PANJAB UNIVERSITY

Scheme and Syllabus of Doctor of Philosophy

(PhD)
(Biotechnology)

2024

University Institute of Engineering and Technology,

Panjab University, Chandigarh

Pre PhD Course Work

(Biotechnology Engineering)

PROPOSED SCHEME OF EXAMINATION OF Ph.D. COURSE WORK FOR ACADEMIC SESSION 2024-25

Biotechnology

S. No	Paper No.	Paper Title	L	T	P	Total	Credits	Marks (Int. Exam)	Marks (Univ. Exam)
1	RM-9001	Research Methodology	4	-	-	4	4	50	50
2	RS-9004	Research and Publication Ethics	4	-	-	4	4	50	50
3	-	**Elective I**	4	-	-	4	4	50	50
Direct Admission after Bachelor of Engineering (*Additional Credit*)									
4		**Elective II**	4	-	-	4	4	50	50
		Elective III	4	-	-	4	4	50	50

Elective I

S. No	Paper No.	Paper Title
1	BT9501	Microbial Biotechnology& Molecular Medicine
2	BT9502	Polymer Science & Engineering
3	BT9503	Advances in Biochemical Engineering
4	BT9504	Enzyme Technology
5	BT9505	Nanobiotechnology: From theory to applications
6	BT9506	Cancer Biology
7	BT9507	Advances in Biosensor Technology

8	BT9508	Genetic Engineering
9	BT9509	Advances in Biomaterials
10	BT9510	Computational Biology and Bioinformatics

ELECTIVE II

S. No	Paper No.	Paper Title
1	ME BIO 102	Biotechniques
2	ME BIO 104	Bioseparation and Bioprocess technology

ELECTIVE III

3	ME BIO 203	Enzyme Engineering
4	ME BIO 204	Genetic Engineering

SYLLABUS OF PhD (BIOTECHNOLOGY)

Paper Title: Research and Publication Ethics

Paper Code: RS-9003

	L	T	P
	4	0	0

Objectives: This course has total 6 units focusing on basics of philosophy of science and ethics, research integrity, publication ethics. Hands on sessions are designed to identify research misconduct and predatory publications. Indexing and citation databases, open access publications, research metrics (citations, h-index, Impact factor etc) and plagiarism tools will be introduced in this course.

Philosophy and Ethics: (3 hrs)
1. Introduction to philosophy: definition, nature and scope, concept, branches
2. Ethics: definition, moral philosophy, nature of moral judgements and reactions

Scientific Conduct: (5 hrs)
1. Ethics with respect to science and research
2. Intellectual honest and research integrity
3. Scientific misconducts: falsification, fabrication, and plagiarism.
4. Redundant publications: duplicate and overlapping publications, salami slicing
5. Selective reporting and misrepresentation of data.

Publication Ethics: (7 hrs)
1. Publication ethics: definition, introduction and importance
2. Best practices/standards setting initiatives and guidelines: COPE, WAME, etc.
3. Conflicts of interest
4. Publication misconduct: definition, concept, problems that lead to unethical behaviour and vice versa, types
5. Violation of publication ethics, authorship and contributor ship
6. Identification of publication misconduct, complaints and appeals
7. Predatory publishers and journals

Open Access Publishing: (4 hrs)
1. Open access publications and initiatives
2. SHERPA/ROMEO online resource to check publisher copyright and self-archiving policies
3. Software tool to identify predatory publications developed by SPPU
4. Journal finder/ journal suggestion tools viz. JANE, Elsevier Journal Finder, Springer Journal Suggester, etc.

Publication Misconduct: (4 hrs)
A. Group Discussions (2 hrs)

1. Subject specific ethical issues, FFP, authorship
2. Conflicts of interest
3. Complaints and appeals: examples and fraud from India and abroad

B. Software tools (2 hrs)
Use of plagiarism software like Turnitin, Urkund and other open-source software tools

Databases and Research Metrics: **(7hrs)**
A Databases (4 hrs)
1. Indexing databases
2. Citation databases: Web of Science, Scopus, etc.

