PUNYASHLOK AHILYADEVI HOLKAR
SOLAPUR UNIVERSITY, SOLAPUR

पुण्यश्लोक अहिल्यादेवी होळकर
सोलापूर विद्यापीठ
।। विद्यया संपन्नता ।।

NAAC Accredited-2022
'B++' Grade (CGPA 2.96)

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 June 2024)

P.A.H.Solapur University, Solapur , Faculty of Science and Technology
Choice Based Credit System (CBCS)
B.Sc.-III Biotechnology
(2024-2025 : W.e.f. June 2024)

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 Biotechnology 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 and Technology
Choice Based Credit System (CBCS)
(w.e.f. 2024-25)

• Title of the Course: B.Sc. Part-III (Honors)
• Subject: **Biotechnology**

- **Introduction**: This course provides a broad overview of Biotechnology and to produce 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 subjects for that purpose.

- **Objectives of the course: The objectives of B. Sc. Biotechnology courses are:** To provide an intensive and in depth learning to the students in the field of Biotechnology. Beyond simulating, learning, and understanding the techniques, the course also addresses the underlying recurring problems of disciplines in today's scientific and changing world. To develop awareness & knowledge of different organization requirements and subject knowledge through varied branches and research methodology in students. To train the students to take up a 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:**
  1. The University follows semester system.
  2. An academic year shall consist of two semesters.
  3. Each B.Sc. course shall consist of three years i.e. six semesters.
  4. B.Sc. Part-III Biotechnology shall consist of two semesters: Semester V and Semester VI. In semester V, there will be four papers of 100 marks for each with compulsory English **50 marks**. Similarly in Semester VI there will be four papers of 100 marks for each with compulsory English **50 marks**.

The scheme of evaluation of performance of candidates shall be based on University assessment as well as College internal assessment as given below.

For B.Sc. Part-III Biotechnology semester V & VI the internal assessment will be based on Unit tests, Home assignment, viva, practicals, project work etc.

Practical course examination of 100 marks for each course shall be conducted at the end of VIth semester. The practical examination of100 marks shall also consist of **80** marks for university practical assessment and 20 marks for college internal assessment. For University practical examination both the examiners will be External and will be appointed by the University.

- **The Credit and Grading System:**

With the view to ensure worldwide recognition, acceptability, horizontal as well as vertical mobility for students completing undergraduate degree, Punyashlok Ahilyadevi Holkar Solapur University, Solapur has implemented Credit and grading system of Evaluation at Undergraduate level. 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. As per present norms, there are 3 contact hours per paper (subject) per week which works out to be 45 contact hours per paper (subject) per semester. In Punyashlok Ahilyadevi Holkar Solapur University, Solapur, for B.Sc.-III Biotechnology, there are 4 papers and Compulsory English. For B.Sc.-III Biotechnology, there are **4** contact hours per paper(subject)perweekforeachpaperandCompulsoryEnglishcarry4contacthoursperweek.

Therefore, total contact hours per week are **20**. Each paper has **60** contact hours, which are transformed into 4 credits. Moreover, the grading system of evaluation is introduced for B.Sc. course where in process of Continuous Internal Evaluation is ensured. The candidate has to appear for Internal Evaluation of **20** marks and University Evaluation for **80** marks. It is **80+20** pattern of evaluation. It is applicable for theory and practical as well. The details regarding this evaluation system are as under.

- **Conversion of marks into Grades:**

A table for the conversion of the marks obtained by a student in each paper (out of 100) to grade and grade point is as given below:

Sr.No.	Range of Marks	Grade	Grade Point
1	80-100	O	10
2	70-80	A+	9
3	60-69	A	8
4	55-59	B+	7
5	50-54	B	6
6	45-49	C+	5
7	40-44	C	4
8	<39	FC	0(FailedinTerm Exam)
9	<39	FR	0(FailedinInternalAssessment)

1. **Grade Point Averageat the end of the Semester (SGPA)**

$$SGPA = \frac{(G1 \times C1) + (G2 \times C2) + \ldots\ldots\ldots\ldots}{\Sigma Ci}$$

(ΣCi= Thetotalnumberofcreditsoffered bythe student duringasemester)

2. **Cumulative Grade Point Average (CGPA)**

$$CGPA = \frac{(G1 \times C1) + (G2 \times C2) + \ldots\ldots\ldots\ldots..}{\Sigma Ci}$$

(ΣCi=The total number of credits offered by the student up to and including the semester for which CGPA is calculated.)

