University of Rajasthan

Jaipur

SYLLABUS

(UG0804 – Three/Four Year Bachelor of Science)

(Bio-Technology)

Semester III-IV
Session 2024-25

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(From the Academic Year 2024-25 onwards)

(Syllabus as per NEP-2020 and Choice Based Credit System)

Vision:

To create potential and competent professionals in Biotechnology through career-oriented courses with practical training and advanced technical skills; equipped with societal and environmental responsibility.

Mission:

- Dissemination of global demand-based knowledge through teaching with technical professionalism.
- Creation of individuals with social and environmental concern.
- Training the students to create economically and environmentally viable solutions.

Programme Outcomes

PO1. Developing the potential for vertical career growth in biotech-industries, service sectors and related fields.
PO2. Development of in-depth analytical and critical thinking, so that students would be able to identify and solve the problems related to Bio-technology field.
PO3. Proficient knowledge in the major domains of biotechnology including plant Biotechnology, Industrial Biotechnology, Bioprocess technology, Animal biotechnology etc.
PO4. Students can successfully learn tools and techniques related to biotechnology.
PO5. Development of Analysis and solving problems related to biology with the help of modern technology.
PO6. After completion of course students would be able to execute their professional roles in society as biotechnology professionals in pharma, medical, industry, academia etc.
PO7. Students will be able to learn skills to work as a team with the people from multidisciplinary environment.
PO8. To design and develop sustainable solutions to major biological problems by applying appropriate biotechnology tools.
PO9. Develop skills, attitude and values required for self-directed, lifelong learning and professional development.
PO10. Acquire knowledge and understanding of norms and ethics in the field of biotechnology.

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Name of University	**University of Rajasthan, Jaipur**
Name of Faculty	**Science**
Name of Subject	**Bio-Technology**
Type of Discipline	**Major**
List of Programme where offered as Minor Discipline	**----------**
Offered to Non-Collegiate Students	**No**

SEMESTER-WISE PAPER TITLES WITH DETAILS

UG0804 – Three/Four Year Bachelor of Science (Bio-Technology)								
				Bio-Technology (I --VI SEM)	**Credits**			
#	**Level**	**Semester**	**Type**	**Title**	**L**	**T**	**P**	**Total**
1.	5	I	MJR	**UG0804 - BTH-51T-151 CELL BIOLOGY AND GENETICS**	4	0	0	4
2.	5	I	MJR	**UG0804 - BTH-51P-152 CELL BIOLOGY AND GENETICS-PRACTICAL**	0	0	2	2
3.	5	I	MJR	**UG0804 - BTH-51T-153 MICROBIOLOGY**	4	0	0	4
4.	5	I	MJR	**UG0804 - BTH-51P-154 MICROBIOLOGY-PRACTICAL**	0	0	2	2
5.	5	I	MJR	**UG0804- BTH-51T-155 BIOPROCESS TECHNOLOGY**	4	0	0	4
6.	5	I	MJR	**UG0804- BTH-51P-156 BIOPROCESS TECHNOLOGY-PRACTICAL**	0	0	2	2
7.	5	II	MJR	**UG0804 -BTH-52T-251 MOLECULAR BIOLOGY**	4	0	0	4
8.	5	II	MJR	**UG0804 BTH-52P-252 MOLECULAR BIOLOGY - PRACTICAL**	0	0	2	2
9.	5	II	MJR	**UG0804 BTH- 52T-253 BIOINFORMATICS AND**	4	0	0	4

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UG0804 – Three/Four Year Bachelor of Science (Bio-Technology)								
				Bio-Technology (I --VI SEM)	Credits			
#	Level	Semester	Type	Title	L	T	P	Total
				BIOSTATISTICS				
10.	5	II	MJR	**UG0804 -BTH-52P-254 BIOINFORMATICS AND BIOSTATISTICS-PRACTICAL**	0	0	2	2
11.	5	II	MJR	**UG0804 -BTH- 52T-255 INSTRUMENTATION AND BIOTECHNIQUES**	4	0	0	4
12.	5	II	MJR	**UG0804 -BTH-52P-256 INSTRUMENTATION AND BIOTECHNIQUES-PRACTICAL**	0	0	2	2
13.	6	III	MJR	**UG0804 – BTH- 63T-351 PLANT BIOCHEMISTRY**	4	0	0	4
14.	6	III	MJR	**UG0804 – BTH-63P-352 PLANT BIOCHEMISTRY -PRACTICAL**	0	0	2	2
15.	6	III	MJR	**UG0804 -BTH-63T-353 ANIMAL BIOCHEMISTRY**	4	0	0	4
16.	6	III	MJR	**UG0804 -BTH- 63P-354 ANIMAL BIOCHEMISTRY -PRACTICAL**	0	0	2	2
17.	6	III	MJR	**UG0804 -BTH- 63T-355 IMMUNOLOGY**	4	0	0	4
18.	6	III	MJR	**UG0804 -BTH- 63P-356 IMMUNOLOGY-PRACTICAL**	0	0	2	2
19.	6	IV	MJR	**UG0804 -BTH-64T-451 PLANT PHYSIOLOGY**	4	0	0	4
20.	6	IV	MJR	**UG0804 -BTH-64P-452 PLANT PHYSIOLOGY-PRACTICAL**	0	0	2	2
21.	6	IV	MJR	**UG0804 -BTH-64T-453 ANIMAL PHYSIOLOGY**	4	0	0	4
22.	6	IV	MJR	**UG0804 -BTH-64P-454 ANIMAL PHYSIOLOGY -PRACTICAL**	0	0	2	2
23.	6	IV	MJR	**UG0804 -BTH-64T-455 MOLECULAR GENETICS**	4	0	0	4
24.	6	IV	MJR	**UG0804 -BTH-64P-456 MOLECULAR GENETICS -PRACTICAL**	0	0	2	2

