Rayat Shikshan Sanstha's

SADGURU GADAGE MAHARAJ COLLEGE, KARAD.

(An Empowered Autonomous college)

Accredited By NAAC with 'A^{+} (3.63 CGPA)' Grade

ISO- 9001-2015 Certified

Affiliated to Shivaji University, Kolhapur

Bachelor of Science (B. Sc. II)

DEPARTMENT OF BIOTECHNOLOGY (ENTIRE)

Under the Faculty of Science and Technology
Choice Based Credit System (CBCS)

Regulations in accordance with **National Education Policy**
to be implemented from Academic Year 2024-25

Syllabus For

B. Sc. Part – II (Biotechnology-Entire)

SEMESTER III & IV

(Syllabus to be implemented from June 2024)

Rayat Shikshan Sanstha's

SADGURU GADAGE MAHARAJ COLLEGE, KARAD.

(An Empowered Autonomous College)

Regulations and Guidelines as per NEP 2020

Choice Based Credit System (CBCS) Syllabus for Bachelor of Science Part- II (Biotechnology-Entire)

1. **Title:** B.Sc. II Biotechnology (Entire)
2. **Year of Implementation:** 2024-25
3. **Duration:** One Year
4. **Pattern:** Semester wise CBCS
5. **Medium of Instruction:** English
6. **Structure of Course:**
   a. **Semester III:**

      Theory: 07

      Practical's: 03

   b. **Semester IV:**

      Theory: 07 Papers

      Practical's: 03

7. **Examination Pattern:**

❖ Internal Evaluation for Theory Paper: **10 Marks**

i) **Semester-I: Semina**r only for one of the major subject (Seminar topic: As per the choice of students from any area which is under the Biotechnology, Submission of seminar synopsis is compulsory), **Unit test** for all remaining papers (Excluding: Environmental science and Democracy)

ii) **Semester-II: Industrial Case study** only for one of the major subject (Students should visit to biological firm other than their working days and make a report and should submit their report to the department), **Unit test** for all remaining papers (Excluding: Environmental science and Yoga)

iii) Each Theory paper having a **40 Marks (For Yoga 50 marks theory exam, long and short questions only))**

-Nature of Theory Question Paper:

Q.1- Multiple Choice Questions (All are compulsory) : 08 Marks

Q.2- Long Questions (2 out of 3) : 16 Marks

Q.3- Short Notes (4 out of 6) : 16 Marks

Total : 40 Marks

- Practical Examination will be conducted semester wise of **50 Marks** for minor and **100 Marks** for Major subject.

- Practical Exam Question Paper Nature (Minor paper):

Q.1 (a) – Major Experiment : 10 Marks
Q.1 (b) – Minor Experiment : 05 Marks
Q.2 (a) – Major Experiment : 10 Marks
Q.2 (b) – Minor Experiment : 05 Marks
Q.3 Spotting (5 Spot) : 05 Marks
Q.4 Viva voce : 05 Marks
Q.5 Certified Journal : 05 Marks
Q.6 Tour Report/ Case Study : 05 Marks

Total : 50 Marks

- Practical Exam Question Paper Nature (Major paper):

Q.1 (a) – Major Experiment : 20 Marks
Q.1 (b) – Minor Experiment : 10 Marks
Q.2 (a) – Major Experiment : 20 Marks
Q.2 (b) – Minor Experiment : 10 Marks
Q.3 Spotting (5 Spot) :10 Marks
Q.4 Viva voce : 10 Marks
Q.5 Certified Journal : 10 Marks
Q.6 Tour Report/ Case Study :10 Marks

Total : 100 Marks

8. Preamble:

Biotechnology is a field that combines basics of life science (biology) and technology. It has been one of the most fast-growing fields in last few decades. Biotechnology can be classified in four categories – green biotechnology (agricultural biotechnology), white biotechnology (industrial biotechnology), red biotechnology (medical biotechnology) and blue biotechnology (marine biotechnology). With development of advanced techniques such gene editing and gene manipulations biotechnology can also be divided as conventional biotechnology and advanced biotechnology/modern biotechnology. Conventional Biotechnology involves usage of natural resources such as plants, animals, microorganisms at optimum conditions to obtain higher yields of commercially important products of biological origin. In Modern Biotechnology genetic engineering

approach is used to obtain high yielding recombinants to obtain commercially important products of biological origin. Stem cell research, Tissue engineering, Site specific drug delivery techniques are examples of Modern Biotechnology. The realm of Biotechnology involves understanding and application of basic sciences such as Physics, Chemistry and Mathematics as well as applied sciences such as Microbiology, Food technology, Bioinformatics, Recombinant DNA technology. State of the art technologies such as Artificial Intelligence and Machine learning are now being explored for their application in Biotechnology. Biotechnology is one such course that provides an educational environment where STEM- Science Technology Engineering and Mathematics are not only taught but practiced together. India has recently implemented its NEP2020- New educational policy. One of the major objectives of NEP is to bridge gaps in education and industry by empowering the students by providing them with training in skill-based courses. To provide such training there is a need to develop courses/syllabi with subjects which provide knowledge about the current and most relevant technologies. Along with the training of basics of core subject the students need to be exposed to subjects such as entrepreneurship and intellectual property rights to inculcate interest in product development. The proposed credit-based curriculum ensures the requirement of academia and industry. Theory supplemented with extensive practical skill sets will help a graduate student to avail the opportunities in the applied fields (research, industry or institutions) without any additional training. Benefit of society and sustainable development. The policy mainly focuses on flexibility in education, multidisciplinary approach, creativity, developing critical thinking and critical thinking. Keeping these mottos in mind, the new syllabi has been designed which will also help students to develop skill sets required when Biotechnology is chosen as a career.

4. Programme Outcomes:

- To introduce different Biotechnological aspects.
- To develop aptitude of students in the field of research.
- To impart knowledge in basic and applied aspects of life sciences
- To make students aware of various applications of Biotechnology and develop their practical skill sets.
- To inculcate scientific, social and environmental awareness in students

5. General Objectives:

- Enrichment of basic knowledge in areas of Biotechnology
- Reconstruction and redesigning of the courses to suite local needs.
- To develop aptitude of students in the field of research.
- More emphasis on applied aspects of biotechnology.

