biochemicstry. 2nd Edition. New Age International Private Ltd. Publishers.
8. Plummer, D.T. 2006. An Introduction to Practical Biochemistry. 3rd Edition. Tata McGraw Hill Co., New Delhi.
9. S.K.Sawhney, Randhir Singh. 2005. Introductory Practical Biochemistry. 2nd Edition. Alpha science international Ltd.

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NON MAJOR ELECTIVE I

BIOTECHNOLOGY FOR HUMAN WELFARE

Objectives

This course is designed to give an idea about the role of biotechnology in relation to Human welfare.

Unit I Agricultural Biotechnology.

Organic farming. Integrated farming, Vermicompost, Crop Improvement.

Unit II Food & Dairy Biotechnology.

Microbes as food, feed. Prebiotics. Probiotics. Algae - SCP, Beta carotene, Fungi as food – Mushroom. Fermented food products.

Unit III Biotechnology for disease diagnosis.

Clinical diagnosis. Lab diagnosis – Microscopy, Macroscopy, Biochemical, serological & Molecular diagnosis of diseases – PCR, RT –PCR, RAPD, RFLP, Karyotping

Unit IV Biotechnology for treatment & prevention of diseases.

Treatment – Symptomatic therapy, specific therapy, antimocrobials
Prevention – Active immunization, passive immunization, combined immunization, herd immunity.

Unit V Environmental Biotechnology.

Waste management – Solid, liquid, sewage, municipal waste Bioremediation. Bioleaching. Biodegradation.

Text Books

1. D. Balasubramanian, C. F. A. Bryce, K. Dharmalingham, J. Green and K.Jayaraman.1996. Concepts in Biotechnology. Universities Press.
2. Ashok K. Chauhan. 2009. A Textbook of Molecular Biotechnology. I.K. International Publishing house Pvt. Ltd.
3. Chandrakant Kokate, SS Jalalpure, Pramod H.J. 2011. Textbook of Pharmaceutical Biotechnology. A division of Reed Elsevier India Pvt. Ltd.

Reference Books

1. B.C. Bhattacharyya and Rintu Banerjee. 2007. Environmental Biotechnology. Oxford Higher Education Publication.
2. Krishna B Ghimire. 2000. Social change and conservation. London Earthscan Publ.
3. P.J.Delves, I S.J.Artin, I D.R.Burton and I I.M.Roitt. 2006. Essential Immunotechnology. 12th Edition. Wiley & Blackwell.

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CORE COURSE IV

IMMUNOLOGY

Objectives

This course is designed to give basic concepts of immunology.

Unit I Fundamental Concepts and Anatomy of the Immune System

Terminology – Antigen, immunogen, hapten, allergen, tolarogen, super antigens, antibody, immunoglobulin, antigenigity, immunogenicity. Self & nonself, innate & acquired immunity. Haematopoesis. Organs, tissues, cells and mediators of immune system - primary lymphoid organs, secondary lymphoid tissues, lymphocytes, mediators. Lymphatic system, lymphocyte circulation and lymphocyte homing. Principles of cell signaling.

Unit II Nonspecific Immunity

Natural built in barriers – skin, semen, saliva, tears, enzymes. Mediators of immune system - lymphokines, cytokines, interferon, tumor necrosis factor. Complement components, natural killer cells, macrophages, phagocytosis, pinocytosis. Inflammatory response. Mucosal and Gut associated lymphoid tissue (MALT&GALT) and mucosal immunity.

Unit III Specific Immunity

Antigen recognition and response. Major Histocompatibility Complex - MHC genes, MHC in immune responsiveness and disease susceptibility. HLA typing. Kinetics of immune response and memory.

CMI response - T cell development, maturation, activation and differentiation. T cell receptor and determinant. T cell subsets. TCR complex. Antigen processing and presentation.

HI response - **B cell:** B cell development, maturation, activation and differentiation. B cell receptor and determinants. B cell subsets. Immunoglobulins - basic structure, classes & subclasses of immunoglobulins, antigenic determinants. Generation of antibody diversity.

Unresponsiveness: tolerance, suppression and potentiation.

Unit IV Vaccinology

Active, passive and combined immunization. Live, killed, attenuated, plasma derived, sub unit, recombinant DNA, protein based, plant-based, peptide, anti-idiotypic and conjugate vaccines – production & applications. Role and properties of adjuvants & ISCOMS.

