Kurukshetra University, Kurukshetra
Scheme of Examinations for B.Sc. (Medical)
under
Choice Based Credit System (CBCS)
***w.e.f.* 2020-21 (in phased manner)**
Subject: Biotechnology

Semester	COURSE	Paper	Nomenclature of Paper	Credits	Workload (hrs/week)	Internal marks	External Marks	Total	Duration of exam (hrs)
1	CC-Biotechnology-I	B-BTY-101	Basic of Biotechnology –I	3	3	15	60	75	3
		B-BTY -102	Basic of Biotechnology – II	3	3	15	60	75	3
		B-BTY -103	Practicals	2	4	10	40	50	3
2	CC-Biotechnology-II	B-BTY -201	Enzymes	3	3	15	60	75	3
		B-BTY -202	Metabolism	3	3	15	60	75	3
		B-BTY -203	Practicals	2	4	10	40	50	3
3	CC-Biotechnology -III	B-BTY -301	Microbiology-I	3	3	15	60	75	3
		B-BTY -302	Microbiology-II	3	3	15	60	75	3
		B-BTY -303	Practicals	2	4	10	40	50	3
4	CC-Biotechnology -IV	B-BTY -401	Molecular Biology	3	3	15	60	75	3
		B-BTY -402	Recombinant DNA Technology	3	3	15	60	75	3
		B-BTY -403	Molecular Biology & Recombinant DNA Technology -Practicals	2	4	10	40	50	3
	SEC-Biotechnology- 1	B-BTY –S1	Bioanalytical Tools	2	2	10	40	50	3
5	DSE-Biotechnology -I	B-BTY -501	Animal Biotechnology-I	2	2	10	40	50	3
		B-BTY -502	Animal Biotechnology -II	2	2	10	40	50	3
		B-BTY -503	Animal Biotechnology-Practical	2	4	10	40	50	3
			OR						
		B-BTY -504	Medical Biotechnology-I	2	2	10	40	50	3
		B-BTY -505	Medical Biotechnology-II	2	2	10	40	50	3
		B-BTY -506	Medical Biotechnology-Practical	2	4	10	40	50	3
		B-BTY -507	MOOC* (From Swayam	*				*	

			Portal)						
6	DSE-Biotechnology -II	B-BTY -601	Plant Biotechnology-I	2	2	10	40	50	3
		B-BTY -602	Plant Biotechnology-II	2	2	10	40	50	3
		B-BTY -603	Plant Biotechnology-Practical	2	4	10	40	50	3
		OR							
		B-BTY -604	Immunology-I	2	2	10	40	50	3
		B-BTY -605	Immunology-II	2	2	10	40	50	3
		B-BTY -606	Immunology-Practical	2	4	10	40	50	3

Note- SEC can be offered in 4^{th}, 5^{th} or 6^{th} semester depending upon the time table adjustments in the institute/college

Programme Outcomes (POs) for UG courses of Faculty of Life Sciences

1. To develop skills in graduate students to be able to acquire theoretical and practical knowledge in fundamentals of biology in respective disciplines of plants, animals, microbes and environment.
2. To inculcate ability to critically evaluate problems and apply lateral thinking and analytical skills for professional development.
3. To create awareness on ethical issues, good laboratory practices and biosafety.
4. To develop ability in youth for understanding basic scientific learning and effective communication skills.
5. To prepare youth for career in teaching, industry, government organizations and self reliant entrepreneurship.
6. To make students aware of natural resources and environment and its sustainable utilization.
7. To provide learning experience in students that instills deep interest in biological science for the benefit of society.

Programme specific Outcomes for UG courses in Biotechnology

After the successful completion of the programme the student will be able to

PSO1 : demonstrate the knowledge and understanding of biological sciences i.e. structure and function of biological molecules, biological mechanisms, such as the processes and control of bioenergetics and metabolism, as chemical reactions with engineering technologies to manipulate living organisms and biological systems to produce products that advance healthcare, medicine, agriculture, food, pharmaceuticals and environment control

PSO2 : critically think and correlate the biological knowledge of distribution, morphology and physiology of organisms (animals, plants and microorganisms) to techniques in aseptic procedures, isolation, identification, characterization and modifications to improve quality of life in person as well as community.

PSO3: demonstrate an understanding of the principles of bio- techniques, and exhibit basic professional skills pertaining to biotechnology, carry out laboratory-orientated numerical calculations and analyse biological data (e.g. in enzyme kinetics, molecular structure analysis, microbiological techniques, immunological inferences)

PSO4 : scientific writing and authentic reporting, effective presentation skills and ability to work in a group with cooperation

Semester I

CC-BIOTECHNOLOGY-1

Paper B-BTY-101

BASICS OF BIOTECHNOLOGY-I

Credits: 3
Total Marks: 75
External Marks: 60
Internal Assessment: 15
Examination Time: 3 h

Learning Outcomes: On successful completion of the course the students will be able to

101.1 Demonstrate the knowledge of the concept and applications of biotechnology in animals and plants

101.2 give an insight of scope and applications of biotechnology in agriculture, environment, food and chemical industries

Approaches to teaching

Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements

Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation

The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting

Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each section. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each section. All questions carry equal marks.

SECTION-A

Definition and scope of Biotechnology; introduction of genetic engineering; plant and animal tissue culture; Animal Biotechnology; Plant Biotechnology; fermentation technology; immobilized enzymes; monoclonal antibodies and hybridoma technology; embryo transfer technology; preservationtechniques; introduction to gene and genomes, Proteins and proteome, history of genetic manipulations; recombinant DNA technology, DNA fingerprinting and forensic analysis.

SECTION-B

Application of biotechnology in agriculture; animal and veterinary sciences, Environment biotechnology; pharmaceutical industry, food industry and chemical industry. Bioremediation and waste treatment biotechnology. Biotechnology research in India.Biotechnology in context of developing world. Brief account of safety guidelines and risk assessment in biotechnology. Ethics in Biotechnology, Intellectual property rights.

Suggested Reading

1. Elements of Biotechnology - PK Gupta
2. Gene Biotechnology - S.N. Jogdand
3. Biotechnology 5th Edition (Cambridge) - John E. Smith
4. Biotechnology for beginners - ReinhardRenneberg Academic Press

Semester I

CC-BIOTECHNOLOGY-I

Paper B-BTY-102

BASICS OF BIOTECHNOLOGY-II

Credits: 3
Total Marks: 75
External Marks: 60
Internal Assessment: 15
Examination Time: 3 h

Learning Outcomes: After the successful completion of the course the student will be able to

102.1 Classify, define, draw structures and explain various properties of carbohydrates and various types of lipids: correlate them to their functions.

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102.2 Classify, draw structures of standard amino acids, explain chemical and physical properties of amino acids; Describe different classes of proteins and nucleic acids; explain different levels of their structural organization

Approaches to teaching

Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements

Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation

The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting

Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each section. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each section. All questions carry equal marks.

SECTION-A

Carbohydrates: Structure, Function and properties of Monosaccharides, Disaccharides and Polysaccharides. Homo & Hetero Polysaccharides, Mucopolysaccharides, Bacterial cell wall polysaccharides, Glycoprotein's and their biological functions.

Lipids: Structure and functions –Classification, nomenclature and properties of fatty acids, essential fatty acids. Phospholipids, sphingolipids, glycolipids, cerebrosides, gangliosides, Prostaglandins, Cholesterol.

SECTION-B

Amino acids & Proteins: Structure & Function. Structure and properties of Amino acids, Types of proteins and their classification, Forces stabilizing protein structure and shape.Different Level of structural organization of proteins, Protein Purification.Denaturation and renaturation of proteins.Fibrous and globular proteins.

Nucleic acids: Structure and functions: Physical & chemical properties of Nucleic acids, Nucleosides & Nucleotides, purines &pyrimidines,. Biologically important nucleotides, Double helical model of DNA structure and forces responsible for A, B & Z – DNA, denaturation and renaturation of DNA.

Suggested Reading

1. Lehninger: Principles of Biochemistry, 3rd edition, by David L. Nelson and M.M. Cox (2000) Maxmillan/ Worth publishers.
2. Fundamentals of Biochemistry by Donald Voet and Judith G Voet (1999). John Wiley & Sons, NY
3. Biochemistry, 2nd edition, by R.H. Garrett and C.M. Grisham (1999). Saunders College Publishing, NY.
4. Outlines of Biochemistry by E.E.Conn, P.K.Stumpf, G. Bruenimg and Ray H.Doi (1987), John Wiley
5. Biochemistry, 2nd edition, by Laurence A. Moran, K.G. Scrimgeour, H. R. Horton, R.S. Ochs and J. David Rawn (1994), Neil Patterson Publishers Prentice H.
6. Introductory Biochemistry by S.K.Singla&O.P.Chauhan (1995) Kalyani Publishers, New Delhi.
7. Biochemistry by J.L. Jain, S. Chand & Co.

