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THE AMERICAN COLLEGE

(An Autonomous Institution Affiliated to Madurai Kamaraj University)

Re-accredited (3rd Cycle) by NAAC with Grade 'A+' CGPA 3.47 on a 4 point scale

MADURAI

B.Sc., Biotechnology Programme

DEPARTMENT OF BIOTECHNOLOGY
Satellite Campus

Department of Biotechnology (UG)

Programme Specific Outcomes (PSO):
On the successful completion of the undergraduate programme, the students will be able to

PSO1 **Disciplinary Knowledge**	acquire basic and adequate knowledge on biological systems and their processes.
PSO2 **Communication Skills**	apply the acquired knowledge in written and oral communication to enhance their employability in biotechnology sector.
PSO3 **Problem Solving**	implement the biotechnological methods and skills to fulfil the real-life challenges in the society.
PSO4 **Analytical Reasoning**	demonstrate analytical and critical thinking skills to understand the environmental and health issues and provide a sustainable solution.
PSO5 **Research Skills**	promote scientific inquiry and innovative research in different aspects of biotechnology.
PSO6 **Digital Literacy**	comprehend the high throughput techniques, databases and online resources efficiently to meet the demands in biotechnology.
PSO7 **Leadership and Teamwork**	develop entrepreneurial and employability skills, explore in various sectors of biotechnology to achieve their goals.
PSO8 **Moral and Ethical Awareness/Reasoning**	understand the moral and ethical guidelines in various aspects of their academic life like report writing, examinations and research projects.
PSO9 **Multicultural Competence**	possess knowledge of the values and beliefs of multiple cultures and a global perspective.
PSO10 **Self-directed & Lifelong Learning**	develop professional skills through lifelong learning, updating and contribute to the growth and development in biotechnology.

Department of Biotechnology (UG)
Learning Outcomes - Based Curriculum Framework (LOCF)

Sem	Part	Course Code	Course Title	Hours /Wk.	Credits	Marks
1	I	24XXXNNNN	Tamil / Hindi / French	3	2	30
1	II	24XXXNNNN	English	3	2	30
1	III CC	24BTC1601	Cell and Molecular Developmental Biology	6	6	90
1	III CC	24BTC1303	Cell and Molecular Developmental Biology Lab	3	3	45
1	III CC	24BTC1405	Graduate Skills for Biotechnologists	4	4	60
1	III S	24BCHNNNN	*Offered by Biochemistry*	5	4	60
1	IV NME	24XXXNNNN	*Non Major Elective – I*	3	2	30
1	IV AEC	24BTC1200	Environmental Studies	3	2	30
1	V	24XXXNNNN	NSS/NCC/PED/SLP/GMP/ GNS/LIB/ACH	-	-	-
	Total			**30**	**25**	**375**
2	I	24XXXNNNN	Tamil / Hindi / French	3	2	30
2	II	24XXXNNNN	English	3	2	30
2	III CC	24BTC1602	Genetics	6	6	90
2	III CC	24BTC1304	Genetics Lab	3	3	45
2	III CC	24BTC1406	Biodiversity and Conservation	4	4	60
2	III S	24BTC1308	Fundamentals of Microbiology	3	3	45
2	III S	24BTC1110	Fundamentals of Microbiology Lab	2	1	15
2	IV NME	24XXXNNNN	*Non Major Elective – II*	3	2	30
2	IV AEC	24HVS1200 / 24CHR1200	Human Values Development / Christian Studies	3	2	30
2	V	24XXXNNNN	NSS/NCC/PED/SLP/GMP/ GNS/LIB/ACH	-	1	15
	Total			**30**	**25+1**	**375+15**
3	I	24XXXNNNN	Tamil / Hindi / French	3	2	30
3	II	24XXXNNNN	English	3	2	30
3	III CC	24BTC2601	Immunology and Immunotechnology	6	6	90
3	III CC	24BTC2303	Immunology and Immunotechnology Lab	3	3	45
3	III CC	24BTC2405	Bioentrepreneurship	4	4	60
3	III CC	24BTC2307	Bioethics, Biosafety and IPR	3	3	45
3	III S	24BTC2309	Bioinstrumentation	3	3	45
3	III S	24BTC2111	Bioinstrumentation Lab	2	1	15
3	IV SEC	24XXXNNNN	*Skill Enhancement Course – I*	3	2	30
3	V	24XXXNNNN	NSS/NCC/PED/SLP/GMP/ GNS/LIB/ACH	-	-	-
	Total			**30**	**26**	**390**

4	I	24XXXNNNN	Tamil / Hindi / French	3	2	30
4	II	24XXXNNNN	English	3	2	30
4	III CC	24BTC2502	Genetic Engineering and rDNA Technology	5	5	75
4	III CC	24BTC2304	Genetic Engineering and rDNA Technology Lab	3	3	45
4	III CC	24BTC2506	Environmental and Industrial Biotechnology	5	5	75
4	III CC	24BTC2308	Environmental and Industrial Biotechnology Lab	3	3	45
4	III S	24BTC2410	Bioinformatics and Biostatistics	5	4	60
4	IV SEC	24XXXNNNN	*Skill Enhancement Course – II*	3	2	30
4	V	24XXXNNNN	NSS/NCC/PED/SLP/GMP/ GNS/LIB/ACH	-	1	15
	Total			**30**	**26+1**	**390+15**
5	III CC	24BTC3601	Plant Biotechnology	6	6	90
5	III CC	24BTC3603	Animal Biotechnology	6	6	90
5	III CC	24BTC3305	Plant and Animal Biotechnology Lab	3	3	45
5	III CC	24BTC3307	Research Methodology	3	3	45
5	III DSE	24XXXNNNN	*Discipline Specific Elective – I*	5	4	60
5	III GE	24XXXNNNN	*Generic Elective – I*	4	3	45
5	IV SEC	24XXXNNNN	*Skill Enhancement Course – III*	3	2	30
5	IV IS	24BTC3255	Internship*	-	2	30
	Total			**30**	**29**	**435**
6	III CC	24BTC3502	Genomics and Proteomics	5	5	75
6	III CC	24BTC3404	Food Technology	4	4	60
6	III CC	24BTC3306	Food Technology Lab	3	3	45
6	III CC	24BTC3608	Project	6	6	90
6	III DSE	24XXXNNNN	*Discipline Specific Elective – II*	5	4	60
6	III GE	24XXXNNNN	*Generic Elective – II*	4	3	45
6	IV SEC	24BTC3266	Professional Competency Skill	3	2	30
	Total			**30**	**27**	**405**
Grand Total				**180**	**158+2**	**2370+30**

* Internship – Second Year Vacation

Part III

Discipline Specific Elective (DSE)

Sem	Part	Course Code	Course Title	Hours/ Wk.	Credits	Marks
5	III	24BTC3409	Nanobiotechnology	5	4	60
		24BTC3411	Enzymology	5	4	60
6	III	24BTC3410	Marine Biotechnology	5	4	60
		24BTC3412	Pharmaceutical Biotechnology	5	4	60

Generic Elective (GE)

Sem	Part	Course Code	Course Title	Hours/ Wk.	Credits	Marks
5	III	24BTC3313	Introduction to Forestry	4	3	45
		24BTC3315	Nutraceuticals	4	3	45
6	III	24BTC3314	Waste Management Technology	4	3	45
		24BTC3316	Microbes in Human Welfare	4	3	45

Part IV

Non-Major Electives (NME)

Sem	Part	Course Code	Course Title	Hours/ Wk.	Credits	Marks
1	IV	24BTC1207	Biotechnology for Society	3	2	30
2	IV	24BTC1212	Herbal Medicine	3	2	30

Skill Enhancement Courses (SEC)

Sem	Part	Course Code	Course Title	Hours/ Wk.	Credits	Marks
3	IV	24BTC2213	Mushroom Technology	3	2	30
4	IV	24BTC2212	Organic Farming	3	2	30
5	IV	24BTC3217	Climate Change and Sustainable Development	3	2	30

Mapping with POs

BTC	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
	3	3	2	2	2	2	2	2	1	2

Mapping of Courses with PSOs

Courses	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
24BTC1601	3	2	2	2	2	2	3	2	2	2
24BTC1303	3	3	3	2	3	3	3	2	1	1
24BTC1405	3	3	2	2	2	3	2	1	1	1
24BTC1200	3	3	3	3	2	2	3	3	3	2
24BTC1602	3	3	3	3	1	3	2	2	2	2
24BTC1304	3	3	2	3	2	2	2	2	1	2
24BTC1406	3	3	2	1	1	1	1	1	1	1
24BTC1308	3	3	2	1	1	1	1	1	1	1
24BTC1110	3	3	1	1	2	1	1	1	1	1
24BTC2601	3	3	3	3	3	2	2	2	1	2
24BTC2303	3	3	3	3	3	2	2	2	1	2
24BTC2405	3	2	2	2	1	2	2	2	1	2
24BTC2307	3	3	2	1	2	2	2	3	1	1
24BTC2309	3	3	2	2	1	1	2	2	2	1
24BTC2111	3	3	2	2	1	1	2	2	1	1
24BTC2213	3	3	3	2	2	2	1	2	1	2
24BTC2502	3	3	2	2	2	2	2	2	1	1
24BTC2304	3	3	3	3	3	2	3	3	2	2
24BTC2506	3	3	2	1	1	2	1	2	1	1
24BTC2308	3	3	2	2	2	1	2	2	1	1
24BTC2410	3	3	1	1	2	2	2	1	1	2
24BTC2212	3	3	2	2	1	2	2	1	1	2
24BTC3601	3	3	2	2	2	2	2	1	1	1
24BTC3603	3	3	2	2	2	2	2	2	1	2
24BTC3305	3	3	2	2	2	2	2	1	1	1
24BTC3307	3	3	3	3	3	2	2	2	1	2
24BTC3255	3	3	3	3	3	3	3	2	2	3
24BTC3409/ 24BTC3411	3	3	3	2	2	2	2	2	1	2
24BTC3217	3	3	3	3	2	1	2	2	1	2

24BTC3502	3	3	1	1	2	2	2	1	1	1
24BTC3304	3	3	3	3	2	2	2	1	1	1
24BTC3206	3	3	3	3	2	2	2	1	1	1
24BTC3808	3	3	3	3	3	3	3	2	2	3
24BTC3410/ 24BTC3412	3	3	2	1	2	2	2	2	2	2
24BTC3266	3	3	3	3	3	3	3	2	2	3
Average	3.0	2.9	2.3	2.1	2.0	2.0	2.1	1.8	1.3	1.6

Mapping of Courses with POs

Courses	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
24BTC1207	3	3	2	2	2	2	2	3	2	2
24BTC1212	3	3	1	1	1	1	2	1	1	2
24BTC3313/ 24BTC3315	3	3	1	2	1	2	2	1	2	2
24BTC3314/ 24BTC3316	3	3	2	2	2	2	1	1	1	1
Average	3.0	3.0	1.5	1.8	1.5	1.8	1.8	1.5	1.5	1.8

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC1601	Cell and Molecular Developmental Biology	Core	6	6

This course is framed to acquire knowledge on structure of a cell, function of organelles, molecular mechanism of replication, transcription and translation. In addition to that the students get the information about the concepts of plant and animal development.

Course Outcomes:

At the end of the course, students will be able to

CO1: have an insight of the cell as the fundamental unit of life and to compare the structure of the eukaryotic cell with the primitive prokaryotic cell.

CO2: analyse the structure and obtain a strong foundation about the functional aspects of cell organelles and cell membrane.

CO3: study the structure and functions of nucleic acid and discuss the molecular mechanism of replication, transcription and translation and post translational modifications of proteins.

CO4: predict the response of cells to the intra and extracellular environment by studying about the intracellular signalling pathways.

CO5: understand the principles and molecular mechanisms involved in cellular differentiation, morphogenesis, growth and potency of the cell.

Unit I: **18 Hours**

Origin of life - Discovery and diversity of cells - Cell theory - Structure and organization of prokaryotic (bacteria) and eukaryotic cells (plant and animal cells) – Endosymbiotic theory – Structure and organization of cell wall – Structure and function of plasma membrane.

Unit II: **18 Hours**

Structure and functions of cell organelles: Cytoplasm, nucleus, chromosomes, endoplasmic reticulum, ribosomes, golgi bodies, plastids, vacuoles, lysosomes, mitochondria, microbodies, flagella, cilia, centrosome and centrioles – Cytoskeleton.

Unit III: **18 Hours**

Central Dogma of the cell: Structure and functions of DNA and RNA-DNA replication - Transcription - Translation - Similarities and differences in prokaryotes and eukaryotes - Genetic code - Post translational modifications.

Unit IV: **18 Hours**

Cell cycle - Cell cycle checkpoints - Cell division - Mitosis and Meiosis - Cellular differentiation - Cell junctions - Cell adhesion – Extra cellular matrix - Cell to cell communications - Signal transduction - G Protein coupled receptors signal transduction pathways.

Unit V: **18 Hours**

Animal development: Gametogenesis - Spermatogenesis and Oogenesis in mammals. Fertilization – Embryo development - Organogenesis. Plant development: Flower, pollen, embryo sac, fertilization, post fertilization events and seed development.

Learning Resources:

Text Books

1. Alberts, B. (2017). Molecular biology of the cell. Garland science.
2. Devasena, T. (2012). Cell Biology. Oxford University Press.
3. Gilbert, S. F., & Barresi, M. J. F. (2016). Developmental Biology, 11th Edit. Sinauer Associates Inc. Publishers, MA. USA.
4. Gupta, R., Makhija, S., & Toteja, R. (2018). Cell Biology Practical Manual. Prestige Publishers.
5. Watson, J.D. (2001). The Double Helix: A Personal Account of the Discovery of the Structure of DNA. Touchstone Books.

References

1. Cooper, G.M. & Hausman, R.E. (2019). The Cell: A Molecular Approach. 7th Edit. Oxford University Press.
2. De Robertis EDP, and De Robertis E.M.F. (2017). Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Karp, G., Iwasa, J., & Marshall, W. (2016). Karp's Cell and Molecular Biology: Concepts and Experiments, 8th Edit. Wiley Publications.
4. Lodish, H. F., Berk, A., Kaiser, C., Krieger, M., Bretscher, A., Ploegh, H. L., Martin, K. C., Yaffe, M. B. & Amon, A. (2021). Molecular cell biology. New York: WH Freeman.
5. Watson, J. D. (2014). Molecular Biology of the Gene. 7th Edit. Pearson Education India.

Websites/ e-Learning Resources

1. http://www.cellbiol.com/education.php
2. https://dnalc.cshl.edu/websites/
3. https://www.cellsignal.com/contents/science/cst-pathways/science-pathways
4. https://nptel.ac.in/courses/102/106/102106025/11.

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	2	3	2	3	2	2	2
CO2	3	3	2	3	3	2	3	2	3	2
CO3	3	2	3	3	3	2	3	1	3	1
CO4	3	2	3	3	2	1	3	2	3	2
CO5	3	2	1	1	2	2	3	2	1	1
Average	3	2.4	2.4	2.4	2.6	2.25	3	1.8	2.4	1.6

High correlation-3 Medium correlation –2 Low correlation –1 No correlation-‘-‘

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC1303	Cell and Molecular Developmental Biology Lab	Core	3	3

This course is designed to acquire practical knowledge on isolation, identification and structure of various cells and cell organelles.

Course Outcomes:
At the end of the course, students will be able to

CO1: demonstrate the operation of light microscope.

CO2: identify blood cells and its components.

CO3: isolate and identify plant and animal cells.

CO4: summarizes the concept of gametes.

CO5: develop skill to perform cell fractionations.

Experiments:

1. Study of prokaryotic and eukaryotic cell structure.
2. Blood smear preparation and identification of blood cells.
3. Buccal smear preparation and identification of squamous epithelial cells.
4. Cell inclusions – Starch and oil.
5. Cell division in onion root tip.
6. Study of plasmolysis and de-plasmolysis.
7. Study the effect of temperature and organic solvents on semi permeable membrane.
8. Observation of sperm and egg.
9. Mounting of chick embryo - 24, 48, 72 and 96 hrs.
10. Demonstration of fractionation and separation of cell organelles.

Learning Resources:

Text Books

1. Chaitanya, K. V. (2013). Cell and Molecular Biology: A Lab Manual. PHI Learning Pvt. Ltd.
2. Das, D. (2017). Essential Practical Handbook of Cell Biology & Genetics, Biometry & Microbiology: A Laboratory Manual. Academic Publishers.
3. Rajan, S., & Selvi Christy, R. (2015). Experimental Procedures in Life Sciences. CBS Publishers & Distributors Pvt Ltd.

References

1. De Robertis EDP, & De Robertis E.M.F. (2017). Cell and Molecular Biology. 8th Edition. Lippincott Williams and Wilkins, Philadelphia.
2. Gupta, R., Makhija, S., & Toteja, R. (2018). Cell Biology Practical Manual. Prestige Publishers

3. Reddy, H. P. *et al*., (2018). Lifesciences protocol manual, Department of biotechnology Ministry of Science and Technology, Govt. of India.

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	2	3	3	3	2	1	1
CO2	3	3	3	2	3	3	3	2	1	1
CO3	3	3	3	2	3	3	3	2	1	1
CO4	3	3	3	2	3	3	3	2	1	1
CO5	3	3	3	2	3	3	3	2	1	1
Average	3	3	3	2	3	3	3	2	1	1

High correlation-3 Medium correlation –2 Low correlation –1 No correlation-‘-‘

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC1405	Graduate Skills for Biotechnologists	Core	4	4

This course has been designed to audit the natural skills and abilities of students and sharpen them to suit the academic and professional situations. It acts as a bridge course to teach the scientific and communication skills to students. The course will also familiarize the students with basics of computer usage and web-based resources for educational purposes.

Course Outcomes:

At the end of the course, students will be able to

CO1: acquire skills on basics of units, measurements and common mathematical calculations.

CO2: know laboratory safety measures and good laboratory practices to ensure a safe laboratory environment.

CO3: acquaint themselves with different scientific skills and equip with the reading, writing, speaking and listening skills.

CO4: enhance their positive attitude, set goals, develop leadership traits and achieve their goals in life.

CO5: comprehend the basics of computing, ICT tools and online resources and apply them efficiently in their career.

Unit I: 12 Hours

Lab safety and good lab practices: General laboratory safety - Good laboratory practices - Biosafety measures - First aid practices - Safety symbols - Lab safety equipments (Fire extinguisher, fume hood, safety glasses, masks) - Classes of laboratory chemicals - Maintenance and handling of chemicals (Labels and Grades) - Precautions for use – disinfectants - Disposal of hazardous chemicals, radioactive and biological waste - Laboratory waste management.