Unit V Clinical Immunology

Immunity to infection. - Bacteria, viral, fungal and parasitic
Hypersensitivity – Type I, II, III and IV.
Autoimmunity
Transplantation immunology
Tumor & Cancer immunology and immunotherapy
Immunodeficiency

Text Books

1. E. Riot. 2011. Essential Immunology 12th Edition. Wiley & Blackwell.
2. Janeway et al. 1999. Immunobiology. 4th Edition. J Current Biology publications.
3. D. M. Weir, John Stewart. 1997. Immunology. 8th Edition. Churchill Livingstone.
4. P.J.Delves, I S.J.Artin, I D.R.Burton and I I.M.Roitt. 2006. Essential Immunotechnology. 12th Edition. Wiley & Blackwell.
5. Richard M. Hyde. 2012. Microbiology and Immunology. 3rd Edition. Springer Science & Business Media.

Reference Books

1. Brostoff J, Seaddin JK, Male D, Roitt IM., 2002. Clinical Immunology. 6th Edition. Gower Medical Publishing.
2. Paul. 1999. Fundamental of Immunology. 4th Edition. Lippencott Raven.

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CORE PRACTICAL IV

IMMUNOLOGY (P)

Objectives

This course is designed to give basic immunological techniques

Hand on Training

1. Separation of serum & plasma
2. Precipitation reaction – AGD, CIE, SRID, Rocket immuno electrophoresis
3. Agglutination - Blood grouping, Latex agglutination, WIDAL.
4. Labeled assays – IF, RIA (Theory), ELISA (Demo)
5. Animal experiments (Theory only)
   Breeding & maintenance of laboratory animals.
   Immunization.
   Raising antibody – polyclonal & monoclonal.
   Bleeding of experimental animals.

Reference Books.

1. Richard A. Goldsby, Thomas J. Kindt. Barbara, A. Osborne, Janis Kuby. 2003. Immunology. 5th Edition, W. H. Freeman & Company.
2. J. Sambrook and D.W. Russel, CSHL. 2001. Molecular Cloning: A Laboratory Manual, Vols 1-3. Cold spring Harbor Laboratory press.
3. Topley and Wilson. G. Wilson, A.Miles, M.T.Paker. Arnold, Heineman, 1984. Principles of Bacteriology, Virology and immunology. Willy – Blackwell.

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SECOND ALLIED COURSE III

APPLIED BIOCHEMISTRY

Objective

This course discusses basic and advanced methods used in instrumentation investigation focusing on biology applications and to provide ample opportunity for the students to specialize in instruments in centrifugation, chromatography, electrophoresis, spectroscopy and crystallography.

Unit I Centrifugation

Basic principles of sedimentation. Types of centrifuges - Preparative, analytical, high speed, low speed, ultracentrifuge, differential and density gradient. Determination of molecular weight - sedimentation velocity and sedimentation equilibrium.

Unit II Chromatography

General principle of chromatographic separation. Principle, instrumentation and applications of Partition Chromatography, Adsorption Chromatography, Paper Chromatography, TLC, HPTLC, Ion Exchange Chromatography, Gel *permeation* Chromatography, Affinity Chromatography, GC, GLC and HPLC, GC-MS, LC-MS.

Unit III Electrophoresis

Basic principle and types of electrophoresis. Electrophoretic mobility. Factors affecting electrophoretic migration, Technique and uses of agarose gel electrophoresis, PAGE, SDS-PAGE, Two-dimensional electrophoresis and Isoelectricfocussing.

Unit IV Spectroscopy

Beer-Lambert law and its limitations. Light absorption and transmission. Extinction coefficient. Basic design of photoelectric colorimeter and spectrophotometer. Applications of uv-visible spectroscopic techniques. Flame Photometry. Atomic absorption spectrophotometry, Circular Dichroism and Optical Rotatory Dispersion, Principle and application of NMR and ESR techniques.

Unit V Crystallography

Principle, instrumentation and applications of X-Ray Crystallography – X-ray diffraction, Bragg equation, Reciprocal lattice, Miller indices & Unit cell, Concept of different crystal structure, determination of crystal structure (concept of rotating crystal method, powder method).

Text Books

1. P.Palanivelu and M.Salihu. 2009. Analytical Biochemistry and Separation Techniques. 4th Edition, MKU, Madurai.
2. Friefelder, D.M. 1983. Physical Biochemistry: Applications to Biochemistry and Molecular Biology. 2nd Revised edition. W. H. Freeman, USA.