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Examination Scheme

1. 1 credit = 25 marks for examination/evaluation
2. For Regular Students there will be Continuous assessment, in which sessional work and the terminal examination will contribute to the final grade. Each course in Semester Grade Point Average (SGPA) has two components- Continuous assessment (20% weightage) and (End of end-semester examination) EoSE (80% weightage).
3. For Regular Students,75% Attendance is mandatory for appearing in the EoSE.
4. To appear in the EoSE examination of a course/subject a regular student must appear in the mid-semester examination and obtain at least a C grade in the course/subject.
5. Credit points in a Course/Subject will be assigned only if, the regular student obtains at least a C grade in the CA and EoSE examination of a Course/Subject.
6. In the case of Non-Collegiate Students there will be no Continuous assessment and credit points in a course/subject will be assigned only if, the non-collegiate student obtains at least a C grade in the EoSE examination of a Course/Subject.

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Examination Scheme for Continuous Assessment (CA)

DISTRIBUTION OF CONTINUOUS ASSESSMENT (CA) MARKS

S. No.	CATEGORY	Weightage (out of total internal marks)		THEORY					PRACTICAL		
				CORE (Only Theory)	CORE (Theory + Practical)	AEC	SEC	VAC	CORE (Theory +Practical)	SEC	VAC
	Max Internal Marks			30	20	20	10	10	10	10	10
1.	Mid-term Exam	*50%*		15	10	10	5	5	5	5	5
2.	Assignment	*25%*		7.5	5	5	2.5	2.5	2.5	2.5	2.5
3.	Attendance	*25%*		7.5	5	5	2.5	2.5	2.5	2.5	2.5
		Regular Class Attendance	= 75%	3	2	2	1	1	1	1	1
			75-80%	4	3	3	1.5	1.5	1.5	1.5	1.5
			80-85%	5	4	4	2	2	2	2	2
			> 85%	7.5	5	5	2.5	2.5	2.5	2.5	2.5

Note:

1. Continuous assessment will be the sole responsibility of the teacher concerned.
2. For continuous assessment no remuneration will be paid for paper setting, Evaluation, Invigilation etc.
3. For continuous assessment Paper setting and Evaluation responsibility will be of teacher concern.
4. For continuous assessment no Answer sheets/question papers etc. will be provided by the University.
5. Colleges are advised to keep records of continuous assessment, attendance etc.

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Examination Scheme for EoSE for Semester-III

CA – Continuous Assessment EoSE – End of Semester Examination

Regular Students –

Type of Examination	Course Code and Nomenclature	Duration of Examination		Maximum Marks		Minimum Marks	
Theory	BTH- 63T-351 PLANT BIOCHEMISTRY	CA	01 Hr	CA	20 Marks	CA	08 Marks
		EoSE	03 Hrs	EoSE	80 Marks	EoSE	32 Marks
Practical	BTH-63P-352 PLANT BIOCHEMISTRY-PRACTICAL	CA	1 Hr	CA	10 Marks	CA	04 Marks
		EoSE	04 Hrs	EoSE	40 Marks	EoSE	16 Marks
Theory	BTH-63T-353 ANIMAL BIOCHEMISTRY	CA	01 Hr	CA	20 Marks	CA	08 Marks
		EoSE	03 Hrs	EoSE	80 Marks	EoSE	32 Marks
Practical	BTH-63P-354 ANIMAL BIOCHEMISTRY-PRACTICAL	CA	1 Hr	CA	10 Marks	CA	04 Marks
		EoSE	04 Hrs	EoSE	40 Marks	EoSE	16 Marks
Theory	BTH-63T-355 IMMUNOLOGY	CA	01 Hr	CA	20 Marks	CA	08 Marks
		EoSE	03 Hrs	EoSE	80 Marks	EoSE	32 Marks
Practical	BTH- 63P-356 IMMUNOLOGY -PRACTICAL	CA	1 Hr	CA	10 Marks	CA	04 Marks
		EoSE	04 Hrs	EoSE	40 Marks	EoSE	16 Marks

The theory question paper will consist of **two** parts **A** & **B**.

PART-A: 20 Marks

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Part A will be compulsory having 10 very short answer-type questions (with a limit of 20 words) of two marks each.

PART-B: 60 Marks

Part B of the question paper shall be divided into four units comprising question numbers 2-5. There will be one question from each unit with internal choice. Each question will carry 15 marks.

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				Bio-Technology 2nd YEAR SEM- III	Credits			
#	Level	Semester	Type	Title	L	T	P	Total
1.	6	III	MJR	UG0804 – BTH- 63T-351 PLANT BIOCHEMISTRY	4	0	0	4
2.	6	III	MJR	UG0804 – BTH-63P-352 PLANT BIOCHEMISTRY - PRACTICAL	0	0	2	2
3.	6	III	MJR	UG0804 -BTH-63T-353 ANIMAL BIOCHEMISTRY	4	0	0	4
4.	6	III	MJR	UG0804 -BTH- 63P-354 ANIMAL BIOCHEMISTRY -PRACTICAL	0	0	2	2
5.	6	III	MJR	UG0804 -BTH- 63T-355 IMMUNOLOGY	4	0	0	4
6.	6	III	MJR	UG0804 -BTH- 63P-356 IMMUNOLOGY-PRACTICAL	0	0	2	2

BTH- 63T-351 PLANT BIOCHEMISTRY

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
III	BTH- 63T-351	PLANT BIOCHEMISTRY				6	4
Level of Course	Type of the Course	Credit Distribution			Offered to NC Student	Course Delivery Method	
		Theory	Practical	Total			
Intermediate	Major	4	2	6	NO	60 lectures with diagrammatic and informative	

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						assessments during lecture hours
List of Programme Codes in which Offered as Minor Discipline		**----------**				
Prerequisites		Basic Knowledge of Introductory/Foundation level				
Objectives of the Course		➢ This module is a general introduction to Photosynthesis, Nitrogen metabolism, plant diseases and plant hormones.				