B. Research Metrics (3 hrs)
1. Impact Factor of journal as per journal citation report, SNIP, SJR, IPP, Cite Score
2. Metrics: h-index, g index, i10 index, altmetrics

References:
1. A Bird, "Philosophy of Science", Routledge 2006.
2. Alasdair MacIntyre, "A Short History of Ethics", London 1967.
3. P. Chaddah, "Ethics in Competitive Research: Do not get Scooped; do not get plagiarized". 2018, ISBN: 978-9387480865.
4. National Academy of Sciences, "on being a scientist: A guide to responsible conduct in research", third edition, National Academic Press, 2009.
5. D. B. Resnik, "What is ethics in research & why is it important" National Institute of Environmental Health Science, 1-10, Nature 489 (7415), 179.
6. Indian National Science Academy (INSA), Ethics in Science Education, Research and Governance, 2019, ISBN: 978-81-939482, 1-7.

Paper Title: Microbial Biotechnology & Molecular Medicine

Paper Code: BT 9501   **L T P 4 0 0**   **Credits: 4**

Internal Assessment: 50   **University Examination: 50**

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter:Thequestion paper will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two Sections having three questions each and candidate is required to attempt at least two questions from each section.

SECTION-A

Microbial Metabolism & Strain Improvement: Microbial metabolic pathways-amphibolic and biosynthetic, production of primary and secondary metabolites, microbial products of industrial importance, ideal growth medium for production of biomass and a microbial product,

culture preservation.

Techniques in Biotechnology:(For Purification and characterization of industrial products)
    i) Centrifugation: Principle, Types, Applications.
    ii) Chromatography: Principle, Types of Chromatography such as gel permeation, ion exchange, affinity etc, modes of Chromatography, Applications.
    iii) Electrophoresis: Principle, protein and DNA electrophoresis, SDS-PAGE,

SECTION- B

Microbial Drugresistance and Drug Development: Understanding pathogenesis, multidrug resistance and mechanisms, screening of microbes and microbial compounds for development of new chemotherapeutic agents, Disease diagnosis, identification and characterization of novel proteins by proteomics study.

Recommended books:

1.   Brock, T.D., Biotechnology : A Text of Industrial Microbiology. Smaeur Associate (1990) IInded.
2.   Crueger, W. and Crueger, A., Bio-Technology, A Handbook of Industrial Microbiology. Ponima Pub (2000) IInded.
3.   Stanbury P.F. and Whitakar A., Principles of Fermentation Technology, Orgamon Press, (1995) 2nd edition.
4.   Maheshwari, D. K., Dubey, R.C and Kang, S.C., Biotechnological applications of microorganisms: A techno-commercial approach. I K International Publishing House (2006).
5.   Waites, M. J.,Morgan N.L., Rockey J.S and Higton G. Industrial Biotechnology: An Introduction. BlackwellScientific Press, UK (2007).
6.   Patel, A.H., Industrial Microbiology. Mac Millan India Ltd, New Delhi (2005)

Paper Title: Polymer Science and Engineering

Paper Code: BT 9502   **L T P 4 0 0**   **Credits:4**

Internal Assessment: 50   **University Examination:50**

Course Duration: 45 lectures of one hour each.

Note for the Paper setter: The semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each section.

SECTION-A

Introduction to polymers: Basic concept, classification of polymers, molecular weight and its distribution, preparation of polymeric materials and their characterization. Step growth and chain polymerization,

copolymerization, kinetics and molecular weight distribution in polycondensation and free radical addition polymerization, control of molecular weight. (15)

Dilute Solution viscometery, conformation and molecular dimensions of polymer chains, Thermodynamics of polymer solutions. Rubber elasticity, flow curve and its determination. (10)

SECTION-B

Polymerization processes (6)

Polymeric materials with discussion on electrical, optical, transport and mechanical properties. (4)

Viscoelasticity, linear viscoelastic models. (5)

Bio-polymer materials, applications in bio-technology and controlled drug delivery system. (5)

Recommended Books

S. No.	Title	AUTHOR(S)	PUBLISHER
1.	Polymer Science and Technology	J.R.fried	Prentice Hall
2.	Polymer Science and Engineering	D.J.Williams	Prentice Hall
3.	Principles of Polymerization	George Odian	John Wiley &Sons,Inc.

Paper Title: Advances in Biochemical Engineering

Paper Code: BT 9503 **L T P 4 0 0** **Credits: 4**

Internal Assessment: 50 **University Examination:50**

Course Duration: 45 lectures of one hour each.

Note for the Paper setter: The semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each section.

