

Punyashlok Ahilyadevi Holkar Solapur University, Solapur



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. III (Sem.– V & VI)

(Syllabus to be implemented from w.e.f. June 2021)

Background of Curriculum:

In accordance with the UGCs reference to standardize curricula at the national level and bring a match across all the Indian Universities, an attempt has been made to follow the pattern given in the UGCs Undergraduate Template.

Biotechnology deals with the study of animal kingdom specially the structural diversity, biology, embryology, evolution, habits and distribution of animals, both living and extinct. As it covers a fascinating range of topics, the modern Biotechnologists need to have insight into many disciplines. The learning outcomes-based curriculum framework for a B.Sc. degree in Biotechnology is designed to cater to the needs of students in view of the evolving nature of animal science as a subject. The framework is expected to assist in the maintenance of the standard of Biotechnology degrees/programmes across the country by reviewing and revising a broad framework of agreed expected graduate attributes, qualification descriptors, programme learning outcomes and course-level learning outcomes. The framework, however, does not seek to bring about uniformity in syllabi for a programme of study in Biotechnology, or in teaching learning process and learning assessment procedures. Instead, the framework is intended to allow for flexibility and innovation in programme design and syllabi development, teaching learning process, assessment of student learning levels. A comprehensive knowledge of structure-function relationship at the level of gene, genome, cell, tissue, organ, and systems, through development would further add to the knowledge base and the learning outcome in terms of editing of genes and genomes for industrial application and research purposes.

Learning Outcomes based approach to Curriculum Planning:

The courses should be delivered in terms of concepts, mechanisms, biological designs & functions and evolutionary significance cutting across organisms at B.Sc. level. These courses should be studied by students of all branches of biology. Both chalk and board, and PowerPoint presentations can be used for teaching the course. The students should do the dissertation/ project work under practical of different courses, wherever possible.

The students are expected to learn the courses with excitements of biology along with the universal molecular mechanisms of biological designs and their functions. They should be able to appreciate shifting their orientation of learning from a descriptive explanation of biology to a unique style of learning through graphic designs and quantitative parameters to realize how contributions from research and innovation have made the subjects modern, interdisciplinary and applied and laid the foundations of Biotechnology, Animal Sciences, Life Sciences, Molecular Biology and Biotechnology. These courses and their practical exercises will help the students to apply their knowledge in future course of their career development in higher education and research. In addition, they may get interested to look for engagements in industry and commercial activities employing Life Sciences, Molecular Biology and Biotechnology. They may also be interested in entrepreneurship and start some small business based on their interest and experience.

Graduate Attributes in Biotechnology:

- **Disciplinary knowledge and skills:** Competent of demonstrating (i) complete information and understanding of major concepts, theoretical principles and experimental findings in Biotechnology and its different subfields (ii) capacity to apply modern instrumentation for advanced genomic and proteomic technology.
- **Skilled communicator:** Capability to communicate complex technical knowledge relating to Biotechnology in a obvious and brief manner in writing and oral skills.
- **Critical thinker and problem solver:** Talent to have critical thinking and competent problem solving skills in the basic areas of Biotechnology
- **Sense of inquiry:** Capability for asking appropriate/proper questions relating to issues and problems in the field of Biotechnology, and planning, executing and reporting the results of an experiment or investigation.

- **Team player/worker:** Accomplished of working effectively in diverse teams in both classroom, laboratory and in industry and field-based situations.
- **Skilled project manager:** Able of identifying/mobilizing appropriate resources required for a project, and manage a project to completion, while observing responsible and ethical scientific conduct; and safety and chemical hygiene regulations and practices.
- **Digitally literate:** Skilled of using computers for Bioinformatics and computation and appropriate software for analysis of genomics and proteomics data, and employing modern bioinformatics search tools to locate, retrieve, and evaluate location and biological annotation genes of different species.
- **Ethical awareness/reasoning:** Capable of conducting their work with honesty and precision thus avoiding unethical behavior such as fabrication, falsification or misrepresentation of data or committing plagiarism, and appreciating environmental and sustainability issues. Research ethics committee expects them to declare any type of conflict of interest that may affect the research. Any plan to withhold information from researchers should be properly explained with justification in the application for ethical approval.
- **Lifelong learners:** Capable of self-paced and self-directed learning aimed at individual growth and for improving knowledge/skill development and re-skilling

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.

PAH Solapur University, Solapur
Faculty of Science-New Choice Based Credit System (CBCS) - (w.e.f.2021-22)
Structure for B. Sc-III Biotechnology

Subject/ Core kCourse	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.- III Semester – V									
Ability Enhancement Course(AECC)		English (Business English)	Paper- III	4.0	--	--	100	80	20	4.0
Discipline Specific Elective (DSE)		DSE-1A Bioprocess Technology		3	--	--	100	80	20	4.0
(Students can opt any one subjects among the three										
Subjects excluding interdisciplinary offered at B.Sc II.										
		DSE- 2 A Recombinant DNA Technology		3	--	--	100	80	20	4.0
		DSE- 3 A Bioinformatics		3	--	--	100	80	20	4.0
		DSE 4 A Intellectual Property Rights		3	--	--	100	80	20	4.0
		(Add-on /-self learning)- MOOC/SWAYAM/Skill based -certificate course –institute or university /internship/ apprenticeship		--	--	--	--	--	--	4.0
Grand Total				16.0	--	--	500	400	110	24
Class :	B.Sc.- III Semester –VI									
Ability Enhancement Course(AECC)		English (Business English)		4.0	--	--	100	80	20	4.0
DSE (Students can opt any one subjects among the three Subjects excluding interdisciplinary offered at B.Sc. II.		DSE- 1B Bio-Analytical Tools		3.0	--	--	100	80	20	4.0
		DSE- 2B Genomics and Proteomics		3.0	--	--	100	80	20	4.0
		DSE- 3 B Evolutionary Biology		3.0	--	--	100	80	20	4.0
		DSE 4B Environmental Biotechnology		3.0	--	--	100	80	20	4.0
Total (Theory)				16.0	--	--	500	400	100	20
DSE - Practical (Annual Exam)		DSE- 1 A&B		--	--	5	100	80	20	4.0
		DSE -2 A&B & DSE- 4 B		--	--	5	100	80	20	4.0
		DSE- 3 A&B & DSE- 4 A				5	100	80	20	4.0
		Project Work				5	100	80	20	4.0