Reference Books

1. Upadhyay and Upadhyay Nath. 2009. Biophysical Chemistry, Principles and Techniques. Himalaya Publishing House.
2. Boyer, R.F. 2000. Modern Experimental Biochemistry, 3rd Edition, Prentice Hall publishers, USA.
3. Hammes, G. G. 2007. Physical Chemistry for the Biological Sciences, 1st Edition. Wiley-Inter science, USA.
4. Pavia, D.L., Lampman, G.M., Kriz , G.S. 2000**.** Introduction to Spectroscopy. 3rd Revised edition. Brooks Cole Publishing Company, USA.
5. Wilson and Walkar. 2000. A Biologist Guide to Principles and Techniques of Practical Biochemistry, 5th Edition, Cambridge University Press, UK.
6. P.Asokan. 2003. Analytical Biochemistry. 2nd Edition. China publications.

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NON MAJOR ELECTIVE II

FOOD PROCESSING

Objectives

This course is planned to give adequate knowledge on various methods of food processing, so that students can this as a means for self employment.

Unit I Introduction to Food processing

Scope and importance; basic concepts about properties of foods: liquid, solid and gases; Equipment for raw material processing: Elementary concept of material handling in food industry, equipment and functioning of belt conveyor, screw conveyor, bucket elevator and pneumatic conveyor, size reduction, mixing and forming, separation and concentration of food components.

Unit II Thermal processing

Degree of processing, selecting heat treatment, heat resistance of microorganisms, nature of heat transfer, protective effects of food constituents, types of thermal treatments.

Unit III Ionizing radiations

Forms of radiant's energy; ionizing radiations, sources and properties; radiation units; radiation effects; limiting indirect effects; dose fixing factors; objectives in food irradiation; safety and quality of irradiated food.

Unit IV Refrigeration

Refrigeration, cool storage and shelf life extension; cool storages with air circulation, humidity control and gas modifications (i.e. CA, MA & SA).

Unit V Freezing

Changes during freezing, rate of freezing, choice for final temperature for frozen foods, freezing methods, freezing effects. Dehydration – Dehydration, water activity and food safety / quality; methods of dehydration. Packaging: Properties of packaging material, factors determining the packaging requirements of various foods and brief description of packaging of frozen products, dried products, fats and oils and thermally processed foods.

Text Books

1. Sivasankar, B. 2002. Food Processing and Preservation. PHI, India
2. Hosahalli S. Ramaswamy & Michele Marcotte. 2005. Food Processing: Principles and Applications Hardcover, CRC Press.

References

1. P.J.Fellows. 2009. Food Processing Technology: Principles and Practice. 3rd Edition Woodhead Publishing.
2. G. Subbulakshmi & Shobha A. Udipi, 2006. Food Processing and Preservation. New Age International Publishers, India.

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CORE COURSE V

PLANT BIOTECHNOLOGY

Objective

This course is planned to give basic knowledge about plant tissue culture, transgenesis, genetic modifications in agriculture.

Unit I Plant tissue culture

Plant tissue culture techniques, *in-vitro* pollination and fertilization, embryo culture and its applications, embryogenesis and organogenesis, micropropagation, haploids and their applications, somaclonal variations and applications, Endosperm culture and production of triploids.

Unit II Genetic manipulation of plants

Introduction, protoplast isolation, culture and regeneration, methods of fusing protoplasts, somatic hybridization. Protoplast and tissue culture manipulation for genetic manipulation of plants.

Unit III Applications of Plant Genetic Engineering

Genetic engineering & crop improvement, herbicide resistance, insect resistance, virus resistance, plants as bioreactors.

Unit IV Genetic modification in Agriculture

Genetic modification in food industry – background, history, controversies over risks, application, future applications.
Transgenic plants, genetically modified food, application, future perspectives & ecological impact of transgenic plants.

Unit V Organic food

Production of organic food, types of organic food, identification of organic food, organic food & preservatives.

Text Books

1. Gamborg O.L and Philips, G.C. 1995. Plant Cell, Tissue and organ culture - Fundamental methods. Narosa Publishing House, New Delhi.
2. Slater A., Scott N.W. and Fowler, M.R. 2008. Plant Biotechnology - The genetic manipulation of plants. Oxford University press, USA.

Reference Books

1. Phundan Singh, 2013. Principles of Plant Biotechnology. Kalyani Publishers,India.
2. V. Kumaresan, 2015. Applied Plant Biotechnology. Saras Publication, India.
3. Singh, 2014. Plant Biotechnology, 2nd Revised Edition, Kalyani Publishers, India.

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CORE COURSE VI

ANIMAL BIOTECHNOLOGY

Objectives

This course is planned to impart knowledge on fundamentals of animal cell culture, GMOs, gene therapy & transgenic animals.

