BHARATHIDASAN UNIVERSITY  **TIRUCHIRAPPALLI - 620 024.**

B.Sc. BIOTECHNOLOGY

CHOICE BASED CREDIT SYSTEM –

LEARNING OUTCOMES BASED CURRICULUM FRAMEWORK (CBCS - LOCF)

(Applicable to the candidates admitted from the academic year 2022-23 onwards)

(NAAN MUDHALVAN SCHEME was implemented from 2nd to 6th Semester)

Sem.	Part	Course	Title	Ins. Hrs	Credit	Exam Hours	Marks		Total
							Int.	Ext.	
I	I	Language Course – I (Tamil $ / Other Languages + #)		6	3	3	25	75	100
	II	English Course - I		6	3	3	25	75	100
	III	Core Course – I (CC)	Cell Biology	5	5	3	25	75	100
		Core Practical – I(CP)	Cell Biology	4	4	3	40	60	100
		First Allied Course – I (AC)	Basic Microbiology	4	4	3	25	75	100
		First Allied Practical (AP)	Microbiology	3	-	-	-	-	-
	IV	Value Education		2	2	3	25	75	100
	TOTAL			**30**	**21**	**-**	**-**	**-**	**600**
II	I	Language Course - II (Tamil $ / Other Languages + #)		6	3	3	25	75	100
	II	English Course - II		4	3	3	25	75	100
	III	Core Course – II (CC)	Molecular Biology	5	5	3	25	75	100
		Core Practical – II (CP)	Molecular Biology	4	4	3	40	60	100
		First Allied Practical (AP)	Microbiology	3	2	3	40	60	100
		First Allied Course – II (AC)	Applied Microbiology	4	4	3	25	75	100
		Add on Course – I ##	Professional English – I	6*	4	3	25	75	100
	IV	Environmental Studies		2	2	3	25	75	100
	VI	Naan Mudhalvan Scheme (NMS) @@	Language Proficiency for Employability - Effective English	2	2	3	25	75	100
	TOTAL			**30**	**29**	**-**	**-**	**-**	**900**

III	I	Language Course – III (Tamil $ / Other Languages + #)		6	3	3	25	75	100
	II	English Course - III		6	3	3	25	75	100
	III	Core Course – III (CC)	rDNA Technology	5	5	3	25	75	100
		Core Practical - III (CP)	rDNA Technology	4	4	3	40	60	100
		Second Allied Course – I (AC)	Biomolecules	4	4	3	25	75	100
		Second Allied Practical (AP)	Biochemistry	3	-	-	-	-	-
		Add on Course – II ##	Professional English - II	6*	4	3	25	75	100
	IV	Non-Major Elective I @ - Those who choose Tamil in Part I can choose a non-major elective course offered by other departments. Those who do not choose Tamil in Part I must choose either a) Basic Tamil if Tamil language was not studied in school level **or** b) Special Tamil if Tamil language was studied upto 10^{th} & 12^{th} std.	Biotechnology for Human Welfare	2	2	3	25	75	100
	VI	Naan Mudhalvan Scheme (NMS) @@	Digital Skills for Employability – Microsoft Digital Skills	-	2	3	25	75	100
	TOTAL			**30**	**27**	**-**	**-**	**-**	**800**
IV	I	Language Course –IV (Tamil $ / Other Languages + #)		6	3	3	25	75	100
	II	English Course – IV		6	3	3	25	75	100
	III	Core Course - IV (CC)	Immunology and Immunotechnology	5	5	3	25	75	100
		Core Practical - IV (CP)	Immunology	4	4	3	40	60	100
		Second Allied Practical (AP)	Biochemistry	3	2	3	40	60	100
		Second Allied Course – II (AC)	Analytical Biochemistry	4	4	3	25	75	100
	IV	Non-Major Elective II @ - Those who choose Tamil in Part I can choose a non-major elective course offered by other departments. Those who do not choose Tamil in Part I must choose either a) Basic Tamil if Tamil language was not studied in school level **or** b) Special Tamil if Tamil language was studied upto 10^{th} & 12^{th} std.	Food Processing Technology	2	2	3	25	75	100
	VI	Naan Mudhalvan Scheme (NM) @@	Employability Skills - Employability Skills	-	2	3	25	75	100
	TOTAL			**30**	**25**	**-**	**-**	**-**	**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)	Environmental Biotechnology	5	5	3	25	75	100
		Core Practical -V (CP)	Plant Animal Biotechnology and Environmental Biotechnology	4	4	3	40	60	100
		Major Based Elective – I (Any one)	1. Developmental Biology 2. Bioinformatics	5	4	3	25	75	100
	IV	Skill Based Elective I	Molecular Diagnostics	4	2	3	25	75	100
		Soft Skills Development	Soft Skills Development	2	2	3	25	75	100
	VI	Naan Mudhalvan Scheme (NMS) @@	Advanced Technology for Employability in Life science – Medical Coding	-	2	3	25	75	100
	TOTAL			**30**	**29**	**-**	**-**	**-**	**800**
VI	III	Core Course - VIII (CC)	Microbial Biotechnology	6	5	3	25	75	100
		Core Course - IX (CC)	Biostatistics and Biosafety	6	5	3	25	75	100
		Core Practical – VI(CP)	Microbial Biotechnology	4	4	3	40	60	100
		Major Based Elective – II (Any one)	1. IPR and Bioethics 2. Nanotechnology	5	4	3	25	75	100
		Project		4	3	-	20	80	100
	IV	Skill Based Elective – II	Clinical Trial and Data Management	4	2	3	25	75	100
	V	Gender Studies		1	1	3	25	75	100
		Extension Activities **		-	1	-	-	-	-
	VI	Naan Mudhalvan Scheme (NMS) @@	Advanced Medical Coding	-	2	3	25	75	100
		TOTAL		**30**	**27**	**-**	**-**	**-**	**800**
GRAND TOTAL				**180**	**158**	**-**	**-**	**-**	**4700**

$ 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.

The Professional English – Four Streams Course is offered in the 2nd and 3rd Semester (only for 2022-2023 Batch) in all UG Courses. It will be taught apart from the Existing hours of teaching / additional hours of teaching (1 hour /day) as a 4 credit paper as an add on course on par with Major Paper and completion of the paper is must to continue his / her studies further. (As per G.O. No. 76, Higher Education (K2) Department dated: 18.07.2020).

* The Extra 6 hrs / cycle as per the G.O. 76/2020 will be utilized for the Add on Professional English Course.

@ NCC Course is one of the Choices in Non-Major Elective Course. Only the NCC cadets are eligible to choose this course. However, NCC Course is not a Compulsory Course for the NCC Cadets.

** Extension Activities shall be outside instruction hours.

@@ Naan Mudhalvan Scheme.

SUMMARY OF CURRICULUM STRUCTURE OF UG PROGRAMMES

Sl. No.	Part	Types of the Courses	No. of Courses	No. of Credits	Marks
1.	I	Language Courses	4	12	400
2.	II	English Courses	4	12	400
3.	III	Core Courses	9	45	900
4.		Core Practical	6	24	600
5.		Allied Courses I & II	4	16	400
6.		Allied Practical	2	4	200
7.		Major Based Elective Courses	2	8	200
8.		Add on Courses	2	8	200
9.		Project	1	3	100
10.	IV	Non-Major Elective Courses	2	4	200
11.		Skill Based Elective Courses	2	4	200
12.		Soft Skills Development	1	2	100
13.		Value Education	1	2	100
14.		Environmental Studies	1	2	100
15.	V	Gender Studies	1	1	100
16.		Extension Activities	1	1	0
17.	VI	Naan Mudhalvan Scheme	5	10	500
	Total		**48**	**158**	**4700**

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First Year	CORE COURSE I CELL BIOLOGY	Semester I
Code	(Theory)	Credit: 5

COURSE OBJECTIVES:

The main objectives of this course are to:

- Familiarize the student in different areas of cell biology, including cell structure and functions and its organelles.
- Develop a comprehensive understanding of the cellular membranes and matrices.
- Impart the knowledge of microscopic techniques to understand the cell structure.

UNIT – I FUNDAMENTALS OF CELL STRUCTURE:

Diversity of cell size and shape. Cell theory, Protoplasm theory, Isolation and growth of cells; Basic properties of cells; Different classes of cells – Prokaryotic and eukaryotic cells. Cell division and cell cycle - Mitosis and meiosis, their regulation, steps in cell cycle, regulation and control of cell cycle.

UNIT – II CELLULAR MEMBRANES AND MATRICES:

Chemical composition and fluidity of membranes; lipid bilayer and membrane protein. Dynamic nature of membranes; membrane potentials; transportation across the cell membrane; Diffusion, osmosis, ion channels, active transport, membrane pumps, mechanism of sorting and regulation of intracellular transport, Extracellular matrices – structure and function; cytoskeleton – structure and function.

UNIT –III CELLULAR ORGANELLES IN METABOLISM:

Endoplasmic reticulum (ER)– smooth & rough; functions of ER; 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 ENERGY METABOLISM:

Mitochondria –Morphology – structural variations; Chemical compositions and Functions; Enzyme system of Mitochondria; Mode of energy production – oxidation of carbohydrates: Glycolysis, oxidative decarboxylation, Krebs cycle; respiratory chain and oxidative phosphorylation; Chloroplast – structure and function. Import and Sorting of Chloroplast Proteins.Photosynthesis; Electron Flow through Photosystems I and II, Cyclic Electron Flow, ATP Synthesis.

UNIT – V TOOLS AND TECHNIQUES IN CELL BIOLOGY:

Resolving power of Microscope- Light microscope, Principles and applications of Bright field, Dark field, Phase contrast, Fluorescent Microscope; Electron microscopes- Transmission electron Microscope (TEM) and Scanning electron microscope (SEM). Cell fractionation and centrifugation; Autoradiography.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Watson JD, Gilman M, Witkowski J and Zoller M. 2010. *Recombinant DNA*. Scientific American Books. 4th Edition. New York.
2. Blackburn GM and Gait MJ. 2006. *Nucleic Acids in Chemistry and Biology*. Oxford University Press.
3. Lodish H, Baltimore D, Beck A, Zipursky SL, Matsudaria P and Darnell J. 2007. *Molecular Cell Biology*. 4th Edition. Scientific American Books.
4. Cooper M. 2007. *The Cell- A Molecular Approach*. 2nd Edition. ASM Press.
5. Lewis JK and Valerie M Kish. 1995. *Principle of Cell and Molecular Biology 2nd Edition*. Benjamin-Cummings Publishing Company.
6. De Robertis, EDP and E.M.F Robertis. 1987. *Cell and Molecular Biology*. 8th Edition. Saunders Company.
7. Brown. T.A. 2011. *Introduction to genetics: A molecular approach*. 1st Edition. Garland Science.
8. Watson, J. D. (2013). *Molecular Biology of the Gene*, Books a la Carte Edition. Benjamin Lewin. 2010. Genes XI. 11th Edition. Jones & Bartlett Learning.
9. Meyers, R. A. (Ed.). (1996). *Molecular biology and biotechnology: a comprehensive desk reference*. John Wiley & Sons.
10. Freifelder D. 1987. *Molecular Biology*, Narosa Publishing House. New Delhi.
11. Lewin B. 2017. *Genes XII*. Oxford University Press, London.
12. Ajoy Paul. 2014. *Textbook of Cell and Molecular Biology*. Books and Allied Ltd.
13. Karp, G., Iwasa, J., & Marshall, W. (2018). *Karp's Cell Biology*. John Wiley & Sons.
14. Alberts, B., Bray, D., Hopkin, K., Johnson, A. D., Lewis, J., Raff, M., & Walter, P. (2015). *Essential cell biology*. Garland Science.
15. Lodish, H., Berk, A., Kaiser, C. A., Kaiser, C., Krieger, M., Scott, M. P. & Matsudaira, P. (2008). *Molecular cell biology*. Macmillan.
16. Pollard, T. D., Earnshaw, W. C., Lippincott-Schwartz, J., & Johnson, G. (2016). *Cell* Elsevier Health Sciences.
17. Verma PS, Agarwal VK. 2016. *Cell Biology*. S.Chand & Company Pvt. Ltd.
18. https://archive.nptel.ac.in/courses/102/103/102103012/
19. https://archive.nptel.ac.in/course.html

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Exhibit a knowledge base in classes of cells and types of cell division.
- Outline a clear and concise idea about cell membrane and cytoskeleton.
- Discuss the properties and functions of the cytoplasmic organelles.
- Illustrate the reactions that comprise energy metabolism.
- Explain the principles and applications of the microscopes.