Total (Practicals)					20	400	320	80	16
Grand Total			32.0		20	1400	1120	280	60

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

Class	Semester	Marks-Theory	Credits-Theory	Marks-Practical	Credits-Practicals	Total – credits
B.Sc.-I	I	500	20	--	--	20
	II	550	20	400	16	36
B.Sc.-II	III	350	14	--	--	14
	IV	350	14	300	12	26
B.Sc.-III	V	500	22	--	--	22
	VI	500	20	400	16	36
Total		2750	110	1100	44	154

B.Sc .Programme :

Total Marks : Theory + Practical's = 2750 +1100 =3950

Credits : Theory + Practical's = 110 + 44 = 154

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

Theory: Discipline Specific Elective Paper (DSE) : 08

Theory: DSC : 12

Skill Enhancement Courses /Add on : 01

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 and Technology
Choice Based Credit System (CBCS)
(w.e.f. 2021-22)

- Title of the Course: B.Sc. Part-III (Honors)
- 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 & abroad.

- Medium of Instruction: English
- Syllabus Structure:
- The University follows semester system.
- An academic year shall consist of two semesters.
- B.Sc. Part-III Biotechnology shall consist of two semesters: Semester V and Semester VI

In semester V: there will be Four DSC papers having paper IX to XII of 100 marks each. There will a **Compulsory paper on “Ability Enhancement Compulsory Course (AECC)” on English** and one self learning compulsory course of any one from - MOOC/SWAYAM COURSE/INTERNSHIP

In Semester VI: there will be two DSC papers having paper XIII to paper XVI of 100 marks each. There will a **Compulsory paper on “Ability Enhancement Compulsory Course (AECC)” on English**

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-III Biotechnology Sem V & VI 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 400 marks shall also consist of **320 marks for University practical assessment** and **80 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 – V: Theory: (100 marks): Comprising DSE-

- a) University Examination (UA) (80 marks): No. of theory papers: 4 (paper IX to paper XII)
- b) Internal Continuous Assessment (CA) (20 marks) No. of theory papers: 4 (paper IX to paper XII)
- c) **Compulsory paper on “Ability Enhancement Compulsory Course (AECC)” on English**
- d) One Add-on - self learning course (**compulsory**) MOOC/SWAYAM/Sill based -certificate course – institute or university /internship/ apprenticeship

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

Semester – VI: Theory: (100 marks): Comprising DSE-

- a) University Examination (UA) (80 marks): No. of theory papers: 4
- b) Internal Continuous Assessment (CA) (20 marks) No. of theory papers: 4

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

Practical Examination: (400 marks)

University Examination (320 marks): Number . of practicals’: 04

Practical-I: Based on DSE- 1 A&B	:(80 UA + 20 CA)
Practical-II: Based on DSE -2 A&B & DSE- 4 B	:(80 UA + 20 CA)
Practical-III: DSE- 3 A&B & DSE- 4 A	:(80 UA + 20 CA)
Practical-IV: Project Work	:(80 UA + 20 CA)

Internal Continuous Assessment: Total 80

- (a) Internal practical test and
- (b) Viva/group discussion/model or chart/attitude/attendance/overall behavior
- (c) University practical examination of 320 marks (Practical I to IV for Four separate days) will be conducted at the end of semester VI

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 stipulated marks of external examination and his/her performance shall be scaled to 100

PAH SOLAPUR UNIVERSITY, SOLAPUR Faculty of Science and technology New CBCS Structure for B.Sc – III Biotechnology Theory -								
Semester V								
Paper No.	Title of Paper	Hrs/Week			Paper Marks	UA	CA	Credits
		L	T	P				
Ability Enhancement Course(AECC)	English (Business English)	4	-	-	100	80	20	4
DSE-IX	DSE-1A Bioprocess Technology	3	-	-	100	80	20	4
DSE-X	DSE- 2 A Recombinant DNA Technology	3	-	-	100	80	20	4
DSE-XI	DSE- 3 A Bioinformatics	3	-	-	100	80	20	4
DSE-XII	DSE 4 A Intellectual Property Rights	3	-	-	100	80	20	4
SEC-	(Add-on /-self learning)-MOOC/SWAYAM/Skill based - certificate course –institute or university /internship/ apprenticeship	--	-	--	--	--	--	4.0
Total		16	-	-	500	400	100	24

marks.

• **ATKT:**

passed in all papers except 6 (six) papers combined together of semester III and IV of B.Sc. Part-II Biotechnology examination and clearly passed in B.Sc. Part-I-Biotechnology shall be permitted to enter upon the course of Semester V of B.Sc. III Biotechnology.

