PUNYASHLOK AHILYADEVI HOLKAR SOLAPUR UNIVERSITY, SOLAPUR

पुण्यश्लोक अहिल्यादेवी होळकर
सोलापूर विद्यापीठ
।। विद्यया संपन्नता ।।

NAAC Accredited-2015
'B' Grade (CGPA 2.62)

Name of the Faculty: Science & Technology

CHOICE BASED CREDIT SYSTEM

Syllabus: Biotechnology

Name of the Course: B.Sc. II (Sem–III& IV)

(Draft Syllabus to be implemented from w.e.f. June 2020)

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Faculty of Science & Technology
Choice Based Credit System (CBCS)
B.Sc.-II Biotechnology
(2020-2021: w. e. f. June 2020)

Choice Based Credit System: With the view to ensure worldwide recognition, acceptability, horizontal as well as vertical mobility for students completing undergraduate degree, Solapur University has implemented Choice Based Credit System (CBCS) at Undergraduate level.

The CBCS provides an opportunity for the students to choose courses from the prescribed courses comprising core, elective/minor or skill based courses. The courses can be evaluated following the grading system, which is considered to be better than the conventional marks system. Therefore, it is necessary to introduce uniform grading system in the entire higher education in India. This will benefit the students to move across institutions within India to begin with and across countries. The uniform grading system will also enable potential employers in assessing the performance of the candidates. In order to bring uniformity in evaluation system and computation of the Cumulative Grade Point Average (CGPA) based on student's performance in examinations.

• Outline of Choice Based Credit System:

1. *Core Course:* A course, which should compulsorily be studied by a candidate as a core requirement is termed as a Core course.

2. *Elective Course:* Generally a course which can be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/subject/domain or nurtures the candidate's proficiency/skill is called an Elective Course.

Discipline Specific Elective (DSE) Course: Elective courses may be offered by the main discipline/subject of study is referred to as Discipline Specific Elective.

3. *Ability Enhancement Courses (AEC):* The Ability Enhancement (AE) Courses may be of two kinds: Ability Enhancement Compulsory Courses (AECC) and Skill Enhancement Courses (SEC). "AECC" courses are the courses based upon the content that leads to Knowledge enhancement; (i) Environmental Science and (ii) English/MIL Communication. These are mandatory for all disciplines. SEC courses are value-based and/or skill-based and are aimed at providing hands-on-training, competencies, skills, etc.

• Credit: Credit is a numerical value that indicates students work load (Lectures, Lab work, Seminar, Tutorials, Field work etc.) to complete a course unit. In most of the universities 15 contact hours constitute one credit. The contact hours are transformed into credits. Moreover, the grading system of evaluation is introduced for B.Sc. course wherein process of Continuous Internal Evaluation is ensured. The candidate has to appear for Internal Evaluation of 20 marks and University Evaluation for 80 marks.

Programme Outcome (POs):

Students having an academic background of science at 10+2 level can pursue B.Sc programme invarious branches. After the completion of the B.Sc degree there are various options available for the science students, they can pursue master degree in Science i.e. M.Sc, work in research relatedfields and can even look for professional job oriented courses. Often, in some reputed universities or colleges the students are recruited directly by big MNC's after the completion of the course. The student is also eligible for the job of a Medical Representative. The student after graduating will be eligible for various government exams conducted by UPSC, SSC etc

Punyashlok Ahilyadevi Holkar Solapur University, Solapur
Faculty of Science & Technology
Choice Based Credit System (CBCS): (w.e.f.2020-21): Draft Structure for B. Sc-II
Biotechnology

Subject/ Core Course	**Name and Type of the Paper**		**No. of papers/ Practical**	**Hrs/week**			**Total Marks Per Paper**	**UA**	**CA**	**Credits**
	Type	**Name**		**L**	**T**	**P**				
Class :	**B.Sc.- II**	**Semester – III**								
Core (*Students can opt any Three subjects among the Four Subjects offered at B.Sc.I. Out of Three Subjects offered One Subject will be the Core Subject OR		DSC 1C Genetics	Paper-I: Genetics-I	3.0	--	--	50	40	10	4.0
			Paper-II: Genetics-II	3.0	--	--	50	40	10	
		DSC 2C General Microbiology	Paper-I: General Microbiology-I	3.0	--	--	50	40	10	4.0
			Paper-II: General Microbiology-II	3.0	--	--	50	40	10	
		DSC 3C Plant Biotechnology	Paper-I: Plant Biotechnology-I	3.0	--	--	50	40	10	4.0
			Paper-II: Plant Biotechnology-II	3.0	--	--	50	40	10	
		AECC - Environmental Studies		3.0	--	--	-	-	-	NC
		SEC-1								
Grand Total				23.5	--	--	350	280	70	14
Class :	B.Sc.- II	Semester – IV								
Core			Paper-I:	3.0	--	--	50	40	10	4.0

(*Students can opt any Three subjects among the Four Subjects offered at B.Sc.I. Out of Three Subjects offered One Subject will be the Core Subject OR Students can opt any Two subjects among the Four Subjects offered at B.Sc.I. Out of Two Subjects One Subject will be the Core Subject and any One Subject among the other willbe Elective Subject	DSC 1D Molecular Biology	Molecular Biology-I							
		Paper-II: Molecular Biology-II	3.0	--	--	50	40	10	
	DSC 2D Immunology	Paper-I: Immunology-I	3.0	--	--	50	40	10	4.0
		Paper-II: Immunology-II	3.0	--	--	50	40	10	
	DSC 3D Animal Biotechnology	Paper-I: Animal Biotechnology-I	3.0	--	--	50	40	10	4.0
		Paper-II: Animal Biotechnology-II	3.0	--	--	50	40	10	
	SEC-2								
Total (Theory)			20.5	--	--	350	280	70	14
DSE (Practical)	DSC 1C & 1D	Paper-I & II	--	--	8	100	80	20	4.0
	DSC 2C & 2D	Paper-I & II	--	--	8	100	80	20	4.0
	DSC 3C & 3D	Paper-I & II	--	--	8	100	80	20	4.0
Total (Practical)					24	300	240	60	12
Grand Total			43.5		24	1000	800	200	40

