BANASTHALI VIDYAPITH

Master of Technology (Biotechnology)

Curriculum Structure

First Semester Examination, December, 2019
Second Semester Examination, April/May, 2020
Third Semester Examination, December, 2020
Fourth Semester Examination, April/May, 2021

BANASTHALI VIDYAPITH
P.O. BANASTHALI VIDYAPITH
(Rajasthan)-304022

July, 2019

150

No. F. 9-6/81-U.3

Government of India
Ministry of Education and Culture
(Department of Education)

New Delhi, the 25th October, 1983

N O T I F I C A T I O N

In exercise of the powers conferred by Section 3 of the University Grants Commission Act, 1956 (3 of 1956) the Central Government, on the advice of the Commission, hereby declare that Banasthali Vidyapith, P. O. Banasthali Vidyapith, (Rajasthan) shall be deemed to be a University for the purpose of the aforesaid Act.

Sd/-
(M. R. Kolhatkar)
Joint Secretary of the Government of India

N O T I C E

Changes in Bye-laws/Syllabi and Books may from time to time be made by amendment or remaking, and a Candidate shall, except in so far as the Vidyapith determines otherwise, comply with any change that applies to years she has not completed at the time of change.

Programme Educational Objectives

The M. Tech. Biotechnology programme aims at overall growth and development of the students considering the exclusive five fold Educational ideology of Banasthali Vidyapith.

Biotechnology is a broad discipline of biological science dealing with commercial exploitation of living organisms and their products for the welfare of mankind. Past few decades have witnessed a steady growth towards invention and innovation oriented research. Thus, the M. Tech Biotechnology programme has been designed to provide knowledge, which can be applied by the students in various related R & D sectors and industries, to find solutions pertaining to bioproduct, bioprocesses, and technology development. It will also help them to inculcate the spirit of teamwork together with leadership qualities. The key objectives of the programme are:

- To provide expertise in various tools and techniques of biotechnology
- To facilitate postgraduates to identify, formulate and analyze complex biotechnological challenges
- To address the societal, ethical and environmental issues that a biotechnologist is facing
- To nurture competence in digital literacy that would support professional needs in biotechnology
- To nurture a temperament that would enable students to develop technical proficiency that can be used to cater the performance driven needs of industry, academia, research and startups
- To strengthen communication, entrepreneurial and leadership skills, which will promote a lifelong learning.

Programme Outcomes

PO1: **Knowledge**: Enrich with the knowledge of core domains like cytology, microbiology, genetics, biochemistry along with applied field including genetic engineering, cell culture, immunology, bioinformatics, , bioprocess engineering, food engineering.

PO2: **Planning ability**: Instill effective time and resource management skills accompanied with good team practices and organizational abilities

PO3: **Problem analysis**: Utilize technical skills to design, conduct experiments, analyze and interpret data for investigating problems in biotechnology.

PO4: **Modern tool usage**: Apply appropriate methodologies, resources, and techniques for biological manipulation and data interpretation.

PO5: **Leadership skills**: Work as an effective leader by applying reasoning skills to assess societal, environmental, safety and legal issues of biotechnology sectors.

PO6: **Professional Identity**: Understand their responsibilities related to biotechnological and engineering practices and work efficiently with multi-disciplinary team in research lab and industry

PO7: **Biotechnology ethics**: Understand the regulatory norms and ethics for production of various products and process development in biotechnology sectors.

PO8: **Communication**: Work as impressive personality in industry and research lab with eloquent communication skill of both oral and written form.

PO9: **Biotechnology and society**: Acquire the technical skills in solving societal challenges related to healthcare, food and environmental sectors through biotechnological approaches.

PO10: **Environment and sustainability**: Understand the impact of the biotechnology solutions on societal and environmental contexts and need for sustainable development.

PO11: **Life-long learning**: Develop self confidence and aptitude for life-long learning to maintain a positive attitude towards personal and professional development.

Curriculum Structure

Master of Technology (Biotechnology)

First Year

Semester - I

Course	Code	Course Name	L	T	P	C*
BIN	501	Biological Databases and Computational Biology	4	0	0	4
BT	523	Advanced Cell Biology	4	0	0	4
MATH	506	Engineering Mathematics	4	0	0	4
BT	505L	Biotechnology Lab - I	0	0	12	6
		Term Paper-I/Minor Project-I/ Seminar-I**	0	0	8	4
		Discipline Elective-I	4	0	0	4
		Semester Total:	**16**	**0**	**20**	**26**

Semester - II

Course	Code	Course Name	L	T	P	C*
BT	527	Bioprocess Engineering	4	0	0	4
BT	530	Genetic Manipulation Technology	4	0	0	4
BT	506L	Biotechnology Lab - II	0	0	12	6
		Term Paper-II/Minor Project-II/Seminar-II**	0	0	8	4
		Discipline Elective-II	4	0	0	4
		Open Elective	4	0	0	4
		Semester Total:	**16**	**0**	**20**	**26**

Second Year

Semester - III

Course	Code	Course Name	L	T	P	C*
BT	606P	Project Part – I	0	0	48	24
		Reading Elective - I	0	0	0	2
		Semester Total:	**0**	**0**	**48**	**26**

Semester - IV

Course	Code	Course Name	L	T	P	C*
BT	607P	Project Part - II	0	0	48	24
		Reading Elective - II	0	0	0	2
		Semester Total:	**0**	**0**	**48**	**26**

List of Discipline Elective

Course	Code	Course Name	L	T	P	C*
BIN	502	Computer Aided Drug Designing	4	0	0	4
BIN	503	Elements of Bioinformatics	4	0	0	4
BIO	417	Structural Biology	4	0	0	4
BIO	501	Bioentrepreneurship	4	0	0	4
BIO	502	Cancer Biology	4	0	0	4
BT	510	Environmental Biotechnology	4	0	0	4
BT	512	Food Biotechnology	4	0	0	4
BT	517	Medical Biotechnology	4	0	0	4
BT	519	Nanobiotechnology	4	0	0	4
BT	511	Enzyme Technology	4	0	0	4
BT	516	Immunotechnology	4	0	0	4

List of Reading Elective

Course	Code	Course Name	L	T	P	C*
BT	538R	Molecular Plant Breeding	0	0	0	2
BT	529R	Drug Discovery	0	0	0	2
BT	531R	Human Genetics and Diseases	0	0	0	2
BT	534R	Intellectual Property Rights	0	0	0	2
BT	535R	Medical Microbiology	0	0	0	2
BT	539R	Protein Engineering	0	0	0	2

List of Online Reading Elective

Course Name
Bioreactor
Downstream Processing
Mass spectrometry based proteomics

*** L - Lecture hrs./week; T - Tutorial hrs./week; P-Project/Practical/Lab/All other non-classroom academic activities, etc. hrs./week; C - Credit Points of the Course**

**** BT 536P Minor Project – I**
BT 540P Term Paper – I
BT 537P Minor Project – II
BT 541P Term Paper – II
BT 542S Seminar – I
BT 543S Seminar – II

Student can opt open (Generic) elective from any discipline of the Vidyapith with prior permission of respective heads and time table permitting.

Every Student shall also opt for:
Five Fold Education: Physical Education I, Physical Education II, Five Fold Education: Aesthetic Education I, Aesthetic Education II, Five Fold Education: Practical Education I, Practical Education II one each semester

Five Fold Activities

Fine Arts		Physical Education and Sports	
BVFF 101	Classical Dance (Bharatnatyam)	BVFF 201	Aerobics
BVFF 102	Classical Dance (Kathak)	BVFF 202	Archery
BVFF 103	Classical Dance (Manipuri)	BVFF 203	Athletics
BVFF 104	Creative Art	BVFF 204	Badminton
BVFF 105	Folk Dance	BVFF 205	Basketball
BVFF 106	Music-Instrumental (Guitar)	BVFF 206	Cricket
BVFF 107	Music-Instrumental (Orchestra)	BVFF 207	Equestrian
BVFF 108	Music-Instrumental (Sarod)	BVFF 208	Flying - Flight Radio Telephone Operator's Licence (Restricted)
BVFF 109	Music-Instrumental (Sitar)	BVFF 209	Flying - Student Pilot's Licence
BVFF 110	Music-Instrumental (Tabla)	BVFF 229	Aeromodelling
BVFF 111	Music-Instrumental (Violin)	BVFF 210	Football
BVFF 112	Music-Vocal	BVFF 211	Gymnastics
BVFF 113	Theatre	BVFF 212	Handball
		BVFF 213	Hockey
Social Service and Extension Activities		BVFF 214	Judo
BVFF 301	Banasthali Sewa Dal	BVFF 215	Kabaddi
BVFF 302	Extension Programs for Women Empowerment	BVFF 216	Karate – Do
BVFF 303	FM Radio	BVFF 217	Kho-Kho
BVFF 304	Informal Education	BVFF 218	Net Ball
BVFF 305	National Service Scheme	BVFF 219	Rope Mallakhamb
BVFF 306	National Cadet Corps	BVFF 220	Shooting
		BVFF 221	Soft Ball
		BVFF 222	Swimming
		BVFF 223	Table Tennis
		BVFF 224	Tennis
		BVFF 225	Throwball
		BVFF 226	Volleyball
		BVFF 227	Weight Training
		BVFF 228	Yoga

Evaluation Scheme and Grading System

Continuous Assessment (CA) (Max. Marks)					End-Semester Assessment (ESA) (Max. Marks)	Grand Total (Max. Marks)
Assignment		Periodical Test		Total (CA)		
I	II	I	II			
10	10	10	10	40	60	100

In all theory, laboratory and other non classroom activities (project, dissertation, seminar, etc.), the Continuous and End-semester assessment will be of 40 and 60 marks respectively. However, for Reading Elective, only End semester exam of 100 marks will be held. Wherever desired, the detailed breakup of continuous assessment marks (40), for project, practical, dissertation, seminar, etc shall be announced by respective departments in respective student handouts.

