Syllabus and Structure

For

Biotechnology (Non-Hons.) in B.Sc. course

Dibrugarh University
2018

Under

Choice Based Credit System

Passed in the Board of Studies in Biotechnology and Bioinformatics, Dibrugarh University held on 7th June, 2019

Details of Courses Under Undergraduate Program (B.Sc.)

Course	***Credits**	
	Theory+ Practical	Theory+Tutorials
I. **Core Course**	12X4= 48	12X5=60
(12 Papers)		
04 Courses from each of the		
03 disciplines of choice		
Core Course Practical / Tutorial*	12X2=24	12X1=12
(12 Practical/ Tutorials*)		
04 Courses from each of the		
03 Disciplines of choice		
II. **Elective Course**	6x4=24	6X5=30
(6 Papers)		
Two papers from each discipline of choice		
including paper of interdisciplinary nature.		
Elective Course Practical / Tutorials*	6 X 2=12	6X1=6
(6 Practical / Tutorials*)		
Two Papers from each discipline of choice		
including paper of interdisciplinary nature		

- **Optional Dissertation or project work in place of one Discipline elective paper (6 credits) in 6th Semester**

III. Ability Enhancement Courses

1. **Ability Enhancement Compulsory**	2 X 2=4	2X2=4
(2 Papers of 2 credits each)		
Environmental Science		
English/MIL Communication		
2. **Skill Enhancement Course**	4 X 2=8	4 X 2=8
(Skill Based)		
(4 Papers of 2 credits each)		
	Total credit= 120	**Total credit= 120**

Institute should evolve a system/policy about ECA/ General Interest/Hobby/Sports/NCC/NSS/related courses on its own.

***wherever there is practical there will be no tutorials and vice -versa**

Proposed scheme for choice based credit system in B. Sc. with Biotechnology (Non-Hons.)

SEMESTER	COURSE OPTED	COURSE NAME	Credits
I	AECC 1	Communicative English/ Communicative Hindi/MIL/Alternative English	2
	BTNC – 101 T	Cell Biology (Theory)	4
	BTNC – 101 P	Cell Biology (Practical)	2
	Discipline-2, Paper-I (Theory)	DCC-II, Paper-I (Theory)	4
	Discipline-2, Paper-I (Practical)	DCC-II, Paper-I (Practical)	2
	Discipline-3, Paper-I (Theory)	DCC-III, Paper-I (Theory)	4
	Discipline-3, Paper-I (Practical)	DCC-III, Paper-I (Practical)	2
II	AECC-2	English/MIL communications/Environmental Science	2
	BTNC – 201 T	Biochemistry (Theory)	4
	BTNC – 201 P	Biochemistry (Practical)	2
	Discipline-2, Paper-II (Theory)	DCC-II, Paper-II (Theory)	4
	Discipline-2, Paper-II (Practical)	DCC-II, Paper-II (Practical)	2
	Discipline-3, Paper-II (Theory)	DCC-III, Paper-II (Theory)	4
	Discipline-3, Paper-II (Practical)	DCC-III, Paper-II (Practical)	2
III	BTNS – 301	Fermentation Technology	2
	BTNC – 301 T	Microbiology and Immunology (Theory)	4
	BTNC – 301 P	Microbiology and Immunology (Practical)	2
	Discipline-2, Paper-III (Theory)	DCC-II, Paper-III (Theory)	4
	Discipline-2, Paper-III (Practical)	DCC-II, Paper-III (Practical)	2
	Discipline-3, Paper-III (Theory)	DCC-III, Paper-III (Theory)	4
	Discipline-3, Paper-III (Practical)	DCC-III, Paper-III (Practical)	2
IV	BTNS – 401 ***Students may select any one course from (I) to (II)***	I. Analytical Techniques II. IPR, Biosafety and Bioethics	2
	BTNC – 401 T	Molecular Biology (Theory)	4
	BTNC – 401 P	Molecular Biology (Practical)	2
	Discipline-2, Paper-IV (Theory)	DCC-II, Paper-IV (Theory)	4
	Discipline-2, Paper-IV (Practical)	DCC-II, Paper-IV (Practical)	2
	Discipline-3, Paper-IV (Theory)	DCC-III, Paper-IV (Theory)	4
	Discipline-3, Paper-IV (Practical)	DCC-III, Paper-IV (Practical)	2
V	BTNS – 501	Biostatistics	2
	BTND 501T ***Students may select any one course from (I) to (II)***	Theory I. Microbial Technology II. Genetics	4

	BTND501P ***Students will select one relevant practical course based on theory course.***	Practical I. Microbial Technology II. Genetics	2
	Discipline specific elective-II, Paper-I (Theory)	DSE-II Paper-I (Theory)	4
	Discipline specific elective-II, Paper-I (Practical)	DSE-II Paper-I (Practical)	2
	Discipline specific elective-III, Paper-I (Theory)	DSE-III Paper-I (Theory)	4
	Discipline specific elective-III, Paper-I (Practical)	DSE-III Paper-I (Practical)	2
VI	BTNS 601	Environmental and Agricultural Biotechnology	2
	BTND 601T ***Students may select any one course from (I) to (II)***	Theory I. Genomics and Proteomics II. Plant Biotechnology	4
	BND601P ***Students will select one relevant practical course based on theory course.***	Practical I. Genomics and Proteomics II. Plant Biotechnology	2
	Discipline specific elective-II, Paper-II (Theory)	DSE-II Paper-II (Theory)	4
	Discipline specific elective-II, Paper-II (Practical)	DSE-II Paper-II (Practical)	2
	Discipline specific elective-III, Paper-II (Theory)	DSE-III Paper-II (Theory)	4
	Discipline specific elective-III, Paper-II (Practical)	DSE-III Paper-II (Practical)	2
Total Credits			120