Sem.	DSC (Major)		DSE (Minor-I)	O E/ G E	AEC (Language)	Value Added Courses	SEC	CC	Summer Internship	Research Project / Dissertation	Total Credits
	Mandatory	Elective									
III	N-MJT-BT-301 (Metabolic Pathway) (2) --- N-MJT-BT-302 (Molecular Biology-I) (2) --- N-MJP-BT-303 (Lab. Exercises in Metabolic Pathway and Molecular biology-I) (4)	--	N-MNT-BT-310 (Microbiology: Genetics) (2) --- N-MNP-BT-311(Laboratory Exercises in Genetics) (2)	--	--	N-VAC-BT- 360 (Democracy)(2) --- N-VAC-BT-361 (Environmental science) (2)	N-SCT-BT-350 (Plant tissue culture) (2) --- N-SCT-BT-351 (Advances in Cell biology) (2) --- N-SCP-BT-352 (Laboratory exercises in PTC &Adv. In Cell biology) (2)	--	--	--	22
	WL/Week (L+P) 04+04=08	--	WL/Week (L+P) 02+02=04	--	--	WL/Week (L+P) 02+02=04	WL/Week (L+P) 04+02=06	--	--	--	WL/Week (L+P) 12+10=22

IV	N-MJT-BT-401 (Plant Biochemistry) (2) --- N-MJT-BT-402 (Molecular Biology-II) (2) --- N-MJP-BT-403 (Lab. Exercises in Plant biochemistry and Molecular biology-II) (4)	--	N-MNT-BT-410 (Microbiology: Immunology) (2) --- N-MNP-BT-411 (Laboratory Exercises in Immunology) (2)	--	--	N-VAC-BT-460 Environmental Science (2)	N-SCT-BT-450 (Animal tissue culture) (2) - N-SCT-BT-451 (Environmental biotech) (2) - N-SCP-BT-452 (Laboratory exercises in ATC&EBT) (2)	N-CCT-BT-470 (Yoga) (2)	-	--	22
	WL/Week (L+P) 04+04=08	--	WL/Week (L+P) 02+02=04	--	--	WL/Week (L+P) 02+00=02	WL/Week (L+P) 04+02=06	WL/Week (L+P) 00+02=02	--	--	WL/Week (L+P) 12+10=22
Credits	08+08=16	--	04+04 = 08	--	--	04+02=06	08+04=12	02+0=02	--	--	26+18=44
Level 6- Students exiting the programme after securing 88 credits will be awarded UG Diploma in the relevant Discipline /Subject (Biotechnology)											

Department of Biotechnology B. Sc. II Credit framework & Evaluation Pattern (2024-25)

SEMESTER-III														
Theory							**Practical**							
Course Type	**Course Code**	**Course Title**	**Credits**	**SEE**	**CCE**	**Total Marks For Theory Exam**	**Course Type**	**Course Code**	**Course Title**	**Credits**	**Practical Exam**	**Journal**	**Case study/ Tour Report**	**Total Marks For Theory Exam**
Major	N-MJT-BT-301	Metabolic pathway	02	40	10	50	Major	N-MJP-BT-303	Laboratory Exercises in Metabolic pathway and Molecular biology	04	40	05	05	100
Major	N-MJT-BT-302	Molecular biology-I	02	40	10	50	Minor	N-MNP-BT-311	Laboratory exercises in Genetics	02	40	05	05	50
Minor	N-MNT-BT-310	Microbiology: Genetics	02	40	10	50	SCP	N-SCP-BT-352	Laboratory exercises in Plant tissue culture and Advances . in Cell biology	02	40	05	05	50
VAC	N-VAC-BT-360	Democracy	02	50	--	50								
VAC	N-VAC-BT-361	Environmental science	02	50	--	50								
SCT	N-SCT-BT-350	Plant tissue culture	02	40	10	50								
SCT	N-SCT-BT-351	Advances in Cell biology	02	40	10	50								
TOTAL CREDITS			**14**							**08**				
					Total	**350**							**Total**	**200**
Total Marks For Semester-III (Theory + Practical) =550														
Total Credit for Semester III= 22														

SEMESTER-IV														
Theory							**Practical**							
Course Type	**Course Code**	**Course Title**	**Credits**	**SEE**	**CCE**	**Total Marks For Theory Exam**	**Course Type**	**Course Code**	**Course Title**	**Credits**	**Practical Exam**	**Journal**	**Case study/ Tour Report**	**Total Marks For Theory Exam**
Major	N-MJT-BT-401	Plant Biochemistry	02	40	10	50	Major	N-MJP-BT-403	Laboratory Exercises in Plant physiology & biochemistry and Molecular biology	04	40	05	05	100
Major	N-MJT-BT-402	Molecular biology-II	02	40	10	50	Minor	N-MNP-BT-411	Laboratory exercises in Immunology	02	40	05	05	50
Minor	N-MNT-BT-410	Microbiology: Immunology	02	40	10	50	SCP	N-SCP-BT-452	Laboratory Exercises in Animal tissue culture and Environmental biotechnology	02	40	05	05	50
VAC	N-VAC-BT-460	Environmental science	02	50	--	50								
VAC	N-SCT-BT-450	Animal tissue culture	02	40	10	50								
SCT	N-SCT-BT-451	Environmental biotechnology	02	40	10	50								
CC	N-CCT-BT-470	Yoga	02	50	--	50								
		TOTAL CREDITS	**14**							**08**				
					Total	**350**							**Total**	**200**
Total Marks For Semester-IV (Theory + Practical) = 550														
Total Credit for Semester IV= 22														

SEMESTER-III Passing Criteria (2024-25)

Course/Subject	TH/ PR	CCE		SEE		Total	
		Max.	Min.	Max.	Min	Max.	Min
N-MJT-BT-301, Metabolic pathway	TH	10	04	40	16	50	20
N-MJT-BT-302, Molecular biology-I	TH	10	04	40	16	50	20
N-MNT-BT-310 , Microbiology: Genetics	TH	10	04	40	16	50	20
N-VAC-BT-360, Democracy	TH	--	--	50	20	50	20
N-VAC-BT-361 , Environmental science	TH	--	--	50	20	50	20
N-SCT-BT-350, Plant tissue culture	TH	10	04	40	16	50	20
N-SCT-BT-351, Advances in Cell biology	TH	10	04	40	16	50	20
N-MJP-BT-303 , Laboratory Exercises in Metabolic pathway and Molecular biology-I	PR	--	--	100	40	100	40
N-MNP-BT-311 , Laboratory exercises in Genetics	PR	--	--	50	20	50	20
N-SCP-BT-352, Laboratory exercises in Plant tissue culture and Advances in Cell biology	PR	--	--	50	20	50	20
	Grand Total					**550**	**220**

SEMESTER-IV Passing Criteria, (2024-25)

