GENERAL INSTRUCTIONS
&
COURSE CURRICULUM

FOR

Ph.D. in Biotechnology

(Effective from Academic Session 2024-2025)

DEPARTMENT OF BIOTECHNOLOGY

HIMACHAL PRADESH UNIVERSITY

(NAAC Accredited "A" Grade University)

SUMMERHILL, SHIMLA-171005

HIMACHAL PRADESH, INDIA

HIMACHAL PRADESH UNIVERSITY
(NAAC ACCREDITED "A" GRADE UNIVERSITY)
OFFICE OF THE DEAN OF STUDIES
SHIMLA-171005

No. 1-60/2023-HPU(DS)- Dated: Shimla-5, the 09th May, 2023

NOTIFICATION

On the recommendations of the Standing Committee of Academic Council vide item No.1 in its meeting held on 04.02.2023, the Executive Council vide Additional Supplementary Item No.6 of its meeting held on 06.04.2023 has approved the adoption of University Grants Commission (Minimum Standards and Procedures for Award of Ph.D. Degree) Regulations, 2022 dated 07.11.2022 and 10.11.2022 (Annexure "A") in toto for its implementation in HP University from the session 2023-24.

Dean of Studies

Endst. No.: 1-60/2023-HPU(DS)- Dated : Shimla-5, the 9th May, 2023

Copy for Information and necessary action to:-

1. All the Deans of Faculties, HPU, Shimla-5.
2. All the Chairpersons/Directors, Teaching Departments/Institutes, HPU, Shimla-5.
3. The Principal, H.P. University centre for Evening Studies, HPU, Shimla-5.
4. The Dean Students' welfare, HPU, Shimla-5.
5. The Director, International Students' Welfare, HPU, Shimla-5.
6. The Controller of Examinations, HPU, Shimla-5.
7. The Chief Warden, HPU, Shimla-5.
8. The Director ICDEOL/DIS,HPU, Shimla-5.
9. Director, H.P.U Regional Centre Khaniara, (Dharamshala), Distt. Kangra.
10. The Deputy Registrar (Secrecy), HPU, Shimla-5.
11. The Assistant Registrar (Admn) & Assistant Registrar (Academic), HPU, Shimla-05.
12. The Web Admn H.P University, Shimla-5 with the request to upload the same on the University website.
13. The Spl. P.S. to the Vice-Chancellor, HPU, Shimla-5 for the kind information of the latter please.

Dean of Studies

DEPARTMENT OF BIOTECHNOLOGY
HIMACHAL PRADESH UNIVERSITY
SUMMER HILL, SHIMLA-171 005
Ph.D. BIOTECHNOLOGY PROGRAMME

GENERAL INSTRUCTIONS/GUIDELINES FOR EXECUTION OF CURRICULUM

1. All candidates admitted to the Ph.D. programme at the Department of Biotechnology have to complete a minimum of 12 credits.
2. There will be four (4) courses in Ph.D. Biotechnology Programme. The students have to take 3 compulsory courses **[PhDBIOTECH-101, PhDBIOTECH-102, PhDBIOTECH-103]** and one additional course out of four **elective courses [PhDBIOTECH-104(i), PhDBIOTECH-104(ii), PhDBIOTECH-104(iii), PhDBIOTECH-104(iv)]**.
3. A Ph.D. scholar must obtain a minimum of 55% marks or its equivalent grade in the UGC 10-point scale in the course work to be eligible to continue in the programme and submit his or her thesis.
4. The detailed syllabi for the courses offered by the Department are appended with a list of suggested books.