*** AECC - Ability Enhancement Compulsory Course**

BTNC – Discipline Core Courses

BTND – Discipline Specific Electives

BTNS – Skill Enhancement Courses

(First Semester)

DISCIPLINE CORE COURSE
COURSE CODE: BTNC – 101 T
DCC-BIOTECHNOLOGY
PAPER TITLE: CELL BIOLOGY (THEORY)
THEORY (CREDITS 4)

COURSE OBJECTIVES:

It would be expected that after completing this course a student would

1. Have an in-depth knowledge about the concepts of fundamentals of cell structure and function and a comprehensive understanding of the basic techniques employed for the study of the same.
2. Have a lucid understanding of the cellular processes of signaling and transport
3. Be able to conceptualize the fundamental principles underlying cellular malignancy and cancer

Course content:

Units	Content	Lectures/h
I	History of Cell Biology; Cells and their classification based on cellular structure and function; Membrane Structure, Organelles- their morphologies and functions; External structures associated with cells	10
II	Membrane structure & function: Structure, models, transport of ions & macromolecules, pump carrier & channels, cellular junction & adhesions, Membrane potential (resting and action potential)	10
III	Cytoskeleton- Structural organization and properties of microtubules, intermediate filaments and microfilaments. Arrangement and function of Cilia and flagella in eukaryotes and prokaryotes	6
IV	Cellcycle: Celldivision, checkpoints in cellcycle, molecularevents and their regulation. Celldifferentiation during development and gametogenesis, Apoptosis	10
V	Cell-to-cell interaction and communication: different kinds of junctions; Cell signaling and mechanism of signal transduction, Cellular response to environmental signals in plants and animals.	8
VI	Characteristics and origin of cancer cells, oncogenes, protooncogenes and tumor suppressor genes. Chemical carcinogens. Benign and malignant tumors. Cellular changes during malignancy. Metastasis.	8

Expected learning Outcome:

The students will have:

- Thorough knowledge and understanding of the developments and core concepts in Cell Biology
- Knowledge on the intricacies of basic cellular structure and function

Recommended readings:

1. Alberts, B., Bray, D., Lewis, J., Roberts, K. & Watson, J. D. 2008. Molecular Biology of the Cell. Garland Publishing, Inc. New York.
2. Sheeler, P. & Bianchi, D. E. 2009. Cell and Molecular Biology. John Wiley & Sons. USA.
3. Sadava. 2009. Cell Biology: organelle structure and function. Jones and Barlett Publishers. USA.
4. Karp, G. 2013. Cell and Molecular Biology. Portland Press. USA.
5. Cooper, G. M. &Hausman, R. E. 2013. The Cell: A molecular approach, 6thedn. ASM Press, USA.
6. Cooper, G. M. 2004. Oncogenes. Jones and Barlett Publishers. USA.
7. Becker, W. M., Kleinsmith, L. J. & Hardin, J. 2015. The World of Cell, 8thedn. Pearson low priced editions. India.

DISCIPLINE CORE COURSE
COURSE CODE: BTNC – 101 P
DCC-BIOTECHNOLOGY
PAPER TITLE: CELL BIOLOGY (PRACTICAL)
PRACTICAL (CREDITS 2)

List of experiments:

1. Temporary slide preparation of onion root tips for the identification of various stages of mitotic
2. Temporary slide preparation of grasshopper testis for the identification of various stages of meiosis
3. Study of the effect of Colchicine on Mitosis in Onion Root Tip Cells
4. Staining Of Mitochondria In Human Cheek Epithelial Cells
5. Study of Cell Viability Assay by Trypan Blue Exclusion

(Second Semester)

DISCIPLINE CORE COURSE
COURSE CODE: BTNC-201T
DCC-BIOTECHNOLOGY
PAPER TITLE: BIOCHEMISTRY
THEORY (CREDITS 4)

COURSE OBJECTIVES:

1. The course is designed to provide an insight into the structure and function of biomolecules, their chemical and physical properties and catalysis.
2. The course introduces the students to biological catalysts, their mechanisms of action, kinetics and provides an overview of the major metabolic pathways.

