KAVAYITRI BAHINABAI CHAUDHARI NORTH MAHARASHTRA UNIVERSITY, JALGAON

'A' Grade
NAAC Re-accredited
(4th Cycle)

Semester-wise Code structure and Syllabus for

Faculty: Science and Technology

F. Y. B. Sc. (Biotechnology)
(Honors/Research) Programme

As per NEP 2020 for Affiliated Colleges

w.e.f. June 2024

Prologue

The 21st Century is recognized as the Century of Biotechnology. Biotechnology is established as an advanced interdisciplinary applied science in last few years. Biotechnology has pervaded in almost every arena touching practically every human activity. The applied aspect of Biotechnology is now getting established with its applications in Industry, Agriculture, Health and Environment. Biotechnology sector in academic, research and industry front is expanding at rapid rate and set to augur the next major revolution in the world. For this, Biotechnology demands a trained, skilled human resource to establish the industry and research sectors. The cumulative demand for trained and skilled workforce in the area of Biotechnology necessitate in depth functional acquaintance of biological science through hands-on training to the students.

Hence, the syllabus orientation should be altered to keep pace with developments in the education and industrial sector. The need of the hour is to design appropriate syllabi that emphasize on teaching of technological as well as the economic aspects of modern biology.

Theory augmented with practical skill sets will support a graduate to benefit the opportunities in the applied fields (research, industry or institutions), without any additional training. Thus, the university/college itself will be developing the trained and skilled man-power.
B.Sc. program in Biotechnology as one of the core subject is designed to cultivate a scientific attitude and interest towards the modern areas of biotechnology in particular and life science in general so that the students become critical and curious in their outlook. The courses are designed to impart the essential basics in Plant Science, Animal Science, Microbiology Biochemistry, Chemistry and Biotechnology.

Being an interdisciplinary subject, the present syllabus will amalgamate the principles of physical, chemical and biological sciences along with advanced technology. The undergraduate curricula are prepared to impart primarily basic knowledge of the respective subject from all possible angles so that postgraduate syllabus will emphasize more on applied aspect.

The present syllabus is restructured anticipating the future needs of Biotechnology Sector with more emphasis on imparting hands-on skills. The main thrust is laid on making syllabus compatible with developments in academics, research and industrial sectors. The Theory and Practical course in new restructured course will lead to impart skill-set essentials to further Biotechnology Sector. The curriculum aims to impart basic knowledge with more emphasis on its applications to make the students industry ready.

- To acquaint with the concepts in various allied subjects
- To improve students' knowledge
- To help the students to build interdisciplinary approach
- To instill sense of scientific responsibilities and social and environment awareness
- To help students build-up a progressive and successful career

On this premise, Board of Studies in Life Sciences in its meeting held on 03/10/2023 resolved to accept the revised syllabus for F.Y.B.Sc. (Biotechnology) based on Choice Based Credit System (CBCS) of UGC, NEP-2020 and the Government of Maharashtra guidelines.

Programme Outcome (PO):

As an outcome, the graduate students are expected to gain the following competencies upon completion of B.Sc. program:

- Students will understand the concepts and significance in the field of Biochemistry /Biotechnology / Microbiology that can be used for solving the real time problems.
- Students will acquire skills and ability in their field and find professional opportunities in industry, agriculture and higher studies.
- Students will have improved personal qualities and transferable skills to help them to groom as responsible citizens.

Program Specific Outcomes (PSO):

- Graduate in Biotechnology shall acquire the basic knowledge of Biotechnology and can be eligible for pursuing higher education/ postgraduate education.
- Students will gain knowledge and develop specialized skill in the different area of Biotechnology.
- Graduate candidates will develop a sense of societal and ethical responsibility pertaining to bioinformatics, health, agriculture, dairy, genetic engineering, and fermentation industry.
- The knowledge shall promote our graduates to stand independently amidst the growing technological innovations in the subject.

Cognitive learning is a change in knowledge attributable to experience. This definition has three components: (1) learning involves a change, (2) the change is in the learner's knowledge, and (3) the cause of the change is the learner's experience.

Six levels of cognitive learning according to the revised version of Bloom's Taxonomy

Cognitive level	**1**	**2**	**3**	**4**	**5**	**6**
Cognitive task	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating

Multiple Entry and Multiple Exit options:

The multiple entry and exit options with the award of UG certificate/ UG diploma/ or three-year degree depending upon the number of credits secured;

Levels	**Qualification Title**	**Credit Requirements**		**Semester**	**Year**
		Minimum	**Maximum**		
4.5	UG Certificate	40	44	2	1
5.0	UG Diploma	80	88	4	2
5.5	Three Year Bachelor's Degree	120	132	6	3
6.0	Bachelor's Degree- Honours **Or** Bachelor's Degree- Honours with Research	160	176	8	4

Credit distribution structure for Three/ Four year Honors/ Honors with Research Degree Programme with Multiple Entry and Exit

Level	Sem	Major Core Subjects		Minor Subjects (MIN)	VSC, SEC (VSEC)	GE/OE	AEC, VEC, IKS	CC, FP, CEP, OJT/Int/RP	Cumulative Credits/Sem	Degree/ Cumulative Credit
		Mandatory (DSC)	Elective (DSE)							
4.5	I	DSC-1(2T) DSC-2(2T) DSC-3(2T)	---	MIN-1(2T) MIN-2(2P)	SEC-1(2T)	OE-1(2T)	AEC-1(2T) (Eng) VEC-1(2T) (ES) IKS(2T)	CC-1(2T)	22	**UG Certificate 44**
	II	DSC-4(2T) DSC-5(2T) (IKS) DSC-6(2T)	---	MIN-3(2T) MIN-4(2P)	SEC-2(2T) SEC-3(2P)	OE-2(2T)	AEC-2(2T) (Eng) VEC-2(2T) (CI)	CC-2(2T)	22	
	Cum. Cr.	**12**	**---**	**8**	**6**	**4**	**4+4+2**	**4**	**44**	
Exit option: Award of UG Certificate in Major with 44 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major and Minor.										
5.0	III	DSC-7(2T) DSC-8(2T) DSC-9(2P) DSC-10(2P)	---	MIN-5(2T) MIN-6(2P)	VSC-1(2T) VSC-2(2P)	OE-3(2T)	AEC-3(2T) (MIL)	CC-3(2T)	22	**UG Certificate 88**
	IV	DSC-11(2T) DSC-12(2T) DSC-13(2P) DSC-14(2P)	---	MIN-7(2T) MIN-8(2P)	---	OE-4(4T)	AEC-4(2T) (MIL)	CC-4(2T) CEP (2T)	22	
	Cum. Cr.	**28**	**---**	**16**	**6+4**	**10**	**8+4+2**	**8+2**	**88**	
Exit option: Award of UG Diploma in Major and Minor with 88 credits and an additional 4 credits core NSQF course/ Internship OR Continue with Major & Minor.										
5.5	V	DSC-15(2T) DSC-16(2T) DSC-17(2T) DSC-18(2P) DSC-19(2P)	DSE-1(2T) DSE-2(2P)	MIN-9(2T)	VSC-3(2P)	---	---	FP (4)	22	**UG Degree 132**
	VI	DSC-20(2T) DSC-21(2T) DSC-22(2T) DSC-23(2P) DSC-24(2P)	DSE-3(2T) DSE-4(2P)	MIN-10 (2T)	VSC-4(2P)	---	---	OJT/Int (4)	22	
	Cum. Cr.	**48**	**8**	**20**	**6+8**	**10**	**8+4+2**	**8+2+4+4**	**132**	
Exit option: Award of UG Degree in Major with 132 credits OR Continue with Major and Minor										
6.0	VII	DSC-25(4T) DSC-26(2T) DSC-27(4T) DSC-28(2P) DSC-29(2P)	DSE-5(4T)	RM(4T)	---	---	---	---	22	**UG Honours Degree 176**
	VIII	DSC-30(4T) DSC-31(2T) DSC-32(4T) DSC-33(2P) DSC-34(2P)	DSE-6(4T)	---	---	---	---	OJT/Int (4)	22	
	Cum. Cr.	**76**	**16**	**20+4**	**6+8**	**10**	**8+4+2**	**8+2+4+8**	**176**	
Four Year UG Honors Degree in Major and Minor with 176 credits										
6.0	VII	DSC-25(4T) DSC-26(2T) DSC-28(2P) DSC-29(2P)	DSE-5(4T)	RM(4T)	---	---	---	RP(4)	22	**UG Honours with Research Degree 176**
	VIII	DSC-30(4T) DSC-31(2T) DSC-33(2P) DSC-34(2P)	DSE-6(4T)	---	---	---	---	RP(8)	22	
	Cum. Cr.	**68**	**16**	**20+4**	**6+8**	**10**	**8+4+2**	**8+2+4+4+12**	**176**	
Four Year UG Honours with Research Degree in Major and Minor with 176 credits										