Based on the cumulative performance in the continuous and end-semester assessments, the grade obtained by the student in each course shall be awarded. The classification of grades is as under:

Letter Grade	Grade Point	Narration
O	10	Outstanding
A+	9	Excellent
A	8	Very Good
B+	7	Good
B	6	Above Average
C+	5	Average
C	4	Below Average
D	3	Marginal
E	2	Exposed
NC	0	Not Cleared

Based on the obtained grades, the Semester Grade Point Average shall be computed as under:

$$SGPA = \frac{CC_1 * GP_1 + CC_2 * GP_2 + CC_3 * GP_3 + ---- + CC_n * GP_n}{CC_1 + CC_2 + CC_3 + ---- + CC_n} = \frac{\sum_{i=1}^{n} CC_i * GP_i}{\sum_{i=1}^{n} CC_i}$$

Where n is the number of courses (with letter grading) registered in the semester, CC_i are the course credits attached to the i^{th} course with letter grading and GP_i is the letter grade point obtained in the i^{th} course. The courses which are given Non-Letter Grades are not considered in the calculation of SGPA.

The Cumulative Grade Point Average (CGPA) at the end of each semester shall be computed as under:

$$CGPA = \frac{CC_1 * GP_1 + CC_2 * GP_2 + CC_3 * GP_3 + ----+ CC_n * GP_n}{CC_1 + CC_2 + CC_3 + ----+ CC_n} = \frac{\sum_{i=1}^{n} CC_i * GP_i}{\sum_{i=1}^{n} CC_i}$$

Where n is the number of all the courses (with letter grading) that a student has taken up to the previous semester.

Student shall be required to maintain a minimum of 4.00 CGPA at the end of each semester. If a student's CGPA remains below 4.00 in two consecutive semesters, then the student will be placed under probation and the case will be referred to Academic Performance Review Committee (APRC) which will decide the course load of the student for successive semester till the student comes out of the probationary clause.

To clear a course of a degree program, a student should obtain letter grade C and above. However, D/E grade in two/one of the courses throughout the UG/PG degree program respectively shall be deemed to have cleared the respective course(s). The excess of two/one D/E course(s) in UG/PG degree program shall become the backlog course(s) and the student will be required to repeat and clear them in successive semester(s) by obtaining grade C or above.

After successfully clearing all the courses of the degree program, the student shall be awarded division as per following table.

Division	CGPA
Distinction	7.50 and above
First Division	6.00 to 7.49
Second Division	5.00 to 5.99
Pass	4.00 to 4.99

CGPA to % Conversion Formula: % of Marks Obtained = CGPA * 10

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First Semester

BIN 501 Biological Databases and Computational Biology

Max. Marks: 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- Mine the biological databases to identify relevant sequence/structure for studies.
- Carry out sequence based evolutionary studies.
- Perform molecular modeling studies with biological macromolecules and explain the results.

Section A

- Introduction to biological Databases: primary, secondary, composite databases.
- Sequence databases: Nucleic Acids (GenBank, DDBJ, EMBL), Proteins (SWISS-PROT, PIR).
- Structures Databases: PDB, SCOP, CATH.
- Specialized databases: KEGG, Transfac, ReBase.
- Submission and retrieval of data to/from public databases.

Section B

- Introduction to Sequence alignment: dot plot, scoring matrices (PAM and BLOSUM), gap penalties, ends free alignment.
- Concept of dynamic programming: Needleman-Wunsch (global alignment) algorithm, Smith-Waterman (local alignment) algorithm.
- Databases similarity search: algorithms of FASTA, BLAST, Statistical significance of alignment scores.
- Concept of multiple sequence alignment: Progressive alignment.

Section C

- Computational approaches of ORF and Gene identification.
- Models of evolution, methods of Phylogenetic analysis: Distance based (UPGMA and NJ method) and Character based (Maximum parsimony).
- Homology based modeling three dimensional structure of proteins.
- Concept of molecular docking: modeling substrate - receptor interaction and its applications.

Suggested Books:

- Baxevanis, A.D. & Ouellette, B.F.F. (2004). *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins* (3rd ed.). Wiley.
- Bosu, O. & Thukral, S.K. (2007). *Bioinformatics: database, tools and algorithms* (1st ed.). Oxford University Press.
- Sharma, V., Munjal, A., & Shanker, A. (2017). *A Text Book of Bioinformatics* (2nd ed.). Meerut: Rastogi Publications.
- Sinha, P.K & Sinha, P. (2016). *Computer Fundamentals* (6th ed.). New Delhi: BPB publication.

Suggested e-Resources:

- **Chou-Fasman Method for protein secondary structure prediction** https://pdfs.semanticscholar.org/fd8c/c95aec2d7af19ed28eea3688b3c231d0e745.pdf
- **Homology modeling**

  https://proteinstructures.com/Modeling/homology-modeling.html
- **Bioinformatic tools**

  https://nptel.ac.in/courses/102103044/pdf/mod6.pdf
- **Essential bioinformatics**

  http://www.aun.edu.eg/molecular_biology/Procedure%20Bioinformatics22.23-4-2015/Xiong%20%20Essential%20Bioinformatics%20send%20by%20Amira.pdf

BT 523 Advanced Cell Biology

Max. Marks: 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- Describe processes in cell biology.
- Compare the role of various characteristic bio-molecules of living organisms.
- Apply concepts of cell biology to relevant and specific problems.

Section-A

- Replication of genetic material in prokaryotes and eukaryotes, Replication of single stranded circular DNA.
- Prokaryotic transcription and Anti-termination; Eukaryotic transcription.
- Post transcriptional modifications: processing of hnRNA, tRNA and rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; Splicing; RNA editing; Nuclear export of mRNA; Catalytic RNA.
- Translation: Genetic code; Translation machinery; Isoaccepting tRNA; Mechanism of initiation, elongation and termination; post-translational modifications.

Section B

- Molecular structure and function: Structural models, Composition and dynamics; Transport of ions and macromolecules; Pumps, carriers and channels; Membrane carbohydrates and their significance in cellular recognition; cellular junctions and adhesions; structure and functional significance of plasmodesmata.
- Endocytosis and exocytosis, clathrin & coatomer coated vesicles, SNARE proteins.

- Cell to cell signalling: autocrine, paracrine and endocrine stimulation; Signaling via G-protein linked cell-surface receptors, adenylate cyclase system, inositol phosphate pathway, role of Ca^{2+} -ions; signalling via enzyme-linked surface receptors, tyrosine kinases, Steroid receptors.

Section C

- Cell cycle and its regulation, apoptosis.
- Transport of proteins into mitochondria and chloroplasts.
- Concept of signal peptide, SRP, SRP Receptor, transport of soluble and membrane bound proteins in Endoplasmic Reticulum, ER Resident proteins, ER chaperone proteins and their functions, glycosylation of proteins in ER, Golgi apparatus, role in protein glycosylation and transport.
- Lysosomes, intracellular digestion, sorting of lysosomal enzymes in Golgi, lysosomal storage diseases.

Suggested Books:

- Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008). *Molecular Biology of the Cell* (5th Ed.). New York: Garland Science.
- Cooper, G. M., & Hausman, R. E. (2013). *The Cell: a Molecular Approach* (6th Ed.). Washington: ASM; Sunderland.
- Gardner, E. J., Simmons, M. J., & Snustad, D. P. (1991). *Principles of genetics*. New York: J. Wiley.
- Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W. M. (2012). *Becker's World of the Cell*. Boston (8th Ed.). Benjamin Cummings.
- Karp, G. (2008). *Cell and molecular biology: Concepts and experiments*. *John New Jersey: Wiley and Sons*
- Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. (2014). *Lewin's Genes XI*. Burlington, MA: Jones & Bartlett Learning.
- Lodish, H. F. (2016). *Molecular Cell Biology* (8th Ed.). New York: W.H. Freeman.
- Watson, J. D. (2008). *Molecular Biology of the Gene* (5th ed.). Menlo Park, CA: Benjamin/Cummings.

Suggested e-Resources:

- **mRNA export**

  https://www.researchgate.net/profile/Evelina_Tutucci/publication/51156486_Keeping_mRNPs_in_check_during_assembly_and_nuclear_export/links/02e7e5213704c24e86000000/Keeping-mRNPs-in-check-during-assembly-and-nuclear-export.pdf

- **ER chaperons and folding enzymes**

  https://iubmb.onlinelibrary.wiley.com/doi/full/10.1002/iub.1272

- **Lysosomal storage disorders**

  https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1365-2141.2004.05293.x

MATH 506 Engineering Mathematics

Max. Marks: 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- Solve differential equation problems in the field of Biotechnology.
- Know how root finding techniques can be used to solve practical engineering problems.
- Use matrices techniques for solving system simultaneous linear equations.
- Apply elementary transformations to reduce the matrix to Echelon and normal form and determine its rank.
- Use the basic mathematical tools to solve engineering problems.
- Demonstrate knowledge of probability and the standard statistical distributions.
- Assemble a mathematical model for a range of physical situations.

Section – A

Calculus: Review of limits, continuity, differentiability, Mean Value Theorem, Maxima and Minima; Riemann Integral, Fundamental theorem of calculus, Improper Integrals; Partial derivatives, Gradient, Curl, Divergence and Directional derivatives.

Linear Algebra: Vectors, Matrices, Determinants, linear independence, Rank, Eigenvalues, Eigenvectors; Numerical solution of equations and system of equations, Newton-Raphson, Gauss elimination, Gauss-Seidel method.

Section – B

Differential Equation: Solution of D.E. of first order and first degree; Linear differential equations of second order, Homogeneous equation, Method of variation of parameters; Numerical solution of ODE, Euler, Runge-Kutta method.

Laplace Transform: Definition, Laplace transform of derivatives and certain elementary functions; Inverse Laplace transform, Inverse Laplace transform of derivatives and integrals, Convolution theorem; Applications of Laplace transform to solve ODE with constant and variable coefficient.

Section – C

Mathematical Modelling: Through ODE of first order and system of ODE, Linear and Nonlinear growth and decay models, Compartment model, Model for diffusion of glucose or a Medicine in the blood stream. Through difference equation, Population dynamics, Epidemic and Genetics models.