Unit I Embryology

Gametogenesis and fertilization in animals, Molecular events during fertilization, genetic regulations in embryonic development – Artificial Fertilization methods (IVF, IUF, ICSI) and embryo transfer, Superovulation, Polycystic ovarian syndrome (PVS), Collection and preservation of embryo, culture of embryos, culture of embryonic stem cells and its applications.

Unit II Animal cell culture

Fundamentals. Facilities and Applications. Media preparation for Animal cells culture. Types of cell culture: Primary and secondary cell culture, cell transformation, cell lines, Insect cell lines, stem cell cultures, Tests: cell viability and cytotoxicity. Biology of cultured cells, measurement of growth, cell synchronization, senescence and apoptosis. Organ culture and transplantation, Cryopreservation.

Unit III Genetic engineering in animals

GMO (Genetically modified organism), methods of DNA transfer into animal cells - calcium phosphate co precipitation, micro-injection, electroporation, Liposome encapsulation, Biological vectors - Bacteria, Virus. Hybridoma technology, DOLLY, Vaccine production.

Unit IV Gene therapy

Mapping of human genome, Human Genome Project (HGP). RFLP, RAPD and its applications. Gene silencing, DNA finger printing and Forensic Science. Molecular diagnosis of Genetic disorders.

Unit V Transgenics

Transgenic animals. Production and recovery of products from animal tissue cultures: cytokines, Plasminogen activators, Blood clotting factors, Growth hormones, inslulin Transgenic animals – Merits and demerits -Ethical issues in animal biotechnology, transgenic microbes and animals.

Text Books

1. B Singh, SK Gautam and MS Chauhan. 2013. Textbook of Animal biotechnology. The Energy and Research Institute.
2. M.K. Sateesh. 2010. Biotechnology: V: (Including Animal Cell Biotechnology, Immunology and Plant Biotechnology). 2nd Edition. New Age International.

Reference Books

1. Freshney, E. D. 2000. Animal Cell Culture: A practical approach. John Wiley Pub. New York.
2. Mather, J.P. and Barnes, D. (Eds.). 1998. Animal Cell Culture Methods (Methods in Cell Biology. Vol. 57). Academic Press**,** London.
3. Butler, M. (Ed.). 1990. Mammalian Cell Biotechnology - A Practical Approach. Oxford Univ. Press, Oxford.
4. Singer, M. and P. Berg. (Ed.). 1997. Exploring Genetic Mechanisms. University Science Books, Sausilato, CA, USA.
5. E.J. Murray (Ed). 1991. Gene Transfer and Expression Protocols – Methods in Molecular Biology Vol.7. Humana Press,Totowa, NJ.
6. Watson, J.D., N.H.Hopkins, T.W.Roberts, J.A.Steitz and A.M. Weiner. 1987. Molecular Biology of Gene. Benjamin Cummins, San Franscisco.
7. Watson, J.D., M. Gilman, J. Witkouski and M.Zoller. 1992. Recombinant DNA. Scientific American Books, New York.
8. Puller, A. (Ed). 1993. Genetic Engineering of Animals. VCH Publishers, New York.
9. Balinsky, B.I. 1975. An Introduction to Embryology. Saunders, Philadelphia.
10. Beril, N.J. 1974. Developmental Biology. Tata McGraw -Hill Publishing Company Ltd. New Delhi.

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CORE COURSE VII

BIOSTATISTICS AND BIOSAFETY

Unit I Biostatistics - Concepts of statistics-basic principles

Variables - measurements, functions and limitation; Data -types of data, methods of collection of data, merits and demerits- tabulation and representation of data by frequency distribution diagram (Simple/Multiple/Subdivided bar diagram, Pie diagram), Graphs (Histogram, polygon, curve) Stem and leaf diagram; Sampling design – essentials of sampling – census methods - sampling methods – statistical laws – statistical error – test of reliability of sample.

Unit II Measures of central tendency

Mean, median, mode and geometric mean; Measures of dispersion - range, mean deviations, standard deviation, Variance, Skewness, Kurtosis, quartile deviation - merits and demerits; coefficient of variations; Correlation - types and methods of correlation; Regression - simple regression equation, fitting prediction, similarities and dissimilarities of correlation and regression.

Unit III Inferential statistics

Hypothesis - definition, types (0ne tailed, two tailed); Sampling distribution and errors; Statistical Tests of significance -'t'-test, Chi-square and goodness of fit, 'F' test Analysis of variance (ANOVA): One-way.& Two-way.