Summary of the Structure of B. Sc. Biotechnology Programme as per CBCS pattern

Class	Semester	Marks-Theory	Credits-Theory	Marks-Practical	Credits-Practicals	Total – credits
B.Sc.-I Biotechnology	I	500	20	--	--	20
	II	550	20	400	16	36
B.Sc.-II Biotechnology	III	350	14	--	--	14
	IV	350	14	300	12	26
B.Sc.-III Biotechnology	V	550	22	--	--	22
	VI	550	22	400	16	38
Total		2850	112	1100	44	156

B. Sc. Programme:

Total Marks : Theory + Practical's = 2850 +1100 =3950

Credits : Theory + Practical's = 112 + 44 = 156

Numbers of Papers Theory: Ability Enhancement Course(AECC) : 05

Theory: Discipline Specific Elective Paper (DSE) : 08

Theory: DSC : 14

Skill Enhancement Courses : 04

Total : Theory Papers : 31

: Practical Papers : 11

Abbreviations:

L: Lectures

T: Tutorials

P: Practicals

UA : University Assessment

CA : College Assessment

DSC / CC: Core Course

AEC : Ability Enhancement Course

DSE : Discipline Specific Elective Paper

SEC : Skill Enhancement Course

GE : Generic Elective

CA: Continuous Assessment

ESE: End Semester Examination

PAH SOLAPUR UNIVERSITY, SOLAPUR
Faculty of Science & Technology
Choice Based Credit System (CBCS)
(W.e.f. 2020-21)

• Title of the Course: B.Sc. Part-II

• Subject: Biotechnology

• **Introduction**: This course provides a broad overview of Biotechnology and to produces expert hands that would have sufficient knowledge and expertise to solve the urgent problems of the region by using Biotechnology. The course structure is basic science centric where students learn core science and are taught necessary fundamental subject for that purpose.

• **Objectives of the course: The objectives of B. Sc. Biotechnology course are:**
To provide an intensive and in depth learning to the students in field of Biotechnology. Beyond simulating, learning, understanding the techniques, the course also addresses the underlying recurring problems of disciplines in today scientific and changing world. To develop awareness & knowledge of different organization requirement and subject knowledge through varied branches and research methodology in students. To train the students to take up wide variety of roles like researchers, scientists, consultants, entrepreneurs, academicians, industry leaders and policy.

- **Course outcome and Advantages:** Biotechnology has tremendous job potential. The successful students will be able to establish research organizations with the help of agriculture, environment protection and also their own industry for transgenic animals, clinical pathology, genetic counseling, human karyotyping etc. Scientific Research Organizations. Universities in India & aboard.

• Medium of Instruction: English

• Syllabus Structure:
• The University follows semester system.
• An academic year shall consist of two semesters.
• B.Sc. Part-II Biotechnology shall consist of two semesters: Semester III and Semester IV

In semester III: there will be two DSC papers having paper V and paper VI of 100 marks. There will be additional **SEC-I Paper** of 50 marks. There will a **Compulsory paper on "Ability Enhancement Compulsory Course (AECC)" on** Environmental Studies

In Semester IV: there will be two DSC papers having paper VII and paper VIII of 100 marks. There will be additional **SEC-II Paper** of 50 marks.

The scheme of evaluation of performance of candidates shall be based on **University Assessment (UA**) as well as **College Internal Assessment (CA)** as given below.

For B.Sc.Part-II Biotechnology Sem III & IV the "internal assessment" will be based on Internal tests, Home assignment, Tutorials, Open Book Examination, Seminars, Group discussion, Brain storming sessions etc. as given below.

- **Practical course examination** is of 100 marks shall be conducted at the end of semester II. The practical examination of 100 marks shall also consist of **80 marks for University practical assessment** and **20 marks for college internal assessment (CA)**.

• **Scheme of Evaluation**: As per the norms of the grading system of evaluation, out of 100 marks, the candidate has to appear for college internal assessment of 20 marks and external evaluation (University assessment) of 80 marks.

Semester – III: Theory: (100 marks): Comprising DSC-

a) University Examination (UA) (80 marks): No. of theory papers: 2 (paper V and paper VI of 40 marks each)

b) Internal Continuous Assessment (CA) (20 marks) No. of theory papers: 2 (paper V and paper VI of 10 marks each)

c) SEC-I: Total Marks =50 Marks;) No. of theory papers: 01 (UA=40 Marks & CA=10 Marks

d) **Compulsory paper on "Ability Enhancement Compulsory Course (AECC)" on** Environmental Studies

Internal test- Home assignment / tutorials / seminars / viva/ group discussion/ outreach programs.

Semester – IV: Theory: (100 marks): Comprising DSC-

a) University Examination (UA) (80 marks): No. of theory papers: 2 (paper VII and paper VIII of 40 marks each)

b) Internal Continuous Assessment (CA) (20 marks) No. of theory papers: 2 (paper VII and paper VIII of 10 marks each)

c) SEC-II: Total Marks =50 Marks;) No. of theory papers: 01 (UA=40 Marks & CA=10 Marks

Internal test- Home assignment / tutorials / seminars / viva/ group discussion/ outreach programs.
Practical Examination: (100 marks)
University Examination (80 marks): No. of practicals': 02

Pactical-I: Based on papers V & VI : (40 UA + 10 CA)
Pactical-II: Based on papers VII & VIII : (40 UA + 10 CA)

Internal Continuous Assessment: (20 marks): Practical-I (10) + Practical-II (10)

(a) Internal practical test and
(b) Viva/group discussion/model or chart/attitude/attendance/overall behavior
(c) University practical examination of 80 marks (Practical I & II for two separate days) will be conducted at the end of semester IV

Passing Standard:

The student has to secure a minimum of 4.0 grade points (Grade C) in each paper. A student who secure less than 4.0 grade point (39% or less marks, Grade FC/FR) will be declared fail in that paper and shall be required to reappear for respective paper. A student who failed in University Examination (theory) and passed in internal assessment of a same paper shall be given FC Grade. Such student will have to reappear for University Examination only. A student who fails in internal assessment and passed in University examination (theory) shall be given FR Grade. Such student will have to reappear for both University examination as well as internal assessment. In case of Annual pattern/old semester pattern students/candidates from the mark scheme the candidates shall appear for the same 70 marks of external examination and his performance shall be scaled to 100 marks.