Statistics and Probability: Concept of mathematical probability and its applications. Karl Pearson's correlation coefficient, Normal distribution, exponential distribution, student's "t" test, one way ANOVA.

Suggested Books:

- Thomas, Calculus, 11th Edition, Pearson Publishers, 2013.
- J.N. Kapur, Mathematical Modelling, New Age International Pvt. Ltd. Publishers, 2013.
- E. Kreyszig, Advanced Engineering Mathematics, 9th edition, Wiley Publisher, 2013.

Suggested e-Resources:

- **Advanced Engineering Mathematics; Platform: NPTEL**

  https://nptel.ac.in/courses/111105035/

BT 505L Biotechnology Lab - I

Max. Marks: 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**12**	**6**

Learning Outcomes:

After successful completion of the course, students should be able to:

- Demonstrate an understanding of microbial production of biomolecules.
- Gain hands on training on extraction and bio-separation techniques for various metabolites.
- Learn basic tools of bioinformatics.
- Analyze and solve problems for statistics, mass balance and energy balance.

Biological Databases and Computational Biology

1. Molecular Evolution: Multiple sequence alignment alignment and phylogenetic analysis (Clustal X/ Mega/ Tree-View).
2. Database Search: Use and analysis of BLAST tool for protein and DNA sequences.
3. Structure Prediction: Protein secondary and tertiary structure prediction using online ExPASy tools.
4. Molecular Visualization: Structural analysis of PDB entries for active and inactive states of protein (Pymol/Chimera/DeepView).

Advanced Cell Biology

5. Buccal smear – Identification of Barr Body.
6. Isolation of cell organelles, viz. chloroplast/ mitochondria/ amyloplast.
7. Determination of hydrogen peroxide scavenging activity of plant.

8. Separation of secondary metabolites/ sugars/ phenolic acids/ fatty acids by Thin Layer chromatography.

Enzymology and Bioprocess Engineering

9. Reductase test for milk.
10. Extraction and determination of protein content by Lowry's method.
11. Estimation of amylase activity in germinating seeds.
12. Determination of the optimum temperature and effect of pH on amylase activity.
13. To determine inhibition constant (K_i) for various inhibitors of enzyme reactions.
14. Separation of isoenzymes by native gel electrophoresis.
15. Lipase production and estimation.
16. Production of penicillin.
17. Filtration/Mass balance based problems.
18. Energy balance based problems.
19. To determine the peroxide value in oil/fat sample.

Engineering Mathematics

20. Engineering Mathematics/Statistical problems-I.
21. Engineering Mathematics/Statistical problems-II.

Suggested Books:

- Datta, A.K. (2014). *Basic Biostatistics and Application*. Kolkata: New Central Book Agency.
- Kumar, V. (2011). *Laboratory Manual of Microbiology*. New Delhi: Scientific Publishers.
- Mahajan, R., Sharma, J., & Mahajan, R.K. (2010). *Practical Manual of Biotechnology* (1st ed.). New Delhi: Vayu Education of India.
- Rao, P.H., & Janardhan, K. (2014). *Fundamentals of Biostatistics*. New Delhi: I. K. International Publishing House.

- Saxena, J., Baunthiyal., & Ravi, I. (2015). *Laboratory Manual of Microbiology, Biochemistry and Molecular Biology*. Jodhpur: Scientific Publishers.
- Shuler, M.L., & Kargi, F. (2002). *Bioprocess Engineering Basic Concepts* (2nd ed,). Prentice Hall PTR Upper Saddle River, NJ, USA.
- Swamy, P.M. *Laboratory Manual on Biotechnology* (1st ed.). Meerut: Rastogi Publication.
- Yadav, V.K., & Yadav, N. (2018). *Biochemistry & Biotechnology: A Laboratory Manual*. Jaipur: Pointer Publisher.

Suggested e-Resources:

- **Harisha, S. Biotechnology procedures and experiments handbook**

  http://site.iugaza.edu.ps/mwhindi/files/BIOTECHNOLOGY-PROCEDURES-AND-EXPERIMENTS-HANDBOOK.pdf

- **Introduction to biotechnology**

  http://www.austincc.edu/awheeler/Files/BIOL%201414%20Fall%202011/BIOL1414_Lab%20Manual_Fall%202011.pdf

- **Sequence Alignment**

  https://blast.ncbi.nlm.nih.gov/Blast.cgi

BT 540P/BT 536P/BT 542S Term Paper-I/Minor Project-I/ Seminar-I

Max. Marks: 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**8**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- Demonstrate a depth of knowledge of advance research in applied engineering field of biotechnology.
- Comprehend knowledge of writing review/research papers and publishing research data in scientific journals
- Develop communication skills and effective use of visual aids.

Second Semester

BT 527 Bioprocess Engineering

Max. Marks: 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- Plan and execute economically viable upstream and downstream processes for any biological products.
- Develop process flow diagram, utility equipments, piping and related instrumentation and controls.
- Give an account of important microbial/enzymatic/food and beverage industrial processes in pharmaceuticals, food and fuel industry.

Section A

Growth stoichiometry, Kinetics of Batch, Fed-batch and Continuous operation of bioreactors, Gas –liquid mass transfer in cellular systems, role of diffusion in bioprocessing, measurement of volumetric mass transfer coefficient (K_La), Sterilization Kinetic, Fluid Rheology, Configuration of biological reactors: Plug-flow, packed bed, fluidized bed, photobioreactor, Stirred tank, Advanced cell bioreactor for cultivation of animal cells and plant cell culture.

Section B

Recovery and purification of products: strategies to recover and purify products, cell disruption, filtration, centrifugation, sedimentation, coagulation and flocculation, solid-liquid/liquid-liquid extraction, precipitation, adsorption, membrane separation-reverse osmosis, ultrafiltration, chromatography-FPLC, HPLC and HPTLC, affinity chromatography, electrophoresis, electrodialysis, crystallization and drying.

Section C

Importance of process flow sheeting in bioprocess engineering, development and utility of process flow diagrams, symbols for equipments, piping, instrumentation and controls, Scale up, Scale down, fermentation process economic, bioproduct regulation, medical applications of bioprocess engineering. Biological waste treatment: An example of the industrial utilization of mixed cultures.

Books Recommended:

- Bailey, J.E., & Ollis, D.F. (1986). *Biochemical Engineering fundamentals* (2nd ed). McGraw-Hill College.
- Blanch, H.W., & Clark, D. S. (1997). *Biochemical Engineering*. CRC Press.
- Crueger, W., & Crueger, A. (2005). *Biotechnology- A Text Book of Industrial Microbiology*. Panima Publishing Corporation, New Delhi.
- Harrison, R. G., Todd, P. W., Rudge S. R., & Petrides, D. P. (2015). *Bioseparations Science and Engineering*. USA: Oxford University Press.
- Ogunnaike, B. A., & Ray, W. H. (1994). *Process Dynamics, Modeling and Control*. Oxford University Press.
- Pandey, A., Larroche, C., Soccol, C. R., & Dussap, C. (2008). *Advances in Fermentation Technology*. Asiatech Publishers, Inc.
- Seader, J. D., & Henley, E. J. (2013). *Separation Process Principles*. Wiley India (P.) Ltd.
- Shuler, M.L., & Kargi, F. (2002). *Bioprocess Engineering Basic Concepts* (2nd ed). Prentice Hall PTR Upper Saddle River, NJ, USA.
- Stanbury, P.F., Whitaker, A., & Hall S.J. (1995).*Principles of Fermentation Technology* (2nd ed.). Elsevier Science Ltd.
- Stanbury, P.F., Whitaker, A., & Hall S.J. (2016).*Principles of Fermentation Technology* (3rd ed.). Elsevier Science Ltd.

- Thakore, S.B., & Bhatt, B.I. (2007). *Introduction to Process Engineering and Design*. Tata McGraw-Hill Publishing Company Limited
- Van Imp, J. F. M., Vanrollegham P. A., & Iserentant, D. I. (1998). *Advanced Instrumentation, Data Instrumentation, and Control of Biotechnological Processes*. Kluwer Academic Publishers
- Vogel, H.C., & Todaro, C. L. (1996). *Fermentation and Biochemical Engineering Handbook*. Elsevier.

Suggested e-Resources:

- **Microbial culture fermentation**

  https://pdfs.semanticscholar.org/b4d3/7ed66ef2e37ce22ff7a3be09e3df7568fe49.pdf

- **Animal Cell Cultivation**

  https://nptel.ac.in/courses/102103012/pdf/mod6.pdf

- **Bioprocess Design**

  https://www.cri.or.th/en/mitthai/Announcement%20and%20Discussion%20Pages/BioprocessDesign.pdf

- **Bioprocess Control**

  http://cdn.intechopen.com/pdfs/44372/InTech-Bioprocess_modeling_and_control.pdf

- **Biotechnology- Downstream processing**

  https://nptel.ac.in/courses/102106022/

BT 530 Genetic Manipulation Technology

Max. Marks: 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- Comprehend tools and techniques used for genetic manipulation of living organisms.

- Familiarize with current genome editing techniques.
- Develop research aptitude and technical skills to secure a job in genetic engineering labs.

Section A

- Concept of the structure of DNA, enzymes as tools of genetic engineering: restriction endonucleases, methylases, DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase; cohesive and blunt end ligation; linkers; adaptors; homopolymeric tailing; labelling of DNA: nick translation, random priming, radioactive and non-radioactive probes
- Hybridization techniques: northern, southern, south-western and far-western and colony hybridization, FISH and GISH.
- Study of protein-DNA interactions: electrophoretic mobility shift assay, DNase footprinting, methyl interference assay, chromatin immunoprecipitation.
- Protein-protein interactions using yeast two-hybrid system; phage display.

Section B

- Plasmid vectors; M13 mp vectors; PUC19 and Bluescript vectors, phagemids; Lambda vectors; Cosmids; YACs, BACs; Expression vectors (pMal; GST; pET-based vectors), Yeast vectors, Baculovirus and *Pichia* vectors, SV40 vectors, Ti and Ri vectors.
- cDNA and genomic libraries, si-RNA Technology, construction of siRNA vectors, chloroplast engineering, introduction to genome editing by CRISPR-CAS with its applications.