Practicals- B .Sc III Biotechnology (CBCS)

Semester –VI								
Paper No.	Title of Paper	Hrs/Week			Paper Marks	UA	CA	Credits
		L	T	P				
Ability Enhancement Course(AECC)	English (Business English)	4	-	-	100	80	20	4
DSE- -XIII	DSE- 1B Bio-Analytical Tools	3	-	-	100	80	20	4
DSE-XIV	DSE- 2B Genomics and Proteomics	3	-	-	100	80	20	4
DSE-XV	DSE- 3 B Evolutionary Biology	3	-	-	100	80	20	4
DSE-A XVI	DSE 4B Environmental Biotechnology	3	-	-	100	80	20	4
SEC-								
Total		16			500	400	100	20

Practical I No.	Paper No. based on	Title of Paper	Hrs/Week			Paper Marks	UA	CA	Credits
			L	T	P				
I		DSE-1A- Bioprocess Technology AND DSE- 1B- Bioanalytical Tools		-	5	100	80	20	4
II		DSE- 2 A - Recombinant DNA Technology AND DSE- 2B –Genomics and Proteomics AND DSE 4B- Environmental Biotechnology Biotechnology		-	5	100	80	20	4
III		DSE- 3A- Bioinformatics AND DSE- 3 B - Evolutionary Biology AND DSE 4 A- Intellectual Property Rights		-	5	100	80	20	4
IV		Project Work		-	5	100	80	20	4
	Total				20	400	320	80	16

Abbreviations:

L: Lectures

T: Tutorials

P: Practicals

UA: University Assessment by End Semester Examination

CA: College Assessment by Internal Continuous Examination

UA: University Assessment: - University Theory paper shall be of 70 marks

CA: College Assessment: - The internal examination for theory and practical course

DSE-1A Bioprocess Technology **[Credits -4, Total Lectures-60]**

Course Objectives:

- This course gives technical and biological aspects of fermentation process
- This course helps to introduce industrial applications of bioprocess technology

Course Outcome:

- After completion of this course students will be able to perform and control fermentation process.
- Students can design protocols for industrial fermentations.

UNIT I -Introduction to bioprocess technology (10 L)

Range of bioprocess technology (Microbial enzymes, Microbial Biomass, Transformation process, Recombinant Technology). Chronological development of fermentation industry. Basic principle components of fermentation technology. Types of microbial culture, its growth kinetics and product formation in-Batch, Fed-batch and Continuous culture.

UNIT II -Bioreactors (20 L)

Design and operation of bioreactor- Significance of Impeller, Baffles, Sparger; Types of culture/production vessels- Airlift; fluidized bed reactor; bubble column reactor, photo bioreactor and their application in production processes.

Principles of upstream processing – Inoculum development Media preparation, and sterilization of media, bioreactor, liquid wastes, air.

UNIT III -Fermentation process control (15 L)

Introduction to oxygen requirement in bioprocess; mass transfer coefficient; factors affecting KLa. Bioprocess measurement and control system (Physical, Chemical, biological parameters). Computer application in fermentation process control.

UNIT IV- Downstream processing (15 L)

Introduction to downstream processing, product recovery and purification. Effluent treatments and disposal. Product recovery (Solid-liquid separation, Cell disintegration, purification, concentration, formulation). Microbial production of ethanol, amylase, lactic acid and Single Cell Protein.

SUGGESTED READINGS:

- 1) Casida LE. (1991). Industrial Microbiology. 1st edition. Wiley Eastern Limited.
 - 2) 2. Crueger W and Crueger A. (2000). Biotechnology: A textbook of Industrial Microbiology. 2nd edition. Panima Publishing Co. New Delhi.
 - 3) 3. Patel AH. (1996). Industrial Microbiology. 1st edition, Macmillan India Limited.
 - 4) 4. Stanbury PF, Whitaker A and Hall SJ. (2006). Principles of Fermentation Technology. 2nd edition, Elsevier Science Ltd.
 - 5) 5. H. A. Modi (2009) .Fermentation Technology Vol.I and Vol. II. Pointer Published by Pointer, Jaipur
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DSE-2 A: Recombinant DNA Technology

[Credits -4, Total Lectures-60]

Course Objectives

- To familiarize the student with emerging field of biotechnology i.e. Recombinant DNA Technology.
- To create understanding and expertise in wet lab techniques in genetic engineering.

Learning outcomes:

On completion of this course, students will have the knowledge and skills to explain the key concepts in genetic modification of living organisms, Techniques in Recombinant DNA Technology

- Acquire skills on techniques of construction of recombinant DNA - Cloning vectors and isolation of genes of interest.
 - Identify problems associated with production of recombinant proteins and devising strategies to overcome problems
-

UNIT I: Enzymes and Vectors

[15]

Enzymes (source and functions): Exonucleases (Exonuclease I, III and λ), Endonucleases (S1 nuclease, Mung bean nuclease, DNase I, Ribonuclease H), Restriction endonuclease (Type I, II, III), Ligases (E. coli DNA Ligase, T₄ - DNA Ligase, T₄ - RNA Ligase), DNA polymerases (Polymerase I, Klenow fragments, Taq), RNA polymerases (E. coli RNA polymerases, SP-6 RNA polymerases, T₇ - RNA polymerases), Reverse transcriptases (AMV Reverse transcriptase, M-MuLV Reverse transcriptase), Alkaline phosphatases, Terminal deoxy nucleotidyl transferase, Kinases (T₄ - Poly Nucleotide kinase, T₄ - Poly Nucleotide kinase phosphatase free)