• ATKT:

Candidate passed in all papers, except 5 (five) papers combined together of semester I and II of B.Sc. Part-I Biotechnology examination shall be permitted to enter upon the course of Semester III of B.Sc. Part-II Biotechnology

B. Sc. II BIOTECHNOLOGY
SEMESTER-III & IV
CHOICE BASED CREDIT SYSTEM (CBCS) STRUCTURE (2020-21)

SEMESTER- III (THEORY)

Paper	Title	Marks
DSC 1C	Genetics	50 (40- UA and 10-CA)
DSC 2C	General Microbiology	50 (40- UA and 10-CA)
DSC 3C	Plant Biotechnology	50 (40- UA and 10-CA)
AECC	Environmental Studies	NC
SEC-1	Molecular Diagnostics	50 (40- UA and 10-CA)

SEMESTER- IV (THEORY)

Paper	Title	Marks
DSC 1D	Molecular Biology	50 (40- UA and 10-CA)
DSC 2D	Immunology	50 (40- UA and 10-CA)
DSC 3D	Animal Biotechnology	50 (40- UA and 10-CA)
SEC-2		

PRACTICALS

PRACTICAL	Title	Marks
DSC 1C & 1D	Genetics and Molecular Biology	100 (80UA and 20 CA)
DSC 2C & 2D	General microbiology and Immunology	100 (80UA and 20 CA)
DSC 3C & 3D	Plant Biotechnology and Animal Biotechnology	100 **(80UA and 20 CA)**
	Total Marks	300 (240 UA and 60CA)

PAH SOLAPUR UNIVERSITY, SOLAPUR
CHOICE BASED CREDIT SYSTEM (CBCS)
B. Sc. II BIOTECHNOLOGY
SEMESTER III

DSC 1C: GENETICS (PAPER-I)

On completion of this course, students will have the knowledge and skills to explain the key concepts in gene mapping, inheritance and linkage.

- Outcome 1.The course also provides comprehensive knowledge gene transfer in bacteria.
- Outcome 2. The student understands how alteration in genes results in various sex linked disorders.

Unit	Content	Total Credits :2 Contact hours:30
I	**Mendelism** Introduction, Mendel's experiment, Monohybrid and Dihybrid crosses,Genotypic and phenotypic ratio, Law of Dominance, Law of segregation and Law of independent Assortment, Back cross and test cross. Modifications of Mendelian ratios: Co-dominance, Incomplete dominance, Interaction of complementary genes, supplementary gene, inhibitory gene, epistasis.	**8**
II	**Genetic Linkage and Chromosome Mapping** Linkage – Definition, types of linkage, significance of linkage. Crossing over– theories, types and mechanism. Gene Mapping – physical map and genetic map (by three-point test crosses), Mapping by tetrad analysis – the analysis of unordered and ordered Tetrads.	**6**
III	**Extra chromosomal inheritance and alleles** Genetic system in mitochondria, chloroplast, and plasmid. Definition of Alleles. Multiple alleles – ABO blood groups in human, fur colour in rabbit, self incompatibility in plants, and eye colour in *Drosophila*. Pseudo alleles, Complementation test.	**6**
IV	**Sex linked Inheritance** Structure of Sex Chromosomes. Complete and incomplete sex linked genes. Inheritance of XY linked genes, Y linked genes, X linked genes. Sex determination with examples.	**5**
V	**The Genetics of Bacteria** The Genetic Organization of Bacteria (folded fiber model), Bacterial Recombination – transformation, conjugation and transduction. F Plasmids	**5**
. **References**		

1. Genetics: Principles and Analysis; Fourth Edition; Daniel L. Hartl; Jones Bartlet Publishers.
2. Experiments in Plant Hybridization – G. Mendel; Prentice Hall, New Jersey.
3. Genetics – B. D. Singh; Kalyani Publication
4. Principles of Genetics – E. J. Gardner; John Willey & Sons, New York.
5. Molecular Biology – P. K. Gupta
6. Genetics – M. W. Strickberger; Macmillan Publication
7. Heterochromatin Science – S. W. Brown
8. The Theory of Gene – T. H. Morgan; Yale University press; New Haven, Conn.
9. Plant Breeding – Principles and Methods: B. D. Singh: Kalyani Publication.
10. Experimental studies in Physiology of Hereditary; Bateson & Punnet; Harrison's & Sons, London

DSC 1C: GENETICS (PAPER-II)

Course learning outcomes: By the conclusion of this course, the students-

- Outcome 1. Has acquired knowledge of population and quantitative genetics.
- Outcome 2. Has acquired a fairly good understanding mechanisms of transposition, mutations and their implications.
- Outcome 3. Has developed practical skill for isolation of bacteria/plasmid DNA and its visualization in gel after separation by electrophoresis.

Unit	Content	Total Credits :2 Contact hours:30
I	**Chromosome** Structure, Morphology, Organization, Heterochromatin and euchromatin, Lampbrush chromosome, polytene chromosome, Sex chromosomes, Role of chromosome in heredity. Mitosis, Meiosis. Karyotyping	6
II	**Mutation** Spontaneous and induced mutation. Chemical, physical and biological mutagenic agents. Effect of mutation and detection of mutants. Chromosomal abrasion – deletion, duplication, inversion, translocation. Numerical alteration in chromosome – polyploidy, aneuploidy, euploidy	6
III	**Transposable elements** Terminology, insertion sequences, types of bacterial transposons. Transposition – structure of transposons and target sites, replicative and nonreplicative transposition. Eukaryotic trasnsposable elements – DNA transposases, retroposes (LINES, SINES), Satellite DNA (mini & micro).	6
IV	**Population Genetics** Introduction, Hardy-Weinberg law, gene frequency, factors affecting gene frequency- migration, selection, genetic drift, inbreeding and Mutations. Significance of population genetics. Genetic basis of evolution, evolutions in some crop plants and animals	6
V	**Quantitative Genetics** Introduction, Multiple factor hypothesis, Transgressive segregation, Handling of quantitative data: mean, range, Variance, Standard deviation, Coefficient of Variation. Effects of the environment on quantitative traits.	6