Course/Subject	TH/ PR	CCE		SEE		Total	
		Max.	Min.	Max.	Min	Max.	Min
N-MJT-BT-401 , Plant Biochemistry	TH	10	04	40	16	50	20
N-MJT-BT-402 , Molecular biology-II	TH	10	04	40	16	50	20
N-MNT-BT-410, Microbiology: Immunology	TH	10	04	40	16	50	20
N-VAC-BT-460, Environmental science	TH	--	--	50	20	50	20
N-SCT-BT-450, Animal tissue culture	TH	10	04	40	16	50	20
N-SCT-BT-451, Environmental biotechnology	TH	10	04	40	16	50	20
N-CCT-BT-470, Yoga	TH	--	--	50	20	50	20
N-MJP-BT-403, Laboratory Exercises in Plant biochemistry and Molecular biology-II	PR	--	--	100	40	100	40
N-MNP-BT-411, Laboratory exercises in Immunology	PR	--	--	50	20	50	20
N-SCP-BT-452, Laboratory Exercises in Animal tissue culture and Environmental biotechnology	PR	--	--	50	20	50	20
					Grand Total	**550**	**220**

Structure of the Course: B.Sc. II Biotechnology (Entire)

Level	Year	Sem.	Course Type	Course Code	Course Title	Credits	No. of Lectures / Practicals
4.5	II	Sem. III	Major	N-MJT-BT-301	Metabolic pathway	2T	30
			Major	N-MJT-BT-302	Molecular biology	2T	30
			Major	N-MJP-BT-303	Laboratory Exercises in Metabolic pathway and Molecular biology-I	4P	30
			Minor	N-MNT-BT-310	Microbiology: Genetics	2T	30
			Minor	N-MNP-BT-311	Laboratory exercises in Genetics	2P	15
			VAC	N-VAC-BT-360	Science of Life and Mind	2T	30
			VAC	N-VAC-BT-361	Environmental science	2T	30
			SEC	N-SCT-BT-350	Plant tissue culture	2T	30
			SEC	N-SCT-BT-351	Advances in Cell biology	2T	30
			SEC	N-SCT-BT-352	Laboratory exercises in Plant tissue culture and Adv. in Cell biology	2P	15
		Sem. IV	Major	N-MJT-BT-401	Plant Biochemistry	2T	30
			Major	N-MJT-BT-402	Molecular biology-II	2T	30
			Major	N-MJP-BT-403	Laboratory Exercises in Plant biochemistry and Molecular biology-II	4P	30
			Minor	N-MNT-BT-410	Microbiology: Immunology	2T	30
			Minor	N-MNP-BT-411	Laboratory exercises in Immunology	2P	15
			VAC	N-VAC-BT-460	Environmental science	2T	30
			SEC	N-SCT-BT-450	Animal tissue culture	2T	30

		Sem-IV	SEC	N-SCT-BT-451	Environmental biotechnology	2T	30
			SEC	N-SCP-BT-452	Laboratory Exercises in Animal tissue culture and Environmental biotechnology	2P	15
			CC	N-CCT-BT-470	Yoga	2T	30

B.Sc. II, Biotechnology Semester III

Course Code and title: N-MJT-BT-301 Metabolic Pathway

Credits: 02 **Total Lectures: 30**

Learning Objectives:

- To make students aware about metabolism.
- To study different types of metabolism and its study.
- To understand the concepts of metabolism of Biomolecules.
- To study the Metabolic Pathways with its Energetics.

Topic No.		Lectures
	Credit – I	
1.	**Metabolism:-** Introduction to metabolism, Types of metabolic reactions: anabolism, catabolism, amphibolism, Methods employed to study metabolism (using auxotrophic Mutants, radioisotopes), High energy compounds (ATP, Phosphoenol pyruvate, 1,3 Bisphosphoglycerate, Phosphocreatine)	7
2.	**Carbohydrates Metabolism: -** Reactions and energetics: Glycolysis, Gluconeogenesis, TCA cycle, HMP and its significance.	9
	Credit -II	
3.	**Lipid Metabolism:-** **Biosynthesis of fatty acid with respect to Palmitic acid** (fatty acid synthase complex, Three stages of fatty acid synthesis) **Degradation of fatty Acid (β-oxidation) with respect to Palmitic acid (**Three stages of fatty acid degradation**).**	6
4.	**Respiration:-** Aerobic Respiration: Flow of electrons in ETC, Redox potential components of ETC, Mechanism of ATP generation: Chemiosmotic hypothesis, ATP synthase complex. Anaerobic Respiration:-Alcoholic and Lactic acid fermentation.	8

Learning outcome: - After completing this course the student will able to understand:

1. Principle & types of metabolism.
2. Parameters used to study metabolism.
3. Biosynthesis of lipid, carbohydrates
4. Metabolic pathways with regulation.
5. Aerobic and Anaerobic respiration.

References:-

1. Biochemistry-Lubert Stryer
2. Biochemistry-Nelson and Cox
3. Practical Biochemistry-Wilson and Walker
4. Fundamentals of Biochemistry–J. L. Jain
5. Principals of Biochemistry-Voet and Voet
6. Fundamentals of Plant Physiology-V .K. Jain

Course Code and title: N-MJT-BT-302 Molecular biology-I

Credits: 02 **Total Lectures: 30**

Learning Objectives:

- To familiarize the students with basic concept in molecular biology.
- To understanding the DNA structure & Replication.
- To understanding the DNA alterations by Mutation & Repair.
- Understand DNA damage.

Topic No.		Lectures
	Credit – I	
1.	**Experimental Evidences for DNA as a genetic material:-** Griffith's Exp., Avery, Macleod, McCarty Exp., Blender Exp., RNA as a genetic material (Gierer and Schram expt). **Properties and Function of DNA:-** Tm, Cot Curve, Purity of DNA, Acid- Base Nature, Buoyant Density Concept of Gene, Unit of Gene (Cistron, Recon, Muton). **Plasmid-** Types, Structure, properties and applications.	06
2.	**Organization of genome:-** Viral (Lambda, T4), Bacteria (*E.coli*), Eukaryote, Typical Structure of chromosome (Euchromatin& Heterochromatin), Packaging of DNA (Nuclesome, Solenoid Model). **Nucleic Acid biosynthesis:-** De novo synthesis of Purine and Pyrimidine ring, Salvage Pathway, Synthesis of Deoxyribonucleotide, Feedback inhibition.	09
	Credit -II	
3.	**DNA Replication:-** Semi conservative model of replication (M.S Expt.).Direction	07
	of replication (Uni & Bidirectional).Rolling circle model and telomere replication. Rules of Replication, Prokaryotic and eukaryotic replication- Enzymes involved in replication, Process of replication.	