Outline of the Course work for Ph.D. Biotechnology

Course Code	**Title of the Course**	**Max. Marks**	**Credits**
PhDBIOTECH-101 (Common with all disciplines under the Faculty of Life Sciences)	Research Methodology (Compulsory)	100	4
PhDBIOTECH-102 (Common with all disciplines under the Faculty of Life Sciences)	Research and Publication Ethics (Compulsory)	50	2
PhDBIOTECH-103	Techniques in Biotechnology (Compulsory)	50	2
Elective Course (any one)			
PhDBIOTECH-104 (i)	Biotechnology for Bioprocess and Biobusiness	100	4
PhDBIOTECH-104 (ii)	Enzyme Technology	100	4
PhDBIOTECH-104 (iii)	Recombinant DNA Technology	100	4
PhDBIOTECH-104 (iv)	Bioinformatics and Artificial Intelligence	100	4
Total Marks/ Credits		**300**	**12**

Ph.D. in Biotechnology (Compulsory Course)
COURSE: PhDBIOTECH-101 (Common with all disciplines under the Faculty of Life Sciences)
RESEARCH METHODOLOGY

L	T	P	C
4	0	0	4

Theory: 60 Credit Hours *Theory examination: 100 marks*

NOTE: Instructions for setting question paper
Examiner will **set nine** questions in total covering the entire syllabus. However, there will be **one compulsory** question containing twenty parts [One mark each], besides two questions from each of the four Units. The students will attempt **five questions** in total by selecting one question from each unit and the compulsory question. All questions shall carry equal marks (20 marks each).

UNIT-I (15 hours)

Foundation of Research: Meaning, objectives of research; criteria of good research; basic steps of research; Qualitative and Quantitative Research.
Problem Identification & Formulation: selection of research problem.
Hypothesis: Qualities of a good Hypothesis, Null & Alternative Hypothesis, Hypothesis Testing, Logic & Importance
Review of Related Literature: Meaning, necessity and sources.

UNIT-II (15 hours)

Research process and Experiment Design: Concept and Importance in Research, features of a good research design, Exploratory Research Design concept, types and uses, Descriptive Research Designs concept, types and uses, Concept of Independent & Dependent variables.
Research Report: Writing preliminaries, main body of research, references and bibliography
Research and Development of Projects: Project formulation, National and international funding agencies for R & D projects, proposal submission, Intellectual Property Right (IPR).

UNIT-III (15 hours)

Sampling: Meaning and types of sampling; Probability and Non-Probability, Practical considerations in sampling and sample size.
Tools and Techniques of Data Collection: questionnaire, schedule, interview, observation, case study, survey *etc*. statistics and its significance in research.
Data Analysis: Frequency distribution, measures of central tendency, measures of dispersion, correlation, regression analysis, test of significance (Z-test, t-test, Chi-square test, F-test).

UNIT-IV (15 hours)

Use of Tools / Techniques for Research: Search engines: NCBI, PubMed, Google Scholar, Thomson Reuters, SCI etc, Reference Management Software like Zotero/Mendeley, Software for paper formatting like LaTeX/MS Office. Bioinformatics tools and applications.

Course objectives:

i. To provide basic framework and guidelines for researchers to clearly and define research problems, hypotheses, and objectives.

Course learning outcomes:

i. Will help the researchers to identify the most appropriate research design, sampling technique, and data collection and analysis methods.
ii. Researchers will be able to understand and comprehend the basics of research methodology and applying them in their research.

Suggested books [Latest Edition]:

1. Council of Biology Editors –CRE Style Manual, American Institute of Biological Sciences, Washington. D.C.
2. Effective Writing for Engineers, Managers, Scientists: Tichy AJ.
3. Scientific and Technical papers: Tribcase SF.
4. How to write and publish a scientific paper: Day RA.

Ph.D. in Biotechnology (Compulsory Course)

COURSE: PhDBIOTECH-102 (Common with all disciplines under the Faculty of Life Sciences))

RESEARCH AND PUBLICATION ETHICS

L	T	P	C
2	0	0	2

Theory: 30 Credit Hours *Theory examination: 50 marks*

NOTE: Instructions for setting question paper

Examiner will **set nine** questions in total covering the entire syllabus. However, there will be **one compulsory** question containing ten parts [One mark each], besides two questions from each of the four Units. The students will attempt **five questions** in total by selecting one question from each unit and the compulsory question. All questions shall carry equal marks (10 marks each).