Unit II: 12 Hours

Measurements and calculations**:** Scientific inquiry – Laboratory and field experiments - Units of measurements (SI) and conversions - Measurement of volumes of liquids, Weighing - calculations: Scientific notations, powers, logarithm and fractions - Solutions and buffers: Molarity, Molality, Normality, percent solution, stock solution, pH, acids and bases, buffers.

Unit III: 12 Hours

Scientific skills: Skill categories (generic, observational, experimental, numerical skills) –Observational skills: Class lectures, seminars. Communication skills: Verbal and nonverbal - Common barriers and impediments - Oral and poster presentation - Learning preferences (VARK scheme) – Notes making styles – Writing skills: Purpose of writing (Class room, examination and assignments) – Scientific terms, diagrams – Tables and graphs – Experimental records - Interpretation.

Unit IV: **12 Hours**

Personal management: Goal setting (SMART approach) – Career planning – Time management – Developing positive attitude - Personality and leadership traits – Team work skills–Problem solving abilities – Critical thinking and strategic planning.

Unit V: **12 Hours**

Basic computing and web resources: Computers: Hardware and software – Microsoft Office: Word, PowerPoint and Excel – Online communications – Scientific web resources – Online learning portals – AI for biotechnologists – Smart phones and its application in biology.

Learning Resources:

Text Books

1. Alex, K. (2014). Soft Skills-Know yourself and know the world. 3rd Edition. Chand and Company Limited. New Delhi.
2. Kumar, S. (2015). Communication skills. 2nd edition. Oxford University Press. India.
3. Thareja, R. (2019). Fundamentals of Computers.2nd edition. Oxford University Press.
4. Xavier Alphonse, S. J. (2011). We shall overcome - A textbook on life coping skills. 5th Edition. ICRDE Publications, Chennai.

References

1. Adair, J. (2009). Effective communication, Pan Macmillan.
2. Evert, R. F., Eichhorn, S. E., & Perry, J. (2012). Laboratory Topics in Botany.8th Edition. Macmillan Learning.
3. Jones, A., Reed, R., &Weyers, J. (2021). Practical Skills in Biology, 7th Edition. Pearsons.
4. Meah, M., & Kebede-Westhead, E. (2012). Essential laboratory skills for biosciences. John Wiley & Sons.
5. Plummer, D. T. (2017). Introduction to Practical Biochemistry.3rd Edition. TataMcGraw-Hill Education.

Websites/ e-Learning Resources

1. https://www.education.gov.in/ict-initiatives
2. https://careercenter.umich.edu/article/biology

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	1	1	2	3	2	1	1	1
CO2	3	3	2	2	2	3	2	1	1	1
CO3	3	3	2	2	2	3	2	1	1	1
CO4	3	3	3	3	2	3	3	1	1	1
CO5	3	3	3	3	2	3	3	1	1	2
Average	3	3	2.2	2.2	2	3	2.4	1	1	1.2

High correlation-3 Medium correlation –2 Low correlation –1 No correlation ‘-’

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC1207	Biotechnology for Society	NME	3	2

This course is designed for the non-biological students to understand the role of biotechnology in various fields such as Sericulture, Apiculture, Mushroom cultivation, biodegradation, antibiotic production and production of transgenic plants.

Course Outcomes:

At the end of the course, students will be able to

CO1: understand the role of biotechnology in Sericulture, Apiculture and Mushroom cultivation.

CO2: gain knowledge about the production of bio fertilizer and advantages of biopestisides.

CO3: know the significance of microorganisms in biodegradation.

CO4: get to know about history of antibiotics.

CO5: comprehend about transgenic plants.

Unit I: **9 Hours**

Introduction to biotechnology - Biotechnology in Sericulture - Rearing of silkworms - Importance and applications - Biotechnology in Apiculture - Bee hive hierarchy - Bee keeping process - Mushroom farming stages - Cultivation of oyster mushroom – Scope of mushroom cultivation and marketing.

Unit II: **9 Hours**

Biofertilizer: Microbial agents - Mass production of *Azolla* - Advantages and disadvantages. Vermicompost: process and applications. Biopesticides: Microbial biopesticides - *Bacillus thuringiensis.* Single Cell Protein (SCP): Introduction – Production of *Spirulina* – Applications - Advantages and disadvantages.

Unit III: **9 Hours**

Biodegradation: Biodegradable and non-biodegradable materials – Biodegradation Process -Microorganisms in biodegradation - Biodegradable plastics – Advantages. Bio weapons: Harmful effects.

Unit IV: **9 Hours**

Antibiotics: Introduction, history and types of antibiotics. Antibiotic resistance. Vaccines: Historical development, basic types of vaccines and immunization schedule.

Unit V: **9 Hours**

Transgenic plants: Introduction to transgene and transgenesis - BT Cotton, Brinjal and Golden Rice: Importance, applications, advantages and disadvantages.

Learning Resources:

Text Books

1. Nair, A. J. (2004). Basics of biotechnology. Firewall Media.

2. Ratledge, C., & Kristiansen, B. (2008). Basic biotechnology. Cambridge University Press.
3. Slater, A., Scott, N., & Fowler, M. (2008). Plant biotechnology: the genetic manipulation of plants. OUP Oxford.

References

1. Chatterji, A. K. (2011). Introduction to environmental biotechnology. PHI Learning Pvt. Ltd.
2. Chawla, H. (2011). Introduction to plant biotechnology. 3th ed., CRC Press.
3. Dubey, R.C. (2020). Advanced Biotechnology. S. Chand & Company Ltd.
4. Glazer, A. N., & Nikaido, H. (2007). Microbial biotechnology: fundamentals of applied microbiology. Cambridge University Press.
5. Satyanarayana, U., & Chakrapani, U. (2019). Biotechnology. 12th Edition. Books & Allied Ltd.

Websites/ e-Learning Resources

1. https://krishijagran.com/agripedia/a-complete-guide-to-profitable-mushroom-farming-in-india-read-composting-harvesting-techniques/
2. https://www.agrifarming.in/honey-bee-farming-information-guide

CO–PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	3	2	3	3	3	2	2
CO2	3	3	2	1	1	1	2	3	2	3
CO3	3	3	2	2	1	2	1	2	2	2
CO4	3	3	3	3	2	3	2	2	2	1
CO5	2	2	2	2	2	1	2	3	1	2
Average	2.6	2.8	2.2	2.2	1.6	2	2	2.6	1.8	2

High correlation-3 Medium correlation –2 Low correlation –1 No correlation-'-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC1200	**Environmental Studies**	**AEC**	**3**	**2**

This course is designed to introduce students the importance and issues related to environment. It focuses on the natural resources, energy flow and types of ecosystems. Values of biodiversity, hotspots, endangered species and conservation are emphasized. It also highlights the social issues and population explosion in the environment.

Course Outcomes:

At the end of the course, students will be able to

CO1: outline the values of renewable and non-renewable resources.

CO2: evaluate the concept, functions and types of ecosystems.

CO3: discuss the values of biodiversity and importance of conservation.

CO4: compare different types of pollution and assess the various waste management strategies.

CO5: critique the importance of environmental issues, climate change and population explosion.

Unit I: 9 Hours

Introduction to Environmental studies: Definition – Scope and importance - Need for public awareness – Role of people and institutions in environment protection - Natural resources: Renewable and non-renewable resources - Management - Concept of sustainability and sustainable development - SDGs.

Unit II: 9 Hours

Ecosystems**:** Concept, structure and functions of ecosystem – Producers - Consumers and decomposers - Energy flow in an ecosystem - Food chain, food web and ecological succession – Types of ecosystems: Natural ecosystem (Forest – Grassland - Desert – Aquatic) – Man made ecosystem (Pond and Garden).

Unit III: **9 Hours**

Environmental Pollution**:** Definition, causes, effects and control measures of air, water, soil, noise and thermal pollution - Nuclear hazards - Global warming: Depletion of ozone layer - greenhouse effect - Solid waste management - Disaster management and precautions - Environment and human health.

Unit IV: **9 Hours**

Environmental movements: Chipko – Appiko, Silent valley, Biodiversity heritage site (Arittapatti) and Bishnois of Rajasthan - Rain water harvesting - Watershed management - Human rights - Human population and the environment: Population explosion - Urbanization – Town planning.

Unit V: **9 Hours**

Outline of environmental acts - Environmental Impact Assessment (EIA) – Principles and methodologies – Environmental audit – Climate related financial disclosures - Nature related financial disclosures – Carbon sequestration – Carbon credit - Role of biotechnology in recent environmental innovations –Neom project (Saudi Arabia).

Learning Resources

Text Books

1. Bharucha, E. (2013), Textbook of Environmental studies for Undergraduate courses, 2nd edition, Universities press (India) Private Ltd.
2. Chawla, S. (2017), Textbook of Environmental studies, MC GRAW HILL Education, India.
3. Verma, P. S., & Agarwal, V. K. (2021). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S Chand and Company Ltd.

References

1. Dubey, R.C. (2020). Advanced Biotechnology. S. Chand & Company Ltd.
2. Kaushik, A & Kaushik, C.P. (2014), Perspectives in Environmental Studies, 4th edition, New Age International (P) Limited Publishers.
3. Krishnamoorthy, K.V. (2018). An Advanced Textbook on Biodiversity*:* Principles and Practice. Oxford and IBH Publishing.
4. Myneni, S. R. (2019) Environmental studies, Asia Law House, Hyderabad.
5. Thatheyus, A.J. (2011) Textbook of Environmental Studies, Narosa Publishing House, New Delhi.

Websites/ e-Learning Resources

1.https://www.bbau.ac.in/dept/UIET/TCE-033%20%20epdf.pub

2. https://microbenotes.com/ecosystem-definition-structure-factors-types-functions/

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	3	2	3	3	3	2
CO2	3	2	3	2	2	3	3	3	3	3
CO3	3	3	3	3	2	3	3	3	3	3
CO4	3	3	3	3	3	2	3	2	3	2
CO5	3	2	3	3	1	1	3	3	3	1
Average	3	2.6	2.8	2.6	2.2	2.2	3	2.8	3	2.2

High correlation-3 Medium correlation –2 Low correlation –1 No correlation-‘-‘

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC1602	**Genetics**	**Core**	**6**	**6**

This course is framed to understand the concepts of Mendelian genetics, linkages, crossing over, mutation, operon concepts, gene transfer methods and population genetics.

Course Outcomes:

At the end of the course, students will be able to

CO1: learn about the classical genetics and transmission of characters from one generation to the next.

CO2: obtain a strong foundation for the advanced genetics.

CO3: explain the properties of genetic materials and storage and processing of genetic information.

CO4: acquire knowledge about the mutagens, mutations, DNA repairs and genetic disorders in human.

CO5: categorize Eugenics, Euphenics and Euthenics and in depth Knowledge on population Genetics.

Unit I: **18 Hours**

Mendel's experiments, monohybrid cross, dihybrid cross, backcross or testcross, Mendel's laws - Incomplete dominance and Co-dominance - Interaction of genes - Epistasis - Lethal genes. Multiple alleles – Drosophila, rabbit and blood group inheritance in man.

Unit II: **18 Hours**

Chromosome organization – Types of chromosomes – Linkage: Morgan's experiments and Factors affecting linkage - Crossing over: Types, mechanism, significance of crossing over - Mapping of chromosomes, interference and coincidence. Cytoplasmic inheritance, Extra nuclear inheritance (Mitochondrial and Chloroplast) – Maternal inheritance - Sex linked inheritance and sex determination in man.

Unit III: **18 Hours**

Identification of the DNA as the genetic material: Griffith experiments – Avery – McLeod - McCarty and Hershey Chase experiment - Fine structure of the gene and gene concept - Operon Concept – Lac operon.

Unit IV: **18 Hours**

Mutation: Types of mutation, mutagens, DNA damage and repair mechanism - Chromosomal aberrations: Numerical, structural and pedigree analysis - Mendelian inheritance in human (Cystic fibrosis and Muscular dystrophy).

Unit V: **18 Hours**

Population genetics: Hardy Weinberg principle, gene frequency, genotype frequency and factors affecting gene frequency - Eugenics, Euphenics and Euthenics.

Learning Resources:

Text Books

1. Rastogi, V.B. (2020). Elements of Genetics, 11th Revised & Enlarged Edition, KedarNath Ram.
2. Verma, P. S., & Agarwal, V. K. (2009). Genetics, S. Chand & Co., New Delhi.
3. Ahluwalia, K. B. (2018). Genetics. New Age International.

References

1. Gardner, E.J., Simmons, M.J., & Snustad, D.P. (2008). Principles of Genetics. VIII Edition. John Wiley & Sons.
2. Klug, W.S. and Cummings, M.R. and Spencer, C.A. and Palladino, M.A. (2014). Concepts of Genetics. Pearson Education.
3. Lewis, R. (2001). Human Genetics: Concepts and Applications. 4thEdition. McGraw Hill.
4. Miglani, G.S., (2012). Advanced Genetics. Alpha Science International, Ltd.
5. Griffiths, A. J., Miller, J. H., Suzuki, D. T., Lewontin, R. C., & Gelbart, W. M. (1995). An introduction to genetic analysis W. H. Freeman and Company.

Websites/ e-Learning Resources

1. https://nptel.ac.in/courses/102/106/102106025/
2. http://www.ocw.mit.edu

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	1	2	2	2	2	2
CO2	3	3	2	3	1	3	2	2	2	2
CO3	3	3	3	3	1	3	2	2	2	2
CO4	3	3	3	3	1	3	3	2	2	2
CO5	3	3	3	3	1	3	3	2	2	2
Average	3	3	2.6	2.8	1	2.8	2.4	2	2	2

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC1304	**Genetics Lab**	**Core**	**3**	**3**

This course is designed to gather practical knowledge on the stages of mitosis and meiosis, observation of chromosome and mutational studies in *Drosophila.*

Course Outcomes:

At the end of the course, students will be able to

CO1: demonstrate the basic principles of important techniques in molecular biology and genetics.

CO2: analyse the polytene chromosome of the organisms.

CO3: identify Barr bodies from Buccal smear.

CO4: demonstrate the preparations and maintenance of culture medium.

CO5: demonstrate human karyotyping.

Experiments:

1. Mitotic stages of onion (*Allium cepa*) root tip.
2. Meiotic stages of flower buds.
3. Genetic study of model organisms - *E. coli* and *Drosophila melanogaster*.
4. Giant chromosomes from Chironomus larvae/ Drosophila salivary glands.
5. Identification of Barr bodies from Buccal smear.
6. Preparations of culture medium and culture of Drosophila – methods of maintenance.
7. Identifications of mutants of Drosophila.
8. Study of monohybrid and dihybrid crosses.
9. Study of polygenic inheritance.
10. Pedigree charts of blood group.
11. Human karyotyping (Demo).
12. Study of chromosome mapping.

Learning Resources:

Text Books

1. Chowdhury, M. R., Shastri, S. S., & Kabra, M. (2014). Laboratory Manual for Molecular Genetic Tests. 1st Edition. Jaypee Brothers Medical Publishers (P) Ltd.
2. Das, D. (2017). Essential Practical Handbook of Cell Biology & Genetics, Biometry & Microbiology: A Laboratory Manual. 1st Edition. Academic Publishers.
3. Panigrahi, K. K. (2019). Practical Manual on Fundamentals of Genetics. Odisha University of Agriculture & Technology.

References

1. Joshi, S. & Dhamija, N. (2016). Rediscovering Genetics: A Laboratory Manual. I.K. International Publishing House Pvt. Ltd.
2. Small, C. (2019). Genetics Laboratory Manual. Kendall Hunt Publishing.
3. Rajan, S., & Selvi Christy, R. (2015). Experimental Procedures in Life Sciences. CBS Publishers & Distributors Pvt Ltd.

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	1	3	2	2	2	2	1	2
CO2	3	3	1	3	2	2	1	2	1	1
CO3	3	3	2	3	2	2	1	2	1	1
CO4	3	3	2	3	2	2	2	2	1	2
CO5	3	3	3	3	2	2	2	2	1	2
Average	3	3	1.8	3	2	2	1.6	2	1	1.6

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC1406	Biodiversity and Conservation	Core	4	4

This course is framed to understand the concepts of biodiversity, methods of studying biodiversity, need for conservation and conservational strategies.

Course Outcomes:

At the end of the course, students will be able to

CO1: understand the basic concepts and measures of biodiversity.

CO2: gain knowledge about biodiversity systems and get aware on the factors affecting primary production.

CO3: acquire the facts on the causes and consequences of loss of biodiversity.

CO4: inform about the strategies to conserve and manage the wildlife.

CO5: become skilled at intellectual property rights and its impact on biodiversity.

Unit I: 12 Hours

Biodiversity: Definition, concept and scope - Levels of biodiversity: Genetic, species and ecosystem diversity – Magnitude of biodiversity – Biodiversity Hot Spots: Distribution of hot spots in the World and India – Values of biodiversity – Island biogeography theory – Endemic diversity – Dominance and evenness - Red Data Book: IUCN categories and its importance.

Unit II: 12 Hours

Biodiversity system – Features, primary, secondary and tertiary production – Methods for measuring the productivity – Factors affecting primary production – General account of productivity in different oceans – Red tide – harmful algal blooms – Causes and effects.

Unit III: 12 Hours

Causes and consequences of biodiversity loss - Impact of exotic species on local biodiversity - Extinction of species - Key stone species and their significance. Climate change mediated Impacts on biodiversity – *El-Nino* Southern Oscillation phenomenon (ENSO) and its impacts –Ecological significance of Coral reefs.

Unit IV: 12Hours

Biodiversity conservation and management: Threats and challenges – Types of conservation - *In situ* conservation: Sanctuaries, National parks and biosphere reserves, *Ex situ* conservation: Zoological parks, gene banks and cryopreservation – Role of indigenous people in conservation – Sacred species and sacred groves – Ramsar convention – Human animal conflicts.

Unit V: 12 Hours

Biotechnological approaches in conservation: Bioprospecting – Biopiracy - Knowledge sharing – Intellectual property rights and its impact on biodiversity - GIS

and remote sensing in biodiversity mapping and conservation - International and National organizations in biodiversity conservations.

Learning Resources:

Text Books

1. Krishnamoorthy, K.V. (2018). An Advanced Textbook on Biodiversity*:* Principles and Practice. Oxford and IBH Publishing.
2. Kumar, H.D. (1999). Biodiversity and Sustainable Conservation. Oxford and IBM publishing Company, New Delhi.
3. Melchias, G. (2001). Biodiversity and Conservation. Oxford and IBM publishing company Pvt., Ltd. New Delhi.