Course content:

Units	Content	Lectures/h
I	**Introduction to Biochemistry** Basic concepts of biochemistry: significance of biochemical reactions in living systems. Chemical bonds, types and properties. Properties of water as an universal solvent. Concepts of *p*H, *p*K, *p*I. Definition and significance of buffers in biological system. Concept of thermodynamics and the three laws. Concept of Gibbs Free Energy and spontaneity of reactions.	6
II	**Introduction to Biomolecules** *Carbohydrates*: Structure, Classification, Properties andFunctionsof carbohydrates. Significance of Monosaccharides, Disaccharides andPolysaccharides. *Amino acids & Proteins:*Structure, Function and Properties of amino acids. Classification of amino acids. Structure and chemical properties of proteins. Peptide bond and its properties. Different levels of proteins structure. Structure and examples of fibrous and globular proteins. *Lipids:*Structure, Classification, Properties andFunctionsof lipids.. *Nucleic acids:* Structure, Classification, Properties andFunctionsof Nucleic acids. Definition and examples of Nucleosides & Nucleotides. Structure and properties of purines &pyrimidines. Double helical model of DNA structure. Different conformations of DNA: A, B & Z – DNA and their significance. Concept of DNA stability, denaturation andrenaturation. Melting of DNA and T_m. Structure, properties and types of RNA.	12
III	**Introduction to Enzymes and Biocatalysts** Enzymes: Nomenclature and classification of Enzymes, Holoenzyme, apoenzyme, Cofactors,coenzymes, prosthetic groups. Monomeric &oligomeric enzymes. Activation energy and transition state. Enzyme	12

	activity, specific activity and active site. Enzyme specificity-definition and significance. Role of: NAD^+, $NADP^+$, FMN/FAD, coenzyme A,Thiamine pyrophosphate, Pyridoxal phosphate,Lipoicacid, Biotin,Vitamin B12 and Tetrahydrofolate.	
IV	**Metabolism of Biomolecules** Carbohydrates metabolism reactions, energetics and regulation. Glycolysis: Fate of pyruvateunder aerobic and anaerobic conditions. Pentose phosphate pathway and its significance, Glycogen synthesis and breakdown. Citric Acid Cycle, Electron Transport Chain,Oxidative phosphorylation. General reactions of amino acid metabolism-transamination, decarboxylation, oxidative & non-oxidative deamination of amino acids. Urea cycle and its reactions.Hydrolysis of tri-acylglycerols, α-, β-, ω- oxidation of fatty acids.	12

Expected learning Outcome:

At the end of the course, the student is expected to be able to:

- Comprehend the role and significance of biomolecules and isanticipated to develop an understanding of working of enzyme.
- In addition, the student is expected to develop an understanding of biochemical pathways and their significance in the sustenance of life.

Recommended readings:

1. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition, W.H Freeman and Co.
2. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants. American Society of Plant Biologists.
3. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA.
4. Hopkins, W.G. and Huner, P.A. (2008) Introduction to Plant Physiology. John Wiley and Sons.
5. Salisbury, F.B. and Ross, C.W. (1991) Plant Physiology, Wadsworth Publishing Co. Ltd.

DISCIPLINE CORE COURSE
COURSE CODE: BTNC-201P
DCC-BIOTECHNOLOGY
PAPER TITLE: BIOCHEMISTRY
PRACTICAL (CREDITS 2)

List of experiments:

1. To study relation between absorbance and % transmission
2. Preparation of buffers.
3. Qualitative tests for amino acids and proteins.
4. Qualitative tests for reducing and non-reducing sugars.
5. Qualitative tests for lipids.
6. To quantify the activity of an enzyme.
7. Separation of Carbohydrates / Amino acids by paper chromatography.

(Third Semester)

SKILL ENHANCEMENT COURSES
COURSE CODE: BTNS – 301
SEC-BIOTECHNOLOGY
PAPER TITLE: FERMENTATION TECHNOLOGY
THEORY (CREDITS 2)

COURSE OBJECTIVES:

It would be expected that after completing this course a student would:

- Gain a comprehensive understanding of the principles underlying the various techniques used in bioprocess engineering and technology.

Course content:

Units	Content	Hr
I	Basic principle of fermentation technology: Isolation, screening and maintenance of industrially important microbes, microbial growth curve (sigmoid curve) and its significance	6
II	Detailed study of the design and operation of different types of fermenters: Tower fermenter, Bubble-up fermenter, bioreactor *etc*.	6
III	Mode of fermentation processes: Batch culture, fed-batch and continuous systems, solid phase fermentation	6
IV	Production of various fermented products: curd, butter milk, yoghurt, cheese, beer, wine, single cell protein (SCP) etc.	6

Expected learning Outcome:

The students will be capable of:

- Productively translate both basic and frontiers research concepts relating to protein production and purification into a modern industrial bioprocess perspective.
- Describe and analyze the control of in vitro cellular growth processes (bacterial, fungal and mammalian) within the industrial-scale bioreactor environment, and demonstrate a technical lexicon that will allow productive interface with complementary disciplines (biochemical and bioprocess engineering).

Recommended readings:

1. Fermentation and Biochemical Engineering Handbook, Principles, Process Design, and Equipment; Edited by Henry C. Vogel; Noyes Publications, New Jersey, U.S.A. ISBN: 0-8 155-1407-7.
2. Biotechnology- Volume 3- Bioprocessing; VCH VerlagsgesellschaftmbH. Weinheim, ISBN 3-527-28313-7 (Weinheim); ISBN 1-56081-153-6 (New York).
3. Principles of Fermentation Technology, P. E. Stanbury, A. Whitaker and S.J. Hall, Butterworth Heinemann, ISBN: 07506 45016.