Semester I

CC-BIOTECHNOLOGY-I
Paper B-BTY-103

BASICS OF BIOTECHNOLOGY- PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

103.1 Prepare various types of solutions used in qualitative and quantitative biochemical estimations; verify and apply the basic principles of spectroscopy
103.2 Analyse the unknown samples qualitatively for the presence of various biomolecules

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals:

1. Study of instruments: Autoclave, Hot air oven, pH meter, Laminar airflow and centrifuge
2. Preparation of normal, molar, percent solutions, buffer solutions and determination of their pH.
3. Qualitative tests for Carbohydrates
4. Qualitative tests for lipids
5. Qualitative tests for amino acids and Proteins
6. Verification of Beer- Lambert's Law

Suggested Reading:

1. Elements of Biotechnology; Gupta PK, Rastogi Publications, Meerut.
2. Gene Biotechnology - S.N. Jogdand
3. Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). Biochemistry. VI Edition. W.H Freeman and Co.
4. Buchanan, B., Gruissem, W. and Jones, R. (2000) Biochemistry and Molecular Biology of Plants.American Society of Plant Biologists.
5. Nelson, D.L., Cox, M.M. (2004) Lehninger Principles of Biochemistry, 4th Edition, WH Freeman and Company, New York, USA

Semester-2

CC-BIOTECHNOLOGY-II

Paper B-BTY-201

ENZYMES

Credits: 3
Total Marks: 75
External Marks: 60
Internal Assessment: 15
Examination Time: 3 h

Learning Outcomes: After successful completion students will be able to

201.1 Define various characteristics of enzymes, classify them, elaborate the role of cofactors in enzyme catalysis and describe various approaches for purification of enzymes

201.2 Exhibit the knowledge of enzyme kinetics of unisubstrate reactions, various kinetics parameters (Km, Vmax etc.), different types of enzyme inhibitions; analysethe industrial importance of enzymes and the techniques to use them..

Approaches to teaching

Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements

Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation

The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting

Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each section. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each section. All questions carry equal marks.

SECTION-A

Enzymes: Historical perspectives, general characteristics, nomenclature & classification, significance of numbering system, holoenzyme, apoenzyme, coenzymes, cofactors, activators, inhibitors, active site, metallo-enzymes, isoenzymes, monomeric enzymes, oligomeric enzymes, multifunctional enzyme and multi-enzyme complexes. Enzyme specificity. Measurement and expression of enzyme activity: Enzyme assay, enzyme units, enzyme turn over number and specific activity. Role of

cofactors in enzyme catalysis: NAD/NADP, FMN/FAD, coenzyme A, biocytin, Vitamin B12 Coenzyme, lipoamide, TPP, pyridoxal phosphate, tetrahydrofolate and metal ions with special emphasis on coenzyme functions

Enzyme Purification: Methods of isolation of enzymes, purification of enzymes - ammonium sulfate precipitation, molecular-sieving, ion-exchange chromatography, affinity chromatography, criteria of homogeneity and determination of molecular weight of enzyme.

SECTION-B

Enzyme Kinetics: Factors affecting enzyme activity- enzyme concentration, substrate concentration, pH and temperature. Derivation of Michaelis - Menten equation for uni-substrate reactions. Km and its significance.Lineweaver-Burk plot.Importance of Kcat/Km. Bi-substrate reactions- brief introduction of sequential and ping-pong mechanisms with examples.Reversible (competitive, non-competitive and uncompetitive inhibitions) and irreversible inhibition.Determination of Km &Vmax in the presence and absence of inhibitor.**Enzyme regulation:**Feed back inhibition, Allosteric enzymes. Covalently modulated enzymes.Zymogenactivation.**Immobilized enzymes:** Advantages, methods of immobilization - Adsorption, ionic binding, covalent coupling, cross-linking, entrapment, microencapsulation etc. Applications of immobilized enzymes (A brief account).Industrial applications of enzymes (Production of glucose from starch, cellulose and dextran; use of lactase in dairy industry; production of glucose-fructose syrup from sucrose; use of protease in food, detergent and leather industry).

Suggested Reading

1. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry by Trevor Palmer (2001) Horwood Publishing.
2. Fundamentals of Enzymology, 3rd edition, by Nicholas C. Price and Lewis Stevens (1999) Oxford U.
3. The Chemical Kinetics of Enzyme action by K.J. Laidler and P.S. Bunting, Oxford University Press London.
4. Structure and mechanism in Protein Science, 2nd edition, by Alan Fersht (1999). W.H. Freeman and Co., NY

Semester-2

CC-BIOTECHNOLOGY-II
Paper B-BTY-202
METABOLISM

Credits: 3
Total Marks: 75
External Marks: 60
Internal Assessment: 15
Examination Time: 3 h

Learning Outcomes: On successful completion of the course the student will be able to

202.1 describe the metabolic pathways *i.e.* glycolysis (catabolism), gluconeogensis (anabolism), and TCA cycle, their regulations;the reactions and regulation of lipid catabolism by beta, oxidative pathways

202.2 analyse how amino acid catabolism leads to formation of diverse type molecules including ketone bodies, glucose, urea: discuss the catabolism and anabolismof nucleic acids

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Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each section. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each section. All questions carry equal marks.

SECTION-A

Carbohydrate Metabolism – Aerobic & Anaerobic glycolysis, sequence of reactions in glycolysis, regulation in glycolysis, citric acid cycle, glycogenesis, glycogenolysis (sequence of reactions & regulation), Pentose-phosphate pathway (sequence of reactions & regulation), extraction of energy from food sources.

Lipid Metabolism – Structures and roles of Fatty acids &Glycerols, beta oxidation of saturated fatty acids, oxidation of unsaturated fatty acids, oxidation of odd chain fatty acids, energy yield, ketone bodies

SECTION-B

Amino acid Metabolism – Amino acid breakdown (amino acid deamination, Urea cycle, metabolic breakdown of individual amino acids – glucogenic&ketogenic amino acids), amino acids as biosynthetic precursors (haem biosynthesis & degradation, biosynthesis of epinephrine, dopamine, seretonin, GABA, histamin, glutathione); biosynthesis of essential & non-essential amino acids.

Nucleotide Metabolism – biosynthesis of purine & pyrimidine (de novo & salvage pathway); degradation of purine & pyrimidine.

Suggested Reading

1. Lehninger: Principles of Biochemistry, 3rd edition, by David L. Nelson and M.M. Cox (2000) Maxmillan/ Worth publishers.
2. Fundamentals of Biochemistry by Donald Voet and Judith G Voet (1999). John Wiley & Sons, NY
3. Biochemistry, 2nd edition, by R.H. Garrett and C.M. Grisham (1999). Saunders College Publishing, NY.
4. Outlines of Biochemistry by E.E.Conn, P.K.Stumpf, G. Bruenimg and Ray H.Doi (1987), John Wiley
5. Biochemistry, 2nd edition, by Laurence A. Moran, K.G. Scrimgeour, H. R. Horton, R.S. Ochs and J. David Rawn (1994), Neil Patterson Publishers Prentice H.
6. Introductory Biochemistry by S.K.Singla&O.P.Chauhan (1995) Kalyani Publishers, New Delhi.
7. Biochemistry by J.L. Jain, S. Chand & Co.

Semester – 2

CC-BIOTECHNOLOGY-II
Paper B-BTY-203
ENZYMES AND METABOLISM-PRATICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: On successful completion of the course the student will be able to

203.1 Exhibit skills in extraction and quantitatively estimating the enzyme activity, Km, Vmax and protein content of the samples

203.2 Isolate and characterize carbohydrates, lipids and proteins from the natural sources

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals;

1. Estimation of protein by biuret / Lowry method
2. Assay of acid phosphatase activity from germinating mungbean seeds and calculation of specific activity of acid phosphatase.
3. Effect of enzyme concentration on enzyme activity.
4. Effect of substrate concentration on acid phosphatase activity and determination of its Km value.
5. Preparation of starch from potato and determination of achromatic point by salivary amylase
6. Isolation of total lipids by Folch method and determine acid value.
7. Isolation of casein from milk and determination of isoelectric pH.

Suggested Reading:

1. Introductory Practical Biochemistry by S.K.Sawhney& R. Singh (2000). Narosa Publishers
2. Practical Biochemistry by David Plummer (1990). Tata Mc-Graw Hill

3. Biochemical Methods by Sadasivam&Manickam (1996) New Age International (P) Ltd.
4. Modern Experimental Biochemistry, 3rd edition, by R. Boyer (2002) Addison-Wesley Longman.

Semester – 3
CC-BIOTECHNOLOGY-III
Paper B-BTY-301
MICROBIOLOGY-1

Credits: 3
Total Marks: 75
External Marks: 60
Internal Assessment: 15
Examination Time: 3 h

Learning Outcomes: On successful completion of the course the student will be able to
301.1 Illustrate the knowledge of history, scope, classification, various approaches of study and microbial diversity
3012.Give an account of microbial growth, reproduction, metabolism andmethods to control them :Identify the microorganisms in water and food

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each section. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each section. All questions carry equal marks.