SECTION-A

1. Various applications of microbes; modeling of biochemical reactions and applications to scale up.

(10)

2. Case studies based on bioreactor models for industrial productions, latest topics in fermentation engineering. (12)

SECTION-B

3. Separation techniques for the extraction of fermentation products, modeling and analysis. Overview of bench-Scale preparative bioseparations. (11)

4. Selectivity in synthesis: biocatalysis and bioconversion; stereochemical considerations, Stereo specific and Stereo selective reactions. Analytical methods and techniques for determination of enantioselectivity: Specific rotation, Chiral 1H NMR, Chiral shift reagents and Chiral HPLC, Chiral GC. (13)

Recommended books:

1. Shuler, M.L. and Kargi, F. Bioprocess Engineering: Basic concepts, 2nd ed., Prentice-Hall, 2002.
2. Doran Pauline M, Bioprocess Engineering Principles, Academic Press, 1995
3. Nielsen, J. and Villadsen, J. "Bioreaction Engineering Principles". Springer, 2007.
4. Blanch, H.W and Clark D.S., "Biochemical Engineering", Marcel Dekker,1997

Paper Title: Enzyme Technology
Paper Code: BT 9504   **L T P 4 0 0**   **Credits: 4**

Internal Assessment: 50   **University Examination:50**

Course Duration: 45 lectures of one hour each.

Note for the Paper setter: The semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each section.

SECTION-A

Introduction

Mechanism of enzyme action. Strategies of purification of enzymes, criteria of purity, molecular weight determination and characterization of enzymes Stereo selective biocatalysts for the synthesis of chiral pharmaceutical intermediate such as synthesis of ACE inhibitors, definition, mode of action of inhibitors. *(10)*

Kinetics of enzyme action:

Methods for investigating the kinetics of Enzyme catalysed reactions – Initial velocity Studies, Estimation of MichaelisMenten parameters, Effect of pH and temperature on enzyme activity, kinetics of inhibition. Modeling of rate equations for single and multiple substrate reactions. *(13)*

SECTION-B

Immobilized Enzymes:

Kinetics of immobilized enzymes, effect of solute, partition & diffusion on the kinetics of immobilized enzymes, design and configuration of immobilized enzyme reactors; applications of immobilized enzyme technology, Economic argument for immobilization. *(7)*

Modelling of Diffusion Systems

External, Internal mass transfer diffusion and reaction within biocatalysts, derivation of finite model for diffusion-reaction systems, dimensionless parameters from diffusion-reaction models, the effectiveness factor concept. *(8)*

Design and Analysis Of Biological Reactors

Ideal bioreactors-batch, fed batch, continuous, cell recycle, plug flow reactor, two stage reactors, enzyme catalyzed reactions, reactor dynamics and stability. *(7)*

Recommended books:

1. Trevor Palmer and Philip L Bonner. "Enzymes: Biochemistry, Biotechnology, Clinical Chemistry", East- West Press, 2004
2. Shuler, M.L. and F. Kargi, "Bioprocess Engineering: Basic Concepts" 2nd Edition, Pearson, 2002.
3. Bailey.J.E and Ollis.D.F, "Biochemical Engineering Fundamentals", 2nd Edition, McGraw-Hill, 1986.
4. Faber, Kurt "Biotransformations in Organic Chemistry: A Textbook." 5th Edition. Springer,2008

Paper Title: Nanobiotechnology: From theory to applications

Paper Code: BT 9505   **L T P 4 0 0**   **Credits: 4**

Internal Assessment: 50   **University Examination: 50**

Course Duration: 45 lectures of one hour each.

Note for the Paper setter: The semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each section.

Section A

Introduction: Overview of nanoparticles in biomedical applications, limitations and challenges in using nanoparticles in biomedical fields, biocompatibility/toxicity of nanomaterials (5)

Bioconjugation: Introduction to bioconjugation, interaction of biomolecules with nanoparticles, surface functionalization/modification of nanoparticles by ligand exchange or ligand modification; reactions of bioconjugation, types of cross linkers-homofunctional, heterofunctional, zero length; bioconjugation using covalent, non-covalent, biological approaches; examples of bioconjugation with metallic, semiconducting, magnetic nanoparticles and liposomes, modification and conjugation of antibody, enzyme, nucleic acid and oligonucleotide coupling reactions.   (10)

Bioanalytical techniques: Fluorescent probes and their use in nanotechnology, ligand immobilization on chromatography supports, PEGylation and synthetic polymer modification, characterization of nanobioconjugates using electrophoresis, chromatography and various spectroscopic techniques.   (7)

Section B

Bioinspirednanomaterials: Superhydrophobic materials such as lotus leaf structure, bio-inspired superglues (adhesive nanostructures), ultrahard materials, organic and inorganic natural nanomaterials, natural fibers (spider silk, sponge fibers), nanomaterials derived from cell walls.   (6)