Section C

- Principles of PCR: primer design, fidelity of thermostable enzymes, Types of PCR – multiplex, nested, reverse-transcription PCR, real time PCR, touchdown PCR, hot start PCR, colony PCR, asymmetric PCR; T-vectors, PCR based site specific mutagenesis, PCR in molecular diagnostics (viral and bacterial detection).

- Sequencing methods (enzymatic and chemical); automated DNA sequencing; Pyrosequencing and Next Generation Sequencing; mutation detection: SSCP, DGGE, RFLP.

Suggested Books:

- Brown, T.A. (2010). *Gene Cloning and DNA analysis: An Introduction.* Oxford: Wiley-Blackwell.
- Glick, B.R., Pasternak, J.J., & *Patten C.L.* (2010). *Molecular Biotechnology: Principles and applications of recombinant DNA* (4th ed). American Society for Microbiology.
- Lemonic, N.R., & Cooper, D.N. (1996). *Gene therapy*. BIOS Scientific publisher.
- Nicholl, D.S.T. (2008). *An introduction to Genetic Engineering* (3rd ed). Cambridge: Cambridge University Press.
- Primrose, S.B., Twyman R.H., & Old R.W. (2001). *Principles of Gene Manipulation* (6th ed). Wiley-Blackwell.
- Watson, J.D., Gilman, M., Witkowski J., & Zoller, M. (1992). *Recombinant DNA* (2nd ed.). W. H. Freeman publisher.

Suggested e-Resources:

- **Next Generation Sequencing**

  file:///C:/Users/all/Downloads/49602.pdf

- **DNA sequencing- approaches**

  https://www.ncbi.nlm.nih.gov/books/NBK21117/CRISPR/

- **CRISPR-CAS technology**

  https://www.ucll.be/sites/default/files/documents/gezondheid/crispr_cas_technology_-_manetsberger.pdf

  https://www.ncbi.nlm.nih.gov/pubmed/24584096

- **Construction of siRNA expression vectors**

  https://www.thermofisher.com/us/en/home/references/ambion-tech-support/rnai-sirna/tech-notes/sirna-expression-vectors--with-selectable-markers.html

- **Gene knockout and transgenic mice**

  https://www.ncbi.nlm.nih.gov/books/NBK21632/

BT 506L Biotechnology Lab - II

Max. Marks: 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**12**	**6**

Learning Outcomes:

After successful completion of the course, students should be able to:

- Gain hands on training on techniques related to genetic engineering, plant tissue culture and immunology.
- Demonstrate an understanding of different methods for chromatography.
- Demonstrate a basic understanding of production and estimation of industrially important biofuel and acids.
- Demonstrate a basic concept of *In Silico* Primer designing.

Bioprocess Engineering

1. Bioethanol production by immobilized *Saccharomyces cerevisiae* cells.
2. Separation of pigments from leaves or flowers by adsorption column chromatography.
3. To perform gel exclusion chromatography.
4. Lactic acid production.
5. Estimation of K_{La} by sodium sulphite method.

Cell Culture and Genetic Manipulation Technology

6. Preparation of stock media (RPMI 1640) from powder, preparation of complete media from stock and sterilization by filtration.
7. Preparation of metaphase chromosome from lymphocyte culture.
8. Isolation of single cells from intact plant organs by enzymatic method, single cell culture.
9. To inoculate anthers for haploid production.
10. To induce callus from the explants of *Phaseolus mungo* (Green Gram).
11. To study DNA amplification by PCR and resolution of PCR products on agarose gel.
12. Purification of amplified PCR Product by column purification.
13. Preparation of bacterial competent cells for transformation.
14. Transfer of recombinant vector into competent bacterial cells.
15. *In silico* primer designing.

Immunology

16. Rocket Immunoelectrophoresis.
17. Sandwich ELISA for the detection of an antigen.
18. Preparation of an immunoglobulin fraction from whole serum by ammonium sulphate precipitation.

Suggested Books:

- Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: a Laboratory Manual*. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
- Mahajan, R., Sharma, J., & Mahajan, R.K. (2010). *Practical Manual of Biotechnology* (1st ed.). New Delhi: Vayu Education of India.

- Saxena, J., Baunthiyal., & Ravi, I. (2015). *Laboratory Manual of Microbiology, Biochemistry and Molecular Biology*. Jodhpur: Scientific Publishers.
- Sharma, R.K., Sangha, S.P.S. (2009). *Basic Techniques in Biochemistry & Molecular Biology*. New Delhi: I.K. International Publisher.
- Swamy, P.M. *Laboratory Manual on Biotechnology* (1st d.). Meerut: Rastogi Publication.

Suggested e-Resources

- **Introduction to biotechnology**

  http://www.austincc.edu/awheeler/Files/BIOL%201414%20Fall%202011/BIOL1414_Lab%20Manual_Fall%202011.pdf

- **Harisha, S. Biotechnology procedures and experiments handbook**

  http://site.iugaza.edu.ps/mwhindi/files/BIOTECHNOLOGY-PROCEDURES-AND-EXPERIMENTS-HANDBOOK.pdf

- ***In silico* primer design**

  https://www.ncbi.nlm.nih.gov/tools/primer-blast/index.cgi

BT 541P/BT 537P/BT 543S Term Paper-II/ Minor Project-II/Seminar-II

Max. Marks: 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**8**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- Demonstrate a depth of knowledge of advance research in applied engineering field of biotechnology.
- Comprehend knowledge of writing review/research papers and publishing research data in scientific journals
- Develop communication skills and effective use of visual aids.

Third Semester

BT 606P Project Part - I

Max. Marks: 100	L	T	P	C
(CA: 40 + ESA: 60)	0	0	48	24

Learning Outcomes:

After successful completion of the course, students should be able to:

- Gain exposure to work in renowned research institutions and industries of biotechnology.
- Develop skill to complete an independent research project and writing thesis report.
- Comprehend knowledge to publish their research outputs in high impact factor journals, conference proceedings, and patents.
- Develop an ability to present and defend their research work to a panel of experts.

Fourth Semester

BT 607P Project Part - II

Max. Marks: 100	L	T	P	C
(CA: 40 + ESA: 60)	0	0	48	24

Learning Outcomes:

After successful completion of the course, students should be able to:

- Gain exposure to work in renowned research institutions and industries of biotechnology.
- Develop skill to complete an independent research project and writing thesis report.
- Comprehend knowledge to publish their research outputs in high impact factor journals, conference proceedings, and patents.
- Develop an ability to present and defend their research work to a panel of experts.

Discipline Elective

BIN 502 Computer Aided Drug Designing

Max. Marks: 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- Understand the scope of pharmacogenomics and computer aided drug designing.
- Identify and search potential drug leads using various tools of computational biology.
- Develop data-mining skills pertaining to drug discovery.

Section A

- Introduction to computer aided drug designing.
- Molecular descriptors, QSAR methodologies, structure based drug designing, ligand based drug designing, different docking methodologies.

Section B

- Pharmacophore identification, pharmacophore generation (Hiphop and HypoGen theories), combinatorial libraries, high throughput screening, virtual screening, Lipinski's rule of five and its application in ADMET screening.
- Chemoinformatics: Introduction, Chemical Databases (ACD, MDDR and WDI), Application of Chemoinformatics in CADD.

Section C

- Introduction to pharmacogenomics and pharmacogenetics, clinical trials in Pharmacogenomics.
- Polymorphism of CYP450 enzymes affecting drug response, role of SNP in pharmacogenomics.
- Multi Drug Resistance proteins: drug carriers affecting drug response.

Suggested Books:

- Alvarez, J. & Shoichet, B. (2004). *Virtual Screening in Drug Discovery*. Taylor and Francis.
- Cramer, C. (2004). *Essentials of Computational Chemistry* (2 nd Ed). John Wiley.
- Thomas, G. (2003). *Fundamentals of Medicinal Chemistry*. John Wiley.
- Young, D.C. (2009). *Computational Drug Design*. John Wiley.

Suggested e-Resources:

- **Personalized medicine**

  https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2957753/

- **Pharmacodynamics and pharmacokinetics**

  https://www.mheducation.co.uk/openup/chapters/9780335245659.pdf

- **Drug Discovery**

  http://www.kubinyi.de/lectures.html

- **Essential bioinformatics**

  http://www.aun.edu.eg/molecular_biology/Procedure%20Bioinformatics22.23-4-2015/Xiong%20-%20Essential%20Bioinformatics%20send%20by%20Amira.pdf

BIN 503 Elements of Bioinformatics

Max. Marks: 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- Understand principles behind the genome wide coding region prediction and RNA folding.
- Predict 3D structure of proteins and their regular structural elements for the integrity of the structure.
- Analyze, interpret and understand the protein structure informatics.
- Write perl program to solve the biological problems.

Section A

- Genome comparison & analysis, Gene prediction, RNA structure prediction algorithms (Minimum free energy method, MFold, Coevolution method).
- Protein secondary structure prediction methods: Chou and Fasman, Garnier-Osguthorpe-Robson, prediction of structural classes, motifs and domains.

Section B

- Steps in homology modeling, Threading, Contact potential, structural profile and segment matching method, *ab initio* method.
- Protein structure comparison, structure comparison algorithms (dynamic programming, distance matrix).
- Perl language and syntax, scalars, arithmetic and logical operators, arrays, array functions, hashes, hash functions, conditional statements (if/else, elsif), control structures (for, foreach, while).

Section C

- Pattern matching, substitutions, translations, splits and joins, file handling, opening, reading and closing a file.
- Directory handling, opening, reading and closing a directory, subroutines, references, packages, modules, classes, objects, introduction to Bioperl.

Suggested Books:

- Christiansen, T., & Torkington, N. (2003). *Perl Cookbook: Solutions & Examples for Perl Programmers*. "O'Reilly Media, Inc.".
- Essen, L. O. (2003). *Structural Bioinformatics*. Edited by Philip E. Bourne and Helge Weissig. *Angewandte Chemie International Edition*.
- Mount, D. W. (2001). *Bioinformatics: Sequence and Genome analysis*. Cold Spring Harbor, N.Y: Cold Spring Harbor Laboratory Press.
- Tisdall, J. (2003). *Mastering Perl for Bioinformatics: Perl Programming for Bioinformatics*. "O'Reilly Media, Inc.".