Unit IV Biosafety

Introduction, biosafety issues in biotechnology-historical background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals.

Unit V Biosafety Guidelines

Biosafety guidelines and regulations (National and International) – operation of biosafety guidelines and regulations of Government of India; Definition of GMOs & LMOs; Roles of Institutional Biosafety Committee, RCGM, GEAC etc. for GMO applications in food and agriculture; Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartegana Protocol.

Text Books

1. Norman T. J. Bailey, 2009. Statistical methods in Biology. University press, Cambridge Rastogi, V.B. 2009. Fundamentals of Biostatistics, Anne Books, India.
2. Sateesh, M.K., 2008. Bioethics and Biosafety, I.K.International Pvt. Ltd, New Delhi, India.
3. Senthil Kumar Sadhasivam and Mohammed, Jaabir. 2008. IPR, Biosafety and Biotechnology Management. Jasen Publications, Tiruchirapalli, India.

Reference Books

1. Sokal, R.R. and F.J. Rohlf. 1981. Biometry. W.K. Freeman. San Francisco.
2. Zar, J.H. 2003. Biostatistical Analysis. Pearson Education (Singapore) Pvt. Ltd., Indian Branch, New Delhi.
3. http://www.cbd.int/biosafety/background.shtml
4. http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section 3.html

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CORE PRACTICAL V

PLANT AND ANIMAL BIOTECHNOLOGY (P)

Objectives

This course is planned to give hands on training on plant & animal tissue culture and biotechnology

Plant Biotechnology

1. Introduction to Safety Practices for plant cell culture laboratory (Theory & Demo).
2. Aseptic culture techniques for establishment and maintenance of cultures (Hands on).
3. Tissue culture media preparation: Preparation of stock solutions of Murashige Skoog basal medium and plant growth regulator stocks (Hands on).
4. Protoplast isolation – 1. Mechanical 2. Enzymatic
5. Protoplast culture (Hands on).
6. Isolation of plant genomic DNA (Hands on).
7. Size analysis of DNA by Agarose Electrophoresis (Hands on).
8. Photoperiodism.
9. Transformation of leaf discs with Agrobacterium (Hands on).
10. Expression of foreign genes into plant cells: use of *Agrobacterium tumefaciens* (Theory).
11. Morphogenesis in tobacco leaf tissue (Hands on).
12. Regeneration of the Shoot Apical Meristem (SAM).
13. Preparation of chloroplast from pea (Hands on).

Animal Biotechnology

1. Isolation of DNA from Animal liver
2. Isolation of DNA from human cheek cells
3. Isolation of DNA from blood
4. Quantification of DNA by spectrophotometeric method
5. Size analysis of DNA by Agarose gell electrophoresis
6. Animal cell culture - Preparation of media
7. Types of Animal cell culture – Primary, secondary & established.

Reference Books

1. M. S. Clark. 1997. *Plant Molecular Biology:* A *Laboratory Manual.* Springer-Verlag.
2. Slater A., Scott N.W. and Fowler, M.R. 2008. Plant Biotechnology - the genetic manipulation of plants. 2nd Edition. Oxford University press, USA.
3. H.S. Chawla, 2002. Introduction to Plant Biotechnology. Oxford and IBH P Publishing Co. Pvt. Ltd. New Delhi.
4. Monica. A. Hughes. 1999. Plant Molecular Genetics. Pearson Education limited, England.
5. Harrison, M.S. and Bal, I.R. 1997. General techniques of all culture Cambridge University press.
6. Prasash M. and Arora. C.K.. 1998. Plant tissue culture, Ammol publication Pvt. Ltd.
7. Darling D.C. and Morgan S.J. 1994. Animal cells, culture Media. Wiley, New York.

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MAJOR BASED ELECTIVE I

BIOINSTRUMENTS

Objectives

This course will give an understanding about the working principles, construction and applications of the instruments often used in the studies related to various disciplines of Biological Sciences.

Unit I Basic Instruments (Theory & Demo)

Principles, operation protocol & applications of the following instruments:Weighing balance, pH meter, Polarography, Radioactivity, ECG, FTIR.

Unit II Microscopy (Hands on)

Observation of different microbes. Light – Bright & Dark field; Phase contrast, Inverted Phase contrast; Fluorescent, Electron – TEM & SEM; Confocal

Unit III Spectroscopy (Theory & Demo)

Colorimeter, Spectrometer, UV visible spectrometer, X – ray spectrometer, ELISA reader, Atomic absorption spectrometer, Flame photometer, Flourimeter & Spectro flourimeter.

