Shikshan Haach Dharma

Shri. S.A.P.D. Jain Pathashala's
(Jain Minority Institute)

Walchand College of Arts & Science, Solapur

Autonomous College

(Affiliated to P.A.H. Solapur University, Solapur)

Name of Faculty: Science & Technology

New Choice Based Credit System

B.Sc. Part-II
Subject: Biotechnology

With Effects from: 2022-23

Walchand College of Arts & Science, Solapur

(Autonomous College)
Faculty of Science
Choice Based Credit System (CBCS)
B.Sc.-II Biotechnology
(2022-2023: w. e. f. June 2022)

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 in various 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 related fields 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

Walchand College of Arts and Science (Autonomous), Solapur
Faculty of Science & Technology
Choice Based Credit System (CBCS): (w.e.f. 2022-23):
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	ESE	ISE	Credits
	Type	Name		L	T	P				
Class :	**B.Sc.- II Biotechnology Semester – III**									
Core (*Students can opt any Three subjects among the Four Subjects offered at B.Sc II. 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	
Total (Sem-III)				**18**	**--**	**--**	**300**	**240**	**60**	**12**
Class :	B.Sc.- II Semester – IV									
Core (*Students can opt any Three subjects among the Four Subjects offered at B.Sc.II. Out of		DSC 1D Molecular Biology	Paper-I: Molecular Biology-I	3.0	--	--	50	40	10	4.0
			Paper-II: Molecular	3.0	--	--	50	40	10	

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.II. Out of Two Subjects One Subject will be the Core Subject and any One Subject among the other will be Elective Subject		Biology-II							
	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	
	AECC – Environmental Studies		3.0	--	--	50	40	10	NC
Total (Sem-IV)			**21**	**--**	**--**	**350**	**280**	**70**	**12**
Total (Theory)			**39**			**650**	**520**	**130**	**24**
DSE (Practical)	Practical-V (DSC-1C &1D)	Paper-I & II	--	--	8	100	80	20	4.0
	Practical-VI (DSC-2C&2D)	Paper-I & II	--	--	8	100	80	20	4.0
	Practical-VII(DSC-3C &3D)	Paper-I & II	--	--	8	100	80	20	4.0
Total (Practical)					**24**	**300**	**240**	**60**	**12**
Grand Total			**39**		**24**	**950**	**760**	**190**	**36**

Abbreviations:
L: No. of Lectures
P: Practical (Number of lectures/practical/batch)
IE: Internal Evaluation
ESE: End Semester Examination
CC: Core Course
AECC: Ability Enhancement Compulsory Course
NC: Non-credit
C: Subjects for Semester-III
D: Subjects for Semester-IV

WALCHAND COLLEGE OF ARTS AND SCIENCE, (AUTONOMOUS) SOLAPUR
Faculty of Science
Choice Based Credit System (CBCS)
(W.e.f. 2022-23)

• **Title of the Course:** B. Sc. Part-II

• **Subject:** Biotechnology

• **Preamble**: 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

Pattern of the Course: The autonomous college follows semester pattern.

Outline of Examination:

 Internal Examination (Theory): Internal examination will consist of **10 marks** per semester per paper. It may be held as **any two components** per semester from (a) to (e).

a) Presentation
b) MCQ Test (Online/Offline)
c) Field studies / Study visits
d) Home Assignments (Online/Offline)
e) Written Test

 Internal Evaluation (IE) (Practical): Internal examination will consist of **20 marks** and may consists of:
Major Practical-15M
Minor practical-5M

 End Semester Examination (Theory): The detailed question paper pattern is given as **Annexure-I**.