UNIT-I (8 hours)

Philosophy, ethics and scientific conduct: Introduction to philosophy: definition, nature and scope, concept, branches

Ethics: Definition, moral philosophy, Nature of moral judgements and reaction;

Scientific conduct: Ethics with respect to science research, intellectual honesty and research integrity; Scientific misconduct: Falsification, fabrication and plagiarism; Redundant publications: Duplicate and overlapping publications, salami slicing; Selective reporting & misrepresentation of data.

UNIT-II (7 hours)

Publication ethics: Definition, introduction and importance, best practices/ standards setting initiatives and guidelines [COPE, WAME etc.], conflict of interest.

Publication misconduct: Definition, concept, problem that lead to unethical behaviour and vice versa, and types; conflict of interest; violation of publication ethics, authorship and contribution ship.; Identification of publication misconduct, complaints and appeals.

UNIT-III (8 hours)

Open-access Publishing & publication misconduct: Open-access publications and initiatives, SHERPA/ RoMEO online resource to check publisher copyright and self-archiving policies, software tools to identify predatory publications developed by SPPU; journal finder/ journal suggestion tools viz. JANE, Elsevier Journal finder, Springer Journal *etc*.

Publication misconduct: Group discussion: Subject specific ethical issues, FFP, authorship; Conflict of interest; complains and appeals: Examples and fraud from India and abroad.

Software tools: Use of plagiarism check software's like Turnitin, Urkund and other open-source software tools.

UNIT-IV (7 hours)

Databases and Research metrics: Databases - Indexing databases, and Citation databases: Web of Science, Scopus *etc*.

Research Matrices: Impact factor of a journal as per citation report, SNIP, SJR, IPP, Cite Score & Research Interest (Research Gate).

Matrices: H-index, I-Index, etc.

Course objectives:

i. To provide students with the fundamental knowledge of basics of philosophy of science, ethics in research and publication.
ii. Concept and understanding of predatory publication, indexing, citation databases, open-access publications and research matrices such as citations, h-index, i-index, impact factor, research interest score etc.
iii. Guide and mentor students in using plagiarism checking tools for a valid and ethical research.
iv. To prepare an evaluation report of a manuscript/ article.

Course learning outcomes:

i. The students will be able to know and practice ethical principles involved in research work and in publication that will help in maintaining integrity and credibility of scientific literature.

Suggested books [Latest Edition]:

1. The Ethics of Teaching and Scientific Research by Miro Todorovich; Paul Kurtz, Sidney Hook.
2. Research Ethics Publication Approaches by Brbara H Stanley; Joan E, Sieber; Gary R. Midbow.
3. Research Methods in Applied Sciences: An Integrated Approach to Design and Analysis by; Morgan Lawrence Erlbaum Associates.
4. Ethics and Values in Industrial –Organizational Psychology by Joel Lefkowitz. Wiley Publishers.

Ph.D. in Biotechnology (Compulsory Course)
COURSE: PhDBIOTECH-103
TECHNIQUES IN BIOTECHNOLOGY

L	T	P	C
2	0	0	2

Theory: 30 Credit Hours *Theory examination: 50 marks*

NOTE: Instructions for setting question paper
Examiner will **set nine** questions in total covering the entire syllabus. However, there will be **one compulsory** question containing ten parts [One mark each], besides two questions from each of the four Units. The students will attempt **five questions** in total by selecting one question from each unit and the compulsory question. All questions shall carry equal marks (10 marks each).

UNIT-I (8 hours)

Sterilization: Autoclave, laminar air flow, HEPA filters, dry and wet sterilization and their applications

Centrifugation: Concept of centrifugation, sedimentation coefficient, differential, rate zonal and isopycnic centrifugation, Analytical and preparative ultracentrifuges, k and k' factor, derating of rotor, special purpose rotors.