Course Outcomes:

At the completion of the course, the student would be able to:

Cognitive level	Course outcomes
1. Understanding	➢ The biochemical processes and metabolic pathways, including photosynthesis, photorespiration in plants. ➢ The physiological and biochemical reaction involved in cell wall biosynthesis, nitrogen fixation and assimilation. Illustrate.
2. Memorizing	➢ The biosynthesis, regulation, physiological and biochemical action of plant hormones
3. Applying	➢ The synthesis, physiological and biochemical actions of plant secondary metabolism.

Detailed Syllabus

BTH- 63T-351 PLANT BIOCHEMISTRY

UNIT-I

Photosynthesis: Significance of photosynthesis, Ultrastructure of chloroplast, photosynthesis, Photosynthetic pigments. Light absorption phenomenon, Photosynthesis in C3 and electron transport, Photophosphorylation: Photorespiration, CAM.

Nitrogen metabolism: Metabolism of N- compound in plants, biological nitrogen cycle, nitrogenase structure and function, nitrate reduction, nitrification denitrification, symbiotic and non-symbiotic nitrogen fixation, Nif-gene- organization, function and regulation, Assimilation of fixed nitrogen by plants.

15 Lectures

UNIT-II

Plant hormones: Definition of phytohormones, Auxins, biochemistry and mode of action of auxin,

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Gibberellin, Cytokinin and other natural growth hormones in plants (ethylene, abscisic acid). Plant stress, Plant responses to abiotic and biotic stresses, Water deficit and drought resistance, Flooding, Temperature stress, Salt stress, Ion toxicity, Pollution stress and potential biotic stress (insects and diseases).

15 Lectures

UNIT-III

Respiration: Overview of glycolysis, Alternative reactions of glycolysis, Regulation of plant glycolysis, Translocation of metabolites across mitochondrial membrane, TCA cycle, electron transport chain, Alternative NAD(P)H oxidative pathways; Cyanide resistant respiration. **15 Lectures**

UNIT-IV

Secondary metabolism in plants: Phenolic metabolism shikimate and phenyl propanoid pathways, flavonoids, lignins, and anthocyanins. Isoprenoid metabolism, terpenoids and carotenoids, alkaloids, cyanogenic glycosides and non-protein amino acids. Micro and Macro nutrient deficiency in plants (biochemical role of inorganic ions in plants) **15 Lectures**

BTH-63P-352 PLANT BIOCHEMISTRY-PRACTICAL

1. Photosynthesis related experiments.
2. Chlorophyll estimation by colorimeter.
3. Induction and estimation of hydrolytic enzymes proteinase/amylase /lipase during germination.
4. Vitamin C (Ascorbic Acid) estimation by titration method.
5. Estimation of carotene/ascorbic acid/phenols/tannins in fruits and vegetables.
6. Extraction and assay of urease from Jack bean.

Suggested readings:

1. **Plant Biochemistry**: Hans-Walter Heldt & Heldt, 4th Ed. 2010.
2. **Biochemistry & Molecular Biology of Plant**: Bob B. Buchanan, Wilhelm Gruissem, Russell L. Jones, 2nd Ed. 2015.
3. **Plant Biochemistry**: Dey P. M. Harbone J. B., 1st Ed. 1997.
4. **Advances In Plant Biochemistry**: K.N. P. Singh, Agrotech Press, 2014.
5. **Cell Biology**: Powar C.B., Himalaya Publishing House Mum, 2015.

Course Learning Outcomes:

At the completion of the course, the student would be able to:

1. Understand the significance of photosynthesis, chloroplast structure, photosynthetic pigments, and processes like light absorption, electron transport, photophosphorylation, photorespiration, and CAM pathways.
2. Learn nitrogen metabolism, including the nitrogen cycle, nitrogenase structure, nitrate reduction, nitrification, denitrification, and nitrogen fixation (symbiotic and non-symbiotic), and the assimilation of fixed nitrogen.
3. Comprehend plant hormones such as auxin, gibberellin, cytokinin, ethylene, and abscisic acid, their actions, and their roles in growth and stress responses (abiotic and biotic).

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4. Gain knowledge of plant respiration, covering glycolysis, its alternative reactions, regulation, metabolite translocation, the TCA cycle, electron transport, and cyanide-resistant respiration.
5. Explore secondary metabolism, including phenolic pathways, flavonoids, lignins, anthocyanins, isoprenoids, terpenoids, carotenoids, alkaloids, and cyanogenic glycosides.
6. Recognize nutrient deficiencies in plants and understand the biochemical roles of inorganic ions.

BTH-63T-353 ANIMAL BIOCHEMISTRY

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
III	BTH-63T-353	ANIMAL BIOCHEMISTRY				6	4
Level of Course	Type of the Course	Credit Distribution			Offered to NC Student	Course Delivery Method	
		Theory	Practical	Total			
Intermediate	Major	4	2	6	NO	60 lectures with diagrammatic and informative assessments during lecture hours	
List of Programme Codes in which Offered as Minor Discipline	----------						
Prerequisites	Basic Knowledge of Introductory/Foundation level						
Objectives of the Course	➢ To learn the methodologies for the detection of abnormalities in blood. ➢ To learn the process of different sample collection and processing. ➢ To know about the markers in the various metabolic disorders.						

Course Outcomes:

At the completion of the course, the student would be able to:

Cognitive level	Course outcomes
1. Understanding	➢ The students will be knowing the important biochemical tests ➢ The students will be introduced to methods of processing and analyzing the

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	results.
2. Memorizing	➢ The students will be learning the role of nutrients.
3. Applying	➢ The students will be knowing the procedures and collection and processing of samples.