SECTION-A

Fundamentals, History and Evolution of Microbiology. Classification of microorganisms: Microbial taxonomy, criteria used including molecular approaches, Microbial phylogeny and current classification of bacteria. Microbial Diversity: Distribution and characterization Prokaryotic and Eukaryotic cells, Morphology and cell structure of major groups of microorganisms eg. Bacteria, Algae, Fungi, Protozoa and Unique features of viruses.

Cultivation and Maintenance of microorganisms: Nutritional categories of micro-organisms, methods of isolation, Purification and preservation.

SECTION-B

Microbial growth: Growth curve, Generation time, synchronous batch and continuous culture, measurement of growth and factors affecting growth of bacteria. Microbial Metabolism: Metabolic pathways, amphi-catabolic and biosynthetic pathways Bacterial Reproduction: Transformation, Transduction and Conjugation. Endospores and sporulation in bacteria.

Control of Microorganisms: By physical, chemical and chemotherapeutic Agents
Water Microbiology: Bacterial pollutants of water, coliforms and non coliforms.Sewage composition and its disposal.
Food Microbiology: Important microorganism in food Microbiology: Moulds, Yeasts, bacteria. Major food born infections and intoxications, Preservation of various types of foods.Fermented Foods.

SUGGESTED READING

1. Alexopoulos CJ, Mims CW, and Blackwell M. (1996).Introductory Mycology. 4 th edition. John and Sons, Inc.
2. Jay JM, Loessner MJ and Golden DA.(2005). Modern Food Microbiology.7thedition, CBS Publishers and Distributors, Delhi, India.
3. Kumar HD. (1990). Introductory Phycology.2nd edition.Affiliated East Western Press.
4. Madigan MT, Martinko JM and Parker J. (2009). Brock Biology of Microorganisms.12th edition.Pearson/Benjamin Cummings.
5. Pelczar MJ, Chan ECS and Krieg NR.(1993). Microbiology.5th edition. McGraw Hill Book Company.
6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.
7. Tortora GJ, Funke BR, and Case CL. (2008). Microbiology: An Introduction. 9 th edition. Pearson Education.

Semester – 3
CC-BIOTECHNOLOGY-III
Paper B-BTY-302
MICROBIOLOGY-II

Credits: 3
Total Marks: 75
External Marks: 60
Internal Assessment: 15
Examination Time: 3 h

Learning Outcomes: On successful completion of the course the student will be able to
302.1 Illustrate the knowledge of normal microflora and infections in human body
302.2.Give an account of pathogenesis by various microorganisms

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each section. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each section. All questions carry equal marks.

SECTION-A

Introduction: Normal microflora of human body, nosocomial infections, carriers, septic shock, septicemia, pathogenicity, virulence factors, toxins, biosafety levels.

Morphology, pathogenesis, symptoms, laboratory diagnosis, preventive measures and chemotherapy of gram positive bacteria: *S.aureus, S.pyogenes, B.anthracis, C.perferinges, C.tetani, C.botulinum, C.diphtheriaeM.tuberculosis, M. leprae*. Morphology, pathogeneis, symptoms, laboratory diagnosis, preventive measures andchemotherapy caused by gram negative bacteria: *E.coli, N. gonorrhoea, N. meningitidis, P.aeruginosa, S. typhi, S. dysenteriae, Y. pestis, B. abortus, H. influenzae, V. cholerae, M. pneumoniae, T. pallidum M. pneumoniae,Rickettsiaceae, Chlamydiae*.

SECTION-B

Diseases caused by viruses: Picornavirus, Orthomyxoviruses, Paramyxoviruses, Rhabdoviruses, Reoviruses, Pox virus, Herpes virus, Papova virus, Retro viruses (including HIV/AIDS) and Hepatitis viruses.

Fungal and Protozoan infections:Dermatophytoses (Trichophyton, Microsporun and Epidermophyton) Subcutaneous infection (Sporothrix, Cryptococcus), systemic infection (Histoplasma, Coccidoides) and opportunistic fungal infections (Candidiasis, Aspergillosis),Gastrointestinal infections (Amoebiasis, Giardiasis), Blood-borne infections (Leishmaniasis, Malaria)

Suggested Reading

1. Brooks GF, Carroll KC, Butel JS and Morse SA.(2007). Jawetz, Melnick and Adelberg's Medical Microbiology.24th edition.McGraw Hill Publication.
2. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology.4th edition.Elsevier. .
3. Willey JM, Sherwood LM, and Woolverton CJ.(2008). Prescott, Harley and Klein's Microbiology.7th edition.McGraw Hill Higher Education.

Semester – 3

CC-BIOTECHNOLOGY-III

Paper B-BTY-303

MICROBIOLOGY-PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: On successful completion of the course the student will be able to
303.1 Exhibit skills in preparation of media and staining
303.2 Isolate, identify and characterizebacteria from different sources

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals:

1. Isolation of bacteria & their biochemical characterization.
2. Staining methods: simple staining, Gram staining, spore staining, negative staining, hanging drop.
3. Preparation of media & sterilization methods, Methods of Isolation of bacteria from different sources.
4. Determination of bacterial cell size by micrometry.
5. Enumeration of microorganism - total & viable count.
6. Identification of pathogenic bacteria (any two) based on cultural, morphological and biochemical characteristics.
7. Growth curve of a bacterium.
8. To perform antibacterial testing by Kirby-Bauer method.
9. To prepare temporary mounts of Aspergillus and Candida by appropriate staining.
10. Staining methods: Gram's staining permanent slides showing Acid fast staining, Capsule staining and spore staining.

Suggested Reading

1. Brooks GF, Carroll KC, Butel JS and Morse SA.(2007). Jawetz, Melnick and Adelberg's Medical Microbiology.24th edition.McGraw Hill Publication.

2. Goering R, Dockrell H, Zuckerman M and Wakelin D. (2007). Mims' Medical Microbiology.4th edition.Elsevier. .
3. Willey JM, Sherwood LM, and Woolverton CJ.(2008). Prescott, Harley and Klein's Microbiology.7th edition.McGraw Hill Higher Education.
4.Pelczar MJ, Chan ECS and Krieg NR.(1993). Microbiology.5th edition. McGraw Hill Book Company.
6. Stanier RY, Ingraham JL, Wheelis ML, and Painter PR. (2005). General Microbiology. 5th edition. McMillan.

Semester – 4
CC-BIOTECHNOLOGY-IV
Paper: B-BTY-401
MOLECULAR BIOLOGY

Credits: 3
Total Marks: 75
External Marks: 60
Internal Assessment: 15
Examination Time: 3 h

Learning Outcomes: After successful completion students will be able to

401.1 Elaborate the central dogma of life, the general principles of gene organization and describe the structure and functions of proteins involved in replication and repair mechanisms

401.2 Give an insight of the process of gene expression, mechanism of transcription, post-transcriptional processing of RNA in prokaryotes; Describe and correlate the concept of genetic code and mechanism of translation in prokaryotes

Approaches to teaching

Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements

Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation

The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting

Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each section. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each section. All questions carry equal marks.

SECTION-A

Basic Concepts of Genetic Information: Structure of DNA, various forces responsible for stability of DNA, various forms of DNA, DNA topology, DNA supercoiling, Topoisomerases in prokaryotes and eukaryotes, DNA, organization in prokaryotes and eukaryotes, C-value paradox, denaturation: different ways for carrying out denaturation, renaturation: requirements, various classes of DNA: highly repetitive, moderately repetitive and unique sequence

DNA replication, mutations and DNA repair: Possible modes of DNA replication, Meselson-Stahl experiment, DNA polymerases and other enzymes involved in DNA replication, Okazaki fragments, Mechanism of replication in prokaryotes and eukaryotes, inhibitors of DNA replication, molecular basis of mutations, DNA repair mechanisms like direct, base-excision, nucleotide-excision, mismatch, SOS and recombinational repair.

SECTION-B

Transcription and post-transcriptional modifications: RNA polymerase/s in prokaryotes and eukaryotes, DNA footprinting technique, initiation, elongation and termination of transcription in prokaryotes and eukaryotes, inhibitors of transcription, RNA replicase, reverse transcriptase, post-transcriptional modifications: different types of introns and their splicing mechanisms, processing of mRNA, rRNA and tRNA precursors, overlapping genes and split genes. Protein synthesis, targeting and degradation:

Characteristics of the genetic code, biological significance of degeneracy, decoding the code, Wobble hypothesis, ribosomes structure and function in prokaryotes and eukaryotes, AminoacyltRNA-synthetases various factors and steps involved in protein synthesis in prokaryotes and eukaryotes, post-translational processing, signal hypothesis and protein targeting to lysosomes, Plasma membrane, extracellular matrix and different compartment of mitochondria, protein degradation.