Sem- Semester, **DSC**- Department Specific Course, **DSE**- Department Specific Elective, **OE/GE**- Open/Generic elective, **VSC**- Vocational Skill Course, **SEC**- Skill Enhancement Course, **VSEC**- Vocation and Skill Enhancement Course, **AEC**- Ability Enhancement Course, **IKS**- Indian Knowledge System, **VEC**- Value Education Course, **T**- Theory, **P**- Practical,**CC**-Cocurricular **RM**- Research Methodology, **OJT**- On Job Training, **FP**- Field Project, **Int**- Internship, **RP**- Research Project, **CEP**- Community Extension Programme, **ENG**- English, **CI**- Constitution of India, **MIL**- Modern Indian Laguage

Details of F.Y. B.Sc. (Biotechnology)

Semester I, Level – 4.5

Course	Course Type	Course Code	Course Title	Credits	Teaching Hours/ Week			Marks			
					T	P	Total	Internal		External	
								T	P	T	P
DSC-1	DSC	BT-111	Cell Biology	2	2	---	2	20	---	30	---
DSC-2	DSC	BT-112	Tools of Biotechnology	2	2	---	2	20	---	30	---
DSC-3	DSC	BT-113	Practical course based on Cell Biology and Biochemical Tools	2	---	4	4	---	20	---	30
MIN-1	MIN	BT-114	Introduction to Biotechnology	2	2	---	2	20	---	30	---
MIN-2	MIN	BT-115	Practical course based on Basic Techniques in Biotechnology	2	---	4	4	---	20	---	30
OE-1	OE	BT-116	Biotechnology for human welfare	2	2	---	2	20	---	30	---
SEC-1	SEC	BT-117	Basic Microbiology	2	2	---	2	20	---	30	---
VEC-1	VEC	EA-118	Environmental Awareness	2	2	---	2	20	---	30	---
IKS	IKS	IK-119	Ayurvedic Medicine in Ancient India	2	2	---	2	20	---	30	---
CC-1	CC	CC-120	Sports and Yoga	2	2	---	2	50	---	---	---
AEC-1	AEC	EG-101	English-1	2	2	---	2	20	---	30	---
Total Credit for Semester I: 22 (T = Theory: 18; P = Practical:4)											

Details of F.Y. B.Sc. (Biotechnology)

Semester II, Level – 4.5

Course	Course Type	Course Code	Course Title	Credits	Teaching Hours/ Week			Marks			
					T	P	Total	Internal		External	
								T	P	T	P
DSC-4	DSC	BT-121	Biomolecules	2	2	---	2	20	---	30	---
DSC-5	DSC	BT-122	Ancient Science (IKS)	2	2	---	2	20	---	30	---
DSC-6	DSC	BT-123	Practical course based on Biomolecules	2	---	4	4	---	20	---	30
MIN-3	MIN	BT-124	Molecules of Life	2	2	---	2	20	---	30	---
MIN-4	MIN	BT-125	Practical course based on molecules of life	2	---	4	4	---	20	---	30
OE-2	OE	BT-126	Medical Biotechnology	2	2	---	2	20	---	30	---
SEC-2	SEC	BT-127	Advanced Microbiology	2	2	---	2	20	---	30	---
SEC-3	SEC	BT-128	Practical course based on advanced Microbiology	2	---	4	4	---	20	---	30
VEC-2	VEC	CI-129	Constitution of India	2	2	---	2	20	---	30	---
CC-2	CC	CC-130	Cyber Security	2	2	---	2	50	---	---	---
AEC-2	AEC	EG-102	English-2	2	2	---	2	20	---	30	---
Total Credit for Semester II: 22 (T = Theory: 16; P = Practical:06)											

SEMESTER-I
Major Course (DSC-1)
BT-111: Cell Biology (Theory)

Total Hours: 30 (2/week) **Credits: 2**

<table>
<tr><td>Course Objectives</td><td colspan="3">▪ To make students familiar with functional unit of life-cell
▪ To study ultra structure of prokaryotic and eukaryotic cell
▪ To acquaint students with cell division</td></tr>
<tr><td rowspan="5">Course Outcomes</td><td colspan="2">After successful completion of this course, students are expected to:</td><td>Cognitive Level</td></tr>
<tr><td colspan="2">▪ learn basic knowledge pertinent to cell as unit, cell organelles and its architecture</td><td>1</td></tr>
<tr><td colspan="2">▪ know the structural and functional details of cell</td><td>1</td></tr>
<tr><td colspan="2">▪ differentiate between prokaryotic and eukaryotic cells, plant and animal cells</td><td>1</td></tr>
<tr><td colspan="2">▪ understand the process of cell division and its significance</td><td>2</td></tr>
<tr><td>Unit</td><td colspan="2">Contents</td><td>Hours</td></tr>
<tr><td>Unit I</td><td colspan="2">Cell: functional unit of life
• Cell: Definition, concept, history of cytology with reference to the cell and cell division
• Cell size and shape, its elemental and organic composition, unicellular and multicellular organisms
• Types of cells: Prokaryotic and Eukaryotic cells, compartmentalization of eukaryotic cells
• Introduction to the cell organelles
• Comparative account on plant and animal cell</td><td>07</td></tr>
<tr><td>Unit II</td><td colspan="2">Ultra structure of cell
• Structure and functions of:
• Nucleus
• Endoplasmic Reticulum (Smooth and Rough)
• Golgi complex
• Ribosomes (prokaryotic and Eukaryotic)
• Mitocondria
• Plastids (types)- chloroplast (structure and functions)
• Lysosomes: Vacuoles and micro bodies
• Cell wall</td><td>08</td></tr>
<tr><td>Unit III</td><td colspan="2">Cell membrane and cell motility
• Cell membrane and permeability: Chemical components of biological membranes, organization and Fluid Mosaic Model, cell recognition and membrane transport.
• Membrane Vascular system, cytoskeleton and cell motility: Structure and function of microtubules, Microfilaments.</td><td>07</td></tr>
</table>

	• Structure and functions of cilia and flagella • Movement of cilia and flagella	
Unit IV	**Cell Division** • Cell cycle: G-phase, S-phase and M-phase • Mitosis: concept and phases of mitosis • Significance of mitosis • Meiosis: concept, types and phases • Significance of meiosis • Comparative account on mitosis and meiosis	**08**
References	• Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments, 6th Edition, John Wiley& Sons. Inc. • De Robertis, E.D.P. and De Robertis, E.M.F. (2006) Cell and Molecular Biology, 8th edition, Lippincott Williams and Wilkins, Philadelphia. • Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach, 5th edition, ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA. • Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, • G.P. (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco. • Powar, C. B. and Daginawala, H. F. (2010). General Microbiology Vol. I and II, 2nd edition, Himalaya Publishing House, Mumbai • Powar, C.B. (2012). Cell Biology, 3rdedition, Himalaya Publishing House, Mumbai	

SEMESTER-I
Major Course (DSC-2)
BT-112: Tools of Biotechnology (Theory)

Total Hours: 30 (2/week) **Credits: 2**

Course Objectives	▪ Introduction of Biotechnology and its various applications in various fields ▪ To complement the students with routine biochemical tools adopted in biotechnology studies ▪ To make students acquaint with microscopy	
Course Outcomes	**After successful completion of this course, students are expected to:**	**Cognitive Level**
	▪ understand scope and applications of Biotechnology in various fields	2
	▪ understand the fundamental biochemical concepts like pH, buffers, solutions and its biological significance	2
	▪ understand parts of microscope and its working principle	2