Plasmids (pSC101, pBR322, pUC), Phages (λ insertion vector and λ replacement vector) Cosmids, Phagemids (pBluescript II KS(+/-), pTZ19R/ pTZ19U), BAC, Shuttle vectors, plants (Caulimoviruses and Tobamoviruses), animals (SV40) and yeast (YIp, YEplac, YCp), YAC

UNIT II: Recombinant DNA Technology in prokaryotes and eukaryotes

[15]

Bacteria and yeast: DNA transfer techniques : transformation (CaCl₂, ultrasonication), transduction. Screening of recombinants (Blue-white screening, immunological screening, colony hybridization,) Recombinant screening in plant cells. Animals : Recombinant screening in animal cells. Examples of proteins produced in animal cells.

UNIT III: Techniques in Recombinant DNA Technology

[15]

Basic techniques: Isolation and Purification of DNA, Principle and applications of Polymerase chain reaction (PCR), Standard PCR, RT (Reverse transcription)-PCR, Real Time PCR). Probes: (Genomic DNA probes, cDNA, RNA probes).

DNA sequencing (Maxam and Gilbert, Sanger's, Automated DNA Sequencing.). Molecular Markers:(RFLP, RAPD, AFLP).

UNIT IV: Genetic and protein engineering & Applications of Recombinant DNA Technology

[15]

Random and site-directed mutagenesis: Primer extension and PCR based methods of site directed mutagenesis, Random mutagenesis, Gene shuffling, production of chimeric proteins, Protein engineering concepts and examples (any two).

Applications: Gene targeting in mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones and vaccines (one example each). Heterologous protein production in plant systems - edible vaccines, plantibodies, Transgenic plants - Insect-resistant, Stress tolerant plants, improved nutritional quality(Amino acids and Iron), Senescence - tolerant plants (fruit ripening and flower wilting- e.g. FlavrSavr), , Modification of food plants taste (Sweetness), plant as bioreactor for polymers

SUGGESTED READINGS:

1. Brown TA. (2006). Gene Cloning and DNA Analysis. 5th edition. Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pazdernik NJ. (2009). Biotechnology-Appling the Genetic Revolution. Elsevier Academic Press, USA.

3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
 4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.
 5. Sambrook J, Fritsch EF and Maniatis T. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press.
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DSE 3 A: Bioinformatics **[Credits -4, Total Lectures-60]**

Course objectives

- This course gives technical and biological aspects of Bioinformatics and its possible use in allied science areas.

Learning outcomes:

- Students will get background of bioinformatics.
 - Students will get knowledge of biological databases.
 - Students will be able to retrieve information from nucleic acid and protein sequence.
 - Students can predict the structure of proteins from their sequence.
-

Unit I : Introduction to Bioinformatics:-

(10 L)

Concept of Bioinformatics, history, branches of bioinformatics. Nomenclature and code letters of DNA and protein sequences. Scope and applications of bioinformatics. NCBI: role and its resources, Entrez. EMBL.

Unit II: Biological Databases:

(20 L)

Primary Protein sequence databases:- PIR, MIPS, Swiss – PROT, TrEMBL, NRL – 3D; Composite Protein sequence databases: - NRDB, OWL, MIPSx, SWISS-PROT + TrEMBL; Secondary Protein databases: - PROSITE, Pfam, Structure classification databases: - SCOP, CATH, PDBsum. Nucleic acid sequence databases: EMBL, DDBJ, GenBank; Structural Databases: - PDB, NDB, MMDB; Genomic database – Ensembl; Bibliographic databases – PubMed, PubMed Central, NCBI Bookshelf.

Unit III: Sequence Analysis and Tools:-

(20 L)

Global and Local alignments; Pairwise alignments – method, algorithm, scoring matrices, tools (e.g. BLAST and FASTA) and applications; Multiple alignments – consensus sequence, methods, tools (e.g. Clustal) and applications. Phylogenetic analysis: Elements of phylogeny, methods of phylogenetic analysis, Phylogenetic tree of life, phylogenetic analysis tools - Phylip.

Unit IV: Protein and Gene Structure Prediction:-

(10 L)

Physicochemical property prediction from primary protein sequence, secondary and tertiary structure prediction from protein sequence. Prokaryotic and eukaryotic gene prediction.

SUGGESTED READINGS

- 1) Introduction to Bioinformatics, (Atwood, T. K. and Parry-Smith, D. J).
- 2) An introduction to Computational Biochemistry. (C. Stain Tsai, A JohnWiley and Sons, Inc., publications).
- 3) Bioinformatics Methods and Applications Genomics, Proteomics and Drug Discovery. (Rastogi S. C. Mendiratta, and Rastogi P.)
- 4) Bioinformatics. (C.S.C. Murthy, Himalaya Publishing House, Mumbai.)
- 5) Biotechnology. (U. Satyanarayan, U Chakrapani, Books and allied Private Ltd)
- 6) Developing Bioinformatics Computer Skills. (Cynthia Gibas and Per Jambeck).
- 7) Basic Bioinformatics. (S. Ignacimuthu, S.J., Narosa Publication House, Pvt., Ltd.)
- 8) Bioinformatics. (R. Sunderlingam, V. Kumaresan, Saras Publication.)
- 9) NCBI Web site: <http://www.ncbi.nlm.nih.gov>
- 10) EMBL Website: <http://ebi.ac.uk>