Unit IV Separation Techniques (Theory & Demo)

Centrifugation - Principle, operation, types & applications.
Chromatography - Principle, operation & applications - Paper – ascending, descending & Circular, TLC, HPTLC, GC, HPLC, Column Chromatography, Ion Exchange & Affinity Chromatography, LC – MS.

Unit V Electrophoresis (Theory & Demo)

Native & denatured - zone, iso-electrofocusing & isotachophoresis, 1D & 2D.PCR, MoldiTof

Reference Books

1. S.Sadasivam., A. Manickam. 1996. Biochemical Methods. 2nd Edition. New Age International (p) Ltd, Publishers.
2. Dr. G.Rajagobal., Dr. B.D.Toora. 2001. Practical Biochemistry. 1st Edition. Ahuja Book Company Pvt.Ltd.
3. J.Jayaraman. 2000. Laboratory Manual in Biochemistry. New Age International (p).
4. Plummer Mu, David T. Plummer. 1988. Introduction to Practical Biochemistry. Tata McGraw-Hill Education.
5. M. Mooyoung. 1985. Comprehensive Biotechnology. Vol. 2, 3 & 4. Pergamon press.

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CORE COURSE VIII

MICROBIAL BIOTECHNOLOGY

Objectives

This course is designed to give an idea about the avenues of exploiting microbes and to study the downstream processes for product recovery in fermentation.

Unit I Basic principle of Biochemical engineering

Isolation, screening and maintenance of industrially important microbes. Microbial growth and death kinetics with reference to industrially useful microorganisms. Strain improvement for increased yield and other desirable characteristics.

Unit II Concepts of basic mode of fermentation processes

Bioreactor designs and types of fermentation and fermentors. Concepts & basic modes of fermentation - Batch, fed batch and continuous fermentation. Conventional fermentation versus biotransformation. Solid substrate, surface and submerged fermentation. Fermentation economics and fermentation media. Fermenter design - mechanically agitated, pneumatic and hydrodynamic fermenters. Large scale animal and plant cell cultivation and air sterilization.

Unit III Upstream processing

Media formulation, sterilization, aeration and agitation. Measurement and control of bioprocess parameters, scale up and scale down process.

Unit IV Downstream processing

Bioseparation - filtration, centrifugation, sedimentation, flocculation, microfiltration, sonication. Cell disruption – enzymatic lysis and liquid-liquid extraction. Purification by precipitation (ammonium sulfate, solvent), electrophoresis and crystallization. Extraction (solvent, aqueous two phase, super critical) and chromatographic techniques. Reverse osmosis and ultra filtration. Drying, crystallization, storage and packaging. Treatment of effluent and its disposal.

Unit V Applications of Microbes in food processing and production

Fermented foods and beverages, food ingredients and additives used in fermentation and their purification. Fermentation in preparing and preserving foods. Microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products. Process wastes - whey, molasses, starch substrates and other food wastes for bioconversion to useful products. Bacteriocins from lactic acid bacteria – production and applications in food preservation.

Text Books

1. Jackson AT. 1991. Bioprocess Engineering in Biotechnology. Prentice Hall, Engelwood Cliffs.
2. Shuler ML and Kargi F. 2002. Bioprocess Engineering: Basic concepts, 2nd Edition. Prentice Hall, Engelwood Cliffs.

Reference Books

1. Young M.M., Reed. 2004. Comprehensive Biotechnology: The Principles, Applications and Regulations of Biotechnology in Industry, Agriculture and Medicine. Vol 1, 2, 3 and 4. Elsevier India Private Ltd, India.
2. Mansi EMTEL, Bryle CFA. 2007. Fermentation Microbiology and Biotechnology. 2nd Edition. Taylor & Francis Ltd, UK.

CORE COURSE IX

IPR and BIOETHICS

Objectives

This course is designed to give knowledge on IPR & Bioethics

Unit I Introduction to Intellectual Property

Types of IP: Patents, Trademarks, Copyright & Related Rights, Design, Draft design, Traditional Knowledge, Geographical Indications- importance of IPR – patentable and non patentables – patenting life – legal protection of biotechnological inventions – world intellectual property rights organization (WIPO). IP rights in India - IPs of relevance to Biotechnology – few Case Studies.

Unit II Patent Filing Procedures

National & PCT filing procedure; Time frame and cost; Status of the patent applications filed; Precautions while patenting – disclosure/non-disclosure; Financial assistance for patenting - introduction to existing schemes Patent licensing and agreement Patent infringement- meaning, scope, litigation, case studies.