References

1. An, S., & Verhoeven, J. T. A. (2019). Wetlands: Ecosystem Services, Restoration and Wise Use (Vol. 238). Ecological Studies. Springer International Publishing Cham.
2. Copsey, J. A., Black, S. A., Groombridge, J. J., & Jones, C. G. (Eds.). (2018). Species Conservation: Lessons from Islands. Ecology, Biodiversity and Cons.
3. Gadgil, M., Ghate, U., & Pramod, P. (1996) Biodiversity resource materials, Center for ecological sciences. Indian Institute of Sciences, Bangalore and Biodiversity Unit, Jawaharlal Nehru, Centre for Advanced Scientific Research, Bangalore.
4. Gillson, L. (2015). Biodiversity conservation and environmental change: using palaeoecology to manage dynamic landscapes in the Anthropocene. OUP Oxford.
5. Verma, P. S., & Agarwal, V. K. (2021). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. S Chand and Company Ltd.

Websites/ e-Learning Resources

1. https://sustainability-innovation.asu.edu/biodiversityoutcomes/biodiversity-introduction/
2. https://nptel.ac.in/courses/102/106/102106025/

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	1	1	1	1	1	1	1	1
CO2	3	3	1	1	1	1	1	1	1	1
CO3	3	3	2	2	1	1	1	1	1	1
CO4	3	3	2	2	1	1	1	1	1	1
CO5	3	3	2	1	1	1	1	1	1	1
Average	3	3	1.6	1.4	1	1	1	1	1	1

High correlation-3 Medium correlation –2 Low correlation –1 No correlation-‘-‘

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC1308	Fundamentals of Microbiology	Supportive	3	3

This course is aimed to know the diversity, classification, structure and growth of various microbes. It also describes sterilization methods and microbiological techniques useful for biological sciences. It also gives a brief outline on pathogenic microbes, disease diagnosis and treatments.

Course Outcomes:

At the end of the course, students will be able to

CO1: comprehend the milestones, diversity and classification of microorganisms.

CO2: demonstrate the structure, growth pattern & reproduction of bacteria and various microbiological techniques.

CO3: categorize the microbial culture collections, storage & preservation methods and analyse the issues on antibiotic resistance.

CO4: exhibit knowledge in analyzing the importance of bioinsecticides, biofertilizers and probiotics.

CO5: understand the clinical features, diagnosis and treatment of microbial diseases.

Unit I: **9 Hours**

History of microbiology – Contributions of Louis Pasteur and Robert Koch - Diversity and characteristics of microorganism - Scope of microbiology – Role of microbes in biotechnology.

Unit II: **9 Hours**

Structure of bacteria – Cell wall of gram-positive and gram-negative bacteria – Flagella -Plasmid - Bacterial growth curve and measurement – Bacterial reproduction - Sterilization methods: Physical and chemical methods – Types of culture media - Staining methods (Simple, differential and LCB mount).

Unit III: **9 Hours**

Methods of preservation and storage of microbes - Culture collection centres of fungi, virus and algae – Mode of action of antibiotics – Antibiotic resistance – MDRO – Human microbiome project.

Unit IV: **9 Hours**

Bioinsecticides - *Bacillus thuringiensis*, Baculo viruses- Biofertilizers - *Azospirillum* and blue green algae - Single Cell Protein (SCP) – Probiotics – Microbial metabolites.

Unit V: **9 Hours**

Microbial disease- Host - Pathogen interaction, clinical features, lab diagnosis and treatment of airborne disease (Chicken pox), food borne disease (Typhoid), Water borne disease (Amoebiasis), Sexually transmitted disease (AIDS), Vector borne disease (Dengue) and Pandemic disease (COVID-19).

Learning Resources:

Text Books

1. Ananthanarayanan & Paniker. (2013).Textbook book of Microbiology, 9th Edition, Orient BlackSwan.
2. Dubey R.C. & Maheswari, S. (2003). A Textbook of Microbiology, S. Chand Ltd.
3. Gunasekaran, P. (2007). Laboratory manual in microbiology. New Age International.
4. Pelczar, M. J., Chan, E.C.S., & Noel, R.K. (2007). Microbiology. 7th Edition., McGraw – Hill, New York.
5. Willey, J., Sherwood, L., & Woolverton C. J. (2016). Prescott, Harleya, Klein's Microbiology. 10th Edition. McGraw-Hill Education.

References

1. Boyd, R.F. (1998). General Microbiology. 2nd Edition. Times Mirror, Mosby College Publishing, St Louis.
2. Cappuccino, J.H. & Sherman, N. (2014). Microbiology – A Lab Manual (10th Edition), The Benjamin Publishing Company, Singapore.
3. Gillespie, S., & Bamford, K. (2012). Medical Microbiology and Infection at a Glance. 4th Edition. John Wiley & Son.
4. Kannan, N. (1996). Laboratory manual in General Microbiology. Palani Publications.
5. Madigan, M. T., Martinko, J. M., Bender, K. S., Buckley, D. H., & Stahl, D. A. (2017) Brock Biology of Microorganisms. 14thEdition. Pearson.

Websites/ e-Learning Resources

1. http://www ejb.org/content.
2. www. Biotech.kth.se Electronic Journal of biotechnology
3. https://www.cliffsnotes.com/studyguides/biology/microbiology/introduction-to-microbiology/a-brief-history-of-microbiology
4. https://bio.libretexts.org/@go/page/9188

CO–PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	1	1	1	2	1	1	1
CO2	3	3	1	1	1	1	1	1	1	1
CO3	3	3	2	1	1	1	1	1	1	1
CO4	3	3	2	1	1	1	1	2	1	1
CO5	3	3	2	1	2	1	1	2	1	1
Average	3	3	1.8	1	1.2	1	1.2	1.4	1	1

High correlation-3 Medium correlation –2 Low correlation –1 No correlation-'-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC1110	Fundamentals of Microbiology Lab	Supportive	2	1

The course designed to learn and explore the fundamental microbiological techniques like sterilization methods, media preparation for culturing of microorganisms and physiochemical and biochemical characterizations.

Course Outcomes:

At the end of the course, students will be able to

CO1: understand the microbiology laboratory safety measures.

CO2: demonstrate the methods of sterilization and media preparations.

CO3: isolate and enumerate microbes from different environments.

CO4: exhibit the knowledge of staining and microscopic techniques.

CO5: apply biochemical assays and characterise the microbes.

Experiments:

1. Microbiology laboratory safety measures and precautions.
2. Sterilization techniques and preparation of media.
3. Isolation of bacteria & fungi from environment – Serial dilution, pour plate and spread plate.
4. Enumeration of colony forming units and colony morphology.
5. Inoculation techniques (Streaking techniques).
6. Bacterial staining techniques – Simple and differential.
7. Staining of fungi by Lacto phenol cotton blue.
8. Motility tests: Hanging drop technique.
9. Study of bacterial growth curve.
10. Antibiotic sensitivity test.
11. Study of coliform bacteria from water sample using MPN method.
12. Biochemical characterization of bacteria (oxidase test and catalase test).
13. Microscopic observation of algae.

Learning Resources:

References

1. Gunasekaran, P. (2007*)*. Laboratory manual in microbiology. New Age International.
2. Cappuccino, J.H. & Sherman, N. (2014). Microbiology – A Lab Manual (10th Edition), The Benjamin Publishing Company, Singapore.
3. Kannan, N. (1996). Laboratory manual in General Microbiology. Palani Publications.

CO–PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	1	1	1	1	1	1	1	1
CO2	3	3	1	1	1	1	1	1	1	1
CO3	3	3	1	1	2	1	1	1	1	1
CO4	3	3	1	1	2	1	1	1	1	1
CO5	3	3	1	1	2	1	1	1	1	1
Average	3	3	1	1	1.6	1	1	1	1	1

High correlation-3 Medium correlation –2 Low correlation –1 No correlation-‘-‘

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC1212	Herbal Medicine	NME	3	2

This course is aimed to introduce the ethnomedicine, Tribal medicine and medicinal plants in Tamil Nadu and its nutritional values.

Course Outcomes:

At the end of the course, students will be able to

CO1: analyses the importance of herbal medicine.

CO2: learn the role of herbal medicines for health.

CO3: explain about tribal medicine.

CO4: explicit the role of traditional medicine for today's health.

CO5: demonstrate the use of medicinal herbs to health.

Unit I: 9 Hours

Systems of medicinal practices - Ethnomedicine: Definition, history and its scope – Inter disciplinary approaches in ethnobotany – Collection of ethnic information.

Unit II: 9 Hours

Tribal medicine: Methods of disease diagnosis and treatment – Plants in folk medicines – *Aegle marmelos*, *Pedalium murex*, *Curcuma domestica*, *Cynodon dactylon* and *Sesamum indicum.*

Unit III: 9 Hours

Traditional knowledge and utility of some medicinal plants in Tamil Nadu – *Solanum trilobatum*, *Cardiospermum halicacabum*, *Vitex negundo*, *Adathoda vasica*, *Gloriosa superba*, *Eclipta alba*, *Aristolochia indica*, *Withania somnifera* and *Phyllanthus fraternus*.

Unit IV: 9 Hours

Bioprospecting plants – Bioactive compounds - Methods of extraction, separation and confirmation - Sources of drugs: Reserpine, Artemisine, Gugulipid, Cocaine, Strychnine.

Unit V: 9 Hours

Plants in everyday life: *Ocimum sanctum*, *Centella asiatica*, *Cassia auriculata*, *Aloe vera* - Nutritive and medicinal value of some plants (*Sida acuta*, *Tridax procumbans, Ipomea sp., Daemia extensa*).

Learning Resources:

Text Books

1. Chevallier, A. (2000). The encyclopedia of medicinal plants. DK Publishers.
2. Green, J. (2000). The Herbal Medicine-Maker's Handbook: A Home Manual. Crossing Press.
3. Jain, S. K. (2001). Contribution to Indian Ethnobotany. 3rd Edition, Scientific Publishers Jodhpur, India.

4. Sinha, R. K., & Sinha, S. (2001). Ethnobiology: role of indigenous and ethnic societies in biodiversity conservation, human health protection and sustainable development. Surabhi Publications

References

1. Easley, T., & Horne, S. (2016). The Modern Herbal Dispensatory: A Medicine-Making Guide. North Atlantic Books.
2. Joshi, M. C. (2007). Handbook of Indian Medicinal Plants Hardcover. Scientific Publishers.
3. Malviya, N., & Malviya, S. (2019). Herbal Drug Technology, 1st Edition. CBS Publishers and Distributors.
4. Pragi & Varun Arora. (2019). Herbal Drug Technology, 1st Edition, S. Vikas and Company Publisher.
5. Usman, R. M., Darvhekar, V. M., Vijay Kumar, D., & Akhila, S.A., (2019). Practical Book of Herbal Drug Technology, 1st Edition, Nirali Prakashan Publishers.

Websites/ e-Learning Resources

1. https://www.ncbi.nlm.nih.gov/books/NBK92773/
2.https://www.urmc.rochester.edu/encyclopedia/content.aspx?contenttypeid=1&contentid=1169

CO–PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	2	2	2	2	2	2	2	2
CO2	3	3	2	1	2	1	2	2	1	1
CO3	3	3	1	1	1	1	2	1	1	1
CO4	3	3	1	1	1	1	2	1	1	2
CO5	3	3	1	1	1	1	2	1	1	2
Average	3	3	1.4	1.2	1.4	1.2	2	1.4	1.2	1.6

High correlation-3 Medium correlation –2 Low correlation –1 No correlation-‘-‘

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC2601	Immunology and Immunotechnology	Core	6	6

To familiarize the cells involved in immunity, organization of Immune system, various types, immune responses immunological reactions and immunization practices.

Course Outcomes:

At the end of the course, students will be able to

CO1: explain the role of immune cells and their mechanism in body defense mechanism.

CO2: deliver a knowledge on essential features of antigens and antibodies.

CO3: gain new insights into Antigen -Antibody interactions and to demonstrate immunological techniques.

CO4: gain knowledge of complement system, cytokines and production of vaccines.

CO5: apply the knowledge of immune associated disease, hypersensitivity reactions.

Unit I: **18 Hours**

Introduction to Immunology - Cells involved in immune response - Primary and Secondary lymphoid organs: Thymus, Bone marrow, Lymph nodes and Spleen – Hematopoiesis: development of B and T lymphocytes - Types of immunity: Innate and acquired.

Unit II: **18 Hours**

Antigen: Characteristics and types – Antibody: Structure, Types, Properties and their Biological Function - Production of antibodies - Hybridoma technology: Applications of Monoclonal antibodies in biomedical research.

Unit III: **18 Hours**

Antigen – Antibody interactions - Immunodiffusion and Immuno electrophoresis - Principle and application of ELISA and RIA - Immuno-fluorescence: Direct, indirect and Sandwich -Western Blotting - Purification of antibodies.

Unit IV: **18 Hours**

The complement system and activation and regulation – Types: Classical, alternative and Lectin pathway - Biological function of C' proteins – Cytokines: Structure and Function. Vaccines: Types, Production and application.

Unit V: **18 Hours**

Hypersensitivity Reactions and Types - Major Histocompatability Complex: MHC genes, MHC in immune responsiveness, Structure and function of Class I and Class II MHC molecules - HLA tissue typing - Immune reaction against host: allergy, autoimmunity, transplantation, Tumor immunology.

Learning Resources:

Text Books

1. Kindt, T.J., Goldsby, R.A., Osborne, B.A. & Kuby, J. (2007). Kuby Immunology. 6th Edition. W. H. Freeman.
2. Kannan, I. (2019). Immunology. MJP Publishers.
3. Nandini Shetty, (2005), Immunology: Introductory Textbook. New Age International.
4. Khan, F.H. & Khan, F. (2009). The Elements of Immunology. Pearson Education.

References

1. Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2017). Roitt's essential immunology. John Wiley & Sons.
2. Delves, P. J., Martin, S. J., Burton, D. R., Roitt, I. M. (2017). Essential Immunology. United Kingdom: Wiley.
3. Hay, F. C., Westwood, O. M. R. (2008). Practical Immunology. Germany: Wiley.
4. Murphy, K. M., Travers, P., Walport, M., Janeway, C. (2012). Janeway's Immunobiology. United Kingdom: Garland Science.
5. Abbas, A.K., Lihtman A.H.L., & Pillai, S. (2010). Cellular and Molecular Immunology, 6th Edition. Saunders Elsevier Publications, Philadelphia.

Websites/ e-Learning Resources

1. https://med.stanford.edu/immunol/phd-program/ebook.html
2. https://ocw.mit.edu/courses/hst-176-cellular-and-molecular-immunology-fall-2005/pages/lecture-notes/

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	3	2	2	2	1	2
CO2	3	3	3	3	3	2	2	2	1	2
CO3	3	3	3	3	3	2	2	2	1	2
CO4	3	3	3	2	3	2	2	2	1	2
CO5	3	3	2	3	3	2	2	2	1	2
Average	3	3	2.8	2.8	3	2	2	2	1	2

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC2303	**Immunology and Immunotechnology Lab**	**Core**	**3**	**3**

This course is designed to establish a basic study skill and to gather practical knowledge of the principles and procedures of immunology.

Course Outcomes:

At the end of the course, students will be able to

CO1: perform blood grouping and determine blood type.

CO2: able to count WBC and RBC.

CO3: conduct serological diagnostic tests such as ASO, CRP, RA and Widal test.

CO4: acquire technical skills required for immunodiffusion and know the principle behind the techniques.

CO5: able to Demonstrate ELISA, Handling of Laboratory animals.

Experiments:

1. Separation of Serum and Plasma.
2. Blood grouping and Rh typing.
3. WBC counting and RBC counting
4. Differential blood count
5. WIDAL Slide test
6. ASO test
7. Double Immunodiffusion
8. Single Radial Immunodiffusion
9. Rocket Immunoelectrophoresis
10. ELISA – Demonstration
11. Skin test – (Mantoux test) Demonstration
12. Handling of Laboratory animals - Demonstration

Learning Resources:

Text Books

1. Talwar, C. P. (2017). Hand Book of Practical and Clinical Immunology: Volume II. India: CBS Publishers & Distributors.
2. Hay, F. C., Westwood, O. M. R. (2008). Practical Immunology. Germany: Wiley.
3. Asim Kumar Roy. (2019). Immunology Theory and Practical, Kalyani Publications.

References

1. Manual of Clinical Laboratory Immunology. (2002). United States: ASM Press.
2. Wilmore Webley. (2016). Immunology Lab Manual, LAD Custom Publishing.
3. Janeway Travers. (1997). Immunobiology- the immune system in health and disease. 3rd Edition. Current Biology Ltd. London, New York.

Websites/ e-Learning Resources

1. https://www.researchgate.net/publication/275045725_Practical_Immunology-_A_Laboratory_Manual

CO –PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	3	2	2	2	1	2
CO2	3	3	3	3	3	2	2	2	1	2
CO3	3	3	3	3	3	2	2	2	1	2
CO4	3	3	3	2	3	2	2	2	1	2
CO5	3	3	3	3	3	2	2	2	1	2
Average	3	3	3	2.8	3	2	2	2	1	2

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC2405	Bioentrepreneurship	Core	4	4

Course Outcomes:

At the end of the course, students will be able to

CO1: identify the challenges of being a Bioentrepreneur

CO2: understand the Business proposal for starting a company

CO3: learn about Vermicomposting and Sericulture

CO4: aspire to set up Mushroom Cultivation

CO5 learn the technique of Single cell protein Cultivation

Unit I **12 hours**

Basics of Bio entrepreneurship -Biotechnology in a Global scale; types of Bio-industries – Biopharma, Bioagri and Bioservice innovations – Successful Entrepreneur – Creativity, Leadership, Managerial skills, Team building, Decision making; Public and private funding agencies (MSME, DBT, BIRAC, Startup & Make in India)

Unit II **12 hours**

Business plan preparation; business feasibility analysis by SWOT, business plan proposal for virtual startup company; statutory and legal requirements for starting a company/venture; basics in accounting practices. Market Conditions, Identifying the need of the customers.

Unit III **12 hours**

Vermicomposting– Earthworms- Ecological types- Vermiculture- Compost pit-Vermibed - applications. Sericulture- Mulberry cultivation- Silkworm Rearing-Economics of silkworm Production-Chawki Rearing-Sericulture in India.

Unit IV **12 hours**

Phases of Mushroom Cultivation; Selection of an acceptable mushroom species/strains, Management of mushroom development, Mushroom harvesting; Mushroom diseases, Medicinal and Nutritional properties of mushroom. Aquaponics-Systems- Fish and Vegetables-Nutrients Biofilters-Advantages and Disadvantages.