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First Year	CORE PRACTICAL I CELL BIOLOGY	Semester I
Code	(Practical)	Credit: 4

COURSE OBJECTIVES:

The main objectives of this course are to:

- Study the cells and their enumeration by appropriate techniques.
- Study the different types of cell division.
- Acquire knowledge in subcellular fractionation.

EXPERIMENTS:

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

REFERENCES:

1. David A. Thompson. 2011. *Cell and Molecular Biology Lab Manual*. Create Space Independent Publishing Platform'
2. Harley, J., & P Harley, J. (2002). *Laboratory exercises in microbiology*. The McGraw – Hill.
3. Gunasekaran, P. (2007). *Laboratory manual in microbiology*. New Age International
4. https://youtu.be/Izk1QMg8190
5. https://youtu.be/IR5jps-xmzA

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Describe the principle and applications of Microscope.
- Demonstrate the observation of different types of cells and their enumeration.
- Illustrate the different types of cell division.
- Outline a clear and concise idea about specialized chromosomes.
- Identify the motility of an organism.

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First Year	FIRST ALLIED COURSE I BASIC MICROBIOLOGY	Semester I
Code	(Theory)	Credit: 4

COURSE OBJECTIVES:

The main objectives of this course are to:

- Study about the history and development of Microbiology.
- Study about the different types of microorganisms- their structure and organization.
- Study the viruses and associated diseases.

UNIT – I History and Scope of Microbiology:

Scope and Relevance of Microbiology, Discovery of Microorganisms. Conflict over Spontaneous generation. The golden age of Microbiology, Development of Industrial Microbiology and Microbial Ecology. Concept of fermentation. Establishment of fields of medical microbiology, immunology and environmental microbiology with special reference to the work of the 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.

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 and Cellular microorganisms.
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 ultrastructure, 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. Corona virus and associated vaccines

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Tortora, G. J., Case, C. L., & Funke, B. R. 2016. *Microbiologia-12ª Edi Microbiology: An Introduction*. Pearson Education.
2. Pommerville, J. C., & Pommerville, J. C. 2011. *Alcamo's fundamentals of microbiology*. Jones & Bartlett Learning.
3. Black, J. G., & Black, L. J. (2018). *Microbiology: principles and explorations*. John Wiley & Sons.
4. Gillespie, S. H., & Hawkey, P. M. (Eds.). (2006). *Principles and practice of clinical bacteriology*. John Wiley & Sons.
5. Saxena, S. (2015). *Applied microbiology*. New Delhi: Springer.
6. Powar and Daginwala. 2010. *General Microbiology*. Vol. I. Himalaya Publisher.
7. Kumar, S. 2012. *Textbook of microbiology*. JP Medical Ltd.
8. Willey, J. M., Sherwood, L., & Woolverton, C. J. 2009. Prescott's principles of microbiology.
9. Alcamo, I. E. 1987. Fundamentals of microbiology. *1987. Benjamin/Cummings Publishing, Menlo Park, Ca(Usa).*
10. Ananthanarayan, R. (2006). *Ananthanarayan and Paniker's textbook of microbiology*. Orient Blackswan.
11. Pelzer, Chan and Kreig. 2008. *Fundamentals of Microbiology*. 7th Edition. McGraw-Hill.
12. https://archive.nptel.ac.in/courses/102/103/102103015/
13. https://dth.ac.in/medical/courses/Microbiology/block-1/1/index.php

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Recall the history and scope of Microbiology.
- Outline the classifications of microorganisms.
- Summarise the structural organization of Bacteria, Algae and Fungi.
- Explain the different types of reproduction in Protozoa and Viruses.
- Describe the corona virus and associated diseases.

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First Year	FIRST ALLIED PRACTICAL I MICROBIOLOGY	Semester I
Code	(Practical)	Credit: 2

COURSE OBJECTIVES:

The main objectives of this course are to:

- Acquire knowledge about sterilization techniques
- Comprehend the various methods for identification of various types of microorganisms
- Study about the various culture techniques.

EXPERIMENTS:

1. SOP and GLP
2. Sterilization – glassware & media – wet, dry & filtration
3. Preparation of Microbiological media
4. Isolation of microorganisms from various samples
5. Counting of microbes – Use of haemocytometer, colony counting
6. Biochemical identification of bacteria.
7. Identification of microbes – Microscopy & Macroscopy
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. Measurement of Bacterial Growth – turbid metric method.
12. Staining of fungi
13. Identification of algae, fungi, lichens & yeast
14. Identification of protozoa
15. Identification of nematodes

REFERENCES:

1. Gunasekaran, P. 2009. *Laboratory Manual in Microbiology.* 1st Edition. New Age International Publishers. Reprint 2009.
2. Delacourt, D 2012. *Laboratory Manual for General Microbiology*. Lake – Sumter Community College, Leesbug, FL.
3. Brown, A., & Smith, H. (2014). *Benson's Microbiological Applications*, Laboratory Manual in General Microbiology, Short Version. McGraw-Hill Education.
4. Leboffe, M. J., & Pierce, B. E. (2015). *Microbiology: laboratory theory and application*. Morton Publishing Company.
5. Atlas, R. M. (2004). *Handbook of microbiological media*. CRC press.
6. James G. Cappuccino and Natalie Sherman. 2013. *Microbiology: A laboratory Manual*. 10th Edition. Benjamin Cummings.
7. Arnold L. Demain& Julian E. Davies. 1999. *Manual of Industrial Microbiology and Biotechnology*. 2nd Edition. ASM press.
8. https://vlab.amrita.edu/?sub=3&brch=73&sim=208&cnt=1
9. https://r.search.yahoo.com/_ylt=Awrx2MAwVKdi0EoAHB27HAx.;_ylu=Y29sbwNzZzMEcG9zAzIEdnRpZAMEc2VjA3Ny/RV=2/RE=1655162033/RO=10/RU=https%3a%2f%2fmicrobenotes.com%2finstruments-used-in-microbiology-lab%2f/RK=2/RS=mPhd5ukzKP8zntIIARI6rZwaZJ8-

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Demonstrate the different types of sterilization used in microbiological laboratory
- Illustrate the methods used for the isolation and counting of microbes.
- Outline the various pure culture techniques and measurements of bacterial growth.
- Summarise the various staining techniques for the identification of microbes.
- Apply various biochemical tests for the identification of bacteria.

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First Year | **CORE COURSE II MOLECULAR BIOLOGY (Theory)** | **Semester I**

Code | **Credit: 5**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Give an understanding about the basics of molecular biology
- Learn about the organization of genetic material
- Study about the classical genetics & molecular aspects.

UNIT – I Organization of Genetic Material:

Identification of genetic material (Griffith, Avery and Hershey and Chase experiments). Organization of genetic material, Nucleus, nuclear envelops, nucleoplasm, chromatin and chromosomes, allele, loci, gene. Structure and functions of Nucleic acids: Nucleosides & Nucleotides, purines and pyrimidine. Biologically important nucleotides, Watson and Crick model of DNA structure, A, B & Z forms of DNA, Supercoiled and relaxed DNA, denaturation and renaturation of DNA.

UNIT – II Classical Genetics:

Specialized chromosomes, chromosomal abnormalities, 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 and crossing over, Pedigree analysis.

UNIT – III Central Dogma:

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. Characteristics of genetic code.

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 – mechanism of excision repair, SOS repair and mismatch 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.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

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.
2. George M. Malacinski. (2013). *Freifeder's Essentials of Molecular Biology*. Norosa Publishing House.
3. Stanely R. Maloy, Jhon E Cornan Jr, David Freifelder. (1994). *Microbial genetics*. 2nd Edition. Jones and Bartlett publisher.
4. Uldis N. Streips and Ronalad E. Yasbin. (2002). *Modern Microbial Genetics*. 2nd Edition. Wiley-Blackwell.
5. Sandy B. Primrose, Richard M. Twyman and Robert W. Old. (2008). *Principles of Gene Manipulation*. 6th Edition. Blackwell Science.
6. Krebs JE., Kilpatrick ST and Goldstein ES. (2013). *Lewin's Genes XI*, Jones & Bartlett Learning. Burlington, MA
7. Ajoy Paul. (2011). *Textbook of Cell and Molecular Biology***.** Books and Allied Ltd.
8. Allison A. Lizabeth (2012) *Fundamental Molecular Biology*, 2nd Edition. J Willey and Sons, Hoboken,New Jersey
9. Berg JM, Tymoczko JL, Gatto GJ and Stryer L (2015) *Biochemistry, 8th Edition*, WH Freeman & Co., New York.
10. Benjamin Lewin. (2007). *Gene IX*. 9th Edition, Jones and Barlett Publishers.
11. 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.
12. Watson JD, Gilman M, Witkowski J, Zoller M. (1992). *Recombinant DNA*. Scientific American Books.
13. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R. (2008). *Molecular Biology of the Gene*, 6th edition, Cold Spring Harbour Laboratory Press, Pearson Publication.
14. Freifelder D (2012). *Molecular Biology*, 5th edition. Narosa Publishing House, India
15. Freifelder D and Malacinski GM (2005) *Essentials of Molecular Biology*, 4th Edition, John and Bartlett Publishing, UK
16. https://www.web-books.com/MoBio/Free/Chap1.htm
17. https://www.web-books.com/MoBio/Free/Chap7.htm
18. https://www.web-books.com/MoBio/Free/Chap5.htm

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Learn about the organization of Chromatin, Chromosomes and Nucleus
- Know about population genetics and laws of inheritance
- Gain knowledge of steps involved in transcription and translation
- Explain how DNA replication has occurred in prokaryotes and eukaryotes
- Understand about the regulation of gene expression

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First Year	CORE PRACTICAL II MOLECULAR BIOLOGY	Semester I
Code	(Practical)	Credit: 4

COURSE OBJECTIVES:

The main objectives of this course are to:

- Trian the students to get hands-on experience in basic molecular biology techniques.
- Learn about purification and quantification of macromolecules
- Acquire knowledge in molecular genetics

EXPERIMENTS:

1. Isolation and purification of genomic DNA from prokaryotes.
2. Isolation and purification of genomic DNA from eukaryotes.
3. Observation of DNA - Agarose gel electrophoresis.
4. Quantification of nucleic acids – DNA & RNA.
5. Separation of protein by SDS PAGE
6. Staining of proteins - Amido black, coomassie brilliant blue & AgNO3.
7. Bacterial mutagenesis – physical & chemical methods.
8. Preparation of *E. coli* competent cells (Demo)
9. Transformation of bacteria – $CaCl_2$ method (Demo)
10. Bacterial conjugation (Demo)

REFERENCES:

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). *Freifelder'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. http://www.fastbleep.com/biology-notes/41/122/1216
6. http://cshprotocols.cshlp.org/content/2006/1/pdb.prot4455
7. http://www.med.upenn.edu/lamitinalab/documents/EthanolPrecipitationofDhttp://bitesizebio.com/384/the-basics-how-phenol-extraction-works/
8. http://physiology.med.cornell.edu/faculty/mason/lab/zumbo/files/PHENOLCHLOROFORM.pdf

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Know about how DNA is isolated from prokaryotes as well eukaryotes
- Develop the basic knowledge on estimation of nucleic acids
- Gain the experience on separation of proteins
- Identify bacterial growth reduction using physical and chemical mutagens
- Learn about how gene transfer methods are used to reproduce bacteria

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First Year	FIRST ALLIED COURSE II APPLIED MICROBIOLOGY	Semester I
Code	(Theory)	Credit: 4

COURSE OBJECTIVES:

The main objectives of this course are to:

- Usage of microorganisms in favour of human beings
- Microbial technologies relevant to food industries
- Microbial applications in environmental and agriculture

UNIT – I Fermentation:

Introduction to fermentation technology. Isolation, preservation and improvement of microbial strains. Culture selection and development of inoculum for various fermentation processes. Upstream process. Media for industrial fermentation: formulation and sterilization.

UNIT – II Microbial Energetics:

Energy from inorganic compounds- production of reducing power in chemolithotrophs. Energy from visible radiation- photosynthesis in blue-green algae and bacteria. Energy from biomolecules-carbohydrates and lipids. Energy from hydrocarbons- alkanes and alkenes. Growth Kinetics of microbes- growth and product formation in batch, fed-batch and continuous cultures.

UNIT – III Food Microbiology:

Introduction to food poisoning and food borne diseases: Determination of microorganisms-Macroscopic, microscopic and sampling methods. Principles of food preservations- Asepsis, Preservation by use of High temperature, Low temperature, Canning, Drying, Radiation and Food additives. Microbial quality and safety.

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.

Bacterial diseases: Gram-positive organisms-*Staphylococcus aureus*; Gram negative organisms: *E. coli.*

Viral diseases: Serological and Molecular diagnosis of viral infections (Detection by PCR techniques): Hepatitis, Polio and Corona.

Fungal diseases: Laboratory diagnosis. Mycosis – Superficial, Subcutaneous and Systemic infections – *Candida albicans* and *Aspergillus*.

Parasitic infections: *Entamoeba histolytica* and *Plasmodium vivax.*

UNIT – V Environmental and Agricultural Microbiology:

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

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Prescott, Harley, Klein. 2003. *Microbiology*. 5thEdition. 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.
5. Geradrd J. Tortora, Berdell R. Funke. 2019. *Microbiology: An Introduction.* 4th Edition-Pearson education
6. Madigan Michael T, Martinko John M, Bender Kelly S. 2017. *Biology of Microorganisms*. 14th edition, Pearson education.
7. AH Rose. 1976. *Chemical Microbiology – An introduction to microbial physiology* –Butterworth, London.
8. MT Madigan, JM Martinko & Jack Parker. 2002. *Brock Biology of Microorganisms* – 10th Edition – Pearson and Education Inc., New Jersey.
9. Patricia M. Tille. 2013. *Diagnostic Microbiology*. 13th Edition-Mosby
10. https://books.google.co.jp/books?hl=en&lr=&id=o3HnX18eU3AC&oi=fnd&pg=PA8&dq=applied+microbiology&ots=yZwM0XiN-2&sig=bXq4n47iiRsEKTD_vjgHE3pJVeQ#v=onepage&q=applied%20microbiology&f=false

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Learn about the organization of Chromatin, Chromosomes and Nucleus
- Know about population genetics and laws of inheritance
- Gain knowledge of steps involved in transcription and translation
- Explain about how DNA replication occurs in prokaryotes and eukaryotes
- Understand about the regulation of gene expression

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Second Year	CORE COURSE III rDNA TECHNOLOGY	Semester III
Code	(Theory)	Credit: 5

COURSE OBJECTIVES:

The main objectives of this course are to:

- Introduce the concepts of gene and genomics for gene cloning vectors and current cloning methods.
- Familiarize with the tools used for gene manipulation towards selection strategies and screening of transformants.
- Impart the knowledge about applications of cloning and its current development.

UNIT - I Introduction to rDNA Technology:

Introduction to genetic engineering and recombinant DNA technology. Methodologies involved in rDNA technology. Isolation and analysis of genes. Enzymes involved in 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:

Methods of transformation. Construction of genomic libraries and cDNA Libraries. Probe construction and screening and Gateway Cloning. DNA amplification using polymerase chain reaction (PCR): key concepts, Analysis of amplified products. Applications of PCR: Ligase chain reaction. RFLP, RAPD and DNA Finger printing. Principles of Southern, Northern and Western blotting techniques. Real-Time qPCR.

UNIT – IV 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:

Transgenic plants- virus and pest resistance, 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.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008). *Molecular Biology of the Cell* (5th Ed.). New York: Garland Science.
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.
2. Old, R.W., and Primrose S.B.(1996). *Principles of Gene Manipulation: An Introduction to Genetic Engineering.* (2nd Edition). Blackwell Scientific Publications, Oxford.
3. Glover, DM. and BD. Hames. (1995). *DNA Cloning: A Practical Approach.* (2nd Edition). IRL Press, Oxford.
4. Innis, M.A., D.H. Gelfand and J.J. Sninskey. (1995). *PCR Strategies.* Academic Press, San Diego.
5. 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.
6. Watson J.D., Gilman M., Witkowski, J. and Zoller M. (1992). *Recombinant DNA.* (2nd Edition). Scientific American Books, New York.
7. Daniel L.Hartl. (2011). *Analysis of Genes and Genomes.* 8th edition. Maryellen Ruvolo. Laxmi Publications.
8. Keya Chaudhuri. (2012). *Recombinant DNA Technology*. The Energy and Resources Institute, TERI.
9. 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.
10. Tvan R.S. (1997). *Recombinant Gene Expression Protocols.* Humana Press Inc., Tokowa.
11. http://epgp.inflibnet.ac.in/
12. https://nptel.ac.in/courses/102/103/102103013/
13. https://www.ncbi.nlm.nih.gov/books/NBK21498/
14. https://www.genome.gov/genetics-glossary/Electrophoresis
15. https://genome.crg.cat/courses/laCaixa05/Genomes/index.html
16. https://onlinecourses.swayam2.ac.in/cec20_bt07

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Obtain an in-depth knowledge of enzymes in rDNA technology.
- Understand the importance of vectors used in molecular biology and use such acquaintance to carry out gene cloning and library construction.
- Acquire complete knowledge about cloning strategies.
- Selection and screening of rDNA products and gene sequencing
- Gain information about the application of rDNA Technology

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Second Year	**CORE PRACTICAL III rDNA TECHNOLOGY (Practical)**	**Semester III**
Code		**Credit: 4**

COURSE OBJECTIVES:

The objectives of this course are to:

1. Provide hands-on training in recombinant DNA technology.
2. Provide an overview of the steps involved in gene cloning

EXPERIMENTS:

1. Isolation of genomic DNA from plant, animal cells & bacterial cells
2. Isolation of plasmid DNA
3. Restriction digestion – single & double digestion.
4. Ligation.
5. Preparation of competent *E. coli* cells
6. Selection & screening of rDNA products – Antibiotic resistance, Blue white colony.
7. PCR amplification
8. Southern blotting (Demo)
9. RAPD (Demo)
10. RFLP (Demo)

REFERENCES:

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.
4. Ashish S. Verma., Surajit Das., Anchal Singh., (2014). *Laboratory Manual in Biotechnology Students Laboratory Manual* in Biotechnology Students Chand Publisher.
5. Chawla (2004). *Plant Biotechnology.* Oxford & IBH Publishing Company Pvt. Limited.
6. https://www.slideshare.net/AsmaAshraf7/dna-isolation-73144905
7. http://www2.southeastern.edu/Academics/Faculty/jtemple/486/experiment%202.pdf

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Demonstrate the relationships between DNA, RNA and proteins.
- Carry out DNA extraction, purification and quantification from living cells.
- Perform Polymerase Chain Reaction (PCR) as a means of DNA amplification

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Second Year	SECOND ALLIED COURSE I BIOMOLECULES (Theory)	Semester III
Code		Credit: 4

COURSE OBJECTIVES:

The objectives of this course are to:

- Gain knowledge about the structure, properties and functions of biomolecules.
- Provide information about the deficiency manifestation of vitamins and minerals

UNIT – I Carbohydrates Definition and Classification:

Isomerism, anomeric form and mutarotation. Classification of monosaccharides - Structure, occurrence, chemistry and functions of glucose, Disaccharides - Structure, occurrence, chemistry and functions of sucrose. Homopolysaccharides - Occurrence, structure, chemistry and functions of starch and glycogen. Heteropolysaccharides - Occurrence, types, composition and functions of peptidoglycan, agarose and hyaluronate.

UNIT – II Amino Acids and Proteins:

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

Proteins: Introduction, classification based on solubility, shape, composition and function. Structure of proteins - Primary, secondary, tertiary and quaternary. The behaviour of proteins in solutions, salting-in and -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 . 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 – V 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.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Allan Fershi. 1984. *Enzyme structure and mechanism.* 2nd Edition. W.H. Freeman & Co. Ltd., USA.
2. Trevor Palmer, 1985. *Understanding Enzymes*. 2nd Edition. Ellis, Horwood Limited.
3. 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.
4. Donald Voet and Judith G.Voet, 2004. *Biochemistry*. 3rd Edition. John Wiley, New York.
5. https://nptel.ac.in/courses/102/105/102105034/
6. https://nptel.ac.in/content/storage2/courses/126104004/LectureNotes/Week-1_06-Carbohydrate.pdf

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Understand the classification and structure of carbohydrates.
- Ensure students know the structure, properties and functions of amino acids and proteins.
- Gain knowledge about the classification, properties and biochemical functions of lipids.
- Enable the students to learn the essential functions, structures and biological importance of nucleic acids, vitamins and minerals.
- Understand the significance of the complex bio-molecules, polysaccharides, lipids, proteins, nucleic acids, vitamins and minerals.

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Second Year	SECOND ALLIED PRACTICAL BIOCHEMISTRY	Semester III
Code	(Practical)	Credit: 5

COURSE OBJECTIVES:

The objectives of this course are to:

- Impart knowledge of the safety measure for working in Biochemistry Laboratory.
- Acquire knowledge about the qualitative analysis of Biomolecules.