References

1. Genetics: Principles and Analysis; Fourth Edition; Daniel L. Hartl; Jones Bartlet Publishers.
2. Genetics – B. D. Singh; Kalyani Publication
3. Principles of Genetics – E. J. Gardner; John Willey & Sons, New York.
4. Molecular Biology – P. K. Gupta
5. Genetics – M. W. Strickberger; Macmillan Publication
6. Heterochromatin Science – S. W. Brown
7. Plant Breeding – Principles and Methods: B. D. Singh: Kalyani Publication.
8. Experimental studies in Physiology of Hereditary; Bateson & Punnet; Harrison's & Sons, London
9. Gene VII; Benjamin Lewin; W. H. Freeman & Company.
10. Molecular Basis of Mutation: J. W. Drakey; Holdan Day, S

DSC 2C: GENERAL MICROBIOLOGY (PAPER-I)

Course learning outcomes: At the conclusion of this course the students –
Outcome 1. Have developed a good knowledge of the development of the discipline of Microbiology and the contributions made by prominent scientists in this field.
Outcome 2. Have developed a very good understanding of the characteristics of different types of microorganisms, methods to organize/classify these into and basic tools to study these in the laboratory.
Outcome 3. Are able to explain the useful and harmful activities of the microorganisms.
Outcome 4. Are able to perform basic experiments to grow and study microorganisms in the laboratory.

Unit	Content	Total Credits :2 Contact hours:30
I	**History and Development of Microbiology:** Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Antonie van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming,Paul Ehrlich, ElieMetchnikoff, Edward Jenner, Martinus W. Beijerinck, Sergei N. Winogradsky,Selman A.Waksman.Germ theory of disease, Hargovind Khorana.	**6**
II	**Taxonomy:** Systems of classification, Binomial Nomenclature, Whittaker's five kingdom and Carl Woese's three kingdom classification systems.Aim and principles ofBacterial classification, systematics and taxonomy, concept of species,taxa, strain;Differences between: prokaryotic-eukaryotic microorganisms, eubacteria-Archaebacteria.	**6**
III	**General characteristics of different groups:** Acellular microorganisms (Viruses,Viroids, Prions) and Cellular microorganisms (Algae, Fungi andProtozoa) withemphasis on distribution and occurrence, morphology, mode ofreproduction andeconomic importance. Study of bacteria-Size,Shape, Arrangement, Cellwall, Cell membrane, Flagella, Nuclear equivalent,Ribosome, Capsule with functions,Slime layer. Mesosomes, Pili	**6**
IV	**Microbial Nutrition and growth:** Nutritional requirement of microorganisms,Classification of microorganisms in response to Nutrition and Energy.Definitions of growth, Growth curve,Batch culture,Continuous culture, Synchronous growth,Diauxic growth,Microbial growth in response to environment(definition with one example) –Temperature, pH, soluteand water activity,Oxygen.	**6**
V	**Control of micro-organisms:** Definition of sterilization, disinfectant, antiseptic,germicide, antimicrobial agents. Physical agent of sterilization– Temperature (Dryheat, moist heat, incineration & boiling), Desiccation, Filtration, Radiation Chemical agents of Sterilization – Alcohols, Phenols, Halogens, gaseous agents(ethylene oxide, formaldehyde, Nitrous oxide, Ozone).	**6**

References: 1.Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9thedition. Pearson Education
2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology ofMicroorganisms. 14th edition. Pearson International Edition
3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9thedition. Pearson Education Limited
4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology.9th Edition. McGraw Hill International.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.BrownPublishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGraw Hill Book Company.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). GeneralMicrobiology. 5th edition. McMillan.

DSC 2C: GENERAL MICROBIOLOGY (PAPER-II)

Course learning outcomes: Major learning outcome of this course is that students develop a very good understanding of several microbiological techniques and instruments which are commonly used in a microbiology laboratory. The students have learnt-

Outcome 1. Principles which underlies sterilization of culture media, glassware and plasticware to be used for microbiological work.

Outcome 2.Principles of a number of analytical instruments which the students have to use during the study and also later as microbiologists for performing various laboratory manipulations.

Outcome 3. Handling and use of microscopes for the study of microorganisms which are among the basic skills expected from a practicing microbiologist. They also get introduced a variety of modifications in the microscopes for specialized viewing.

Outcome 4. Several separation techniques which may be required to be handled later as microbiologists.

Unit	Content	Total Credits :2 Contact hours:30
I	**Microscopy:** Construction, Working, Principles & Application of- Bright FieldMicroscopy, Dark Field Microscopy, Phase Contrast Microscopy, Fluorescent Microscopy, Confocal microscopy, Scanning and Transmission Electron Microscopy.	**6**
II	**Nutrition and Culture media:** components of media, natural and synthetic media,chemically defined media, complex media, selective, differential, indicator, enriched andenrichment media. Living media- Eggs, cell lines, animals.	**6**
III	**Cultivation and Isolation Techniques:** Serial dilution, Streak plate, Pour plate, Spreadplate. Cell Enumeration Techniques- Direct methods, DMC, Neubauer chamber, IndirectMethods- SPC/TVC, Membrane filter technique. Maintenance and preservation/stockingof pure cultures; cultivation of anaerobic bacteria.	**6**
IV	**Stains and staining procedures:** Difference between dye and stain.Classification ofStains – acidic, basic and neutral. Theories, Procedures and mechanisms of – Simplestaining, Differential staining, Gram staining, Acid fast staining, Negative staining,special staining- Capsule, Cell wall, Metachromatic granules.	**6**
V	**Microbial Biochemical Tests:** Media composition, mechanism and significance- IMViCtest, Catalase test, Starch hydrolysis test, casein hydrolysis test, urea hydrolysis test,sugar utilization test, nitrate reduction test, triple sugar iron agar test, Oxidase test,Coagulase test etc.	**6**

References:

1. Tortora GJ, Funke BR and Case CL. (2008). Microbiology: An Introduction. 9thedition. Pearson Education

2. Madigan MT, Martinko JM, Dunlap PV and Clark DP. (2014). Brock Biology ofMicroorganisms. 14th edition. Pearson International Edition

3. Cappucino J and Sherman N. (2010). Microbiology: A Laboratory Manual. 9th edition. Pearson Education Limited

4. Wiley JM, Sherwood LM and Woolverton CJ. (2013) Prescott's Microbiology. 9th Edition. McGraw Hill International.
5. Atlas RM. (1997). Principles of Microbiology. 2nd edition. WM.T.Brown Publishers.
6. Pelczar MJ, Chan ECS and Krieg NR. (1993). Microbiology. 5th edition. McGrawHill Book Company.
7. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology, 5th edition. McMillan.