 End-semester Practical Examination:
Practical examination shall be conducted at the end of academic year. Certified journal is compulsory for appearing in the examination. The detailed question paper pattern is given as **Annexure-II**

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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 (2022-23)

SEMESTER- III (THEORY)

Paper	Title	Marks
DSC 1C	Genetics	50 (40- ESE and 10-ISE)
DSC 2C	General Microbiology	50 (40- ESE and 10- ISE)
DSC 3C	Plant Biotechnology	50 (40- ESE and 10- ISE)
AECC	Environmental Studies	NC

SEMESTER- IV (THEORY)

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

PRACTICALS

PRACTICAL	Title	Marks
Practical-V (DSC 1C & 1D)	Genetics and Molecular Biology	100 (80-ESE and 20-ISE)
Practical-VI (DSC 2C & 2D)	General microbiology and Immunology	100 (80-ESE and 20-ISE)
Practical-VII (DSC 3C & 3D)	Plant Biotechnology and Animal Biotechnology	100 (80-ESE and 20-ISE**)**
	Total Marks	300 (240-ESE and 60-ISE)

WALCHAND COLLEGE OF ARTS AND SCIENCE (AUTONOMOUS), SOLAPUR

Choice Based Credit System (CBCS)

B. Sc. II BIOTECHNOLOGY- SEMESTER III

DSC 1C: GENETICS

About the course:

Genetics course will enable you to study a discipline of fundamental importance to all branches of modern biology, from evolutionary biology to medicine, extending into practical areas such as biotechnology and agriculture. Students will discover the principles of heredity and evolution and learn how we can map genes, and understand their function.

DSC 1C: GENETICS (PAPER-I)

Total Credits :2 **Contact hours:30**

Unit	Content	Hrs: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 and hypostasis.	**7**
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.	**5**
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.	**5**
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.	**5**
VI	**Physical Mapping of Gene on chromosome** In-situ hybridization with DNA probes using FISH and GISH. Introduction of Gene sequencing and bar coding, micro array technology.	**3**
SUGGESTED READING:		

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)

Total Credits :2 **Contact hours:30**

Unit	Content	Hrs:30
I	**Chromosome** Structure, Morphology, Organization, Heterochromatin and Euchromatin, Lampbrush chromosome, polytene chromosome, Sex chromosomes, Role of chromosome in heredity. Mitosis, Meiosis. Karyotyping	**5**
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	**5**
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.	**5**
VI	**Epigenetics** Definition, Molecular basis and mechanism of epigenetics, functions.	**3**
SUGGESTED READING:		

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

Learning Outcomes:

After completion of this course, students will be able to:

- Get the knowledge and skills to explain the key concepts in gene mapping, inheritance and linkage.
- Understand the key concepts of gene transfer in bacteria.
- Understand how alteration in genes results in various sex-linked disorders.knowledge of population and quantitative genetics.
- Acquire good understanding of mechanism of transposition, mutations and their implications.
- Develop practical skill for isolation of bacteria/plasmid DNA and its visualization in gel after separation by electrophoresis**.**

DSC 2C: GENERAL MICROBIOLOGY

About the course:

General Microbiology encompasses the study of various microorganisms and their respective impact & contribution to the environment. It involves the historical approach to microbiology and also the implementations of various microbial techniques performed in research, industrial fields.

DSC 2C: GENERAL MICROBIOLOGY (PAPER-I)

Total Credits :2 **Contact hours:30**

Unit	Content	Hrs:30
I	**History and Development of Microbiology** Development of microbiology as a discipline, Spontaneous generation vs. biogenesis. Contributions of Antony van Leeuwenhoek, Louis Pasteur, Robert Koch, Joseph Lister, Alexander Fleming, Paul Ehrlich, Elie Metchnikoff, Edward Jenner, Martinus W. Beijerinck	**5**
II	**Bacterial Taxonomy**: General principles of nomenclature For bacterial classification: morphological, cultural, biochemical, and serological. Classification schemes: phonetic and phylogenetic classification. Concept of Numerical Taxonomy	**5**
III	**General characteristics of type of microrganisms** Differences between: prokaryotic-eukaryotic microorganisms. Types of microorganisms: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Algae, Fungi, Protozoa, bacteria) with emphasis on distribution and occurrence, morphology, mode of reproduction and economic importance.	**5**
IV	**Study of bacteria** Size, Shape, Arrangement, structure and function of Cell wall, Cell membrane, Flagella, Nuclear equivalent, Ribosome, Capsule, Slime layer. Mesosomes, Pili,	**5**
V	**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,	**5**
VI	**Control of micro-organisms**: Definition of sterilization, disinfectant, antiseptic, germicide, antimicrobial agents. Physical agent of sterilization– Temperature (Dry heat, moist heat, incineration & boiling), Desiccation, Filtration, Radiation Chemical agents of Sterilization – Alcohols, Phenols, Halogens, gaseous Agents (ethylene oxide, formaldehyde, Nitrous oxide, Ozone)	**5**