DSE – 4A Intellectual Property Rights
[Credits -4, Total Lectures - 60]

About the course

- The course envisages information on IPR

Learning outcomes:

- To learn, understand and analyze the Laws and Relations relating to Intellectual Property Rights in India along with the glimpse of International practices.
 - Apply intellectual property law principles (including copyright, patents, designs and trademarks) to real problems and analyze the social impact of intellectual property law and policy.
 - Analyze ethical and professional issues which arise in the intellectual property law context.
 - To create public awareness about the economic, social and cultural benefits of IPRs
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Unit I: Introduction to IPR

(15 L)

Introduction to Intellectual Property Rights: IPRs Policy, Novelty, Utility Inventiveness/Non-obviousness, Kinds of Intellectual Property Rights-copyright, patent, trademark, trade secrets, geographical indications (GI), Advantages and Disadvantages of IPR. Patentable subject matter, Patentability criteria, non-patentable inventions, Pharmaceutical products and process patent.

Unit-II: IPR in India & abroad

(15 L)

Genesis and development – IPR in abroad - Major International Instruments concerning Intellectual Property Rights: Paris Convention 1883, the Berne Convention 1886, the Universal Copyright Convention 1952, the WIPO Convention 1967, the Patent Co-operation Treaty, 1970, the TRIPS Agreement, 1994.

Unit -III: Procedure of patenting

(15 L)

Types of patenting, Rights of patentee, Procedure for granting a patent and obtaining patents in India and Abroad (ICT), Grounds for opposition Working of Patents, Compulsory License Acquisition, Surrender, Revocation, restoration Transfer of patent rights, Patenting of biological materials with examples and case studies, Infringement.

Unit -IV: Plant Breeder's rights

(15 L)

International Union for the Protection of New Varieties of Plants (UPOV), Breeders exemption, Plant variety protection in India. Farmer's right, Procedure for registration, effect of registration and term of protection, advantages and disadvantages of PBR.

SUGGESTED READINGS:

1. Entrepreneurship: New Venture Creation : David H. Holt
2. Patterns of Entrepreneurship: Jack M. Kaplan
3. Entrepreneurship and Small Business Management: C.B. Gupta, S.S. Khanka, Sultan Chand & Sons.
4. Sateesh MK (2010) Bioethics and Biosafety, I. K. International Pvt Ltd.
5. Sree Krishna V (2007) Bioethics and Biosafety in Biotechnology, New age international publishers.

6. Ahuja, V K. (2017). Law relating to Intellectual Property Rights. India, IN: Lexis Nexis.
7. Nithyananda, K V. (2019). Intellectual Property Rights: Protection and Management. India, IN: Cengage Learning India Private Limited.

*As a part of self learning mode students have to acquire 4 credits compulsorily other than routine credits mentioned in the university syllabus structure. It also mandatory for the students to submit the certificate from competent authorities in the stipulated time. It is the whole responsibility of the students with consultation of mentor to complete the course for successful acquiring 4 credits. Department will monitor the progression of the course completion of the students by assigning the responsibility to the concerned faculty as a mentor. It is also suggested that the students opting for internships or apprenticeship (should be of 60 hrs duration) will be allowed to join and complete the assignment preferably during winter and summer vacation. If the duration is extended, the institute may allow the students to complete the assignment with prior permission from the head of the institution/competent authorities and the absentee from the host institute may be compensated by allowing the students to join during holidays of the working period. During the completion of self learning course at the time of semester III in emergency or exceptional case students are allowed to continue and complete in the IV semester. Students have the options to select any one or two from **SWAYYAM/MOOCs/NPTEL /Skill based course-Institute or University/Internship/Apprenticeship.**

SEMESTER –VI

PAH SOLAPUR UNIVERSITY, SOLAPUR (CBCS)
Theory Syllabus
B.Sc. III-Biotechnology (Semester-VI)
w. e. f. June 2021

DSE 1B - Bio-Analytical Tools
[Credits -4, Total Lectures-60]

Course Objectives:

- To develop the skills to understand the theory and practice of bio analytical techniques.
- To provide scientific understanding of analytical techniques and detail interpretation of results.
- To understand basic instruments used in Bioanalytical sciences laboratory

Learning outcomes

After successfully completing this course, the students will be able to:

- To be able to use selected analytical techniques.
- To get knowledge of working principals, tools and techniques of analytical techniques.
- To understand the advantages, disadvantages and creative use of techniques for problem-solving

Unit 1: Introduction: pH meter & Electrophoresis

15L

Principle, construction, working and application of the following instruments: **pH meter:** Definition – acids and bases; pH. Dissociation of acids and bases, measurements of pH – pH indicators, pH paper, pH meter glass electrode, operation and calibration of pH electrode, errors in pH measurements.

Electrophoresis: Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno- electrophoresis, isoelectric focusing.

Unit 2: Spectroscopy

15L

Electromagnetic wave, Electromagnetic spectrum, Applications of each region of electromagnetic spectrum for spectroscopy. Introduction to molecular energy levels: Excitation, Absorption, Emission. Types of transition: Electronic, Vibrational, Rotational UV-visible spectroscopy. Principle Beer – Lambert's Law, deviation from Beer-Lambert' Law, construction and working of colorimeter, turbidometer, nephelometer. IR spectroscopy, Atomic absorption spectroscopy (AAS).

Unit 3: Centrifugation & Chromatography

15L

principle and application, Types of Centrifugation : Differential Centrifugation, Rate-Zonal Centrifugation, Isopycnic Centrifugation, Analytical Ultracentrifugation.