DISCIPLINE CORE COURSE
COURSE CODE: BTNC-301T
DCC-BIOTECHNOLOGY
PAPER TITLE: MICROBIOLOGY AND IMMUNOLOGY
THEORY (CREDITS 4)

It would be expected that after completing this course a student would:

1. Be able to conceptualize how the innate and adaptive immune responses coordinate to give the body immunity from incoming pathogens
2. have an in-depth understanding of different diseases which result from genetic or congenital defects of immune system components
3. Develop skills, through lab experiments and exercises, for detection and quantification of immune responses.
4. Have an in-depth knowledge about the diversity of microorganisms and a comprehensive understanding of the basic techniques employed for their isolation, characterization and culture.
5. Have a basic understanding of microbial genetics
6. Be able to conceptualize the fundamental principles underlying host-pathogen interactions and disease development

Course content:

Units	Content	Hr
I	History of microbiology, ultra structure of bacteria; nutrition, growth medium, methods of sterilization; pure culture, isolation, selective method of isolation, cultivation, preservation; difference between gram positive and negative cell wall.	8
II	Microbial genetics: Transformation–competence, transformation conjugation; generalized transduction, specialized transduction plasmids; types of plasmids, Transposons and transposable elements.	8
III	Microbial Diseases: Tuberculosis; Cholera, Malaria and HIV, Sexually transmitted diseases including AIDS; General characters, structure of TMV, HIV, bacteriophages, and Prions, lytic and lysogenic cycles.	8
IV	Types of immunity: innate and acquired immunity, active and passive immunity, concept of herd immunity, humoral and cell-mediated immunity. Cells and organs involved in immunity. Cell mediated effector responses.	8
V	Immunoglobulins: Structure, classes and functions, T Cell and B Cell generation and differentiation; Natural Killer cell receptors and MHC molecules	8
VI	Antigen-antibody precipitation reactions, techniques involved in immunology: RIA, ELISA, Ouchterlony double diffusion, Rocket immunoelectrophoresis, hybridoma and myeloma technology, vaccines	8

Expected learning Outcome:

The students will have:

- Thorough knowledge and understanding of the core concepts in the discipline of Immunology
- Knowledge on how immunological techniques are used as immunodiagnostics
- Thorough knowledge and understanding of the core concepts in the discipline of Microbiology.
- Knowledge on how microorganisms are used as model systems to study basic biology, genetics, metabolism and ecology.

RECOMMENDED READINGS:

1. Microbiology: A Text Book of Microorganisms,General and Applied,Charles Edward marshall,F.TBioletti Published P. P.Blakiston's son &co.
2. Microbiology , M.J Pelczer and R.D Reid.
3. General Microbiology- by R. Y. Stanier .et.al
4. Soil Microbiology- by S. A. Walman
5. Microbiology, by Prescott, Tata MacGrawHill
6. Immunology, Kuby et al, W. H. Freeman, 2013
7. Essential Immunology, Roitt et al, Wiley-Blackwell, April 2011
8. Janeway's Immunology, Kenneth Murphy, Casey Weaver, March 2016.

DISCIPLINE CORE COURSE
COURSE CODE: BTNC-301P
DCC-BIOTECHNOLOGY
PAPER TITLE: MICROBIOLOGY AND IMMUNOLOGY
PRACTICAL (CREDITS 2)

List of experiments:

1. Cleaning and sterilization of glass wares.
2. Preparation of liquid and solid media for growth of microorganism and pure culture technique.
3. Isolation and enumeration microorganisms from mixed population.
4. Microbial colony characterization in various media.
5. Microbial sub-culturing and preservation techniques.
6. Grams staining
7. Endospore staining.
8. Negative staining of yeast cells.
9. IMViC test.
10. Starch hydrolysis test.
11. Catalase test.
12. Human blood grouping.
13. Ouchterlony double diffusion.
14. Demonstration of agglutination inhibition using Latex beads
15. ELISA

(Fourth Semester)

SKILL ENHANCEMENT COURSES
COURSE CODE: BTNS – 401(I)
SEC-BIOTECHNOLOGY
PAPER TITLE: ANALYTICAL TECHNIQUES
THEORY (CREDITS 2)

COURSE OBJECTIVES:

It would be expected that after completing this course a student would:

1. Get a strong basis of Analytical chemistry that will be applicable to other areas of the degree course such as chemical reaction engineering.
2. It also helps for assurance of quality, safety and efficacy of drugs, pharmaceuticals and of any compound.

Course content:

Units	Content	Hr
I	Fundamentals of Analytical Chemistry: Concept of quality: Definition of quality, Quality control & assurance, TQM. Correlation between quality & analysis, steps & types of chemical analysis, Stoichiometry & expression of concentration.	6
II	Volumetric analysis: Acid base titrations: Indicators; Oxidation-reduction titrations; Complexation using ligands, metal ion indicators;	6
III	Quantitative analysis: Precipitation, types of precipitates, impurities, co-precipitation, post-precipitation, conditions for precipitation, precipitation from homogeneous solution.	6
IV	UV-Visible Spectroscopy: Introduction, Theory of UV-Visible Spectroscopy & colourimetry, Beer Lambert law, Deviation from Beer Lambert law. Infrared Spectroscopy: Introduction, Infrared radiation & its interaction with organic molecules, vibrational mode of bonds, instrumentation & applications, interpretation of IR spectra.	6

Expected learning Outcome:

The students will be capable of:

- To express fundaments of Analytical Techniques.
- To understand the working of instruments as well as for the development of new technologies.
- It provides assurance of quality, safety and efficacy of drugs, pharmaceuticals and of any Compound.