Bionegineering: Biomaterials-biomineralization,   applications   and   importance   of   compatibility, biological/circadian rhythms and its phase markers, neurotransport:nerve impulse conduction and conduction across synapse, EEG, ECG and its association with the working of the heart.   (6)

Tissue engineering: Concept of tissue engineering-cell types, scaffolds and bioreactors, nanopump, molecular motors-types and examples, nanoscalebiostructures, self-healing structures.   (5)

Applications: Lab-on-a-chip, organic molecular based computing -amorphous computing, DNA fingerprinting, bio-imaging, bioassays, nanovectors&drug delivery, nano-diagnostics &therapeutics, DNA molecular therapy, photodynamic therapy, smart materials, biosensors, nanorobotics.   (6)

Books and Suggested Readings

1. Nanostructures and Nanomaterials by G. Cao, Imperial College Press, 2004
2. Biophysics, PV Gautham, Narosa Publishing House, New Delhi, 2002
3. Biometals by SV Bhat, Narosa Publishing House, New Delhi, 2002
4. Modern Bioelectricity by A. A. Marino, Marcel Dekker Inc New York, 1998

Paper Title: Understanding Cancer Biology

Paper Code: BT 9506   **L T P 4 0 0**   **Credits: 4**

Internal Assessment: 50   **University Examination: 50**

Course Duration: 45 lectures of one hour each.

Note for the Paper setter: The semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each section.

Section A

Incidence and etiology of cancer, Molecular biology of cancer, Immune system and cancer cells, risk and prevention genetics of cancer, various factors controlling cancer progression, Cellular hallmarks of cancer, Cancer metastasis, journey of benign tumor to metastatic cancer, Stages of cancer metastasis, tools of cancer diagnosis, cell imaging

Section B

Relation between nutrition and cancer, Diet- and lifestyle-related risk factors for cancer development and survival, mechanisms by which nutrition impacts cancer, prevention, Different types of cancer, Cancer treatment; surgery, radiation therapy, chemo therapy, recent developments.

Text Book/References

1. Molecular Biology of the Cell. 4th edition. Alberts B, Johnson A, Lewis J, et al. New York: Garland Science; 2002.
2. Molecular Cell Biology. 4th edition. Lodish H, Berk A, Zipursky SL, et al. New York: W. H. Freeman; 2000
3. All Cancers Fact Sheet, GLOBOCAN 2018. The Global Cancer Observatory. Available online: https://gco.iarc.fr/today/data/factsheets/cancers/39-All-cancers-fact-sheet.pdf.
4. Bray, F.; Ferlay, J.; Soerjomataram, I.; Siegel, R.L.; Torre, L.A.; Jemal, A. Global Cancer Statistics 2018:GLOBOCAN Estimates of Incidence and Mortality Worldwide for 36 Cancers in 185 Countries. CA Cancer J.Clin. 2018, 68, 394–424.
5. Arruebo, M.; Vilaboa, N.; Sáez-Gutierrez, B.; Lambea, J.; Tres, A.; Valladares, M.; González-Fernández, Á. Assessment of the evolution of cancer treatment therapies. Cancers 2011, 3, 3279–3330.

Paper Title: Advances in Biosensor Technology

Paper Code: BT 9507   **L T P 4 0 0**   **Credits: 4**

Internal Assessment: 50   **University Examination: 50**

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter:Thequestion paper will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two Sections having three questions each and candidate is required to attempt at least two questions from each section.

SECTION-A

Sensors-signals and systems, Biosensors and its components, types of recognition elements (aptamers, antibodies, DNAzymes, enzymes, nucleic acids, bacteriophages) and transducers (optical and electrochemical). (4)

Colorimetric biosensors, fluorescent biosensors, SPR based sensors (5)

Electrochemical biosensors (potentiometric, amperometric, and impedimetric) (4)

Dipstick, strip-based, and microfluidic assays (5)

Applications of biosensors in healthcare, food, and environment sectors (5)

SECTION-B

Biology at the nano-interface, conjugation and crosslinking approaches for development of biosensor, types of crosslinkers. (5)

Nanomaterials: synthesis and characterization, Properties, Applications in Biosensors (5)

Characterization techniques involved in biosensor development: Thermal methods, X-ray methods, Spectroscopic methods (UV, FTIR, Raman, PL), Chromatographic methods, Mass spectroscopy, Electron Microscopy (SEM, TEM), Electron Probe Micro Analysis (EDX), Quantitative Analysis (AAS, ICP). (12)