Unit V **12 hours**

Single Cell Protein Production: Source: Algae, Bacteria, Yeast – Cultivation of Single Cell protein: Spirulina Cultivation – Production site, Experimental design; harvesting and drying.

Text Books

1. Shimasaki, C. D. (2014). Biotechnology entrepreneurship: Starting, managing, and leading biotech companies. Amsterdam: Elsevier.
2. Onetti, A., Zucchella, A. (2014). Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge. United Kingdom: Taylor & Francis.
3. Ismail, S. A. (2009). The Earthworm Book. India: Other India Press.

Reference Books

1. Adams, D. J., Sparrow, J. C. (2011). Effective Learning in the Life Sciences: How Students Can Achieve Their Full Potential. United Kingdom: Wiley.
2. Jordan, J. F. (2014). Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press.
3. Russell, S. (2014). The Essential Guide to Cultivating Mushrooms: Simple and Advanced Techniques for Growing Shiitake, Oyster, Lion's Mane, and Maitake Mushrooms at Home. United States: Storey Publishing, LLC.

Web Resources

1. 2. http://www.recirculatingfarms.org/resources/
3. https://academy.vertical-farming.net/intro-to-mushroom-growing/

CO-PSO Mapping Table

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO 1	3	2	2	3	1	2	2	3	1	3
CO 2	3	2	2	1	1	2	3	2	2	2
CO 3	3	1	2	1	1	2	2	2	2	1
CO 4	3	3	2	2	2	2	2	2	1	2
CO 5	3	2	2	3	2	3	1	1	1	2
Average	3	2	2	2	1.4	2.2	2	2	1.4	2

High correlation-3 Medium correlation –2 Low correlation –1 No correlation-'-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC2307	**Bioethics, Biosafety and IPR**	**Core**	**3**	**3**

This course is framed to learn about human rights, biohazards, biosafety levels, Biosafety guidelines, GMP & GLP and to impart information about IPR and bioethics in biotechnology

Course Outcomes:

At the end of the course, students will be able to

CO1: describe about biohazards, Biological Safety Cabinets and Biosafety Levels

CO2: explain about role of Biosafety guidelines Government of India and Risk analysis, assessment, management and communication

CO3: exert the principles of Good Manufacturing Practices (GMP), Good Laboratory Practices (GLP) and Test system

CO4: deliver information on IPR and Agreements

CO5: bring acquaintance about Principles of bioethics and ethical implications of biotechnological products

Unit I: **9 hours**

Human Rights: Definition, Classification and Scope of Human Rights. United Nations Commission for Human Rights, National and State Human Rights Commission. Article 21 of Indian Constitution – UDHR. Social issues of Human rights.

Unit II: **9 hours**

Bioethics - ethical criteria in biotechnology- animal ethics; Licensing of animal house - Human cloning - Ethical issues - Ethical clearance norms for conducting studies on human subjects. Bioethical issues concerning reproduction (Assistive reproductive technologies) -Impact of gene cloning.

Unit III: **9 hours**

Biosafety- hazardous materials used in biotechnology — handling and disposal- Waste Categories- Chemical waste- Radioactive waste- Biohazardous waste- Sharp material; Instructions for Hazardous Waste Disposal- Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals;

Unit IV: **9 hours**

Biosafety - General guidelines - DBT guidelines on biosafety in conducting research in biotechnology - Risk assessment studies- Good manufacturing practices & Good Laboratory practices, Containment facilities and Biosafety practices - Regulation on field experiments and release of GMO’s - Labelling of GM foods - Guidelines for research in transgenic plants and Animals.

Unit V: **9 hours**

IPR - Patents - Introduction -Treaties and Conventions of Patents, Patent Cooperation Treaty - TRIPS Basis of Patentability – Non Patentable Inventions - Patent Application Procedure in India. Other Forms of IP: Copyright - Trade Mark – Industrial designs – Geographical Indications - Farmer's Rights. Patenting of Biotechnology products and processes.

Learning Resources:

Text Books

1. Ignacimuthu, S (2009), *Bioethics*, Narosa Publication house, ISBN: 978-81-7319-966-0
2. Sree Krishna . V (2007), *Bioethics and Biosafety in Biotechnology*, (1st ed.), New Age International Private Limited.
3. Sateesh MK. Bioethics and Biosafety. 2010. I. K. International Pvt Ltd

Reference Books

1. Trayer, P.C, Fredrick.R., and Koch, M. (2002), *Biosafety*. Michigan State University
2. Kankanala C., Genetic Patent Law & Strategy. 2007. 1st Edition, Manupatra Information Solution Pvt. Ltd.,
3. Bareact, Indian Patent Act 1970 Acts & Rules. 2007. Universal Law Publishing Co. Pvt.Ltd.,
4. Rhona Smith. (2003), *International Human rights*, Blackstone Press.

Web Resources

1. www.ipr-helpdesk.org/
2. www.patentoffice.nic.in/ipr/patent/patents.htm
3. www.bangalorebio.com/GovtInfo/ipr.htm

CO–PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	1	1	1	2	-	2	1	1
CO2	3	3	1	2	2	2	1	3	1	1
CO3	3	3	2	1	2	2	1	2	1	2
CO4	3	3	2	1	2	2	2	3	1	1
CO5	3	3	2	1	2	2	2	3	1	2
Average	3	3	1.6	1.2	1.8	2	1.5	2.6	1	1.4

High correlation-3 Medium correlation –2 Low correlation –1 No correlation-'-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC2309	Bioinstrumentation	Supportive	3	3

The subject imparts a thorough knowledge on the basics of all the instrumentation concepts, in biology. The student will get to understand the core concepts of biological instruments and their principles.

Course Outcomes:

At the end of the course, students will be able to

CO1: practice experiments and apply the basic instruments in the laboratory.

CO2: predict the functionality of Beer – Lambert's law in identifying and quantifying a biomolecule.

CO3: employ the separation techniques for separating biomolecules based on chromatography and electrophoretic techniques.

CO4: understand the clinical important isotopes and detection of isotopes.

CO5: operate the separation techniques for separating biomolecules based on centrifugal force by centrifugation.

Unit I: **9 Hours**

pH – Definition, working principle, measurement and calibration of pH meter. Buffers – Preparation of Buffers (Acetate and Phosphate). Microscopy: Principle and applications of Compound, Bright field, Dark field, Phase contrast, Fluorescence and Inverted Microscope.

Unit II: **9 Hours**

Electromagnetic Spectrum – Absorption and Emission Spectra – Beer Lambert's law – Colorimeter, UV-Visible Spectrophotometer. Mass spectroscopy - Atomic absorption spectrometer (AAS) - Nuclear magnetic resonance spectrometer (NMR).

Unit III: **9 Hours**

Chromatography - Principles – Paper Chromatography, TLC, Gel filtration, Ion-Exchange, Affinity Chromatography, Adsorption Chromatography, Partition Chromatography, Gas Chromatography and HPLC. Electrophoresis: Principle, Paper Electrophoresis – Cellulose Acetate Electrophoresis - Agarose Gel Electrophoresis – SDS- PAGE, Iso-electric focusing and Immuno-electrophoresis.

Unit IV: **9 Hours**

Radioactivity – Isotopes – Clinically important isotopes – Measurement of Radioactivity – GM Counters, Scintillation Counters – Autoradiography – Applications. SOPs for Radioactive materials.

Unit V: **9 Hours**

Centrifugation – Principles - RCF, Sedimentation coefficient - Different types of centrifuge – Types of rotors – Centrifugation types: Differential and Density gradient centrifugation – Ultra Centrifuge.

Learning Resources:

Text Books

1. Upadhyay and Nath, U. (2009). "Biophysical Chemistry", Principles and Techniques. Himalaya Publishing House.

2. Veerakumari, L. (2006). "Bioinstrumentation" MJP publishers , Kindle Edition.
3. Skoog, D.A.F. Holler, J, and Stanky, R. Crouch, (2007). "Instrumental Methods of Analysis" Cengage Learning.
4. Palanivelu, P, (2000). Analytical Biochemistry & Separation Techniques, 4th edition, Twenty first century publications.
5. Prakash, M. (2009). Understanding Bioinstrumentation, 1st edition, Discovery Publishing House Pvt Ltd

References

1. Keith Wilson, John Walker (2010). Principles and techniques of Biochemistry and Molecular Biology"(7^{th} edition).Cambridge University Press.
2. David L. Nelson, Michael M Cox.Lehninger. (2008)."Principles of Biochemistry",Fifth edition W.H.Freeman,Newyork.
3. Khandpur R.S, (2014). Handbook of Biomedical Instrumentation, 3rd edition, McGraw Hill Education (India).
4. Geddes L.A. and Baker L.E. (2008). "Principles of Applied Biomedical Instrumentation"Wiley India Third Edition.
5. Sharma B.K (2005). Instrumental Methods of Chemical Analysis, 24th Edition, GOEL Publishing House.

Websites/ e-Learning Resources

- https://www.olympus-ims.com/en/knowledge/metrology/lext_principles/basic/
- https://www.excedr.com/resources/chromatography-techniques
- https://www.mrclab.com/ultracentrifuge-working-process-types-and-uses

CO–PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	1	1	2	2	1	1
CO2	3	2	2	2	1	1	2	1	1	1
CO3	3	3	2	2	2	2	2	1	2	1
CO4	3	3	2	2	2	2	2	2	2	1
CO5	3	3	2	2	1	1	2	2	2	1
Average	3	2.8	2	2	1.4	1.4	2	1.6	1.6	1

High correlation-3 Medium correlation –2 Low correlation –1 No correlation-'-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC2111	Bioinstrumentation Lab	Supportive	2	1

The practical will establish a basic study skill on the subject and will improve the student's ability to have a hands-on experience on the basic bioinstruments.

Course Outcomes:

At the end of the course, students will be able to

CO1: practice the experiments and apply the basic instruments in the laboratory such as microscope, weighing balance, pH meter, shaker, incubator etc. in various research processes.

CO2: identifying and quantifying biomolecules using calorimetry.

CO3: develop the separation techniques for separating biomolecules based on paper and thin layer chromatography.

CO4: engage the separation techniques for separating biomolecules based on column chromatography.

CO5: employ the separation techniques for separating biomolecules based on centrifugal force by centrifugation.

Experiments

1. Preparation of buffer (Phosphate buffer).
2. Determination of pH of biological samples using pH meter.
3. Biomolecules analysis by colorimetric analysis
4. Identification of UV spectrum (nucleic acids and proteins).
5. Separation of amino acids/ lipids/sugars by paper chromatography.
6. Separation of phenolic acids/ pigments by thin layer chromatography.
7. Column chromatography.
8. Fractionation of biomolecules using centrifuge.
9. High Performance Liquid Chromatography (Demonstration).

Learning Resources:

Text Books

1. Sharda University Abstract Laboratory Manual for Bio-instrumentation, Biochemistry, Microbiology, Cell Biology and Enzyme Technology.2018
2. Bhomwik, (2011). Analytical techniques in Biotechnology– A complete laboratory manual, MGH Publisher, ISBN-13 : 978-0070700130

References

1. Palanivelu, P. (2017). Analytical Biochemistry and Separation techniques – A laboratory manual, (5^{th} Edition), Twenty first century publishers, ISBN: 978-81-908489-0-9

Websites/ e-Learning Resources

1. https://www.olympus-ims.com/en/knowledge/metrology/lext_principles/basic/
2. https://www.excedr.com/resources/chromatography-techniques
3. https://www.mrclab.com/ultracentrifuge-working-process-types-and-uses

CO–PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	1	1	2	2	1	1
CO2	3	2	2	2	1	1	2	1	1	1
CO3	3	3	2	2	1	1	2	1	1	1
CO4	3	3	2	2	1	1	2	2	1	1
CO5	3	3	2	2	1	1	2	2	1	1
Average	3	2.8	2	2	1	1	2	1.6	1	1

High correlation-3 Medium correlation –2 Low correlation –1 No correlation-‘-’

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC2213	Mushroom Technology	SEC	3	2

This course is aimed to provide theoretical and technical skill about mushroom cultivation technology including mushroom biology, types of mushrooms, nutritional value, infrastructure requirement, cultivation methods-spawn production, disease management and marketing.

Upon successful completion of the course, students will be able to

CO1: deliver the information about historical perspectives, biology, nutritional value

CO2: construct mushroom production shed and gain information about equipments and substrate required for mushroom

CO3: exert knowledge on spawn production and compost preparation for mushroom production

CO4: scientifically produce various kinds of mushrooms

CO5: manage post-harvest technology and disease management

Unit-I **9 Hours**

History of mushroom cultivation, Biology of mushrooms; Nutritional value: (Proteins, amino acids, mineral elements, carbohydrates, fibers, vitamins); Medicinal value of mushrooms; Edible mushrooms and cultivation in India and world; Poisonous mushrooms and mushroom poisoning.

Unit-II **9 Hours**

Mushroom Cultivation Technology, Infrastructure- Structure and construction of mushroom house; Equipments requirement- vessels, inoculation hook, inoculation loop, sieves, culture racks, water sprayer, tray, boilers, driers, and Polythene bags; Substrates in mushroom cultivation- Sterilization of substrates.

Unit-III **9 Hours**

Spawn production - Spawn: types of spawn- culture media preparation- production of pureculture, mother spawn, and multiplication of spawn; Mushroom bed preparation; Compost:preparation of compost; Casing- raw material used for casing- preparation of casing material.

Unit-IV **9 Hours**

Cultivation of important mushrooms- cultivation of *Agaricus bisporus*, *Pleurotus ostreatus* and *Volvariella volvaceae*- Pests and Pathogens of mushrooms and their management in mushroom cultivation.

Unit-V **9 Hours**

Post Harvest Management- Methods of storage of mushroom -Short-term Storage- Long- term Storage of mushrooms-Packing and Transportation- Recipes from mushrooms; Marketing of mushrooms in India and world.

Learning Resources:

Text Books

1. S.Rajan and N.Sivakumar. (2020). Mushroom Technology. CBS Publishers &Distributors
2. Sharma V.P. (2006). Diseases and Pests of Mushrooms, M/s. IBD Publishers and Distributors, New Delhi.

Reference Books

1. Philip G. Miles and S. T. Chang. (1997). Mushroom Biology: Concise Basics and Current Developments
2. R.Gogoi, Y.Rathaiah and T.R.Borah. (2019). Mushroom Cultivation Technology. Scientific Publishers.

CO–PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	2	2	2	2	2	1	2
CO2	3	3	3	2	2	2	1	2	2	1
CO3	3	3	3	1	2	2	1	2	2	1
CO4	3	3	3	2	2	3	1	2	1	1
CO5	3	3	3	2	2	2	1	1	1	1
Average	3	3	3	1.8	2	2.1	1.2	1.8	1.4	1.6

High correlation-3 Medium correlation –2 Low correlation –1 No correlation-‘-’

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC2502	Genetic Engineering and rDNA Technology	Core	5	5

This course is framed to acquire knowledge on principles of genetic engineering techniques and enumerate various recombinant techniques and gene probes & molecular markers identification. It helps the students to exhibit knowledge in sequencing technologies and protein engineering techniques.

Course Outcomes:

At the end of the course, students will be able to

CO1: demonstrate the basic principles of genetic engineering techniques and illustrate the specificity of vectors for cloning and advantages.

CO2: exhibit knowledge in sequencing technologies and molecular markers identification.

CO3: understand Gene transfer techniques by Viral and Nonviral mediated gene transfer mechanisms.

CO4: enumerate gene expression system and their applications and also protein engineering techniques.

CO5: explore the strategies of Recombinant DNA Technology in medicine, Industry and agriculture.

Unit I: **15 Hours**

Genetic Engineering – Introduction. Tools in recombinant DNA technology – recombinant DNA – cloning strategies (enzymes, vectors, host) – introduction of rDNA into host cells.

Unit II: **15 Hours**

Identification of recombinants, selection and screening for Recombinants. DNA sequencing – Construction of Genomic DNA library and cDNA library), Chromosome walking. Human Genome Project. Polymerase Chain Reaction-Methodology and its Types.

Unit III: **15 Hours**

Gene transfer techniques – Viral mediated gene transfer, Selectable markers and reporter genes - Non viral mediated gene transfer - Physical methods: Microinjection - Electroporation - Particle Bombardment, Chemical methods: Calcium phosphate - DEAE dextran - Liposomes.

Unit IV: **15 Hours**

Gene Expression – Expression system and their applications - protein based products – Protein engineering– production of protein from cloned genes. Site directed Mutagenesis, Restriction Fragment Length Polymorphism (RFLP).

Unit V: **15 Hours**

Application of Recombinant DNA technology in medicine, industry, agriculture and r-DNA technology - merits and demerits.

Learning Resources:

Text Books

1. Brown T.A, 2015. Gene Cloning and DNA Analysis: An Introduction, 7th edition, Wiley - Blackwell.
2. Desmond S.T. Nicholl, 2008. An Introduction to Genetic Engineering, 3rd edition, Cambridge university press.
3. R.W. Old & S.B. Primrose, Principles of Gene Manipulation, Fifth Edition, Blackwell Science.
4. Genetic Engineering Principles and Methods by Setlow, Jane K. (Volume 24).
5. Keya Chaudhuri, 2012. Recombinant DNA Technology.

References

1. David Clark Nanette Pazdernik Michelle McGehee (2018), *Molecular Biology techniques*,(3rd edition).
2. Anton Byron (2019), *Introduction to Gene Cloning*, Publisher: Oxford Book Company
3. Monika Jain (2012), *Recombinant DNA technology*, (I edition), Alpha Science International. ISBN-13 : 978-1842656679.
4. Primrose.S.B (2014), *Principles of gene manipulation*, (7th edition), Blackwell Scientific limited, Germany. ISBN: 978-1-405-13544-3

Websites/ e-Learning Resources

1. https://www.britannica.com/recombinant-DNA-technology
2. https://www.le.ac.uk/recombinant-dna-and-genetic-techniques
3. https://www..ncbi.nlm.nih.gov

CO–PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	2	2	2	2	1	1
CO2	3	3	2	2	2	2	2	2	1	1
CO3	3	3	2	2	2	2	2	2	1	1
CO4	3	3	3	3	3	2	2	2	1	1
CO5	3	3	3	3	3	2	2	2	1	2
Average	3	3	2.4	2.4	2.4	2	2	2	1	1.2

High correlation-3 Medium correlation –2 Low correlation –1 No correlation-‘-‘

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC2304	Genetic Engineering and rDNA Technology Lab	Core	3	3

The course enables the students to learn working principles of PCR, RFLP and other important Genetic Engineering techniques and to predict the molecular weight of DNA by agarose gel electrophoresis.