4.	**Mutation:-** Introduction, Causes: Spontaneous & induced, chemical and physical agent, Types of mutation (missense mutation, nonsense mutation, silent mutation, point mutation, frameshift mutation) **Mechanism of DNA repair:-** Direct repair, Excision repair (Nucleotide and Base), Mismatch repair, SOS repair, Recombination repair, Repair of double strand DNA break.	08

Learning Outcomes: After completing this course the student will able to understand

1. Experiment behind the Genetic material.
2. DNA structure & process of Replication.
3. DNA alterations by Mutation & Repair.
4. Nucleic acid biosynthesis &genome organization of different organisms.

References:-

1. Molecular biology by Watson
2. Genetics by Strickberger
3. Molecular Biology by Dr. P.S. Vermas& Dr. V.K. Agarwal (latest edition)
4. W.H. Freeman & Co. Primrose SB. 2001. Molecular Biotechnology. Panima.
5. Genes XI, 11th edition (2012), Benjamin Lewin, Publisher - Jones and Barlett Inc. USA
6. Genome by T.A. Brown
7. Nelson, D.L. and Cox, M.M. (2012) Lehninger's Principle of Biochemistry.

Course Code and title: N-MJP-BT-303 (Practical)

Laboratory Exercises in Metabolic pathway and Molecular biology-I

Credits: 04 **Total Practicals: 15**

Sr. No.	Name of the Experiment	Number of practical
1.	Quantitative Estimation of fructose by Resorcinol method.	01
2.	Quantitative Estimation of DNA by Diphenylamine method.	01
3.	Separation of Bimolecules by Gel Filtration Chromatography.	01
4.	Quantitative Estimation of protein by lowery method.	01
5.	Purification of proteins/enzymes by Ion exchange chromatography using DEAE Cellulose	01
6.	Quantitative Estimation of RNA by Orcinol Method.	01
7.	Quantitative Estimation of Urea by DAM method	01
8.	Isolation of DNA from - Plant Material	02
9.	Quantitation of Genetic material	01
10.	Isolation of Genomic DNA from bacteria.	01
11.	Purification of DNA by silica membrane.	01
12.	Isolation of Plasmid from *E.coli.*	02
13	Separation of DNA by using Agarose gel electrophoresis .	01

Learning outcome:

1. Students get basic knowledge of various estimation technique
2. Students get aware of techniques used for purification of bimolecules.
3. Student gets basic knowledge of electrophoresis technique.
4. Students get knowledge about laboratory equipments used in molecular biology.
5. Students get knowledge about DNA extraction techniques.

References:

1. Experiments in Molecular Biology by Slater, Robert J.
2. Wilson & Walker's principles & techniques of Molecular biology.
3. Molecular Biology of Gene 6th Edition (2008), James D. Watson, Baker et.al. (Unit II)
4. Genetics by Monroe W. Strickberger, 3rd Edition. (Unit I).
5. Introduction to practical biochemistry by David Plummer.

Course Code and title: N-MNT-BT-310 Microbiology: Genetics

Credits: 02 **Total Lectures: 30**

Learning Objectives:

1. To understand principle of Mendelian genetics.
2. To make students aware of Gene interaction and Gene expression.
3. To Study the basic concepts of Cytogenetics.
4. To study the basic concepts of microbial genetics.
5. To study basic concept of mutations.

Topic No.		Lectures
	Credit – I	
1.	**Mendel's law of Inheritance** –Mendel's Experiment, Dominance and recessiveness, Principle of segregation, independent assortment, back and test cross. Incomplete dominance, co-dominance, multiple allele. Interaction of gene-Epistasis(Dominant Epistasis),complimentary gene ,Supplementary gene.	07
2.	**Linkage** Definition, coupling and repulsion hypothesis, linkage groups. Crossing over-Mechanism and theory. Structural changes in chromosomes- deletion, duplication, inversion and translocation Numerical changes in chromosomes- aneuploidy **,** euploidy. Maternal effect-Concept and example. Extra chromosomal or cytoplasmic or organellar inheritance- mitochondrial and plastid.	08
	Credit -II	
3.	**Transposable elements-**IS elements, transposons and retroelements. Transposons in prokaryotes and eukaryotes, mechanism of transposition, uses of transposons. **Basic concepts -** a) Gene, genome, genotype, phenotype, mutagen, recon, muton , cistron b) Split genes. c) Genetic code – definition and properties of genetic code.	08
4.	**Genetic recombination in bacteria-** Definition, fate of exogenote in recipient cell, transformation, conjugation, transduction. **Mechanism of recombination**-The Holliday model, Messelson and Radding model, Double strand break repair model.	07

Learning outcomes: After completing the credits students should gain knowledge about:

1. The basic knowledge of Inheritance Biology.
2. The concepts of Gene interaction and Gene expression.
3. The structural and numerical changes in chromosomes.
4. The mechanisms of bacterial genetics such as: -transformation, conjugation,transduction and recombination.
5. The basic knowledge of mutations.

References:

1. Strickberger "Genetics"
2. Freifelder "Genetics"
5. Stanier "General Microbiology"
6. P. K. Gupta "Genetics"
7. C. Sarin "Genetics"
8. Larry Snyder Wendy Champness "Molecular Genetics of Bacteria"
9. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning.

Course Code and title: N-MNP-BT-311 Microbiology: Laboratory exercises in Genetics

Credits: 02 **Total Practicals: 15**

Learning Objectives:

1. To understand basic concepts of Mendelian inheritance.
2. To study the microbial genetic processes like generation of mutant.
3. To study the basic concepts of microbial genetics
4. To understand the basic steps of transformation and conjugation in bacteria.

Sr. No.	**Name of the Experiment**	**Number of practical**
1.	Isolation of Lac negative mutants of *E.coli* by visual detection method.	02
2.	Isolation of Streptomycin resistant mutants by gradient plate technique.	01
3.	Isolation of vitamin B_{12} requiring mutants by replica plate technique.	02
4.	Transformation in *E.coli*.	02
5.	Conjugation in *E.coli.*	03
6.	U.V survival curve.	01
7.	Study the effect of chemical (HNO_2) and physical (UV) mutagens on bacterial cells.	01
8.	Problems based on Mendelian Inheritance, linkage and crossing over.	01
9	Study of meiotic abnormality in *Rhoeo.*	01
10	Study of karyotype by using photograph.	01

Learning Outcomes:

1. At the end of course, students will acquire the knowledge of techniques like karyotyping, Bacterial genetics, mutations etc.