Recommended Books

1. Jeong-Yeol Yoon, 2016. Introduction to Biosensors, Springer International Publishing.

2. ChandranKarunakaran, KalpanaBhargava, Robson Benjamin, 2015. Biosensors and Bioelectronics.Elsevier Publishers.

3. Helmut Günzlerand Alex Williams, 2001. Handbook of Analytical Techniques.Wiley Publishers.

Paper Title: Genetic Engineering
Paper Code: BT 9508   **L T P 4 0 0**   **Credits: 4**
Internal Assessment: 50   **University Examination:50**

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter:The Semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two Sections having three questions each and candidate is required to attempt at least two questions from each section.

SECTION-A

Scope of Genetic Engineering- Milestones in Genetic Engineering, genetic code, genetic elements that control gene expression. (2)

Molecular Tools in Genetic Engineering – Restriction and DNA Modifying enzymes (Polymerases, Reverse Transcriptase, Ligases, Alkaline phosphatase, Terminal deoxynucleotidetransferases, Nucleases - S1 nucleases etc.), Vectors for *E. coli* (Plasmids, Phages, Cosmids, Fosmids, Phagemids, BAC), Vectors for Eukaryotes (YEPs, YIPs, YRPs, YAC), Vectors for plants (Ti and Ri plasmids, caulimoviruses, geminiviruses), Vectors for animals (P-elements, baculovirus, adenovirus, papillomavirus and retrovirus). (10)

Nucleic Acid Amplification and Gene Cloning Strategies- PCR analysis, their types and applications, prokaryotic and eukaryotic transformations, Creating and screening DNA libraries (Genomic library and cDNA library preparations)**.** (6)

Directed Mutagenesis and Protein Engineering- *in-vitro* mutagenesis, *in-vivo* mutagenesis, error-prone PCR, adding disulphide bond, increasing enzymatic activity, modifying metal cofactor requirement *etc*. (5)

SECTION-B

Molecular Markers and Diagnostic Systems- Molecular Markers (RFPL, AFLP, RAPD, SSR, SNP, CAPs, SSR and their applications), Human molecular genetics **(**genetic linkage and genetic mapping), Detection of microbes (radioactive, non-radioactive hybridization procedure, molecular beacons, DNA fingerprinting, bacterial biosensor), Diagnosis of genetic diseases (cystic fibrosis, sickle cell anemia, PCR/OLA). (10)

Application of Genetic Engineering in Plants, Animals and Microbes- Transgenic plants (Disease resistant, insect resistance, herbicide tolerance and biopharming), in Animals (hormones and pharmaceutical protein production, generation of transgenic animal, Gene therapy, to fight AIDS), Transgenic Microbes (Production of restriction endonucleases, small biological molecules such as ascorbic acid, indigo, antibiotics and enzymes, insulin, growth hormones, monoclonal antibodies/magic bullets, humanized monoclonal antibodies, biopolymers such as xanthum gum, animal adhesive biopolymer, bioremediation i.e. degradation of xenobiotics, clearing oil spills, starch and cellulose utilization and case studies. (10)

Regulation and Patenting in Molecular Biology- importance of regulation, regulating food and food ingredients, GMOs release and controversy, Human gene therapy. (2)

Recommended books:
1. Gene Cloning and DNA Analysis, An Introduction. T.A.Brown, Wiley –Blackwell publication, 2010.
2. Recombinant DNA by Watson., Scientific American books, New York, 1992.
3. Bernard R. Glick and J. J. Pasternak,2003, Molecular biotecnlogy, ASM Press, Washigton, 3rd edition

Paper Title: Advances in Biomaterials

Paper Code: BT 9509   **L T P   4 0 0**   **Credits: 4**

Internal Assessment: 50   **University Examination:50**

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each section.