Detailed Syllabus

BTH-63T-353 ANIMAL BIOCHEMISTRY

UNIT-I

Scope and importance of biochemistry. Buffer system and pH. Dissociation of and Handerson – Hasselbalch equation Structure of cell membranes and transport across cell membranes. Donnan membrane equilibrium Biochemistry of carbohydrates: Biological significance (structure and properties) of: Monosaccharides, Disaccharides, Polysaccharides, Mucopolysaccharides.

Metabolism of Carbohydrates: Sequential Reactions and regulation of: Glycolysis, Citric acid cycle and Gluconeogenesis; Phosphate pentose pathway, Glycogenolysis and Glycogenesis; Compartmentalization, Shuttle systems and membrane transporters; Oxidative phosphorylation (Redox system and coupler reaction), Inhibitors and un-couplers of ETC. **15 Lectures**

UNIT-II

Biochemistry of lipids: Properties (structure) and biological significance of simple, compound and derived lipids and lipoproteins Structure and functions of prostaglandins. Chemistry of bile and bile salts; Biochemistry of Lipid: β-oxidation and omega-oxidation of saturated fatty acids (with even and odd number of carbon atoms); Biosynthesis Palmitic acid; Ketogenesis Metabolism of unsaturated fatty acids.

15 Lectures

UNIT-III

Amino acids: Classification and structure of neutral basic and acidic amino acids

Properties of amino acids: amphoteric nature, optical activity and peptide bond formation Structure properties, biological significance and chemical reactions of proteins Degradation of protein: deamination, transamination & decarboxylation of amino acids; Ammonia transport and urea cycle. Protein-protein interactions; Fate of C-skeleton (Glucogenic and Ketogenic amino acids). **15 Lectures**

UNIT-IV

Biochemistry of nucleic acids: Chemistry of purines and pyrimidines, nucleosides and nucleotides. Biological significance of nucleosides and nucleotides.

Structures and functions of deoxyribonucleic acid (DNA) and a typical ribonucleic acid DNA & RNA biosynthesis Integration of metabolism Metabolic functions of macro nutrients Metabolic functions of micro nutrients Metabolic functions of lipid soluble vitamins Metabolic functions of Vitamin A & E.

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Metabolic functions of Vitamin D & K Vitamin C, Thiamine, Riboflavin, Niacin & Pyridoxine, Pantothenic acid, Folic acid & Cyanocobalamin. Use of isotope in metabolic studies. **15 Lectures**

BTH- 63P-354 ANIMAL BIOCHEMISTRY-PRACTICAL

1. Qualitative and quantitative estimation of Carbohydrates
2. Qualitative and quantitative estimation of Proteins
3. Qualitative and quantitative estimation of Lipids
4. Qualitative and quantitative estimation of Nucleic acid
5. Buffer system and pH
6. Handerson and Hasselbalch equation
7. Titration curve of amino acids
8. Plotting a standard curve using UV-Vis Spectrophotometer and validating the Beer Lambert Law by making BSA protein standard graph by Lowry method

Suggested readings:

1. **Harper's Illustrated Biochemistry,** Robert K Murray et al. (McGraw-Hill Education, 31st Edition)
2. **Principles of Biochemistry,** Voet & Voet (Wiley, 5th Edition)
3. **Principle of Biochemistry,** David L Nelson, Michael M Cox (W.H. Freeman, 8th Edition)
4. **Biochemistry & Molecular Biology of Plants,** Buchanan et al. (American Society of Plant Biologists, 2nd Edition)
5. **Lippincott's Illustrated Reviews- Biochemistry,** Richard Harvey, Denis Ferrier (Lippincott Williams & Wilkins, 7th Edition)
6. **Biochemistry,** Campbell, Farrell (Cengage Learning, 9th Edition)
7. **Biomolecules – Chemistry of Living Systems,** V.K. Ahluwalia (Manakin Press, 2015)
8. **Biochemistry for Medical Students,** Rafi (Orient Blackswan Private Limited - New Delhi, 2014, 2nd Edition)
9. **Textbook of Biochemistry,** S P Singh (CBS publishers and distributors, 2020, 7th Edition)
10. **Biochemistry,** U Satyanarayan (Elsevier, 5th Edition)
11. **Fundamentals of Biochemistry,** J L Jain (S. Chand Publishing, 2004, 7th Edition)
12. **Textbook of Biochemistry for Nurses, Ashok Kumar J** (I. K. International Pvt Ltd)

Course Learning Outcomes:

At the completion of the course, the student would be able to:

1. Understand the scope and importance of biochemistry, buffer systems, pH, cell membrane structure, and transport mechanisms.
2. Gain knowledge of carbohydrate biochemistry, including the structure and metabolism of monosaccharides, disaccharides, polysaccharides, and mucopolysaccharides.
3. Comprehend the biochemistry of lipids, including the structure and significance of simple, compound, and derived lipids, as well as lipid metabolism processes like β-oxidation, omega-oxidation, biosynthesis, and ketogenesis.
4. Learn about amino acids and proteins, their classification, structure, properties, and metabolism,

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including deamination, transamination, and the urea cycle.

5. Understand nucleic acid biochemistry, including the chemistry and biological significance of purines, pyrimidines, nucleosides, and nucleotides, as well as the structure and function of DNA and RNA.
6. Explore the metabolic functions of macronutrients, micronutrients, and various vitamins, and understand the use of isotopes in metabolic studies.

BTH- 63T-355 IMMUNOLOGY

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
III	BTH- 63T-355	IMMUNOLOGY				6	4
Level of Course	Type of the Course	Credit Distribution			Offered to NC Student	Course Delivery Method	
		Theory	Practical	Total			
Intermediate	Major	4	2	6	NO	60 lectures with diagrammatic and informative assessments during lecture hours	
List of Programme Codes in which Offered as Minor Discipline		----------					
Prerequisites		Basic Knowledge of Introductory/Foundation level					
Objectives of the Course		➢ To articulate the role of various cells and organs involved in immune responses and associated functions ➢ To gain knowledge on the interaction between the immune system and pathogens ➢ To develop the ability to identify issues in clinical immunology.					