Chromatography: Paper, TLC, Gas chromatography, gel filtration, ion-exchange chromatography, reverse phase chromatography, hydrophobic interaction, affinity chromatography and HPLC.

UNIT-II (7 hours)

Electrophoresis: Paper and gel electrophoresis, Ferguson plots, Immuno-electrophoresis, isoelectric focusing, two-dimensional electrophoresis, capillary electrophoresis, western blotting and pulse field gel electrophoresis.

Spectrophotometry: UV & Visible spectroscopy, spectro-fluorimetry, atomic absorption and atomic emission spectroscopy. ORD and Circular dichroism, Florescent activated cell sorter (FACS).

UNIT-III (8 hours)

Microscopy: Principle of microscopy, limit of resolution, Electron Microscopy: Transmission and Scanning Electron Microscopy, Concept of Tunnelling Electron Microscopy and Atomic Force Microscopy.

Radioisotope Techniques: Radio-tracers, types of radioisotopes, interaction of radiation with matter, adsorbed body dose, GM counter, Proportional and Scintillation counters, methods of quench correction, auto-radiography and radioimmunoassay.

UNIT-IV (7 hours)

Molecular analysis: DNA isolation (prokaryotic and eukaryotic), qualitative and quantitative analysis of DNA, DNA amplification by PCR, Primer designing, Gene cloning and expression, RFLP, RAPD, AFLP, DNA, RNA and protein sequencing, CRISPR/Cas-9 Technology and applications.

Course objectives:

i. To develop a deeper understanding of the principles involved behind the working of different instruments used in Biotechnology research.
ii. To make researchers able to utilize scientific learning for expanding their research aptitude.

Course learning outcomes:

i. Students will be able to learn all the basic and advanced techniques used in Biotechnology research.
ii. By using various tools, students will be able to identify, characterise, and quantify biomolecules with precision.

Suggested books [Latest Edition]:

1. Basic Biotechniques for Bioprocess and Bioentrepreneurship: Bhatt AK, Bhatia RK and Bhalla TC.
2. Principles and Techniques of Practical Biochemistry: Keith Wilson and John Walker.
3. Spectroscopy of Biological Molecules: Modern Trends: Carmona P, Navarro R and Hernanz A.
4. Molecular Fluorescence: Principles and Application: Bernard Valeur.

Ph.D. in Biotechnology (Elective Course)
COURSE: PhDBIOTECH-104(i)
BIOTECHNOLOGY FOR BIOPROCESS AND BIOBUSINESS

L	T	P	C
4	0	0	4

Theory: 60 Credit Hours *Theory examination: 100 marks*

NOTE: Instructions for setting question paper
Examiner will **set nine** questions in total covering the entire syllabus. However, there will be **one compulsory** question containing twenty parts [One mark each], besides two questions from each of the four Units. The students will attempt **five questions** in total by selecting one question from each unit and the compulsory question. All questions shall carry equal marks (20 marks each).

UNIT-I (15 hours)

Bio-Process technology: Primary and secondary metabolites, integrated bio-process technology for products like baker's yeast, organic acids, enzymes and biofuels. Bio-process technology for the production of recombinant vaccines, therapeutic proteins and antibiotics, Monitoring and control of environmental parameters in fermentation process, Biosensors: Use of enzymes in analysis, biosensors- calorimetric, potentiometric, amperometric, optical, piezoelectric biosensors and immuno-sensors.

UNIT-II (15 hours)

Bioreactors and Bioreactor Control: Basic concepts of bioreactors, parameters of biochemical process, packed bed, fed-batch, bubble column, fluidized bed, trickle bed, CSTR, plug flow reactors, Innovative bioreactors, Reactor Dynamics and reactors with non-ideal characteristics**,** Manual and automatic control system, on-line and off-line analytical instruments, methods of measurement of process variables, Data analysis and process control.