2. The student will gain a basic understanding on human genetics and heredity.

References:

1. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings.

2. Krebs J, Goldstein E, Kilpatrick S (2013). Lewin's Essential Genes, 3rd Ed., Jones and Bartlett Learning. 3. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning.

3. Watson JD, Baker TA, Bell SP et al. (2008) Molecular Biology of the Gene, 6th Ed., Benjamin Cummings.

4. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India.

5. Russell PJ. (2009). i Genetics- A Molecular Approach. 3rd Ed, Benjamin Cummings.

6. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.

7. Maloy SR, Cronan JE and Friefelder D(2004) Microbial Genetics 2nd EDITION., Jones and Barlett publishers.

Course Code and title: N-SCT-BT- 350, Plant Tissue Culture

Credits: 02 **Total Lectures: 30**

Learning Objectives:

1. To make students aware of fundamentals of Plant Tissue culture.
2. Study of laboratory organization for plant tissue culture.
3. Study of callus, organ, anther and pollen culture Technique.
4. Study of suspension, protoplast culture and micropropagation Technique.
5. To study use and application of Plant Tissue culture.

Topic No.		Lectures
	Credit – I	
1.	**Introduction to plant tissue culture**- Definition, History. **Infrastructure & Organization Of Plant Tissue Culture:** **Laboratory- General and aseptic laboratory-** different work areas, equipment's and instruments required and other requirements. **Aseptic Techniques-** Washing and preparation of glassware's, packing and sterilization, media sterilization, surface sterilization, aseptic workstation and precautions to maintain	**8**
	aseptic conditions. **Culture Medium-** Composition of basal M.S. medium and preparation of media.	
2.	**Callus Culture Techniques-** Introduction, Cellular totipotency principle, protocol, morphology and internal structure, genetic variations and applications. **Somatic Embryogenesis-** Introduction, principle, protocol, factors affecting, applications and limitations.	**7**
	Credit -II	
3.	**Organogenesis-** Introduction, principle, protocol, applications. **Ovary and ovule Culture Technique-** Introduction, principle, protocol, and applications. **Anther & Pollen Culture Technique-** Introduction, principle, protocol, factors affecting and applications.	**7**
4.	**Micropropagation-** Introduction, stages of Micropropagation, factors affecting, advantages and applications. **Different Pathways of Micropropagation-** Axillary bud proliferation, somatic embryogenesis, organogenesis and meristem culture. **Somaclonal Variation-** Introduction, terminology, origin, selection at plant level, selection at cell level, mechanism, assessment, applications and limitations.	**8**

Learning Outcomes:

1. Knowledge about laboratory organization for plant tissue culture.
2. Know technique of preparation of plant tissue culture media.
3. Knowledge about various techniques for plant tissue culture.
4. Job oriented skill developments of students to start or work in commercial plant tissue culture laboratory.

References:-

1. Introduction to plant tissue culture- M.K. Razdan
2. Plant tissue culture-Theory & practice-S.S.Bhojwani& M.K. Razdan
3. Plant tissue culture-KalyankumarDey
4. Biotechnology- B.D. Singh
5. A text book of Biotechnology- R.C. Dubey
6. Plant tissue culture-U.Kumar
7. Plant cell, tissue & organ culture-Gam Borg & Phillips
8. Fundamentals of Biotechnology- S.S. Purohit
9. Biotechnology- H.S. Chawla
10. Crop Improvement In biotechnology- H.S.Chawla

Course Code and title: N-SCT-BT-351,

Advances in Cell biology

Credits: 02 **Total Lectures: 30**

Learning Objectives:

1. To study secretary pathways and trafficking.
2. To study cell signaling and Cell surface receptor proteins.
3. To gain knowledge of cell cycle, molecular events in cell cycle.
4. To gain knowledge of programmed cell death.
5. To study cancer cells, causes of cancer and tumor suppressor genes.

Topic No.		Lectures
	Credit – I	
1.	**Cell division cycle** Introduction, definition, phases of cell cycle. Control of cell cycle and its checkpoints. Molecular events of cell cycle-CDK and cyclins, s-phase, CDK cyclins Complex, M-phase CDK cyclins complex, anaphase promoting complex. Programmed cell death (Intrinsic & Extrinsic), Necrosis. Cancer -types, characteristics of cancer cells, tumor suppressor genes(p 53 & Rb).	08
2.	**Mechanism of cell division** Introduction, Types of cell division- mitosis and meiosis. Mitosis- history, phases in mitosis, significance. Meiosis -history, phases in meiosis, significance.	07
	Credit -II	
3.	**Cell Signaling** Introduction, Types of cell signaling: Contact dependent signaling, Autocrine, Paracrine, Synaptic, Endocrine, Gap junctions, Combinatorial signaling, Secondary Messengers Cell surface receptor proteins, Ion channel linked receptors, G-protein linked receptors, and enzyme linked receptors.	08
4.	**Secretary pathway and protein trafficking** Secretary pathway-ER associated ribosomal translation, co-translational transport of nascent polypeptide chain to ER lumen, Transport of proteins to- mitochondria, chloroplast, peroxisomes, nucleus, Golgi apparatus.	07

Learning Outcomes:-

After completing the credits students should gain knowledge about:

1. Transport systems through membrane.
2. Cell cycle, cell division and cellular events.
3. Cell signalling and cell surface receptor proteins.
4. Cancer cells, tumour suppressor genes.

References:-

1. Bruce Albert; Molecular biology of cell- 4th Edition, March 21st 2002 by Garland Science. (Unit I,II,III and IV)
2. Harvey Lodish et al; Molecular biology & cell biology – 5th Edition. (Unit I,II,III and IV)
3. De Robertis ; Cell biology – 8th edition (Unit I, II)
4. P. S. Verma & Agarwal; Cell biology, Genetics, Molecular Biology September 1st 2004 by Chand (Unit II and III)
5. Levin's ; Essential Genes 7th,, 8th , 9th, 10th edition, November 27th 2009 by Jones & Bartlett (Unit III and IV)
6. Gerald Karp; Cell biology (Unit I,II,III and IV)

Course Code and title: N-SCP-BT-352

Laboratory exercises in Plant Tissue Culture and Adv. in Cell biology

Credits: 02 **Total Practical: 15**

Sr. No.	Name of the Experiment	Number of practical
1.	Laboratory Organizations & general techniques in PTC.	1
2.	Preparation of M.S. stock solutions & medium.	1
3.	Micropropagation stage I-Initiation of micropropagation of shoot tip/ axillary bud.	1
4.	Micropropagation stage II- multiplication of culture.	1
5.	Micropropagation stage III-Rooting- *in vitro* .	1
6.	Micropropagation stage IV-Acclimatization & hardening.	1
7.	Callus culture technique- Initiation of culture and study of callus morphology.	1
8.	Aseptic *in vitro* seed germination.	1
9.	Embryo culture technique.	1
10.	Anther Culture technique.	1
11.	Effect of temperature and organic solvent on membrane permeability of cells.	2
12.	Study of mitotic stages.	1
13.	Study of meiotic stages.	1
14.	Study of plasmolysis.	1
15.	Study of methodology of cell lyses.	1

Course Code and title: N-MJT-BT-401

Plant biochemistry

Credits: 02 **Total Lectures: 30**

Learning Objectives:

1. To make students aware of Ultra structure of chloroplast.
2. To study photosynthesis and its reaction mechanism.
3. To study biosynthesis and role of plant hormones in plant.
4. To study concept of Photosynthesis, photoperiodism.

