DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, CHHATRPATI SAMBHAJINAGR.

CIRCULAR NO.SU/NEP/B.Sc. Honor's/Model College/38/2024

It is hereby inform to all concerned that, the syllabi prepared by the Ad-hoc Boards and recommended by the Dean, Faculty of Science & Technology, the Hon'ble Vice-Chancellor has accepted the **following syllabi under National Education Policy-2020 as per Guidelines of UGC** run at Model College, Ghansawangi Dist.-Jalna in his emergency powers under section 12(7) of the Maharashtra Public Universities Act, 2016 on behalf of the Academic Council as appended herewith.

Sr.No.	Courses	Semester
1.	Honours Degree of B.Sc. Biotechnology	IIIrd & IVth
2.	Honour's Degree of B.Sc. Biochemistry	IIIrd & IVth
3.	Honour's Degree of B.Sc. Computer Science	IIIrd & IVth

This is effective from the Academic Year 2024-25 and onwards.

All concerned are requested to note the contents of this circular and bring the notice to the students, teachers and staff for their information and necessary action.

University Campus,
Chhatrapati Sambhajinagar
431 004.
REF.No.SU/2024/ 7081-89
Date:- 10.09.2024

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Deputy Registrar,
Academic Section

Copy forwarded with compliments to :-

1] **The Principal, Model College, Ghansawangi Dist. Jalna**
Dr. Babasaheb Ambedkar Marathwada University,

2] **The Director, University Network & Information Centre, UNIC, with a request to upload this Circular on University Website.**

Copy to :-

1] **The Director, Board of Examinations & Evaluation,** Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.

2] The Section Officer,[B.Sc.Unit] Examination Branch, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.

3] The Programmer [Computer Unit-1] Examinations, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.

4] The Programmer [Computer Unit-2] Examinations, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.

5] The In-charge,[E-Suvidha Kendra], Rajarshi Shahu Maharaj Pariksha Bhavan, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.

6] The Public Relation Officer, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.

7] The Record Keeper, Dr.Babasaheb Ambedkar Marathwada University, Chhatrapati Sambhajinagar.

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DR. BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY, CHHATRAPATI SAMBHAJINAGAR

Structure & Syllabus

(Four Year Multidisciplinary Degree Program with Multiple Entry and Exit Option)

Under the Faculty of Science & Technology

B.Sc. Biochemistry

IIIrd & IVth semester

As per National Education Policy -2020

(For Model College, Ghansawangi Dist- Jalna.)

Under the Faculty of Science & Technology

Dean,
Faculty of Science & Technology

Chairperson
Ad-hoc Board
in Biochemistry

From the Academic Year 2024-25 & Onwards/-

B.Sc. Biochemistry Second Year (Semester III)
Teaching Scheme

Year/ Semester and Level		Section	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/week)	
					Theory	Practical	Total	Theory	Practical
First Year Semester I	Major	DSE-5	NBC301T	Plant Biochemistry	03	--	03	03	--
			NBC301P	Lab based on Plant Biochemistry	--	02	02	--	04
		DSE-6	NBC302T	Membrane Biology and Bioenergetics	03	--	03	03	--
			NBC302P	Lab based on Membrane Biology and Bioenergetics	--	02	02	--	04
	Supportive	Minor-1 Select any one from Basket1	NBC303T1	Molecular Biology-I	02	--	02	02	--
			NBC303T2	Immunology I	02	--	02	02	--
		Generic Elective Select any one from Basket 2	NBC304T1	Metabolism of Carbohydrates and Lipids	02	--	02	02	--
			NBC304T2	Metabolism of Amino Acids and Nucleotides	02	--	02	02	--
	Applied	SEC-1 Select any one from Basket3	NBC303P1	Lab based on Molecular Biology-I	--	02	02	--	04
			NBC303P2	Lab based on Immunology-I	--	02	02	--	04

B.Sc.Biochemistry Second Year (Semester III)
Evaluation / Examination Scheme

[40% Continuous Assessment and 60% of Semester End/ University Assessment]

20Year/ Semester and Level		Section	Course Code	Course Name	Credit		Evaluation Method		Total Marks	Max Marks	Min. Marks
					Theory	Practical	CA	UA			
Second Year Semester III	Major	DSE-5	NBC301T	Plant Biochemistry	03	-	20	30	50	50	20
			NBC301P	Lab based on Plant Biochemistry	-	02	--	50	50	50	20
		DSE-6	NBC302T	Membrane Biology and Bioenergetics	03	-	20	30	50	50	20
			NBC302P	Lab based on Membrane Biology and Bioenergetics	-	02	--	50	50	50	20
	Supportive	Minor-1 Select any one course from basket 1	NBC303T1	Molecular Biology-I	02	--	20	30	50	50	20
			NBC303T2	Immunology-I							
		Generic Elective Select any one course from basket 2	NBC304T1	Metabolism of Carbohydrates and Lipids	02	--	20	30	50	50	20
			NBC304T2	Metabolism of Amino Acids and Nucleotides							
	Applied	SEC-1 Select any one course from basket 3	NBC303P1	Lab based on Molecular Biology-I	-	-	-	-	-	-	-
			NBC303P2	Lab based on Immunology-I	--	02	--	50	50	50	20
								Total Marks	350	350	140