DSC 2C: GENERAL MICROBIOLOGY (PAPER-II)

Total Credits :2 **Contact hours:30**

Unit	Content	Hrs:30
I	**Microscopy** Construction, Working, Principles & Application of- Bright Field Microscopy, Dark Field Microscopy, Phase Contrast Microscopy, Fluorescent Microscopy, Confocal microscopy. Handling and care of compound microscope. (new microscopy techniques)	**5**
II	**Nutrition and Culture media** Components of media, natural and synthetic media, complex media, selective, differential, indicator, enriched and enrichment media. Living media- Eggs, cell lines, animals.	**5**
III	**Cultivation and Isolation Techniques** Serial dilution, Streak plate,Pour plate, Spread plate. Cell Enumeration Techniques- Direct Methods: DMC, Neubauer's chamber, Indirect Methods- SPC/TVC, Membrane filter technique. Maintenance and preservation/stocking of pure cultures; cultivation of anaerobic bacteria.	**5**
IV	**Stains and staining procedures** Difference between dye and stain. Classification of Stains – acidic, basic and neutral. Theories, Procedures and mechanisms of – Simple staining, Differential staining, Gram staining, Acid fast staining, Negative staining, special staining- Metachromatic granules.	**5**
V	**Microbial Biochemical Tests** Media composition, mechanism and significance- IMViC test, 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 .	**5**
VI	**Microbial Interactions** **C**oncept of Commensalism, symbiosis, amensalism, parasitism and predation, competition**.** Application of positive microbial interactions to plants and human.	**5**

SUGGESTED READING:

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 Biologyof Microorganisms. 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). General Microbiology, 5th edition. McMillan.

Learning Outcomes:

After completion of this course, students will be able to:

- Developed a good knowledge of the development of the discipline of Microbiology and the contributions made by prominent scientists in this field.
- 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.

- Explain the useful and harmful activities of the microorganisms.
- Perform basic experiments to grow and study microorganisms in the laboratory.
- Get the knowledge of Principles which underlies sterilization of culture media, glassware and plastic wares to be used for microbiological work..
- Perform 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.
- Understand the key concepts of techniques which may be required to be handled later as microbiologists.

DSC 3C: PLANT BIOTECHNOLOGY

About the course:

Plant Biotechnology is a branch of biology that involves the scientific study of plant life. Plant biology is an area that concentrates the complete plant kingdom. Biotechnology applies technological methods to biological systems and living organisms to customize products and processes. The course includes biochemistry, molecular biology, biophysics, immunology, genetic engineering, plant biotechnology, animal biotechnology, environmental biotechnology, agricultural biotechnology, medical biotechnology, cell biology, microbiology, etc.

DSC 3C: PLANT BIOTECHNOLOGY (PAPER-I)

Total Credits :2 **Contact hours:30**

Unit	Content	Hrs: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**.**	5
III	**Production Of Haploids** Invitro Haploid Production, Androgenic Methods, Anther Culture, Microspore Culture, Androgenesis, Significance And Use Of Haploids,.	8
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.	5
V	**Greenhouse Management** Greenhouse Technology, Advantages Of Greenhouse, Classification Of Greenhouse, Types Of Greenhouse Based On Shape, Utility, Material And Constructions.	4
VI	**Applications of Plant Biotechnology** Commercial Micro propagation, Industrial products; Industrial enzymes, Biodegradable plastics, Therapeutic proteins, edible vaccines.	4

SUGGESTED READING:

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)