3. **Final Grade Point Average (FGPA)**

Itwillbecalculatedinthesimilarmannerforthetotalnumberofcreditsofferedforthecompletion of the said course. Where:

Ci =Credits allocated for the i^{th} course.

Gi =Grade point scored in the i^{th} paper (subject)

4. Conversion of average grade points into grades:

SGPA/CGPA/FGPA	LetterGrade
9.5 – 10	O
8.5 – 9.49	A+
7.5 – 8.49	A
6.5 – 7.49	B+
5.5 – 6.49	B
4.5 – 5.49	C+
4.0 – 4.49	C
<3.99	FC/F
	FR

- **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 will be required to reappear for respective paper. A student who failed in University Examination (theory) and passed in internal assessment of a same paper will 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) will 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 will appear for the same stipulated marks of external examination and his/her performance will be scaled to 100 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 will be permitted to enter upon the course of Semester V of B.Sc. III Biotechnology.

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New CBCS Structure for B.Sc. III Biotechnology

Semester – V (THEORY)

Paper No.	Title of Paper	Hrs./Week (L)	Marks	UA	CA	Credits
Ability Enhancement Course(AECC)	**English (Business English)**	3	50	40	10	2
DSE-1A	**Bioprocess Technology**	3	100	80	20	4
DSE- 2 A	**Recombinant DNA Technology**	3	100	80	20	4
DSE- 3 A	**Bioinformatics**	3	100	80	20	4
DSE 4 A	**Intellectual Property Rights**	3	100	80	20	4
	Total	**15**	**450**	**360**	**90**	**18**

Semester –VI (THEORY)

Paper No.	Title of Paper	Hrs./Week (L)	Marks	UA	CA	Credits
Ability Enhancement Course(AECC)	**English (Business English)**	3	50	40	10	2
DSE- 1B	**Bio-Analytical Tools**	3	100	80	20	4
DSE- 2B	**Genomics and Proteomics**	3	100	80	20	4
DSE- 3 B	**Evolutionary Biology**	3	100	80	20	4
DSE 4B	**Environmental Biotechnology**	3	100	80	20	4
	Total	**15**	**450**	**360**	**90**	**18**
	Total of Sem V and VI (Theory)	**30**	**900**	**720**	**180**	**36**

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New CBCS Structure for B.Sc. III Biotechnology

PRACTICALS (ANNUAL)

Pr. No.	Based on	Title of Practical Course	Hrs./Week (P)	Marks	UA	CA	Credits
I	**DSE-1A and DSE1B**	**Bioprocess Technology AND Bioanalytical Tools**	5	100	80	20	4
II	**DSE 2 A, DSE- 2B and DSE 4B**	**Recombinant DNA Technology, Genomics and Proteomics** AND **Environmental Biotechnology**	5	100	80	20	4
III	**DSE- 3A, DSE- 3 B and DSE 4 A**	**Bioinformatics, Evolutionary Biology AND Intellectual Property Rights**	5	100	80	20	4
IV	—	**Project Work**	5	100	80	20	4
		Total	**20**	**400**	**320**	**80**	**16**
		$ SEC	**4**	**100**	**80**	**20**	**4**

Note:(Add-on-self learning)- MOOC/SWAYAM COURSE/INTERNSHIP/INDUSTRIAL TRAINING/Courses offered * byCollege (4 Credits) Add on College course list should be submitted to the university for information.