Suggested Reading:

1. Molecular Cell Biology, 5th edition H Lodish et al. (2004) W H Freeman and Company.
2. Genes X, B Lewin (2015) Pearson Education International.
3. Freifelder's Essentials of Molecular Biology, 4rd edition, D Freifelder. (2005) Narosa publishing house
4. Biochemistry, 2nd edition, Moran. Neil Patterson Publishing.
5. Fundamentals of Biochemistry, 2nd edition, D Voet& G J Voet. John-Wiley & sons.
6. Biochemistry, 5th edition, JM Berg et al. W H Freeman & Co. N York.
7. Lehninger's Principles of Biochemistry, 4nd edition, D L Nelson and M M Cox. (2005) W H Freeman & Co. N York.
8. The Biochemistry of Nucleic acid, 11th edition, R L Adams et al, Chapman and Hall.
9. Molecular Biology of the Gene, 5th Edition, Watson et al (2004) Pearson Education International.

Semester – 4
CC-BIOTECHNOLOGY-IV
Paper: B-BTY-402
RECOMBINANT DNA TECHNOLOGY

Credits: 3
Total Marks: 75
External Marks: 60
Internal Assessment: 15
Examination Time: 3 h

Learning Outcomes: On successful completion of the course the student will be able to

402.1 give insight of the principles and applications of the molecular tools used in recombinant DNA technology

402.2 elaborate the process and applications of genetic engineering in animals

Approaches to teaching

Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements

Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation

The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting

Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each section. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each section. All questions carry equal marks.

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SECTION-A

Molecular tools and applications -restriction enzymes, ligases, polymerases, alkaline phosphatase. Gene Recombination and Gene transfer: Transformation, Episomes, Plasmids and other cloning vectors (Bacteriophage-derived vectors, artificial chromosomes), Microinjection, Electroporation, Ultrasonication

Principle and applications of Polymerase chain reaction (PCR), primer-design, and RT- (Reverse transcription) PCR

SECTION-B

Restriction and modification system, restriction mapping. Southern and Northern hybridization. Preparation and comparison of Genomic and cDNA library, screening of recombinants, reverse transcription,. Genome mapping, DNA fingerprinting

Applications of Genetic Engineering: Genetic engineering in animals: Production and applications of transgenic mice, role of ES cells in gene targeting in mice, Therapeutic products produced by genetic engineering-blood proteins, human hormones, immune modulators and vaccines (one example each)

Suggested Reading

1. Brown TA. (2010). Gene Cloning and DNA Analysis.6th edition.Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pasternik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
4. Primrose SB and Twyman RM. (2006).
5. Principles of Gene Manipulation and Genomics, 7th edition. Blackwell Publishing, Oxford, U.K.

Semester – 4
CC-BIOTECHNOLOGY-IV
Paper: B-BTY-403
MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY-PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: On successful completion of the course the student will be able to

403.1 isolate DNA from plants and bacteria, plasmid DNA.

403.2 demonstrate the making and transforming competent cells

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals:

1. Isolation of chromosomal DNA from plant cells
2. Isolation of chromosomal DNA from *E.coli*
3. Qualitative and quantitative analysis of DNA using spectrophotometer
4. Plasmid DNA isolation
5. Restriction digestion of DNA
6. Making competent cells
7. Transformation of competent cells.
8. Demonstration of PCR

Suggested Reading

1. Brown TA. (2010). Gene Cloning and DNA Analysis.6th edition.Blackwell Publishing, Oxford, U.K.
2. Clark DP and Pasternik NJ. (2009). Biotechnology: Applying the Genetic Revolution. Elsevier Academic Press, USA

3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington
4. Primrose SB and Twyman RM. (2006). Principles of Gene Manipulation and Genomics, 7th edition.Blackwell Publishing, Oxford, U.K.
5. Sambrook J and Russell D. (2001). Molecular Cloning-A Laboratory Manual. 3rd edition. Cold Spring Harbor Laboratory Press

SEC-BIOTECHNOLOGY-I
Paper: B-BTY-S1
BIOANALYTICAL TOOLS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h

Learning Outcomes: Students who successfully complete this course will be able to

S1.1 Demonstrate the knowledge of the general principles, components and applications of pH meter and centrifuges; principles and applications of chromatographic techniques in isolation, quantification and characterization of biomolecules

S1.2 Demonstrate the knowledge of the general principles, components and applications of spectrophotometer; principles and applications of electrophoresis and radioisotopes in biochemical studies.

Approaches to teaching

Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements

Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation

The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting

Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each section. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each section. All questions carry equal marks.

SECTION-A

Measurement of pH: Principles and composition of reference electrodes, glass electrode and combined electrode.

Hydrodynamic Methods: Sedimentation: sedimentation velocity including factors affecting it, preparative and analytical centrifugation techniques, ultracentrifugation, determination of molecular weight by hydrodynamic methods (derivations excluded and numericals included).

Chromatographic techniques- General principles and applications of adsorption, ion-exchange, molecular-sieve, thin layer, hydrophobic, affinity & paper chromatography.

SECTION-B

Electrophoresis- Basic principles of electrophoresis; Native & SDS-PAGE; Agarose gel electrophoresis.

Radioisotopic Techniques: Types of radiations, radioactive decay, units of radioactivity, detection and measurement of radioactivity (methods based on gas ionization and liquid scintillation counting) and Quenching. Biological hazards of radiations and safety measures in handling radioisotopes.Biological applications of radioisotopes.

Spectroscopic Techniques: Beer-Lambert law, light absorption and its transmittance, extinction coefficient, a brief account of instrumentation and applications of visible and UV spectroscopic techniques (structure elucidation excluded).

Suggested reading:

1. Physical Biochemistry, 2nd edition, by D Friefelder (1983). W.H. Freeman & Co., U.S.A.
2. Biophysical Chemistry: Principles and Techniques, 2nd edition, by A. Upadhyay, K. Upadhyay and N.Nath. (1998). Himalaya Publishing House, Delhi.
3. Principles & Techniques of Practical Biochemistry, 5th edition, by Keith Wilson and John Walker (2000). Cambridge University Press.
4. Introductory Practical Biochemistry by S.K. Sawhney and Randhir Singh (2000). Narosa Publishing House, New Delhi.

Semester – 5
DSE-BIOTECHNOLOGY-I
Paper: B-BTY-501
ANIMAL BIOTECHNOLOGY-I

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h

Learning Outcomes: On successful completion of the course the student will be able to

501.1 exhibit the knowledge of the basic concepts of animal biotechnology; animal cell and tissue culture technology, principles and applications

501.2 illustrate the applications of stem cell technology and Cellular reprogramming in animal science

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each section. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each section. All questions carry equal marks.

SECTION-A

Animal Cell & Tissue Culture: Introduction, Principles & practice. History and Development of animal cell culture.Scope and Applications.

Culture Media: Media components, Serum containing and serum free media. Natural media- Plasma clot, biological fluids, tissue extracts. Growth factors required for proliferation of animal cells. Chemically defined media, balanced salt solutions.Physical requirements for growing animal cells in culture.Washing, drying, sterilization practices, various instruments and their uses in animal cell culture practices.

Cell Culture techniques: Primary Cell Culture:Initiation of cell culture-substrates (glass, plastic, metals) their preparation and sterilization. Isolation of tissue explants, disaggregation- enzyme disaggregation and mechanical disaggregation of the tissue. development of primary culture and cell lines. Subculture. Contamination.. Suspension culture, Growth curve of animal cells in culture. Secondary cell culture – transformed cell and continuous cell lines.Finite and infinite cell lines.Cell lines: Insect and animal cells. Commonly used cell lines- their organization and characteristics.Cell repositories and their function.Karyotyping, biochemical and genetic characterization of cell lines.

SECTION-B

Stem cells; main types of stem cells, embryonic stem cells, perinatal stem cells, amniotic and placental stem cells, mesenchymal stem cells, leydig stem cells, trophoblast stem cells, epiblast stem cells, mammary stem cells, induced pluripotent stem cells, potential use of stem cells – cell based therapies stem cells and in vitro derivation of gametes, stem cells in human health, porcine stem cells in human and biomedical sciences, clinical trials update.

Stem cells in livestock: brief introduction to stem cells, types of stem cells, embryonic stem cell research in livestock species, stem cells in in vitro development of gametes, status of stem cell research in livestock. Somatic cell nuclear transfer: progress in SCNT, methodology of animal cloning, , embryo development block and reprogramming in cloning, ES cells can be used for gene targeting in miceetc

Cellular reprogramming and induced pluripotency: molecular basis of cellular reprogramming, gene expression in pluripotent cells, strategies for induction of genome reprogramming, reprogramming and induced pluripotency in animal sciences.