EXPERIMENTS:

1. General guidelines and laboratory safety measure for working in Biochemistry laboratory.
2. Units of volume, weight, density and concentration measurements and their range in biological measurements.
3. Demonstration of proper use of volume and weight measurement devices.
4. Determination of pH - pH meter.
5. Preparation of buffer –titration of a strong acid and a weak base.
6. Qualitative tests for carbohydrates – distinguishing reducing from non-reducing sugars
7. Qualitative analysis of amino acids (Tryptophan, Tyrosine, Arginine, Proline and Histidine)
8. Qualitative analysis of Lipids-Solubility, acrolein test for unsaturation, Libermann Burchard test for cholesterol.
9. Paper and Thin layer Chromatography (Seperation of amino acids).
10. Column chromatography.
11. Preparation of starch from potato.
12. Preparation of casein from milk.
13. Preparation of albumin from egg

REFERENCES:

1. Dr. J. Jayaraman, 2011. *Manuals in Biochemistry*, New Age International Pub, Bangalore.
2. Plummer, 2000. *Practical Biochemistry*, New Delhi: Tata Mcgraw Hill Publishing Company.
3. S.Sadasivam, V.A Manickam, 2006. *Biochemical methods* –2 ed New Age International Publishers.
4. Anil Kumar, Sarika Garg and Neha Garg, 2012. *Biochemical Tests – Principles and Protocols*.
5. Vinod Vasishtha Viva Books Pvt Ltd.
6. https://nptel.ac.in/courses/104/105/104105102/
7. https://nptel.ac.in/content/storage2/courses/102103047/PDF/mod1.pdf

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Understand the principles, theory and calculations of each experiment.
- Gain hands-on preparation of all the solutions and standardize solutions individually.
- Acquire the concept of pH meter and preparation of Buffer solution.
- Carry out qualitative analysis of carbohydrates, amino acids and lipids.
- Gain practical knowledge about the chromatographic technique.

Second Year **NON-MAJOR ELECTIVE I** **Semester III**

BIOTECHNOLOGY FOR HUMAN WELFARE

Code **(Theory)** **Credit: 2**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Impart the significance of the biotechnology in various disciplines
- Provide information about the tools employed in genetic engineering
- Impart the knowledge about ethics in biotechnology

UNIT – I Basic Biology and Introduction to Biotechnology:

Plant and animal cell, Biomolecules - DNA, RNA and Protein, Transcription, translation and Central dogma of molecular biology, biotechnology – Definition, history of biotechnology.

UNIT – II Plant and Animal Cell Culture:

Medium for plant cell culture, Sterilization procedures, Micropropagation and application, regeneration of plants from cell culture, Somaclonal variation and application, Cryopreservation, Germplasm conservation. Animal cell culture environment and establishment of cell lines. Applications of animal cell line culture.

UNIT – III Tools and Methods of Genetic Engineering:

Restriction enzymes, DNA polymerase, DNA Ligase, RNA polymerase, reverse transcriptase, Linkers, adapters, Polymerase chain reaction, Vectors (Plasmid vectors), basic steps in recombinant DNA technology, *Agrobacterium* mediated genetic transformation, Direct DNA transfer techniques. Methods for transgenic mice production.

UNIT – IV Applications of Biotechnology:

Application of Transgenic plants in Agriculture, Edible vaccine, Secondary metabolite and Antibody production by transgenic plants. Animal cloning, in vitro fertilization, gene therapy, applications of transgenic animals. Industrial applications of recombinant DNA technology (Insulin, Antibody and ethanol production), application of genetically engineered microorganisms in environment protections. DNA markers and it's applications in Forensic science.

UNIT – V Biotechnology and Ethics:

Socio - Economic and legal impacts of biotechnology, Controversy over GM crops, bioterrorism, IVF technologies - Embryonic cell Research - Amniocentesis - Sex determination and abortion, Surrogate mother, Human cloning - Regulation pertaining to organ transplantation.

UNIT – VI CURRENT CONTOURS (For Continuous Internal Assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Nicholl, D.S.T. (2008). An Introduction to Genetic Engineering, Cambridge University Press, Cambridge, UK.
2. Clerk, D.P. and Pazdernik, N.J. (2012). Biotechnology - Academic Publisher, California, 2012.
3. Gupta, P.K., (2014). Elements of Biotechnology (Second Edition), Rastogi Publication, New Delhi.
4. https://doi.org/10.1016/j.tifs.2019.07.002
5. https://doi.org/10.1007/978-981-16-8125-7_2

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Obtain an in-depth knowledge of methodologies involved in biotechnology.
- Understand the importance of different fields of biotechnology
- Acquire complete knowledge about gene-cloning and genetic transformation strategies.

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Second Year **CORE COURSE IV** **Semester IV**

IMMUNOLOGY AND IMMUNOTECHNOLOGY

Code **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Impart knowledge of the Immune system by learning about the antigens, antibodies, antibody production and purification.
- Gain knowledge on Immune cells, cell-mediated immune reactions, immune regulators, and vaccines.

UNIT – I Fundamental Concepts and Anatomy of the Immune System:

Terminology – Antigen, immunogen, hapten, allergen, tolarogen, superantigens, antibody, immunoglobulin, antigenicity, immunogenicity. Self &nonself, innate & acquired immunity. Haematopoiesis. Organs, tissues, cells and mediators of the immune system - primary lymphoid organs, secondary lymphoid tissues, lymphocytes, and mediators. Lymphatic system, lymphocyte circulation and lymphocyte homing. Principles of cell signalling.

UNIT – II Nonspecific Immunity:

Natural built-in barriers – skin, semen, saliva, tears, enzymes. Mediators of the immune system - lymphokines, cytokines, interferon, tumour 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 Antibody and Cell Mediated Immune Response:

Hybridoma technology - monoclonal & polyclonal antibody production, purification, and application. Immunization techniques, antibody titer assessment. Immunochemistry. Purification of antibody - ammonium sulphate precipitation, PEG Precipitation, affinity purification and column chromatography.Mitogen and antigen-induced lympho-proliferation assay; cell-mediated lympholysis, and mixed lymphocyte reaction.

Assessment of delayed-type hypersensitivity reactions. *In-situ* and *In - vivo* characterization of cells from tissues, generation of T cell clones and HLA typing..

UNIT – V New Generation Antibodies and Therapeutic Agents:

Immunoregulators as therapeutic products. Production of immunoregulators, process design, selection criteria for cell lines, culture media, process development, product recovery, stability checking and validation. The 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, tumour necrosis factor, cytokines, lymphokines & chemokines.

UNIT – VI Current Contours (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Kuby Immunology (8th Edition) - Jenni Punt, Sharon Stranford, Patricia Jones.
2. Essentials of Immunology - Dr. S.K. Gupta.
3. Immunology and Immunotechnology - Dr. B. Annadurai.
4. Allergy and Immunology- Scott Jasmin RV.
5. Roitt's Essential Immunology (13th Edition) - Seamus J. Martin and Dennis R Burton - Iran M Roitt.
6. Goldsby R.A. Kindt T.I and Osborne B.A Kuby. 2000. Immunology 4th Edition. WH Freeman &Co, NY.
7. E. Riot. 2011. Essential Immunology 12th Edition. Wiley & Blackwell.
8. Hybridoma technology in the Biosciences and Medicine – Timothy Springer (1985) Plenum Press.
9. Vaccines 86: New approaches to immunization: Developing vaccines against Parasitic, bacterial & viral diseases, Robert M. Chanock, Fred Brown, Richard A. Lerner, 1986,Cold Spring Lab. Press.5.P.J.Delves I S.J.artin I D.R.Burton I I.M.Roitt. 2006. Essential Immunotechnology. 12th Edition
10. https://doi.org/10.1016/S1380-2933(97)00010-9

Course Outcomes:

On the successful completion of the course, the students will be able to:

- Understand the basic concepts and immunology and immunological techniques
- Understand the polyclonal and monoclonal antibodies production, purification, and application
- Understand the functions of immune cells and organs
- Widen their knowledge of immune reactions and immuno-regulators of the cells
- Enrich their understanding of new-age recombinant vaccines

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Second Year	**CORE PRACTICAL IV IMMUNOLOGY**	**Semester IV**
Code	**(Practical)**	**Credit: 4**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Enrich the practical skills on the immunological techniques
- Understand the immune reactions, antigen-antibody reactions, separation of lymphocytes, purify immunoglobulins and detect antigens via techniques like western blotting

EXPERIMENTS:

1. Preparation of serum & plasma from blood samples
2. Precipitation reaction – AGID, SRID, Ouchterlony double immunodiffusion, and Rocket immunoelectrophoresis
3. Agglutination - Blood grouping, Latex agglutination, WIDAL.
4. Labelled assays – IF, RIA (Theory), ELISA (Demo)
5. Western Blotting.
6. Tissue typing – Microcytotoxicity Assay, Mixed Lymphocyte Reaction and Primed Lymphocyte Typing.
7. Isolation of and quantification of immunoglobulin from serum.
8. Separation of lymphocytes from whole blood
9. Preparation of lymphocytes from peripheral blood by density gradient centrifugation

REFERENCES:

1. Practical Immunology - Frank C. Hay, Olwyn M.R. Westwood
2. Text of Practical Immunodermatology - Xing Hua Gao and Hong Duochen.
3. Practical immunology - Mohamed Mohsin Ahmed.
4. Immunology: A Laboratory Manual, Richard L. Myers, 1989
5. Diagnostic Immunology Laboratory Manual, Ronald J. Harbeck, 1991
6. Richard A. Goldsby, Thomas J. Kindt. Barbara, A. Osborne, Janis Kuby. 2003. Immunology. 5th Edition, W. H. Freeman & Company
7. J. Sambrook and D.W. Russel, CSHL. 2001. Molecular Cloning: A Laboratory Manual, Vols 1-3. Cold spring Harbor Laboratory press.
8. Topley and Wilson. G. Wilson, A.Miles, M.T.Paker. Arnold, Heineman, 1984. Principles of Bacteriology, Virology and immunology. Willy – Blackwell.
9. https://www.cabdirect.org/cabdirect/abstract/19432701768

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Prepare the serum and plasma from blood and perform blood grouping assay
- Understand the antigen-antibody interactions and visualize in gels
- Prepare the lymphocytes from blood
- Separate and purify the immunoglobulins

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Second Year **SECOND ALLIED COURSE II** **Semester IV**

ANALYTICAL BIOCHEMISTRY

Code **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Discuss basic and advanced instrumentation methods with emphasis on biological applications
- Understand the principles and working methods of the techniques including centrifugation, chromatography, electrophoresis, spectroscopy and crystallography.

UNIT – I General Approaches to Biochemical Investigations:

Cell disruption methods and subcellular fractionation. Centrifugation techniques: Basic principles of sedimentation, Svedberg's constant and RCF. Principle, technique and applications of preparative centrifugation-differential and density gradient centrifugation. Analytical ultracentrifugation.

UNIT – II Microscopy and Radioactivity:

Basic principles, instrumentation and applications of Light microscopy, Fluorescence microscopy, Phase contrast microscopy and Electron microscopy. Biosensors, X-ray diffraction, X-ray absorption, Basics of radioactivity, Safety aspects of radiation, Detection and Measurement of radiation.