Recommended readings:

1. Instrumental Methods of Chemical Analysis, E. W. Ewing, McGraw Hill, New York. 4th Ed, 1975.
2. Instrumental Methods of Analysis, B. K. Sharma, Goel Publishing house.
3. Elementary Organic Spectroscopy, Y.R. Sharma, S.Chand & company Ltd. New Delhi 2008.

SKILL ENHANCEMENT COURSES
COURSE CODE: BTNS 401 (II)
SEC-BIOTECHNOLOGY
PAPER TITLE: IPR, BIOSAFETY, BIOETHICS
THEORY (CREDITS 2)

COURSE OBJECTIVES:

It would be expected that after completing this course a student would

1. Have an in-depth knowledge about the different types of intellectual property rights and their applications in the modern world
2. Have a basic understanding of ethical practices appropriate to the various scientific disciplines at all times.
3. Be able to be well-versed in the safe working practices relevant to the different biotechnology industries & fields of research.

Course content:

Units	Content	Lectures/h
I	General concept of property, different types of property, intellectual property rights and their types, their significance and application in the commercial world through case examples	7
II	International Conventions relating to Intellectual Property, Establishment of WIPO – Mission and Activities, Indian IPR legislations	6
III	Biosafety- concepts, symbols and significance in experimental biological sciences, International laws on Biosafety- Carategna and Nagoya protocols, Laws relating to Biosafety in India: The Biological Diversity Act, 2002, Biosafety procedures, rules and guidelines under Environment (Protection) Act 1986 and Rules 1989, Regulatory bodies in India	7
IV	Basic PrinciplesofBioethics;RegulatorybodiesforBioethics in India; International incidentsleadingtothebirthofbioethics; Bioethics in Plants, Animals andMicrobialGenetic Engineering	6

Expected learning Outcome:

The students will have:

- Thorough knowledge and understanding of international and national laws of Intellectual Property rights
- In-depth knowledge of biosafety laws and protocols- in both international and national concept
- Understanding of the concepts and laws regarding bioethics, and the importance of regulatory bodies in bioethics

Recommended readings:

1. S. Ignacimuthu, Bioethics, Alpha Science International, Limited (2009)
2. Matthew Rimmer, Intellectual Property and Biotechnology: Biological Inventions (2008)
3. Arthur L. Caplan, Robert Arp, Contemporary Issues in Bioethics (2014)
4. Kshitij Kumar Singh, Biotechnology and Intellectual Property Rights: Legal and Social Implications Springer (India) (2014)
5. Bioethics: the basics, Alastair V. Campbell, Routledge; 2 edition (19 June 2017)
6. IPR, Biosafety and Bioethics, Deepa Goel and ShominiParashar, Pearson; 1 edition (1 January 2013)

DISCIPLINE CORE COURSE
COURSE CODE: BTNC-401T
DCC-BIOTECHNOLOGY
PAPER TITLE: MOLECULAR BIOLOGY
THEORY (CREDITS 4)

COURSE OBJECTIVES:

- The course is designed to introduce students to the concepts of molecular biology and central dogma of life.

Course content:

Units	Content	Lectures/h
I	**DNA structure and replication** DNA as genetic material, Structure of DNA, Conformations of DNA, Replication of DNA in prokaryotes and eukaryotes: Semi conservative model of DNA replication, DNA polymerases. The replication process: steps and enzymes, replication fork, leading and lagging strand. Primosome. Replisome. Restriction enzymes and types	12
II	**DNA damage, repair and homologous recombination** DNA damage and repair: causes and types of DNA damage, Mechanisms of DNA repair: Photoreactivation, base excision repair, nucleotide excision repair, mismatch repair, recombinational repair, nonhomologous end joining. Homologous recombination: models and mechanism.	10
III	**Transcription and RNA processing** RNA structure and types of RNA. Structure and significance of rRNA and tRNA. Transcription in prokaryotes: Prokaryotic RNA polymerases and promoters of transcription. Role of sigma factor. Initiation, elongation and termination of transcription. Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters,enhancers. Post-transcriptional modifications: 5' cap formation, polyadenylation, splicing.	10
IV	**Translation and Regulation of gene expression** Genetic code and its characteristics, Translation: stages, mechanism ofinitiation, elongation and termination. Differences in translation in prokaryotes and eukaryotes. Inhibitors of translation. Post-translational modifications. Regulation of gene expression in prokaryotes: Operon concept (inducible and repressiblesystems): Lac Operon and Tryptophan operon	10

Expected learning Outcome:

- At the end of the course, the student is expected to develop an understanding of the concepts of replication, transcription, translation and other concepts of molecular biology.