Course Outcomes:

At the completion of the course, the student would be able to:

Cognitive level	Course outcomes

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1. Understanding	➢ The basic components of immune system and their functions. ➢ Various diagnostic methods based on antigen-antibody interaction ➢
2. Memorizing	➢ Principles and methods of various cellular immune responses
3. Applying	➢ Find effective solutions for the treatment of immune disorders and problem associated.

Detailed Syllabus

BTH- 63T-355 IMMUNOLOGY

UNIT-I

Historical Background-Humoral and Cellular Components of The Immune System, Innate Immunity-Skin And Mucosal Surface, Physiological Barrier, Phagocytic Barrier, Inflammation, Adaptive Immunity, Cells And Organs Of Immune System. **15 Lectures**

UNIT-II

Antigens And Antibody-Structure, Properties, Type, Epitopes, Haptens, Antibodies-Structure, Function, Antibody Mediated Functions, Antibody Classes & Biological Activities, Monoclonal Antibodies.
Antigen-Antibody Interaction: Precipitation, Agglutination, RIA, ELISA, Western Blotting.
15 Lectures

UNIT-III

MHC-General Structure and Function, MHC Molecules and Genes, Antigen Processing & Presentation, T Cell Receptor, T Cell Maturation And Differentiation; B Cells-Generation, Activation, Differentiation.
15 Lectures

UNIT-IV

Immune Effector Mechanisms: Cytokines- Properties, Receptors, Antagonist, Secretion; Complement System- Functions, Components, Activation, Regulation and Deficiency, Immune disorders, Cell Mediated Effector Response-Cytotoxic T Cell, Natural Killer Cells, ADCC, Inflammation. **15 Lectures**

BTH- 63P-356 IMMUNOLOGY-PRACTICAL

1. Blood Grouping
2. Differential Leukocyte Count
3. Total Leukocyte Count
4. Widal Test
5. Radial Immunodiffusion (RID)
6. Ouchterlony Double Diffusion

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7. Rocket Immuno Electrophoresis
8. Counter Current Immunoelectrophoresis
9. Enzyme Linked Immunosorbent Assay (ELISA) – DOT
10. Immunoprecipitation

Suggested readings:

1. Kuby J. "I**mmunology**", WH Freeman & Co., 5th edition, 2000.
2. M Roitt I., Male., Brostoff, "I**mmunology**", Mosby Publ., 12th edition, 2002.
3. Chakaravarthy A.K., "**Immunology and Immunotechnology**", Oxford University Press India, 1st Edition, 2006.
4. **The Elements of Immunology** -Fahim Khan.
5. **Immunology**-3rd Edition -Ivan Roitt.

Course Learning Outcomes:

At the completion of the course, the student would be able to:

1. Understand the historical background and components of the immune system, including humoral and cellular aspects, innate immunity, and adaptive immunity.
2. Learn about the structure, properties, and functions of antigens and antibodies, including different antibody classes and biological activities, and techniques for studying antigen-antibody interactions.
3. Comprehend the general structure and function of MHC molecules, antigen processing and presentation, and the maturation and differentiation of T and B cells.
4. Explore immune effector mechanisms, including cytokine properties, complement system functions, activation, and regulation, and various cell-mediated effector responses such as those by cytotoxic T cells and natural killer cells.
5. Gain insights into immune disorders and the roles of inflammation and antibody-dependent cellular cytotoxicity (ADCC) in immune responses.

Examination Scheme for EoSE for Semester-IV

CA – Continuous Assessment EoSE – End of Semester Examination

Regular Students –

Type of Examination	Course Code and Nomenclature	Duration of Examination	Maximum Marks	Minimum Marks

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Theory	**BTH-64T-451 PLANT PHYSIOLOGY**	**CA**	**01 Hr**	**CA**	**20 Marks**	**CA**	**08 Marks**
		EoSE	**03 Hrs**	**EoSE**	**80 Marks**	**EoSE**	**32 Marks**
Practical	**BTH-64P-452 PLANT PHYSIOLOGY-PRACTICAL**	**CA**	**1 Hr**	**CA**	**10 Marks**	**CA**	**04 Marks**
		EoSE	**04 Hrs**	**EoSE**	**40 Marks**	**EoSE**	**16 Marks**
Theory	**BTH-64T-453 ANIMAL PHYSIOLOGY**	**CA**	**01 Hr**	**CA**	**20 Marks**	**CA**	**08 Marks**
		EoSE	**03 Hrs**	**EoSE**	**80 Marks**	**EoSE**	**32 Marks**
Practical	**BTH-64P-454 ANIMAL PHYSIOLOGY-PRACTICAL**	**CA**	**1 Hr**	**CA**	**10 Marks**	**CA**	**04 Marks**
		EoSE	**04 Hrs**	**EoSE**	**40 Marks**	**EoSE**	**16 Marks**
Theory	**BTH-64T-455 MOLECULAR GENETICS**	**CA**	**01 Hr**	**CA**	**20 Marks**	**CA**	**08 Marks**
		EoSE	**03 Hrs**	**EoSE**	**80 Marks**	**EoSE**	**32 Marks**
Practical	**BTH-64P-456 MOLECULAR GENETICS-PRACTICAL**	**CA**	**1 Hr**	**CA**	**10 Marks**	**CA**	**04 Marks**
		EoSE	**04 Hrs**	**EoSE**	**40 Marks**	**EoSE**	**16 Marks**

The theory question paper will consist of **two** parts **A** & **B**.

PART-A: 20 Marks

Part A will be compulsory having 10 very short answer-type questions (with a limit of 20 words) of two marks each.