Unit	Contents	Hours
Unit I	**Introduction and scope of Biotechnology** • Introduction to Biotechnology and historic perspectives • Scope of Biotechnology in Agriculture, Industry, Medical and Environment • Introduction to Genetic engineering, Bioinformatics and Nano-biotechnology • Applications of Biotechnology: Agriculture, Pharmaceutical, Environment, medicine and human health • Commercial opportunities in Biotechnology sector at national and International level	**07**
Unit II	**Biochemical tools** • Structure of atoms and molecules, and chemical • Chemical bonds (covalent, ionic, Hydrogen, van der waal's, hydrophobic). • Solution, and types of solutions (homo and heterogeneous solutions), standard solutions. • Concept of pH, pOH, buffer system, types of buffer solutions, biological buffers • Weak acid and weak base, dissociation constant of weak acid and base • Concept of pKa and pH, pH scale • Concept and definition of enzymes concept, active site, Transition state theory	**08**
Unit III	**Microscopy** • Basics of Microscopy: Magnification, Resolution, Numerical Aperture, Illumination system.	**08**

	• Principle with Ray diagram, Working and Significance of: Compound Microscope- Bright field and Dark filed Microscope, Phase Contrast microscope. • Oil immersion objective. • Concept and types of aberrations, correction for aberrations. • Micrometry: Occular micrometer, stage micrometer, calibration & measurement of cell size	

Unit IV	**Instrumentation**
	• Working principle, construction and applications:
	  • UV-Vis spectrophotometer
	  • Centrifuge machine
	  • Autoclave
	  • Incubator
	  • Hot air oven
	  • pH meter
	  • Weighing balance
		07

References	• Channarayappa (2006) Molecular Biotechnology: Principles and Practices, Universities Press Pvt. Ltd., Hyderabad • Wiley, JM, Sherwood, LM and Woolverton, CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hillnternational, New York • Frobisher M. Hinsdill, Crabtree and Goodheart (1974). Fundamentals of Microbiology, 9th edition, WB Saunder's Co. USA. • Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms, 14th edition, Pearson International Edition, New Delhi • Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company, New York • Tortora, Funke and Case (2010). Microbiology, 10th edition, Brenjamin Cummings Inc, California. • Ulhas Patil, JS Kulkarni, AB Chaudhari and SB Chincholkar (2016). Foundations in Microbiology 9th edition, Nirali Prakashan, Pune • Modi, H. A. (2014) Elementary Microbiology, Vol. 1 and 2, Akshar Prakashan, Ahmedabad	

SEMESTER-I
Major Course (DSC-3)
BT-113: Practical course based on Cell Biology and Biochemical Tools (Practical)

Total Hours: 60 (4/week) **Credits: 2**

Course objectives	▪ To make students familiar with safety measures in laboratory and common laboratory instruments ▪ To prepare normal, molar, percent and buffer solutions ▪ To study compound microscope and its parts ▪ To visualize cell and cell organelles under microscope ▪ To study various phases of mitosis using microscope	
Course Outcomes	**After successful completion of this course, students are expected to:**	**Cognitive Level**
	▪ understand safety measures in laboratory and principle and working of common laboratory instruments	2
	▪ prepare normal, molar, percent and buffer solutions	3
	▪ use, handle and take care of compound microscope	3
	▪ stain and visualize cell and cell organelles under microscope	3
	▪ identify various phases of mitosis under microscope	2

Sr. No.	Contents	Hours
1	First aid, Hazardous Chemicals, Antidotes to hazardous and toxic chemicals, Safety measures in laboratory	**04**
2	Handling and care of instruments: Autoclave, Laminar air flow, Centrifuges, spectrophotometer, weighing balance, pH meter, incubator, hot air oven	**04**
3	Handling, use and care of compound microscope	**04**
4	Study of cell organelles- temporary mounts/ permanent slides (e,g. Nucleus/ Golgi complex, ER/ chloroplast etc.)	**04**
5	Temporary mounting of available cells/tissues	**04**
6	Study the structure of plant cell through temporary mounting	**04**
7	Visualization of mitochondria by Janus green stain	**04**
8	Differential staining for DNA and RNA in human cheek epithelial cells	**04**
9	Study of various phases of mitosis using suitable sample	**04**
10	Preparation of standard solutions (Normal/ Molar/ Percentage)	**04**
11	Problems based on preparation of normal, molar and percent solutions	**04**
12	Preparation of std. 0.1N sodium carbonate solution and standardization of HCl solution	**04**
13	Preparation of std. 0.1N oxalic acid solution and standardization of NaOH solution	**04**
14	Preparation of buffers of desired pH and molarity.	**04**

15	Experimental verification of Beer's Law	**04**
Study Resources	▪ Wilson, K. and Walker, J. (2003). Practical Biochemistry: Principles and techniques, 5th edition, Cambridge University Press, UK. ▪ Plummer, D. T. (2017). An Introduction to Practical Biochemistry, 3rd edition, Tata McGraw Hill Publishing Company Ltd., New Delhi. ▪ Oser, B. L. (ed.) (1965). Hawk's physiological chemistry, 14th edition, McGraw-Hill Book Company, New York, USA. ▪ Jayaraman, J. (2011). Laboratory Manual in Biochemistry, New Age International (P) Ltd. Publishers, New Delhi. ▪ Sadashivam, S. and Manikam, A. (2018). Biochemical Methods, 3rd edition, New Age International (P) Ltd. Publishers, New Delhi. ▪ Rao, B. S. and Deshpande, V. (2005). Experimental Biochemistry: A student companion, I. K. International Pvt. Ltd., New Delhi. ▪ Cappuccino, J. G. and Sherman, N. (2014). Microbiology – a Laboratory Manual, 10th edition, Addison Wesley Publishing Company Inc., Boston, USA. ▪ Baker, F. J. (1967). Handbook of bacteriological techniques, 2nd edition, Butterworth & Co Publishers Ltd., UK. ▪ Oser, B. L. (ed.) (1965). Hawk's physiological chemistry, 14th edition, McGraw-Hill Book Company, New York, USA. ▪ Aneja, K. R. (2017). Experiments in Microbiology, Plant Pathology, and Biotechnology, 5th edition, New Age International (P). Ltd. Publishers, New Delhi. ▪ Gunasekaran, P. (2018). Laboratory Manual in Microbiology, 2nd edition, New Age International (P) Ltd. Publishers, New Delhi.	

Note: At least 12 experiments should be performed.

SEMESTER-I
Minor Course (MIN-1)
BT-114: Introduction to Biotechnology (Theory)

Total Hours: 30 (2/week) **Credits: 2**

Course Objectives	▪ Introduction of Biotechnology and its various applications in various fields ▪ To complement the students with routine biochemical tools microscopy adopted in biotechnology studies ▪ To make students understand ultra structure of the cell	
Course Outcomes	**After successful completion of this course, students are expected to:**	**Cognitive Level**
	▪ understand scope and applications of Biotechnology in various fields	2
	▪ understand the fundamental biochemical concepts like pH, buffers, solutions and its biological significance	2
	▪ understand parts of microscope and its working principle	2
	▪ understand ultra structure of the cell, cell organelles and their functions	2
Unit	**Contents**	**Hours**
Unit I	**Introduction and scope of Biotechnology** • Introduction to Biotechnology and historic perspectives • Scope of Biotechnology in Agriculture, Industry, Medical and Environment • Introduction to Genetic engineering, Bioinformatics and Nano-biotechnology • Applications of Biotechnology: Agriculture, Pharmaceutical, Environment, medicine and human health • Commercial opportunities in Biotechnology sector at national and International level	**07**
Unit II	**Basic Techniques in Biotechnology** • Solution, and types of solutions (homo and heterogeneous solutions), standard solutions. • Concept of pH, pOH, buffer system, types of buffer solutions, biological buffers • Concept of pKa and pH, pH scale • Basics of Microscopy: Magnification, Resolution, Numerical Aperture, Illumination system. • Principle with Ray diagram, Working and Significance of: Compound Microscope, Bright field and Dark filed Microscope, Phase Contrast microscope. • Micrometry: Occular micrometer, stage micrometer, calibration & measurement of cell size	**08**