DSC 3C: PLANT BIOTECHNOLOGY (PAPER-I)

Learning outcomes On the completion of the course the students will be able to

- Understand the core concepts and fundamentals of plant biotechnology and green house
- Develop their competency on different types of plant tissue culture
- Evaluate different methods production of haploids
- Understand the method of germ plasm storage and cryopreservation
- Critically analyze the major concerns and applications of plant biotechnology in sustainable agriculture

Unit	Content	Total Credits :2 Contact hours:30
I	**Introduction To Plant Biotechnology:** Introduction, History, New Technology, Origin Of Plant Biotechnology, Conventional Plant Breeding And Plant Tissue Culture, Terms Used In Plant Tissue Culture, Basic Techniques In Plant Tissue Culture.	4
II	**Embryo Culture:** History And Methodology In Seed Culture, Embryo Culture, Categories Of Embryo Culture, Objectives, Embryo Rescue, Application Of Embryo Culture In Plant Biotechnology**.**	6
III	**Production Of Haploids:** Invitro Haploid Production, Androgenic Methods, Anther Culture, Microspore Culture, Androgenesis, Significance And Use Of Haploids, Gynogenic Haploids, Factors Affecting Gynogenesis.	9
IV	**Germ Plasm Storage And Cryopreservation:** Cryopreservation, Cryoprotectant, Pretreatment Method-Freezing, Storage, Thawing. Viability Methods- TTC Method Of Staining, Evan's Blue Stain. Plant Growth And Regeneration, Slow Growth Method, Applications.	6
V	**Greenhouse Management:** Greenhouse Technology, Advantages Of Greenhouse, Classification Of Greenhouse, Types Of Greenhouse Based On Shape, Utility, Material And Constructions.	5

References:

1. An introduction to Plant Tissue Culture 2nd edn. Razdan, M. K, Science Publishers, USA.
2. Textbook of plant biotechnology, Chawala P.K.2002, Oxford & IBH, New Delhi.
3. Bhojwani, S. S. and M. K. Razdan 1996.Plant Tissue Culture:Theory and Practice, Elsevier Pub.
4. Chrispeels, M. J. 2002. Plant Tissue Culture: Genetical Aspects. Jones and Bortlett Publishers, International.
5. Chopra V. L. et al 1999. Applied Plant biotechnology. Science Publishers Inc.

6. Verpoorte, R. and A.W. Alfermann (Eds) 2000.Metabolic Engineering of plant secondary metabolism, lower Academic Publisher.
7. Chawla HC (2004) – Introduction to plant biotechnology (Science Publ)
8. Davies K (Ed) (2004) – Plant pigments and their manipulation – Annual plant revies, vol 14 Blackwell Publ)
9. Altman A, Hasegawa PM (Ed) (2012) – Plant Biotechnology and agriculture. Prospects for the 21th century (Academic press).
10. Bhojwani SS. &Razdan MK (1996). - Plant Tissue Culture: Theory & Practice (Elsevier)
11. Hou CT, Shaw JF (2009) – Biocatalysis and agricultural biotechnology (CRC Press)
12. Slater A, Scott NW, Fowler MR (2008) – Plant Biotechnology: the genetic manipulation of plants (Oxford Press)
13. Vasil IK, Thorpe TA (1994) – Plant cell and tissue culture (Springer)
14. H K Das Textbook of Biotechnology 4th edition

DSC 3C: PLANT BIOTECHNOLOGY (PAPER-II)

Learning outcomes On the completion of the course the students will be able to

- Outcome 1 Understand the core concepts and fundamentals of plant transformation technology
- Outcome 2 Develop their competency on development different types of GM plants
- Outcome 3 Understand the key concepts in plant development.

Unit	Topics	Total Credits :2 Contact hours:30
I	**UNIT-I Plant Transformation Technology-** Mechanism of DNA transfer:- Indirect method- (agro bacterium mediated gene transfer,Ti plasmid, Ri plasmids as vector) role of virulence genes; Direct method of gene transrfer- Partical bombardment , electroporation and microinjection.	**6**
II	**UNIT –II Metabolic engineering of plants:-** Plant cell culture for production of useful chemicals and secondary metabolites (Hairy roots culture, Biotransformation, Elecitation) pigments, flavonoids, alkaloids ; Mechanism and manipulation of shikimate pathway.	**6**
III	**UNIT-III Plant Development:-** Plant growth promoting bacteria(PGPB): Nitrogen fixation, Nitrogenase, hydrogenase, nodulation; vermicomposting technology. Biofrtilizers- types, production, VAM, Rhizobium, Azobactor. Biocontrol of pathogens:- herbicide resistant, viral resistant, bacterial resistant and fungal resistant crops.	**6**
IV	**UNIT- III GM Technology:-** Crop improvement, productivity, performance and fortification of agricultural product-Bt cotton, Bt brinjal, golden rice and transgenic sweet potato.	**7**
V	**UNIT- IV Applications of plant technology:-** Single cell protein (SCP)- introduction, microorganisms used in SCP. (Algal, fungi, spirulina, scenedesmus) Nutritional value of SCp. Algal Biomass production and maintainance. Mushroom cultivation- introduction, paddystrant and oyster mushroom, Nutritional value of mushroom cultivation and methods of cultivation, control of pests and pathogens. Edible vaccines and antibiotics using transgenic technology.	**5**

References:

1. An introduction to Plant Tissue Culture 2nd edn. Razdan, M. K, Science Publishers, USA.
2. Textbook of plant biotechnology, Chawala P.K.2002, Oxford & IBH, New Delhi.
3. Bhojwani, S. S. and M. K. Razdan 1996.Plant Tissue Culture:Theory and Practice, Elsevier Pub.
4. Chrispeels, M. J. 2002. Plant Tissue Culture: Genetical Aspects. Jones and Bortlett Publishers, International.
5. Chopra V. L. et al 1999. Applied Plant biotechnology. Science Publishers Inc.
6. Verpoorte, R. and A.W. Alfermann (Eds) 2000.Metabolic Engineering of plant secondary

metabolism, lower Academic Publisher.
7. Chawla HC (2004) – Introduction to plant biotechnology (Science Publ)
8. Davies K (Ed) (2004) – Plant pigments and their manipulation – Annual plant revies, vol 14 Blackwell Publ)
9. Altman A, Hasegawa PM (Ed) (2012) – Plant Biotechnology and agriculture. Prospects for the 21th century (Academic press).
10. Bhojwani SS. &Razdan MK (1996). - Plant Tissue Culture: Theory & Practice (Elsevier)
11. Hou CT, Shaw JF (2009) – Biocatalysis and agricultural biotechnology (CRC Press)
12. Slater A, Scott NW, Fowler MR (2008) – Plant Biotechnology: the genetic manipulation of plants (Oxford Press)
13. Vasil IK, Thorpe TA (1994) – Plant cell and tissue culture (Springer)
14. H K Das Textbook of Biotechnology 4th edition