Course Outcomes:

At the end of the course, students will be able to

CO1: isolate the Plasmid DNA and Genomic DNA.

CO2: prepare the competent cells and perform bacterial transformation.

CO3: determine the restriction digestion of DNA

CO4: determine the restriction fragment length polymorphism.

CO5: demonstrate working principles of PCR, RFLP and other important Genetic Engineering techniques.

Experiments:

1. Isolation of genomic DNA
2. Isolation of plasmid DNA
3. Isolation of RNA
4. Agarose Gel Electrophoresis
5. Production of competent cells for transformation
6. Bacterial transformation
7. Restriction Digestion of DNA
8. PCR (Demonstration)
9. Restriction Fragment Length Polymorphism (DEMO)
10. Cloning vectors (DEMO)

Learning Resources:

References

1. Zyskind, J. W., Bernstein, S. I. (2014). Recombinant DNA Laboratory Manual. United States: Elsevier Science.
2. Carson, S., Miller, H. B., Srougi, M. C., Witherow, D. S. (2019). Molecular Biology Techniques: A Classroom Laboratory Manual. United Kingdom: Elsevier Science.
3. Miller, H. B., Witherow, D. S., Carson, S. (2011). Molecular Biology Techniques: A Classroom Laboratory Manual. Netherlands: Elsevier Science.

CO-PSO Mapping

	PSO 1	PSO 2	PSO 3	PSO 4	PSO 5	PSO 6	PSO 7	PSO 8	PSO 9	PSO 10
CO 1	3	3	3	3	3	2	3	3	2	2
CO 2	3	3	3	3	3	2	3	3	2	2
CO 3	3	3	3	3	3	2	3	3	2	2
CO 4	3	3	3	3	3	2	3	3	2	2
CO 5	3	3	3	3	3	2	3	3	2	2
Average	3	3	3	3	3	2	3	3	2	2

High Correlation – 3 Medium Correlation – 2 Low Correlation – 1 No Correlation '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC2506	Environmental and Industrial Biotechnology	Core	5	5

This course is framed to study about the biotechnological methods to manage environmental issues and to learn the applications of biotechnology in industrial sectors.

Course Outcomes:

At the end of the course, students will be able to

CO1: know about the environment, environmental issues and its management.

CO2: understand the process of waste water treatment, drinking water treatment and solid waste management in various industries.

CO3: illustrate the significance of bioreactors in bioprocess technology and culture methods.

CO4: explain downstream processing and fermented Products production.

CO5: speculate the role and importance of microorganisms behind ore leaching and production of food products.

Unit I **15 hours**

Environmental Pollution – Sources and types - Water, Air, Thermal, Industrial and Radiation - Global environmental changes. Global warming, Greenhouse effect, acid rain, ozone depletion, and photochemical smog. Environmental issues, management strategies and safety, Biotechnological approaches for management.

Unit II **15 hours**

Waste water treatment: Aerobic and anaerobic methods (Primary, Secondary and Tertiary) – Biotechnological approach to industrial effluent (Paper, Tannery, Textile) –Single Dwelling Unit - Use of aquatic plants in waste water treatment. Solid waste management. Bioenergy and SCP from waste. Drinking water treatment. Pesticide waste disposal.

Unit III **15 hours**

Bioprocess Engineering-Steps in bioprocess development. Design of bioreactors - Basic objective of fermenter design, aseptic operation & containment. Bioreactor configurations and types: Bubble column, airlift reactor, packed bed, fluidized bed, trickle bed, Membrane reactor, Photobioreactor, Animal and plant cell bioreactors. Factors affecting broth viscosity, Mixing in Fermenters. Fermentation systems Batch culture, Continuous culture, Fed-batch culture.

Unit IV **15 hours**

Downstream processing Filtration, Centrifugation, Cell disruption, Liquid-liquid extraction, Chromatography, membrane processes, Drying, Crystallization, Whole broth processing. Microbial biomass, Microbial enzymes– Amylase & protease, Immobilization of enzymes: Methods, Properties, Applications, Advantages and Disadvantages of Immobilization.

Unit V **15 hours**

Microbial Polysaccharide production: Xanthan. Different types of fermented foods, beverages and dairy products produced from microorganisms. Production of antibiotics – Penicillin - streptomycin. Vitamins- Folic acid & Vitamin B12, Organic acids.

Text Books

1. T.Satyanarayana, Bhavdish Narain Johri,Anil Prakash (2012), Microorganisms in Sustainable Agriculture and Biotechnology.
2. Murugesan, A G., Rajakumari, C., 2005. Environmental Science and Biotechnology Theory and Techniques., MJP publishers, Chennai.
3. Chatterji, A.K., 2002. Introduction to Environmental Biotechnology, Prentice-Hall of India, New Delhi.

Reference Books

1. Peter F. Stanbury, Allan Whitaker, Stephen J. Hall (2013). Principles of Fermentation Technology Second Edition, Elsevier Science Ltd
2. Nduka Okafor, Modern Industrial Biotechnology & Microbiology ((**2017**, Science Publishers, Edenbridge Ltd.
3. Michael J. Waites, Neil L. Morgan, John S. Rockey Gary Higton (2001.), Industrial Microbiology: An Introduction. . Blackwell Science Ltd
4. Madigan, Michael and Martinko, John, Brock biology of microorganism, 11th edition, (2005).

Web Resources

1. https://nptel.ac.in/courses/120/108/120108004/
2. https://www2.hcmuaf.edu.vn/data/quoctuan/Environmental%20Biotechnology%20-20Theory%20and%20Application,%20G%20M%20Evans%20&%20J%20C%20Furlong.pdf
3. www. Prenhall.com/Madigan

CO–PSO Mapping

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	1	1	2	1	2	2	1
CO2	3	3	3	2	2	2	1	2	1	1
CO3	3	3	1	1	1	2	1	2	1	1
CO4	3	3	1	1	2	2	2	2	1	1
CO5	3	3	2	1	1	2	2	2	1	1
Average	3	3	2	1.2	1.4	2	1.4	2	1.2	1

High correlation-3 Medium correlation –2 Low correlation –1 No correlation-‘-‘

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC2308	**Environmental and Industrial Biotechnology Lab**	**Core**	**3**	**3**

This course is designed to train students in analysing environmental quality. This course also equips the students with hands on skills on screening & isolation of industrially important microrganisms and to carry out fermentation.

Course Outcomes:

At the end of the course, students will be able to

CO1: analyse microbial water samples.

CO2: perform immobilization and production of Wine.

CO3: develop skills in bio fertilizer production and microbial identification

CO4: gain basic skills to analyse raw milk and determine the pasteurization efficacy.

CO5: perform microbial polysaccharide production.

Experiments:

1. Water analysis – MPN and BOD.
2. Test for fecal contamination with *E. coli* as indicator organisms in waterbodies.
3. Isolation of antibiotic producing microorganisms from soil by crowded plate technique.
4. Study of Growth Curve and Generation time of Bacteria/ Yeast using turbidometry.
5. Immobilisation of yeast cells.
6. Production of wine.
7. Production of citric acid by *Aspergillus niger.*
8. Compost Making.
9. Laboratory scale production of biofertilizer.
10. Production of microbial Polysaccharide. (Demo)

Learning Resources:

Text Books

1. Aneja K R, *Laboratory Manual of Microbiology and Biotechnology*, MEDTECH, 2014.ISBN-13 : 978-9381714553
2. Vijaya Ramesh, (2007), *Food Microbiology*, MJP Publishers, Chennai, ISBN-13 : 978-8180940194

References

1. Raghuramulu, N., Madhavan Nair, K., and Kalyanasundaram, S. Ed., (1983), *A Manual of Laboratory Techniques*, National Institute of Nutrition, ICMR, Hyderabad.

Web Resources:

1. https://www.youtube.com/watch?v=3UafRz3QeO8
2. https://www.youtube.com/watch?v=jpuNYpvBmDM
3. https://www.youtube.com/watch?v=tUCfkNKyQyc

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	2	1	2	2	1	1
CO2	3	3	2	2	2	1	2	2	1	1
CO3	3	3	2	2	2	1	2	2	1	1
CO4	3	3	2	2	2	1	2	2	1	1
CO5	3	3	2	2	2	1	2	2	1	1
Average	3	3	2	2	2	1	2	2	1	1

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - ‘-’

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC2410	Bioinformatics and Biostatistics	Supportive	5	4

The paper imparts a thorough knowledge on the basics of bioinformatics and biostatistics. The student will get to understand the core concepts of various bioinformatics softwares and statistical analysis of scientific data.

Course Outcomes:

At the end of the course, students will be able to

CO1: acquire knowledge about the developments and applications of bioinformatics.

CO2: gain knowledge about the importance of the bioinformatics, databases, tools and software of bioinformatics and explain different types of biological databases.

CO3: understand the basics of sequence alignment, sequence analysis and protein structure prediction method.

CO4: demonstrate the basic methods of data collection, graph construction and sampling techniques and Calculate measures of central tendency

CO5: correlate and analyze biological data through various statistical methods and interpret biological data via various probabilistic distribution methods.

Unit I: **15 Hours**

Introduction to Bioinformatics – Genome, Transcriptome and Proteome, Gene prediction rules and software. Nucleic acid Databases – Primary and Secondary Databases – Structure Database – CATH, SCOP – Data base Searching – BLAST and FASTA, BLOSSUM.

Unit II: **15 Hours**

Sequence analysis (Proteins and Nucleic acids), Protein Database: Comparison of Protein sequences and Database searching – methods for protein structure prediction - Homology modeling of proteins, visualization tools (RASMOL).

Unit III: **15 Hours**

Multiple Sequences alignment – method of multiple sequences alignment- Evolutionary analysis, Clustering methods Phylogenic trees - Methods to generate phylogenetic tree- Tools for multiple sequences alignment and phylogenetic analysis - History of Drug Discovery, Steps in Drug design - Chemical libraries – Role of molecular docking in drug design.

Unit IV: **15 Hours**

Methods of data collection and analysis - classification, tabulations of statistical data – Diagrammatic representation – Graphs – Frequency distribution. Measures of central tendency – Mean, median and mode. Measures of dispersion – Standard deviation, standard error and variance.

Unit V: **15 Hours**

Correlation and regression – simple correlation, correlation co-efficient, simple and linear regression analysis. Probability distribution-Binomial, Negative binomial,

multinomial distribution, Poisson distribution. Tests of significance – t tests – F tests – Chi square test. Analysis of variance – Statistical Softwares.

Learning Resources:

Text Books

1. Pennington, S.R. and Punn, M.J. (2002).Proteomics: from protein sequence to function. Viva books Pvt. Ltd.
2. Shuba, G,(2010). Bioinformatics, Tata McGraw Hill publishing. India.
3. Rastogi, S.C, Mendiratta, N,Rastogi, P. (2004). Bioinformatics methods and application. Prentice-Hall of India private limited, New Delhi.
4. Gurumani, N. (2011) "An Introduction to Biostastistics" MJP Publishers
5. Rastogi, V. (2011).”Fundamentals of Biostatistics”, Ane books Pvt Ltd Publishers, Chennai.

References

1. Attwood, T.K. and Parry-Smith, D.J. (2008). Introduction to Bioinformatics. Pearson Education.
2. Mount, D. (2009). Bioinformatics: sequence and genome analysis, second edition., Taylor & Francis, UK.
3. Westhead D.R. (2009). Instant Notes in Bioinformatics., second edition., Taylor & Francis, UK.
4. Zar, J.H. (2010). “Biostatistical Analysis” Fifth Edition, Pearson Education Pvt Ltd, Indian Branch,NewDelhi.
5. Arora, P.N. and Malhan, P.K. (2013). "Biostatistics"Himalaya publishing House.

Websites/ e-Learning Resources

1. www.ncbi.nlm.nih.gov/
2. www.Bioinformatics.org
3. https://blast.ncbi.nlm.nih.gov/Blast.cgi

CO–PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	1	1	1	2	2	1	1	2
CO2	3	3	1	1	1	2	2	1	1	2
CO3	3	3	1	1	2	2	2	1	1	2
CO4	3	3	1	1	2	2	1	1	1	2
CO5	3	3	1	1	2	2	1	1	1	2
Average	3	3	1	1	1.6	2	1.6	1	1	2

High correlation-3Medium correlation –2 Low correlation –1 No correlation-‘-’

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC2212	Organic Farming	SEC	3	2

In this course, students will explore the principles and practices of organic farming to achieve high quality, yield and financial profit, prioritizing soil health and ecosystem services.

Course Outcomes:

At the end of the course, students will be able to
CO1: acquire knowledge about the types and advantages of conventional farming.
CO2: implement soil fertility strategies.
CO3: develop a sustainable farm plan and farm practices
CO4: develop skills in pest management using organic pesticides
CO5: market and sell organic products effectively.

Unit I: **9 hours**

Organic farming – definition, need, scope, principles, characteristics, challenges and relevance to modern agriculture. Different eco friendly farming systems- biological farming, natural farming, regenerative agriculture – permaculture - biodynamic farming. global agriculture and future prospects, advantages and barriers

UNIT II: **9 hours**

Initiatives taken by the central and state governments, NGOs and other organizations for promotion of organic agriculture in India. Organic nutrient sources and their fortification – organic manures- methods of composting. Green manures- bio fertilisers – types, methods of application – benefits and limitations.

UNIT III: **9 hours**

Nutrient use in organic farming - scope and limitations. Nutrient management in organic farming. Organic ecosystem and their concepts. Choice of crops and varieties in organic farming. Crop rotations – need and benefits. Multiple cropping.

UNIT IV: **9 hours**

Fundamentals of insect, disease and weed management under organic mode of production-biological methods-non chemical pest & disease management. Botanicals-pyrethrum, neem seed kernel extract, neem seed powder, soluble neem formulations, neem oil.

UNIT V: **9 hours**

Inspection, certification, labelling and accreditation procedures for organic products. Farm to table concept. Processing, economic consideration and viability. Marketing and export potential of organic products. Influence in national economy.

Learning Resources:
Text Books:

1. Sharma, A.K. (2002). A Hand book of organic farming. Agrobios, India. 627p
2. Gehlot, D. (2005). Organic Farming- standards, accreditation, certification and inspection. Agribios, India.

Reference Books:

1. Gupta, M. (2004). Organic Agriculture Development in India. ABD publishers, Jaipur, India.
2. Sathe, T.V. (2004). Vermiculture and Organic Farming. Daya Publishers.
3. Rao V.S. (2006). Principles of Weed Science. Oxford and IBH Publishing Co.,New Delhi,India.

Web Resources:

1. https://elearning.icar.gov.in/DisplayUG_ECoursesContent.aspx?CourseCode=w!xSp/q1UJID9StJThrLpA==
2. http://www.ignou.ac.in/ignou/aboutignou/school/soa/programmes/detail/29/2

CO–PSO Mapping

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	1	2	1	2	1	1	1	1
CO2	3	3	2	1	2	2	1	1	1	2
CO3	3	3	2	1	1	2	2	1	1	2
CO4	3	3	2	2	1	2	2	1	1	2
CO5	3	3	1	2	1	2	3	1	1	2
Average	3	3	1.6	1.6	1.2	2	1.8	1	1	1.8

High correlation-3 Medium correlation –2 Low correlation –1 No correlation-‘-‘

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC3601	**Plant Biotechnology**	**Core**	**6**	**6**

The subject imparts a thorough knowledge on the basics of all the biotechnological application on plants. The student will get to understand the core concepts of plant biotechnology.

Course Outcomes:

At the end of the course, students will be able to

CO1: explore the history of plant biotechnology and state the importance and organization of plant genome.

CO2: acquaint with the molecular basis of action of plant hormones and gene expression.

CO3: illustrate about various culture medium preparations, haploid, triploid plant production and its applications.

CO4: explore symbiotic organisms as a vector for gene transfer to produce transgenic plants.

CO5: demonstrate molecular technique skills for crop improvement.

Unit I: **18 Hours**

History of plant biotechnology, Conservation of plant using Biotechnology. Plant genome organization: structural features of a representative plant gene, gene families in plants. Organization of chloroplast genome and mitochondrial genome.

Unit II: **18 Hours**

Plant growth regulators - Auxins, cytokinins and gibberlins – Molecular basis of action – Phytochrome – Role in photomorphogeneisis – Abscisic acid – stress – Induced promoter switches in the control of gene expression – Ethylene and fruit ripening.

Unit III: **18 Hours**

Plant tissue culture - Media composition (MS media) – Types of cultures - Micropropagation techniques - Direct and indirect organogenesis - Somoclonal variation - Somatic embryogenesis - haploid and triploid - Protoplast isolation, fusion and culture - hybrid and cybrid production, Synthetic seed production. Secondary metabolite production.

Unit IV: **18 Hours**

Agrobacterium and crown gall tumour – Mechanism of T-DNA transfer to plants, Ti and Ri Plasmid vectors and their utility – Plant viral vectors. Symbiotic nitrogen fixation in Rhizobia and nif gene.

Unit V: **18 Hours**

Crop improvement, herbicide resistance, insect resistance, virus resistance, plants as bioreactors. Transgenic plants - Plant vaccines, genetically modified food - Future perspectives and ecological impact of transgenic plants. Safety aspects and regulations of GMOs.

Learning Resources:

Text Books

1. Slater, A., Scott, N.W., & Fowler, M. R. (2008). Plant Biotechnology. Oxford: Oxford University Press.
2. Ignacimuthu, S. (2004). Plant Biotechnology. New Delhi: Oxford and IBH Publishing House.
3. Stewart, N.C. (2016). Plant Biotechnology and Genetics. 2nd Edition. New Jersey: John Wiley & Sons, Inc
4. Chawla, H.S., (2009). "Introduction to Plant Biotechnology", 3rd Edition, Science Publishers, 2009

References

1. Kojima, Lee, H. and Kun, Y. (2001). Photosynthetic microorganisms in Environmental Biotechnology. Springer – Verlag.
2. Stewart Jr, C.N. (2008)"Plant Biotechnology and Genetics: Principles, Techniques and Applications" Wiley-Interscience.
3. Razdan. M. K. (2011). Plant tissue culture. Oxford and IBH publishing Company Pvt. Ltd, New Delhi.
4. Chawla. H. S. (2010). Introduction to plant biotechnology. Oxford and IBH publishing company pvt. Ltd, New Delhi.