Unit III	**Ultra structure of cell** • Definition of cell and its elemental composition • Characteristics of prokaryotic and eukaryotic cell • Comparative account on plant and animal cell • Structure and functions of - cell wall, cell membrane (Fluid Mosaic model), cytoplasm, mitochondria, golgi complex, endoplasmic reticulum (smooth and rough)., chloroplast, nucleus, ribosomes, lysosomes • Cell cycle and division: Mitosis and meiosis	**08**
Unit IV	**Cell Division** • Cell cycle: G-phase, S-phase and M-phase • Mitosis: concept and phases of mitosis • Significance of mitosis • Meiosis: concept, types and phases • Significance of meiosis • Comparative account on mitosis and meiosis	**07**
References	• Channarayappa (2006) Molecular Biotechnology: Principles and Practices, Universities Press Pvt. Ltd., Hyderabad • Wiley, JM, Sherwood, LM and Woolverton, CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hillnternational, New York • Frobisher M. Hinsdill, Crabtree and Goodheart (1974). Fundamentals of Microbiology, 9th edition, WB Saunder's Co. USA. • Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology of Microorganisms, 14th edition, Pearson International Edition, New Delhi • Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company, New York • Tortora, Funke and Case (2010). Microbiology, 10th edition, Brenjamin Cummings Inc, California. • Ulhas Patil, JS Kulkarni, AB Chaudhari and SB Chincholkar (2016). Foundations in Microbiology 9th edition, Nirali Prakashan, Pune • Modi, H. A. (2014) Elementary Microbiology, Vol. 1 and 2, Akshar Prakashan, Ahmedabad • Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments, 6th Edition, John Wiley& Sons. Inc. • De Robertis, E.D.P. and De Robertis, E.M.F. (2006) Cell and Molecular Biology, 8th edition, Lippincott Williams and Wilkins, Philadelphia. • Cooper, G.M. and Hausman, R.E. (2009) The Cell: A Molecular Approach, 5th edition, ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA. • Becker, W.M., Kleinsmith, L.J., Hardin, J. and Bertoni, • G.P. (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco. • Powar, C. B. and Daginawala, H. F. (2010). General Microbiology Vol. I and II, 2nd edition, Himalaya Publishing House, Mumbai • Powar, C.B. (2012). Cell Biology, 3rdedition, Himalaya Publishing House, Mumbai	

SEMESTER-I
Minor Course (MIN-2)
BT-115: Practical course based on Basic Techniques in Biotechnology (Practical)

Total Hours: 60 (4/week) **Credits: 2**

Course objectives	▪ To make students familiar with safety measures in laboratory and common laboratory instruments ▪ To prepare normal, molar, percent and buffer solutions ▪ To study compound microscope and its parts ▪ To visualize cell and cell organelles under microscope ▪ To study various phases of mitosis using microscope	
Course Outcomes	**After successful completion of this course, students are expected to:**	**Cognitive Level**
	▪ understand safety measures in laboratory and principle and working of common laboratory instruments	2
	▪ prepare normal, molar, percent and buffer solutions	3
	▪ use, handle and take care of compound microscope	3
	▪ stain and visualize cell and cell organelles under microscope	3
	▪ identify various phases of mitosis under microscope	2

Sr. No.	Contents	Hours
1	First aid, Hazardous Chemicals, Antidotes to hazardous and toxic chemicals, Safety measures in laboratory	**04**
2	Handling and care of instruments: Autoclave, Laminar air flow, Centrifuges, spectrophotometer, weighing balance, pH meter, incubator, hot air oven	**04**
3	Handling, use and care of compound microscope	**04**
4	Study of cell organelles- temporary mounts/ permanent slides (e,g. Nucleus/ Golgi complex, ER/ chloroplast etc.)	**04**
5	Temporary mounting of available cells/tissues	**04**
6	Study the structure of plant cell through temporary mounting	**04**
7	Visualization of mitochondria by Janus green stain	**04**
8	Differential staining for DNA and RNA in human cheek epithelial cells	**04**
9	Study of various phases of mitosis using suitable sample	**04**
10	Preparation of standard solutions (Normal/ Molar/ Percentage)	**04**
11	Problems based on preparation of normal, molar and percent solutions	**04**
12	Preparation of std. 0.1N sodium carbonate solution and standardization of HCl solution	**04**
13	Preparation of std. 0.1N oxalic acid solution and standardization of NaOH solution	**04**
14	Preparation of buffers of desired pH and molarity.	**04**

15	Experimental verification of Beer's Law	**04**
References	▪ Wilson, K. and Walker, J. (2003). Practical Biochemistry: Principles and techniques, 5th edition, Cambridge University Press, UK. ▪ Plummer, D. T. (2017). An Introduction to Practical Biochemistry, 3rd edition, Tata McGraw Hill Publishing Company Ltd., New Delhi. ▪ Oser, B. L. (ed.) (1965). Hawk's physiological chemistry, 14th edition, McGraw-Hill Book Company, New York, USA. ▪ Jayaraman, J. (2011). Laboratory Manual in Biochemistry, New Age International (P) Ltd. Publishers, New Delhi. ▪ Sadashivam, S. and Manikam, A. (2018). Biochemical Methods, 3rd edition, New Age International (P) Ltd. Publishers, New Delhi. ▪ Rao, B. S. and Deshpande, V. (2005). Experimental Biochemistry: A student companion, I. K. International Pvt. Ltd., New Delhi. ▪ Cappuccino, J. G. and Sherman, N. (2014). Microbiology – a Laboratory Manual, 10th edition, Addison Wesley Publishing Company Inc., Boston, USA. ▪ Baker, F. J. (1967). Handbook of bacteriological techniques, 2nd edition, Butterworth & Co Publishers Ltd., UK. ▪ Oser, B. L. (ed.) (1965). Hawk's physiological chemistry, 14th edition, McGraw-Hill Book Company, New York, USA. ▪ Aneja, K. R. (2017). Experiments in Microbiology, Plant Pathology, and Biotechnology, 5th edition, New Age International (P). Ltd. Publishers, New Delhi. ▪ Gunasekaran, P. (2018). Laboratory Manual in Microbiology, 2nd edition, New Age International (P) Ltd. Publishers, New Delhi.	

Note: At least 12 experiments should be performed.

SEMESTER-I
Open Elective Course (OE-1)
BT-116: Biotechnology for Human Welfare (Theory)

Total Hours: 30 (2/week) **Credits: 2**

Course Objectives	▪ To acquaint students with the applications of Biotechnology in various fields ▪ To make students understand the proper use of Biotechnology helps to improve human life	
Course Outcomes	**After successful completion of this course, students are expected to:**	**Cognitive Level**
	▪ explore applications of Biotechnology in various fields	2
	▪ understand industrial applications of enzymes	2
	▪ learn the role of Biotechnology in environmental pollution reduction	2
	▪ understand the applications of Biotechnology in improvement of agricultural practices	2
	▪ explore the role of Biotechnology in improving human health	2

Unit	Contents	Hours
Unit I	**Industry** • Protein engineering; enzyme and polysaccharide synthesis, activity and secretion, alcohol production • Industrial applications of enzymes: textile industry, breweries, food industry, supplements – single cell protein, • Vitamins, food processing - cheese, yoghurt making,	**07**
Unit II	**Environment** • Soil, water and air pollution- introduction • Waste management • Biodegradation of heavy metals, water cleaning, removing oil spills from water and soil. • Bioremediation, phytoremediation, biomining. • Chlorinated and non-chlorinated organ pollutant degradation • Degradation of hydrocarbons and agricultural wastes • Development of biodegradable polymers such as PHB and biofuels	**08**
Unit III	**Human Health** • Development of non-toxic therapeutic agents, recombinant therapeutics – insulin • Development of vaccines and recombinant live vaccines • Gene therapy and diagnostics, • Monoclonal antibodies production in *E. coli*, Antibiotic production • Human genome project.	**07**
Unit-IV	**Agriculture** • N_2 fixation, transfer of pest resistance genes to plants, interaction between plants and microbes; • Qualitative improvement of livestock- transgenic animals, animal vaccine	**08**

	production, increased milk production in milking animals, poultry and fishery. **Forensic Science** • Solving violent crimes such as murder and rape • Solving claims of paternity and theft etc. using various methods of DNA finger printing.	
References	• Peter F. Stanbury. (2009) Principles of Fermentation Technology, 2E, Elsevier India Pvt. Limited. • Patel, A. H., Industrial Microbiology, 2nd edition, (2016), Laxmi Publications, New Delhi. • Satyanarayan, U., (2009) Biotechnology, Books and Allied Pvt. Ltd. • Asthana D.K. and Asthana M. (2001), Environment: Problems and Solutions, S. Chand and Company Ltd, New Delhi. • Jogdand S.N. (2006), Environmental Biotechnology, 3rd Edn., Himalaya Publishing House, Mumbai. • Gupta P.K (2004), Biotechnology and Genomics, Rastogi Publication Meerut. • Freshney R. Ian (2006), Culture of Animal Cells: A Manual of Basic Techniques, John Wiley and Sons, Inc., New York.	