B.Sc. Biochemistry Second Year (Semester IV)
Teaching Scheme

Year/ Semester and Level		Section	Course Code	Course Name	Credits Assigned			Teaching Scheme (Hrs/week)	
					Theory	Practical	Total	Theory	Practical
First Year Semester I	Major	DSE-7	NBC401T	Gene Expression and Regulation	03	--	03	03	--
			NBC401P	Lab based on Gene Expression and Regulation	--	02	02	--	04
		DSE-8	NBC402T	Recombinant DNA Technology	03	--	03	03	--
			NBC402P	Lab based on Recombinant DNA Technology	--	02	02	--	04
	Supportive	Minor-2 Select any one from Basket 1	NBC403T1	Molecular Biology-II	02	--	02	02	--
			NBC403T2	Immunology-II	02	--	02	02	--
		Generic Elective/ OE2 Select any one from Basket 2	NBC404T1	Fermentation Technology	02	--	02	02	--
			NBC404T2	Plant and Animal Tissue Culture	02	--	02	02	--
	Applied	SEC Select any one from Basket 3	NBC403P1	Lab based on Molecular Biology-II	--	02	02	--	04
			NBC403P2	Lab based on Immunology-II	--	02	02	--	04

B.Sc. Biochemistry Second Year (Semester IV)

Evaluation / Examination Scheme

[40% Continuous Assessment and 60% of Semester End/ University Assessment]

20Year/ Semester and Level		Section	Course Code	Course Name	Credit		Evaluation Method		Total Marks	Max Marks	Min. Marks
					Theory	Practical	CA	UA			
Second Year Semester III	Major	DSE-7	NBC401T	Gene Expression and Regulation	03	-	20	30	50	50	20
			NBC401P	Lab based on Gene Expression and Regulation	-	02	--	50	50	50	20
		DSE-8	NBC402T	Recombinant DNA Technology	03	-	20	30	50	50	20
			NBC402P	Lab based on Recombinant DNA Technology	-	02	--	50	50	50	20
	Supportive	Minor-1 Select any one course from basket	NBC403T1	Molecular Biology-II	02	--	20	30	50	50	20
			NBC403T2	Immunology-II							
		Generic Elective Select any one course from basket	NBC404T1	Fermentation Technology	02	--	20	30	50	50	20
			NBC404T2	Plant and Animal Tissue Culture							
	Applied	SEC-2 Select any one course from basket	NBC403P1	Lab based on Molecular Biology-II	-	-	-	-	-	-	-
			NBC403P2	Lab based on Immunology-II	--	02	--	50	50	50	20
	Total Marks								350	350	140

Basket 1: Minor Subject

* Students will have to choose one subject from Basket 1 as a minor subject, from same faculty or discipline or other than DSC (in col. 3)

Semester	Details of Minor subjects	
	Code	Title of Subject
Semester I	NBC303T1	Molecular Biology-I
	NBC303T2	Immunology-I
Semester II	NBC403T1	Molecular Biology-II
	NBC403T2	Immunology-II

Basket 2: Generic Elective Course (GE)

*Students will choose one GEcourse offered as a generic major

Semester	Details of Generic Elective	
	Code	Title of Subject
Semester I	NBC304T1	Metabolism of Carbohydrates and Lipids
	NBC304T2	Metabolism of Amino Acids and Nucleotides
Semester II	NBC404T1	Fermentation Technology
	NBC404T2	Plant and Animal Tissue Culture

Basket 3:Skill Enhancement Course (SEC)

Semester	Details of Skill Enhancement Course (SEC)	
	Code	Title of Subject
Semester I	NBC303P1	Lab based on Molecular Biology-I
	NBC303P2	Lab based on Immunoogy-I
Semester II	NBC403P1	Lab based on Molecular Biology-II
	NBC403P2	Lab based on Immunoogy-II

Curriculum of Semester –III

B.Sc. Biochemistry Honors (Semester III)

NBC301T: Plant Biochemistry

Paper: DSC-5 **Total Credit: 03**

Contact Hours: 45 (Clock Hours) **Marks: 30**

THEORY

UNIT I: Introduction to plant cell structure and carbon fixation

Introduction to Plant cells, Plasma membrane, Vacuole and Tonoplast membrane, Cell wall, Plastids and Peroxisomes. Photosynthesis and Carbon assimilation. Structure of PSI and PSII complexes, Light reaction, Cyclic and non-cyclic photophosphorylation, Calvin cycle and regulation; C4 cycle and Crassulacean acid metabolism (CAM), Photorespiration, Photo inhibition of photosynthesis, Photosynthetic carbon reduction (PCR) cycle, Synthesis of polysaccharides in plants.

UNIT II: 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.

UNIT III: Nitrogen metabolism

Biological nitrogen fixation by free living and in symbiotic association; Structure and function of the enzyme nitrogenase. Nitrate assimilation: Nitrate and Nitrite reductase. Primary and secondary ammonia assimilation in plants; ammonia assimilation by glutamine synthetase-glutamine oxoglutarate amino transferase (GS-GOGAT) pathway. Seed storage proteins in legumes and cereals.

UNIT IV: Regulation of plant growth and stress physiology

Introduction to plant hormones and their effect on plant growth and development, Regulation of plant morphogenetic processes by light.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).

UNIT V: Secondary metabolites and toxins

Representative alkaloid group and their amino acid precursors, function of alkaloids. Examples of major phenolic groups; simple phenylpropanoids, coumarins, benzoic acid derivatives, flavonoids, tannins and lignin, biological role of plant phenolics, Classification of terpenoids and representative examples from each class, biological functions of terpenoids.

UNIT VI: Plant tissue culture and biotechnology

Cell and tissue culture techniques, types of cultures: organ and explants culture, callus culture, cell suspension culture and protoplast culture. Plant regeneration pathways: organogenesis and somatic embryogenesis. Applications of cell and tissue culture and somoclonal variation. Germplasm storage and cryo- preservation. Brief introduction to transgenic plants.