Suggested e-Resources:

- **Chou-Fasman Method for protein secondary structure prediction** https://pdfs.semanticscholar.org/fd8c/c95aec2d7af19ed28eea3688b3c231d0e745.pdf
- **Homology modeling**

  https://proteinstructures.com/Modeling/homology-modeling.html
- **Essential bioinformatics**

  http://www.aun.edu.eg/molecular_biology/Procedure%20Bioinformatics22.23-4-2015/Xiong%20-%20Essential%20Bioinformatics%20send%20by%20Amira.pdf
- **Bioinformatic tools**

  https://nptel.ac.in/courses/102103044/pdf/mod6.pdf

BIO 417 Structural Biology

Max. Marks: 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After the successful completion of the course, students should be able to:

- Explain the biophysical processes working at molecular level.
- Answer the biological questions of macromolecular folding and interactions.
- Understand the molecular processes behind locomotion, neuronal signaling and vision.

Section A

- Introduction to protein structure: Physical and chemical properties of amino acids and polypeptides, secondary, super secondary, tertiary and quaternary structure of proteins, Helix-coil transition, and Ramachandran plot.

- Protein structure determination: Isolation and purification of proteins, Methods for determination of size of proteins, Basic principles of X-ray diffraction studies, Phase determination, Calculation and interpretation of electron density map, Electron crystallography of proteins.

Section B

- Protein secondary structure prediction methods: Chou and Fasman, Garnier-Osguthorpe-Robson.
- Classification of three-dimensional structure of protein: Prediction of structural classes, motifs, folds and domains, classification of three-dimensional structures in Protein Data Bank (HSSP, SCOP, FSSP, CATH).

Section C

- Nucleic acid structure: Nucleic acid conformation, A-DNA, B-DNA, Z-DNA and C-DNA, their geometrical and structural features.
- RNA secondary and tertiary structures, idea about local doublet parameters.
- Molecular interactions: Protein-protein interactions, protein-DNA interactions, techniques for the studies of these interactions, Forces that stabilize bimolecular structure.

Suggested Books:

- Berg, J. M., Tymoczko, J.L., Stryer, L., & Stryer, L. (2002). *Biochemistry*. New York: W.H. Freeman.
- Cantor, C. R., & Schimmel, P. R. (1980). *Biophysical Chemistry Part I: The Conformation of Biological Macromolecules*. New York: W. H. Freeman & Company.
- Gu, J., & Bourne, P. E. (2011). *Structural Bioinformatics*. Chicester: Wiley.
- Hoffmann, A., Clokie, S., Wilson, K., & Walker, J. M. (2018). *Wilson and Walker's Principles and Techniques of Biochemistry and Molecular Biology: Principles and Techniques of Biochemistry and Molecular Biology*. Cambridge: Cambridge University Press.
- Lehninger, A. L., Nelson, D. L., & Cox, M. M. (2000). *Lehninger Principles of Biochemistry*. New York: Worth Publishers.

- Mount, D. W., & Cold Spring Harbor Laboratory Press. (2006). *Bioinformatics: Sequence and Genome analysis*. Cold Spring Harbor, N.Y: Cold Spring Harbor Laboratory Press.

Suggested e-Resources:

- **Chou-Fasman Method for protein secondary structure prediction** https://pdfs.semanticscholar.org/fd8c/c95aec2d7af19ed28eea3688b3c231d0e745.pdf
- **Homology modeling**

  https://proteinstructures.com/Modeling/homology-modeling.html
- **Essential bioinformatics**

  http://www.aun.edu.eg/molecular_biology/Procedure%20Bioinformatics22.23-4-2015/Xiong%20-%20Essential%20Bioinformatics%20send%20by%20Amira.pdf
- **Protein-protein interaction**

  https://nptel.ac.in/courses/102103017/pdf/lecture%2020.pdf

BIO 501 Bioentrepreneurship

Max. Marks: 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- Comprehend fundamental concepts of entrepreneurship.
- Identify and utilize various schemes promoting entrepreneurship.
- Develop skills to convert a viable idea into start ups.

Section A

- Entrepreneurship: meaning and definition; fundamentals of entrepreneurship; development of entrepreneurship through training, achievement motivation training- theory and concept, Kakinada experiment: developing achievement motivation, experiential exercises, scoring and coding.

- Entrepreneurship in area of Biotechnology; MSMEs: definition, role in India's economic development, regulations covering MSMEs, sources of information and non financial support, Incentives and benefits available to MSMEs entrepreneurs.
- Schemes for women entrepreneurs, psychological stress encountered by women in the light of her dual role and managing it.

Section B

- Business opportunity sensing and idea generation, idea feasibility testing through market research, Developing Vision and mission statements, deciding the offering and identifying target market, positioning the offering.
- Designing sales process, marketing mix and promotional strategies, maintaining and hiring team.
- Knowing competitors, preparing revenue model up to break-even point, projecting future moves of business, product road map, writing a detailed business plan, basics of finance & accounting.
- Raising funds: banks, financial institutions, venture capitalists, angel investors, bootstrapping; role of incubation centres.

Section C

- Role of knowledge centres like universities and institutions and R & D, role of technology and upgradation, managing technology transfer, regulation for transfer of foreign technology, technology transfer agencies.
- Business crisis and its management, ethical entrepreneurship, social entrepreneurship, use of IT in business administration, available software for better financial management; setting an E-business; key leadership and management skills.

Suggested Books:

- Barringer, B. R., & Ireland, R. D. (2019). *Entrepreneurship: Successfully launching new ventures*. New York, NY Pearson Education
- Drucker, P. F. (2015). *Innovation and entrepreneurship: Practice and principles*. London: Routledge.

- Holt, D. H. (1992). *Entrepreneurship: New venture creation*. Englewood Cliffs, N.J: Prentice Hall.
- Jain, P. C. (1998). *Handbook for new entrepreneurs*. New Delhi, India: Oxford University Press.
- Schaper, M., & Schaper, M. (2014). *Entrepreneurship and small business*. Milton, Qld: John Wiley and Sons Australia.

Suggested e-Resources:

- **Start up and Technology news**

  https://techcrunch.com/

- **Demo events**

  http://www.demo.com/ehome/DEMO/home/

- **Entrepreunership in biotechnology**

  http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.463.4354&rep=rep1&type=pdf

BIO 502 Cancer Biology

Max. Marks: 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- Explain mechanisms leading to cancer.
- Identify sources of cancer causing agents.
- Understand various therapies involved in cancer treatment.

Section-A

- Basics of cancer biology, cancer incidence and mortality, cancer as a cellular disease, tumor growth kinetics.
- Different forms of cancers, diet and cancer. Regulation of cell cycle, modulation of cell cycle in cancer.
- Oncogenes and tumor suppressor genes, Aberrant cell signaling in cancer, anti-apoptotic mechanisms for survival of cancer cells.

Section-B

- Environmental carcinogens, carcinogen metabolism, Chemical carcinogenesis, targets of chemical carcinogenesis, initiation, promotion and progression.
- Radiation induced carcinogenesis, animal models of cancer research, athymic nude mice, syngeneic mouse model, transgenic mouse model.

Section-C

- Molecular mechanisms of tumor angiogenesis, cancer invasion and metastasis.
- Concept of stem cells in cancer, advances in cancer detection, Different forms of therapy: chemotherapy, radiotherapy, and surgery.

Suggested Books:

- King, R., & Robins, M. (2006). *Cancer biology*. Harlow, England: Pearson/Prentice Hall.
- Macdonald, F., Ford, C. H. J., & Casson, A. G. (2004). *Molecular biology of cancer*. London: BIOS Scientific Publishers.
- Ruddon, R. W. (1995). *Cancer biology*. New York: Oxford University Press.
- Weinberg, R. A. (2007). *The biology of cancer*. New York: Garland Science.

Suggested e-Resources:

- **Types of cancer**

  https://nptel.ac.in/courses/104103068/pdf/M4.pdf

- **Carcinogenes**

  http://www.prc.cnrs.fr/IMG/pdf/cmr-criteria-clp.pdf

  https://www.ilo.org/legacy/english/protection/safework/ghs/ghsfinal/ghsc10.pdf

- **Cancer Therapy**

  https://www.aafp.org/afp/2008/0201/p311.pdf

BT 510 Environmental Biotechnology

Max. Marks: 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- Understand sources and role of environmental contaminants.
- Demonstrate various techniques involved in bioremediation.
- Develop understanding of generation of energy from waste.

Section A

- Definition and scope of environmental biotechnology, environmental pollution: Types, causes and effects on soil, air, water.
- Control measures of pollution, social issues: Green house gases, global warming, acid rain, ozone depletion, nuclear accidents and holocaust.
- Purification of waste water: Aerobic and anaerobic treatments, laboratory methods for the detection of coliform organisms in water.
- Water recycling methods, management of radioactive pollutants in water, VOC, COD, BOD and BOD sensors.

Section B

- Molecular biology tools for environmental management, rDNA technology in waste treatment, genetically modified organisms in Waste management, genetic sensors, metagenomics, bioprospecting, nanoscience in environmental management.
- Phytoremediation for heavy metal pollution, biosensors development to monitor pollution.
- Biomass waste as renewable source of energy, cellulose and hemi cellulose as source of energy, biocomposting, vermiculture, biofertilizers, organic farming, biofuels, biomineralization.

Section C

- Bioelectricity through microbial fuel cell, Conversion of Solid Waste to Methane.
- Biogas production, management of sludge and solid waste treatment: Land filling, lagooning, ecofriendly agriculture.
- *Ex situ* and i*n situ* bioremediation; genetically engineered microbes for bioremediation, bioremediation of ground water, biodegradation of hydrocarbons, pesticides, herbicides, insecticides and xenobiotics.