Unit III IPR Agreements and Treaties

History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT; Indian Patent Act 1970 & recent amendments. Patent and copyright Infringement, Patent and copyright misappropriation, and enforcement. Trade secret.

Unit IV Bioethics

Introduction to ethics/bioethics – framework for ethical decision making; purpose and principles of bioethics, Bioethics in medical – drug testing, non-maleficence, Informed consent and human cloning, Bioethics on religious rules and guidelines,

Unit V Biotechnology and ethics

Benefits and risks of genetic engineering – ethical aspects of genetic testing – ethical aspects relating to use of genetic information – genetic engineering and biowarfare; Ethical implications of cloning: Reproductive cloning , therapeutic cloning ; Ethical, legal and socioeconomic aspects of gene therapy, germ line, somatic, embryonic and adult stem cell research-GM crops and GMO's – biotechnology and biopiracy – Ethical implications of human genome project

Text Books

1. Bioethics - by Ellen Frankel Paul, Fred D. Miller, Jeffrey Paul, Fred Dycus Miller Cambridge University Press, 2002.
2. Bioethics & Science, John A. Bryant, Linda Baggott la Velle, John F. Searle – 2002.

Reference Books

1. 1. Jose B. Cibelli, Robert P. Lanza, Keith H. S. Campbell, Michael D.West. 2002. Principles of Cloning, Academic Press, SanDiego, Gurdon.
2. Hoosetti, B.B. 2002. Glimpses of Biodiversity. Daya, New Delhi.
3. Martin. M.W. and Schinzinger.R. 2003. Ethics in engineering. 3rd Edition, Tata McGraw-Hill, New Delhi.
4. BAREACT. 2007. Indian Patent Act 1970 Acts & Rules. Universal Law Publishing Co. Pvt. Ltd.
5. 5. Kankanala, K. C. 2007. Genetic Patent Law & Strategy. 1st Edition. Manupatra Information Solution Pvt. Ltd. Noida, India.
6. 6. Senthil Kumar Sadhasivam and Mohammed, Jaabir. 2008. IPR, Biosafety and Biotechnology Management. Jasen Publications, Tiruchirapalli, India.
7. http://www.cbd.int/biosafety/backgrounds.html
8. http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section 3.html

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CORE PRACTICAL VI

MICROBIAL BIOTECHNOLOGY (P)

Objectives

By doing this course the students will get hands on exposure on strain selection, fermentation, upstream & downstream the product.

1. Isolation of industrially important microorganisms.
2. Selective isolation of actinomycetes – study their growth characteristics.
3. Isolation and enumeration of lactic acid bacteria.
4. Ethanol production by yeast.
5. Estimation of alcohol content by colorimetric method and GLC.
6. Wine production by yeast – setting up a lab experiment.
7. Enzyme production – amylase production.
8. Production of organic acids – citric acid production by solid state fermentation.
9. Antibiotic production by different strains of microbes (Theory).
10. Test for sensitivity of microorganisms.
11. Down stream processes of enzymes – dialysis.
12. Immobilization of yeast cell by alginate beads
13. Bioassay techniques for antibiotics.
14. Isolation & identification microbes from spoiled food.
15. Production of yogurt, butter.
16. 16. Visit to Distillery unit; alcohol production and pharmacological industries. Pasteur Institute (Field visit).

Reference Books

1. E Mans, E.M.T. and C.F.A. Bryce, Taylor and Francis, UK. 2002. Fermentation technology and Biotechnology.
2. Ghose, T.K and P.Ghose. 2003. Biotechnology in India. Springer Publishers, India.
3. Glazer, A.N and H. Nikaido. 1995. Microbial Biotechnology. W.H. Freeman and Co., New York.
4. Stanbury, P.F., A. Whitaker and S.J. Hall. 1995. Principles of fermentation Technology,
   Pergamon, UK.
5. Wolf. Cruzer and Annalise Cruzer. 2000. Biotechnology Text Book of Industrial Microbiology. Panima Publishing House, New Delhi.
6. Patel, A.H. 2001. Industrial Microbiology. Macmillan India Ltd.

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MAJOR BASED ELECTIVE II

FOOD TECHNOLOGY

Objectives

This course is designed to give adequate knowledge on food technology so as to train the students entrepreneurs

Unit I Food chemistry

Constituent of food - contribution to texture, flavour and organoleptic properties of food; food additives - intentional and nonintentional and their functions; enzymes in food processing.