REFERENCES

1. Buchann (2015). Biochemistry and Molecular Biology of plant. (2nd ed.). I K International.
2. Caroline Bowsher, Martin steer, Alyson Tobin (2008). Plant Biochemistry. Garland Science.
3. Dey, P. M. and J.B. Harborne, J.B., (Editors) (1997). Plant Biochemistry. Academic Press.

NBC301P : Lab Based on Plant Biochemistry

Paper: Lab Course **Total Credit: 02**

Contact Hours: 30 (Clock Hours) **Marks: 50**

PRACTICALS

1. Induction of hydrolytic enzymes proteinases /amylases/lipase during germination
2. Extraction and assay of urease from Jack bean
3. Estimation of carotene/ascorbic acid/phenols/tannins in fruits and vegetables.
4. Separation of photosynthetic pigments by TLC.
5. Culture of plants (explants).

NBC302T: Membrane Biology and Bioenergetics

Paper: DSC-6 **Total Credit: 03**

Contact Hours: 45 (Clock Hours) **Marks: 30**

THEORY

UNIT I: Membrane composition and structure

Historical background and various membrane models. Overview of membrane functions. Composition of membranes: Lipids -Phospholipids, Glycolipids, sterols; Proteins - Peripheral Proteins, Integral Membrane Proteins and Lipid-Anchored proteins, and carbohydrates. Comparison of the composition of various cellular and subcellular membranes. Lateral and transverse asymmetry in membranes. Role of Flippase, Floppase and Scramblase. Model systems to study membranes - Lipid Monolayers, Planar Bilayer and Liposome, and their application. Polymorphic Lipid-Water Systems. The various determinants of polymorphic phases: CMC, lipid shape, critical packing parameter.

UNIT II: Membrane dynamics

Membrane fluidity: lateral, transverse and rotational motion of lipids and proteins. Factors affecting membrane fluidity- composition, barriers (tight junctions), cytoskeleton interactions, microdomains – rafts, caveolae. Fence and gate model. Study of RBC membrane architecture. Homeoviscous Adaptation. Techniques to study membrane dynamics: FRAP, TNBS, SPT.

UNIT III: Membrane transport

Thermodynamics of transport. Simple diffusion and facilitated diffusion. Passive transport-glucose transporter and anion transporter. Primary active transporters- P type ATPases, V type ATPases, F type ATPases. Secondary active transporters - lactose permease, Na+ -glucose symporter. ABC family of transporters – MDR and CFTR. Group translocation and bacteriorhodopsin. Ion channels: voltage-gated ion channels (Na+ /K+ voltage-gated channel) and ligand-gated ion channels (acetyl choline receptor), and aquaporins. Ionophores: valinomycin, gramicidin. Relationship of membrane transport and diseases.

UNIT IV: Introduction to Bioenergetics

Laws of thermodynamics. Concept of state functions, free energy change, equilibrium constant, coupled reactions, energy charge, ATP cycle, phosphorylation potential, and phosphoryl group transfers. Chemical basis of high standard energy of hydrolysis of ATP, PEP, 1,3 BPG and thioesters. Redox reactions, standard redox potentials and Nernst equation. Universal electron carriers.

UNIT V: Oxidative phosphorylation

The electron transport chain - its organization and function. Peter Mitchell's chemiosmotic hypothesis and Proton motive force. FoF1 ATP synthase, structure and mechanism of ATP synthesis. Metabolite transporters in mitochondria. Regulation of oxidative phosphorylation. ROS production and antioxidant mechanisms. Thermogenesis Alternative respiratory pathways in plants.

UNIT VI: Photophosphorylation

General features of photophosphorylation, historical background and Hill's reaction. Role of photosynthetic pigments and light harvesting systems in plants and microbes. Bacterial photophosphorylation in purple bacteria and Green sulfur bacteria. Photophosphorylation in plants. Molecular architecture of Photosystem I and Photosystem II. The Z-scheme of photosynthetic electron flow. Cyclic photophosphorylation and its significance.

REFERENCES

1.Garret, R.H., Grisham, C.M. (2016). Biochemistry (6th ed.). Boston, Cengage Learning.

2. Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., Scott, M.P. (2016). Molecular Cell Biology (8th ed.). New York, WH: Freeman & Company.

3. Nelson, D.L., Cox, M.M. (2017). Lehninger: Principles of Biochemistry (7th ed.). New York, WH: Freeman and Company.

4. Voet, D.J., Voet, J.G., Pratt, C.W. (2008). Principles of Biochemistry (3rd ed.). New York, John Wiley & Sons, Inc.

NBC302P: Lab Based on Membrane Biology and Bioenergetics

Paper: Lab Course **Total Credit: 02**

Contact Hours: 30 (Clock Hours) **Marks: 50**

PRACTICALS

1. Effect of lipid composition on the permeability of a lipid monolayer.
2. Determination of CMC of detergents.
3. Preparation of RBC ghost cell.
4. Study the photosynthetic O2 evolution in hydria plant.
5. Isolation of chloroplast from spinach leaves and estimation of chlorophyll content.
6. Study the Hill reaction by using artificial electron acceptor.
7. Separation of photosynthetic pigments by TLC.
8. Separation of RBC membrane proteins by SDS-PAGE.
9. Isolation of mitochondria from liver and assay of marker enzyme SDH.

NBC303T1: Molecular Biology-I

Paper: Minor -1 **Total Credit: 03**

Contact Hours: 45 (Clock Hours) **Marks: 30**

THEORY

Unit 1. Nucleic Acids convey Genetic Information

DNA as the carrier of genetic information, Key experiments establishing-The CentralDogma, DNA Double helix, Genetic code, Direction of Protein Synthesis, Genomics.