Websites/ e-Learning Resources

1. https://nptel.ac.in/courses/102103016
2. https://science.umd.edu/classroom/bsci124/lec41.html
3. https://www.nifa.usda.gov/grants/programs/biotechnology-programs/plant-biotechnology
4. http://mydunotes.blogspot.com/p/plant-biotechnology.html

CO–PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	2	2	2	1	1	1
CO2	3	3	2	2	2	2	2	1	1	1
CO3	3	3	1	1	2	2	2	1	1	1
CO4	3	3	2	2	2	2	2	1	1	1
CO5	3	3	2	2	2	2	2	1	1	1
Average	3	3	1.8	1.8	2	2	2	1	1	1

High correlation-3 Medium correlation –2 Low correlation –1 No correlation-'-'

Course Code	Name of the Course	Category	Hours/Wk	Credits
24BTC3603	**Animal Biotechnology**	**Core**	**6**	**6**

The subject imparts a thorough knowledge on the basics of all the biotechnological application on plant and animals. The student will get to understand the core concepts of biotechnology.

Course Outcomes:

CO1: learn the basic concepts of Animal cell culture and cell laboratory

CO2: describe the media preparation, preservation, trypsinization, counting, maintenance and application of cell lines.

CO3: describe the media preparation, preservation, trypsinization, counting, maintenance and application of cell lines.

CO4: acquaint with genetic modification and stem cell technology in production of transgenic animals.

CO5: learn the assisted reproductive technology and its applications**.**

Unit I: 18 hours

Animal cell culture – History and development, Pluripotency, Media, balanced salt solutions, Physical, chemical and metabolic functions of constituents of culture media, Role of carbon dioxide, Serum, growth factors and amino acids in media. Serum containing and serum free media. Constitution of a media for cell line. Essential equipments required for animal cell culture.

Unit II: **18 hours**

Types of cell culture- Primary, Secondary, Organ culture and cell lines. Role of feeder layers in cell culture, Cell separation techniques, cell synchronization, Cell counting methods, cryopreservation, Cell banking procedures. Biology of cultured cells- Apoptosis.

Unit III: **18 hours**

Transfection of cells in culture- Animal viral vectors for transfection, Physical methods of transfection, HAT selection, selectable markers. Micro manipulation of cells, gene targeting, gene silencing, gene knockout and their applications.

Unit IV: 18 hours

Protein production by genetically engineered mammalian cell lines, Stem cells and their applications - Cell culture as a source of valuable products. Transgenic Animals – Methods, examples and applications.

Unit V: 18 hours

Collection and preservation of embryos, Semen banking, AI, IVF and ICSI – methods, merits and demerits. Ethical issues and regulations. Case study - any two relevant studies.

Learning Resources:

Text Books

1. Ramasamy.P. 2002.Trends in Biotechnology, University of Madras of Publications, Pearl Press.
2. Ignacimuthu. 1996. Basic Biotechnology. Tata McGraw-Hill.
3. K. Srivastava et al., 2009, Animal Biotechnology, Oxford & IBH Publishing Co. Pvt.Ltd.
4. B.C. Currell et al., 1994, In vitro Cultivation of Animal Cells (Biotol), Butterworth- Heinemann Ltd.
5. Jenkins, N. (ed). 1999 Animal cell Biotechnology: Methods and protocols. Humana press, New Jersey.

References:

1. R. Ian Freshney, Culture of Animal cells – A Manual of Basic Technique Fourth Edition, WILEY LISS & Publications.

2. Glick, B.R. and Pasternark. 2002. Molecular Biotechnology: Principle and applications of recombinant DNA.

3. Kreuzer, H. and Massey, A. 2001. Recombinant DNA and Biotechnology: A guid**e** for teachers, 2nd edition. ASM Press Washington.

4. Traven. 2001. Biotechnology. Tata McGraw – Hill.

5. Walker,J.M. and Gingold, E.B. 1999.Molecular biology and Biotechnology,3 rd edition. Panima Publishing Corporation.

Websites/ e-Learning Resources

1. http://ecoursesonline.iasri.res.in/course/view.php?id=350

CO–PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	2	3	2	2	2	1	2
CO2	3	1	2	2	2	2	2	1	1	1
CO3	3	3	2	1	1	2	2	2	1	2
CO4	3	3	3	1	1	2	2	2	2	2
CO5	3	3	2	2	2	2	2	2	2	1
Average	3	3	2.4	1.6	1.8	2	2	1.8	1.4	1.6

High correlation-3 Medium correlation –2 Low correlation –1 No correlation-‘-’

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC3305	Plant and Animal Biotechnology Lab	Core	3	3

The practical will establish a basic study skill on the subject and will improve the student's ability to have a hands-on experience on the above core subjects.

Course Outcomes:

At the end of the course, students will be able to

CO1: explain plant tissue culture and illustrate Callus development.
CO2: develop technical skills in isolation of protoplast.
CO3: demonstrate isolation of DNA and RNA from plants.
CO4: practice tissue culture and cell culture techniques.
CO5: familiarize with MTT assay.

Experiments

1. Plant tissue culture - sterilization techniques and media preparation.
2. Generation of Callus from leaf /root/bud & shoot apex.
3. Plant embryogenesis.
3. Isolation of plant protoplast.
4. Isolation of plant DNA and RNA.
5. Animal cell culture - sterilization techniques and media preparation.
6. Preparation of sera for animal cell culture.
8. Trypsinization of established cell culture.
9. Cell counting and viability - staining of cells (Vital Staining - Trypan blue and Giemsa staining).
10. MTT Assay (Demonstration).

Learning Resources:

Text Books

1. Adhav, M. (2009). Practical Biotechnology and Plant Tissue Culture, S. Chand & Company Ltd.
2. Giri,C.C., Giri, A. (2007). Plant Biotechnology: Practical Manual, I.K. International Pvt Ltd.
3. Neumann, K., Kumar, A., Imani, J. (2009). Plant Cell and Tissue Culture - A Tool in Biotechnology: Basics and Application, Springer.
4. Borah, D. (2018). *Environmental Biotechnology Theory and Lab Practices*, (2nd edition), Hardcover – Global Vision Publishing House.

References

1. Lal, S., and Vikas. (2018). *Public Health Management Principles And Practice*, (2nd Edition), CBS Publishers and Distributors Pvt Ltd, ISBN 13: 9789387742932
2. Harisha, S., (2012). *Biotechnology procedures and experiments handbook*, ISBN13 9781934015117
3. Animal Cell culture Practical approach. Ed. John R.W.Masters, Oxford.(2004)

Websites/ e-Learning Resources

1. https://www.plantcelltechnology.com/pct-blog/different-types-of-tissue-culture-processes/
2. https://www.thermofisher.com/in/en/home/references/gibco-cell-culture-basics.html

CO–PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	3	3	1	2	1	1	1
CO2	3	3	1	2	3	1	2	1	1	1
CO3	3	3	2	2	3	3	2	1	1	1
CO4	3	3	2	1	2	2	2	1	1	1
CO5	3	3	1	2	1	1	2	2	1	1
Average	3	3	1.6	2	2.4	1.6	2	1.2	1	1

High correlation-3 Medium correlation –2 Low correlation –1 No correlation-‘-‘

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC3307	Research Methodology	Core	3	3

This course aims to inculcate a clear idea of research among students, understand the existing social issues in research, design the wet lab procedures and interpret the results.

Course Outcomes:

At the end of the course, students will be able to

CO1: enhance basic knowledge on research.

CO2: gain new insights to select an appropriate research, experiment and sample design.

CO3: apply the methods of data collection, analysis and presentation.

CO4: discuss the significance of research report writing and publication.

CO5: acquire knowledge on usage of software in writing research paper.

Unit I: 9 Hours

Objectives, Motivation to perform research - Types of research (Descriptive vs analytical, applied vs fundamental, quantitative vs qualitative, conceptual vs empirical) - Research methods vs methodology - Literature-review and its consolidation, Library research, field research, laboratory research.

Unit II: 9 Hours

Research question & investigation question, hypothesis, qualities of a good hypothesis. Research process: Definition and steps of research process - Research design: Exploratory and descriptive research design, Features of good research design, Important concepts – Experimental design: Principle, Informal, formal experimental designs.

Unit III: 9 Hours

Steps in sample design, Types of sample design - Statistical sampling methods – Sample Size - Sampling Frame - Sampling Error - Characteristics of a good sample - Data Analysis: Methods of collection and classification of data (Primary and Secondary data) - Measures of central tendency (Mean, Median and Mode) - Measure of Dispersion - Standard Deviation – ANOVA: Construction of one-way ANOVA table - Data Preparation: Univariate analysis (frequency tables, bar charts, pie charts, percentages).

Unit IV: 9 Hours

Report writing - Layout of a Research Paper - Journals in Life Science - Impact factor of Journals – Publishing in a journal - Ethical issues related to publishing: Plagiarism and Self-Plagiarism.

Unit V: 9 Hours

Computer and its role in research - Methods to search required information - Reference Software like Zotero, EndNote and Mendeley - Software for paper formatting like LaTeX/MS Office - Software's for detection of Plagiarism.

Learning Resources:

Text Books

1. Garg, B. L. (2002). Introduction To Research Methodology. India: RBSA Publishers.
2. Kothari, C. R. (2004). Research Methodology: Methods and Techniques. India: New Age International (P) Limited.
3. Sridhar, M. S. (2010). Introduction to Research Methodology: Problem Selection, Formulation and Research Design. United States: M. S. Sridhar, Lulu.

References

1. Bell, J., Waters, S. (2018). Doing Your Research Project: a Guide for First-Time Researchers. United Kingdom: McGraw-Hill Education.
2. Daniel, W. W., Cross, C. L. (2014). Biostatistics: Basic Concepts and Methodology for the Health Sciences. India: Wiley.
3. Day, R. A., Gastel, B. (2006). How to Write and Publish a Scientific Paper. Spain: Cambridge University Press.
4. Holmes, D., Moody, P., Dine, D., Trueman, L. (2017). Research Methods for the Biosciences. United Kingdom: Oxford University Press.
5. Ruxton, G., Colegrave, N. (2011). Experimental Design for the Life Sciences. United Kingdom: OUP Oxford.

Websites/ e-Learning Resources

1. www.ask.com/Methodology+Research
2. www.qmethod.org/

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	3	2	2	2	1	2
CO2	3	3	3	3	3	2	2	2	1	2
CO3	3	3	3	3	3	2	2	2	1	2
CO4	3	3	3	2	3	3	1	3	1	2
CO5	3	3	3	3	3	3	1	3	1	2
Average	3	3	3	2.8	3	2.4	1.6	2.4	1	2

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC3409	Nanobiotechnology	DSE	5	4

This course aims to gather knowledge on nanomaterials and their properties, types, preparation, characterization and application in various fields such as medical, agriculture and environment

Course Outcomes:

At the end of the course, students will be able to

CO1: outline about nano biotechnology and its research in India.

CO2: discuss about nanoparticles and their analysis using Advanced Instrumentation.

CO3: gain insight on nano devices.

CO4: explore the applications of nano biotechnology.

CO5: know about the Nano Biosensors and their applications.

Unit I: **15 Hours**

Nanotechnology timeline – Nanomaterials: Introduction, Types (Dimensional and Compositional based) and its applications - Glimpse of Nanotechnology based material in ancient India: Wootz steel (iron carbide) and the Delhi iron pillar (anticorrosive nanomaterial), Bhasma (nanomaterial as medicine), pottery - Contributions of Indian Research Institutes in the field of nanobiotechnology.

Unit II: **15 Hours**

Synthesis of nanomaterials: Top-Down and Bottom-up approaches – Size-dependent properties of nanomaterial – Metals nanoparticle: Silver nanoparticle synthesis (chemical and green synthesis) and its analyses by UV-spectroscopy, XRD and FT-IR – Nanoparticle characterization by advanced microscopy (TEM, SEM, AFM).

Unit III: **15 Hours**

Nano-thin films: Chitosan thin film - Nanodevices (nanorobots) - Nanotubes: Microtubules assembly and its importance - Nano shells- Dendrimers: Liposomes - Nanofibers: Collagen, Fibronectin & elastin - Nano fluidics: Extracellular matrix assembly and its importance.

Unit IV: **15 Hours**

Agriculture: Crop production- Nano fertilizers technology, Biomaterial to improve shelf life of vegetables - Medicine: Collagen thin films in wound healing mechanism - Nanoscale devices: DNA microarray for disease diagnosis - Targeted drug delivery system.

Unit V: **15 Hours**

Nano biosensors (Firefly-luciferase) and its applications, Introduction to Biomimetics (Gecko foot effect, Lotus leaf effect: Paint and fabrics, Box fish-based Car). Safety aspects of nanoparticles.

Learning Resources:

Text Books

1. Goodsell, D. S. (2004). Bionanotechnology: Lessons from Nature. Wiley.
2. Pradeep, T. (2012). A Textbook of Nanoscience and Nanotechnology. India: McGraw-Hill Education (India) Private Limited.
3. Shanmugam, S. (2019). Nanotechnology. MJP Publisher.

References

1. Rai, M., Posten, C. (2014). Green Biosynthesis of Nanoparticles: Mechanisms and Applications. CAB International.
2. Cao, G., Wang, Y. (2011). Nanostructures and Nanomaterials: Synthesis, Properties, and Applications. World Scientific.
3. Niemeyer, C.M. & Mirkin, C.A. (2004). Nanobiotechnology: Concepts, Applications and Perspectives. Wiley.
4. Shoseyov, O. & Levy, I. (2010). NanoBioTechnology: BioInspired Devices and Materials of the Future. Humana Press.
5. Mirkin, C.A. & Niemeyer, C.M. (2007). Nanobiotechnology II: More Concepts and Applications. Wiley.

Websites/ e-Learning Resources

1. http://vvm.org.in/study_material/ENG%20-20Indian%20Contributions% 20to% 20 Science.
2. https://www.jabonline.in/admin/php/uploads/16_pdf.pdf
3. https://www.nature.com/nnano/

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	2	2	2	2	2	1	2
CO2	3	3	3	2	3	2	2	2	1	2
CO3	3	3	3	3	3	2	2	2	1	2
CO4	3	3	2	2	2	2	2	2	1	2
CO5	3	3	3	2	3	2	2	2	1	2
Average	3	3	2.6	2.2	2.6	2	2	2	1	2

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC3411	**Enzymology**	**DSE**	**5**	**4**

The course helps the students to render immense knowledge about enzymes and applications of along with the enzyme kinetics it also deals about the various biological compounds

Course Outcomes:

At the end of the course, students will be able to

CO1: learn the Fundamentals of Enzymology.

CO2: study about the characteristic features of Enzymes.

CO3: know the details of Enzyme Kinetics.

CO4: apply the biochemical techniques for enzyme isolation.

CO5: understand the process of Enzyme engineering.

Unit I: 15 hours

Nomenclature and classification of enzymes according to the International Union of Biochemistry and Molecular Biologists Convention. Properties of enzymes and factors that influence rate of enzyme action. Definitions - Apoenzyme, holoenzyme, zymogens. Coenzymes – (Vitamin and Non vitamin origin).

Unit II: 15 hours

Active site (definition, characteristic features), Enzyme specificity. Bisubstrate and multi-substrate reactions. ES complex formation, lock and key model and induced fit model. Enzyme units – IU, Katal. Turnover number. Isoenzymes, Definition – Ribozymes; Abzymes.

Unit III: 15 hours

Enzyme Kinetics – Michaelis-Menten equation and its derivation, significance of Km and Vmax, Lineweaver- Burk plot and Eadie- Hofstee plot, Hanes- Woolf plot. Enzyme inhibition - competitive, non-competitive, uncompetitive and allosteric inhibition – sequential model, concerted model, feedback inhibition.

Unit IV: 15 hours

Extraction of enzymes – chemical agents and physical methods of extraction. Nature of the extraction medium. Technique for enzyme isolation - Purification of enzymes - dialysis, chromatography, electrophoresis. Intracellular localization of enzymes and marker enzymes.

Unit V: **15 hours**

Immobilization of enzymes- Chemical and physical methods. Applications of immobilized enzymes. Enzyme engineering and designer enzymes. Pharmaceutical, clinical and industrial uses of enzymes.

Text Books

1.Satyanarayana U. 2013. Biochemistry.4 th edition, Elsevier India.

2 Jain J L, 2014, Fundamentals of Biochemistry, 7 th edition, S.Chand publishing.

3 Rodwell, V.W, Bender D.A, Botham K.M. 2015, Harper's Illustrated Biochemistry, 30th edition. McGraw-Hill Education.

4 Voet, D. and Voet, J.G. 2016. Biochemistry, 5th edition. John Wiley and Sons, Inc.,

References

1.Enzyme – Palmer, 18th edition, 2004.London: Portland Press

2 Biochemistry- Jeremy M Berg, John L Tymoczko, and LubertStryer,6th Edition, Freeman Publications, 2006.

3 Ralph A. Messing (2012) Immobilised Enzymes Academic Press, NY.

4 Nelson D.L., and Cox, M.M. 2013. Lehninger Principles of Biochemistry.

6th edition.W.H. Freeman & Company.

5 Jeremy M Berg, Stryer, L. 2015. Biochemistry, 8 th edition. Macmillan Learning.

Websites/ e-Learning Resources

1. https://www.youtube.com/watch?v=tPCOEUo6J8s
2. https://www.youtube.com/watch?v=ALwziZSRiqM

CO–PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	2	1	3	2	1	1	2
CO2	3	3	3	2	2	2	1	2	1	1
CO3	3	2	3	1	1	1	2	1	1	1
CO4	3	3	2	2	1	1	2	2	2	2
CO5	3	3	2	2	1	1	2	2	1	2
Average	3	2.8	2.6	1.8	1.2	1.6	1.8	1.6	1.2	1.6

High correlation - 3 Medium correlation – 2 Low correlation –1 No correlation -'-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC3313	Introduction to Forestry	GE	4	3

The subject imparts a thorough knowledge on the basics of all the forestry and its management concepts. The student will get to understand the basic concepts of silviculture, conservation and ethnobotany.

Course Outcomes:

At the end of the course, students will be able to
CO1: develop an understanding of the terminology of forestry and silviculture.
CO2: attain knowledge on key concepts of forest ecology.
CO3: learn about medicinal plants and its importance.
CO4: apply forest management concepts.
CO5: discuss forest protection laws, conservation acts and policy.

Unit I: **12 Hours**

Introduction of forest - Historical and current uses of trees and forests – Tree Structure, Function and Identification - Forest types. Silviculture – Systems and Management: Temperate, subtropical, dry tropical, mangrove and cold desert - Forestry related Careers.