Topic No.		Lectures
	Credit – I	
1.	**Photosynthesis:-**Ultra structure of chloroplast, Photosynthetic pigments, red drop and Emerson's enhancement effect, mechanism of photosynthesis, light reaction, dark reaction,C-3pathway,C-4pathway, CAM, photorespiration.	9
2.	**Nitrogen Metabolism: -** Role of nitrogen in plants, source of nitrogen, nitrogen fixation- symbiotic & Non-symbiotic, Mechanism of Nitrogen fixation, nif gene-concept and significance, transamination.	8
	Credit -II	
3.	**Introduction to Plant Hormones** Biosynthesis of plant hormones- Auxin, Cytokinin, Gibberellin. **Growth: - Definition**, phases of growth curve,	6
	Photoperiodism, Vernalisation.	
4.	**Metabolism of amino acid** Introduction and general aspects of amino acid metabolism **Transamination** Silent features of Transamination, Mechanism of transamination, **Deamination** Oxidatve and Non oxidative Deamination.	7

Learning outcome:

At the end of the course, the students will have sufficient scientific understanding of

1. Mechanism of plant growth and development.
2. The basic knowledge about photosynthesis, respiration and biosynthesis.
3. Synthesis and applications of secondary metabolites
4. Metabolism of Amino acids.

References:

1. Biochemistry- Lubert Stryer
2. Biochemistry-Nelson and Cox
3. Practical Biochemistry-Wilson and Walker
4. Fundamentals of Biochemistry– J. L. Jain
5. Principals of Biochemistry- Voet and Voet
6. Fundamentals of Plant Physiology -V. K. Jain

Course Code and title: N-MJT-BT-402

Molecular biology-II

Credits: 02 **Total Lectures: 30**

Learning Objectives:

1. To familiarize the students with biological processes at molecular level.
2. To Understanding the basic concept in molecular biology.
3. To understanding about central dogma of life.
4. To get knowledge about gene expression and regulation.

Topic No.		Lectures
	Credit – I	
1.	**Transcription in prokaryote and Eukaryote**: -RNA polymerase, RNA synthesis and processing (Initiation, Elongation, termination)	
	-Regulation of mRNA stability: Capping, RNA processing, RNA editing, splicing, polyadenylation, structure and function. -Modification in tRNA	
2.	**Genetic Code:** - Assignment of codons with Unknown sequences: i) Polyuridylic ii) Acid Method iii) Copolymers method Assignment of codons with known sequences: i) Binding technique ii) Repetitive seq. technique -Triplet nature, Salient feature of genetic code, Wobble Hypothesis, Variation in genetic code.	
	Credit -II	
3.	**Translation in prokaryote and Eukaryote:** Structure and role of ribosome in translation, Amino acid t-RNA complex formation, Initiation, Elongation, termination of translation, Post- translation modifications (Protein folding, Removal of Leader sequences, Phosphorylation, glycosylation, acetylation).	
4.	**Regulation of gene expression in prokaryote and eukaryote:** -Regulation of gene expression: i) Promoter ii) Enhancers ii) Activators iii) Repressor iv) Co- Repressors -Regulation of gene expression in prokaryote: i) Lac operon ii) Tryptophan operon iii) Arabinose operon	

Learning outcomes

1. At the end of the course, the students will have sufficient scientific understanding of DNA Transcription, Translation and Gene Expression.
2. Students get knowledge about mechanism associated with Gene Expression at the level of Transcription and Translation.
3. Discuss the mechanisms associated with Regulation of Gene Expression in Prokaryotes and Eukaryotes

References:

1. Molecular Biology of Gene 6th Edition (2008), James D. Watson, Baker et.al. (Unit I, II, III)
2. Genetics by Monroe W. Strickberger, 3rd Edition. (Unit I)
3. Molecular biology 8thedition Geralad karp. (Unit III)
4. Gene XI, 11th edition (2012) Benjamin Levin, Publisher- Jones & Barletta Inc. USA. (Unit IV)
5. Genome 4 by T.A. Brown, 4th Edition (Unit III)

Course Code and title: N-MJP-BT-403

Laboratory Exercises in Plant biochemistry and Molecular biology-II

Credits: 04 **Total Practical: 15**

Sr. No.	Name of the Experiment	Number of practical
1.	Study of lipase activity.	01
2.	Study of nitrate reductase activity.	01
3.	Estimation of Indole-3 Acetic Acid by (Salkowaski reagent) Colorimetric method.	01
4.	Separation of plants pigments by column chromatography	01
5.	Estimation of arginine by sakaguchi method.	01
6.	Isolation of Amylase from germinating seed and determination of its activity	01
7.	Determination of Tm of DNA.	01
8.	Restriction digestion of lambda DNA.	01
9.	Isolation of RNA from animal tissue.	02
10.	Agarose gel electrophoresis to separate RNA.	01
11.	SDS-PAGE for separation of protein CBB staining.	02
12.	DNA Ligation.	01

Learning outcomes: After completing this paper student will acquires:

1. Basic knowledge of various estimation techniques.
2. Learn about plant pigments, enzymes and other phytochemicals present in the plant
3. The basic knowledge of electrophoresis technique.
4. Knowledge of laboratory equipments used in molecular biology.
5. To acquire the techniques of isolation Purification and Quantification of DNA, RNA and Plasmid.