UNIT-III (15 hours)

Kinetics of Sterilization and Scale-up Studies: Translation of laboratory, pilot and plant scale data, Criteria for translation between two scales of operation, Scale-up practices, Bases for scale-up methods, Comparison of various scale-up methods, Nongeometric scale-up. Kinetics of media sterilization, design of batch sterilization process, D-time, Z-value and F-value, calculation of Del-factor and holding time, Richards rapid method for design of sterilization cycles, Design of continuous sterilization, Air sterilization-design of air filters, Effect of air velocity and bed depth on filtration, single fibre efficiency.

UNIT-IV (15 hours)

Economics of fermentation processes: Total product cost, capital investment and profitability, manufacturing cost estimation, capital investment estimation, Risk capital and working capital, cost analysis for R & D decision making. **Biobusiness and Legal issues in Biotechnology:** Concept of Bio-business management, Project formulation, business plan, technological Assessment, feasibility and commercial viability of a project. Regulatory and IPR issues, Intellectual Property Rights (IPR), Licensing and Patenting of bio-product, GLP and GMP guidelines in fermentation processes.

Course objectives:

i. Technical know-how on versatile techniques in bioprocess technology.
ii. Will provide an understanding on application of bioprocess engineering techniques in basic and applied research.
iii. Will provide proficiency in designing and conducting fermentation studies.
iv. To provide basic knowledge to become next generation entrepreneurs.

Course learning outcomes:

i. Students will be able to learn the techniques of upstream & down-stream bio-process development, sterilization and scale up studies.
ii. Students will learn valuable skills for starting up of own company and be able to handle a broad range of tasks in life-science companies that develop and launch new products and services.

Suggested books [Latest edition]:

1. Bioprocess Engineering Principles: Pauline M Doran.
2. Principles of Fermentation Technology: Stanbury PF and Whitaker A.
3. Manual of Industrial Microbiology and Biotechnology: Demain AL and Solomon NA.
4. Basic Biotechniques for Bioprocess and Bioentrepreneurship: Bhatt AK, Bhatia RK and Bhalla TC.

Ph.D. in Biotechnology (Elective Course)
COURSE: PhDBIOTECH-104(ii)
ENZYME TECHNOLOGY

L	T	P	C
4	0	0	4

Theory: 60 Credit Hours *Theory examination: 100 marks*

NOTE: Instructions for setting question paper
Examiner will **set nine** questions in total covering the entire syllabus. However, there will be **one compulsory** question containing twenty parts [One mark each], besides two questions from each of the four Units. The students will attempt **five questions** in total by selecting one question from each unit and the compulsory question. All questions shall carry equal marks (20 marks each).

UNIT-I (15 hours)

Introduction to enzyme and enzyme technology: History and scope of enzymes and enzyme technology, nomenclature of enzymes, enzyme activity units.

Enzyme Kinetics: Activation Energy & Transition State concept. Mechanism of enzyme catalysis, simple kinetics of enzyme action, factors affecting enzyme activity, reversible reaction, enzyme inhibition, determination of Vmax and Km values.

Sources and preparation of enzymes: Sources of enzymes, screening strategies for novel enzymes, media for enzyme production, methods of purification and concentration of intracellular and extracellular enzymes, factors affecting enzyme stability, preparation of enzymes for sale, customer service, safety and regulatory aspects of enzyme use

UNIT-II (15 hours)

Large Scale use of enzymes in solution: Use of enzymes in detergents, food industry, fruit juice, wine, brewing and distilling industries, textile industries, waste treatment, diagnostics, pharmaceutical and chemical industries, application of enzymes in medicine

Preparation and kinetics of immobilized enzymes: Methods of immobilization of enzymes, Physical adsorption, covalent binding, entrapment and micro encapsulation, kinetics of immobilized enzymes, effect of solute partition and diffusion on the kinetics of immobilized enzymes, use of immobilized enzymes.

UNIT-III (15 hours)

Enzyme immobilisation: Immobilized enzymes and their use, Enzyme reactors, stirred tank reactors, plug flow reactors, continuous flow stirred tank fluidized bed reactor, Membrane/hollow fiber reactors, selection of reactors, productivity and performance of various types of reactors, immobilized enzyme processes - production of high fructose corn syrups, production of antibiotics, production of acrylamide and use of immobilized invertase, lactase and raffinase.