Total Credits :2 **Contact hours:30**

Unit	Content	Hrs:30
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 transfer- Partical bombardment , electroporation and microinjection.	6
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.	5
III	**Plant Development** Plant growth promoting bacteria (PGPB): Nitrogen fixation, Nitrogenase, hydrogenase, nodulation; vermicomposting technology. Biofertilizers- types, production, VAM, Rhizobium, Azobactor. Biocontrol of pathogens:- herbicide resistant, viral resistant, bacterial resistant and fungal resistant crops.	6
IV	**GM Technology** Crop improvement, productivity, performance and fortification of agricultural product-Bt cotton, Bt brinjal, golden rice and transgenic sweet potato.	5
V	**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.	5

	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.	
VI	**Role of plant biotechnology in conservation –** Significance of conservation, synthetic seed preparation : principle, method and its application	**3**

SUGGESTED READING:

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)
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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

Learning Outcomes:

After completion of this course, 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 Germplasm storage and cryopreservation
- Critically analyze the major concerns and applications of plant biotechnology in sustainable agriculture
- Understand the core concepts and fundamentals of plant transformation technology
- Develop their competency on development different types of GM plants
- Understand the key concepts in plant development.

SEMESTER IV

DSC 1D: MOLECULAR BIOLOGY

About the course:

The course will provide a brief overview of Nucleic acid background comprising of salient features and models of DNA and RNA. The course will mainly focus on the study of principal molecular events of cell incorporating DNA Replication, Transcription and Translation in

prokaryotic as well as eukaryotic organisms. The course will also emphasize Post Transcriptional Modifications and Processing of Eukaryotic RNA covering the concepts of Split genes, Introns, Exons, Splicing Mechanisms and RNA Editing.

DSC 1D: MOLECULAR BIOLOGY (PAPER-I)

Total Credits :2 **Contact hours:30**

Unit	Content	Hrs: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.	**7**
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.	**8**
IV	**Replication of DNA in Eukaryotes** D-loop (mitochondrial) replication model; DNA polymerases of eukaryotes; Initiation, elongation and termination of replication.	**4**
V	**Mutability and Repair of DNA** DNA damage; DNA Repair- Photoreactivation, Mismatch, Excision, Recombination, SOS repair mechanisms and disorders.	**4**
VI	**Recombination:** Homologous (General and Site specific) and Non Homologous recombination in prokaryotes and eukaryotes. Mechanisms and proteins involved	**3**

SUGGESTED READING:

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)

Total Credits :2 **Contact hours:30**

Unit	Content	Hrs:30
I	**Transcription**	**6**

	RNA polymerase and the transcription unit; Initiation, elongation and termination of transcription in Prokaryotes and Eukaryotes	
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** mRNA processing; 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.	**6**
VI	**Regulation of Gene expression**: In plant cells by light. In animal cells by hormones and signaling factors, Diseases associated with defects in regulation.	**3**

SUGGESTED READING:

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

Learning Outcomes:

After completion of this course, students will be able to:

- Understand the core concepts and fundamentals of central dogma and various repair mechanisms.
- Learn the key concepts in molecular biology.
- Explain role of different proteins and enzymes in DNA replication and repair mechanisms.
- Understand the core concepts and fundamentals of gene expression mechanisms.
- Understand of the key concepts in transcription and translation.
- Explain role of different proteins and enzymes in transcription and translation mechanisms.

DSC 2D: IMMUNOLOGY

About the course:

Immunology is the science which covers the study of immune system, its functioning, its components and characteristics. It has applications in numerous disciplines of medicines, pathology, research, vaccine production, diagnostics and Genetic engineering.