SEMESTER IV

DSC 1D: MOLECULAR BIOLOGY (PAPER-I)

Learning outcomes on the completion of the course the students will be able to

- Outcome 1Understand the core concepts and fundamentals of central dogma and various repair mechanisms.
- Outcome 2 Thorough learning of the key concepts in molecular biology.
- Outcome 3 Students will able explain role of different proteins and enzymes in DNA replication and repair mechanisms.

Unit	Content	Total Credits :2 Contact hours:30
I	**Central Dogma** The Central Dogma, Mischer to Watson and Crick historic perspective; DNA structure; Salient features of double helix, Types of DNA	**4**
II	**Structure of Genetic Elements** DNA as genetic material, Molecular nature of Gene, Genetic code – evidences and properties. Denaturation and renaturation of DNA; cot curves; DNA topology-linking number, topoisomerases; Organization of DNA in Prokaryotes, Viruses, Eukaryotes; RNA Structure; Organelle DNA – mitochondria and chloroplast DNA.	**8**
III	**Replication of DNA in Prokaryotes** General principles - bidirectional replication, Semiconservative, Semi discontinuous; RNA priming;Enzyme involved in DNA replication of prokaryotes – DNA polymerases, DNA ligase, Primase, and other accessory proteins; Initiation, elongation and termination of replication, Various models of DNA replication including rolling circle, Θ (theta) mode of replication, replication of linear ds-DNA.	**9**
IV	**Replication of DNA in Eukaryotes** D-loop (mitochondrial) replication model; DNA polymerases of eukaryotes; Initiation, elongation and termination of replication.	**5**
V	**Mutability and Repair of DNA** DNA damage; DNA Repair- Photoreactivation, Mismatch, Excision, Recombination, SOS repair mechanisms and disorders.	**4**

References

1. Molecular Biology; R. Weaver; 2nd Edition, McGraw Hill.
2. Molecular Cell Biology; Lodish; 6th Edition; W. H. Freeman & Company.
3. Gene VII; Benjamin Lewin; Pearson Education.
4. Genetics; B.D. Singh; Kalyani Publication

DSC 1D : MOLECULAR BIOLOGY (PAPER-II)

Learning outcomes on the completion of the course the students will be able to

- Outcome 1 Understand the core concepts and fundamentals of gene expression mechanisms.
- Outcome 2 Thorough learning of the key concepts in transcription and translation.
- Outcome 3 Students will able explain role of different proteins and enzymes in transcription and translation mechanisms.

Unit	Content	Total Credits :2 Contact hours:30
I	**Transcription** RNA polymerase and the transcription unit; Initiation, elongation and termination of transcription in Prokaryotes and Eukaryotes	**6**
II	**Transcription Regulation in Prokaryotes** Principles of transcriptional regulation; Operon concept; Repression and induction of genes; Regulation of operon : Lac operon and Trp operon.	**6**
III	**Transcription Regulation in Eukaryotes** Regulatory Sequences- Promotors and Enhancers, Eukaryotic Activaters, Repressors, Transcriptional Regulatory Protein, Regulation of Transcription by Non-Encoding RNA signal integration, Signal Transduction in Regulation [Ex. Auxin]	**3**
IV	**RNA Modification** Split genes, concept of introns and exons, removal of Introns, spliceosome machinery, splicing pathways, alternative splicing, exon shuffling, RNA editing, and mRNA transport	**6**
V	**Translation (Prokaryotes and Eukaryotes)** Ribosome structure and assembly; various steps in protein synthesis; Charging of tRNA, amino acyl tRNA synthetases; Proteins involved in initiation, elongation and termination of polypeptides; Fidelity of translation; Inhibitors of protein synthesis; Regulation of translation- Translation dependent regulation of mRNA and Protein Stability, Post translational modifications.	**9**

References

1. Molecular Biology; R. Weaver; 2nd Edition, McGraw Hill.
2. Molecular Cell Biology; Lodish; 6th Edition; W. H. Freeman & Company.
3. Gene VII; Benjamin Lewin; Pearson Education.
4. Genetics; B.D. Singh; Kalyani Publication
5. Life-The Science of Biology; David Sadava; 9th Edition; W. H. Freeman & Company

DSC 2D: IMMUNOLOGY (PAPER-I)

Learning outcomes on the completion of the course the students will be able to

- Outcome 1 Understand the core concepts and fundamentals of innate and cognate immunity.
- Outcome 2 Thorough learning of the key concepts in antigen, antibody, cells & organ system Students will able explain role of different cells & organs involved in immune system and major histocompatibility complex.

Unit	Content	Total Credits :2 Contact hours:30
I	**Native or Innate immunity**: Introduction, First line of Defense – Physical and Chemical barriers at the portal of entry. Second line of Defense –Cellular Processes in nonspecific defense mechanism **Haematopoisis**: Introduction, factors involved in hematopoisis, programmed cell death and Homeostasis	**6**
II	**Cells of immune system**: B lymphocytes, T lymphocytes, Natural Killer Cells, Mononuclear phagocytes, Dendritic cells, Follicular dendritic cells. **Organs of immune system**: Structure and functions of primary lymphoid organs (Thymus, Bone marrow, and Lymphatic system), secondary lymphoid organs (Lymph nodes, Spleen, Mucosa Associated Lymphoid Tissue and Cutaneous Associated Lymphoid Tissue).	**6**
III	**Antigen**: Introduction, immunogenicity, antigenicity, types of antigens, properties of immunogen, role of biological system in immunogenicity (genotype of animal, immunogen dosage, route of Administration), adjuvant, epitope.	**3**
IV	**Antibody**: Introduction, History of Antibody invention(*Instructive and selective theories of antibody production)*, basic structure and biological function of antibody classes, antigenic determinants, Antibody diversity	**6**
V	**Major Histocompatibility Complex**: Introduction, classes-structure and function. **Cytokines**: Introduction, properties, function, Cytokine receptors **Complement system**: Introduction, functions, components, general account on complement activation – classical and alternative pathways	**9**