Chromatography :Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC

Unit 4: Blotting techniques

15L

Introduction of blotting technique for Nucleic acids and proteins, Principle and working of: Southern blotting, Northern blotting and Western blotting. Principles of autoradiography, Dot Blot technique.

SUGGESTED READINGS

1. Instrumental Methods of Chemical Analysis – G. R. Chatwal, S.K.Anand
2. Handbook on Analytical Instruments –R. S. Khandpur. (Mc Graw Hill).
3. Biophysical Chemistry - Upadhyay, Nath, Upadhyay (Himalaya Publishing House).
4. Practical Biochemistry –Wilson & Walker.
5. Biophysics– Dr. Mohan P. Arora
6. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley& Sons. Inc.
7. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
8. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates,
9. MA. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell.7th edition. Pearson Benjamin Cummings Publishing, San Francisco

DSE- 2B Genomics and Proteomics

[Credits -4, Total Lectures-60]

Course Objectives:-

- To acquaint the student with genome organization, gene identification, Expression and application of genomics analysis.
- To acquaint the student with proteomics, it's analysis and its applications.

Course Outcomes:-

- On the completion of this course students will have the knowledge and skill to explain the key concepts in genomics and proteomics.
- The course will provide comprehensive knowledge in genome analysis and proteomic analysis.
- The student will understand the applications of genomics and proteomics in Drug development, Glycobiology and Plant genetics and breeding.

UNIT I Organization of genomes:

10 L

Introduction: Genome, Genomics, Omics and importance, General features, The origin of genomes- Origin of macromolecules, RNA world and DNA world , Genome diversity. Introduction to Molecular taxonomy.

UNIT II Genome projects:

20 L

The Human genome project, HapMap Project, The 1000 genome project, and The ENCODE Project. Structural genomics: Assembly of a contiguous DNA sequence- Genome sequencing assembly clone counting method, and whole –genome shotgun sequencing, computer tools for sequencing project.

Significance of genomes – Bacteria, Yeast, Drosophila, Caenorhabditis, *Homo sapiens*, Arabidopsis.

UNIT III Introduction to Proteomics:

15 L

Introduction to proteomics, Analysis of Proteomes- Two -dimensional polyacrylamide gel electrophoresis, Sample preparation, Solubilization, Reduction, Resolution, Reproducibility of 2DE. Detecting proteins in Polyacrylamide gels, Image analysis of 2-DE gels. Mass spectrometry based methods for protein identification, 2-DE gel electrophoresis coupled with mass spectrometry

UNIT IV Applications of Genomics and Proteomics Analysis:

15 L

Analysis of Genomes- Human, Mouse, *Plasmodium falciparum*, *Saccharomyces cerevisiae*, *Mycobacterium tuberculosis*. Application of proteome analysis- drug development and toxicology, glycobiology and proteomics in plant genetics and breeding. Molecular diagnosis of human genetic diseases: Sickle cell anemia, Hemophilia.

SUGGESTED READINGS:

1. S.B. Primrose and R. M. Twyman- Principles of Genome Analysis and Genomics, 7th edition, Blackwell publishing, 2006
2. S. Sahai- Genomics and Proteomics, Functional and Computational Aspects, Plenum Publishing, 1999.
3. Andrezej K Konopka and James C. Crabbe, Compact hand book- computational biology, Marcel Dekker, USA, 2004.
4. Pennington & Dunn- Proteomics from protein Sequence to function, 1st edition, Academic Press, San Diego, 1996.

Paper- -XIV- DSE-3B : Evolutionary Biology [Credits -4, Total Lectures-60]

Course objectives

The course provides information about the patterns and processes of evolution above the species level. Besides elaborating the process of speciation, it also categorically differentiates between the three methods of phylogenetic analysis viz., evolutionary systematics, phenetics and cladistics.

Learning outcomes

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

- Understand the historical development of systematics past to the present.
- Understand the similarities and differences of different types of data.
- Understand the uses and limitations of phylogenetic trees.
- Appreciate the complexities and difficulties of various species concepts.
- Gain a basic grasp on the rules and philosophy of nomenclature.

Unit 1: Origin of Life & Historical Review of Evolutionary Concepts (15L)

Chemogeny, RNA world, organic evolution, Evolution of prokaryotes and eukaryotes. Theories of Evolution: Lamarckism, Darwinism, Neo-Darwinism

Unit 2: Evidences of Evolution & Sources of Variation (15L)

Fossil records (types of fossils, transitional forms, geological time scale, evolution of horse, Molecular evolution:- universality of genetic code and protein synthesizing machinery, example of globin gene family. Sources of variations: Heritable variations and their role in evolution

Unit 3: Evolutionary Genetics, Product of Evolution and Extinctions

(15L)

Micro evolutionary changes - inter-population variations, clines, races, species concept, isolating mechanisms, modes of speciation-allopatric, sympatric & parapatric; Adaptive radiation/ macroevolution as exemplified by Galapagos finches.

Back ground and mass extinctions: causes and effects; example of K-T extinction.

Unit 4: Origin and Evolution of Man

(15L)

Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from Dryopithecus leading to Homo sapiens, molecular analysis of human origin; Socio-cultural evolution of man.