CLASSIFICATION OF BIOMATERIALS AND THEIR PROPERTIES: Metals- crystal structure, properties, processing, oxide formation and corrosion, Examples-Stainless steel, Ti and Ti-based alloys.**Ceramics**- classification- inert, bioactive and resorbable ceramics, structure and processing, Examples-Alumina, Carbon, hydroxyapatite. **Composite material**- -basic concept, matrix phase, particle reinforcement-organic and inorganic, fibre reinforcement.Synthesis techniques.Example- Ceramic- Polymer composites.**Polymers**- natural and synthetic polymers- structure- property relationship
(15)

CHARACTERIZATION OF BIOMATERIALS: atomic bonding, crystal lattice. Methods of material characterization: Thermal analysis, TGA, DTA, DSC, basic principle. Mechanical properties(stress strain curve, tensile strength) optical properties, surface properties, tribology   (8)

SECTION B

TESTING OF BIOMATERIAL: In vitro assessment of cell and tissue compatibility. In vivo assessment of tissue compatibility   (4)

HOST RESPONSE TO BIOMATERIALS: Biomaterial-Blood interaction, blood coagulation, foreign body reaction, inflammation, wound healing process   (5)

APPLICATIONS OF BIOMATERIALS:Soft tissue application- cardiovascular, skin and facial implants. **Hard tissue application** – orthopedic and dental implants. **Tissue engineering scaffolds**- scaffolds for bone and skin tissue engineering. **Drug delivery**-.Targeted drug delivery. Coating on implant surface   (10)

IMPLANT FAILURE: Wear, cracks, fatigue, degradation of material in the biological environment.   (3)

Recommended books:

Biomaterials.Bhat, S.V. Alpha Science International, 2005, 2nd edition.

Biomaterials Science: An Introduction to Materials in Medicine, Edited by: Ratner, B.D., Hoffman, A.S., Schoen, F.J. and Lemons, J.E.Academic Press ,2013, 3rd edition.

Biomaterials: An Introduction. Park, J. and Lakes, R.S.Springer Science+ Business Media, 2007, 3rd edition.

Essential Biomaterials Science.Williams, D.Cambridge University Press, 2014, 1st edition.

Paper Title: Computational Biology and Bioinformatics

Paper Code: BT 9510   **L T P   4 0 0**   **Credits: 4**

Internal Assessment: 50   **University Examination:50**

Course Duration: 45 Lectures of one hour each.

Note for the Paper setter: The semester question paper of a subject will be of 50 Marks having 7 questions of equal marks. Students are required to attempt 5 questions in all. First question, covering the whole syllabus and having questions of conceptual nature, will be compulsory. Rest of the paper will be divided into two parts having three questions each and the candidate is required to attempt at least two questions from each section

Section-A

Introduction: Objectives and Applications of Bioinformatics, Bioinformatics Resources: NCBI, EBI, ExPASy, RCSB : The knowledge of databases and bioinformatics tools available at these resources. Open access bibliographic resources and literature databases, Various file formats for bio-molecular sequences. (8)

Sequence Analysis: Basic concepts of sequence similarity, identity and homology. Scoring matrices: basic concept of a scoring matrix, PAM and BLOSUM matrices, Pairwise sequence alignment: Basic concepts of sequence alignment, Needleman and Wunsch, Smith and Waterman algorithms for pairwise alignments, FASTA and BLAST algorithms. Multiple Sequence Alignment methods (MSA). (8)

Phylogenetic Analysis: Phylogenetic tree and terminology, different methods of Phylogenetic tree prediction: maximum parsimony, distance (UPGMA, NJ), maximum likelihood methods. (6)

Section-B

Genomics and Proteomics : Overview of genes and proteins, Structural Annotation: open reading frame, Exon prediction, Functional Annotation: Primary protein structure analysis, primary and secondary protein structure prediction, Molecular modeling, Mutagenesis, Functional analysis (7)

Data Analysis in NGS: Types of Sequencing, File formats in NGS, Applications of NGS: DNA seq, RNA seq, Metagenomics analysis of Amplicon sequencing (8)

Data preprocessing and visualization: Types of data, dealing with missing data, data visualization: Scatter Plot, histogram, group plots, box plots etc., dimensionality reduction (3)

Drug Discovery Technology or Insights of Protein-Ligand Interactions: Introduction, concepts of protein optimization, energy minimization, molecular docking using Autodock. (5)

Recommended Books:

S.No.	Name	Authors	Publisher
1.	Bioinformatics-A Beginners Guide	Claverie, J. M. and Notredame, C.	Wiley Publishing, Inc. (2007)2nd edition
2.	Bioinformatics Concepts, Skills and Applications	Rastogi, S. C., Mendiratla, N. and Rastogi, P.	CBS Publishers and Distributors, New Delhi (2009) 2nd edition
3.	Introduction to Bioinformatics	Attwood, T. K. and Parry Smith, D.J.	Pearson Education Ltd. (2007) Ist edition
4.	Bioinformatics: Principles and Applications	Ghosh, Z. and Mallick, B	Oxford University Press (2008)