Suggested Books:

- Jogdand, S. N. (2010). *Environmental Biotechnology (Industrial pollution management)* (3rd ed.). Mumbai, India: Himalaya Publishing House.
- Metcalf & Eddy. (Ed.). (1991). *Wastewater Engineering Treatment Disposal and Reuse* (3rd ed.). New Delhi, India: Tata McGraw Hill Edition.
- Milton, W. (Ed.). (1999). *An Introduction to Environmental Biotechnology*. USA: Springerlink,
- Modi, P. N. (2015). *Sewage treatment & disposal and waste water engineering*. New Delhi, India: Rajsons publications Pvt. Ltd.
- Srinivasan, D. (2009). *Environmental Engineering*. New Delhi, India: PHI Learning Pvt. Ltd.
- Thakur, I. S. (2012). *Enviromental Biotechnology: Basic concepts and Application* (2nd ed.). New Delhi: I K International Publishing House.
- Tripathi, B. N., Shekhawat, G. S., & Sharma, V. (Ed.). (2009). *Applications of Biotechnology*. Jaipur, India: Aavishkar publishers.

Suggested e-Resources:

- **Biological treatment of wastewater**

  http://www.neoakruthi.com/blog/biological-treatment-of-wastewater.html

- **Biogas**

  http://www.biologydiscussion.com/biomass/production-of-biogas-from-biomass/10436

- **Biofuel**

  http://uru.ac.in/uruonlinelibrary/BioFuels/Biomass%20and%20biofuels.pdf

- **Biosensor**

  https://www.edgefx.in/biosensors-types-its-working-and-applications/

- **Xenobiotic compound biodegradation**

  http://www.biologydiscussion.com/microbiology-2/bioremediation/xenobiotic-compounds-meaning-hazards-and-biodegradation/55625

BT 512 Food Biotechnology

Max. Marks: 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- Learn processing and preparation of various food products.
- Determine role of microbes in food spoilage and understand the various methods used for food preservation.
- Understand the scope of food biotechnology for future endeavors.

Section A

- Constituent of food : contribution to texture, flavour and organoleptic properties of food.
- Food additives : intentional and non-intentional and their functions.
- Enzymes in food processing, Physical Properties of Foods: Rheological, thermal, aerodynamic, hydrodynamic and electrical properties of food.
- Raw material characteristics, cleaning, sorting and grading of foods; physical conversion operations : mixing, emulsification, extraction, filtration, centrifugation, membrane separation, crystallization, heat processing, evaporation, dehydration.

- Dehydration : Dehydration principles, Preparation of fruits and vegetables for dehydration, Equipments used for drying with their principles, packaging of dried slices, dices and powder.

Section B

- Emerging technologies in food processing: High pressure processing, pulse electric field processing, osmotic dehydration, hurdle technology.
- Principles of food preservation: UHT, LTT, canning, frozen storage, irradiation, acidulants, salts and sugars.
- Factors leading to rancidity and reversion, Colloidal systems in food, stability of colloidal system.
- Food aroma compounds microbial and enzymatic techniques, Types of Food Starches, Soluble Fibers: Pectin, Gums & Mucilages, Properties of granular food and powders.

Section C

- Food processing technology : Bread and baked goods, dairy products: milk, cheese, butter, ice-cream, Vegetable and food products.
- Food processing technology: Edible oils, fats, meat, poultry and fish products, confectionary, beverages- wine, beer.
- Popular oils and fats in foods-pulses, dairy products and vegetable oils. Sugar and distillation industries.

Suggested Books:

- Adams, M. R., & Moss, M. O. (2007). *Food Microbiology*. Royal Society of Chemistry.
- Banwart, G.J. (1989*). Basic Food Microbiology*. CBS Publishers and Distributors, Delhi.
- Frazier, W.C., & Westhoff, D.C. (2003). *Food Microbiology*. Tata McGraw Hill, Inc., New York.
- Joshi, V. K., & Pandey, A. (1999). *Biotechnology: Food Fermentation*. Asiatech Publishers Inc.

- Robinson, R.K. (1990).*Dairy Microbiology*. Elsevier Applied Sciences, London.

Suggested e-Resources:

- **Quality control of food detection system**

  https://www.engineersgarage.com/Contribution/Arduino-based-Smart-IoT-Food-Quality-Monitoring-System

- **Food Preservation**

  https://sciencesamhita.com/methods-of-food-preservation/

- **Genetically modified food**

  http://anrcatalog.ucdavis.edu/pdf/8180.pdf

BT 517 Medical Biotechnology

Max. Marks: 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- Understand various in utero diagnostic techniques.
- Identify gene therapy techniques used for the treatment of diseases.
- Comprehend the applications of embryonic stem cells.

Section A

- Prenatal diagnosis, invasive techniques: Amniocentesis, fetoscopy, chorionic villi sampling (CVS).
- Noninvasive techniques: Ultrasonography, X-ray, TIFA, maternal serum and fetal cells in maternal blood.
- Diagnosis using protein and enzyme markers, monoclonal antibodies, DNA/RNA based diagnosis, Hepatitis, HIV - CD 4 receptor.
- Microarray technology: genomic and cDNA arrays, application to diseases.

Section B

- Clinical management and metabolic manipulation: PKU, Familial Hypercholesterolemia, Rickets, ADA, Congenital hypothyroidism.
- Gene therapy: Ex-vivo, in vivo, in situ gene therapy, strategies of gene therapy, gene augmentation.

Section C

- Vectors used in gene therapy: retrovirus, adenoviruses, herpes synthetic vectors, liposomes, receptor mediated gene transfer.
- Gene therapy trials, familial hypercholesterolemia, cystic fibrosis, solid tumors.
- Properties and application of embryonic stem cells and its potential, nanomedicine.

Suggested Books:

- Aschengrau, A., & Seage, G. R. (2014). *Essentials of epidemiology in public health*.
- Bongso, Ariff. & Lee, Eng Hin. (2005). *Stem cells: from bench to bedside*. Singapore: World Scientific Publishing.
- George, A. J., & Urch, C. E. (Eds.). (2000). *Diagnostic and therapeutic antibodies* (Vol. 40). Springer Science & Business Media.
- Pagano, M., & Gauvreau, K. (2000). *Principles of biostatistics*. Australia: Duxbury.
- Strachan, T., Read, A. P., & Strachan, T. (2011). *Human molecular genetics*. New York: Garland Science.

Suggested e-Resources:

- **Prenatal Diagnosis**

  http://semmelweis.hu/noi1/files/2017/02/Prenatal-diagnostic-methods.pdf

- https://www.health.wa.gov.au/docreg/Education/Prevention/Genetics/HP3131_prenatal.pdf

- **Gene Therapy**

  https://nptel.ac.in/courses/102103013/pdf/mod8.pdf

  http://uniqure.com/patients/Gene-Therapy-Information.pdf

- **Nanomedicine**

  https://noharm-europe.org/sites/default/files/documents-files/2462/HCWH%20Europe%20Nanoreport.pdf

BT 519 Nanobiotechnology

Max. Marks: 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- Understand the fundamental concepts of nanobiotechnology.
- Apply engineering concepts to the nano-scale domain and design processing conditions.
- Plan research career in institute working on nanobiotechnology.

Section A

- Nanoscale and nanobiotechnology: Introduction to nanoscience and nanotechnology, milestones in nanotechnology, overview of nanobiotechnology and nanoscale processes.
- Physicochemical properties of materials in nanoscales, Fabrication and characterization of nanomaterials, Types of nanomaterials (quantum dots, nanoparticles, nanocrystals, dendrimers, buckyballs, nanotubes).
- Gas, liquid, and solid –phase synthesis of nanomaterials.

Section B

- Lithography techniques (photolithography, dip-pen and electron beam lithography), Thin film deposition, Electrospinning.

- Bio-synthesis of nanomaterials, properties and measurement of nanomaterials, optical properties: absorption, fluorescence, and resonance.
- Methods for the measurement of nanomaterials, microscopy measurements: SEM, TEM, AFM and STM, confocal and TIRF imaging.
- Nanobiology and bioconjugation of nanomaterials: Properties of DNA and motor proteins, Lessons from nature on making nanodevices, reactive groups on biomolecules (DNA & Proteins).

Section C

- Surface modification and conjugation to nanomaterials, Fabrication and application of DNA nanowires.
- Nanofluidics to solve biological problems.
- Nano drug delivery and nanomedicine: Properties of nanocarriers, drug delivery systems used in nanomedicine, enhanced permeability and retention effect, blood-brain barrier, active and passive targeting of diseased cells, health and environmental impacts of nanotechnology.

Suggested Books:

- Bhattacharya, S. (2013). *Introduction to nanotechnology*. New Delhi: Wisdom Press.
- Bhushan, B. (2017). *Springer Handbook of Nanotechnology*. Berlin, Heidelberg: Springer Berlin Heidelberg.
- Di, V. M. (2008). *Introduction to nanoscale science and technology*. New York, NY: Springer.
- Wilson, M. (2004). *Nanotechnology: Basic science and emerging technologies*. Boca Raton: Chapman & Hall/CRC.

Suggested e-Resources:

- **Nanofluidic devices**

  https://aip.scitation.org/doi/pdf/10.1063/1.4794973?class=pdf

- **Quantam dot**

  file:///C:/Users/all/Downloads/9783642449093-c2.pdf

- **Preparation of Nanomaterial**

  https://nptel.ac.in/courses/103103033/module9/lecture2.pdf

- **Nanodrug delivery system**

  http://cdn.intechopen.com/pdfs/40262/InTech-Nanotechnology_in_drug_delivery.pdf

  http://iapc-obp.com/assets/files/883189NBDD.pdf

BT 511 Enzyme Technology

Max. Marks: 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- Describe structure, functions and the mechanisms of action of enzymes.
- Get exposure of wide applications of enzymes and their future potential.
- Describe methods for enzyme mediated production of drugs, fine chemicals and other industrial intermediates.

Section A

- Introduction to enzymes, classification, sources, mechanism of enzyme action.
- Strategies of purification of enzymes, criteria of purity, molecular weight determination and characterization of enzymes.
- Methods for investigating the kinetics of enzyme catalysed reactions : initial velocity studies, estimation of Michaelis-Menten parameters, effect of pH and temperature on enzyme activity, modeling of rate equations for single and multiple substrate reactions.