Unit 2. The Structures of DNA and RNA / Genetic Material

DNA Structure: Miescher to Watson and Crick- historic perspective, DNA structure,Salient features of double helix, Types of DNA, Types of genetic material, denaturationand renaturation, cot curves.

DNA topology - linking number, topoisomerases; Organization of DNA- Prokaryotes,Viruses, Eukaryotes.RNA Structure, Organelle DNA - mitochondria and chloroplast DNA.

Unit 3. Genome Structure, Chromatin and the Nucleosome

Genome Sequence and Chromosome Diversity, Chromosome Duplication andSegregation, The NucleosomeChromatin structure- Euchromatin, Heterochromatin- Constitutive and Facultativeheterochromatin.Regulation of Chromatin Structure and Nucleosome Assembly.Organization of Chromosomes

Unit 4. The Replication of DNA (Prokaryotes and Eukaryotes)

Chemistry of DNA synthesis, general principles - bidirectional replication, Semiconservative,Semi discontinuous,RNA priming, Various models of DNA replicationincluding rolling circle, D-loop (mitochondrial), Θ (theta) mode of replication,replication of linear ds-DNA, replicating the 5'end of linear chromosome. Enzymeinvolved in DNA replication – DNA polymerases, DNA ligase, Primase, Telomeraseand other accessory proteins. Regulation of replication.

Unit 5. The Mutability and Repair of DNA

Replication Errors, DNA Damage and their repair.

REFERENCES

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6thedition. John Wiley & Sons. Inc.

2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.

3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., 2008. Molecular Biology of the Gene 6th edition. Cold Spring Harbour Lab. Press, Pearson Pub.

NBC303T2: Immunology- I

Paper: Minor 1 **Total Credit: 03**

Contact Hours: 45 (Clock Hours) **Marks: 30**

THEORY

1. **Introduction**: Historical Perspective; early studies on humoral and cellular immunity.

2. **Cells and organs of the immune system**: cells of the immune system; hematopoiesis; HSC; hematopoietins and the role of stromal cells in blood cell formation; key characteristics, distribution and function(s) of lymphoid and myeloid cells; CD nomenclature; structure and function of primary and secondary lymphoid tissues and organs; lymphatic circulation.

3. **Innate immunity**: Non- immunological barriers; cells and soluble mediators of innate immunity; pattern recognition receptors (PRR)-soluble and cell surface and pathogen associated molecular patterns (PAMPS); induced innate response and acute phase proteins; acute inflammatory response; role of cell adhesion molecules, cytokines and chemokines in recruiting cells. Complement system, biological consequences of activation and complement regulatory proteins.

4. **Adaptive immunity**: salient features; clonal selection theory; collaboration betweenadaptive and innate immunity.

B-Cell Biology

(i) **Antibody structure**: structure of IgG, IgM, IgA, IgD & IgE; structure of the B-cell receptor (BCR) and co-receptor; immunoglobulin (Ig) fold and Ig super family; isotype, allotype and idiotype; characteristics of B-cell epitopes; epitope- paratope interactions; distribution and effector functions of Ig and cells expressing Fc- receptors.

(ii) **B-cell development**: Antigen-independent phase of B-cell development; characteristics of the major stages of maturation & important cell surface changes; B-1 and B-2 cells; and generation of central tolerance.

(iii) **Receptor diversity**: Dreyer- Bennett model for the structure of Ig and its experimental demonstration; organization of Ig genes- kappa, lambda and heavy chain multi-gene families; mechanism of DNA rearrangement and the role of RAG recombinase, Tdt and DNA repair enzymes; immunoglobulin diversification mechanisms.

(iv) **Humoral response**: Initiation in peripheral lymphoid organs and tissues; signals required for the activation of naive B-cells; T-dependent proliferation, maturation, somatic hyper-mutation, class switching & the formation of plasma and memory cells; role of activation induced deaminase (AID); peripheral tolerance; T-independent B-response; requirements for immunogenicity; haptens carriers and adjuvant.

T-Cell Biology

T-cell development; structure of T-cell receptor (TCR) - αβ and γδ and coreceptors; positive and negative selection in the thymus; other mechanisms of tolerance induction; MHC restriction; MHC locus; structure, function and distribution of MHC glycoproteins; non-classical MHC proteins; characteristics of professional antigen presenting cells; pathways of antigen processing and presentation; T cell epitopes and cell mediated immune responses by different Tcell sub populations.

5. **Mucosal immune system**: organization and distinctive features; lymphocytes populations and their role; mucosal response to infection, regulation of the immune responses; oral tolerance.

REFERENCES

1. Kindt, T.J.,Goldsby, R.A. and Osborne, B.A.(2007). Kuby Immunology, W.H.Freeman and Co, New York.

2. Murphy, K.,Travers, P. and Walport, M.(2008). Janeway's Immunobiology, Garland Science, Taylor and Francis Group, LLC.

NBC304T1: Metabolism of Carbohydrates and Lipids

Paper: Generic Elective **Total Credit: 03**

Contact Hours: 45 (Clock Hours) **Marks: 30**

THEORY

Carbohydrate Metabolism

1. **Introduction to Intermediary metabolism**: Auxotrophs , Heterotrophs, Anabolism and Catabolism.

2. **Glucose: central role in metabolism** of plants, Animals and microorganism .

3. **Glycolysis**, reactions of glycolysis . Fermentation: anaerobic fate of pyruvate, control of metabolic flux. Regulation of glycolytic pathway. Entry of Galactose , Mannose and fructose into glycolytic pathway .Substrate cycle and their physiological importance.

4. **TCA cycle**: Overveiw of TCA, Metabolic sources of Acetyl-Coenzyme A. Amphibolic nature, anaplerotic reactions. TCA Cycle inhibitors . Regulation, pyruvate dehydrogenase complex enzyme.