Suggested Readings:

1. Animal Cell Culture Methods In: Methods in Cell Biology, Vol. 57, Ed. Jenni P Mather and David Barnes, Academic Press.
2. Animal Cell Culture Techniques. Ed. Martin Clynes, springer.
3. Text Book of Animal Biotechnology- (2020) published by The Energy and Resources Institute Press, New Delhi.
4. Advances in Animal Biotechnology (2020) published by Springer Nature Switzerland AG.
5. Animal Cell Culture - Practical Approach, Ed. John R.W. Masters, OXFORD.
6. Culturing of animal cells by Ian Freshney, 6th edition

Semester – 5
DSE-BIOTECHNOLOGY-I
Paper B-BTY-502
ANIMAL BIOTECHNOLOGY-II

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h

Learning Outcomes: On successful completion of the course the student will be able to:-

502.1 Describe the Techniques of transfection and applications in production of vaccines and gene therapy

502.2 Elaborate the techniques and applications of invitro fertilization and transgenic animals

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each section. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each section. All questions carry equal marks.

SECTION-A

Animal Biotechnology: global perspective and new horizons

Transfection: Transfection of animal cells: transfection methods. Methods for cell fusion, Selectable markers, HAT selection and Antibiotic resistance.
Cloning and expression of foreign genes in animal cells: Expression vectors. Over production and preparation of the final product i.e. expressed proteins.

Production of vaccines in animal cells:
Hybridoma Technology: Production of monoclonal antibodies and their applications.

Therapeutic products through genetic engineering – blood proteins, insulin, growth hormone etc.
Gene Therapy: introduction, types of gene therapy, vectors in gene therapy, major achievements, problems and prospects.

SECTION-B

In vitro fertilization:- collection of ovaries and recovery of oocytes, selection of oocytes for in vitro maturation , Oocyte-cumulus cell interactions, IVM, assessment of cumulus expansion, factors affecting IVM of oocytes, semen processing, in vitro fertilization, embryo development, Cryopreservation of oocytes and sperm; need of cryopreservation, principle of cryopreservation, steps involved in cryopreservation, methods, cryopreservation as strategy to establish somatic cell banking,Artificial insemination, Animal clones.Embryo transfer technology

Transgenic animals: Introduction, biopharming through animal transgenesis, Transgenic Animals: transgenic mice, sheep etc.,methods of producing transgenic animals, choices of species and tissue to produce recombinant biomolecules, limitations of large mammals transgenesis.

Suggested Readings:

1. Animal Cell Culture Methods In: Methods in Cell Biology, Vol. 57, Ed. Jenni P Mather and David Barnes, Academic Press.
2. Animal Cell Culture Techniques. Ed. Martin Clynes, springer.
3. Text Book of Animal Biotechnology- (2020) published by The Energy and Resources Institute Press, New Delhi.
4. Advances in Animal Biotechnology (2020) published by Springer Nature Switzerland AG.
5. Animal Cell Culture - Practical Approach, Ed. John R.W. Masters, OXFORD.
6. Culturing of animal cells by Ian Freshney, 6th edition

Semester – 5
DSE-BIOTECHNOLOGY-I
Paper B-BTY-503
ANIMAL BIOTECHNOLOGY-PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: On successful completion of the course the student will be able to:-

503.1 prepare different media, culture and cryopreserve the animal cells
503.2 Isolate and quantify DNA from animal cells/ tissue

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals

1. Preparation of media for animal cells
2. In vitro maturation of oocytes
3. Preparation of cryopreservation media
4. Freezing/cryopreservation of animal cells and post thaw damages in animal cells after cryopreservation
5. Isolation and cryopreservation of lymphocytes
6. Isolation and quantification of DNA from animal cell/ tissue

Suggested Readings:

1. Animal Cell Culture - Practical Approach, Ed. John R.W. Masters, OXFORD.
2. Animal Cell Culture Methods In: Methods in Cell Biology, Vol. 57, Ed. Jenni P Mather and David Barnes, Academic Press.
3. Text Book of Animal Biotechnology- (2020) published by The Energy and Resources Institute Press, New Delhi.
4. Advances in Animal Biotechnology (2020) published by Springer Nature Switzerland AG.
5. Animal Cell Culture Techniques. Ed. Martin Clynes, springer.

Semester – 5

DSE-BIOTECHNOLOGY-I
Paper B-BTY-504
MEDICAL BIOTECHNOLOGY-1

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h

Learning Outcomes: On successful completion of the course the student will be able to

504.1 Correlate abnormalities in chromosomal structure, number, stability to the related diseases
504.2 give insight of techniques helpful diagnosis and prognosis of diseases.

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion
Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc
Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination
Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each section. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each section. All questions carry equal marks.
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SECTION-A

Chromosomal disorders – Numerical disorders e.g. trisomies&monosomies, Structural disorders e.g. deletions, duplications, translocations & inversions, Chromosomal instability syndromes. Gene controlled diseases – Autosomal and X-linked disorders, Mitochondrial disorders and Multifactorial conditions. Identification of disease genes, Functional cloning –Eg. haemophilia gene. Positional cloning - eg. DMD and CGD genes. Candidate gene approach – Eg. Marfan's syndrome, Alzeimer's disease.

Molecular basis of human diseases - Pathogenic mutations. Gain of function mutations: Oncogenes, Huntingtons Disease, Pittsburg variant of alpha 1 antitrypsin. Loss of function - Tumour Suppressor Genes, PAX- 3 gene; Gene Dosage Effect - PMP22 , Collagen gene; Genomic Imprinting -Mechanisms, Praderwilli / Angelman syndrome, WAGR syndrome, Beckwith Weidemann Syndrome. Immuno Pathology, Hepatitis, HIV, Autoimmune Disorders-SLE, RA

SECTION-B

Prenatal diagnosis - Invasive techniques - Amniocentesis, Fetoscopy, Chorionic Villi Sampling (CVS), Non-invasive 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, CML – bcr/abl, HIV - CD 4 receptor; Microarray technology- genomic and c DNA arrays, application to diseases.

Suggested Reading

1. Medical Biotechnology by Glick, Bernard and Patten.
2. Pharmaceutical and Medical Biotechnology by Gennady Zaikov
3. Medical Biotechnology by JuditPongracz and Marry Keen

Semester – 5

DSE-BIOTECHNOLOGY-I
Paper B-BTY-505
MEDICAL BIOTECHNOLOGY-II

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h

Learning Outcomes: On successful completion of the course the student will be able to

505.1 Correlate various deficiency diseases and mechanisms involved in their treatment.

505.2 discuss the application of vaccines as a tool to prevent these diseases

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each section. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each section. All questions carry equal marks.

SECTION-A

Clinical management and Metabolic manipulation - PKU, Familial Hypercholesterolemia, Rickets, ADA, Congenital hypothyroidism; Gene therapy Ex-vivo, Invivo, Insitu gene therapy Stratagies of gene therapy: gene augmentation – ADA defeiciency, CFTR Prodrug therapy/ suicide gene – glioma, evoking immune

response – melanoma TFO, Antisense therapy, Ribozymes, Protein Aptamers, Intrabodies

Vectors used in gene therapy- Biological vectors – retrovirus, adenoviruses, Herpes Synthetic vectors– liposomes, receptor mediated gene transfer; Gene therapy trials – Familial Hypercholesterolemia, Cystic Fibrosis, Solidtumours. Cell and tissue engineering: Encapsulation technology and therapeutics - Diabetes, Hypothyroidism, Haemophilia, Bioartificial organs, Artificial Cells- ForHaemophilia, Phenylkeptonuria, Diabetes

SECTION-B

Nanomedicine - Nanoparticles, Nanodevices-medical microrobotics, nanoroboticsMicrobiovers, Nanomedicine and Nanosurgery – for cancers, neurological disorders.

Functional cloning – anti-haemophilic factor; Positional cloning- Dystrophin; Gene products in medicine - Humulin, Erythropoietin, Growth Hormone/Somatostatin, tPA, Interferon; DNA based vaccines ,subunit vaccines – Herpes Simplex Virus; Attenuated Vaccines– Cholera; Vector vaccines – Cholera and Salmonella

Semester – 5
DSE-BIOTECHNOLOGY-1
Paper: B-BTY-506
MEDICAL BIOTECHNOLOGY-PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: On successful completion of the course the student will be able to

506.1 Perform various tests to identify infectious diseases.

506.2 Isolate DNA from blood sample and demonstrate qualitative analysis of DNA damage

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

List of Practical

1. To perform DOT-ELISA.
2. To isolate DNA from blood and quality determination by agarose gel electrophoresis.
3. To study in vitro DNA damage and analysis by agarose gel electrophoresis
4. Determination of growth inhibition Zone
5. To isolate Serum and plasma from blood.
6. To perform WIDAL test, AMES test and VDRL test

Suggested Reading

1. Medical Biotechnology by Glick, Bernard and Patten.
2. Pharmaceutical and Medical Biotechnology by Gennady Zaikov
3. Medical Biotechnology by JuditPongracz and Marry Keen

Semester-6
DSE-BIOTECHNOLOGY-II
Paper: B-BTY-601
PLANT BIOTECHNOLOGY-I

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h

Learning Outcomes: On successful completion of the course the student will be able to

601.1 Elaborate the basic concept of plant tissue culture, different aseptic conditions, culture media and their supplements

601.2 Describe different types of plant culture (tissue, organ and protoplast) and various techniques such as micropropagation, totipotency, somaclonal variation, their applications and limitations.