Unit II Food Microbiology

Sources and activity of microorganisms associated with food; food fermentation; food chemicals; food borne diseases - infections and intoxications, food spoilage - causes.

Unit III Food Processing

Raw material characteristics; cleaning, sorting and grading of foods; physical conversion operations - mixing, emulsification, extraction, filtration, centrifugation, membrane separation, crystallization, heat processing.

Unit IV Food Preservation

Use of high temperatures - sterilization, pasteurization, blanching, canning - concept, procedure & application; Low temperature storage - freezing curve characteristics. Factors affecting quality of frozen foods; irradiation preservation of foods.

Unit V Manufacture of food products

Bread and baked goods, dairy products - milk processing, cheese, butter, ice-cream, vegetable and fruit products; edible oils and fats; meat, poultry and fish products; confectionery, beverages.

Text Books

1. Crosby, N.T. 1981. Food packaging. Materials Applied Science Publishers, London.
2. David, S. Robinson. 1997. Food Chemistry and nutritive value. Longman group, UK.
3. Frazier, W.C. and Westhoff, D.C. 1988. Food Microbiology. 4th Edition. McGram-Hill, New York.
4. Pyke, M. 1981. Food Science and Technology. 4th Edition. John Murray, London.
5. Sivasankar, B. 2002. Food processing and preservation. Prentice Hall, New Delhi.

Reference Books

1. Brenner, J.G., Butters, J.R., Cowell, N.D. and Lilly, A.E.V. 1979. Food engineering Operations. 2nd Edition. Applied Sciences Pub. Ltd., London.
2. Desrosier, N.W. 1996. The Technology of Food Preservation. CBS Publishers and Distributors, New Delhi.
3. Fennema, O.R. 1976. Principles of food science: Part I, Food chemistry, Marcel Dekker, New York.
4. Lindsay, W. 1988. Biotechnology, Challenges for the flavor and food Industries. Elsevier Applied Science.

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MAJOR BASED ELECTIVE III

IMMUNOTECHNOLOGY

Unit I Introduction to Immunotechnology

Principles, methods of immunization. Hybridoma technology - monoclonal & polyclonal antibody production, antigen nature, animals of choice and purification of antibodies. Quantification of immunoglobulin by RID, EID and nephlometry.
Immunization techniques, antibody titer assessment. Immunochemistry. Purification of antibody - ammonium sulphate precipitation, PEG Precipitation, affinity purification and column chromatography.

Unit II Cellular Immunology

Purification of mononuclear cells from peripheral blood, isolation and characterization of T cell subsets, B cells and macrophages High content screening & cell imaging by fluorescent activated cell sorter (FACS). Mitogen and antigen induced lympho - proliferation assay; cell mediated lympholysis, and mixed lymphocyte reaction. Assessment of delayed type hypersensitivity reactions. Macrophage cultures, assay for macrophage activation and isolation of dendritic cells. *In - situ* and *In - vivo* characterization of cells from tissues, generation of T cell clones and HLA typing.

Unit III Antigen – Antibody Reaction

Surface plasma resonance. Biosensor assays for assessing ligand –receptor interaction.

Unit IV New generation antibodies

Multigene organization of immunoglobulin genes, antibody diversity, antibody engineering and phage display libraries. Antibodies as *in - vitro* and *in - vivo* probes. Immuno regulators as therapeutic products. Production of immuno regulators, process design, selection criteria for cell lines, culture media, process development, product recovery, stability checking and validation.

Unit V Therapeutic agents

Rationale for vaccine design based on clinical requirements. Recombinant DNA and protein based vaccines, plant-based vaccines and reverse vaccinology. Peptide vaccines, conjugate vaccines, cell therapy and cell based vaccines. Growth factors, interferon, tumor necrosis factor, cytokines, lymphokines & chemokines.

Text Books

1. D. M. Weir, John Stewart. 1997. Immunology. 8th Edition. Churchill Livingstone.
2. P.J.Delves I S.J.artin I D.R.Burton I I.M.Roitt. 2006. Essential Immunotechnology. 12th Edition,
3. Roitt, I. 2000. Essential Immunology, IV Edition. Blackwell Sci. NY.

Reference Books

1. Benjamini E, Coico R and G. Sunskise. 2000. Immunology a short course. IV Edition. Wiley – Liss publication, NY.
2. Goldsby R.A. Kindt T.I and Osborne B.A Kuby. 2000. Immunology 4th Edition. WH Freeman &Co, NY.

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