5. **Other pathways of carbohydrate metabolism** :Gluconeogenesis and its Regulation, Glyoxalate Cycle reactions,Pentose phosphate Pathway, Calvin Cycle, photorespiration,

6. **Carbohydrate synthesis**, Synthesis of starch, cellulose and peptidoglycan.

7. **Glycogen metabolism**, Synthesis and breakdown, glycogen synthetase and phosphoryllase and their regulation, Glycogen Storage diseases.

Lipid Metabolism

8. **Lipid digestion**, absorption and transport.

9. **Fatty acids Oxidation**, oxidation of saturated, unsaturated fattys in mitochondria ,transport of fatty acids to mitochondria. α ώ .β Oxidation. Peroxisomal and glyoxisomal pathways of Fatty acids oxidations.

10. **Ketone Bodies** synthesis and degradation.

11. **Biosynthesis of lipids,** fatty acid synthesis in plants and animals and its regulation, Biosynthesis of triacylglycerols, Phospholipids, Cardiolipids, Glycolipids and sphingolipids.

12. **Arachidonate metabolism,** Prostaglandins, Prosta cyclins,Thrombaxanes and leukotrienes

13. **Starve Feed Cycle**

14. **Cholesterol metabolism in animals,** synthesis of cholesterol and steroid hormones; degradation to bile acids

REFERENCES

1. Nelson, D.L. and Cox, M.M. (2005); Lehninger Principles of Biochemistry, 4thedition, W.H.Freeman and company, N.Y. USA.

2. Garret, R.H. and Grisham, C.M. (2005) Biochemistry, 3rd Edition. Thomson Learning INC.

3. Voet, D and Voet, J.G, (2009) Biochemistry, John Wiley and Sons, N.Y. U

NBC304T2: Metabolism of Amino acids and Nucleotides

Paper: Generic Elective **Total Credit: 03**

Contact Hours: 45 (Clock Hours) **Marks: 30**

THEORY

1. Nitrogen Cycle: Overview; assimilation of inorganic nitrogen in biomolecules.

2. Nitrogen Balance: Positive and negative nitrogen balance, protein quality: complete and incomplete proteins, criteria to assess protein quality, protein calorie malnutrition, Kwashiorkor and Marasmus.

3. Outlines of Amino Acids metabolism: Digestion, absorption and uptake of Amino Acids including γ-glutamyl cycle; Transamination, role of PLP, oxidative and nonoxidative deamination, glucose-alanine cycle, urea cycle and inherited defects of urea cycle, Krebs's bicycle

4. Degradation of the carbon skeleton: Glucogenic and ketogenic amino acids, catabolic pathways for the 20 standard amino acids; Metabolism of one-carbon units

5. Biosynthesis of Amino Acids: Biosynthesis of non-essential amino acids; biosynthesis of Essential amino acids (Only overview-in plants) and their regulation.

6. Disorders of amino acid metabolism: Phenylketonuria, Alkaptonuria, Maple syrup urine disease, Methylmalonic aciduria, Parkinson's disease, Homocystinuria, and Hartnup's disease

7. Precursor function of Amino acids: Biosynthesis of Creatine, Creatine phosphateand creatinine; Creatine- Creatine phosphate energy shuttle; polyamines (putresine, spermine, spermidine,); catecholamines (dopamine, epinephrine, nor-epinephrine); and neurotransmitters such as serotonin, GABA; porphyrin biosynthesis and disorders of porphyrin metabolism.

8. Biosynthesis of purine nucleotides: Biosynthesis of IMP; pathways from IMP to AMP and GMP; conversion to triphosphates; regulation of purine nucleotide biosynthesis, salvage pathways; synthesis of coenzymes (NAD+, FMN, FAD, HSCoA)

9. Biosynthesis of pyrimidine nucleotides: Biosynthesis of UMP, conversion of triphosphate and regulation of Biosynthesis of pyrimidine nucleotide synthesis

10. Deoxy ribonucleotides and synthesis of dTTP; inhibitors of nucleotide metabolism and their use as anti bacterial / anticancer drugs

11. Degradation of purine and pyrimidine nucleotides.

12. Disorders of nucleotide metabolism: Lesch Nyhan syndrome, Gout, SCID, Adenosine deaminase deficiency.

REFERENCES

1. Cox, M.M. and Nelson, D.L.(2008). Lehninger Principles of Biochemistry, W.H. Freeman and Company, New York, USA

2. Voet, D. and Voet, J.G.(2004). Biochemistry, John Wiley and Sons. INC.

3. Devlin, T.M.(2002)Textbook of Biochemistry with clinical correlations, John Wiley and sons, INC.

4. Bowsher, C, Steer, M. and Tobin, A (2008). Plant Biochemistry, Garland science, Taylor and Francis Group, LLC.

NBC303P1: Lab Based on Molecular Biology-I

Paper: SEC-1 **Total Credit: 02**

Contact Hours: 30 (Clock Hours) **Marks: 50**

PRACTICALS

1. Preparation of Polytene chromosome from *Chironomous* larva/*Drosophila* larva
2. Demonstration of mammalian sex chromatin.
3. Preparations of temporary mount and study the different stages of Mitosis (Onion root tip).
4. Isolation of DNA from plant/bacterial cell
5. Agaroase gel electrophoresis of isolated DNA
6. Effect of UV light on bacterial growth
7. Dark repair mechanism in bacteria
8. Perform DNA amplification by PCR.