Unit II: **12 Hours**

Forest ecology – Major drivers (climate, landform, soils, etc.) - Biotic and abiotic components, forest ecosystem- forest community concepts – Vegetation concepts – Ecological succession and climax – Nutrient cycling – Types of forest in India - Herbaria and Arboreta – Forest Disturbances and Stressors: Natural and Human Caused - fire, insects and disease, storms. Conservation of forest ecosystem.

Unit III: **12 Hours**

Ethnobotany: Role of ethnobotany in Indian systems of medicine (Siddha, Ayurveda & Unani). Botanical features of medicinal and aromatic plants - Drug and chemical constituents in plants - Toxicity of drug plants – Economic importance of medicinal and aromatic plants – Conservation strategies of plants.

Unit IV: **12 Hours**

Forest Management - Fire Management - Outdoor Recreation Management - Watershed Management - Wildlife and Range Management - Management of Trees outside the Forest – Reforestation - Urban Forest Management - Agroforestry – Social forestry – Joint forest management and Tribology.

Unit V: **12 Hours**

Forest economics - Role of government and private sectors – Forest productivity, goods and service valuation - Forest Policy and Public Lands - Forest Policy and Private Lands – Indian Forest Policy of 1990 – Indian Forest Act 1927 – Forest Conservation Acts 1980– Wildlife protection Act 1972 – Scope and objectives of forest inventory.

Learning Resources:

Text Books

1. Negi, S.S. (2016). Principles and practices of Silviculture.
2. Blakeney, B. (2012). Forest soils by Wilde.
3. Khanna, L.S. (2015). Principles and Practice of Silviculture.

Reference

1. Manikandan, K and Prabhu, S. (2023). Indian Forestry A Breakthrough Approach (9th Edition)

Websites/ e-Learning Resources

1. https://onlinecourses.nptel.ac.in/noc24_bt23/announcements?force=true
2. https://www.drishtiias.com/daily-updates/daily-news-analysis/forest-and-tree-cover-in-india/print_manually

CO–PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	1	1	1	1	2	1	1	1
CO2	3	3	1	2	1	2	2	1	1	2
CO3	3	3	2	2	2	2	2	1	2	2
CO4	3	3	2	2	2	2	2	1	2	2
CO5	3	3	1	1	1	1	2	1	2	2
Average	3	3	1.4	1.6	1.4	1.6	2	1	1.6	1.8

High correlation-3 Medium correlation –2 Low correlation –1 No correlation-‘-’

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC3315	Nutraceuticals	GE	4	3

This course is intended to impart knowledge on fundamental concepts on nutraceuticals, classification and biochemical constituents of food, nutraceutical products derived from animal, plants and microbes and gain acquaintance of role of nutraceutical industries for human development

Course Outcomes:

At the end of the course, students will be able to

CO1: deliver information about historical and future perspectives and classification of nutraceuticals and dietary supplements

CO2: well familiar with biochemistry of nutrition, classification of food components, nutritional assessment and basics of energy balance

CO3: develop skill on nutraceutical compounds from plant and animal origin and their application in human health

CO4: clarify the information about microbial derived nutraceutical products and their function in health sector

CO5: understand about the role of medicinal and aromatic plants in nutraceutical industry and nutrition related diseases

Unit I: **12 Hours**

Historical perspective - scope & future prospects of nutraceuticals - classification of nutraceuticals, dietary supplements, fortified foods, functional foods and phytonutraceuticals.

Unit II: **12 Hours**

Biochemistry of nutrition and dietetics - Classification of food components based on nutritional value, nutritional assessment of carbohydrates, proteins and fats, recommended dietary intake, acceptable dietary intake, nitrogen balance, protein efficiency ratio, net protein utilisation. Basics of energy balance - Basal Metabolic Rate (BMR), Body Mass Index (BMI) and Standard Dynamic Action (SDA) with special reference to nutraceutical industry.

Unit III: **12 Hours**

Nutraceuticals of plant and animal origin- Plant secondary metabolites - Alkaloids, phenols, Terpenoids. Animal metabolites - chitin, chitosan, glucosamine, chondroitin sulphate- applications in preventive medicine and treatment - Concept of cosmoceuticals and aquaceuticals. Properties and functions of various Nutraceuticals - Glucosamine, Octacosanol, Lycopene, Carnitine, Melatonin and Ornithine alpha ketoglutarate.

Unit IV: **12 Hours**

Microbial and algal nutraceuticals-Concept of prebiotics and probiotics - principle, mechanism and applications – Synbiotics - Algae as source of omega - 3 fatty acids,

antioxidants and minerals - antioxidants in prevention and treatment of cancer, obesity and stress related diseases.

Unit V: **12 Hours**

Role of medicinal and aromatic plants in nutraceutical industry- Biofortification and nutritional enhancement. GM foods with enhanced nutraceutical properties-Golden rice, Nutrition related diseases- symptoms, prevention and management (diabetes mellitus and hypercholesterolemia)

Learning Resources:

Text Books

1. Bhat, S.V., Bhimsen A., Nagasampagi, Sivakumar, M. (2006). Chemistry of Natural Products. Narosa Publishing House.
2. Buchananm B., Gruissem, W., Jones, R. (2002). Biochemistry and Molecular Biology of Plants. John Wiley & Sons

References

1. Hanson, J.R. (2003). Natural Products: The Secondary Metabolites. Royal Society of Chemistry.
2. Crozier, A., Michael, N. Clifford, Ashihara, H., (2006). Plant Secondary Metabolites: Occurrence, Structure and Role in the Human Diet..Blackwell Publishing Ltd.

Websites/ e-Learning Resources:

1. https://onlinecourses.swayam2.ac.in/cec22_ag08/preview

2. https://www.udemy.com/course/introduction-to-nutraceuticals/?couponCode=LETSLEARNNOWP

CO–PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	1	1	1	1	2	1	1	1
CO2	3	3	1	1	1	1	2	1	1	2
CO3	3	3	1	2	1	1	2	1	1	2
CO4	3	3	2	2	1	1	2	1	1	2
CO5	3	3	2	2	1	1	2	1	1	2
Average	3	3	1.4	1.6	1	1	2	1	1	1.8

High correlation-3 Medium correlation –2 Low correlation –1 No correlation -‘-‘

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC3217	**Climate Change and Sustainable Development**	**SEC**	**3**	**2**

On completion of this course, the students will be able to understand the concept and issues of global environmental change. They will gain knowledge about the physical basis of natural greenhouse effect on man and materials.

Course Outcomes:

At the end of the course, students will be able to

CO1: understand the international frameworks for addressing climate change.

CO2: know the science behind the ozone layer, the threats posed by its depletion.

CO3: discuss the greenhouse effect and its impact on climate change.

CO4: explain the atmospheric impacts on ecosystems.

CO5: acquire knowledge on pollution control, disaster preparedness, and environmental sustainability.

Unit I: **9 Hours**

Global Environmental change issues - UNFCC, IPCC, Kyoto protocol, CDM, Carbon foot print and ecological foot print.

Unit II: **9 Hours**

Stratospheric ozone layer: Evolution of ozone layer - Causes of depletion and consequences - Effects of enhanced UV-B on plants, microbes, animals, human health and materials - Global efforts for mitigation ozone layer depletion.

Unit III: **9 Hours**

Climate change: Greenhouse effects - causes - Greenhouse gases and their sources - Consequences on climate, oceans, agriculture, natural vegetation and humans - International efforts on climate change issues.

Unit IV: **9 Hours**

Atmospheric deposition: Past and present scenario - Causes and consequences of excessive atmospheric deposition of nutrients and trace elements – Eutrophication - Acid rain and its effects on plants, animals, microbes and ecosystems.

Unit V: **9 Hours**

Pollution and disaster management – Water conservation and rain water harvesting – Environmental protection Act - Issues involved in Enforcement of Environmental Legislation - Public awareness.

Learning Resources:

Text Books

1. Houghton, J. T. (2007). Global Environmental Change. Royal Society of Chemistry.
2. Matthew, R.A. and Barnett, J. and McDonald, B. and O'Brien, K.L. & Dabelko, G.D. (2009). Global Environmental Change and Human Security. MIT Press.
3. Bharucha, E. (2005). Textbook of Environmental Studies for Undergraduate Courses. Universities Press (India) Pvt. Limited.

References

1. Adger, N. Brown, K &Conway, D. (2012). Global Environmental Change: Understanding the Human Dimensions. The National Academic Press.
2. Dessler, A. (2016). Introduction to Modern Climate Change. United Kingdom: Cambridge University Press.
3. Ruddiman, W. (2020). Earth's Climate: Past and Future. United Kingdom: Macmillan Learning.
4. Dash, S. K. (2007). Climate Change: An Indian Perspective. Cambridge University Press, India [and] Centre for Environment Education, Ahmedabad.
5. Maslin, M. (2014). Climate Change: A Very Short Introduction. Oxford University Press.

Websites/ e-Learning Resources

1. http://unfccc.int/resource/docs/publications/infokit_2002_en.pdf
2. http://www.physicalgeography.net/fundamentals/contents.html
3. https://www.indiabudget.gov.in/budget202122/economicsurvey/doc/vol2chapter/echap06_vol2.pdf

CO –PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	2	2	2	2	2	2
CO2	3	3	3	3	2	1	2	2	1	2
CO3	3	3	3	3	2	1	2	2	2	2
CO4	3	3	3	3	2	1	2	2	1	2
CO5	3	3	3	3	2	2	2	2	1	2
Average	3	3	3	3	2	1.4	2	2	1.4	2

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC3255	Internship	IS	-	2

To gain hands on training in handling instruments & acquire knowledge in their applications and to get laboratory exposure.

Course Outcomes:

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

CO1: understand working principles and the techniques of various processes.

CO2: apply standard operating procedures followed in laboratories and industries.

CO3: prepare to face challenges & gain confidence in the field of study.

CO4: critically assess the utilization of instruments and consumables.

CO5: develop work ethics to be followed in a scientific laboratory.

CO –PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	3	3	3	2	2	2
CO2	3	3	3	3	3	3	3	2	2	2
CO3	3	3	3	3	3	3	3	2	2	3
CO4	3	3	3	3	3	3	3	2	2	3
CO5	3	3	3	3	3	3	3	2	2	3
Average	3	3	3	3	3	3	3	2	2	2.6

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk	Credits
24BTC3502	Genomics and Proteomics	Core	5	5

This course is useful for the students to explore the basic concept of genome analysis, human and *E. coli* genome projects, protein analysis and the applications of genomics and proteomics.

Course Outcomes:

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

CO1: know about basics of genomics, SNP and EST
CO2: learn about the gene identification methods and functional genomic studies
CO3: understand the concepts in transcriptomics and genome projects in *E.coli* and Human
CO4: analyze the protein - protein interaction and techniques involved in protein analysis
CO5: discuss the applications of genomics and proteomics

Unit I: **15 hours**

Introduction to Genomics- Genes to protein- construction of genetic map- Single Nucleotide Polymorphisms (SNPs), Expressed sequenced tags (ESTs), Gene-disease association- FISH to identify chromosome landmarks.

Unit II: **15 hours**

Gene identification and expression- Genome annotation- detecting open-reading frames-identifying the function new gene- gene ontology - Functional genomic studies with model system- Drosophila- Next Generation Sequencing – principles, methods and applications. =

Unit III: **15 hours**

Transcriptomics – Global expression profiling, analysis of mRNA expression- DNA microarray technology – Whole transcriptome analysis – SAGE (Serial Analysis of Gene Expression)- Genome projects on *E.coli*-Human genome project.

Unit IV: **15 hours**

Proteomics – Introduction, concepts of proteome analysis – Protein – 2D gel electrophoresis - Protein interaction – Yeast two hybrid system - Mass spectrometry for proteome analysis- biomarker for clinical diagnosis - tryptic digestion of protein and peptide fingerprinting.

Unit V: **15 hours**

Applications of Genomics and Proteomics – Pharmacogenomics; proteomics in drug discovery in humans; capstone project on genomics and proteomics; Metabolomics - metabolic engineering of biomolecule production pathway.

Learning Resources:

Text Books

1. Primrose, S. B. & Twyman R.M. (2006). Principles of Genome Analysis and Genomics, 7th Edition, Blackwell Publishing.

2. Campbell, A.M., Heyer, L.J., (2007). Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. CSH Press, NY. ISBN-10: 81317155902

References

1. Pennington, Dunn.(1996). Proteomics from Protein Sequence to Function, 1st Edition, Academic Press, San Diego.
2. Winnaker E.L.X. (2002). Genes to Clones - Introduction to Gene Technology, Republic Germany.
3. Brown T.A. (2000) Gene Cloning, 4th Edition, Chapman and Hall Publications, USA.

Websites/ e-Learning Resources

1. https://onlinecourses.nptel.ac.in/noc19_bt26/preview
2. https://www.coursera.org/learn/genomics-research

CO–PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	1	1	2	2	2	1	1	1
CO2	3	3	1	1	2	2	2	2	1	1
CO3	3	3	1	2	2	2	2	1	2	1
CO4	3	3	2	2	2	2	2	1	1	1
CO5	3	3	2	1	2	2	2	2	1	1
Average	3	3	1.4	1.4	2	2	2	1.4	1.2	1

High correlation-3 Medium correlation –2 Low correlation –1 No correlation-‘-‘

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC3404	Food Technology	Core	4	4

This course is to familiarize with the history and evolution of food processing and to know about the structure, composition, nutritional quality and post - harvest changes of various foods and aids in comprehending the technology involved in the production of different food products.

Course Outcomes:

At the end of the course, students will be able to

CO1: understand the basic concepts of the food industry

CO2: gain knowledge about classification of food

CO3: learn about fruits, vegetables and horticulture

CO4: gain in-depth knowledge in Non vegetarian food

CO5: impart technical knowledge of food adulteration and biosensors to detect them

Unit I: **12 Hours**

Biotechnology relating to the food industry – Role of bioprocess engineering in biotechnology industry- Regulatory and social aspects of biotechnology in foods- Application of biotechnology in waste treatment of food industries. Historical evolution of food processing technology.

Unit II: **12 Hours**

Cereals and Millets. Wheat- composition, types (hard, soft/ strong, weak). Malting, gelatinization of starch, types of browning- Maillard & caramelization. Rice- and composition, parboiling of rice- advantages and disadvantages. Structure and composition of pulses, toxic constituents in pulses, processing of pulses soaking, germination, decortications, cooking and fermentation. Fats and Oils. Refining of oils, types- steam refining, alkali refining, bleaching, steam deodorization, hydrogenation. Rancidity –Types- hydrolytic and oxidative rancidity and its prevention.

Unit III **12 Hours**

Classification of fruits and vegetables, general composition, enzymatic browning, names and sources of pigments, Dietary fibre. Post-harvest changes in fruits and vegetables – Climacteric rise, horticultural maturity, physiological maturity, physiological changes, physical changes, chemical changes, pathological changes during the storage of fruits and vegetables.

Unit IV: **12 Hours**

Concept of red meat and white meat, composition of meat, marbling, post-mortem changes in meat- rigor mortis, tenderization of meat, ageing of meat. Aquaculture, composition of fish, characteristics of fresh fish, spoilage of fish - microbiological,

physiological and biochemical. Composition and nutritive value of egg, characteristics of fresh egg, deterioration of egg quality, difference between broiler and layers. Milk and Milk Products. Chemical composition of milk, its constituents, processing of milk, pasteurization, homogenization. An overview of types of market milk and milk products.

Unit V: **12 Hours**

Types of food adulterants – test to detect adulterants in foods – metal contaminants - contaminants of processed foods- Food products as analytical samples, general aspects of biosensors- biosensors for food contaminant analysis, commercially available biosensors for food analysis. Food additives, FSSAI regulations, Methods of fortifying and enriching foods.

Text Books

1. Bawa. A.S, O.P Chauhan et al. Food Science. New India Publishing agency, 2013.

2. B. Srilakshmi, Food science, New Age Publishers,2002

3. Joshi, V.K. and Singh, R.S., A. (2013), Food Biotechnology- Principles and practices, I.K.International Publishing House Pvt. Ltd., New Delhi,.

4. Ravishankar Rai, V, (2015), Advances in Food Biotechnology, (First edition), John Wiley & Sons, Inc, ISBN 9781118864555.

5. Perry Johnson- Green (2018), Introduction to Food Biotechnology, Special Indian Edition, CRC Press, ISBN 9781315275703.

References

1. Roday,S. Food Science, Oxford publication, 2011.

2. Meyer, Food Chemistry, New Age,2004 5. De Sukumar., Outlines of Dairy Technology, Oxford University Press, 2007

3. Foster, G.N., (2020), Food Biotechnology, (First edition), CBS Publishers & Distributors Pvt Ltd, ISBN 9789389396348.

4. Anthony Pometto, Kalidas Shetty, Gopinadhan Paliyath, Robert E. Levin (2005), Food Biotechnology, (2nd edition), CRC Press,ISBN 9780824753290.

5. Roday,S. Food Science, Oxford publication, 2011.

Web Resources

1. https://ifst.onlinelibrary.wiley.com/journal/13652621

2. https://app.knovel.com/web/browse-a-subject-area.v/catid:216/cat_slug:food-science/subcatid:27

3. https://www.springer.com/journal/13197

4. https://www.sciencedirect.com/referencework/9780081005965/food-science
5. https://www.ift.org/news-and-publications/food-technology-magazine

CO – PSO Mapping

	PSO1	**PSO2**	**PSO3**	**PSO4**	**PSO5**	**PSO6**	**PSO7**	**PSO8**	**PSO9**	**PSO10**
CO1	3	3	3	3	2	2	2	1	1	1
CO2	3	3	3	3	2	2	2	1	1	1
CO3	3	3	3	3	2	2	2	1	1	1
CO4	3	3	3	3	2	2	2	1	1	1
CO5	3	3	3	3	2	2	2	1	1	1
Average	3	3	3	3	2	2	2	1	1	1

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - ‘-’

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC3306	Food Technology Lab	Core	3	3

The lab course is designed to learn and explore the techniques and technology used in various foods like cereals, fruits and vegetables, and meat products.

Course Outcomes:

At the end of the course, students will be able to

CO1: acquire knowledge on learn the proximate analysis of cereals.

CO2: learn the quality control testing of bakery

CO3: assess the role in pre- and post-harvest changes in fruits and vegetables on product quality.