Section B

- Kinetics of inhibition: Reversible Inhibitors, tight Binding Inhibitors, time-Dependent Inhibition.
- Techniques of enzyme immobilization, 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.
- Functional group interconversion using enzymes (hydrolysis reaction, oxidation/reduction reactions, C-C bond formations), Cooperativity in enzyme catalysis.

Section C

- Reaction engineering for enzyme-catalyzed biotransformations, Catalytic antibodies.
- Biocatalysts from extreme thermophilic and hyperthermophilic microorganisms (extremozymes).
- The design and construction of novel enzymes, artificial enzymes.
- Biotransformation of drugs (hydroxylation of Steroids), host guest complexation chemistry, enzyme design using steroid templates, enzymes for production of drugs, fine chemicals and chiral intermediates.
- Enzymes of biological importance: Acetylcholinesterase, angiotensin converting enzyme (ACE), ACE Inhibitors, HMG CoA reductase inhibitors, pseudocholinesterase, 5-nucleotidase (5NT) and glucose-6-phosphate dehydrogenase (GPD).

Suggested Books:

- Bhaskar, A., Vidhya, V. G. (2014). *Enzyme Technology*. India: Mjp Publishers.
- Copeland, R. A. (2000). *Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis*. USA: John Wiley & Sons.
- Devasena, T. (2010). *Enzymology* (3rd ed.). UK: Oxford University Press.

- Meena, M., & Chauhan, D. (2009). *Fundamentals of Enzymology*. Jaipur, India: Aavishkar publishers.
- Palmer, T., & Bonner, P. (2008). *Enzymes: Biochemistry, Biotechnology, Clinical Chemistry* (2nd ed.). India: East West Publications.
- Scopes, R. K. (2013). *Protein Purification: Principles and Practice* (3rd ed.). USA: Springer.

Suggested e-Resources:

- **Factors affecting rate of chemical reaction**

  https://www.adichemistry.com/physical/kinetics/factors/factors-affecting-rate-reaction.html

- **Extraction and purification of enzyme**

  http://chemsites.chem.rutgers.edu/~kyc/Teaching/Files/543-05/09%20544-10%20ppt.pdf

- **Catalytic antibodies**

  https://nptel.ac.in/courses/104103018/28

BT 516 Immunotechnology

Max. Marks: 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- Compare and describe the different components of immune system and their functions.
- Demonstrate and understand the principle techniques used for disease diagnostics.
- Apply the knowledge of disease resistance and gene therapy in clinical research.

Section A

- Concept of immunity, cells and organs involved in the immune system, clonal selection theory, ubiquity of innate immunity.
- Antigens, basic structure of antibodies, complementarity determining regions (CDRs) and antigenic determinants.
- Multigene organization of Ig genes, assembly of TCR genes, antibody diversity and its generation.

Section B

- Antibody engineering, general organization and immune responsiveness of MHC, roles of APCs.
- Components of immune effector mechanism (cytokines, chemokines, T cells and NKs).
- Antigen antibody interactions and their diagnosis methods: cross reactivity, surface plasmon response (SPR), RIA, ELISA, western blotting, immunoprecipitation, immunofluorescence, flow cytometry, immunoelectron microscopy.

Section C

- Mechanism of self tolerance and autoimmunity, hypersensitivity.
- Designing of vaccines, primary and secondary immunodeficiency, cancer immunotherapy.
- General and specific immunosuppressive therapy, hybridoma technology, SCID mice, Humanized-SCID-mice model, technology for separation or identification of antigen.

Suggested Books:

- Abbas, A. K., Lichtman, A. H. & Pillai, S. (2017). *Cellular and Molecular Immunology* (9th ed.). Elsevier.
- Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2006*). Roitt's Essential Immunology*, (11th ed.). Wiley-Blackwell.
- Punt, J., Stranford, S., Jones, P., & Owen, J. (2018). *Kuby Immunology* (8th ed.). W. H. Freeman and company.

- Tizard, I. R. (1995). *Immunology: Introduction,* (4th ed.). Philadelphia: Saunders College Publishing.

Suggested e-Resources:

- **Cellular and Molecular Immunology**

  https://ocw.mit.edu/courses/health-sciences-and-technology/hst-176-cellular-and-molecular-immunology-fall-2005/lecture-notes/

- **Immunology**

  https://study.com/academy/topic/immunology.html

- **Antibodies**

  https://nptel.ac.in/courses/102103038/download/module2.pdf

  https://nptel.ac.in/courses/102103047/PDF/mod5.pdf

Reading Electives

BT 538R Molecular Plant Breeding

Max. Marks: 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**0**	**2**

Learning Outcomes:

After successful completion of the course, students should be able to:

- Understand strategies and applications of plant breeding technologies.
- Comprehend the knowledge of different plant molecular markers.
- Plan a research career in the area of plant biotechnology.

Plant breeding study involves breeding methods for self and cross pollinated crops. There are several limitations of conventional breeding. Thus, there is need to have a better breeding approaches to overcome this limitation. Development of molecular markers (RFLP, RAPD, SSRs, ISSRs, SNPs), construction of molecular maps, linkage analysis, mapping populations for QTLs using molecular markers play an important role in plant breeding. In order to develop potential plant having better qualities,

Marker Assisted Selection (MAS) is also a viable approach which can be done by using selection of traits and markers, trait association, marker assisted backcrossing and recurrent selection, marker assisted hybrid breeding and marker assisted improved varieties/germplasm.

Suggested Books:

- Chawla, H. S. (2000). *Introduction to Plant Biotechnology*. USA: Science Publishers.
- Glick, B.R., Pasternak, J.J., & Patten *C.L.* (2010). *Molecular Biotechnology: Principles and applications of recombinant DNA* (4th ed). American Society for Microbiology.
- Nicholl, D.S.T. (2008). *An introduction to Genetic Engineering* (3rd ed). Cambridge: Cambridge University Press.
- Primrose, S.B., Twyman R.H., & Old R.W. (2001). *Principles of Gene Manipulation* (6th ed). Wiley-Blackwell.
- Slater, A., Scott, N., & Fowler, M. (2008). *Plant Biotechnology: The Genetic Manipulation of Plants* (2nd ed.). UK: Oxford University Press.
- Watson, J.D., Gilman, M., Witkowski J., & Zoller, M. (1992). *Recombinant DNA* (2nd ed.). W. H. Freeman publisher.

Suggested e-resources:

- **Plant breeding**

  https://nptel.ac.in/courses/102103013/pdf/mod6.pdf

- **Molecular marker**

  http://eacharya.inflibnet.ac.in/data-server/eacharya documents/55d44ff9e41301fd23d8facc_INFIEP_203/734/ET/203-734-ET-V1-S1__lec_32.pdf

- **Gene mapping in plant**

  http://eacharya.inflibnet.ac.in/data-server/eacharya-documents/55d44ff9e41301fd23d8facc_INFIEP_203/733/ET/203-733-ET-V1-S1__lec_31.pdf

BT 529R Drug discovery

Max. Marks: 100	L	T	P	C
	0	0	0	2

Learning Outcomes:

After successful completion of the course, students should be able to:

- Understand basics of R&D in drug discovery and should be able to apply knowledge gained in respective fields of pharmaceutical industry.
- Understand the role of synthetic chemistry in the development of pharmaceutical agents and the modification of chemical structures to develop new drug molecules.
- Have an advanced understanding of the chemical structure of a pharmaceutical agent and determine the chemical group responsible for a given biological effect.
- Demonstrate a basic understanding of pharmacogenomics and bioinformatics as it relates to drug design and discovery.

Modern drug discovery involves the identification of a target or drug lead using different techniques including molecular modeling, combinatorial libraries and high-throughput screening (HTS). Rational drug design is based on the understanding of the three-dimensional structures and physicochemical properties of drugs and receptors. Knowledge of molecular mechanisms, molecular dynamics simulations and homology modeling is necessary for studying drug/receptor interactions. Different conformational sampling techniques, fitness functions used in molecular docking, computational receptor-based and ligand-based drug design approaches are mostly used to design compounds with improved biological activity in rational drug design. Quantitative drug design using QSAR models are used to correlate structural molecular properties (descriptors) with functions (i.e. physicochemical properties, biological activities, toxicity, etc.) of the compounds. Understanding the structure activity relationship between the 3D structure of a molecule and its biological activity may act as the basis for the prediction of compounds with improved biological activities. Different bio-analytical assays (LC/MS/MS, GC/MS and ELISA) could be developed further in support of *in vitro* and *in vivo* studies. Understanding the principles as well as an early characterization of drug toxicity, adsorption, distribution, metabolism and excretion (ADME) along with drug-drug interactions, plasma protein binding assays and metabolite profile studies helps in eliminating compounds with unacceptable pharmacokinetic characteristics, which is critical to successful drug discovery programs.

Suggested Books:

- Dastmalchi, S. *et. al.* (2016). *Methods and Algorithms for Molecular Docking-Based Drug Design and Discovery*. IGI Global.
- Krogsgaard-Larsen *et. al.* (2016). *Textbook of Drug Design and Discovery*. 5th Edition. CRC Press.
- Rahman, A. U., Caldwell, G. W., and Choudhary, M. I. (2007). *Frontiers in Drug Design and Discovery.* Bentham Science publishers Limited.
- Satyanarayanajois, S. D. (2011). *Drug Design and Discovery: Methods and Protocols*. Humana Press.

Suggested e-resources:

- **Drug Discovery**

  https://www.studocu.com/en/document/university-of-leeds/drug-development-pre-clinical-to-practice/lecture-notes/lecture-i-drug-discovery-lecture-notes-lectures-1-8/615380/view

- **Peptide therapeutics**

  https://www.sciencedirect.com/science/article/pii/S1359644614003997

- **Bio-analytical techniques**

  https://www.pharmatutor.org/articles/bioanalytical-techniques-overview

BT 531R Human Genetics and Diseases

Max. Marks: 100	**L**	**T**	**P**	**C**
	0	**0**	**0**	**2**

Learning Outcomes:

After successful completion of the course, students should be able to:

- Understand hereditary and molecular genetics with a strong human disease perspective.
- Describe genetic abnormalities underlying human disease and disorders.
- Develop interest in biomedical research, genetic counseling, medicine, and clinical genetics.