UNIT – III Electrophoretic Techniques:

General principle, technique and applications of Paper, Gel electrophoresis. Factors affecting electrophoresis. Agarose gel electrophoresis. Polyacrylamide gel electrophoresis (PAGE): Native and SDS-PAGE. 2D-Gel, Isoelectric focusing

UNIT – IV Chromatographic Techniques:

Principles of chromatography, technique and applications of Paper chromatography, Thin Layer chromatography (TLC), Adsorption, Partition, Ion exchange, Gel filtration and Affinity chromatography. Principle, components and applications of Gas chromatography (GC), Highperformance liquid chromatography (HPLC).

UNIT – V Spectroscopy:

Laws of absorption and absorption spectrum. Principle, instrumentation and applications of UV-visible spectrophotometry, ESR, NMR, IR and spectrofluorimetry. Basic principles of turbidimetry and nephelometry. Principle, instrumentation and applications of luminometry. Atomic spectroscopy – principle and applications of atomic flame and flameless spectrophotometry. Use of lasers for spectroscopy. MALDI TOF

UNIT – VI Current Contours (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Ghosal Sabari and Srivastava A. 2009. Fundamentals of Bio Analytical Techniques and Instrumentation,. K., PHI Learning Pvt. Ltd. India.
2. Dr. Istvan Bak, 2011. Modern analytical techniques in the pharmaceutical- and bioanalysis,
3. Ghosal and Srivastava, 2009. Fundamentals of Bioanalytical Techniques and Instrumentation, PHI Learning Pvt. Ltd.
4. K Wilson and J Walker, 2005. Principles and Techniques of Practical Biochemistry, Cambridge University Press, India.
5. A Upadhyay, K Upadhyay and N Nath, 2014. Biophysical Chemistry (Principles and Techniques) 4th Edition, Himalaya Publishing House, India.
6. A Shourie and SS Chapadgaonkar, 2015. Bioanalytical Techniques, the Energy and Resources Institute, TERI, India.
7. C.R. Kothari, Methods and Techniques, 2004 2nd ed, Research Methodology, New Age International Publishers. India.
8. R.P. Braun, 1987. Introduction to Instrumental Analysis, Tata McGraw Hill, India.
9. https://nptel.ac.in/courses/102/103/102103044

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Develop the skills to understand the theory and practice of bio analytical techniques.
- Describe the working principle, techniques and applications of bioinstrumentation.
- Gain knowledge and apply the concept of electrophoretic techniques, their procedure, principle and applications.
- Describe the concepts of chromatography and concept of partition coefficient and perform various chromatographic techniques.
- Understand the various approaches employed in spectroscopic characterization.

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Second Year **NON MAJOR ELECTIVE II** **Semester IV**

FOOD PROCESSING TECHNOLOGY

Code **(Theory)** **Credit: 2**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Provide knowledge of food types and sources of microorganisms required in the production of food products and food processing technology
- Understand technologies involved in food preservation
- Provide the importance of food packing in the industry

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 idea of material handling in the 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, and 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.

UNIT – VI Current Contours (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

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.
3. Fellows. P.J.,(2009). Food Processing Technology: Principles and Practice. (3rd Edition) Woodhead Publishing.
4. Subbulakshmi. G., & Shobha A. Udipi, (2006). Food Processing and Preservation. New Age International Publishers, India.
5. Byong H Lee. (2016). Fundamentals of food Biotechnology - 2nd Edition, Wiley Blackwell.
6. Fellows, P., (2000). Food Processing Technology Principles and Practice - 2nd Edition, Woodhead Publishing Limited.
7. Ravishankar Rai V. (2016). Advances in Food Biotechnology, Wiley- Blackwell
8. Kalidas shetty. (2005). Food Biotechnology, Taylor & Francis group
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10. http://epgp.inflibnet.ac.in/
11. https://www.nutritionintl.org/
12. http://ncert.nic.in/textbook/pdf/lehe105.pdf

Course Outcomes:

On the successful completion of the course, the students will be able to:

- Understand the principles and concepts of technology to overcome the problems in food handling and processing.
- Acquire the information about role of thermal and ionizing process in food processing.
- Acquire the importance of refrigeration and its role in food preservation.
- Understand the process of food in the industry.
- Provide the opportunities to be an entrepreneur in food processing companies /Agricultural fields.

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Third Year	**CORE COURSE V**	**Semester V**
	PLANT BIOTECHNOLOGY	
Code	**(Theory)**	**Credit: 5**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Provide the basics of plant tissue culture
- Understand the principles and strategies involved in the plant transgenesis

UNIT – I Plant Physiology and Biochemistry:

Hormones- Auxin, gibberellins, cytokinins, ethylene. Growth regulation, application of hormones in agriculture Photosynthesis. C3, C4 and CAM pathways. Glycolysis - Krebs's cycle - Oxidation - Reduction potential - ATP synthesis. Nitrogen metabolism: Role of Nitrogen and sources, Conversion of nitrate to ammonia – assimilation of ammonia. Molecular nitrogen, mechanism of biological nitrogen fixation.

UNIT – II Plant Tissue Culture:

Plant tissue culture techniques –Origin, history and its importance. Laboratory organization. Nutrient Medium- composition and its types. Sterilization techniques. Types of culture- seed, callus, embryo and organ culture. Micropropagation.

UNIT – III Somatic Hybridization:

Protoplast isolation- enzymatic and mechanical method. Somatic hybridization – protoplast fusion, types, mechanism of fusion, identification and selection of hybrid cells, Verification and characterization of somatic hybrids. Production of haploid plants, germplasm storage and cryopreservation.

UNIT – IV Plant Genetic Engineering:

Marker genes. Methods of gene transfer – vector mediated, virus mediated, vector less and chemicals. Resistance to biotic stress- insect, virus and disease resistance. Abiotic stress- Herbicide resistance. Transgenesis for quality- and as bioreactors.

UNIT – V Molecular Markers:

Markers and their types. RFLP, RAPD, AFLP, SSR, STM and fingerprinting. Marker assisted selection.

UNIT – VI Current Contours (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

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.
3. Gupta, P. K. 1994. Elements of Biotechnology. Rastogi Publications. Meerut.
4. Ignacimuthu , S., 2003. Plant Biotechnology. Oxford & IBH Publishing Co. Pvt. Ltd. New Delhi.
5. Kalyan Kumar De., 1997. Plant Tissue Culture – New Central Book Agency (P) Ltd., Calcutta.
6. Mascarenhas A.F., 1991. Hand book of Plant Tissue Culture. Indian Council of Agricultural Research. New Delhi.
7. Devlin, O.P. 1974. Plant Physiology, Affiliated East West Press Pvt. Ltd.
8. Jain, V.K. 2005. Text Book of Plant Physiology, S. Chand & Company Ltd., New Delhi.
9. Phundan Singh, 2013. Principles of Plant Biotechnology. Kalyani Publishers, India.
10. V. Kumaresan, 2015. Applied Plant Biotechnology. Saras Publication, India.
11. Singh, 2014. Plant Biotechnology, 2nd Revised Edition, Kalyani Publishers, India.
12. Ashwani Kumar, Sudhir K. Sopory. (2013). Recent Advances in Plant Biotechnology and its Applications. L.K. International Pvt. Ltd. New Delhi.
13. B.D. Singh. Plant Biotechnology (2015). Kalyani Publishers.
14. Razdan M.K. Introduction to Plant Tissue Culture. (3rd Edition).Oxford& IBH Publishing Co Pvt. Ltd.
15. Leyser, O. and Day, S. Mechanisms in plant development. John Wiley & Sons. 2009.
16. Howell, S.H. Molecular genetics of plant development. Cambridge University Press. 1998.
17. Taiz, L. and Zeiger, E. Plant Physiology. Sinauer Associates. 2010 5th Eds.
18. Raven, P.H. Evert, R.F. and Eichhorn, S.E. Biology of plants. Macmillan. 2005 8th Eds.
19. https://onlinecourses.swayam2.ac.in/cec19_bt09/preview
20. https://onlinecourses.nptel.ac.in/noc19_bt17/preview
21. https://youtu.be/LQA2d3t82ho

Course Outcomes:

On the successful completion of the course, the students will be able to:

- Know the physiology and metabolism of plants.
- Understand the scope and importance of plant tissue culture in plant sciences.
- Understand the genetic manipulation of plants.
- Understand the mechanism of gene transfer in plants.
- Understand the concepts of markers and their application in plants.

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Third Year **CORE COURSE VI** **Semester V**

ANIMAL BIOTECHNOLOGY

Code **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Grasp the knowledge of fundamentals of animal cell culture
- Impart the basics about various genetic engineering methods
- Get an idea about transgenic animals

UNIT – I Cell and Embryo 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 and its applications, Tests: cell viability and cytotoxicity. Biology of cultured cells, growth measurement, cell synchronization, senescence and apoptosis. Organ culture, Cryopreservation. Artificial Fertilization methods (IVF, IUF, ICSI) and embryo transfer, Superovulation, Polycystic ovarian syndrome (PVS), Collection and preservation of embryo, culture of embryos.

UNIT – II Genetic Transformation and Cloning:

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 – III Transgenic Animals:

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.

UNIT – IV Regulating DNA Technology:

Regulating DNA technology – DNA barcoding. Ethical issues in animal biotechnology, transgenic microbes and animals. Patenting Biotechnology inventions– patenting offundamental research. Indian and USA patents.

UNIT – V 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 – VI Current Contours (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. R. Sasidhara, (2019). Animal Biotechnology ; Author, R. Sasidhara ; Publisher, MJP Publisher.
2. B Singh, SK Gautam and MS Chauhan. (2013). Textbook of Animal biotechnology. The Energy and Research Institute.
3. M.K. Sateesh. (2010). Biotechnology: V: (Including Animal Cell Biotechnology, Immunology and Plant Biotechnology). 2nd Edition. New Age International.
4. Freshney, E. D. (2000). Animal Cell Culture: A practical approach. John Wiley Pub. New York.
5. Mather, J.P. and Barnes, D. (Eds.). (1998). Animal Cell Culture Methods (Methods in Cell Biology. Vol. 57). Academic Press, London.
6. Butler, M. (Ed.). (1990). Mammalian Cell Biotechnology - A Practical Approach. Oxford Univ. Press, Oxford.
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8. E.J. Murray (Ed). (1991). Gene Transfer and Expression Protocols – Methods in Molecular Biology Vol.7. Humana Press, Totowa, NJ.
9. 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.
10. Watson, J.D., M. Gilman, J. Witkouski and M. Zoller. (1992). Recombinant DNA. Scientific American Books, New York.
11. Puller, A. (Ed). (1993). Genetic Engineering of Animals. VCH Publishers, New York.
12. Balinsky, B.I. (1975). An Introduction to Embryology. Saunders, Philadelphia.
13. Beril, N.J. (1974). Developmental Biology. Tata McGraw -Hill Publishing Company Ltd. New Delhi
14. Gahlawat, S.K & Duhan, J.S. (2018). Advances in Animal Biotechnology and its applications. Springer Nature
15. Ed by Verma, A. S. & Singh, A. (2014). Animal Biotechnology: Models in Discovery and Translation. Elsevier
16. Conn, P.M. (2013). Animal models for the study of human diseases. Academic press
17. Freshney, R.I. (2005). Cultue of animal cells. John Wiley Ed. By Cabral, Joaquim M.S & De Silva, C. (2016). Stem cell manufacturing. Elsevier.
18. Pinkert, C.A. (2014). Transgenic animal technology: A laboratory handbook. Elsevier
19. https://link.springer.com/book/10.1007/978-3-319-92327-7/cover
20. https://www.elsevier.com/books/animal-biotechnology/verma/978-0-12-811710-1#:~:text=Animal%20Tissue%20Culture%3A%20Principles
21. https://www.elsevier.com/books/animal-biotechnology/verma/978-0-12-811710-1#:~:text=33.%20In%20vitro-,Fertilization,-34.%20Human%20Embryonic

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Understand different types of animal cell lines and the preparation of their media
- Ability to know how genetic engineering methods are applied to produce GMOs
- Improve knowledge of gene therapy to treat genetic disorders
- Update the knowledge to synthesize various products from transgenic animals
- Have basic knowledge of Regulating DNA technology.