SUGGESTED READINGS:

- 1) Ridley, M (2004) Evolution III Edition Blackwell publishing
- 2) Hall, B.K. and Hallgrimson, B (2008). Evolution IV Edition. Jones and Barlett Publishers.
- 3) Campbell, N.A. and Reece J.B (2011). Biology. IX Edition. Pearson, Benjamin & Cummings.
- 4) Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
- 5) Pevsner, J (2009). Bioinformatics and Functional Genomics. II Edition Wiley-Blackwell

DSE-4B : Environmental Biotechnology [Credits -4, Total Lectures-60]

Course objectives:

- This course gives technical and biological aspects of Environmental Biotechnology.
- This course helps to introduce industrial applications of Environmental Biotechnology.

Learning outcome :

On completion of this course, students will have the knowledge and skills to explain the key concepts in

- Understanding the current applications of biotechnology to environmental quality evaluation, monitoring and remediation of contaminated environments.

UNIT I : Natural and Commercial Resources of Fuels

(15 L)

Conventional fuels and their environmental impact – Firewood, Plant, Animal, Water, Coal and Gas.

Modern fuels and their environmental impact – Role of Microorganisms in process and production of Biogas,

Microbial hydrogen Production, Conversion of sugars, agriculture and food industry waste (Corn starch, cotton) to alcohol Gasohol.

UNIT II: Bioremediation

(20 L)

Concept and Importance of bioremediation: Microbial bioremediation, Phytoremediation, Mycoremediation . Bioremediation of soil & water contaminated with oil spills, heavy metals and detergents. Bioremediation of lignin and

cellulose, Pesticides(chlorpyrifos, Acephate,), insecticides(Aldrin, Malathion), herbicides (Glyphosate, diclofop,), aromatic and chlorinated hydrocarbons, petroleum products(Diesel fuel, Kerosene, Paraffin wax) , plastic(Polyethylene terephthalate, Polyvinyl chloride) and radioactive wastes(nuclear waste, ion exchange resins).

UNIT III: Waste water treatment and bio-fertilizers

(15 L)

Different methods of treatment of municipal waste water and Industrial effluents. Biomedical waste management. Bio-fertilizers: Role of symbiotic and asymbiotic nitrogen fixing bacteria in the enrichment of soil (Rhizobium, Azotobacter, Azospirillum, Cyanobacteria, Phosphate solubilizing bacteria). Role of Algal and fungal bio-fertilizers (VAM, Frankia, Azolla.) in enhancement of soil fertility

UNIT IV: Bioleaching and Genetically modified Organisms

(10 L)

Bioleaching: Definition, microorganisms used in bioleaching, chemistry of bioleaching, types of bioleaching, Examples (Gold, Copper and Uranium leaching).

General introduction of genetically modified microbes, plants and animals and its role in environment clean-up.

Location, establishment and Rules and regulations of Environment Protection Act(EPA)

SUGGESTED READING

1. Environmental Science, S.C. Santra
2. Environmental Biotechnology, Pradipta Kumar Mohapatra
3. Environmental Biotechnology – Concepts and Applications, Hans-Joachim Jordening and Josef Winter
4. Waste Water Engineering, Metcalf and Eddy, Tata McGraw hill
5. Agricultural Biotechnology, S.S. Purohit
6. Environmental Microbiology : Methods and Protocols, Alicia L. Ragout De Spencer, John F.T. Spencer
7. Introduction to Environmental Biotechnology, Milton Wainwright
8. Principles of Environmental Engineering, Gilbert Masters
9. Wastewater Engineering – Metcalf & Eddy

PAH SOLAPUR UNIVERSITY, SOLAPUR (CBCS)

B.Sc. III-Biotechnology

w. e. f. June 2021 -Practicals Syllabus

Practical -I

Paper No. based on:

DSE-1A Bioprocess Technology

and

DSE- 1B Bio-analytical tools

(Credits-4)

DSE-1A Bioprocess Technology:-Practicals'

1. Isolation of antibiotic producer microorganisms from natural resource.

2. Calculation of thermal death point (TDP) of a given bacterial culture.
3. Calculation of thermal death time (TDT) of given bacterial culture.
4. Production and analysis of ethanol.
5. Production and analysis of amylase.
6. Production and analysis of lactic acid/ citric acid.
7. Biological assay of antibiotic by disc diffusion method.
8. Prepare SOPs for handling of instruments required for Laboratory scale fermentation
9. Determination of Minimum Inhibitory Concentration (MIC) of antibiotic on test organism.
10. Production of wine from any fruit.

DSE- 1B Bio-analytical tools

1. Gel electrophoresis of DNA/RNA
 2. SDS-polyacrylamide gel electrophoresis of proteins.
 3. Preparation of the sub-cellular fractions of cells.
 4. Maltose calibration curve.
 5. Separation of plant pigments by paper chromatography.
 6. To identify amino acids in a given sample by TLC.
 7. Southern blotting technique.
 8. pH measurement of biological samples.
 9. UV spectra of protein and nucleic acid.
 10. Qualitative and quantitative analysis of DNA using spectrophotometer
-

Practical –II
Paper No. based on:
DSE- 2A Recombinant DNA Technology
and
DSE- 2B Genomics and Proteomics
and
DSE 4B- Environmental Biotechnology
(Credits-4)

DSE- 2A Recombinant DNA Technology

1. Isolation of genomic DNA from whole blood
2. Elution of DNA band from agarose gel
3. Plasmid DNA isolation
4. Restriction digestion of DNA
5. Construction of restriction map of plasmid DNA

6. Demonstration of PCR
7. Calculation of molecular weight of digested DNA
8. Preparation of single stranded DNA template