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Approaches to teaching

Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements

Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation

The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting

Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each section. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each section. All questions carry equal marks.

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SECTION-A

Plant Tissue Culture: Introduction/Concept, History, Scope and Applications along with major achievements.

Plant Tissue Culture Laboratory: Layout and organization, different work areas, infrastructure/equipments and instruments and other requirements.

Aseptic Techniques: General sanitation/cleanliness of PTC laboratory and precautions regarding maintenance of aseptic conditions, Washing, drying and sterilization of glassware, sterilization of media, surface sterilization, aseptic work station.

Culture Media: Nutritional requirements for plant tissue culture, role of different media components, plant growth regulators, different culture media viz. MS, B_5Nitsch and White's medium, Preparation of culture media.

SECTION-B

In-vitro methods in plant tissue culture: Explants, their cellular characteristics, dedifferentiation and redifferentiation, cellular totipotency, organogenesis and somatic embryogenesis. Micropropagation/clonal propagation of elite species (different routes of multiplication-axillary bud proliferation, somatic embryogenesis, organogenesis), Synthetic seeds (a brief account)

Callus and suspension culture techniques: Introduction, principle, methodology, applications and limitations. Somaclonal variation.

Organ culture: Anther & Pollen culture, ovary, ovule, embryo and endosperm culture – concept, technique, applications and limitations. Embryo rescue.

Protoplast culture: Protoplast isolation, viability test, protoplast culture. Somatic hybridization – protoplast fusion techniques (chemical and electro-fusion), selection of hybrids, production of symmetric and asymmetric hybrids and cybrids.Practical applications of somatic hybridization and cybridization.

Suggested Reading

1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
2. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.
3. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2008 8th edition Principles of Genetics.Wiley India.
4. Raven, P.H., Johnson, GB.,Losos, J.B. and Singer, S.R. 2005 Biology. Tata MC GrawHill.
5. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell,Tissue and Organ Culture.Narosa Publishing House.
6. Russell, P.J. 2009 Genetics – A Molecular Approach. 3rdedition. Benjamin Co.
7. Sambrook&Russel. Molecular Cloning: A laboratory manual. (3rd edition)
8. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press.

Semester – 6
DSE- BIOTECHNOLOGY-II
Paper: B-BTY-602
PLANT BIOTECHNOLOGY-II

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h

Learning Outcomes: On successful completion of the course the student will be able to
602.1 exhibit the knowledge of organization plant genome, different genetic transformation techniques with their merits and limitations. All types of characterization of transformants with different markers
602.2 apply the principles and techniques of genetic engineering in improving quality of plants/ food

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion
Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc
Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination
Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each section. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each section. All questions carry equal marks.
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SECTION-A

Organization of plant genome- Nuclear, Chloroplast and Mitochondrial genome. Chloroplast Transformation- vector designing, methods and advantages.

Plant Nuclear Transformation- Agrobacterium mediated transformation, Ti and Ri plasmids.
Mechanism of transformation: Role of virulence genes, mechanism of T-DNA transfer, vectors based on Ti and Ri plasmids, cointegrate and binary vectors,

techniques and factors effecting Agrobacterium mediated transformation of plants. Gene targeting in plants.Use of plant viruses as vectors (brief account only).

Direct gene transfer methods- particle bombardment, PEG-mediated, electroporation, microinjection and Calcium phosphate mediated etc.

SECTION-B

Genetic Engineering – crop improvement, herbicide resistance, insect resistance, virus resistance, plants as bioreactors. transgenic plants, ecological impact of transgenic plants. Genetic modification in Food industry – background, history, controversies over risks, application, future applications.Genetically modified foods – organic foods, types of organic foods, identifying organic foods, organic food & preservative.

Transgenic Plants: Introduction and applications. Developing insect resistance, bacterial and fungal disease resistance, virus resistance and abiotic stress tolerance in plants.Improving food quality – nutritional enhancement of plants (carbohydrates, seed storage proteins and vitamins).

Production of secondary metabolites in vitro: introduction, technique and utilities. Biotransformation (a brief account only).Plant germ plasm conservation and cryopreservation.
Plants as Bioreactors: antibodies, polymers, industrial enzymes. Edible vaccines.

Suggested Reading

1. Bhojwani, S.S. and Razdan 2004 Plant Tissue Culture and Practice.
2. Brown, T. A. Gene cloning and DNA analysis: An Introduction. Blackwell Publication.
3. Gardner, E.J. Simmonns, M.J. Snustad, D.P. 2008 8th edition Principles of Genetics. Wiley India.
4. Raven, P.H., Johnson, GB.,Losos, J.B. and Singer, S.R. 2005 Biology. Tata MC Graw Hill.
5. Reinert, J. and Bajaj, Y.P.S. 1997 Applied and Fundamental Aspects of Plant Cell, Tissue and Organ Culture.Narosa Publishing House.
6. Russell, P.J. 2009 Genetics – A Molecular Approach. 3rdedition. Benjamin Co.
7. Sambrook&Russel. Molecular Cloning: A laboratory manual. (3rd edition)
8. Slater, A., Scott, N.W. & Fowler, M.R. 2008 Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press

Semester-6
DSE-BIOTECHNOLOGY-II
Paper: B-BTY-603
PLANT BIOTECHNOLOGY-PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning Outcomes: On successful completion of the course the student will be able to

603.1 culture plant tissues by various techniques

603.2 prepare the extract and analyse for antibiotic activity.

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

List of practical

1. Haploid culture: Andogenesis and Gynogenesis.
2. Protoplast isolation using enzymatic method.
3. Analysis of various plant extracts for their antibiotic activity.
4. Performance of node culture.
5. Suspension culture with different explants.
6. Embryo culture.
7. Transferring the grown plants to hardening medium.

Suggested reading

1. Brown C. W and Thorpe T. A Cell culture and Somatic Cell Genetics of plants, Academic Press Orlando
2. Chu, C Plant Tissue Culture, Peking Science Press, Peking
3. Gamborg O. L and Phillips. G.G. Plant Cell, Tissue culture and Organ culture Fundamental Methods. Narosa Publishing House, New Delhi

Semester-6
DSE-BIOTECHNOLOGY-II
Paper: B-BTY-604
IMMUNOLOGY-I

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h

Learning outcomes:

After successful completion of course, students will be able to

604.1 Exhibit the knowledge of basic components, organs, cells of immune system, components of immunity and will understand the coordination between humoral, cell-mediated and innate immune responses in combating pathogens

604.2 Illustrate the attributes of antigens, immunogens, factors affecting immunogenicity; the structure and functions of different types of immunoglobulins

Approaches to teaching

Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements

Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation

The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting

Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each section. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each section. All questions carry equal marks.

SECTION –A

Introduction to immune system: Historical Perspective, Cells and organs of the immune system; primary and secondary lymphoid organs; bone marrow, thymus, spleen, lymphnodes and tissues (MALT)

Components of immunity: Innate immunity- Anatomic, physiological, phagocytic and inflammatory barriers; Adaptive immunity- A brief account of the functions of Humoral and cell-mediated immune responses. Primary and secondary immune responses, connection between innate and adaptive immunity, cell adhesion molecules, chemokines, leukocyte extravasation, localized and systemic response

Antigens: Antigens and haptenes**,** Immunogenicity versus antigenicity, factors influencing immunogenicity; Adjuvants; Epitopes (properties of B-Cell and T-cell epitopes)

SECTION –B

Immunoglobulins: Structure, distribution of classes and subclasses of immunoglobulins, physicochemical properties of different classes of immunoglobulins, antigenic determinants on immunoglobulins and Ig superfamily

Monoclonal Antibodies: Introduction, formation and selection of hybrid cells, their production and applications.