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Third Year **CORE COURSE VII** **Semester V**

ENVIRONMENTAL BIOTECHNOLOGY

Code **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Reveal the current status and basics of ecosystems
- Understand the concepts of ecology and environmental conservation
- Provide knowledge of contemporary perspectives on ecological issues

UNIT – I Basic Elements of Environment:

Introduction to ecosytems and ecology- Branches of ecology. Biotic and abiotic factors; Abiotic factors- light, water, temperature, soil. Biotic factors- Pathogens, Animal relationship, symbiosis, commensalisms, mutualism, antagonism, parasitism, predation, competition.

UNIT – II Cycles and Ecosystems:

Ecosystem- Introduction and Definition. Pond ecosystem, primary production. Secondary production, food chain, food web, trophic levels, energy flow, pyramid of biomass, pyramid of energy. Biogeochemical cycle: Nitrogen and Phosphorous.

UNIT – III Types of Pollution:

Introduction to pollution and its types. Sources and effects of pollution. Air pollution, water pollution, soil pollution, noise pollution, thermal pollution, pesticides, radioactive substances, emerging pollutants. Green house effect, ozone and their impact on ecosystems. Global warming, Acid rain– Bioaccumulation. Biological control.

UNIT – IV Bioremediation:

Bioremediation- Introduction and concepts of bioremediation. Biostimulation and Bioaugmentation. Introduction to phytoremediation and phycoremediation. Bioremediation of metals, radionuclides, organic pollutants, tobacco waste. in situ and ex situ bioremediation.

UNIT – V Disaster Management:

Hazards and Disasters, Risk and Vulnerability in Disasters, Natural and Man-made disasters. Basic principles of disasters management, Disaster Management cycle, Disaster management policy, National and State Bodies for Disaster Management. Awareness generation program, Usages of GIS and Remote sensing techniques in disaster management.

UNIT – VI Current Contours (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Odum, E.P. 1971. Fundamentals of Ecology. W.B.Saunders company, Philadelphia
2. Sharma, P.D. 1990. Ecology and environment. Rsatogi publications, Meerut.
3. Verma P.S. and V.K. Agarwal. 1996. Principles of Ecology. S.Chand. & co., New Delhi.
4. Gupta A.K., Niar S.S and Chatterjee S. (2013*)* Disaster management and Risk Reduction, Role of Environmental Knowledge, Narosa Publishing House, Delhi.
5. https://books.google.co.jp/books?hl=en&lr=&id=-P1qZN2XBbEC&oi=fnd&pg=PR5&dq=environmental+biotechnology&ots=vXD1hNgiL1&sig=WHZiVrK79n-NM7NrBgPnkkKbh4M
6. https://books.google.co.jp/books?hl=en&lr=&id=l3LRBQAAQBAJ&oi=fnd&pg=PP1&dq=environmental+biotechnology&ots=6czC5gyf6Z&sig=zpLJ0lBfo1HJ_rqxDqmJDU68nSs
7. https://books.google.co.jp/books?hl=en&lr=&id=VhdFd0V3H5YC&oi=fnd&pg=PR9&dq=environmental+biotechnology&ots=I8Iz7vYKV9&sig=9-u8uBEpu6QWYltDpcLbgZjpZAA#v=onepage&q=environmental%20biotechnology&f=false

Course Outcomes:

On the successful completion of the course, the students will be able to:

- Classify microbes according to the energy source and carbon source.
- Describe suitable methods for characterizing the activity, function, diversity, and composition of microbial communities.
- Describe the most commonly applied disinfection methods and the steps typically involved in wastewater treatment.
- Demonstrate biotechnological solutions to address environmental issues, including mitigation of emerging pollutants.

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Third Year **CORE PRACTICAL V** **Semester V**

PLANT ANIMAL BIOTECHNOLOGY AND ENVIRONMENTAL BIOTECHNOLOGY

Code **(Practical)** **Credit: 4**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Learn the principles of advanced techniques in biotechnology
- Obtain hands-on experience in performing complex and sensitive biological assays.
- Understand the potential of molecular assays to solve biological problems

EXPERIMENTS:

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 and 2. Enzymatic
5. Isolation of plant genomic DNA (Hands on).
6. Size analysis of DNA by Agarose Electrophoresis (Hands on).

Animal Biotechnology

1. Isolation of DNA from human cheek cells
2. Isolation of DNA from blood
3. Quantification of DNA by spectrophotometric method
4. Animal cell culture - Preparation of media
5. Types of Animal cell culture – Primary, secondary

ENVIRONMENTAL BIOTECHNOLOGY

1. Isolation of Air borne Pathogens
2. Study of Growth Curve and Generation time of Bacteria / Yeast using turbidometry.
3. Water Analysis – MPN and BOD.

REFERENCES:

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 IBHP

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6. Harrison, M.S. and Bal, I.R. 1997. General techniques of all culture Cambridge University press.
7. Prasash M. and Arora. C.K. 1998. Plant tissue culture, Ammol publication Pvt. Ltd.
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9. Bhojwani, S. S. (1990). Plant Tissue Culture. Oxford, NY. Gamborg, O. L. and G. C. Phillips (1996).
10. Plant Cell, Tissue and Organ Culture: Fundamental Methods. Narosa Publishing House, New Delhi, India.
11. Razdan, M. K. (1993). An Introduction to Plant Tissue Culture. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi, Calcutta. India.
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13. Vasil, I. K. and Thorpe. T. A. (1994). Plant Cell and Tissue Culture. Kluwer Academic Publishers. The Netherlands.
14. https://archive.nptel.ac.in/courses/102/107/102107075/

Course Outcomes:

On the successful completion of the course, the students will be able to:

- Prepare culture medium and transfer cultures without contamination.
- Sterilize instruments, lab wares, culture media and explants.
- Design and prepare various culture media, stock solutions of inorganic salts, growth regulators.
- Identify appropriate explant and learn inoculation techniques into suitable culture media under sterile condition.
- Isolate pure DNA from various sources and utilize it as source material for DNA based experiments.

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Third Year **MAJOR BASED ELECTIVE I** **Semester V**

1. DEVELOPMENTAL BIOLOGY

Code **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Understand different areas of developmental biology including the early and late embryonic development
- Develop a comprehensive understanding of the cell-cell communications

UNIT – I Patterns and Processes of Animal Development:

Mechanisms of Developmental Organization: A Frog's Life - Gametogenesis and fertilization, Cleavage and gastrulation, Organogenesis, Metamorphosis and gametogenesis, Differential Gene Expression: Mechanisms of Cell Differentiation, Cell-to-Cell Communication: Mechanisms of morphogenesis, Stem Cells: their potential and their niches.

UNIT – II Gametogenesis and Fertilization:

Mammalian Pattern of Sex Determination: Primary Sex Determination in Mammals, Secondary Sex Determination in Mammals, Chromosomal Sex Determination in Drosophila: The Sex-lethal gene, switch gene for sex determination. Mammalian Gametogenesis; Spermatogenesis, Oogenesis. Fertilization: External Fertilization in Sea Urchins, Activation of Egg Metabolism in Sea Urchins, Fusion of Genetic Material in Sea Urchins.

UNIT – III Early Development: Cleavage, Gastrulation, and Axis Formation:

Cleavage and Axis Formation in *C. elegans*: Rotational cleavage of the egg, Anterior-posterior axis formation, Dorsal-ventral and right-left axis formation, Control of blastomere identity. Gastrulation in *C. elegans.* Early Drosophila Development: Fertilization, Cleavage, mid-blastula transition, Gastrulation. Segmentation Genes: Segments and parasegments, gap genes, pair-rule genes, segment polarity genes.

UNIT – IV Postembryonic Development:

Metamorphosis: Morphological changes associated with amphibian metamorphosis, Hormonal control of amphibian metamorphosis, Regionally specific developmental programs. Metamorphosis in Insects: Imaginal discs, Hormonal control of insect metamorphosis, The molecular biology of 20-hydroxyecdysone activity, Determination of the wing imaginal discs, Metamorphosis of the Pluteus Larva.

UNIT – V Aging and Senescence:

Genes and Aging: DNA repair enzymes, Aging and the insulin signaling cascade, The mTORC1 pathway, Chromatin modification. Epigenetic Drift, Stem Cells and Aging.

UNIT – VI Current Contours (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Grubb, B. J. (2006). Developmental Biology, Scott F. Gilbert, editor. Integrative and Comparative Biology, 46(5), 652-653.
2. Carlson, B. M. (2018). Human embryology and developmental biology. Elsevier Health Sciences.
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4. Balinsky B.I., An introduction to Embryology, International Thomson Computer Press, London, UK, 2008.
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6. https://nptel.ac.in/courses/102103045/

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Cognize the cell development and their stages.
- Comprehend the links between basic aspects of the cell and early embryogenic development.
- Elaborate on the Later Embryonic development of different organs with placentation structure and types.
- Provide knowledge on implications and diagnosis techniques.
- Illustrate the post-embryonic development and its stages.

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Third Year **MAJOR BASED ELECTIVE I** **Semester V**

2. BIOINFORMATICS

Code **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Get introduced to the basic concepts of Bioinformatics
- Learn the usage of basic online bioinformatics tools and techniques
- Apply the concepts and tools of bioinformatics in various fields
- Familiarize with the available databases related to bioinformatics

Unit – I Basic Introduction to Bioinformatics:

History of Bioinformatics – Introduction to concepts and terminology of Internet, Search Engines, Databases and Softwares.

UNIT – II Bioinformatic Tools:

Review of basics about structure of macromolecules - DNA, RNA and Proteins. Online resources for Bioinformatics – Biological Databases – NCBI, Genbank, EMBL, Swissprot, PDB. Executing search and retrieval of data. Sequence alignment – Multiple sequence alignment – Pairwise alignment.

UNIT - III Proteomics and Genomics:

Bioinformatics in genomics and proteomics – gene sequencing tools traditional methods – Maxam and Gilbert's method, Sanger's sequencing – structure prediction tools – Nucleic acid and protein structure prediction – Gene and protein expression analysis – similarity search databases – FASTA, BLAST. Analysis of Phylogeny - Phylogenetic tree construction. Protein ligand interaction, Ramachandran Plot, PYMOL.