SEMESTER-I
Skill Enhancement Course (SEC-1)
BT-117: Basic Microbiology (Theory)

Total Hours: 30 (2/week) **Credits: 2**

Course Objectives	▪ To study various types of microorganisms and their characteristics ▪ To study growth, nutrition and isolation of microorganisms ▪ To study various methods of controlling microorganisms	
Course Outcomes	**After successful completion of this course, students are expected to:**	**Cognitive Level**
	▪ understand the basic microbial structure and structural and similarities and differences among various microbes.	2
	▪ know various culture media and their applications and also understand various physical and chemical means of sterilization.	2
	▪ know microbial techniques for isolation of pure cultures of bacteria, fungi and algae.	2
	▪ learn aseptic techniques and be able to perform routine culture handling task safely and effectively.	2
	▪ know the various physical and chemical growth requirements of bacteria	2

Unit	Contents	Hours
Unit I	**Historical development of Microbiology** • Spontaneous generation (abiogenesis) – Concept and experimental evidences to prove it • Discovery of Microscope • Germ theory of Fermentation • Germ theory of Disease: Koch's and Revere's postulate • Development of pure culture methods and preparation of Decimal Dilution, solidifying agent (potato, gelatin, agar agar) • Contribution(s) of the following scientists in the development of microbiology o Antonie von Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Martinus W. Beijerinck, Sergei N. Winogradsky, Selman A. Waksman, Paul Ehrlich, Elie Metchnikoff, Edward Jenner	**07**
Unit II	**Diversity of microorganisms** • Concept of microorganisms • Comparative account of prokaryotic and eukaryotic cells. • Morphology and cell structure of Bacteria, virus, Algae, Fungi, and Protozoa. • Classification of microorganisms: Whittaker's five kingdom system of classification, Microbial. Taxonomy, Microbial phylogeny and current classification of bacteria. • Morphological features of Bacteriophage	**07**

Unit III	**Microbial Growth and cultivation of microbes** • Concept of Culture: Pure culture, axenic culture, mixed culture. • Cultivation of microbes: Media and media ingredients (water, peptone, malt extract, meat extract, yeast extract, trace elements, growth factors). • Types of media: complex, synthetic, natural, selective, differential, enriched media. • Isolation methods: Streak Plate, Spread Plate, Pour Plate, stab inoculation. • Cultivation of fungi: Slide culture technique. • Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture	**08**
Unit-IV	**Control of microorganisms** • Concept of Sterilization, disinfectant, antiseptic, sanitizer, • Sterilization by filtration • Physical methods (Heat, radiation, filtration) and chemical (Ethylene oxide, formaldehyde) methods of sterilization. Biological indicators of sterilization • Definition of Disinfection, characteristics of ideal disinfectant, Mode of action of alcohol, phenolic compounds, halogen, heavy metals, H2O2, detergents.	**08**
References	• Alexopoulos, CJ, Mims CW, and Blackwell, M. (1996) Introductory Mycology, 4th edition, John and Sons, Inc., • Jay, JM, Loessner, MJ and Golden, DA. (2005) Modern Food Microbiology, 7th edition, CBS Publishers and Distributors, New Delhi • Kumar, HD. (1990) Introductory Phycology, 2nd edition, Affiliated East Western Press, • Madigan, MT, Martinko, JM and Parker, J. (2009) Brock Biology of Microorganisms, 12th edition, Pearson/Benjamin Cummings, • Pelczar, MJ, Chan ECS and Krieg NR. (1993) Microbiology, 5th edition, McGraw Hill Book Company, • Stanier, R Y, Ingraham, J L, Wheelis, M L, and Painter P R.(2005) General Microbiology, 5th edition, McMillan • Tortora, GJ, Funke, BR, and Case, CL. (2008) Microbiology: An Introduction, 9th edition, Pearson Education. • Willey, JM, Sherwood, LM, and Woolverton, CJ. (2008) Prescott, Harley and Klein's Microbiology, 7th edition, McGraw Hill Higher Education,	

SEMESTER-II
Major Course (DSC-4)
BT-121: Biomolecules (Theory)

Total Hours: 30 (2/week) **Credits: 2**

Course Objectives	▪ To acquaint students with chemistry of biomolecules ▪ To make students understand the importance of biomolecules in life	
Course Outcomes	**After successful completion of this course, students are expected to:**	**Cognitive Level**
	▪ differentiate between monomers and polymers	2
	▪ compare and contrast the structure and function of the oligo and polysaccharides	2
	▪ summarize the functions of proteins and able to recognize the importance of the three dimensional shape of a protein in its function	2
	▪ compare and contrast saturated, mono-unsaturated, and poly-unsaturated fatty acids	2
Unit	**Contents**	**Hours**
Unit I	**Carbohydrates** • Definition, classification (glyceraldehydes, SimpleAldose, Simple Ketoses, D-glucose, Conformation of D- glucose) and biological functions of carbohydrates. • D and L isomers, dextrorotatory and levorotatory, reducing sugar and mutarotation • Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides, Homo- and Hetero- • Polysaccharides, Mucopolysaccharides, • Structure and biological significance of lactose, sucrose and maltose • Polysaccharides: Homopolysaccharides- Cellulose, Glycogen and Starch, Heteropolysaccharides- hyaluronic acid, heparin, chondroitin sulfate	**08**
Unit II	**Lipids** • Classification, nomenclature and properties of fatty acids, saturated and unsaturated fatty acids. • Definition, classification and biological functions of simple, compound and derived lipids • Structure and biological significance of phospholipid and cholesterol, Saturated (palmetic acid), Non-saturated (oleic acid), Use as signal, cofactor, pigment	**07**
Unit III	**Proteins** • Amino acids: Definition, general structure, physical and chemical properties, classification based on structure, nutrition and metabolic fate	**08**

	• Protein: primary, secondary, tertiary and quaternary structure • Bonds stabilizing structural conformation of proteins • Classification of proteins based on shape, composition and solubility, biological functions and nutrition • Denaturation and renaturation of proteins.	
Unit IV	**Nucleic acids** • Definition and types of nucleic acid-DNA and RNA • Structural Components of Nucleic acids: phosphoric acid, pentose sugar, nitrogenous bases - purines and pyrimidine • Nucleosides- deoxyribonucleosides, ribonucleosides and Nucleotides- deoxyribonucleotides, ribonucleotides • DNA: formation of 3'5'-phosphodiester bond, structure (Watson and Crick Model), Chargaff's Rule. • Denaturation of DNA: definition and its effect on UV absorption, viscosity, and specific optical rotation. • Effect of pH and temperature on DNA denaturation, definition of renaturation of DNA. • RNA: Structure and Significance of: mRNA, tRNA and rRNA.	**07**
References	• Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006) Biochemistry, VI Edition, W.H Freeman and Co. • Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants, American Society of Plant Biologists. • Nelson, D.L., Cox, M.M. (2004) Lehningers' Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA. • Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology, John Wiley and Sons, • Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd. • Satyanarayana, U. and Chakrapani U. (2010) Biochemistry, Books and Allied Pvt. Ltd., Kolkata, India. • Agarwal, G. R. Agarwal K., Agarwal O. P. (2005) Text Book of Biochemistry, 13th edn., Goel Publishing House, Krishna Prakashan Media Pvt. Ltd., Meerut, India. • Jain, J.L., Jain,S. and Jain,N. (2005) Fundamentals of Biochemistry, 6th edn., S. Chand and Company Ltd., Delhi.	