NBC303P2: Lab Based on Immunology-I

Paper: SEC-1 **Total Credit: 02**

Contact Hours: 30 (Clock Hours) **Marks: 50**

PRACTICALS

1 To isolate peripheral blood mononuclear cells (PBMC) from whole blood

2. Preparation of single cell suspension from spleen.

3. Viability and cell counting of peritoneal macrophages

4. Isolation of a IgG,IgA,IgM antibody using Ion Exchange chromatography.

5. Antibody-antigen reactions in gels-DID,SRID and immunoelectrophoresis.

6. Phagocytic activity of Macrophages.

7. Dissection of animal to visualize lymphoid system.

Semester IV

NBC401T: Gene Expression and Regulation

Paper: DSC-7 **Total Credit: 03**

Contact Hours: 45 (Clock Hours) **Marks: 30**

THEORY

UNIT I: Transcription in prokaryotes

Comparison between transcription and DNA replication, RNA polymerases, transcription cycle in bacteria, sigma factor, bacterial promoters, identification of DNA binding sites by DNA footprinting, various stages of RNA synthesis, initiation, elongation and termination, rho-dependent and rho-independent termination. Inhibitors of transcription and applications as antimicrobial drugs.

UNIT II: Transcription in eukaryotes

Comparison between initiation, elongation and termination of prokaryotic and eukaryotic transcription. Introduction on basal transcription machinery and three classes of eukaryotic RNA

polymerases – I, II and III and their respective promoters. Details on transcription by RNA polymerase II, features of RNA polymerase II core promoters and general transcription factors. Identification of DNA binding sites by DNA foot printing. Inhibitors of eukaryotic transcription and their applications.

UNIT III: RNA Processing

Various types of RNA processing- polyadenylation and capping, processing of rRNA and tRNA. Chemistry of RNA splicing, the spliceosome machinery, splicing pathways, group I and group II introns, alternative splicing, exon shuffling and RNA editing.

UNIT IV: Translation of proteins

Salient features of the genetic code, triplet nature, degenerate, wobble in the anticodon. Experimental approaches used to decipher the genetic code. Suppressor tRNAs. Exceptions to the nearly universal genetic code. Messenger RNA, transfer RNA, charging of tRNA. The structure of ribosome. Three stages of translation-initiation, elongation and termination. Translation in eukaryotes. Regulation of translation. Comparison of prokaryotic and eukaryotic protein synthesis. Inhibitors of translation and their clinical importance.

UNIT V: Regulation of gene expression in prokaryotes

Strategies for gene regulation, negative and positive regulation, concept of operons, regulatory proteins, activators, repressors, DNA binding domains, regulation of lac operon and the concept of combinatorial control, trp operon. Regulatory RNAs in bacteria, small RNA and riboswitches.

UNIT VI: Regulation of gene expression in eukaryotes

Gene regulation by chromatin remodeling, regulation of galactose metabolism in yeast, action Gof enhancers and insulators, working of activators and repressors, concept of combinatorial control. Regulatory RNAs in eukaryotes: synthesis and mechanism of siRNA and miRNA. Comparison of regulatory mechanisms of gene expression in prokaryotes and eukaryotes.

REFERENCES

1. Nelson, D.L. and Cox, M.M (2017) Lehninger: Principles of Biochemistry (7th ed.) W.H. Freeman & Company (New York).

2. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008) Watson: Molecular Biology of the Gene (7th ed.), Cold Spring Harbor Laboratory Press, Cold spring Harbor (New York).

NBC401P: Lab Based on Gene Expression and Regulation

Paper: Lab Course **Total Credit: 02**

Contact Hours: 30 (Clock Hours) **Marks: 50**

PRACTICALS

1. **Isolation of Lactose negative mutant**
2. Study of the β-galactosidase assay of the lacY and lacZ mutants.
3. .Estimation of RNA by Orcinol Method
4. Extraction of total nucleic acids from plant tissue/bacteria
5. To study growth curve and diauxic growth curve effect in *E. coli*
6. Isolation of total RNA from bacteria/yeast
7. To study the effect of inhibitors on protein synthesis

NBC402T: Recombinant DNA Technology

Paper: DSC-8 **Total Credit: 03**

Contact Hours: 45 (Clock Hours) **Marks: 30**

THEORY

UNIT I: Introduction to recombinant DNA technology

Overview of gene cloning. Restriction, modification systems and DNA modifying enzymes, DNA analysis by electrophoresis.

UNIT II: Cloning vectors for prokaryotes and eukaryotes

Plasmids and bacteriophages as vectors for gene cloning. Cloning vectors for *E. coli* like pBR322, pUC8, pGEM3Z. Cloning vectors based on M13 and λ bacteriophage. Ti plasmid, BAC and YAC.

UNIT III: Introduction of DNA into cells and selection of recombinants

Ligation of DNA molecules. Introduction of DNA into cells, Transformation, selection for transformed cells. Identification of recombinants, blue-white selection. Identification of recombinant phages. cDNA and Genomic libraries.

UNIT IV: Polymerase chain reaction and DNA sequencing

Fundamentals of polymerase chain reaction, designing primers for PCR. DNA sequencing by Sanger's method and automated DNA sequencing.

UNIT V: Expression of cloned genes

Vectors for expression of foreign genes in *E. coli*, cassettes and gene fusions. Production of recombinant protein by eukaryotic cells. Fusion tags and their role in purification of recombinant proteins.

UNIT VI: Applications of genetic engineering in biotechnology

Production of recombinant proteins such as insulin and factor VIII. Gene therapy. Genetically modified herbicide glyphosate resistant crops. Ethics concerns.

REFERENCES

1. Brown, T. A. (2016) Gene Cloning and DNA Analysis: An Introduction, (7th ed.). Wiley-Blackwell Publishing (Oxford, UK).