UNIT-IV (15 hours)

Advanced topics in enzyme technology: Enzyme reactions in biphasic liquid systems; proteases, glycosidases and lipases in synthetic reactions, interesterification of lipids, artificial enzymes, un-natural substrates, enzyme engineering, extremophilic enzymes, hybrid enzymes, high throughput screening and assay techniques.

Course objectives:

i. To inculcate the knowledge about different enzymes, characteristics and mechanism of action of enzymes, their kinetics and applications of enzymes that can benefit various sectors in society.

Course learning outcomes:

i. The students will be able to have in depth knowledge about the application of enzymes in the industry, research and pharmaceutical sciences.
ii. The students will able to assay the enzyme and their kinetics and also apply to this in the industry and other technological fields and will also be able to purify enzymes and use the same for the benefit of the mankind
iii. Will be able to understand about the process for commercialization of any biotechnological products developed with the use of specific enzymes.

Suggested books [Latest edition]:

1. Enzyme Technology: Chaplin MF and Bucks DC.
2. Industrial Enzymology: Godfrey and West.
3. Enzyme: Copeland
4. Enzymes in Industry: Gerhartz W

Ph.D. in Biotechnology (Elective Course)
COURSE: PhDBIOTECH-104(iii)
RECOMBINANT DNA TECHNOLOGY

L	T	P	C
4	0	0	4

Theory: 60 Credit Hours *Theory examination: 100 marks*

NOTE: Instructions for setting question paper
Examiner will **set nine** questions in total covering the entire syllabus. However, there will be **one compulsory** question containing twenty parts [One mark each], besides two questions from each of the four Units. The students will attempt **five questions** in total by selecting one question from each unit and the compulsory question. All questions shall carry equal marks (20 marks each).

UNIT-I (15 hours)

Recombinant DNA: Basics and scope of Recombinant DNA Technology enzymes that break, mend and synthesize DNA and RNA backbone bonds, remove phosphates at nucleic acid termini, and proteins which protect, coat, twist and untwist DNA.

UNIT-II (15 hours)

Cloning and expression vectors: Characteristics of cloning and expression vectors; plasmid, phage and cosmid vectors, multipurpose cloning vectors, shuttle vectors; bacterial, yeast, plant and mammalian expression vectors.
DNA Cloning Strategies: Preparation of genomic and cDNA libraries, criteria for selection of cloning vectors - plasmid, bacteriophage and cosmid, transformation and transfection, electroporation, screening of gene library and selection of clone.

UNIT-III (15 hours)

Nucleic acid Blotting and Hybridization: Southern and northern blotting and hybridization techniques, radioactive and non-radioactive labelling of probe, western blotting.
Expression of cloned genes: Expression of cloned genes in *E. coli*, *Bacillus subtilis*, *Streptomyces*, yeast and mammalian cells, detection and analysis of proteins expression from cloned genes.
Sequencing and other techniques: DNA, RNA and protein sequencing, DNA finger and foot printing, CRISPR/Cas-9 technology, antisense RNA.

UNIT-IV (15 hours)

Polymerase chain reaction and site directed mutagenesis: Principle and application of polymerase chain reaction, site-directed mutagenesis and protein engineering, molecular markers.
Impact of rDNA on human genetics: DNA based diagnosis, gene targeting, human genome project history and scope, ethical issues in relation to rDNA technology.
Applications of r-DNA technology: Application of genetic engineering in industry, agriculture, medicine, environment and forensic science

Course objectives:

i. To make students understand the basics of tools and techniques used in manipulation and analysis of DNA.
ii. A sound knowledge of the subject will help students to apply these tools in their research.