Recommended readings:

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006).Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009).The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene (VI Edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

DISCIPLINE CORE COURSE
COURSE CODE: BTNC-401P
DCC-BIOTECHNOLOGY
PAPER TITLE: MOLECULAR BIOLOGY
PRACTICAL (CREDITS 2)

List of experiments:

1. Preparation of buffers- Tris, TE (Tris-EDTA), TAE (Tris- Acetate-EDTA), TBE (Tris-Borate-EDTA), SDS-Tris-Glycine (Laemmli Buffer).
2. Isolation of genomic DNA from bacterial/ plant/ animal cells.
3. Isolation of Plasmid DNA from bacteria.
4. Agarose gel electrophoresis of genomic DNA &/or plasmid DNA.
5. Preparation of restriction enzyme digests of DNA samples.
6. RFLP/RAPD analysis

(Fifth Semester)

SKILL ENHANCEMENT COURSES
COURSE CODE: BTNS – 501
SEC-BIOTECHNOLOGY
PAPER TITLE: BIOSTATISTICS
THEORY (CREDITS-2)

COURSE OBJECTIVES:

1 To understand the role of biostatistics in public health or medical studies;
2 To use descriptive tools to summarize and display data from public health or medical studies;
3 To understand the principles of various study designs, and explain their advantages and limitations;
4 To identify appropriate tests to perform hypothesis testing, and interpret the outputs adequately;
5 To differentiate between quantitative problems from public health or medical studies that can be addressed by statistical tools, choose the appropriate statistical procedures, and interpret the statistical results in a public health or medicine context;
6 To get familiar with statistical software and standard packages for biostatistics

Course content:

UNITS	CONTENTS	HOURS
UNIT 1	Collection, Classification and Tabulation of data, Bar diagrams and Pie diagrams, Histogram, Frequency curve and frequency polygon, Ogives. Mean, median, mode, Standard deviation.	4
UNIT 2	Correlation and Regression analysis: Correlations and regressions-: Relation between two variables, scatter diagram, definition of correlations, curve fitting, principles of least squares, Two regression lines, Karl Pearson's coefficient of correlation, Rank correlation, Tied ranks.	4
UNIT 3	Probability theory: Random experiments, sample space, probability theory, conditional probability. Baye's theorem.	4
UNIT 4	Random variable (discrete and continuous): Probability density function (discrete and continuous), Distribution function for discrete random variable. Distribution function for continuous random variable, Joint probability distribution, Conditional and marginal distribution.	4

Learning outcomes:

After completion of this course, students will be able to:

- Select from, use and interpret results of, descriptive statistical methods effectively.
- Demonstrate an understanding of the central concepts of modern statistical theory and their probabilistic foundation.
- Communicate the results of statistical analyses accurately and effectively.

Recommended Readings:

1. Fundamentals of Biostatistics. by Irfan A Khan.
2. An introduction to Biostatistics. by PSS Sunder Rao.
3. Introduction to the Practice of Statistics by Moore and McCabe

DISCIPLINE SPECIFIC ELECTIVES
COURSE CODE: BTND 501 T(I)
DSE-BIOTECHNOLOGY
PAPER TITLE: MICROBIAL TECHNOLOGY
THEORY (CREDITS 4)

COURSE OBJECTIVES:

It would be expected that after completing this course a student would:

1. Be able to identify common infectious agents and the diseases that they cause.
2. Be able to valuate methods used to identify infectious agents in the clinical microbiology lab.
3. Be able to explain general and specific mechanisms by which an infectious agent causes disease.

Course content:

Units	Content	Hr
I	General topics on Medical Microbiology: History and development, Koch's postulates. Infection: source, modes of transmission	8
II	Bacterial pathogenicity, identification of bacteria: staining methods, culture methods, biochemical tests and other recent methods.	8
III	Sterilization and disinfection. Normal microbial flora, antimicrobial agents.	8
IV	Common diseases caused by bacteria: sore throat, pneumonia, gonorrhoea, Tuberculosis, Tetanus, Cholera	8
V	Important Protozoan Diseases: Malaria, Amoebiasis; Important Helmenthic Diseases: Ascariasis, Ankylostomiasis.	8
VI	Overview of Medical Virology, Important Viral Diseases– Herpes virus, Poliovirus, Rabies virus, HIV *etc*.	8

Expected learning Outcome:

The students will have:

- Thorough knowledge and understanding of general and specific mechanisms by which an infectious agent causes disease.

Recommended readings:

1. Greenwood D (2007). Medical Microbiology. I.K. International.
2. Murray PR, Pfaller MA, Tenover FC and Yolken RH (2007). Clinical Microbiology. ASM Press.
3. Talaro KP and Talaro A. (2006). Foundations in Microbiology. McGraw-Hill College Dimensi.
4. Willey J, Sherwood L. and Woolverton C (2007). Prescott/Harley/Klein's Microbiology, McGraw Hill.
5. Atlas RM (1997). Principles of Microbiology. McGraw Hill.
6. Nester E.W, Anderson DG and Nester MT (2006). Microbiology. A Human Perspective. McGraw Hill.

DISCIPLINE SPECIFIC ELECTIVES
COURSE CODE: BTND 501 P(I)
DSE-BIOTECHNOLOGY
PAPER TITLE: MICROBIAL TECHNOLOGY
PRACTICAL (CREDITS 2)

List of experiments:

1. Sterilization techniques
2. Isolation and screening of *Streptococcus* and *Staphyloccus sp.*
3. Characterization and identification of *Streptococcus sp.*
4. Characterization and identification of *Staphyloccus sp.*
5. Preparation of blood and chocolate agar
6. Haemolysis assay
7. Identification of enteric Gram-negative *Bacilli*

DISCIPLINE SPECIFIC ELECTIVES
COURSE CODE: BTND 501 T(II)
DSE-BIOTECHNOLOGY
PAPER TITLE: GENETICS
THEORY (CREDITS 4)

COURSE OBJECTIVES:

It would be expected that after completing this course a student would

1. To have a preliminary understanding of the basic concepts of Genetics and Cytogenetics
2. To be able to discern the significance of various organelles on inheritance and its effect on consecutive generations
3. To be able to comprehend the consequences of any alteration in genetic constitution.