2. Glick, B.R., Pasternak, J.J., Patten, C. L. (2010) Molecular Biotechnology: Principles and Applications of Recombinant DNA (4th ed.). ASM Press (Washington DC).

NBC402P : Lab Based on Recombinant DNA Technology

Paper: Lab Course **Total Credit: 02**

Contact Hours: 30 (Clock Hours) **Marks: 50**

PRACTICALS

1. Isolation of DNA from bacteria/plant cells
2. DNA estimation by UV spectrophotometry.
3. Electrophoresis of isolated DNA
4. Isolation of plasmid DNA from *E. coli.*
5. Restriction digestion and agarose gel electrophoresis.
6. Amplification of a DNA fragment by PCR.

NBC403T1: Molecular Biology-II

Paper: Minor-2 **Total Credit: 03**

Contact Hours: 45 (Clock Hours) **Marks: 30**

THEORY

Unit 1. Mechanism of Transcription

RNA Polymerase and the transcription unit, Transcription in Prokaryotes, Transcription in Eukaryotes

Unit 2. RNA Modifications

Split genes, concept of introns and exons, removal of Introns, spliceosome machinery, splicing pathways, alternative splicing, exon shuffling, RNA editing, and mRNA transport.

Unit 3. Translation (Prokaryotes and Eukaryotes)

Assembly line of polypeptide synthesis - ribosome structure and assembly, various steps inprotein synthesis. Charging of tRNA, aminoacyl tRNA synthetases. Proteins involved ininitiation, elongation and termination of polypeptides. Fidelity of translation. Inhibitors of protein synthesis. Regulation of translation Translation-dependent regulation of mRNA and Protein Stability.

Unit 4. Transcription Regulation in Prokaryotes

Principles of transcriptional regulation, regulation at initiation with examples from *lac* and*trp* operons

Unit 5. Transcription Regulation in Eukaryotes

Conserved mechanism of regulation, Eukaryotic activators, Signal integration, combinatorial control, transcriptional repressors, signal transduction and control of transcriptional regulator, Gene Silencing

Unit 6. Regulatory RNAs

Riboswitches, RNA interference, miRNA, siRNA, Regulatory RNA and X-inactivation

REFERENCES

1. Karp, G. 2010 Cell and Molecular Biology: Concepts and Experiments. 6th edition.John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006 Cell and Molecular Biology. Lippincott Williams and Wilkins, Philadelphia.
3. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.
4. Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., 2008.Molecular Biology of the Gene (6th edition.). Cold Spring Harbour Lab. Press, Pearson Pub.

NBC403T2 Immunology-II

Paper: Minor 2 Total Credit: 03
Contact Hours: 45 (Clock Hours) Marks: 30

THEORY

1. Techniques based on antigen- antibody interactions inhibition; ELISA and variations of the basic technique; radioimmunoassay, RAST and RIST; complement fixation test; western blotting, immune precipitation and immune fluorescence; Hybridoma technology and their application.

2. **Hypersensitivity**: Gell and Coombs classification; representative examples of type I, II, III and IV hypersensitive reactions against innocuous antigens, auto antigens (wherever applicable) and potentially harmful antigens.

3. **Autoimmunity**: Organ specific and systemic autoimmune diseases; animal models for autoimmune disease; mechanisms for the induction of autoimmunity and treatment.

4. Immunodeficiency: primary (humoral and cell mediated) and secondary immunodeficiency; treatment.

5. Immune response against major classes of pathogens: bacteria (extracellular and intracellular); viruses (influenza); protozoan's (Plasmodium) and parasitic worms (helminthes); reemergence of some infectious diseases; evasion and subversion of immune defenses: antigenic variation; immunosuppressant; inappropriate immune responses; blocking antigen processing and presentation etc.

6. **Transplantation immunology**: typing of tissues; characteristics of graft rejection; major and minor histocompatability antigens; all reactivity of T cells; immunosuppressive therapy; Graft Vs host disease (GVHD) and privileged sites.

7. Tumor immunology: Introduction to malignant transformation of cells; tumor antigens; immune response against tumors; tumor evasion of immune system and cancer immunotherapy.

8. Immunomodulation

(i) Immunosuppressive drugs: corticosteroids, cytotoxic drugs; cyclosporine and rapamycin.
(ii) Vaccines: types of vaccines-live attenuated, inactivated organisms, toxoids, subunit vaccines, DNA vaccines and recombinant vector vaccines; requirements for an effective vaccine and recommended childhood vaccination schedules in India.
(iii) Cytokines

REFERENCES

1. Kindt, T.J., Goldsby, R.A. and Osborne, B.A. (2007). Kuby Immunology, W.H.Freeman and Co, New York.

2. Murphy, K, Travers, P. and Walport, M. (2008). Janeway's Immunobiology, GarlandScience, Taylor and Francis Group, LLC

NBC404T1: Fermentation Technology

Paper: Generic Elective **Total Credit: 03**

Contact Hours: 45 (Clock Hours) **Marks: 30**

THEORY

Unit I: Design of Fermentors

History of fermentation, definition and examples, ideal properties of Fermenter (Bioreactor), Components of the fermenters & their specifications: Body Construction, Agitator, Impeller, Baffles etc. Types of Bioreactors, Basic design of fermenter.

Unit II: Important Microorganisms

Isolation, identification and screening of industrially important microorganisms, their preservation and growth curve.Genetic Engineering for strain improvement

Unit III: Upstream and Downstream Process

Development of inoculum, media sterilization, types of fermentation process- Batch, Fed-batch, & Continuous, recovery and purification of product

Unit IV: Microbial Production and purification

Citric acid, ethanol, penicillin, biofertilizer, single cell protein, cheese, amylase, and dextran.