UNIT – IV Drug Discovery:

Structure based drug discovery – Molecular docking of novel compounds – SAR and QSAR, Introduction to Simulation softwares in biology – Autodock, ADMET.

UNIT – V Applications:

Applications of Bioinformatics in different fields – Medicine, Agriculture, Environmental monitoring - Emerging areas in bioinformatics..

UNIT – VI Current Contours (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Gupta, M. K., & Behera, L. (2021). Introduction to Bioinformatics. In Bioinformatics in Rice Research (pp. 3-20). Springer, Singapore.
2. Abdurakhmonov, I. Y. (Ed.). (2016). Bioinformatics: Updated Features and Applications. BoD–Books on Demand.
3. Selzer, P. M., Marhöfer, R. J., & Koch, O. (2018). Biological databases. In Applied Bioinformatics (pp. 13-34). Springer, Cham.
4. Lohar, P. S. (2019). Bioinformatics. MJP Publisher.
5. Shaik, N. A., Hakeem, K. R., Banaganapalli, B., & Elango, R. (2019). Essentials of Bioinformatics, Volume I
6. Ranganathan, S., Nakai, K., &Schonbach, C. (2018). Encyclopedia of Bioinformatics and Computational Biology: ABC of Bioinformatics. Elsevier.
7. Arabnia, H. R., & Tran, Q. N. (2015). Emerging trends in computational biology, bioinformatics, and systems biology: algorithms and software tools.
8. Shanker, A. (Ed.). (2018). Bioinformatics: Sequences, Structures, Phylogeny. Springer.
9. Lecca, P., Re, A., Ihekwaba, A. E., Mura, I., & Nguyen, T. P. (2016). Computational systems biology: inference and modelling. Woodhead Publishing.
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Course Outcomes:

On the successful completion of the course, the students will be able to:

- Understand the basic concepts and terminologies in bioinformatics.
- Understand the basic online biological resources and databases.
- Apply the online softwares and tools for macromolecular structure prediction and sequencing.
- Employ the bioinformatics tools in medicine for drug discovery and identification of novel drugs.
- Apply the bioinformatics ideas in different fields and explore upcoming areas of interest in bioinformatics.

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Third Year	**SKILL BASED ELECTIVE I MOLECULAR DIAGNOSTICS**	**Semester V**
Code	**(Theory)**	**Credit: 2**

COURSE OBJECTIVES:

- To learn basics of instruments at clinical level
- To know the safety and regulations at laboratory
- To familiarize on molecular level gene identification
- To learn about methods to determine infection rate for diseases

UNIT – I Fundamentals:

Principles of molecular biology - specimen type, collections and uses - Design of molecular diagnosis laboratory - Ethical issues –- role of Molecular diagnosis's in blood bank-Benefits of molecular diagnostics- future prospects.

UNIT – II Techniques and Principles:

Basics clinical techniques – Laboratory safety and guidelines - Optical techniques- Nucleic acid techniques – Immunochemical technique – Application of microfabrication and microfluidics- Instrumentation care.

UNIT – III Nucleic Acid Techniques:

Isolation of Extraction of Nucleic acids- Detection of gene mutation: Hybridization-Based Methods -Sequencing (Polymerization)-Based Methods – Detection of SNPs using agarose based and PCR based methods

UNIT – IV Infectious diseases:

Molecular diagnostics of bacterial infections: Mycobacterium tuberculosis, Pathogenic E. coli, sample preparation and pathogen detection. Parasitic diseases - Neiseria gonorrhoeae and malaria. Molecular diagnostic of various viral diseases: HIV, Herpes, hepatitis B, Influenza (H1N1) - sample preparation - viral infection analysis and Viral load monitoring - Infectious diseases .

UNIT – V Genetic disorder:

Monogenetic disorder – Cystic fibrosis; Epigenetic disorder – cancer - Polygenetic disorder – Diabetes. Inborn error of metabolism: Lipidosis, Lysosomal storage disorders, glycogen storage disorders; Neuro-degenerative disorders: Parkinson's and Alzheimer

REFERENCES:

1. Lela Buckingham (2019).Molecular Diagnostics: Fundamentals, Methods, and Clinical Applications. F. A. Davis Company Publishers.
2. Betty A. Forbes, Daniel F. Sahm, Alice, (2007).Bailey & Scott's Diagnostic Microbiology, 12th Edition, Elsevier Mosby.

3. David E. Bruns, Edward R. Ashwood,Carl A. Burtis. Fundamentals of Molecular Diagnostics (2007). Saunders Group. ISBN-13: 978-1-4160-3737-8.
4. George P. Patrinos, Wilhelm Ansorge, Phillip B. Danielson (2016). Molecular Diagnostics 3rd Edition. Elsevier.

COURSE OUTCOME:

- Understand the working principle and maintenance of clinical instruments.
- Acquire knowledge on laboratory safety guidelines
- Ability to isolate nucleic acids and to study gene expression
- Learn about infectious disease and infectivity at molecular level
- Know about role of molecular diagnosis at genetic abnormalities

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Third Year **CORE COURSE VIII** **Semester VI**

MICROBIAL BIOTECHNOLOGY

Code **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Understand the growth properties and kinetics of the industrially important microorganisms
- Study the different types of fermenters and their design
- Acquire knowledge of the upstream and downstream processes of 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 Fermentation Processes:

Bioreactor designs and types of fermentation and fermentors. Concepts & basic modes of fermentation; Solid state fermentation, Submerged fermentation; Batch, fed batch and continuous fermentation. Conventional fermentation versus biotransformation. Fermentation economics and fermentation media. Fermenter design - mechanically agitated, pneumatic and hydrodynamic fermenters. Types of Fermenter ; Stir tank Reactors, Continuous reactors, Air Driven Column Reactors, Bubble column Reactors, Airlift Reactors.

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 ultrafiltration. 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.

UNIT – VI Current Contours (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. M. Doran, P2010. Bioprocess Engineering Principles. Academic Press.
2. Shuler ML and Kargi F. 2002. Bioprocess Engineering: Basic concepts, 2nd Edition. Prentice Hall, Engelwood Cliffs.
3. Mendez-Vilas, A. 2009. Current Research Topics in Applied Microbiology and Microbial Technology. World Scientific.
4. Naduka O, Benedict C. O. 2017. Modern Industrial Microbiology and Biotechnology. Cambridge University Press.
5. Alexander N. Glacer, Hiroshi Nikaido. Microbial Biotechnology : Fundamentals of Applied Microbiology. 2nd Edition. Cambridge University Press.
6. Michael C. Flickinger, Stephen W. Drew. 1999. Encyclopedia of Bioprocess Technology. John Wiley & Sons.
7. Mansi EMTEL, Bryle CFA. 2012. Fermentation Microbiology and Biotechnology. 3rd Edition. Taylor & Francis Ltd, UK.
8. https://doi.org/10.1016/S0167-7799(99)01400-6
9. https://books.google.co.jp/books?hl=en&lr=&id=o3HnX18eU3AC&oi=fnd&pg=PA8&dq=microbial+biotechnology&ots=yZwN2QkS14&sig=GqeCcAeZodO9ipui0AWFmKp5YxE#v=onepage&q=microbial%20biotechnology&f=false
10. https://link.springer.com/chapter/10.1007/978-3-319-09287-4_2
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Course Outcomes:

On the successful completion of the course, the students will be able to:

- Demonstrate the isolation, screening and maintenance of industrially important microbes.
- Discuss the design and types of fermentation and fermenters.
- Illustrate the measurement and control of bioprocess parameters.
- Outline the upstream and downstream processes in fermentation.
- Apply the knowledge of microbes for the production of value-added foods.

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Third Year **CORE COURSE IX** **Semester VI**

BIOSTATISTICS AND BIOSAFETY

Code **(Theory)** **Credit: 5**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Imply the Applications of statistics in biological data
- Different analytical methods for biological data
- Microbial risk management and safety analysis

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 (one 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 (I, II and III); Recommended Biosafety Levels for Biological samples.

Unit – V Biosafety Guidelines:

Biosafety guidelines and regulations (National and International) – operation of biosafety guidelines and regulations 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-Protocol.

Unit – VI Current Contours (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

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.
4. Veer Bala Rastogi. 2015. Biostatistics. 3rd Edition. Medtech publication
5. VinodKumar and Anil Kumar. 2021. Biostatistics and ResearchMethodology. S Vikas and Company.
6. Sokal, R.R. and F.J. Rohlf. 1981. Biometry. W.K. Freeman. San Francisco.
7. Zar, J.H. 2003. Biostatistical Analysis. Pearson Education (Singapore) Pvt. Ltd., Indian Branch, New Delhi.
8. Wayne W. Daniel and Chad L. Cross. 2014. Biostatistics. 10th edition. Wiley.
9. https://books.google.co.jp/books?hl=en&lr=&id=WfsVAAAAQBAJ&oi=fnd&pg=PR1&dq=biostatistics+introduction&ots=W-oWKkEW8Z&sig=2l_VqexqWEaUwC0pwbUjdosOfus#v=onepage&q=biostatistics%20introduction&f=false

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Understand various applications of mathematical concepts.
- Enhance knowledge of Analysis of central tendency.
- Know the test of significance and hypothesis.
- Understand Biosafety levels and Guidelines.
- Improve knowledge on risk assessment strategies and regulations.

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Third Year	**CORE PRACTICAL VI MICROBIAL BIOTECHNOLGOY**	**Semester VI**
Code	**(Practical)**	**Credit: 4**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Equip the students with skills pertaining to isolation and enumeration of industrially important microbes
- Acquire hands on exposure to fermentation techniques
- Study about the antibiotic production by different strains of microorganisms

EXPERIMENTS:

1. Isolation of industrially important microorganisms.
2. Selective isolation of actinomycetes and analysis of 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 the sensitivity of microorganisms.
11. Downstream processes of enzymes – dialysis.
12. Immobilization of yeast cells by alginate beads
13. Bioassay techniques for antibiotics.
14. Isolation & identification of microbes from spoiled food.
15. Production of yogurt, butter.
16. Industrial Visit to Distillery unit; alcohol production and pharmaceutical industries. Field visit to Institutes like Pasteur Institute.

REFERENCES:

1. E Mans, E.M.T. and C.F.A. Bryce, Taylor and Francis, UK. 2012. Fermentation technology and Biotechnology. CRC Press.
2. Ghose, T.K and P.Ghose. 2013. Biotechnology in India I. 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,
5. Pergamon, UK.
6. V H Hui and G GKhachatorians. 1995. Food Biotechnology. VCH Publishers, New York.
7. Wolf. Cruzer and AnnaliseCruzer. 2000. Biotechnology Text Book of Industrial Microbiology. Panima Publishing House, New Delhi.
8. Patel, A.H. 2019. Industrial Microbiology. Macmillan India Ltd..

9. https://archive.nptel.ac.in/courses/102/107/102107075/

COURSE OUTCOMES:

On the successful completion of the course, the students will be able to:

- Enumerate the industrially important microorganisms.
- Demonstrate the various types of Fermentation methods.
- Establish the technique of estimation of alcohol content.
- Discuss about the yogurt and butter production process.
- Understand the immobilization techniques.