DSC 2D: IMMUNOLOGY (PAPER-I)

Total Credits :2 **Contact hours:30**

Unit	Content	Hrs: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 Hematopoisis: Introduction, Process of hematopoiesis, factors involved in hematopoiesis, programmed cell death and Homeostasis	5
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).	**5**
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.	**5**
IV	**Antibody**: Introduction, History of Antibody invention (Instructive and Selective) basic structure and biological function of antibody classes, antigenic determinants	**5**
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 pathway	**5**
VI	**Nutrition and Immunity:** Balanced and healthy diet, Role of specific nutrient in maintain optimal immune system. Locally available foods and fruits as source of nutrients. Dietary Guidelines to enhance immunity.	**5**

SUGGESTED READING:

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 2D: IMMUNOLOGY (PAPER-II)

Total Credits :2 **Contact hours:30**

Unit	Content	Hrs: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. Role of cytokines in Humoral Immunity	6
II	**Cell mediated Immunity** Processing of Endogenous Antigens by theCytosolic Pathway, T cell – maturation, activation, differentiation. Mechanism of CTL mediated cytotoxicity (Lytic activity mediated by perforin and Granzymes, Fas pathway), role of cytokines in cell mediated Immunity	4
III	**Autoimmunity** Introduction, general mechanism, classification of autoimmune diseases Hemolytic, organs specific (Grave's disease, Myasthenia Gravis) and non-organ specific (RA, SLE). Introduction to Hypersensitivity. General Mechanisms types of hypersensitivity reactions.	4
IV	**Vaccines** Introduction active and passive immunization, Types of vaccines – Live-attenuated, killed, subunit, conjugate, DNA vaccines, recombinant Vector vaccines,	4
V	**Antigen antibody interactions** Principles and applications of interaction, strength of interactions, cross-reactivity, features of interactions, and measurement of antigen-antibody. Reactions of antigen-antibody complex – precipitation, flocculation, agglutination, complement fixation. Immunodiffusion, Immuno- electrophoresis.	7
VI	**Immunity to infections** Specific and Nonspecific immunity to Bacteria, Fungi, Virus and Protozoa infections.	5

SUGGESTED READING:

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

Learning Outcomes:

After completion of this course, students will be able to:

- Understand the core concepts and fundamentals of innate and cognate immunity.
- Get the knowledge of the key concepts in antigen, antibody, cells & organ system Students will able to explain role of different cells & organs involved in immune system and major histocompatibility complex.
- Understand the core concepts and fundamentals of humoral and cell mediated immunity, autoimmunity, vaccines and antigen-antibody interactions.
- Get the knowledge of the key concepts in humoral and cell mediated immunity, autoimmunity, vaccines and antigen-antibody interactions.
- Explain type of immune response, processing of antigen, types of autoimmune diseases and antigen and antibody interactions.

DSC 3D: ANIMAL BIOTECHNOLOGY

About the course:

Animal biotechnology is a branch of biotechnology in which molecular biology techniques are used to genetically engineer animals in order to improve their suitability for agriculture, industrial and pharmaceutical applications. Advances in animal biotechnology have been facilitated by recent progress in sequencing animal genomes, gene expression and metabolic profiling of animal cells. The objective of this course is to familiarize the techniques involved animal biotechnology.

DSC 3D: ANIMAL BIOTECHNOLOGY (PAPER-I)

Total Credits :2 **Contact hours:30**

Unit	Content	Hrs:30
I	**Mammalian Cell Culture Products** Viral Vaccines: Production of viruses, Cell line for vaccine production; Glycoprotein from mammalian cells: Interferons, Plasminogen activators, Blood clotting factors, Erythropoietin Cells as product: Artificial skin, Artificial organs.	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, Conservation Biology – Embryo transfer	3
V	**Hybridomas- source of Antibodies** Introduction, Antibody production invivo, Monoclonal antibodies – Immunization invivo, Immunization invitro, Cell hybridization, Cell Selection, Assay of Monoclonal antibodies.	5
VI	**Biosafety** The Cartagena protocol on biosafety, levels of containment, Good Manufacturing Practice and Good Laboratory Practice (GMP and GLP), Useof genetically modified organisms and their release to environment	4

SUGGESTED READING:

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. IVEdition. 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, Departmentof 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)

Total Credits :2 **Contact hours:30**

Unit	Content	Hrs: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	5
IV	**Applications of Animal Biotechnology:** Improvement of biomass, livestock-pharming products, pharmaceutical products produced by mammalian cells, cell culture based vaccines,	5
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
VI	**Cell Synchronization** – Introduction, methods of synchronization, applications	3

SUGGESTED READING:

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

Learning Outcomes:

After completion of this course, students will be able to:

- Use or demonstrate the basic techniques of biotechnology like DNA isolation, PCR, transformation, restriction digestion etc.
- 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.
- Understand better the ethical and social issues raised regarding GMOs.
- Use the knowledge for designing a project for research and execute it.
- Know the basic techniques used in genetic manipulation helping them continue with higher

studies in this field.