NBC404T2: Plant and Animal Tissue Culture

Paper: **Generic Elective** Total Credit: 03

Contact Hours: 45 (Clock Hours) Marks: 30

UNIT-I Tools, techniques and procedures of Tissue culture:

Media for in vitro culture - minerals, vitamins, and natural adjuvants like coconut milk and fruit juice. Requirements for auxin, cytokinin and other growth regulators. Solid and liquid media. Commercial prepacked media. Design of laboratory and commercial tissue culture facility. Procedures in Tissue Culture: Fumigation, wet and dry sterilization, ultraviolet sterilization, ultrafiltration and surface sterilization. Laminar flow hood. Maintenance of axenic cultures. Explants for Tissue Culture: Shoot tip, axillary buds, leaf discs, cotyledons, inflorescence and floral organs. Callus culture - initiation and maintenance of callus.

UNIT-II Principles of Micropropagation:

Direct and indirect morphogenesis, somatic embryogenesis, caulogenesis, rhizogenesis, acclamatization. Synthetic seed production.

UNIT-III Tissue culture and Biotechnology:

Mericloning for virus-free plants, selection of plantlets tolerant to biotic and abiotic stresses. Use of techniques of genetic engineering for obtaining transgenic plants resistant to diseases, insect pests, abiotic stress and herbicides.. Introduction of desired genes from microbes, plant

and animals. Modifying the expression of resistent gene by antisense RNA technique. In vitro mutagenesis. Genetic engineering with protoplast and haploid cells.

UNIT-IV Applications in Agriculture, Horticulture and Forestry:

Achievement and current trends in improvement of cereals, vegetable crops, oil yielding plants, ornamental plants an forest trees

UNIT-V Tissue culture in Industrial and Medical field:

Suspension Culture systems, isolation of single and aggregate of cells. Immobilization of cells and use of bioreactors. Protoplast Culture: Isolation of protoplast and transformation. Bioprocessing for active principles. In vitro production of secondary metabolites, pharmaceuticals and aromatic chemicals. Edible vaccine. **Tissue Culture in Germplasm Conservation:** Introduction to in vitro conservation. Storage techniques, equipment, cryopreservation and tissue culture components used for storage. Achievements and current trends.

Unit VI:Cell Culture Laboratory Design and Equipements

Planning, construction and services; Layout; Sterile handling area; Incubation; Hot room;Air circulation; Service bench; Laminar flow; Sterilizer; Incubator; CO2incubator;Refrigerators and freezers; Centrifuge; Inverted stage microscope; Magnetic stirrer;Liquid nitrogen freezers; Slow cooling system for cell freezing; Water bath; Autoclavesand hot air oven; Pipette washers; Water purification system; Fluid handling systemsand other equipments; Washing, packing and sterilization of different materials used inanimal cell culture; Aseptic concepts; Maintenance of sterility; Cell culture vessels.

Unit VII:Cell Culture Media and Reagents

Types of cell culture media; Ingredients of media; Physiochemical properties; CO2 and bicarbonates; Buffering; Oxygen; Osmolarity; Temperature; Surface tension and foaming; Balance salt solutions; Antibiotics, growth supplements; Fetal bovine serum; Serum free media; Trypsin solution; Selection of medium and serum; Conditioned media; Other cell culture reagents; Preparation and sterilization of cell culture media, serum and other reagents.

Unit VIII: Cell Culture Techniques

History of animal cell culture; Different tissue culture techniques; Types of primaryculture; Chicken embryo fibroblast culture; Chicken liver and kidney culture; Secondary culture;Trypsinization; Cell separation; Continuous cell lines; Suspension culture; Organ cultureetc.; Behavior of cells in culture conditions: division, growth pattern, metabolism ofestimation of cell number; Development of cell lines; Characterization and maintenanceof cell lines, stem cells; Cryopreservation; Common cell culture contaminants.

REFERENCES

1. Plant Cell Culture: A Practical Approach R.A. Dixon & Gonzales IRL Press 1994
2. Culture of animal cells-A manual of basic technique and specialized applications R. Ian Freshney Wiley Blackwell publishers 1983
3. Microbial Biotechnology Alexander N Glazer, Hiroshi Nikaido W H Freeman & Company 1995
4. Living resources for Biotechnology, Animal cells Doyle, R. Hay and B.E. Kirsop Cambridge University Press 1990
5. Plant Tissue Culture Sathyanarayana B N, IK Intl. Publishers 2007
6. Principle of Microbe & Cell Cultivation SJ Prit Blackwell Scientific co 1975
7. Animal Cell Culture and Technology THE BASICS Garland Science Michael Butler

NBC403P1: Lab Based on Molecular Biology-II

Paper: Lab Course **Total Credit: 02**

Contact Hours: 30 (Clock Hours) **Marks: 50**

PRACTICALS

1. Isolation of DNA from plant/bacterial cells
2. Quantification of isolated DNA
3. Gel electrophoresis of DNA
4. Isolation of total RNA from bacterial cells
5. To perform Ames test in *Salmonella / E.coli* to study mutagenicity.
6. Demonstration of antibiotic resistance. (Culture of *E.coli* containing plasmid (pUC18/19) in LB medium with/without antibiotic pressure and interpretation ofresults).

NBC403P2 :Lab Based on Immunology-II

Paper: Lab Course **Total Credit: 02**

Contact Hours: 30 (Clock Hours) **Marks: 50**

PRACTICALS

1. Western Blotting
2. Enzyme-linked Immunosorbent assay (ELISA)
3. Dot Blot
4. Cytotoxic Assay-LDH
5. Rocket electrophoresis