PART-B: 60 Marks

Part B of the question paper shall be divided into four units comprising question numbers 2-5. There will be one question from each unit with internal choice. Each question will carry 15 marks.

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UG0804 – Three/Four Year Bachelor of Science (Bio-Technology)								
				Bio-Technology 2nd YEAR SEM- IV	Credits			
#	Level	Semester	Type	Title	L	T	P	Total
1.	6	IV	MJR	UG0804 -BTH-64T-451 PLANT PHYSIOLOGY	4	0	0	4
2.	6	IV	MJR	UG0804 -BTH-64P-452 PLANT PHYSIOLOGY-PRACTICAL	0	0	2	2
3.	6	IV	MJR	UG0804 -BTH-64T-453 ANIMAL PHYSIOLOGY	4	0	0	4
4.	6	IV	MJR	UG0804 -BTH-64P-454 ANIMAL PHYSIOLOGY -PRACTICAL	0	0	2	2
5.	6	IV	MJR	UG0804 -BTH-64T-455 MOLECULAR GENETICS	4	0	0	4
6.	6	IV	MJR	UG0804 -BTH-64P-456 MOLECULAR GENETICS -PRACTICAL	0	0	2	2

BTH-64T-451 PLANT PHYSIOLOGY

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
IV	BTH-64T-451	PLANT PHYSIOLOGY				6	4
Level of Course	Type of the Course	Credit Distribution			Offered to NC Student	Course Delivery Method	
		Theory	Practical	Total			
Intermediate	Major	4	2	6	NO	60 lectures with diagrammatic and informative assessments during lecture hours	
List of Programme Codes in which Offered as Minor Discipline		----------					

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Prerequisites	Basic Knowledge of Introductory/Foundation level
Objectives of the Course	➢ This course aims to educate student about the mechanism and physiology life processes in plants. ➢ It focuses on the plant nutrient uptake and translocation, flowering and the roles of light in plant development.

Course Outcomes:

At the completion of the course, the student would be able to:

Cognitive level	Course outcomes
1. Understanding	➢ The various physiological life processes in plants. ➢ The various uptake and transport mechanisms in plants and are able to coordinate the various processes ➢ The role of various hormones, signaling compounds, thermodynamics and enzyme kinetics
2. Memorizing	➢ Principles and methods of various mechanisms in plants used for water transport ➢ How plants achieve water balance ➢ Assimilation of different mineral nutrients in plants ➢ The roles of light in plant development ➢ The plant hormones and their roles in plant development
3. Applying	➢ Find effective solutions for the treatment of mineral deficiency and problem associated.

Detailed Syllabus

BTH-64T-451 PLANT PHYSIOLOGY

UNIT-I

Plant water relationship: Water Potential and its components, water absorption by roots, aquaporins, pathway of water movement, symplast, apoplast, trans-membrane pathways, root pressure, guttation. Ascent of sap– cohesion-tension theory. Transpiration and factors affecting transpiration, anti-transpirants, mechanism of stomatal movement. Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation.

Translocation in the phloem: Experimental evidence in support of phloem as the site of sugar translocation. Pressure–Flow Model; Phloem loading and unloading; Source– sink relationship.

15 Lectures

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UNIT-II

Mineral nutrition: Essential and beneficial elements, macro and micronutrients, methods of study and use of nutrient solutions, criteria for essentiality, mineral deficiency symptoms, roles of essential elements, chelating agents.

Nutrient Uptake: Soil as a nutrient reservoir, transport of ions across cell membrane, passive absorption, electrochemical gradient, facilitated diffusion, active absorption, role of ATP, carrier systems, proton ATPase pump and ion flux, uniport, co-transport, symport, and antiport **15 Lectures**

UNIT-III

Plant growth regulators: Discovery, chemical nature (basic structure), bioassay and physiological roles of Auxin, Gibberellins, Cytokinin, Abscisic acid, Ethylene. Brassinosteroids and Jasmonic acid.

Enzymes: Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition. **15 Lectures**

UNIT-IV

Physiology of flowering: Plant response to light and temperature: Photoperiodism (SDP, LDP, Day neutral plants); flowering stimulus, florigen concept, vernalization, seed dormancy.

Phytochrome: Discovery, chemical nature, role of phytochrome in photomorphogenesis, low energy responses (LER) and high irradiance responses (HIR), mode of action-red and far red light responses on photomorphogenesis. **15 Lectures**

BTH-64P-452 PLANT PHYSIOLOGY-PRACTICAL

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Determination of water potential of given tissue (potato tuber) by weight method
3. To study the effect of two environmental factors (light and wind) on transpiration by excised twig.
4. Calculation of stomatal index and stomatal frequency
5. To study the phenomenon of seed germination (effect of light).
6. Demonstration of Hill reaction
7. To study the induction of amylase activity in germinating barley grains
8. Demonstrate the activity of catalase and study the effect of pH and enzyme concentration.
9. To study the effect of light intensity and bicarbonate concentration on O2 evolution in photosynthesis
10. Comparison of the rate of respiration in any two parts of a plant.

Suggested readings:

1. C. Sahu (2018). **Plant Physiology and Metabolism**. Kalyani Publishers, New Delhi.
2. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). **Plant Physiology and Development**. Sinauer Associates Inc. USA. 6th edition.
3. Hopkins, W.G., Huner, N.P., (2009). **Introduction to Plant Physiology**. John Wiley & Sons, U.S.A. 4th Edition.
4. Bajracharya, D., (1999). **Experiments in Plant Physiology- A Laboratory Manual.** Narosa

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Publishing House, New Delhi.
5. H. S. Srivatava. **Plant Physiology**, Rastogi Publications, New Delhi.