	Total of annual Practical	**20**	**400**	**320**	**80**	**16**
	Total of Sem. V and VI (Theory)	**30**	**900**	**720**	**180**	**36**
	Grand Total	**50**	**1300**	**1040**	**260**	**56**

SEMESTER –V

P.A.H. SOLAPUR UNIVERSITY, SOLAPUR (CBCS)

Theory Syllabus

B.Sc. III-Biotechnology (Semester-V)

w. e. f. June 2024

DSE-1A BIOPROCESS TECHNOLOGY
[Credits -4, Total Lectures-60]

Objectives:

This course gives technical and biological aspects of fermentation process

This course helps to introduce industrial applications of bioprocess technology

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 the 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

DSE-2 A: RECOMBINANT DNA TECHNOLOGY
[Credits -4, Total Lectures-60]

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.

Outcome:

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 L)**

Enzymes (source and functions): Exonucleases (Exonuclease I, III and λ), Endonucleases (S1nuclease, Mung bean nuclease, DNase1, Ribonuclease H), Restriction endonuclease (Type I, II, III), Ligases - DNA and RNA, Polymerases DNA Polymerase I, klenow fragments, Taq, RNA polymerases, Reverse transcriptases, Alkaline phosphatases, Terminal deoxy nucleotidyl transferase, Kinases (T_4 – Poly Nucleotide kinase, T_4 – Poly Nucleotide kinase phosphatase free)

Plasmids (pSC101, pBR322, pUC), Phages, Cosmids, Phagemids , BAC,YAC, Shuttle vectors, plants, animals

UNIT II	**Recombinant DNA Technology in prokaryotes and eukaryotes**	**(15 L)**

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 L)**

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	**Applications of Recombinant DNA Technology**	**(15 L)**

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), , 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-Applying 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.

DSE 3 A: BIOINFORMATICS

[Credits -4, Total Lectures-60]

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

Outcome:

Students will get background of bioinformatics.
Students will get knowledge of biological databases.
Students will 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**	**(15 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**	**(15 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**	**(15 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**	**(15 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) Bioinfrmatics. (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]

Objectives: The course envisages information on IPR

To learn, understand and analyze the Laws and Relations relating to Intellectual Property Rights in India along with the glimpse of International practices.

Outcome:

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

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. Biotechnology: New Venture Creation : David H. Holt
2. Patterns of Biotechnology: Jack M. Kaplan
3. Biotechnology 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.

SEMESTER –VI

P.A.H. SOLAPUR UNIVERSITY, SOLAPUR (CBCS)

Theory Syllabus

B.Sc. III-Biotechnology (Semester-VI)

w. e. f. June 2024

DSE 1B - BIO-ANALYTICAL TOOLS

[Credits -4, Total Lectures-60]

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

Outcome:

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 I	**pH meter & Electrophoresis**	**(15 L)**

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 II	**Spectroscopy**	**(15 L)**

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, nephalometer. IR spectroscopy, Atomic absorption spectroscopy (AAS).

UNIT III	**Centrifugation & Chromatography**	**(15 L)**

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 IV	**Blotting techniques**	**(15 L)**

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]

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.

Outcome:

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**	**(15 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**	**(15 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**	**(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.

DSE-3B : EVOLUTIONARY BIOLOGY

[Credits -4, Total Lectures-60]

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, phonetics and cladistics.

Outcome: On completion of this course, students will

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 I	**Origin of Life & Historical Review of Evolutionary Concepts**	**(15 L)**

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

UNIT II	**Evidences of Evolution & Sources of Variation**	**(15 L)**

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 III	**Evolutionary Genetics, Product of Evolution and Extinctions**	**(15 L)**

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 IV	**Origin and Evolution of Man**	**(15 L)**

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]

Objectives:

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

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**	**(15 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 chlorinates 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**	**(15 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 Jesef 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 2024 -Practical Syllabus

PRACTICAL -I (CREDITS-4)

DSE-1A Bioprocess Technology

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. Sothern 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 (CREDITS-4)