Since the rediscovery of Mendel's work in 1900, investigations on the genetic nature of human traits have gained significant importance. Understanding the genetic basis behind human disease is one of the most important reasons to study human chromosome structure, human karyotype, banding techniques, chromosome identification and nomenclature (ISCN)**.** Classical genetics has considerable importance in constructing genetic hypothesis from pedigree data analysis in monogenetic traits, autosomal dominant, autosomal recessive, sex linked dominant, sex linked recessive and sex influenced traits. The impact of consanguinity in causing sex linked anomalies (haemophilia, colour blindness and Duchenne Muscular Dystrophy) has been observed in human population. Current knowledge on genetic variations across populations is applied to study human health and diseases which include chromosomal disorders, structural and numerical chromosomal anomalies (Klinefelter syndrome, Down's syndrome, Turner syndrome, Achondroplasia), inborn errors of metabolism (Phenylketonuria (PKU), Alkaptonuria, Albinism, Galactosemia), haemoglobinopathies, Thalassemia syndromes, multifactorial disorders (diabetes, schizophrenia, huntington disease). Medical genetics involves ethical issues therefore serious discussion is required for prenatal/adult diagnosis of genetic disorders, medical ethics, risks and benefits, informed consent and right of choice.

Suggested Books:

- Nussbaum, R., McInnes, R., & Willard, H. (2007). *Thompson & Thompson-Genetics in Medicine* (7th ed.). Elsevier.
- Pasternak, J. J. (2005). *An Introduction to Human Molecular Genetics: Mechanisms of Inherited Diseases* (2nd ed.). Wiley-Blackwell.
- Strachan, T., & Read, A. P. (2018). *Human Molecular Genetics* (5th ed.). Garland Science.

Suggested e-resources

- **Chromosome identification and nomenclature (ISCN)**
  http://www.cydas.org/Resources/ISCN_Discussion.html
- **Pedigree data analysis**
  https://learn.genetics.utah.edu/content/disorders/

- **Genetic disorders**
  https://www.genome.gov/10001204/specific-genetic-disorders/
- **Prenatal/ adult diagnosis of genetic disorders, medical ethics**
  https://www.michiganallianceforfamilies.org/all/#sectionD

BT 534R Intellectual Property Rights

Max. Marks: 100	**L**	**T**	**P**	**C**
	0	**0**	**0**	**2**

Learning Outcomes:

After successful completion of the course, students should be able to:

- Understand the concept of IPR and its types.
- Describe the steps for patenting.
- Discuss the role of WTO and WIPO on IPR.

Intellectual property rights (IPR) have an old history and are very relevant for economic development. Various types of IPR (patents, trademarks, copyright & related rights, industrial design, traditional knowledge, geographical indications) are recognized with specific uses. There is currently an emergence of specific IP pertaining to plants and animals (UPOV, Plant Breeder's rights, plant variety protection, farmers rights act, patent protection of plant and animal inventions (WTO) and Law on the protection of new plant varieties and animal breeds (WIPO)). It is important to know about types of patent applications and the process of patenting with special emphasis to India. The role of WTO (GATT and TRIPS) and WIPO in implementation of IPR is significant to understand the relevance of Patent Cooperation Treaty (PCT) in patenting. IPR also are associated with certain ethical dilemma and there are some interesting case studies which highlight its relevance.

Suggested Books:

- Goel D. & Parashar S. (2013). *IPR, Biosafety and Bioethics* (1st ed.) Pearson Education India.
- Pandey, N. & Dharni, K. (2014). *Intellectual Property Rights.* PHI Learning.

- Ramakrishna, B., & Kumar, A. (2017). *Fundamentals of Intellectual Property Rights: For Students, Industrialist and Patent Lawyers* (1st ed.). Notion Press.
- Sateesh, M.K. (2008). *Bioethics and Biosafet*y. I.K. International Publishing House.

Suggested e-resource

- **World Trade Organisation**

  http://www.wto.org

- **World Intellectual Property Organisation**

  http://www.wipo.int

- **International Union for the Protection of New Varieties of Plants**

  http://www.upov.int

- **National Portal of India**

  http://www.archive.india.gov.in

BT 535R Medical Microbiology

Max. Marks: 100	**L**	**T**	**P**	**C**
	0	**0**	**0**	**2**

Learning Outcomes:

After successful completion of the course, students should be able to:

- Identify various bacterial, fungal, viral and protozoan diseases and their epidemiology.
- Understand the relevance of emerging and reemerging diseases.

Medical Microbiology describes the cause, transmission, epidemiology, pathogenesis, symptoms, diagnosis and treatment of various bacterial (tuberculosis, typhoid, leprosy), fungal (superficial, subcutaneous, systemic mycosis), protozoan (Malaria, amoebiasis) and viral (AIDS, Influenza, measles) diseases. Currently, it is necessary to understand the impact of emerging and remerging diseases (cholera, dengue, multidrug resistant tuberculosis, H5N1 avian influenza, drug resistant malaria,

chikungunya) on human health. Global assessment for various diseases also shows an increasing trend of nosocomial infections and opportunistic infections which cause significant mortality and health concerns.

Suggested books:

- Brooks, G.F., Carroll, K.C., Butel, J.S., Morse, S.A., & Mietzner, T.A. (2013) Jawetz, Melnick and Adelberg's Medical Mcirobiology (26th ed.). US: Lange Medical Books, Mc Graw-Hill.
- Madigan, M., Martinko, J., Stahl, D., & Clark, D. (2010). *Brock Biology of Microorganisms* (13th ed.). UK: Pearson Education.
- Pelczar Jr., M.J., Chan, E.C.S., & Krieg, N.R. (2011). *Microbiology*. New York, USA: Tata McGraw-Hill.

Suggested e- Resources:

- **Emerging Diseases**
  https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3701702/
- **Epidemiology**
  https://www.bmj.com/about-bmj/resources-readers/publications/epidemiology-uninitiated/1-what-epidemiology
- **Nosocomial Infections**
  https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3470069/

BT 539R Protein Engineering

Max. Marks: 100	**L**	**T**	**P**	**C**
	0	**0**	**0**	**2**

Learning Outcomes:

After successful completion of the course, students should be able to:

- Analyse structure and construction of proteins by computer-based methods.
- Describe structure and classification of proteins.
- Analyse and compare the amino acid sequence and structure of proteins, and relate this information to the function of proteins.

- Explain how proteins can be used for different industrial and academic purposes such as structure determination, organic synthesis and drug design.
- Plan and carry out activity measurements of isolated proteins and characterize their purity and stability.

An introduction to protein engineering for developing proteins with desired functions. Various methods (rational design and directed evolution) of protein engineering are employed to manipulate the different features or characteristics (affinity, specificity and stability etc) of proteins. Engineering various physicochemical and biological properties (stability to changes in parameters as pH, temperature, amino acid sequence and aggregation propensities etc) of the proteins could be important in their use as protein drugs and/or catalysts in bioreactors. The insight into the fundamental understanding of the mechanisms and forces (Van der waals, electrostatic, hydrogen bonding, weakly polar interactions, and hydrophobic effects), by which protein stabilizes, will help in the formulation of protein based pharmaceuticals. Protein engineering with site-specifically incorporation of unnatural or non-canonical amino acids has been used to improve protein function for medical and industrial applications. Different computational approaches (sequence and 3D structure analysis, data mining, Ramachandran map etc) to protein engineering would help to address the requirements in order to find amino acid sequences that will optimize a desired property (physicochemical property and/or biological function) of a protein. Determination of the physicochemical properties of proteins using various spectroscopic methods (Far-UV and Near-UV CD, Fluorescence, UV absorbance and Optical rotatory dispersion) would further support the drug development process. Yeast surface display (YSD) has become a valuable protein engineering tool for modifying the affinity, specificity, and stability of antibodies, as well as other proteins. YSD could be successfully used for protein epitope mapping, identification of protein-protein interactions, and uses of displayed proteins in industry and medicine. Developing vaccines and peptidomimetics will further allow the investigators to identify novel therapeutic leads for numerous unmet clinical needs.

Suggested Books:

- Cleland, J. L., and Craik, C. S. (2006). *Protein Engineering, Principles and Practice*, Vol 7. Springer Netherlands.

- Creighton, T. E. (1997). *Protein Structure: a Practical Approach*, 2nd Edition. Oxford University press.
- Kyte, J. (2006). *Structure in Protein Chemistry*, 2nd Edition. Garland publishers.
- Mueller, K., and Arndt, K. (2006). *Protein Engineering Protocols*, 1st Edition. Humana Press.
- Robertson, D., and Noel, J. P. (2004). *Protein Engineering Methods in Enzymology*, Vol 388. Elsevier Academic Press.
- Walsh, G. (2014). *Proteins: biochemistry and biotechnology*, Second edition. Chichester, West Sussex: Wiley Blackwell.
- Williamson, M. P. (2012). *How proteins work*. New York: Garland Science.

Suggested e-resources:

- **Protein Engineering**:

  https://nptel.ac.in/courses/102103017/pdf/lecture%2022.pdf

- **Conformational stability of proteins**:

  https://www.khanacademy.org/test-prep/mcat/biomolecules/amino-acids-and-proteins1/v/conformational-stability-protein-folding-and-denaturation

- **Protein Engineering with Non-Natural Amino Acids:**
  https://library.umac.mo/ebooks/b2805488x.pdf

Online Reading Electives:

Sr. No.	Name of course	URL
1	Downstream Processing	http://nptel.ac.in/syllabus/102106022/
2.	Mass spectrometry based proteomics	https://onlinecourses.nptel.ac.in/noc15_bt05/preview https://swayam.gov.in/search?keyword=Mass%20spectrometry%20based%20proteomics
3.	Bioreactor	https://swayam.gov.in/course/1339-bioreactors