Biology of B lymphocytes: Antigen independent phase of B cell maturation and selection, humoral response- Thymus dependent and Thymus independent response, anatomical distribution of B-cell population

Suggested Readings:

1. I.M. Riott, J. Brostoff, D. Male “Immunology” 3rd edn. W.H. Freeman and Pub. Company, USA.
2. Kuby “Immunology” 3rd edn., Mosby Year Book Co., England Introduction to Immunology – NandiniShetty (2003)
3. Immunology – Janis Kuby – W. H. Freeman and Co. 7th edition (2019)
4. Janeway’sImmunobiology 2012 8th ed., Murphy, K., Mowat, A., and Weaver, C.T., Garland Science (London & New York), ISBN:978-0-8153-4243-4

Semester-6
DSE-BIOTECHNOLOGY-II
Paper: B-BTY-605
IMMUNOLOGY-II

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h

Learning outcomes: After successful completion of course, students will be able to

605.1 Understand the basis and applications of antigen antibody interactions disease diagnosis and exhibit the knowledge of different modes of complement activation, types of MHCs and their role in antigen presentation and processing

605.2 Illustrate structures and functions of various components of cell mediated immune response; the principles of tolerance, autoimmunity anddifferent types of hypersensitivity

Approaches to teaching
Lectures, Chalk and board teaching, power point Presentations, models, Group Discussion

Requirements
Regular attendance and active participation during the course; Books and reference material; assignments and presentations etc

Evaluation
The performance of the students will be evaluated against the expected learning course outcomes on the basis of class participation, regularity, house tests, quiz and assignments carrying 20 percent of the marks and the rest through Terminal Examination

Mode of paper setting
Seven questions will be set in all. Question No.1 comprising of objective/short answer type questions from the entire syllabus, will be compulsory. The remaining six questions will be set taking three questions from each section. The candidates will be required to attempt Q.No.1 & four others selecting two questions from each section. All questions carry equal marks.

SECTION-A

Antigen–antibody interactions: Antibody affinity, antibody avidity, Agglutination & Precipitation reactions; Immunodiffusion; Radio immunoassay & ELISA.

Complement system: Components if complement system,Complement activation by classical, alternate and MB lactin pathways**,** Biological consequences of complement activation and regulation.

Major Histocompatibility Complex (MHC): General organization and inheritance of MHC, Structure, distribution and role of class I & II MHC molecules;.

Antigen Processing & Presentation: A brief account of antigen processing and presentation pathways.

SECTION-B

Biology of the T lymphocyte: Structure and role of T cell receptor, and co-receptor, T cell development, generation of receptor diversity, selection and differentiation.

Cell mediated cytotoxic responses: General properties of effector T cells, cytotoxic T cells (Tc), natural killer cells; NKT cells and antibody dependent cellular cytotoxicity (ADCC).

Tolerance, autoimmunity and hypersensitivity: Central tolerance, pherpheral tolerance, autoimmunity, autoimmune diseases, possible mechanisms of induction of autoimmunity, Hypersensitivity reactions: Gell and Coombs classification, IgE mediated (Type I) hypersensitivity, antibody mediated cytotoxic (Type II) hypersensitivity, immune complex mediated (type III) hypersensitivity and delayed type (Type IV) hypersensitivity.

Transplantation immunology and vaccines : Immunological basis of graft rejection, clinical manifestations, Vaccines - active and passive immunization

Suggested Reading:

1. A Short Course in Immunology by Benjamini
2. Kuby Immunology, 4rd ed. by R.A. Goldsby et al, W.H. Freeman & Co.
3. Immunology, 4th ed. by Roitt et al., Mosby Publications
4. Immunology – Janis Kuby – W. H. Freeman and Co. 7th edition (2019)
5. Janeway'sImmunobiology by Kenneth Murphy and Casey Weaver

Semester-6
DSE-BIOTECHNOLOGY-II
Paper: B-BTY-606
IMMUNOLOGY-PRACTICALS

Credits: 2
Max. Marks: 50
External Marks: 40
Internal Assessment: 10
Time allowed: 3 h (one session)

Learning outcomes: After successful completion of course, students will be able to

606.1 Exhibit skills to isolate lymphocytes from blood/spleen and to perform various immunoassays such as Ouchterlony double immunodiffusion (DID), Western Blotting , ELISA for diagnosis of various diseases.
606.2 perform techniques to purify immunoglobulins and the blood typing.

Approaches to teaching
Instructions, Chalk and board teaching, demonstrations, models, practical and practice
Requirements
Regular attendance and active participation during the course; reference material; laboratory equipments, glassware and chemicals
Evaluation
The performance of the students will be evaluated against expected learning course outcomes on the basis of class participation, regularity, performance in lab practicals, records and viva voce.

Practicals:
1. Isolation of lymphocytes from blood / spleen.
2. Ouchterlony double immunodiffusion (DID)
3. Partial purification of immunoglobulins
4. Demonstration of Western Blotting
5. Assays based on agglutination reactions - Blood typing
6. Enzyme linked immunosorbent assay (ELISA)

Suggested Reading

1. Abbas AK, Lichtman AH, Pillai S. (2007). Cellular and Molecular Immunology. 6th edition
Saunders Publication, Philadelphia.
2. Delves P, Martin S, Burton D, Roitt IM. (2006). Roitt's Essential Immunology.11th edition
Wiley- Blackwell Scientific Publication, Oxford.
3. Goldsby RA, Kindt TJ, Osborne BA. (2007). Kuby's Immunology.6th edition W.H. Freeman and Company, New York.

4. Murphy K, Travers P, Walport M. (2008). Janeway'sImmunobiology. 7th edition Garland
Science Publishers, New York.
5. Peakman M, and Vergani D. (2009).Basic and Clinical Immunology. 2nd edition Churchill
Livingstone Publishers, Edinberg.
6. Richard C and Geiffrey S. (2009). Immunology.6th edition.Wiley Blackwell
Publication.

Programme Outcomes for UG courses of Faculty of Life Sciences

1. To developskills in graduate studentsto be able to acquiretheoretical and practical knowledge in fundamentals of biology in respective disciplines of plants, animals, microbes and environment.
2. To inculcate ability to critically evaluate problems and apply lateral thinking and analytical skills for professional development.
3. To create awareness on ethical issues and adoption of good laboratory practices and biosafety.
4. To develop ability in youth for understanding basic scientific learning and effective communication skills.
5. To prepare youth for career in teaching, industry, government organizations and self reliant entrepreneurship.
6. To make students aware of natural resources and environment and its sustainable utilization.
7. To provide learning experience in students that instills deep interest in biological science for the benefit of society.

Programme specific Outcomes for UG courses in Biotechnology

After the successful completion of the programme the student will be able to

PSO1 : demonstrate the knowledge and understanding of biological sciences **i.e. structure and function of biological molecules, biological mechanisms, such as the processes and control of bioenergetics and metabolism, as chemical reactions** with engineering technologies to manipulate living organisms and biological systems to produce products that advance healthcare, medicine, agriculture, food, pharmaceuticals and environment control

PSO2 critically think and correlate the biological knowledge of distribution, morphology and physiology of organisms (animals, plants and microorganisms) to techniques in aseptic procedures, isolation, identification, characterization and modifications **to improve quality of life in person as well as community.**

PSO3 demonstrate an understanding of the principles of bio- techniques, and exhibit basic professional skills pertaining to biotechnology, carry out laboratory-orientated numerical calculations and analyse biological data (e.g. in enzyme kinetics, molecular structure analysis, microbiological techniques, immunological inferences)

PSO4 scientific writing and authentic reporting, effective presentation skills and **ability to work in a group with cooperation**

CORE COURSE- **BIOTECHNOLOGY-1 (BASICS OF BIOTECHNOLOGY)**	
CO#	After the successful completion of the course the student will be able to
101.1	Demonstrate the knowledge of the concept and applications of biotechnology in animals and plants
101.2	Give an insight of scope and applications of biotechnology in agriculture, environment, food and chemical industries
102.1	Classify, define, draw structures and explain various properties of carbohydrates and various types of lipids: correlate them to their functions.
102.2	Classify, draw structures of standard amino acids, explain chemical and physical properties of amino acids; Describe different classes of proteins and nucleic acids; explain different levels of their structural organization
103.1	Prepare various types of solutions used in qualitative and quantitative biochemical estimations; verify and apply the basic principles of spectroscopy
103.2	Analyse the unknown samples qualitatively for the presence of various biomolecules

CORE COURSE- **BASICS OF BIOTECHNOLOGY**											
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO 4**
101.1	3	3	3	3	3	3	3	3	3	2	3
101.2	3	3	3	3	3	3	3	3	3	2	3
102.1	3	3	2	3	3	3	3	3	3	2	3
102.2	3	3	2	3	3	3	3	3	3	2	3
103.1	3	3	3	3	3	2	2		3	3	3
103.2	3	3	3	3	3	3	2	3	3	3	3
Average	3	3	2.66	3	3	2.82	2.66	2.5	3	2.33	3