DSE- 2A Recombinant DNA Technology

1. Isolation of DNA from whole blood/ yeast/ plant extract
2. Plasmid DNA isolation
3. Restriction digestion and study of restriction map of plasmid DNA
4. Demonstration of PCR
5. Calculation of molecular weight of digested DNA
6. Preparation of single stranded DNA template

DSE- 2B Genomics and Proteomics

1. *In silico* Genome study of *Drosophila/ Caenorhabditis*/ Homo sapiens/Aradopsis.
2. Study of Hydropathy plot/ Ramchandran plots
3. Demonstration of 2D gel electrophoresis.
4. Protein prediction by Mass Spectroscopy data.
5. Use of the SNP database at NCBI.
6. Use of OMIM database.
7. Detection of open reading frames using ORF Finder

DSE 4B- Environmental Biotechnology

1. Analysis of water sample: Determination of Total Dissolved Solids (TDS)
2. Analysis of water sample: Determination of COD and BOD of water sample.
3. Analysis of water sample: Determination of MPN
4. Decolorization of a textile dye to demonstrate concept of microbial bioremediation/ phytoremediation
5. Estimation of pesticides from given samples.
6. Estimation of residual chlorine from given water sample.

PRACTICAL –III (CREDITS -4)

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 using BLAST and FASTA.
5. Performing multiple alignment and cladogram by Clustal.
6. Prediction of physicochemical property of protein from sequence (ProtParam tool).
7. Retrieval 3-D structure of proteins from RCSB PDB.
8. Study 3-D structure of protein by RasMol.

DSE- 3 B Evolutionary Biology

1. Study of Zoogeographical Regions of world to understand the concept of speciation with examples
2. Study of biogeographic zones of India to study evolutionary variation and adaptation in species with examples
3. Study of macroevolution using Darwin's Finches using charts/models
4. Study of : types of fossils, homologous and analogous organs and adaptive radiation using laboratory models/specimen.
5. Study of phylogeny of horse using model/charts (reconstruction using limbs and teeth of horse ancestors)
6. Study of Molecular phylogeny of prokaryote and eukaryote.

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)

PROJECT WORK

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 a group of **minimum 2 to maximum 5 students**. The coordinator will guide the students in selecting the topic of the project, working on experiments, results of the same and writing the report.

COLLEGE ASSESSMENT (20 Marks)

The research project work should be continuously assessed by the respective project guides. Students must be asked to keep a continuous record of their project work. Team members of the project group should be equally assigned the tasks from time to time. **The project students should be encouraged to present their research work in the annual University Aavishkar Festival.** The progress of the research group to be continuously assessed by:

- Checking the record book.
- Monitoring of literature review.
- Project's powerpoint presentation.

UNIVERSITY ASSESSMENT (80 Marks)

Project Report:(Group Activity)	**60 Marks**
The final project thesis signed by research coordinator and head of department must be submitted at the time of University assessment. The project work should be presented as a Power-Point during the university examination.	

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ANY ONE of the following: **(Group Activity)**	**10 Marks**
Visit Report: 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 of the Project Work. The visit report should be duly certified by the Head of the Department.	
One national or international research publication: A research article should be published **on the performed project topic** in any one of **the UGC approved journal.** An authentic proof of the published article or its acceptance for publication in the journal to be shown by the research group.	

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ANY ONE of the following: **((Individual Activity)**	**10 Marks**
Review article: A review article on any **other than project topic** prepared by **individual students** in consultation with project guide will be submitted at the time of university practical examination, signed by project guide and head of the department.	
Presentation in National/International Conference: The **project topic or any other scientific topic** to be studied and presented **individually** by the student in the national/international conference **(other than Aavishkar)**. A certificate of paper/poster presentation should be shown by the student.	

Note:

Reports on multiple excursion tours may be clubbed for preparing and submitting reports at the time of final examination. Reduce or avoid the use of plastic files during submission of reports / projects as an eco-friendly method.