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Third Year **MAJOR BASED ELECTIVE II** **Semester VI**

1. IPR AND BIOETHICS

Code **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Develop knowledge of intellectual property rights
- Know about patent application process
- Emphasize the purpose of ethical regulations on Biotechnology and bioethical issues

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-patentable– patenting of life – legal protection of biotechnological inventions – world intellectual property rights organization (WIPO). IP rights in India – few Case Studies.

UNIT – II Patent Filing Procedures:

PCT filing procedure; Time frame and cost; Status of the patent applications; Precautions while patenting – disclosure/non-disclosure; Financial assistance for patenting –Schemes of 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. 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, Bioethical aspects of generating transgenic organisms.

UNIT – V Biotechnology and ethics:

Benefits and risks of genetic engineering – ethical aspects of genetic testing, genetic engineering and bio-warfare. Ethical implications of cloning: Reproductive cloning, therapeutic cloning. Ethical, legal and socioeconomic aspects of gene therapy, germ line therapy, GM crops and GMO's. Ethical implications of human genome project and bio-piracy.

Unit – VI Current Contours (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

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.
3. Alastair V. Campbell. 2017. Bioethics. 2nd Edition-Routledge
4. M. K. Sateesh. 2020. Bioethics and Biosafety. Dreamtech Press.
5. G.B. Reddy. 2017. Intellectual Property Rights and the Law.12th Edition-Gogia Law Ageny.
6. Martin. M.W. and Schinzinger. R. 2003. Ethics in engineering. 3rd Edition, Tata McGraw-Hill, New Delhi.
7. V. K. Ahuja. 2017. Law Relating to Intellectual Property Rights. 3rd Edition-Lexis Nexis.
8. Kankanala, K. C. 2007. Genetic Patent Law & Strategy. 1st Edition. Manupatra Information Solution Pvt. Ltd. Noida, India.
9. Senthil Kumar Sadhasivam and Mohammed, Jaabir. 2008. IPR, Biosafety and Biotechnology Management. Jasen Publications, Tiruchirapalli, India.
10. Ramkrishna B & Anil Kumar H.S. 2017. Fundamentals : Intellectuel Property Rights. 1st Edition- National Press.
11. http ://www.cbd.int/biosafety/backgrounds.html
12. http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section 3.html

Course Outcomes:

On the successful completion of the course, the students will be able to:

- Understand IPR concepts and significance.
- Comprehend filing of innovative products for patent.
- Know the International and Indian: IPR agreement and various treaties.
- Understand Bioethical regulations and guidelines.
- Explain the ethical issues of biotechnology products like GMO.

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Third Year **MAJOR BASED ELECTIVE II** **Semester VI**

2. NANOTECHNOLOGY

Code **(Theory)** **Credit: 4**

COURSE OBJECTIVES:

The main objectives of this course are to:

- Provide the basics of nanotechnology
- Develop basic knowledge about the nanomaterials and their applications

UNIT - I: Introduction to Nanotechnology:

Introduction to Nanotechnology – History and importance of nanotechnology - Scientific Revolutions – Types of Nanotechnology and Nanomachines – Nanotechnology Products and Applications – Future Applications of Nanotechnology – Risks of Nanotechnology. Definition of nano-sized material. Opportunity at the nanoscale, length and timescale in structures, differences between bulk and nanoscale materials and their significance.

UNIT – II Nanostructures and Dimensions:

Classification of nanostructures: zero, one, two and three-dimensional nanostructures, size dependency in nanostructures, quantum size effects in nanostructures, chemistry of tailored nano shapes, quantum dots, nano wells, nanoribbons and nanowires.

UNIT – III Synthesis and Properties of Nanomaterials:

Synthesis of nanomaterials - basics of bottom-up and top down approach, method of nanomaterials preparation, wet chemical routes of synthesis: reduction, sol-gel, hydrothermal, sonochemical synthesis, physical routes, physical vapor deposition (PVD), and chemical vapor deposition (CVD). Phytochemical and microbial synthesis methods. Optical, electronic, magnetic and chemical properties of nanoscale materials.

UNIT – IV Characterization of Nanomaterials:

UV-visible spectroscopy, Scanning electron microscope (SEM), transmission electron microscope (TEM), Fourier transform-Infra red (FT-IR) analysis, X-ray diffraction (XRD) analysis, Dynamic light scattering (DLS) analysis, Photoluminescence analysis, and Energy dispersive X-ray spectroscopy (EDX) analysis.

UNIT – V Applications of Nanotechnology:

Nanotechnology in energy systems, textiles, food and health care, agriculture, automotive industry, solar technology, pharmaceutical and drugs, nanoelectronics, nanosensors and devices. Application of nanomaterials in nanomedicines and pollution control.

UNIT – VI Current Contours (For continuous internal assessment only):

The recent advancements in the course topics will be explained to the students then and there through expert lectures, online seminars or webinars.

REFERENCES:

1. Nanotechnology : An Introduction to synthes properties and Applications of Nanomaterials .
2. Nano Science and Nano technology - Sundar Singh
3. An Introduction to Nanobiotechnology - Yashwanth Kumar .
4. Nanotechnology for Biomedical Application - Thomas Varghese.
5. Nanobiotechnology: Concepts, Applications and Perspectives – Christof M. Niemeyer, Chad A. Mirkin, John Wiley & Sons Inc (2004).
6. Nanofabrication Towards Biomedical Applications – Challa S.S.R. Kumar, Josef Hormes, CarolaLeuschner, John Wiley & Sons Inc (2005).
7. Nanotechnology: Basic Science and Emerging Technologies – Michael Wilson, KamaliKannangara, Geoff Smith, Michelle Simmons, BuckhardRaguse, Chapman & Hall/CRC Press (2002).
8. Textbook of Nanosciene and Nanotechnology - BS Murthy P Shankar, BaldevRaj, BBRath, and James Murday - Orient Blackswan Private Limited - New Delhi.
9. A.K. Bandyopadhyay, Nano Materials, New Age International Publisher. R. Kelsall, I.W. Hamley, and M. Geoghegan, Nanoscale Science and Technology, John Wiley & Sons, 2005.
10. Instrumentations and Nanostructures by A.S. Bhatia, NuTech books, 2009
11. https://doi.org/10.1016/j.surneu.2003.09.036

Course Outcomes:

On the successful completion of the course, the students will be able to:

- Advance their knowledge of nanotechnology and nanomaterials.
- Extend their understanding of the synthesis methods, characterization. techniques, and applications of the nanomaterials.

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Third Year **PROJECT** **Semester-VI**

Code: **Credit: 3**

The candidate shall be required to take up a Project Work by group or individual and submit it at the end of the final year. The Head of the Department shall assign the Guide who, in turn, will suggest the Project Work to the students in the beginning of the final year. A copy of the Project Report will be submitted to the University through the Head of the Department on or before the date fixed by the University.

The Project will be evaluated by an internal and an external examiner nominated by the University. The candidate concerned will have to defend his/her Project through a Viva-voce.

ASSESSMENT/EVALUATION/VIVA VOCE:

1. PROJECT REPORT EVALUATION (Both Internal & External)

   I. Plan of the Project - 20 marks

   II. Execution of the Plan/collection of Data / Organisation of Materials / Hypothesis, Testing etc. and presentation of the report. - 45 marks

   III. Individual initiative - 15 marks

2. Viva-Voce / Internal & External - 20 marks

TOTAL **- 100 marks**

PASSING MINIMUM:

	Vivo-Voce 20 Marks	**Dissertation 80 Marks**
Project	40% out of 20 Marks (i.e. 8 Marks)	40% out of 80 marks (i.e. 32 marks)

A candidate who gets less than 40% in the Project must resubmit the Project Report. Such candidates need to defend the resubmitted Project at the Viva-voce within a month. A maximum of 2 chances will be given to the candidate.

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Third Year **SKILL BASED ELECTIVE II** **Semester VI**

CLINICAL TRIAL AND DATA MANAGEMENT

Code **(Theory)** **Credit: 2**

COURSE OBJECTIVES:

- Demonstrate the knowledge and capability to search and retrieve information of individual clinical practice issues.
- Describe and demonstrate leadership skills that can lead to effective in a healthcare environment.
- Demonstrate effective written and oral communication skills.

UNIT – I Introduction:

Definition – History of clinical trial - Glossary of Common Terms in clinical Trials: Clinical Research, clinical Practice, Healthy Volunteer, Inclusion/Exclusion, Criteria, Informed Consent, Patient Volunteer, Phases of Clinical Trials, Placebo, Protocol, Principal Investigator, Randomization, Single- or Double-Blind Studies. mTypes – Diagnostic trials, Natural history studies, Prevention trials, Quality of life trials, Screening trials, Treatment trials. Clinical Trial Protocol and its components.

UNIT – II Clinical Trial Management:

Project Management, Protocol in Clinical Research, Informed Consent, Case Report Form, Investigator's Brochure (IB), Selection of an Investigator and Site-Clinical Trial Stakeholders, Contract Research Organization (CRO), Site management organizations.

UNIT – III Data Safety Monitoring Board:

Monitoring Visits, Investigator Meeting, Documentation in Clinical Trials, Regulatory Binder, Record Retention – Pharmacovigilance, Training in clinical Research, Project Auditing, Inspection, Fraud and Misconduct, Roles and Responsibilities of Clinical Research Professionals.

UNIT – IV Clinical Data Management:

Introduction to CDM – Case Report Forms design – Clinical Data entry and validation – Discrepancy Management – Quality Assurance and CDM- Guidelines and Regulation in clinical trial data.

UNIT – V Importance of Ethics in Clinical trial:

General ethical issues in clinical trials, General principles, Historical guidelines in Clinical Research: Nuremberg code-Declaration of Helsink-Belmont report. International Conference on Harmonization (ICH)-Brief history of ICH-Structure of ICH- ICH Harmonization Process, Responsible conduct of research, Ethical review procedures, Informed consent process, Vulnerability.

REFERENCES:

1. Richard K. Rondel, Sheila A. Varley, Colin F. Webb Clinical Data Management: 2nd Edition.
2. Susanne Prokscha Practical Guide to Clinical Data Management by - Taylor & Francis.
3. Basic Principles of Clinical Research and Methodology by S.K.Gupta
4. Clinician's Guide to Medical Writing :Robert B. Taylor. 1st ed. 2004. Springer Publications.
5. Lawrence M. Friedman (2010). Fundamentals of Clinical Trials, Springer Science & Business Media.
6. David Machin, Simon Day, Sylvan Green (2007).Textbook of Clinical Trials, John Wiley & Sons.
7. Stuart J. Pocock (2013).Clinical Trials: A Practical Approach, , John Wiley & Sons.
8. Duolao Wang and Ameet Bakhai. Remedica(2006). Clinical trials, A practical guide to design, analysis and reporting.
9. R K Rondels, S A Varley, C F Webbs (2000). Clinical Data Management edited Second Edition, Wiley Publications

COURSE OUTCOMES:

- Recognize and respond to misconduct
- Safeguard participant safety and trial integrity
- Develop and maintain study documents
- Knowledge on the Ethics & regulatory perspectives on clinical research trials activities.
- Acquire knowledge on pharmacovigilance, Project Management and Medical Affairs teams function.

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