References

1. Immunology - Kuby
2. Essential Immunology- Roitt
3. Cellular and Molecular Immunology- Abbas
4. Immunology and Serology- Philip Carpenter
5. Textbook of Immunology- Barrette J.T.
6. Basic and Clinical Immunology- Fundenberg H.
7. Biology of Immune response- Abramoff and Lavice
8. Fundamental Immunology 5th edition (August 2003): by William E., Md. Paul
9. Immunology an Introduction- Tizard
10. TextText book of Medical laboratory technology,Vol.1&2 -PrafulGodkar and DarshanGodkar

DSC 2D: IMMUNOLOGY (PAPER-II)

Learning outcomes on the completion of the course the students will be able to

•Outcome 1 Understand the core concepts and fundamentals of humoral and cell mediated immunity, autoimmunity, vaccines and antigen-antibody interactions.

- Outcome 2 Thorough learning of the key concepts in humoral and cell mediated immunity, autoimmunity, vaccines and antigen-antibody interactions.
- Outcome 3 Students will able explain type of immune response, processing of antigen, types of autoimmune diseases and antigen and antibody interactions.

Unit	Content	Total Credits :2 Contact hours:30
I	**Humoral immunity**: Components of Humoral Immunity, Primary and secondary immune response, B cell – maturation, activation, differentiation. Antibody production against T cell dependent and independent antigens, Processing of Exogenous Antigens – The Endocytic Pathway.	**6**
II	**Cell mediated Immunity:** Processing of Endogenous Antigens by the Cytosolic Pathway, T cell – maturation, activation, differentiation. Mechanism of CTL mediated cytotoxicity	**4**
III	**Autoimmunity**: Introduction, general mechanism, classification of autoimmune diseases Hemolytic, organspecific (Hashimoto's disease, Grave's disease, Myasthenia Gravis) and non-organ specific (RA). Introduction to Hypersensitivity. Immunodeficiency disease: AIDS	**4**
IV	**Vaccines**: Introduction active and passive immunization, Types of vaccines – Live-attenuated, killed, subunit, conjugate, DNA vaccines, recombinant Vector vaccines, Vaccination Schedule.	**4**
V	**Antigen antibody interactions**: Principles and applications of interaction, strength of interactions, crossreactivity, features of interactions, and measurement of antigen-antibody. Reactions of antigen-antibody complex – precipitation, flocculation, agglutination, complement fixation. Immunodiffussion, Immuno- electrophoresis, Complement FixationTest, Immunofluorescence Test, Radioimmunoassay, ELISA.	**7**
VI	**Immunity to infections:** Specific and Nonspecific immunity to Bacteria, Fungi, Virus and Protozoa infections.	**5**

References

1. Immunology - Kuby
2. Essential Immunology- Roitt
3. Cellular and Molecular Immunology- Abbas
4. Immunology and Serology- Philip Carpenter
5. Textbook of Immunology- Barrette J.T.

6. Basic and Clinical Immunology- Fundenberg H.
7. Biology of Immune response- Abramoff and Lavice
8. Fundamental Immunology 5th edition (August 2003): by William E., Md. Paul
9. Immunology an Introduction- Tizard
10.TextText book of Medical laboratory technology,Vol.1&2 –Praful Godkar and Darshan Godkar

DSC 3D: ANIMAL BIOTECHNOLOGY (PAPER-I)

Upon completion of the course, students should be able to:

•Outcome 1 Use or demonstrate the basic techniques of biotechnology like DNA isolation, PCR, transformation, restriction digestion etc.

•Outcome 2 Make a strategy to manipulate genetic structure of an organism for the improvement in any trait or its well-being based on the techniques learned during this course.

•Outcome 3 Understand better the ethical and social issues raised regarding GMOs.

•Outcome 4 Use the knowledge for designing a project for research and execute it.

Unit	Content	Total Credits :2 Contact hours:30
I	**Animal Cell Culture:** Culture and maintenance of primary and established cell lines; Biology of cultured cells – culture environment, cell adhesion, cell proliferation and differentiation; Characterization of cultured cells, cell viability and cytotoxicity and expression of culture efficiency	7
II	**Stem cells technology:** Introduction and scope, Types of Stem cells, Stem cell culture techniques and their applications;	5
III	**Genetic manipulation of animals:** Introduction to transgenesis, Genetic manipulation of animals by Pronuclear microinjection, Recombinant retroviruses and Transfection of Embryonic Stem Cells;	6
IV	**Animal propagation:** Cloning livestock by nuclear transfer and In Vitro Fertilization (IVF) technology for livestock, Conservation Biology – Embryo transfer techniques.	6
V	**Biosafety:** The Cartagena protocol on biosafety, levels of containment, Good Manufacturing Practice and Good Laboratory Practice (GMP and GLP), Use of genetically modified organisms and their release to environment	6

References:

1. Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis. II Edition. Academic Press, California,USA.
2. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers
3. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applications of recombinant DNA. IV Edition. ASM press, Washington, USA
4. Molecular Biotechnology – S. B. Primerose
5. Principals of Gene Manipulation – Primerose
6. Culture of animal cell 3rd edition-R Ian Freshney
7. M. K. Sateesh (2010) Bioethics and Biosafety; I. K. International Publishing House Pvt. Ltd.
8. LIFE SCIENCES PROTOCOL MANUAL (2018) Compiled by Dr. P. Hemalatha Reddy, Dr. Suman Govil, Department of Biotechnology, Ministry of Science & Technology, Government of India
9. P.M. Swami (2008) Laboratory Manual on Biotechnology; Rastogi Publications

DSC 3D: ANIMAL BIOTECHNOLOGY (PAPER-II)

Upon completion of the course, students will be able to: Get a clear concept of the basic principles and applications of biotechnology.

•Outcome 1 Know the basic techniques used in genetic manipulation helping them continue with higher studies in this field.