SEMESTER-II
Major Course (DSC-5)
BT-122: Ancient Science (IKS) (Theory)

Total Hours: 30 (2/week) **Credits: 2**

Course Objectives	▪ To make students understand the role and importance of ancient knowledge in science and technology ▪ To make students understand IKS approach to Healthcare, Medicine, Microbiology, Surgery, and Yoga etc. ▪ To explain importance of holistic health care system through Ayurved	
Course Outcomes	**After successful completion of this course, students are expected to:**	**Cognitive Level**
	▪ learn importance of ancient bhartiya scientific knowledge and its utility in current scenario.	2
	▪ understand the significance of study of science & technology and their potential application	2
	▪ exlain the meaning of Ayurveda and exemplify tridosh with elaboration	2
	▪ elaborate the importance of life style management through ayurvedic practices	2

Unit	Contents	Hours
Unit I	**Science and technology in ancient India** • Introduction and importance of IKS • Contribution of ancient Indian scientist in science and technology • Concept of Matter, Life and Universe, Gravity • Sage Agastya's Model of Battery • Laboratory and Apparatus • Dyes, Paints and Metallurgy • Velocity of Light • Sun, Earth, Moon, and Eclipses, Earth is Spherical and Rotation of Earth • Concepts of Zero and Pi, Number System	**08**
Unit II	**Importance of IKS in life science** • Ethnic Studies • Life Science in Plants, Anatomy, Physiology, Agriculture, Ecology and Environment, • Ayurveda, Integrated Approach to Healthcare, Medicine, Microbiology, Surgery, and Yoga, etc.	**07**
Unit III	**Tridosha** • Definition and meaning of Ayurveda • Charak sahita main points only. • The concept of tridosha and its effect on body	**08**

	• The concept of holistic health care • Psychosometic aspects and health • Brief on Diagnosis and treatment in Ayurveda.	
Unit IV	**Ayurveda and Healthcare** • Life style management through Ayurveda. • Water, food, and system of digestion related aspects: • Satva, Rajas, Tamas, and qualities of a person. • Health care through Ayurveda • Contribution of Vaghbhatt and Madhav in brief.	**07**
References	• Charak Sahita, CHAUKHAMBHA PRAKASHAK • An Introduction to Indian Knowledge Systems: Concepts and Applications, B Mahadevan, V R Bhat, and Nagendra Pavana R N; 2022 (Prentice Hall of India). • Indian Knowledge Systems: Vol I and II, Kapil Kapoor and A K Singh; 2005 (D.K. Print World Ltd). • Vedic Science and Technology, Biswal Sadasiva; 2009 (D.K. Printworld (P) Ltd) • Ancient Indian Science and its Relevance to the Modern World, Prof. K.E. Govindan; 2009 (ashtriya Sanskrit Vidyapeetha) • Vedic Science and History - Ancient Indian's Contribution to the Modern World, Swami B.B. Vishnu; 2018 • Science and Technology in Ancient Indian Texts, Various Authors • Pride of India- A Glimpse of India's Scientific Heritage edited by Pradeep Kohle et al. Samskrit Bharati; 2006 • Ancient Indian Sciences, Swami Chidatman Jee Maharaj • Ancient Indian Scientific Thought and Modern Theories, Sanjit Kumar Sadhukhan • https://archive.org/ • https://web.archive.org/web/2/http://ayurved-online.com/	

SEMESTER-II
Major Course (DSC-6)
BT-123: Practical course based on Biomolecules (Practical)

Total Hours: 60 (4/week) **Credits: 2**

Course Objectives	▪ To acquaint students with various techniques used like extraction, detection, estimation and separation ▪ To develop skill-full hand of the students	
Course Outcomes	**After successful completion of this course, students are expected to:**	**Cognitive Level**
	▪ perform qualitative tests for carbohydrates, lipids and amino acids	3
	▪ extract carbohydrate and proteins	3
	▪ estimation carbohydrates, nucleic acids and proteins	3
	▪ separate carbohydrates and amino acids by paper chromatography	3
Sr. No.	**Contents**	**Hours**
1	Qualitative tests for carbohydrates	**04**
2	Qualitative tests for amino acids	**04**
3	Qualitative tests for lipids	**04**
4	Qualitative test for amylase	**04**
5	Extraction and detection of Starch from Potatoes/ maize	**04**
6	Extraction and detection of Casein from milk	**04**
7	Estimation of protein by Biuret method	**04**
8	Estimation of carbohydrates by DNSA method	**04**
9	Quantitative determination of DNA by spectrophotometric method and its purity check	**04**
10	Quantitative determination of RNA by spectrophotometric method and its purity check	**04**
11	Thermal denaturation of DNA	**04**
12	Estimation of DNA by DPA method	**04**
13	Estimation of RNA by Orcinol method	**04**
14	Separation of amino acids by paper chromatography	**04**
15	Separation of carbohydrates by paper chromatography	**04**
References	▪ Wilson, K. and Walker, J. (2003). Practical Biochemistry: Principles and techniques, 5th edition, Cambridge University Press, UK. ▪ Plummer, D. T. (2017). An Introduction to Practical Biochemistry, 3rd edition, Tata McGraw Hill Publishing Company Ltd., New Delhi. ▪ Oser, B. L. (ed.) (1965). Hawk's physiological chemistry, 14th edition, McGraw-Hill	

	Book Company, New York, USA. ▪ Jayaraman, J. (2011). Laboratory Manual in Biochemistry, New Age International (P) Ltd. Publishers, New Delhi. ▪ Sadashivam, S. and Manikam, A. (2018). Biochemical Methods, 3rd edition, New Age International (P) Ltd. Publishers, New Delhi. ▪ Rao, B. S. and Deshpande, V. (2005). Experimental Biochemistry: A student companion, I. K. International Pvt. Ltd., New Delhi.	

Note: At least 12 experiments should be performed.

SEMESTER-II
Minor Course (MIN-3)
BT-124: Molecules of Life (Theory)

Total Hours: 30 (2/week) **Credits: 2**

Course Objectives	▪ To acquaint students with chemistry of biomolecules ▪ To make students understand the importance of biomolecules in life	
Course Outcomes	**After successful completion of this course, students are expected to:**	**Cognitive Level**
	▪ Differentiate between monomers and polymers	2
	▪ Compare and contrast the structure and function of the oligo and polysaccharides	2
	▪ Summarize the functions of proteins and able to recognize the importance of the three dimensional shape of a protein in its function	2
	▪ Compare and contrast saturated, mono-unsaturated, and poly-unsaturated fatty acids	2

Unit	Contents	Hours
Unit I	**Carbohydrates** • Definition, classification (glyceraldehydes, Simple Aldose, Simple Ketoses, D-glucose, Conformation of D-glucose) and biological functions of carbohydrates. • D and L isomers, dextrorotatory and levorotatory, reducing sugar and mutarotation • Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides, Homo- and Hetero- polysaccharides, Mucopolysaccharides, • Structure and biological significance of lactose, sucrose and maltose • Polysaccharides: Homopolysaccharides- Cellulose, Glycogen and Starch, Heteropolysaccharides- hyaluronic acid, heparin, chondroitin sulfate	**08**
Unit II	**Lipids** • Classification, nomenclature and properties of fatty acids, saturated and unsaturated fatty acids. • Definition, classification and biological functions of simple, compound and derived lipids • Structure and biological significance of phospholipid and cholesterol, Saturated (palmetic acid), Non-saturated (oleic acid), Use as signal, cofactor, pigment	**07**
Unit III	**Proteins** • Amino acids: Definition, general structure, physical and chemical properties, classification based on structure, nutrition and metabolic fate • Protein: primary, secondary, tertiary and quaternary structure	**08**

	• Bonds stabilizing structural conformation of proteins • Classification of proteins based on shape, composition and solubility, biological functions and nutrition • Denaturation and renaturation of proteins.	
Unit IV	**Nucleic acids** • Definition and types of nucleic acid-DNA and RNA • Structural Components of Nucleic acids: phosphoric acid, pentose sugar, nitrogenous bases - purines and pyrimidine • Nucleosides- deoxyribonucleosides, ribonucleosides and Nucleotides-deoxyribonucleotides, ribonucleotides • DNA: formation of 3'5'-phosphodiester bond, structure (Watson and Crick Model), Chargaff's Rule. • Denaturation of DNA: definition and its effect on UV absorption, viscosity, and specific optical rotation. • Effect of pH and temperature on DNA denaturation, definition of renaturation of DNA. • RNA: Structure and Significance of: mRNA, tRNA and rRNA.	**07**
References	• Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006) Biochemistry, VI Edition, W.H Freeman and Co., • Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants, American Society of Plant Biologists. • Nelson, D.L., Cox, M.M. (2004) Lehningers' Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA. • Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology, John Wiley and Sons, • Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd. • Satyanarayana, U. and Chakrapani U. (2010) Biochemistry, Books and Allied Pvt. Ltd., Kolkata, India. • Agarwal, G. R. Agarwal K., Agarwal O. P. (2005) Text Book of Biochemistry, 13th edn., Goel Publishing House, Krishna Prakashan Media Pvt. Ltd., Meerut, India. • Jain, J.L., Jain,S. and Jain,N. (2005) Fundamentals of Biochemistry, 6th edn., S. Chand and Company Ltd., Delhi.	