DSE- 2B Genomics and Proteomics

1. *In silico* Genome study of *Drosophila*/ *Caenorhabditis*/ Homo sapiens/ Aradopsis.
 2. Isolation of DNA from Yeast.
 3. Protein molecular weight determination by SDS-PAGE
 4. Isolation of whole cell protein and profiling from Bacteria/Plant .
 5. Extraction of wheat gluten protein.
 6. Hydropathy plots/ Ramchandran plots.
 7. Image analysis of 2D gel.
 8. Protein prediction by Mass Spectroscopy data.
 9. Use of the SNP database at NCBI and other sites.
 10. Use of OMIM database.
 11. Detection of open reading frames using ORF Finder
-
-

Practical- DSE 4B- Environmental Biotechnology

1. Calculation of Total Dissolved Solids (TDS) of water sample.
2. Calculation of BOD of water sample.
3. Calculation of COD of water sample.
4. Bacterial Examination of Water by MPN Method
5. Chemical analysis of soil by rapid spot tests.
6. Decolorization of a textile dye to demonstrate concept of phytoremediation
7. Decolorization of a textile dye to demonstrate concept of bacterial remediation
9. Estimation of pesticides from given samples.
10. Estimation of residual chlorine from given water sample.

Practical –III
Paper No. based on:
DSE 3 A: Bioinformatics
and
DSE- 3 B Evolutionary Biology
and
DSE – 4A Paper Intellectual Property Rights
(Credits -4)

Practicals- DSE 3 A: Bioinformatics –

1. Searching and retrieval of literature from PubMed.

2. Retrieving of gene sequence from GenBank.
3. Retrieving of protein sequence from PIR/Uniprot.
4. Performing sequence similarity search by BLAST.
5. Performing sequence similarity search by FASTA.
6. Performing multiple alignment and cladogram by Clustal.
7. Prediction of physicochemical property of protein from sequence (ProtParam tool).
8. Retrieval 3-D structure of proteins from RCSB PDB.
9. Study 3-D structure of protein by RasMol.

Practicals- DSE- 3 B Evolutionary Biology –

1. Study of types of fossils using samples available in Biotechnology and Geology Lab./or models (for eg. Limulus, Peripatus, Dipnoi, Sphenodon, *Archaeopteryx*, examples based on: Molluscan, Echinoderms, Brachiopods and as available in laboratory)
2. Study of Zoogeographical Regions of world to understand the concept of speciation with examples
3. Study of biogeographic zones of India to study evolutionary variation and adaptation in species with examples
4. Study of macroevolution using Darwin's Finches using charts/models
5. Study of homologous organs from suitable specimens/models in the museum
6. Study of analogous organs from suitable specimens/ models in the museum
7. Study of adaptive radiation in mammals from museum specimens/models
8. Study of phylogeny of horse using model/charts (reconstruction using limbs and teeth of horse ancestors)
9. Study of Molecular phylogeny of prokaryote and eukaryote.
10. Visit to natural history museum and submission of report

Practical- DSE – 4A Paper Intellectual Property Rights

1. Indian and ICT patent search
2. Demonstration of Indian and International patent filing
3. Case study of Biotechnological patents
4. A case study on clinical trials of drugs in India with emphasis on ethical issues.

Practical –IV

(Credits-4)

The project report is to be prepared by the student on the subjects in consultation with the Project coordinator in the year. The project work is carried out in group of maximum 4-5 students OR individually. The coordinator will guide the students in selecting the topic of the project, working of the experiments, results of the same and writing the report. The report shall be signed by the coordinator and shall be submitted to the University at the time of the University Practical examination of B.Sc. Part III. The student should visit any place of Biotechnological interest (Pharmaceutical industry, Dairy, Research institutes, Food processing industry, Botanical or Zoological place etc.) and submit the report of their visit at the time of practical examination in practical course No. XI: Project Work. The visit report should be duly certified by the Head of the Department. For this visit 10 marks are allotted in Practical Course No. IV: .Project Work.

And

Review article on any topic prepared by individual student in consultation with project guide will be submitted at the time of university practical examination whichever signed by project guide and head of the department. **(10 mark)**

OR

One national or international research publication in any one of the UGC approved journal **(10 mark)**

Note:

1. Kindly note that during field visits students shall observe only animals and make record of the observations without disturbing natural habitat nor kill the animals. Students should be told about the importance of biodiversity and conservation;
2. Students are encouraged to prepare and submit a concise report of the excursion;
3. Report on multiple excursion tours may be clubbed for preparing and submitting report at the time of final examination will be allowed;
4. Reduce or avoid the use of plastic files during submission of reports / projects as an ecofriendly method.

Equivalence:

Paper no.	Old CBCS (June 2018)	New CBCS w e f .2021-22
Semester-V		
Core BT 301	Plant Development	NO- Equivalence
Core BT 302	Fermentation Technology	DSE-1A Bioprocess Technology
Core BT 303	Tools and Techniques	NO- Equivalence
DSE BT 304A	Recent Trends in Biotechnology	NO- Equivalence
DSE BT 304B	Introduction to Biotechnology based Industries	NO- Equivalence
Semester-VI		

Core BT 305	Animal Development	NO- Equivalence
Core BT 306	Food and Dairy Technology	NO- Equivalence
Core BT 307	Bioinformatics and Nanotechnology	NO- Equivalence
DSE BT 308A	Applications of Biotechnology	NO- Equivalence
DSE BT 308B	Quality Standard Practices in Biotechnology	NO- Equivalence

Chairman
(Board of studies in Biotechnology)