Course Learning Outcomes:
At the completion of the course, the student would be able to:

1. Understand plant water relationships, including water potential, absorption, movement, ascent of sap, transpiration, and factors affecting these processes.
2. Learn about translocation in the phloem, including experimental evidence, the pressure-flow model, phloem loading and unloading, and source-sink relationships.
3. Gain knowledge of mineral nutrition, essential and beneficial elements, criteria for essentiality, mineral deficiency symptoms, and roles of essential elements and chelating agents.
4. Comprehend nutrient uptake mechanisms, including ion transport across cell membranes, passive and active absorption, electrochemical gradients, and various carrier systems.
5. Explore plant growth regulators, their discovery, chemical nature, physiological roles, and the mechanisms of enzyme catalysis and inhibition.
6. Understand the physiology of flowering, plant responses to light and temperature, photoperiodism, the florigen concept, vernalization, seed dormancy, and the role of phytochrome in photomorphogenesis.

BTH-64T-453 ANIMAL PHYSIOLOGY

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
IV	BTH-64T-453	ANIMAL PHYSIOLOGY				6	4
Level of Course	Type of the Course	Credit Distribution			Offered to NC Student	Course Delivery Method	
		Theory	Practical	Total			
Intermediate	Major	4	2	6	NO	60 lectures with diagrammatic and informative assessments during lecture hours	

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List of Programme Codes in which Offered as Minor Discipline	**----------**
Prerequisites	Basic Knowledge of Introductory/Foundation level
Objectives of the Course	➢ Students gain fundamental knowledge of animal physiology. ➢ Students are taught the detailed concepts of digestion, respiration, excretion, the functioning of nerves and muscles, cardiovascular system, endocrine system and reproductive system.

Course Outcomes:

At the completion of the course, the student would be able to:

Cognitive level	Course outcomes
1. Understanding	➢ To understand the mechanisms that work to keep the animal body alive and functioning. ➢ To understand the physiological functions of various organ systems of the mammalian physiology. ➢ To understand the correlation between histology, anatomy and physiology
2. Memorizing	➢ Students learn the concepts of endocrine systems and homeostasis ➢ Comprehend the study of endocrine system their role in maintaining homeostasis of the human body ➢ The patho-physiology of common diseases related to organ systems of the body The roles of light in plant development ➢
3. Applying	➢ Perform, analyze and report on experiments and observations in physiology ➢ The final goal of the course is to empower students to use their conceptual understanding to solve problems

Detailed Syllabus

BTH-64T-453 ANIMAL PHYSIOLOGY

UNIT-I

Introduction to Physiology: Cell & General Physiology, Membrane Physiology, Nerve and Muscle; **Blood and circulation:** Blood corpuscles, haemopoiesis and formed elements, plasma function, blood volume, blood volume regulation, blood groups, haemoglobin, immunity, haemostasis, Immunity, and Blood

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Clotting. **The Heart and its Circulation**: Comparative anatomy of heart structure, myogenic heart, specialized tissue, ECG – its principle and significance, cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation. **15 Lectures**

UNIT-II

The Kidneys and Body Fluids: Comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination, micturition, regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance.

Gastrointestinal Physiology: Digestion, absorption, energy balance, BMR.

Respiration: Comparison of respiration in different species, anatomical considerations, transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration, Aviation, Space, and Deep-Sea Diving Physiology. **15 Lectures**

UNIT-III

The Nervous System: General Principles and Sensory Physiology, Neurons, action potential, gross neuroanatomy of the brain and spinal cord, central and peripheral nervous system, neural control of muscle tone and posture, Motor and Integrative Neurophysiology, the Special Senses.

Sense organs: Vision, hearing and tactile response. **15 Lectures**

UNIT-IV

Endocrinology and Reproduction: Endocrine glands, basic mechanism of hormone action, hormones and diseases; reproductive processes and organs, neuroendocrine regulation.

Metabolism and Temperature Regulation: Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization, Sports Physiology, Stress and adaptation. **15 Lectures**

BTH-64P-454 ANIMAL PHYSIOLOGY-PRACTICAL

1. Preparation of blood film and microscopic study of stained blood film for identification of cell types.
2. Determination of RBC, WBC, PCV count in given blood sample.
3. Determination of haematocrit value of given blood sample.
4. Determination of haemoglobin content by Shali's haemometer.
5. Study of permanent slides of Mammalian tissue -To study TS of Thyroid gland, Ovary, kidney, bone, squamous epithelium, liver, blood smear, pancreas, muscle, small intestine, testis, nerve cell smear, trachea, VS of eye, stomach, skin, lung, brain, spinal cord.

Suggested readings:

1. **Textbook of Medical Physiology**, A C Guyton and John E Hall, W.B. Saunders Company, ISBN: 0-7216-5944-6.
2. **Fundamentals of Anatomy and Physiology**, FH Martini, Prentice Hall, ISBN: 0-13-017292-8 3.
3. **Animal Physiology**, Prof. A. L. Bhatia &Dr. K. S. Kohli.
4. **Human Animal Physiology**, C. C. Chatterjee vol. 1&2.

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5. **Animal Physiology**, Eckert, W. H. Freeman.

Course Learning Outcomes:
At the completion of the course, the student would be able to:

1. Understand cell and membrane physiology, nerve and muscle functions, blood components, circulation, and the mechanisms of immunity and blood clotting.
2. Comprehend the anatomy and physiology of the heart, including the cardiac cycle, ECG principles, heart function, blood pressure, and its neural and chemical regulation.
3. Learn the comparative physiology of excretion, kidney function, urine formation, and regulation of water, electrolyte, and acid-base balance.
4. Gain knowledge of gastrointestinal physiology, including digestion, absorption, energy balance, and respiration across species, with a focus on gas transport, exchange, and regulation.
5. Explore the nervous system, including the principles of sensory physiology, neuroanatomy, neural control of muscle tone, posture, and motor functions, and the special senses of vision, hearing, and tactile response.
6. Understand endocrinology and reproduction, the mechanisms of hormone action, reproductive processes, and neuroendocrine regulation, along with metabolism, temperature regulation, and physiological responses to stress and sports.