Course content:

Units	Content	Lectures/h
I	Beginning of genetics; Cell structure and cell division; Early concepts of inheritance, Mendel's lawsof heredity; Punnet square	
II	Chromosomal theory of inheritance, Sex linkage, X linked inheritance, Y linked inheritance	
III	Cytoplasmic Inheritance: Plastid inheritance in plants, Petite characters in yeast and Kappaparticles in Paramecium	
IV	Mutation, Mutagens and Mutant. Spontaneous and Induced,Reverse mutations; examples of Genemutation;	
V	Chromosomal aberrations: Structural and numerical changes in chromosomes;Study of genetic abnormalities – Turner syndrome,Klinefelter syndrome, Down syndrome, Cri-du-chat and Philadelphia chromosome	
VI	Genetic Recombination, Linkage and Crossing Over.Human Genetics: Karyotype in human; Nature, structure and replication of the genetic material	

Expected learning Outcome:

The students will have:

1. A firm grasp on the basic concepts and theories of both classical and modern genetics.
2. A comprehensive and clear understanding of the consequences of change in genetic constitution and also the role of genetic mechanisms in evolution
3. A clear understanding in distinguishing between chromosomal and extra-chromosomal inheritance.
4. technical skills by performing experiments and exercises on different aspects of genetic analysis.
5. proficiency in determination of linkage maps and the mechanism of sex determination

Recommended readings:

1. Genetics, Monroe W. Strickburger, Macmillian 1976
2. Genetics: The continuity of life, D. J. Fairbanks and W. H. Andersen, Brooks/Cole Pub., 1999

3. Introduction to Genetic Analysis- Vol. 10, Anthony J.F. Griffiths, W. H. Freeman, 2008
4. Genetics: Analysis of Genes and Genomes, Daniel L. Hartl, Elizabeth W. Jones, Jones & Bartlett Learning, 2009

DISCIPLINE SPECIFIC ELECTIVES
COURSE CODE: BTND 501 P(II)
DSE-BIOTECHNOLOGY
PAPER TITLE: GENETICS
PRACTICAL (CREDITS 2)

List of experiments:

1. Study of mitotic chromosome (in root cells – onion, pea etc.)
2. Study of meiotic chromosome (in flower buds of available plants)
3. Preparation of Salivary gland Chromosomes
4. Study of barr bodies in animal cheek cells
5. Laboratory exercises in probability and chi-square

(Sixth Semester)

SKILL ENHANCEMENT COURSES
COURSE CODE: BTNS 601
SEC-BIOTECHNOLOGY
PAPER TITLE: ENVIRONMENTAL AND AGRICULTURAL BIOTECHNOLOGY
THEORY (CREDITS 2)

COURSE OBJECTIVES:

It would be expected that after completing this course a student would:

1. Concentrate on principles of Environmental and Agricultural Microbiology
2. Become familiar with the technical aspects of these areas of Microbiology and their pertaining to real-life significance through technology involved in the gaining of in-depth knowledge in these areas.

Course content:

Units	Content	Hr
I	Microbes in agriculture: N2 fixation, Biofertilizer, mycorrhizae, Vermicomposting; Biopesticides and bioinsecticides: Integrated pest management (IPM); Microbial plant hormones.	4
II	Food and dairy microbiology - Microbial production of SCP and edible mushroom, Microbial production of flavours and fragrances, Probiotics and neutraceuticals, Fermented dairy products and Fermented foods.	4
III	Environmental Microbiology: Understanding environmental problems and monitoring, environmental impacts and their assessments using bioindicators, Bioremediation: Principles, Strategies and techniques of bioremediation.	4
IV	Microbial indicators of water pollution, Waste treatment; Biological methods of solid and liquid waste treatment; Environmental laws and policies in India.	4

Expected learning Outcome:

The students will be capable of:

- Appreciate the diversity of microorganism and microbial communities inhabiting a multitude of habitats and occupying a wide range of ecological habitats.
- Learn the occurrence, abundance and distribution of microorganism in the environment and their role in the environment and also learn different methods for their detection and characterization.
- Competently explain various aspects of environmental microbiology and microbial ecology and to become familiar with current research in environmental microbiology.

Recommended readings:

1. Microbiological Examination of Water and Wastewater By Maria Csuros; CRC Publishing House
2. Textbook of Environmental Microbiology By Pradipta K. Mohapatra; I. K. International Pvt Ltd.
3. Environmental Microbiology (Second Edition) *Edited by: Ian L. Pepper, Charles P. Gerba, Terry Gentry and Raina M. Maier; Elsevier LLC.* Agricultural Microbiology by Rangaswami G; MT Publishers.