CO4: perform the microbial analysis of meat and meat products

CO5: gain knowledge on the quality tests of egg, meat and fish

Experiments:

1. Determination of physical characteristics of cereals.
2. Determination of moisture content of different cereal grains.
3. Determination of crude fibre & ash in wheat flour.
4. Determination of gluten formation
5. Determination of alcoholic acidity of the sample of the wheat flour/Maida
6. Dehydration and sun drying of fruits and vegetables.
7. Preparation of flavoured milk
8. Quality evaluation of milk and milk products
9. Total plate count of meat samples Yeast and mould count of meat samples
10. Determination of egg quality.
11. Sensory analysis of meat/fish/poultry products.

Reference Books

1. Roday,S. Food Science, Oxford publication, 2011.
2. Meyer, Food Chemistry, New Age,2004 5. De Sukumar., Outlines of Dairy Technology, Oxford University Press, 2007
3. Kay DE. 1979. Food Legumes. Tropical Products Institute. Kent NL. 1983. Technology of Cereals. 4th Ed. Pergamon Press. Kulp K & Ponte GJ. 2000. Handbook of Cereal Science and Technology. 2nd Ed. Marcel Dekker.
4. G. C. Mead. 2004. Poultry Meat Processing and Quality. CRC Press A K Biswas and P K Mandal. 2014. Textbook of Poultry, Egg and Fish Processing Technology. Studium Press India Pvt Ltd

Web Resources

1. https://ifst.onlinelibrary.wiley.com/journal/13652621
2. https://app.knovel.com/web/browse-a-subject-area.v/catid:216/cat_slug:food-science/subcatid:27

3. https://www.springer.com/journal/13197
4. https://www.sciencedirect.com/referencework/9780081005965/food-science
5. https://www.ift.org/news-and-publications/food-technology-magazine

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	2	2	2	1	1	1
CO2	3	3	3	3	2	2	2	1	1	1
CO3	3	3	3	3	2	2	2	1	1	1
CO4	3	3	3	3	2	2	2	1	1	1
CO5	3	3	3	3	2	2	2	1	1	1
Average	3	3	3	3	2	2	2	1	1	1

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC3608	**Project**	**Core**	**6**	**6**

The paper imparts a thorough knowledge on the basics of academic research. The student will get to understand the concepts of pursuing research.

Course Outcomes:

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

CO1: understand working principles and the techniques of various processes in the field of research work.

CO2: design experiments to solve/answer a problem identified in the field of study.

CO3: prepare to face challenges & gain confidence in the field of study.

CO4: develop work ethics to be followed in a scientific laboratory.

CO5: seek basic research-based knowledge, professional employment, or entrepreneurship in diverse fields of Biotechnology.

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	3	3	3	2	2	3
CO2	3	3	3	3	3	3	3	2	2	3
CO3	3	3	3	3	3	3	3	2	2	3
CO4	3	3	3	3	3	3	3	3	2	3
CO5	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	2.4	2.2	3

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation - '-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC3410	Marine Biotechnology	DSE	5	4

This course is designed to study about the fundamentals of marine biotechnology, role of biotechnology in the area of marine ecology and marine resources.

Course Outcomes:
At the end of the course, students will be able to
CO1: understand marine Ecosystem and Resources.
CO2: discuss marine conservational strategies
CO3: acquire knowledge on importance of medicinal seaweeds
CO4: demonstrate the culture techniques of seaweeds and Aquaculture
CO5: gain insight on bioactive compounds from Marine sources

Unit I: **15 hours**

Marine ecosystems & its functioning, Ocean currents, Ecological divisions of the Sea- Euphotic, Mesopelagic, Bathopelagic, Benthos - Intertidal, Estuarine, Salt Marsh, Mangrove, Coral Reef - Physical & chemical properties of seawater.

Unit II: **15 hours**

Threats: Increase in SST – Algal Blooms – Coral Bleaching – Mining - Oil spills – Unethical fishing – Dumping of wastes (Radioactive, silicon, plastics) – Microplastics – Heavy metal pollution. Conservational strategies: Coral restoration - Mangrove restoration - Sustainable fishing – biosurfactants – bioremediation - bioreserves.

Unit III: **15 hours**

Marine microbial habitats- Screening for Secondary metabolites from marine microbes (Bacteria, Fungi, Actinomycetes and marine microalgae). Biofouling, Biofilm, Antifouling, Anticorrosion. Probiotics and their importance in aquaculture.

Unit IV: **15 hours**

Culture aspect - Seaweed (*Kappaphycus alvarezii*) - Methods of cultivation. Fish chromosome manipulation in aquaculture- Hybridization- Gynogenesis- Androgenesis- Polyploidy, Artificial breeding techniques, Eyestalk ablation- Transgenesis and Cryopreservation.

Unit V: **15 hours**

Marine products and applications: Agar Agar - Agarose - Alginate- Carrageenan- Chitin- Chitosan- Heparin – Diatomaceous earth - Marine pigments - Medicinal compounds from flora (Seaweeds, Seagrass and Mangrove) and fauna (Sponges, Sea anemone and Corals) - marine toxins- antiviral and antimicrobial agents.

Learning Resources:
Text Books

1. Attaway, D.H. (2001). Marine Biotechnology, Volume 1, Pharmaceutical and Bioactive Natural Products.
2. Kim, S. (2015) Springer Handbook of Marine Biotechnology. Springer Publication.
3. Nybakken, J.W., Bertness, M.D., (2005). Marine biology: An ecological approach. 6th ed. Benjamin Cummings, San Francisco.

Reference Books

1. Sanchez, G., Hernandez, E. (2019). Environmental Biotechnology and cleaner Bioprocess, (1st edition). CRC Press, ISBN 9780367455552
2. Kirchman, D.L., Gasol, J.M. (2018). Microbial ecology of the oceans, (3rdedition), Wiley –Blackwell.
3. Kim, S. (2020) Encyclopedia of Marine Biotechnology: 5 Volumes. Wiley Publication.
4. Campbell, A.C., 2004. The Hamlyn guide to the seashore and shallow seas of Britain and Europe. Hamlyn, London.

Web Resources

1. https://onlinecourses.swayam2.ac.in/cec23_bt22/preview
2. https://www.coursera.org/learn/marine-biology
3. https://www.course-bookings.lifelong.ed.ac.uk/courses/SN/science-and-nature/SN125/marine-biology-and-ecology-online/

CO–PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	1	1	1	2	1	1	1	1
CO2	3	3	2	1	2	2	2	1	1	2
CO3	3	3	2	1	2	2	2	1	1	2
CO4	3	3	1	1	2	2	2	1	1	2
CO5	3	3	1	1	1	2	2	1	1	2
Average	3	3	1.4	1	1.6	2	1.8	1	1	1.8

High correlation-3 Medium correlation –2 Low correlation –1 No correlation-‘-‘

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC3412	Pharmaceutical Biotechnology	DSE	5	4

The subject imparts knowledge on the fundamentals of pharmaceutical biotechnology. The student will be provided with a basic knowledge and understanding about the pharmaceutical products produced based on biotechnological methods and its biomedical applications.

Course Outcomes:

At the end of the course, students will be able to

CO1: elaborate the series of processes involved in drug development, patenting and drug approval.

CO2: learn about Biopharmaceuticals

CO3: discuss generic and modern drugs

CO4: understand management of drugs

CO5: explore pharmaceutical sectors

Unit I: **15 Hours**

Objectives of Pharmaceutical Biotechnology - Generic and Biogeneric drugs. Stages in the drug development process -Drug discovery - Drug designing - Drug production - Preclinical trials - Clinical trials – Pharmacokinetics and Pharmacodynamics - Patenting & Drug Approval - Drug Marketing - Post clinical trials.

Unit II: **15 Hours**

Production of recombinant proteins - Development of Nucleic acid based therapies - Biopharmaceutical considerations - Pharmaceutical regulations - Formulation of Biotechnology products - Drug delivery – Pharmacognosy.

Unit III: **15 Hours**

Human Insulin (Humulin), Growth hormones (Humatrope) - Blood coagulating factor (factor VIII - Kogenate) - Erythropoietin - (Epogen) Granulocyte colony stimulating factors (Neulasta) - Interferons (Avonex) - Antimicrobial peptides (β - defensin 2) - Vaccines (Pentavac, Covishield & Covaxin), Biologics (Humira - Adalimumab), - Cancer based biologics (rituximab).

Unit IV: **15 Hours**

Drug toxicity analysis (LD50, IC50 & ED50) - Common side effects of drugs and managements - Drugs of abuse - Life changing complications - Prevention and management.

Unit V: **15 Hours**

National and International Drug approval agencies (CDSCO, FDA & USDA) - Top National and International pharmaceutical industries - Scope and career opportunities in pharmaceutical sectors.

Learning Resources:

Text Books

1. Chandrakant Kokate and Pramod H.J 1st Edition (2011), Text Book of Pharmaceutical Biotechnology, Elsevier
2. Crommelin, Dean J. A., Sindelar, Robert, Meobohm, Bernd (Eds.) (2019), Pharmaceutical Biotechnology: Fundementals and Applications, Springer.
3. Ashish Dixit, Pawan Tiwari and Vivekanand Kishan Chatap (2015), Textbook of Pharmaceutical Biotechnology, Studium Press (India) Pvt. Ltd.
4. John F. Corpenter, Mark C. Manning (2012). *Rational Design of stable formulation Theory and Practice,*(1st edition), US: Springer Science,ISBN: 9781461351313.

References

1. Gary Walsh (2003), Biopharmaceuticals; biochemistry and Biotechnology, John Wiley & Sons Ltd.
2. Oliver Kayser and Heribert Warzecha (2012), Pharmaceutical Biotechnology: Drug Discovery and Clinical Applications, Wiley - Blackwell.
3. Simon Wills, 2nd Edition (2005), Drugs of abuse, Pharmaceutical Press
4. Hiten J. Gutka, Harry Yang, Shefali Kakar (2018*). Biosimilars: Regulatory, Clinical, and Biopharmaceutical Development,* (1st ed), USA: Springer, ISBN: 978-3-319-99679-0.
5. Yui-Wing F. L. and Stuart S. (2019). *Pharmacogenomics: Challenges and Opportunities in Therapeutic Implementation,* (2nd Ed), TX, USA: Academic Press,ISBN:9780128126264.

Websites/ e-Learning Resources

1. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5178364/
2. https://www.patentdocs.org/biotech_news/
3. https://www.pharmamanufacturing.com/
4. https://nptel.ac.in/courses/102/103/102103013/

CO–PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	2	1	2	1	2	2	1	1
CO2	3	3	2	2	2	2	2	3	2	2
CO3	3	3	1	1	2	2	2	2	1	2
CO4	3	3	2	1	2	2	2	1	3	2
CO5	3	3	2	2	2	2	2	2	1	2
Average	3	3	1.8	1.4	2	1.8	2	2	1.6	1.8

High correlation-3 Medium correlation –2 Low correlation –1 No correlation-'-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC3314	Waste Management Technology	GE	4	3

Course Outcomes:

At the end of the course, students will be able to

CO1: know the sources and types of solid waste.

CO2: learn the importance of methods of collection and selection of location for solid waste.

CO3: understand the various recovery methods of solid waste.

CO4: gain in depth knowledge on sewage treatment.

CO5: perform the rules & regulations of waste management.

Unit I: 12 hours

Solid Waste Management: Introduction - Sources – Types of waste (Municipal, Domestic, Agricultural, Industrial, Medical) –- Effects of improper disposal of solid wastes - Public health effects.

Unit II: 12 hours

On-site storage methods - Methods of Collection - Types of vehicles – manpower requirement - collection routes - Transfer stations - Selection of location - Operation & maintenance - segregation of solid wastes.

Unit III: 12 hours

Resource recovery from solid wastes - Composting – Incineration – Pyrolysis - Dumping of solid waste - Sanitary landfills - Site selection - Design and operation of sanitary - Leachate collection & treatment.

Unit IV: 12 hours

Sewage waste – Source – Types - Sewage Treatment – Single Dwelling Unit, Industrial (Primary, Secondary and Tertiary Treatment). Reuse of treated water.

Unit V: 12 hours

Social & economic aspects- public awareness – Sustainability - Role of NGOs – legislation – Auditing – Entrepreneurial opportunities.

Learning Resources:

Text Books:

1. George Tchobanoglouset.al., "Integrated Solid Waste Management", McGraw-Hil Publishers, 2003.
2. Stijn van Ewijk and Julia Stegemann., An Introduction to Waste Management and Circular Economy, 2023.
3. George Tchobanoglous, Frank Kreith, Handbook of Solid Waste Management, 2nd Edition, 2022

4. Ankur Rajpal, Moharana Choudhury, Waste Management and Treatment Advances and Innovations 1st edition 2024.

References:

1. Biltewski .B, HardHe .G, Marek .K, Weisbach.A, and Boedicker .H, "Waste Management",Springer, 2004.

2. Manual on Municipal Solid Waste Management, "CPHEO", Ministry of Urban Development, Government of India, New Delhi, 2010.

3.Landreth.R.E and Rebers .P.A,"Municipal Solid Wastes–problems and Solutions",Lewis Publishers, 2002.

4. Bhide .A.D. and Sundaresan .B.B, "Solid Waste Management in Developing countries

Websites/ e-Learning Resources:

1. https://www.ciwm.co.uk/ItemDetail?iProductCode=WLEE&Category=MOODLE
2. https://www.ciwm.co.uk/ciwm/training/introduction_to_the_management_of_wastes_and_resources.aspx?hkey=95e241b6-a82d-4a99-aae0-a0f49b65d10b

CO – PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	3	2	2	2	1	1	1	1
CO2	3	3	3	2	2	2	1	1	1	1
CO3	3	3	3	2	2	2	1	1	1	1
CO4	3	3	3	2	2	2	1	1	1	1
CO5	3	3	3	2	2	2	1	1	1	1
Average	3	3	3	2	2	2	1	1	1	1

High correlation -3 Medium correlation –2 Low correlation –1 No correlation-'-'

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC3316	Microbes in Human Welfare	GE	4	3

This course is aimed to know the roles of microbes in human health, food production, environmental conservation and in industries for production of commercial products.

Course Outcomes:

At the end of the course, students will be able to

CO1: comprehend the milestones, diversity and classification of microorganisms.

CO2: discuss influence of microorganism in household products.

CO3: discuss the production methods of Food products, antibiotics and vaccines.

CO4: explain how microorganism influence human health.

CO5: analyze the various methods involved in disposal of wastes and bioremediation.

Unit I: 12 Hours

Introduction to microorganisms - Diversity and characteristics of microorganism - Classification of microorganisms (bacteria, fungi, viruses, protozoa) -Techniques for studying microbes - Scope of microbiology – Role of microbes in biotechnology.

Unit II: 12 Hours

Role of microbes in household products. Curd production by Lactobacillus bacteria, Fermentation of dough for South Indian delicacies (e.g., Idli and dosa), Bread production using yeast (Saccharomyces cerevisiae), Toddy fermentation from palm sap, Cheese production with specific microorganisms (e.g., Swiss cheese, Roquefort cheese, Camembert cheese).

Unit III: 12 Hours

Role of microbes in Industries. Introduction to bioprocess technology.Fermentor and their types. Alcoholic beverages (wine, beer) produced by *Saccharomyces cerevisiae*. Antibiotics and vaccines. Microbial metabolites.

Unit IV: 12 Hours

Role of microbial community in human biology. Role of gut microbiota in human health. Prebiotics, Probiotics and Synbiotics. Single Cell Protein (SCP) – Spirulina, Yeast. Microbial production of vitamins.

Unit V: 12 Hours

Role of microbes in Sewage Treatment Plants – Primary, Secondary and Tertiary treatment. Biogas Production. Bioremediation – oil spills, heavy metal degradation. Bioleaching. Bioinsecticides - *Bacillus thuringiensis*, Baculo viruses. Biofertilizers.

Learning Resources:

Text Books

1. Joginder Singh (2020) Microbial Biotechnology: Basic Research and Applications, 1st ed.,Kindle Edition, Springer Publication.

2. Prescott L.M., Dunn, R.G. (2004) Industrial Microbiology, 4th Edition, CBS Publishers & Distributors, New Delhi.
3. Pelczar, M. J., Chan, E.C.S., & Noel, R.K. (2007). Microbiology. 7th Edition., McGraw – Hill, New York.

References

1. Boyd, R.F. (1998). General Microbiology. 2nd Edition. Times Mirror, Mosby College Publishing, St Louis.
2. Dubey R.C. & Maheswari, S. (2003). A Textbook of Microbiology, S. Chand Ltd.
3. Gillespie, S., & Bamford, K. (2012). Medical Microbiology and Infection at a Glance. 4th Edition. John Wiley & Son.
4. Madigan, M. T., Martinko, J. M., Bender, K. S., Buckley, D. H., & Stahl, D. A. (2017) Brock Biology of Microorganisms. 14thEdition. Pearson.

Websites/ e-Learning Resources

1. https://trainingexpress.org.uk/course/industrial-microbiology-fundamentals/
2. https://elearning.icar.gov.in/DisplayUG_ECoursesContent.aspx?CourseCode=VwtkpVVMfxtH7!jp6O9gCA==www.Biotech.kth.seElectronicJournalofbiotechnology

CO–PO Mapping

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	3	3	1	1	1	2	1	1	1	1
CO2	3	3	1	1	1	2	1	1	1	1
CO3	3	3	1	1	1	2	1	1	1	1
CO4	3	3	2	2	2	2	1	1	1	1
CO5	3	3	2	2	2	2	1	1	1	1
Average	3	3	1.4	1.4	1.4	2	1	1	1	1

High correlation-3 Medium correlation –2 Low correlation –1 No correlation-‘-‘

Course Code	Name of the Course	Category	Hours/Wk.	Credits
24BTC3266	**Professional Competency Skill**	**SEC**	**3**	**2**

This course enables to acquire thorough knowledge, practical skills, research abilities and social competences for their lifelong career management.

Course Outcomes:

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

CO1: aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development.
CO2: apply educational and collaborative technologies that foster learning and prepare learners for post graduate studies and professional environments.
CO3: prepare to face challenges & gain confidence in the biotechnology and its allied field.
CO4: set high personal standards of performance in the PG Entrance Examinations and competitive exams viz, IIT JAM, CUET, Banking Services, TNPSC group services, etc.
CO5: seek research-based knowledge, professional employment, or entrepreneurship in diverse fields of Biotechnology.

CO – PSO Mapping

	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
CO1	3	3	3	3	3	3	3	2	2	3
CO2	3	3	3	3	3	3	3	2	2	3
CO3	3	3	3	3	3	3	3	2	2	3
CO4	3	3	3	3	3	3	3	3	3	3
CO5	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	3	3	2.4	2.4	3

High correlation - 3 Medium correlation – 2 Low correlation – 1 No correlation – '-'