CORE COURSE- **BIOTECHNOLOGY-2 (ENZYMES& METABOLISM)**	
CO#	After the successful completion of the course the student will be able to
201.1	Define various characteristics of enzymes, classify them, elaborate the role of cofactors in enzyme catalysis and describe various approaches for purification of enzymes
201.2	Exhibit the knowledge of enzyme kinetics of unisubstrate reactions, various kinetics parameters (Km, Vmax etc.), different types of enzyme inhibitions; analyse the industrial importance of enzymes and the techniques to use them
202.1	describe the metabolic pathways *i.e.* glycolysis (catabolism), gluconeogensis (anabolism), and TCA cycle, their regulations;the reactions and regulation of lipid catabolism by beta, oxidative pathways.
202.2	analyse how amino acid catabolism leads to formation of diverse type molecules including ketone bodies, glucose, urea: discuss the catabolism and anabolismof nucleic acids
203.1	Exhibit skills in extraction and quantitatively estimating the enzyme activity, Km, Vmax and protein content of the samples
203.2	Isolate and characterize carbohydrates, lipids and proteins from the natural sources

CORE COURSE- ENZYMES& METABOLISM											
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
201.1	3	3	3	3	3	3	3	3	3	3	3
201.2	3	3	3	3	3	3	3	3	3	3	3
202.1	3	3	3	3	3	3	3	3	3	2	3
202.2	3	3	3	3	3	3	3	3	3	2	3
203.1	3	3	3	3	3	2	2	3	3	3	3
203.2	3	3	3	3	3	3	2	3	3	3	3
Average	3	3	3	3	3	2.82	2.66	3	3	2.66	3

CORE COURSE- **BIOTECHNOLOGY-3 (MICROBIOLOGY)**	
CO#	After the successful completion of the course the student will be able to
301.1	Illustrate the knowledge of history, scope, classification, various approaches of study and microbial diversity
301.2	Give an account of microbial growth, reproduction, metabolism and methods to control them :Identify the microorganisms in water and food
302.1	Illustrate the knowledge of normal microflora and infections in human body.
302.2	Give an account of pathogenesis by various microorganisms
303.1	Exhibit skills in preparation of media and staining
303.2	Isolate, identify and characterize bacteria from different sources

CORE COURSE- **MICROBIOLOGY**											
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
301.1	3	3	3	3	3	3	3	3	3	3	3
301.2	3	3	3	3	3	3	3	3	3	3	3
302.1	3	3	3	3	3	3	3	3	3	2	3
302.2	3	3	3	3	3	3	3	3	3	2	3
303.1	3	3	3	3	3	2	2	3	3	3	3
303.2	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	3	3	3	2.82	2.82	3	3	2.66	3

CORE COURSE- **BIOTECHNOLOGY-4 (MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY)**	
CO#	After the successful completion of the course the student will be able to
401.1	Elaborate the central dogma of life, the general principles of gene organization and describe the structure and functions of proteins involved in replication and repair mechanisms
401.2	Give an insight of the process of gene expression, mechanism of transcription, post-transcriptional processing of RNA in prokaryotes; Describe and correlate the concept of genetic code and mechanism of translation in prokaryotes
402.1	give insight of the principles and applications of the molecular tools used in recombinant DNA technology
402.2	elaborate the process and applications of genetic engineering in animals
403.1	isolate DNA from plants and bacteria, plasmid DNA.
403.2	demonstrate the making and transforming competent cells

CORE COURSE- **MOLECULAR BIOLOGY AND RECOMBINANT DNA TECHNOLOGY**											
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
401.1	3	3	2	3	3	3	2	3	2	3	3
401.2	3	3	2	3	3	3	2	3	2	3	3
402.1	3	3	3	3	3	3	3	3	3	3	3
402.2	3	3	3	3	3	3	3	3	3	3	3
403.1	3	3	3	3	3	2	2	3	3	3	3
403.2	3	3	3	3	3	3	3	3	3	3	3
Average	3	3	2.66	3	3	2.82	2.5	3	2.66	3	3

DISCIPLINE SPECIFIC COURSE- ANIMAL BIOTECHNOLOGY	
CO#	After the successful completion of the course the student will be able to
501.1	exhibit the knowledge of the basic concepts of animal biotechnology; animal cell and tissue culture technology, principles and applications
501.2	Illustrate the applications of stem cell technology and Cellular reprogramming in animal science
502.1	Describe the Techniques of transfection and applications in production of vaccines and gene therapy
502.2	Elaborate the techniques and applications of invitro fertilization and transgenic animals
503.1	prepare different media, culture and cryopreserve the animal cells
503.2	Isolate and quantify DNA from animal cells/ tissue

DISCIPLINE SPECIFIC COURSE- ANIMAL BIOTECHNOLOGY											
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO 3**	**PSO4**
501.1	3	3	3	3	3	3	3	3	3	3	3
501.2	3	3	3	3	3	3	3	3	3	3	3
502.1	3	3	3	3	3	3	3	3	3	3	3
502.2	3	3	3	3	3	3	3	3	3	3	3
503.1	3	3	3	3	3	2	3	3	3	3	3
503.2	3	3	3	3	3	2	2	3	3	3	3
Average	3	3	3	3	3	2.83	2.83	3	3	3	3

DISCIPLINE SPECIFIC COURSE- **MEDICAL BIOTECHNOLOGY**	
CO#	After the successful completion of the course the student will be able to
504.1	Correlate abnormalities in chromosomal structure, number, stability to the related diseases
504.2	Give insight of techniques helpful diagnosis and prognosis of diseases.
505.1	Correlate various deficiency diseases and mechanisms involved in their treatment.
505.2	discuss the application of vaccines as a tool to prevent these diseases
506.1	Perform various tests to identify infectious diseases.
506.2	Isolate DNA from blood sample and demonstrate qualitative analysis of DNA damage

DISCIPLINE SPECIFIC COURSE- **MEDICAL BIOTECHNOLOGY**											
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
504.1	3	3	3	3	3	2	3	3	2	2	3
504.2	3	3	3	3	3	2	3	3	3	3	3
505.1	3	3	3	3	3	2	3	3	3	2	3
505.2	3	3	3	3	3	3	3	3	3	3	3
506.1	3	3	3	3	3	3	3	3	3	3	3
506.2	3	3	3	3	3	2	3	3	3	3	3
Average	3	3	3	3	3	2.33	3	3	2.83	2.66	3

DISCIPLINE SPECIFIC COURSE- **PLANT BIOTECHNOLOGY**	
CO#	After the successful completion of the course the student will be able to
601.1	Elaborate the basic concept of plant tissue culture, different aseptic conditions, culture media and their supplements.
601.2	Describe different types of plant culture (tissue, organ and protoplast) and various techniques such as micropropagation, totipotency, somaclonal variation, their applications and limitations.
602.1	exhibit the knowledge of organization plant genome, different genetic transformation techniques with their merits and limitations. All types of characterization of transformants with different markers
602.2	apply the principles and techniques of genetic engineering in improving quality of plants/ food
603.1	culture plant tissues by various techniques
603.2	prepare the extract and analyse for antibiotic activity

DISCIPLINE SPECIFIC COURSE- **PLANT BIOTECHNOLOGY**											
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
601.1	3	3	3	3	3	2	3	3	3	3	3
601.2	3	3	3	3	3	2	3	3	3	3	3
602.1	3	3	3	3	3	2	3	3	3	3	3
602.2	3	3	3	3	3	3	3	3	3	3	3
603.1	3	3	3	3	3	3	3	3	3	3	3
603.2	3	3	3	3	3	2	3	3	3	3	3
Average	3	3	3	3	3	2.33	3	3	3	3	3

DISCIPLINE SPECIFIC COURSE- **IMMUNOLOGY**	
CO#	After the successful completion of the course the student will be able to
604.1	Exhibit the knowledge of basic components, organs, cells of immune system, components of immunity and will understand the coordination between humoral, cell-mediated and innate immune responses in combating pathogens
604.2	Illustrate the attributes of antigens, immunogens, factors affecting immunogenicity; the structure and functions of different types of immunoglobulins
605.1	Understand the basis and applications of antigen antibody interactions disease diagnosis and exhibit the knowledge of different modes of complement activation, types of MHCs and their role in antigen presentation and processing
605.2	Illustrate structures and functions of various components of cell mediated immune response; the principles of tolerance, autoimmunity anddifferent types of hypersensitivity
606.1	Exhibit skills to isolate lymphocytes from blood/spleen and to perform various immunoassays such as Ouchterlony double immunodiffusion (DID), Western Blotting , ELISA for diagnosis of various diseases. .
606..2	Perform techniques to purify immunoglobulins and the blood typing

DISCIPLINE SPECIFIC COURSE- **IMMUNOLOGY**											
CO#	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PSO1**	**PSO2**	**PSO3**	**PSO4**
604.1	3	3	2	3	3	2	3	3	2	3	3
604.2	3	3	2	3	3	2	3	3	2	3	3
605.1	3	3	2	3	3	2	3	3	2	3	3
605.2	3	3	2	3	3	2	3	3	2	3	3
606.1	3	3	3	3	3	2	3	3	3	3	3
606..2	3	3	3	3	3	2	3	3	3	3	3
Average	3	3	3	3	3	2	3	3	2.33	3	3