•Outcome 2 Acquire knowledge of the basic principles, preparations and handling required for animal cell culture.

•Outcome 3 Understand principles underlying the design of fermenter and fermentation process and its immense use in the industry.

•Outcome 4 Design small experiments for successful implementation of the ideas and develop solutions to solve problems related to biotechnology keeping in mind safety factor for environment and society.

•Outcome 5 Apply knowledge and skills gained in the course to develop new diagnostic kits and to innovate new technologies further in their career.

•Outcome 6 Enhance their understanding of the various aspects and applications of biotechnology as well as the importance of bio-safety and ethical issues related to it.

Unit	Content	Total Credits :2 Contact hours:30
I	**Transgenic Animals** –Cow, Pig, Sheep, Goat, Bird. Transgenic mice model for tackling human diseases	6
II	**Importance of Biotechnology in Animal diseases** – Foot-and mouth disease, Coccidiosis, Trypanosomiasis, Theileriosis.	5
III	**Genetic modification in Medicine:** Gene therapy – use of genes to prevent, treat or cure disease; vectors in gene therapy Gene augmentation therapy – transferring a functional copy of the gene into the genome	7
IV	**Applications of Animal Biotechnology:** Improvement of biomass, livestock-pharming products, pharmaceutical products produced by mammalian cells, cell culture based vaccines, monoclonal antibodies production	6
V	**Bioethics:** Use of animals for research and testing, Use of cell cultures as alternative for animal models for research, Ethical issues associated with consumptions of genetically modified foods, animal and human genetic engineering/cloning – ethical and social issues	6

References:

1. Brown, T.A. (1998). Molecular biology Labfax II: Gene analysis. II Edition. Academic Press, California,USA.
2. Butler, M. (2004). Animal cell culture and technology: The basics. II Edition. Bios scientific publishers
3. Glick, B.R. and Pasternak, J.J. (2009). Molecular biotechnology- Principles and applications of recombinant DNA. IV Edition. ASM press, Washington, USA
4. Molecular Biotechnology – S. B. Primerose

5. Principals of Gene Manipulation – Primerose
6. Culture of animal cell 3rd edition-R Ian Freshney
7. M. K. Sateesh (2010) Bioethics and Biosafety; I. K. International Publishing House Pvt. Ltd.
8. LIFE SCIENCES PROTOCOL MANUAL (2018) Compiled by Dr. P. Hemalatha Reddy, Dr. Suman Govil, Department of Biotechnology, Ministry of Science & Technology, Government of India
9. P.M. Swami (2008) Laboratory Manual on Biotechnology; Rastogi Publications

PRACTICALS

PRACTICAL COURSE: DSC 1C & 1D GENETICS AND MOLECULAR BIOLOGY

Sr. No	Practical Title
1.	Meiosis in Flower Buds of *Allium cepa*-Acetocarmine Stain
2.	Study of Mendelian Traits
3.	Problem sets in Mendelian inheritance, single point, two point crosses and gene interaction & gene mapping
4.	Induction of Polyploidy
5.	Identification of mutant phenotypes- Body shape / nature of wings / eye colour in *Drosophila*.
6.	Sex-Linked Inheritance in *Drosophila melanogaster*
7.	Preparation of Salivary Gland Chromosomes
8.	Culture maintenance of *Drosophila*
9.	Spontaneous mutation: Fluctuation test – StrR
10.	Examples based on Hardy Weinberg Equilibrium
11.	Isolation of bacterial DNA
12.	Isolation of Plasmid DNA
13.	Isolation of DNA from animal cell / plant cell / yeast cells
14.	Isolation of DNA from yeast cells
15.	Isolation of RNA from yeast
16.	Isolation of RNA from plant cells / tissue
17.	Separation of nucleotides by column chromatography
18.	Isolation of coli phages
19.	Transfer of genetic material – Transformation
20.	Transfer of genetic material – Conjugation
21.	Transfer of genetic material – Transduction
22.	Visit to Molecular Biology Laboratory OR Review of recent advances in Molecular Biology or Molecular Genetics thereby submitting a brief report

PRACTICAL COURSE: DSC 2C & 2D GENERAL MICROBIOLOGY AND IMMUNOLOGY

Sr. No	Practical Title
1	Study of Compound Microscope
2	Demonstration of Laboratory Equipments: Incubator, Autoclave, Hot Air Oven, Centrifuge,Laminar Air flow, Colony counter.
3	Monochrome staining
4	Negative staining
5	Gram staining
6	Hanging drop technique
7	Cell wall staining
8	Mounting & Identification of Fungi
9	Isolation of *E. coli* on differential media (Streak plate technique)
10	IMViC test
11	Enumeration of microorganisms from Soil by SPC (Pour Plate technique)
12	Enumeration of microorganisms from Soil by SPC (Spread plate technique)
13	Growth curve
14	Latex agglutination test
15	Coomb's test
16	Ouchterlony procedure
17	Counter current immunoelectrophoresis
18	Rocket immunoelectrophoresis
19	Widal Test (Qualitative and Quantitative)
20	VDRL Test
21	Visit to any recognize Biochemistry and Microbiology (or Pathology lab) laboratory OR Review of recent advances in Techniques in Biochemistry/Immunology thereby submitting a brief report

PRACTICAL COURSE: DSC 3C & 3D PLANT BIOTECHNOLOGY AND ANIMAL BIOTECHNOLOGY

Sr. No	Practical Title
1.	Initiation and establishment of cell suspension culture.
2.	Protoplast fusions and culture by calcium ion or polyethylene glycol (**PEG**) method.
3.	Isolation of Ti plasmid from *Agrobacterium tumefaciens*.
4.	Anther culture and production of haploids.
5.	Synthetic seed production.
6.	Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization,
7.	Laboratory sterilization
8.	Sources of contamination and decontamination measures.
9.	Preparation of Hanks Balanced salt solution
10.	Preparation of Minimal Essential Growth medium
11.	Isolation of lymphocytes for culturing
12.	DNA isolation from animal tissue
13.	Quantification of isolated DNA.
14.	Resolving DNA on Agarose Gel.
15.	Cell Viability test by dye uptake assay
16.	Cell Viability test by dye exclusion assay
17.	Visit to biotechnology or tissue culture lab. And their by submitting the brief report.