DISCIPLINE SPECIFIC ELECTIVE
COURSE CODE: BTND 601 T(I)
DSE-BIOTECHNOLOGY
PAPER TITLE: GENOMICS AND PROTEOMICS
THEORY (CREDITS 4)

COURSE OBJECTIVES:

It would be expected that after completing this course a student would be able

1. To have a basic understanding of prokaryotic and eukaryotic genome constitution
2. To have a firm underpinning of gene, genome and genomic analysis techniques
3. To have a thorough understanding of contemporary genome sequencing principle and working methodology.
4. To have a comprehensive understanding of protein sequencing and identification techniques and explore its myriad scope and applications

Course content:

Units	Content	Lectures/h
I	Introduction: Gene, Genome, Genomics, transcriptomics. Scope and application of omics	
II	The origin of genomes: Origin of macromolecules, RNA world and DNA world	
III	Genome diversity: anatomy of prokaryotic genome. Anatomy of eukaryotic genome.	
IV	Inter genic and intra genic sequences, repetitive DNA	
V	Genetic mapping: DNA markers - RFLPs, SNPs	
VI	Methods of isolation of genomic DNA; DNAsequence analysis methods: Sanger Dideoxy method and Fluorescence method	

Expected learning Outcome:

The students will have:

- Thorough knowledge and understanding of the core concepts in the discipline of Genomics.
- A basic knowledge of the underlying principles of genomics and their varied application
- A lucid understanding of the various regular, contemporary and high throughput genomic tools, their underlying principles and varied application.

Recommended readings:

1. Cantor and Smith, Genomics. John Wiley & Sons, 1999.
2. Introduction to Genomics - Arthur M Lesk, Oxford University Press, 2007.
3. R.M.Twyman, Principles of Proteomics, BIOS Scientific Publishers, 2004.
4. Genome III – T.A. Brown, Garland Science Publ. June 08, 2006.

DISCIPLINE SPECIFIC ELECTIVE
COURSE CODE: BTND 601 P(I)
DSE-BIOTECHNOLOGY
PAPER TITLE: GENOMICS AND PROTEOMICS
PRACTICAL (CREDITS 2)

List of experiments:

1. Isolation of Genomic DNA from plant
2. Isolation of Genomic DNA from micro-organisms
3. Isolation of Genomic DNA from animal cells
4. Gel electrophoresis for identification of DNA
5. Isolation of genomic DNA from microorganism *in-silico*

DISCIPLINE SPECIFIC ELECTIVE
COURSE CODE: BTND 601 T(II)
DSE-BIOTECHNOLOGY
PAPER TITLE: PLANT BIOTECHNOLOGY
THEORY (CREDITS 4)

COURSE OBJECTIVES:

It would be expected that after completing this course a student would

1. Be able to understand the concepts of modern Biotechnology, with emphasis on plant research and the Agricultural revolution
2. have an in-depth understanding of the principles and techniques in Plant Tissue Culture
3. develop skills, through lab experiments and exercises, for Plant tissue culture

Course content:

Units	Content	Lectures/h
I	Brief History of Modern Biotechnology- Genetics and Plant Breeding, Agricultural Revolution, Micropropagation and other tissue culture techniques, GMO crops, Industrial agriculture in India and other countries	10
II	Laboratory requirements of Plant Tissue culture labs, Sterilisation Techniques- dry heat, wet heat, UV and filter sterilisation, Maintenance of aseptic conditions, Sterilisation of explants, Equipment and reagents used for Plant Tissue culture	10
III	Nutrient medium composition, Carbon and energy sources, vitamins, growth regulators, organic supplements, gelling agents, role of pH	8
IV	In vitro regenerationtechniques- somaticembryogenesisandorganogenesis, Micropropagation- advantagesanddisadvantages, Cell suspension culture, Single cell cultures, Production of secondary metabolites, Immobilised Cell systems, Biotransformation	10
	In vitro production of haploids and triploids and their significance, Somatic hybridization techniques- protoplast isolation, fusion and culture, somaclonal variation	8
VI	Germplasm conservation and storage techniques, use of cryopreservation and dessication techniques, artificial seed production	6

Expected learning Outcome:

The students will have:

- Knowledge on the significant discoveries and events that helped to shape the field of modern plant biotechnology
- Thorough knowledge and understanding of the core concepts and their application in Plant Tissue Culture

Recommended readings:

1. Plant Tissue Culture: Theory and Practice. S.S. Bhojwani, M.K. Razdan, Elsevier, November 1996
2. Plant Tissue Culture Techniques and Experiments. Roberta H. Smith. Academic Press; 3rd edition (August 3, 2012)
3. Plants from Test tubes- An Introduction to Micropropagation. Holly Scoggins and Mark Bridgen. Timber Press; Fourth Edition, Revised edition (August 13, 2013)
4. Plant Biotechnology: The Genetic Manipulation of Plants. Slater, Scott, Fowler. Oxford University Press; 2nd edition (June 2, 2008)
5. Introduction to Plant Biotechnology. H.S. Chawla. CRC Press, 2009

DISCIPLINE SPECIFIC ELECTIVE
COURSE CODE: BTND 601 P(II)
DSE-BIOTECHNOLOGY
PAPER TITLE: PLANT BIOTECHNOLOGY
PRACTICAL (CREDITS 2)

List of experiments:

1. Handling and Operation of Tissue Culture equipments
2. Sterilisation Techniques
3. Media preparation
4. Micropropagation techniques- meristem culture, callus culture, pollen culture
5. Protoplast isolation, fusion and culture
6. Artificial seed production