Course learning outcomes:

i. Students will be able to understand the principles of genetic manipulation; isolation of total genomic DNA, restriction and ligation of DNA molecules, amplifying recombinant DNA, molecular cloning, bacterial transformation
ii. Students also gain an insight as to how genetic engineering is used to provide innovative solutions to the societal challenges.

Suggested books [Latest Edition]:

1. Recombinant DNA Principles and Methodologies: James J Greene.
2. Molecular Biotechnology: Glick and Pasternak.
3. Principles of Gene Manipulation: Old RW and Primrose SB.
4. Genetic Engineering Fundamentals: Kammermeyer and Clark.
5. Gene Cloning and DNA Analysis: Brown TA

Ph.D. in Biotechnology (Elective Course)
COURSE: PhDBIOTECH-104(iv)
BIOINFORMATICS AND ARTIFICIAL INTELLIGENCE

L	T	P	C
4	0	0	4

Theory: 60 Credit Hours *Theory examination: 100 marks*

NOTE: Instructions for setting question paper
Examiner will set nine questions in total covering the entire syllabus. However, there will be one compulsory question containing twenty parts [One mark each], besides two questions from each of the four Units. The students will attempt five questions in total by selecting one question from each unit and the compulsory question. All questions shall carry equal marks (20 marks each).

UNIT-I (15 hours)

Bioinformatics: Introduction to NCBI website, NCBI Taxonomy, NCBI Genome, and Swiss-Prot Databases, Sequence retrieval from genomic databases, Restriction endonuclease mapping, Comparison of sequences using Basic Local Alignment Search Tool (BLAST), Local Alignment using L-Align, Global Alignment using MatGAT, Multiple Alignment using Clustal, Construction of distance based phylogenetic trees, Construction of character based phylogenetic trees, Determination of consensus sequences, locating genes (gene prediction) and open reading frames in DNA sequences, Gene prediction II, Comparison and analysis of whole genomes

UNIT-II (15 hours)

Molecular modelling: Introduction, molecular mechanics and dynamics, dynamic simulation, conformational search, molecular modelling packages (Chem3D, Hyperchem), protein modelling, structure prediction and molecular docking. Role in drug designing and synthetic biology, Theoretical methods in drug discovery: Docking, protein structure prediction, QSAR, Simulation of biochemical reactions, Modelling of enzymatic catalysis

UNIT-III (15 hours)

Protein engineering: Methods of Mutagenesis and Library creation: Random Mutagenesis, Targeted Mutagenesis and Gene Shuffling. Directed Laboratory Evolution and Rational Protein Designing: Concepts, strategies and applications. High-throughput Screening Methodologies: Bacteriophage display, Bacterial cell surface display, Yeast display, m-RNA display, Ribosome display, Cis-display, DNA-display and waterin-oil emulsions.

UNIT-III (15 hours)

AI in Biotechnology: Overview of AI technologies used in biotech, Machine learning algorithms in biotech
Neural networks and deep learning in biotech, Image recognition and computer vision in biotech, Applications of AI in the pharmaceutical industry, drug design, clinical trials, precision medicine, medical imaging, monitoring health and disease, synthetic biology, transforming Agriculture with AI. Ethical and legal implications of AI in biotech, Data privacy and security concerns in AI-powered biotech

Course objectives:
i. To make students understand the basics of bioinformatics and to develop analytical ability in molecular modelling.
ii. Learning of Artificial Intelligence in various Biotech & health sector.

Course learning outcomes:
i. Students will be able to understand basic bioinformatics software and programs
ii. Student will be able to grasp the AI knowledge and its role in human welfare

Suggested books [Latest Edition]:

1. Bioinformatics: Methods and Applications Genomics Proteomics and Drug Discovery: Rastogi SC, Mendiratta N, Rastogi P.
2. Protein Engineering: Principles and Practice: Jeffrey L. Cleland and Charles S. Craik.
3. Artificial Intelligence and Biotechnology: The Golden Age of Medical Research. Kumar U and Gupta KK.
4. Artificial Intelligence in Biotechnology: Preethi Kartan.