SEMESTER-II
Minor Course (MIN-4)
BT-125: Practical course based on Molecules of Life (Practical)

Total Hours: 60 (4/week) **Credits: 2**

Course Objectives	▪ To acquaint students with various techniques used like extraction, detection, estimation and separation ▪ To develop skill-full hand of the students	
Course Outcomes	**After successful completion of this course, students are expected to:**	**Cognitive Level**
	▪ perform qualitative tests for carbohydrates, lipids and amino acids	3
	▪ extract carbohydrate and proteins	3
	▪ estimation carbohydrates, nucleic acids and proteins	3
	▪ separate carbohydrates and amino acids by paper chromatography	3
Sr. No.	**Contents**	**Hours**
1	Qualitative tests for carbohydrates	**04**
2	Qualitative tests for amino acids	**04**
3	Qualitative tests for lipids	**04**
4	Qualitative test for amylase	**04**
5	Extraction and detection of Starch from Potatoes/ maize	**04**
6	Extraction and detection of Casein from milk	**04**
7	Estimation of protein by Biuret method	**04**
8	Estimation of carbohydrates by DNSA method	**04**
9	Quantitative determination of DNA by spectrophotometric method and its purity check	**04**
10	Quantitative determination of RNA by spectrophotometric method and its purity check	**04**
11	Thermal denaturation of DNA	**04**
12	Estimation of DNA by DPA method	**04**
13	Estimation of RNA by Orcinol method	**04**
14	Separation of amino acids by paper chromatography	**04**
15	Separation of carbohydrates by paper chromatography	**04**
References	▪ Wilson, K. and Walker, J. (2003). Practical Biochemistry: Principles and techniques, 5th edition, Cambridge University Press, UK. ▪ Plummer, D. T. (2017). An Introduction to Practical Biochemistry, 3rd edition, Tata McGraw Hill Publishing Company Ltd., New Delhi. ▪ Oser, B. L. (ed.) (1965). Hawk's physiological chemistry, 14th edition, McGraw-	

	Hill Book Company, New York, USA. ▪ Jayaraman, J. (2011). Laboratory Manual in Biochemistry, New Age International (P) Ltd. Publishers, New Delhi. ▪ Sadashivam, S. and Manikam, A. (2018). Biochemical Methods, 3rd edition, New Age International (P) Ltd. Publishers, New Delhi. ▪ Rao, B. S. and Deshpande, V. (2005). Experimental Biochemistry: A student companion, I. K. International Pvt. Ltd., New Delhi.	

Note: At least 12 experiments should be performed.

SEMESTER-II
Open Elective Course (OE-2)
BT-126: Medical Biotechnology (Theory)

Total Hours: 30 (2/week) **Credits: 2**

Course Objectives	▪ To create awareness about the infectious diseases ▪ To create theoretical base for practical approaches ▪ To study prognosis of bacterial, viral and other diseases	
Course Outcomes	**After successful completion of this course, students are expected to:**	**Cognitive Level**
	▪ Become aware about the various types of diseases and their sources	2
	▪ Justify the variation between viral, bacterial and other diseases	2
	▪ Explain prognosis of diseases and understand the role of medical microbiology in public health	2

Unit	Contents	Hours
Unit I	**Basic concepts in Medical Biotechnology** • Commensal and Pathogenic Human Microflora - normal microflora of the human body, dual nature of normal flora with respect to disease • Classification of disease – infectious, communicable, contagious, nosocomial, iatrogenic & zoonotic diseases • Chain of infection -Portal of entry and exit of pathogen • Stages of infectious diseases and virulence factors • Transmission of disease – Modes of transmission • Epidemiology of disease	**08**
Unit II	**Viral infections and diseases** • Study of diseases with respect to causative agent, infectious dose, portal of entry, pathogenicity, epidemiology, laboratory diagnosis, prophylaxis, treatment, prevention and control of the following: o AIDS o Picornavirus disease –Poliomyelitis o Rhabdovirus disease – Rabies o Hepadnavirus diseases –Hepatitis A, B and C o Corona virus disease	**07**
Unit III	**Bacterial Infections and diseases** • Study of diseases with respect to causative agent, infectious dose, portal of entry, pathogenicity, epidemiology, laboratory diagnosis, prophylaxis, treatment, prevention and control of the following: o Respiratory disease: Tuberculosis o Gastrointestinal diseases: Typhoid & Cholera o Bacterial disease affecting the brain and nervous system: Tetanus	**08**

	○ Sexually transmitted bacterial disease: Syphilis	
Unit IV	**Fungal and Protozoal diseases** • Study of diseases with respect to causative agent, infectious dose, portal of entry, pathogenicity, epidemiology, laboratory diagnosis, prophylaxis, treatment, prevention and control of the following: ○ Cutaneous mycoses: Dermatophytosis, Tinea Pedis (Athlete's foot) ○ Systemic mycoses: Histoplasmosis ○ Opportunistic mycoses: Candidiasis ○ Protozoal diseases: Malaria & Amoebic dysentery	**07**
References	• Ananthnarayan, P., Paniker, C. K. J., (2009), Ed 8th Textbook of Microbiology, Universities press, Hyderabad. • Atlas, R. M. (1995), Microorganisms in our world, Mosby Year Book Inc. • Chakraborty P (2013), A text book of Microbiology, New Central Book Agency, Delhi. • Davis, B. D., Dulbecco, R, Eisen, H. N., Ginsberg, R. S., (1990), Microbiology, 4th Ed., Harper and Row Publishers, Singapore. • Dey, N. C. and Dey, T. K., (1999), Medical Bacteriology and Microbiology, 16th Ed, Allied Agency, Calcutta. • Nagoba BS and Pichare Asha (2012), Medical Microbiology: Prep Manual for Under Graduates, Elsevier • Prescott, L. M., Hartley, J. P. and Klein, D. A., (1993), Microbiology, 2nd Ed., W. M. C. Brown Publishers, England. • Tortora, G. J., Funke, B. R. and Case, C. L., (2004), Microbiology, 8th Ed., Person • Education (Low Price edition), Delhi. • http://www.who.ch.: World Health Organization • http://www.ncbi.nlm.nih.gov/PubMed:PubMed -Medline on the Web. • http://www.cdc.gov: US Centre for Disease Control (Atlanta) • http://www.who.int/emc/ : WHO Communicable Disease Surveillance and Response	

SEMESTER-II
Skill Enhancement Course (SEC-2)
BT-127: Advanced Microbiology (Theory)

Total Hours: 30 (2/week) **Credits: 2**

Course Objectives	▪ To accustom students with various microscopic techniques used for visualization of microbes ▪ To study various types of staining methods ▪ To acquaint students with various microbial isolation methods and biochemical techniques used for microbial identification ▪ To study sterilization and microbial preservation methods	
Course Outcomes	**After successful completion of this course, students are expected to:**	**Cognitive Level**
	▪ Understand and explore various microscopic techniques used for visualization of microbes	2
	▪ Perform various types of staining methods for studying micro-organisms	3
	▪ Isolate and identify micro-organisms by various methods	3
	▪ Sterilize the equipments and preserve micro-organisms	3
Unit	**Contents**	**Hours**
Unit I	**Growth, Nutrition and Isolation of Microorganisms** ▪ Concept of growth. Growth curve – lag, log, stationary and death phase. ▪ Mathematical expression of growth – growth rate and generation time. ▪ Measurement of growth o Methods for determination of cell number- direct (breed method, counting chamber method, Coulter method) and indirect (total viable count) o Determination of cell mass – direct (measurement of dry weight of cell, measurement of cell nitrogen) and indirect (turbidometric) methods. o Determination of cell activity ▪ Nutritional classification of microorganisms. ▪ Media –ingredients, types on the basis of physical state, composition and use. ▪ Methods of isolation of bacteria on solid media – streakplate method, pour plate method, roll tube method andspread plate method.	**08**
Unit II	**Staining Techniques** ▪ Concepts of Dyes and Stains ▪ Types of stain (Acidic, Neutral and Basic) ▪ Mordant and fixative ▪ Preparation and fixation of smear ▪ Principles, procedures and interpretation of staining techniques:	**07**