References:

1. Experiments in Molecular Biology by Slater, Robert J.
2. Wilson & Walker's principles & techniques of Molecular biology.
3. Molecular Biology of Gene 6th Edition (2008), James D. Watson, Baker et.al. (Unit II)
4. Genetics by Monroe W. Strickberger, 3rd Edition. (Unit I)

Course Code and title: N-MNT-BT-410 Microbiology: Immunology

Credits: 02 **Total Lectures: 30**

Learning Objectives:

1. To study the overview of vertebrates Immune System.
2. To study the Types and mechanism of Defense.
3. To study the Cells and Organs of immune system.
4. Students should aware of Antigen and antibody reactions.
5. Students should aware of immune response and parasitic immunology.

Topic No.		Lectures
	Credit – I	
1.	**Introduction:-** Scope of Immunology, Historical background of Immunology, **Types of Defense:-** a) First line of defense (barriers at the portal of entry, physical and chemical barriers) b) Second line of defense (Phagocytosis– oxygen dependent and independent) c) Third line of defense-specific defense mechanism. **Inflammation:-** Cardinal signs, mediators, vascular and cellular change, toll like receptors.	08
2.	**Immune response:-** Primary and secondary immune response, theories of antibody production. **Major Histocompatibility Complex:-** a) Structure and functions of MHC class–I and class–II molecules b) MHC antigen typing (microcytotoxicity and mixed lymphocyte reaction) **Complement:-** Classical and Alternative pathways	07
	Credit -II	
3.	**Antigen and Antibody** **Antigen:-** Definition, Essential features of Ag, Haptens, Carrier molecule, types of antigen, Adjuvants, factors affecting antigenicity. **Antibody:-** Definition, nature, basic structure of immunoglobulin molecule, major human immunoglobulin classes, properties and functions.	06
4.	**Antigen Antibody reactions:**-Principle and applications of a) Agglutination	09

	b) Precipitation c) Complement fixation. **Immunofluorescence techniques**:- Direct and Indirect, fluorescence-activated cell sorting (FACS) **Radioimmunoassay:-** ELISA – Principle, Methodology and applications., Radioimmunoassay RIA. **Hypersensitivity-** Concept and types with example.	

Learning outcomes: After completing this paper student will acquires:

1. The basic knowledge of vertebrates Immune System.
2. The knowledge about Types and mechanism of defense.
3. The knowledge of Cells and Organs of immune system.
4. The concept of Antigen and antibody reaction

References:

1. Riott “Essential Immunology”
2. Kuby “Immunology”
3. AshimChakravar “Immunology and Serology”
4. Tizzard “Immunology-An Introduction”-4th Edition
5. S. K. Gupta “Essentials of Immunology”
6. M. P. Arora “Immunology”

Course Code and title: N-MNP-BT-411 Laboratory exercises in Immunology

Credits: 02 **Total Practicals: 08**

Learning objective-

- The objective of this course is to get hands on training of antigen antibody reactions.
- To acquire the knowledge of serological tests.

Sr. No.	Name of the Experiment	Number of practical
1.	Radial immunodiffusion Assay	01
2.	Immunoelectrophoresis-Qualitative	01
3.	Double Immunodiffusion Technique	01
4.	Widal test – Quantitative	01
5.	Rapid Plasma Reagin (RPR) card test	01
6.	Enzyme linked immune sorbent assay ELISA-dot ELISA	01

Learning outcome:

- Students will acquire the scientific knowledge of medical immunology for detection of Antigen or Antibody.
- Students will acquire the scientific knowledge of serological practical's

---

Course Code and title: N-SCT-BT-450 Animal tissue culture

Credits: 02 **Total Lectures: 30**

Learning Objectives:

1. To study the general concept of Animal tissue culture.
2. To understand applications of Animal tissue culture in various field.
3. To study the Animal tissue culture technique.
4. To study the goal and scope & applications of Animal tissue culture.

Topic No.		Lectures
	Credit – I (Theory)	
1.	**History and Introduction of Animal Cell culture**- History of animal cell culture **Requirements of Animal cell culture**- Characteristics of animal cell in culture, substrate for cell growth, Equipments required for animal cell culture (Laminar air flow, Co2 incubator, Centrifuge, Inverted microscope) **Laboratory design and layout-**Construction and services, layout of aspetic room (sterile handling area, laminar air flow, service bench), incubation (incubators, hot room), preparation area (media preparation, washing area, storage). **Sterilization of Glassware's-** Equipment's & culture media Glassware sterilization, reagent and media sterilization, sterility testing.	08
2.	**Culture media-** Natural media, synthetic media (serum containing media, serum free media, balanced salt solution, media constituent, complete culture media, physicochemical properties of media) **Biology and Characterization of cultured cells-** **Characteristics of cultured cells-** cell adhesion, cell proliferation, cell differentiation, metabolism of cultured cells, Initiation of cell culture, Evolution and development of cell lines. **Characterization of cultured cells-** Morphology of cells, species of origin of cells, Identification of tissue of origin, transformed cells, Identification of specific cell lines.	07
	Credit –II	

3.	**Measurement of growth parameters of cultured cells-** Growth cycle of cultured cells, plating efficiency of cultured cells **Cell synchronization-** Cell separation by physical means, cell separation by chemical blockade **Senescence and apoptosis-** Cellular senescence, Measurement of senescence. Apoptosis, Measurement of apoptosis **Basic technique of mammalian cell culture-** Isolation of tissue, disaggregation of tissue, measurement of viability, primary cell culture, Cell lines, Maintenance of cell culture, Subculture, Stem cell cultures,	08
4.	**Scale up of Animal cell culture**-Scale up in suspension-stirrer culture, continuous flow culture, Airlift fermenter culture **Scale up in monolayer-** Roller bottle culture, multisurface culture, multiarray disks, and tubes, Microcarrier culture, Perfused monolayer culture, Immobilized cell culture, Insect culture. **Applications of cell culture**-In transplantation, and tissue engineering, monoclonal antibodies production, culture based vaccine, valuable recombinant product, cloning, ethics and morality.	07

Learning Outcomes: After successfully completion of this course-

1. Students will understand the basic concepts of Animal tissue culture.
2. Student will able to handle Animal tissue.
3. They will be able to use different basic tools and techniques in Animal tissue culture.
4. Students will understand the applications of Animal tissue culture.