BTH-64T-455 MOLECULAR GENETICS

Semester	Code of the Course	Title of the Course/Paper				NHEQF Level	Credits
IV	BTH-64T-455	MOLECULAR GENETICS				6	4
Level of Course	Type of the Course	Credit Distribution			Offered to NC Student	Course Delivery Method	
		Theory	Practical	Total			
Intermediate	Major	4	2	6	NO	60 lectures with diagrammatic and informative assessments during lecture hours	
List of Programme Codes in which Offered as Minor Discipline	----------						

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Prerequisites	Basic Knowledge of Introductory/Foundation level
Objectives of the Course	➢ Students gain the basics in genetic concepts and organization of genome on cellular and chromosomal level. ➢ Students are taught the basic molecular genetics mechanisms in relation to the structure and function of the cells.

Course Outcomes:

At the completion of the course, the student would be able to:

Cognitive level	Course outcomes
1. Understanding	➢ Acquire the knowledge in the field of Medical, Cyto-, Immuno-, Molecular, Cancer, Developmental and Neuro genetics to diagnose diseases and disorders. ➢ Capable to explain the various types of molecular biology methods that are used to study the regulation and function of biomolecules ➢ Acquire the ability to use their theoretical knowledge in solving practical issues. ➢ Know the bioethics and safety measures to be followed in handling the biological samples
2. Memorizing	➢ Understanding the fundamentals of hereditary materials and their role in functioning of human system. ➢ Able to identify the damage in hereditary material and malfunctioning of genes to help in eradicating the disease. ➢ Capable of understanding the Gene editing techniques ➢ Able to understand the human Genome and features ➢ With the wide technical knowledge, the students able to modify the genes and restore the functions of the hereditary material
3. Applying	➢ The final goal of the course is to empower students to use their conceptual understanding to solve problems

Detailed Syllabus

BTH-64T-455 MOLECULAR GENETICS

UNIT-I

Central dogma and advancements: Properties and evolution of genetic material, flow of genetic information; Organization of viral, bacterial genomes and Eukaryotic genome; General concept of a gene, gene families, C-value paradox non- coding genes, repetitive DNA, Genome –types of genomes, genomes & genetic variation, comparison of different genomes, genome evolution. Genomics – about the

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genomics, history, comparative genomics, comparative genomic hybridization, functional genomics.

15 Lectures

UNIT-II

Fundamentals of DNA cloning and molecular hybridization: Cell based DNA cloning, vector-based cloning; nucleic acid hybridizations, PCR based DNA cloning and DNA analyses. Types of mutations and nomenclature, mutagenesis. **15 Lectures**

UNIT-III

Recombination: Models and molecular mechanisms, Site Specific recombination: Molecular mechanism. Transposons and transposition mechanisms. Gene editing techniques: using CRISPR-Cas9, ZFNs and TALENs.

Features of the human genome: Organization of the human genome, human multigene families, Mapping of the human genome: Physical mapping and Genetic mapping. Footprints of evolution, human DNA instability. Chromosome walking. Introduction to human genome project- telomere to telomere, Ancestry by variations an overview of the project, goals of the project, major scientific strategies & approaches used in HGP, expected scientific & medical benefits of this project, about the organizations behind this project. Mapping of Human genome. **15 Lectures**

UNIT-IV

Applications of molecular genetics: Disease diagnosis, Epigenetic testing, Prognostic and diagnostic markers, Development of molecules in Biopharma, Therapeutic advancements, Disease diagnosis and Disease inheritability, improving existing biological outcomes, Vaccine development and Gene therapy and other molecular genetics based therapeutic approaches. **15 Lectures**

BTH-64P-456 MOLECULAR GENETICS-PRACTICAL

1. Introduction to Molecular genetics & Instrumentation.
2. Nucleic acid extraction: Isolation of prokaryotic DNA from bacterial cells.
3. Estimation of purity & quantity of extracted DNA by spectrophotometer.
4. Separation and estimation of integrity of DNA by agarose gel electrophoresis.
5. Determination of T_m values for the DNA sample.
6. Restriction Digestion and Ligation.
7. Primer designing.
8. Polymerase chain reaction.
9. Retrieval of sequences from nucleic acid databases.
10. Chromatogram analysis.

Suggested readings:

1. **Principles of Genetics**, Gardner, Simmons, Snustad 8th Edition 2006.
2. Tom Strachan and Andrew. P. Read, **Human Molecular Genetics**, Bios‟ Scientific Pub UK

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(1996).
3. Watson, J.D., Hopkins, N.H., Roberts, J.W., Steitz, J. and Weinter, A.M., **Molecular Biology of Genes** (4th Edition) (1987). The Benjamin/Cummings publishing Company Inc., Joky.
4. Lewin, B. **Genes VI** (1997). Oxford University Press, Oxford, New York, Tokyo.
5. Darvell, J.et. al., **Molecular Cell Biology** (7th Edition) (2002). Garland Publishing Iwc., New York.
6. **Molecular Biology**, Glick and Pasternack (2003).
7. Lewin, **Genes IX**, 9th Edition Jones and Bartlett (2007).

Course Learning Outcomes:

At the completion of the course, the student would be able to:

1. Understand the central dogma of molecular biology, properties and evolution of genetic material, and the organization of various genomes.
2. Learn about genomics, including the history, comparative genomics, genomic hybridization, and functional genomics, as well as genome types, variations, and evolution.
3. Gain knowledge of DNA cloning techniques, as well as nucleic acid hybridizations and types of mutations.
4. Comprehend recombination mechanisms, site-specific recombination, transposons, and gene editing techniques.
5. Explore the organization and mapping of the human genome, the human genome project, and the scientific and medical benefits of genome research.
6. Understand applications of molecular genetics in various fields.

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