- Acquire knowledge of the basic principles, preparations and handling required for animal cell culture.
- Understand principles underlying the design of fermenter and fermentation process and its immense use in the industry.
- 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.
- Apply knowledge and skills gained in the course to develop new diagnostic kits and to innovate new technologies further in their career.
- 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.

PRACTICALS

PRACTICAL COURSE V: 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
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 coliphages
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 VI :DSC 2C &2D-GENERAL MICROBIOLOGY & 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	Subculturing of bacteria on slant
15	Latex agglutination test
16	Coomb's test
17	Ouchterlony procedure
18	Counter current immunoelectrophoresis
19	Rocket immunoelectrophoresis
20	Widal Test
21	VDRL Test
22	Visit to any recognize Biochemistry and Microbiology (or Pathology) laboratory OR Review of recent advances in Techniques in Microbiology/Immunology thereby submitting a brief report

PRACTICAL COURSE VII: 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.	DNA isolation from plant cell.
6.	Synthetic seed production.
7.	Sterilization techniques: Theory and Practical: Glass ware sterilization, Media sterilization,
8.	Laboratory sterilization
9.	Sources of contamination and decontamination measures.
10.	Preparation of Hanks Balanced salt solution
11.	Preparation of Minimal Essential Growth medium
12.	Isolation and microscopic observation of lymphocytes.

13.	Preparation of pH standard and calibration of pH meter.
14.	Quantification of isolated DNA.
15.	Resolving DNA on Agarose Gel.
16.	Cell Viability test by dye uptake assay
17.	Cell Viability test by dye exclusion assay
18.	Visit to biotechnology or tissue culture lab and submitting its brief report.

Learning Outcomes:
After completion of this practical course, students will be able to:

- Use or demonstrate the basic techniques of biotechnology like DNA isolation, transformation, conjugation, restriction digestion etc.
- Perform various hematological techniques.
- Perform 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.
- Understand the key concepts of microbial techniques which may be required to be handled later as microbiologists.
- Perform in vitro culturing of plants & their acclimatization of agricultural benefits.

Justification – Repetitive points were deleted from exiting syllabus and new unit was added for enhancement of subject knowledge.

ANNEXURE-I

Theory Question Paper Pattern: B.Sc.-II Biotechnology (Sem-III & IV)
Scheme of Marking for End Semester Examination (Theory)

Day and date: Maximum Marks: 40
Time: 2 Hrs

Instructions: a) All questions are compulsory
b) Figures to the right indicates full marks
c) Draw neat & well labeled diagram wherever necessary

Q.1: Fill in the blanks by choosing correct alternatives (**eight**): 08

1)
2)
3)
4)
5)
6)
7)

8)

Q.2: Answer the following questions briefly (**any four**): 08

1)
2)
3)
4)
5)
6)

Q.3: Write notes on **any two** of the following 08

1)
2)
3)

Q.4: Attempt the following 08

1)
2)

Q.5: Answer any one of the following 08

1)
2)

ANNEXURE-II

Theory Question Paper Pattern: B.Sc.-II Biotechnolgy (Sem-III & IV)
Scheme of Marking for End Semester Examination (Practical)

Day and date: Maximum Marks: 80
Time:

Q.1. Major experiment 15

Q.2. Major experiment 15

Q.3. Minor experiment 10

Q.4. Minor experiment 10

Q.5. Spotting (Five spots) 05

(a)

(b)

(c)

(d)

(e)

Q.6. Tour Report/Study visit/ project report or review article submission 10

Q.7. Laboratory Record (Journal) 10

Q8: Viva-Voce 05

Board of Studies in Biotechnology
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