References:

1. Animal tissue culture- Paul
2. Culture of animal cell 3rd edition-R Ian Freshney
3. Animal cell culture- R.W.Masters
4. Animal biotechnology-M.M.Ranga
5. Animal biotechnology-R.Sasidhara
6. Animal cell culture technique-Ed. Martin Clynes Springer
7. Cell growth & division a practical approach-Ed. R. B. Sega& R.L.Press

---

Course Code and title: N-SCT-BT-451 Environmental Biotechnology

Credits: 02 **Total Lectures: 30**

Learning Objectives:

1. To make students aware of Environmental Biotechnology
2. Study of Environmental Impact Assessment.
3. Study of Environmental Survey for different approaches.
4. Study of environmental toxicology their magnification, effects.
5. To study different remediation techniques for environmental pollution

Topic No.		Lectures
	Credit – I	
1.	**Water Pollution** -Definition, Sources and Types-Physical, Chemical and Biological, Hardness [Mechanism, Determination, Types],Water softening methods [Clark's method, Use of cation and anion exchange resins], COD and BOD [Concept, Determination], Eutrophication (Concept, Types and Control), Purification of water (Physical Methods-UV Treatment, Distillation, Chemical Methods- Chlorination, Ozonization) **Air Pollution** -Definition, Sources, London and LA Smogs (Mechanisms of Formation), Greenhouse Effect (Concept, Reasons, Role of dipole moment of gaseous molecules), Ozone Depletion (Role of CFCs, Control), Instrumental analysis methods of SO2, NOx. **Soil Pollution** -Definition, Sources, Role of pesticide in soil pollution, control Measures.	8
2.	**Environmental Toxicology-** Definition, classification and concept, Pesticide Toxicity – Classification (Organic and Inorganic), Mode of action of toxicants (Metals, organophosphates, carbamates and mutagens), Bioconcentration, Bioaccumulation, Biomagnification, Potentiation and Synergism, Control of Toxic effects- Biotransformation and excretion.	7
	Credit –II	
3.	**Environmental quality Assessment and Monitoring-** Definition, Quality of environment for life on earth and man. Deterioration of environment quality, short term studies, rapid	7
	assessment, continuous-short and long term monitoring, Basic Concept of Environment Impact Assessment.	

4.	**Bioremediation Techniques-** Definition, Principle, *Insitu and Exsitu* Bioremediation, Bioremediation of waste waters (MSW, BSW and ISW), Activated Sludge Process, Lagoons, Oxidation ponds, Trickling filter. Solid Waste Treatment [Plastics and Aromatics], Slurry Phase Treatment, Agricultural Bioremediation- Microbial Composting, Biogas, Land, Farming and paste Control, Bioremediation of Industrial wastes, Xenobiotics, Bioaugmentation and Biofiltration.	8

Learning Outcomes

1. Knowledge about recycling, and remediation methods of different pollutants.
2. Know the technique of remediation method for pollution.
3. Knowledge about various techniques for Environmental Impact Assessment.
4. Knowledge about effluent treatment system.

References:-

1. Applied and enviornmental Microbiology; Amann, R.I Stromely,J.Stahl.
2. Environmental Biotechnology. , Chattergy.
3. Enviornmental Biology,Verma Agerwal
4. Enviornmental pollution, Peavy and Rowe.
5. Enviornmental problems and solution., Asthana and Asthana.
6. Enviornmental Science., Saigo, Canninhham

Course Code and title: N-SCP-BT-452

Laboratory exercises in Animal tissue culture and Environmental biotechnology

Credits: 02 **Total Practical: 15**

Sr. No.	Name of the Experiment	Number of practical
1.	Laboratory organization for Animal tissue culture	01
2.	Sterilization procedures and media preparation for Animal Cell cultures	01
3.	Purification of Serum	01
4.	Growth studies by viable cell count analysis	01
5.	Trypsinisation treatment	01
6.	Estimation of Hemoglobin	01
7.	Validation of Autoclave	01
8.	Estimation of COD of water sample.	**01**
9.	Estimation of BOD of water sample.	01
10.	IMVIC Test	01
11.	Study of effect of pesticide on *Azotobater* population by viable count method.	01
12.	Isolation of phages of *E. coli* from sewage.	01
13.	Determination of TDS of water sample & Determination of total and permanent hardness of water sample.	01
14.	Routine bacteriological analysis of water Presumptive, Confirmatory, Completed, MPN.	01
15.	Study of effect of heavy metal on growth of organisms.	01
16.	Isolation of microorganism from air by solid impaction technique.	01

Course Code and title: N-CCT-BT-470: YOGA

Credits: 02 **Total Lectures: 30**

Learning Objectives:

- To make students aware about Concept of Yog.
- To study different types of yoga.
- To understand the importance of yoga

Topic No.		Lectures
	Credit – I	
1.	**General introduction to yoga** **Brief about origin of Yoga**: Psychological aspects and Mythological concepts; **History and Development of Yoga**: prior to the Vedic period, Vedic period, Medival period, modern era; Etymology and Definitions of Yoga, Aim and Objectives of Yoga, Misconceptions of Yoga; Brief about Streams of Yoga; Principles of Yoga,	10
2.	**Astang Yoga of Patanjali** Yam, Niyam, Asana, Pranyam, Pratyahar, Dharana, Dhyan, Samadhi	10
	Credit -II	
3.	**Importance of Yoga** **Yoga and Holistic Health**: Attitude change towards yoga through individualized counselling, Psychological & yogic method Tackling ill effects of conflict and Frustration; Yogic methods Yoga Psychology for Adjustment: Psychological, philosophical and yogic counselling; the remedial measures; Action in relaxation-the secret of Karma Yoga;	10

Learning Outcomes:

- Students of the UG course will have an understanding about origin, history and development of Yoga
- They will have an idea about the insights of Indian philosophy and Astika & Nastika darshanas.
- Introduction about Yoga according to various yogic texts

References:

1. Lal Basant Kumar : Contemporary Indian Philosophy, Motilal Banarsidas Publishers Pvt. Ltd, Delhi, 2013
2. Dasgupta S. N : History of Indian Philosophy, Motilal Banarsidas, Delhi, 2012
3. Singh S. P : History of Yoga, PHISPC, Centre for Studies in Civilization Ist, 2010
4. Singh S. P & Yogi Mukesh : Foundation of Yoga, Standard Publication, New Delhi, 2010
5. Ghosh, Shyam : The Original Yoga Munshiram Manoharlal, New Delhi, 1999)
6. Jnanananda Bharati : Essence of Yoga Vasishta Pub: Sanata Books,Chennai
7. Hatha Ratnavali: Tirumala Tirupathi Devasthana, Andhra Pradesh.
8.Gheranda Samhita: Shri Sadguru Publication, New Delhi.
9. Dr R Nagarathna and Dr H R Nagendra: Yoga and Health, Swami Vivekananda Yoga Prakashana, 2002 6. Dr R Nagarathna and Dr H R Nagendra: Yoga for Promotion of Positive Health Published by SVYP, Bangalore
10.Dr Nagendra H R : The Secret of Action - Karma Yoga, Published by SVYP, Bangalore,2003