	○ Simple staining • Monochrome and Negative staining ○ Differential staining • Gram's staining and Acid fast staining (Ziehl Neelsen staining) ○ Special staining • Spore staining & staining of metachromatic granules **Biochemical and Molecular tests for Identification of Microorganisms** ▪ Biochemical tests for Identification of microorganisms: Concepts, principles, procedures and interpretation: ○ Catalase Test ○ Starch hydrolysis test ○ Nitrate reductase test ○ Urease test ○ Casein hydrolysis test ○ Tyrosine hydrolysis test ○ IMViC test ○ TSI test ○ Sugar fermentation acid and gas production test ▪ Molecular test- 16s rRNA	
Unit III	**Sterilization Techniques** ▪ Definitions- sterilization, disinfection, antisepsis,sanitization, decontamination, pasteurization, preservation,germicidal and bactericides ▪ Sterilization ○ Heat- thermal death point, thermal death time,decimal reduction time • Moist heat- mode of action, steam underpressure, Fractional sterilization, Boilingwater, Pasteurization and canning • Dry heat- mode of action, incineration, hotair oven ○ Radiation- ionizing radiations, non-ionizingradiations ○ Chemical sterilization- ethylene oxide,formaldehyde ○ Filtration ▪ Factors influencing sterilization. ▪ Disinfection: characteristics of an ideal disinfectant ▪ Disinfectants- phenol and phenolic compounds,alcohol, heavy metals, halogens, dyes, detergents,hydrogen peroxide	**08**
Unit IV	**Preservation Techniques** ▪ Preservation: Concept, Definition and purpose ▪ Preservation in continuous metabolic active state: ○ Short-term preservation (Agar slants, Agar stabs), ○ Long-term preservation (Glycerol stocks, Mineral oil, Storage in soil), ▪ Suspended metabolic state: ○ Freeze drying (Lyophilization)	**07**

	○ Drying in vacuum ○ Cryopreservation ○ Storage in silica gel ▪ Quality control of preserved stock cultures	
References	▪ Madigan, M. T., Bender, K. S., Buckely, D. H., Sattley, W. M. and Stahl, D. A. (2018). Brock Biology of Microorganisms, NY Pearosn publisher. ▪ Talaro, K. P. and Chess, B. (2020). Foundations In Microbiology, 11th McGraw Hill. ▪ Tortora, G. J., Funke, B. R. and Case, C. L. (2018). Microbiology An Introduction, 13th edition, pearson Benjamin-Cummings Pub Co. ▪ Pelczar, M. J. Jr, Chan, E. C. S. and Krieg, N. R. (1985). Microbiology, 5th edition, Tata McGraw-Hill Education Pvt. Ltd, India ▪ Wiley, J. M., Sherwood, L. M. and Woolverton, C. J. (2017). Prescott's Microbiology 10th edition, McGrawHill International, USA. ▪ Aneja, K. R. (2017). Experiments in Microbiology, Plant Pathology, and Biotechnology, 5th edition, New Age International (P) Ltd. Publishers, New Delhi. ▪ Modi, H. A. (2019).A Handbook of Elementary Microbiology, Shanti Prakashan. ▪ Kale, V. and Bhusari, K. (2010). Practical Microbiology: Principles and Techniques, Himalaya Publishing House. ▪ Rajgopal, G. and Toora, B. D. (2020). Practical Biochemistry, 4th edition, Ahuja Publishing House. ▪ Maheshwari, D. K. (2012). Practical Microbiology, 3rd edition, S. Chand Publishing. ▪ Rajan, S. and Christy, S. R. (2015). Experimental procedures in Life Sciences, CBS Publishers and Distributors Pvt Ltd.	

SEMESTER-II
Skill Enhancement Course (SEC-3)
BT-128: Practical course based on Advanced Microbiology (Practical)

Total Hours: 60 (4/week) **Credits: 2**

Course Objectives	▪ To acquaint students with micrometry ▪ To study various types of staining techniques ▪ To make students familiar with various biochemical tests for identification of microorganisms To accustom students with microorganism preservation techniques	
Course Outcomes	**After successful completion of this course, students are expected to:**	**Cognitive Level**
	▪ Determine the size of bacteria	3
	▪ Perform various staining techniques like monochrome, negative, Gram staining etc.	3
	▪ Identify micro-organisms using various biochemical tests	3
	▪ Learn preservation of microorganism	2

Sr. No.	Contents	Hours
1	Preparation of culture media for bacterial cultivation (Nutrient broth and nutrient agar/ MacConkeys broth and MacConkeys agar).	**04**
2	Isolation and culture characterization of bacteria by streak plate techniques	**04**
3	Determination of viable count by spread plate method from water/soil sample	**04**
4	Determination of viable count by pour plate method from water/soil sample	**04**
5	Study of bacterial morphology using Monochrome staining	**04**
6	Study of bacterial morphology using negative staining	**04**
7	Study of Gram characteristics of bacteria using Gram's staining	**04**
8	Study of acid fast charactristics of bacteria using Acid fast staining Nocardia spp/ Atypical mycobacteria)	**04**
9	Study of fungal morphology using lacto phenol cotton blue stain	**04**
10	Determination of microorganism size by micrometry	**04**
11	Biochemical Characterization of Bacteria– IMViC test	**04**
12	Preservation of bacterial culture by suitable method	**04**
13	Study of Algae/BGA temporary mounts/ permanent slides (e,g. Spirogyra /Anabena / Nostoc/ Cyanobacteria)	**04**
14	Study of Fungus e.g.. Rhizopus/ Penicillium/ Aspergillus/ Fusarium using temporary mounts / permanent slides	**04**
15	Study of Protozoans e.g. Amoeba/Entamoeba/ Paramecium / Plasmodium using temporary mounts / permanent slides	**04**

References	▪ Cappuccino, J. G. and Sherman, N. (2014). Microbiology – a Laboratory Manual, 10th edition, Addison Wesley Publishing Company Inc., Boston, USA. ▪ Baker, F. J. (1967). Handbook of bacteriological techniques, 2nd edition, Butterworth & Co Publishers Ltd., UK. ▪ Oser, B. L. (ed.) (1965). Hawk's physiological chemistry, 14th edition, McGraw-Hill Book Company, New York, USA. ▪ Aneja, K. R. (2017). Experiments in Microbiology, Plant Pathology, and Biotechnology, 5th edition, New Age International (P) Ltd. Publishers, New Delhi. ▪ Gunasekaran, P. (2018). Laboratory Manual in Microbiology, 2nd edition, New Age International (P) Ltd. Publishers, New Delhi.	

Note: At least 12 experiments should be performed.

Skills acquired and Job prospectus for the Biotechnology students

Biotechnology, being part of Life Science, has established as advanced interdisciplinary applied science. The interdisciplinary networking potential of biotechnology has given it a separate status in fundamental research as well as in modern industrial enterprise. Global and local focus has slowly shifted current knowledge-based system to technology driven development and application in life sciences. In the milieu of research and industrialization for economic development and social renaissance, biotechnology emerged out as a major tool to work.

The interdisciplinary nature of biotechnology integrates living systems including animal, plant and microbes and studies from (i) molecular biology to cell biology, (ii) biochemistry to biophysics, (iii) genetic engineering to stem cell research, (iv) bioinformatics to genomics proteomics, (v) environmental biology to biodiversity, (vi) microbiology to bioprocess engineering, (vii) bioremediation to material transformation and so on. The application of the studies on cell bioprocesses is covered with the help of technology. Green, blue and white revolution was possible due to intrinsic understanding of biotechnology. The integration of various courses in the program is aimed to develop proficiency in the theory as well as practical experiments, common equipment, laboratory, along with the collection and interpretation and presentation of scientific data in proper manner. Beside this, the students will be equipped with knowledge in the newer areas of biotechnology and its application in medical science, agriculture, industry, proteomics, genomics, metabolomics, bioinformatics, nano-biotechnology etc. This will create awareness about biotechnology. At the end of the course, the students are expected to have good working knowledge in the field of Biotechnology. Students will surely have an urge to continue higher studies in Biotechnology and contribute significantly in the development.

Biotechnologists are always in demand as an efficient work force in fundamental research and industries. Education and research sectors require such interdisciplinary trained workforce to develop future generations of science leaders. Career opportunities for graduate students are created and expanding at the biotechnology parks and in manufacturing industries, teaching, research institutes and IT industry.