Government of Karnataka

Curriculum Framework for Four-Year Undergraduate Multidisciplinary Programme (Honours) & Master Programme in Colleges and Universities of Karnataka State Under NEP 2020.

3rd and 4th Semester Model Syllabus

ForUG Program in

Biotechnology

Submitted to
Vice Chairman
Karnataka State Higher Education Council

Submitted by

Prof. DAYANAND AGSAR
Vice Chancellor, Gulbarga University
CHAIRMAN and MEMBERS
SUBJECTWISE EXPERT COMMITTEE
In Microbiology and Biotechnology

PREAMBLE

The role of education is paramount in nation building. One of the major objectives of UGC is maintenance of standards of higher education. Over the past decades the higher education system of our country has undergone substantial structural and functional changes resulting in both quantitative and qualitative development of the beneficiaries. Such changes have gained momentum with the introduction of Choice Based Credit System (CBCS) which further expects Learning Outcome-Based curriculum to maximize the benefits of the newly designed curriculum. The Learning Outcome- Based Curriculum in Biotechnologywill help the teachers of the discipline to visualize the curriculum more specifically in terms of the learning outcomes expected from the students at the end of the instructional process. The commission strives to promote the link of students with the society/industry such that majority of the students engage in socially productive activities during their period of study in the institutions and at least half of the graduate students will secure access to employment/self-employment or engage themselves in pursuit of higher education. The model curriculum envisages to cater to the developmental trends in higher education, incorporating multi- disciplinary skills, professional and soft skills such as teamwork, communication skills, leadership skills, time management skills and inculcate human values, professional ethics, and the spirit ofInnovation / entrepreneurship and critical thinking among students and promote avenues for display of these talents, linking general studies with professional courses. Besides imparting disciplinary knowledge to the learners, curriculum should aim to equip the students with competencies like problem solving, analytical reasoning and moral and ethical awareness. Introduction of internship and appropriate fieldwork/case studies are embedded in the curriculum for providing wider exposure to the students and enhancing their employability.

Learning outcomes specify what exactly the graduates are expected to know after completing a program of study. The expected learning outcomes are used as reference points to help formulate graduate attributes, qualification descriptors, program learning outcomes and course learning outcomes. Keeping the above objectives of higher education in mind the Learning Outcome-Based Curriculum Framework (LOCF) for the discipline of Biotechnologyhas been prepared and presented here.

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Model Curriculum

Program Name	**B.Sc. Discipline**	Total Credits for the Program	**176**
Core	**Biotechnology**	Starting year of implementation	**2021-22**

Program Outcomes: At the end of the program the student should be able to:

(Refer to literature on outcome-based education (OBE) for details on Program Outcomes)

PO1. Understandingconcepts of Biotechnology and demonstrate interdisciplinary skills acquired in cell biology, genetics, biochemistry, microbiology, and molecular biology

PO2. Demonstrating the Laboratory skills in cell biology, basic and applied microbiology withan emphasis on technological aspects

PO3. Competent to apply the knowledge and skills gained in the fields of Plantbiotechnology, animal biotechnology and microbial technology in pharma, food,agriculture, beverages, herbal and nutraceutical industries.

PO4. Critically analyse the environmental issues and apply the biotechnology knowledgegained for conserving the environment and resolving the problems.

PO5. Demonstrate comprehensive innovations and skills in the fields of biomolecules, celland organelles, molecular biology, bioprocess engineering and genetic engineering ofplants, microbes, and animals with respect to applications for human welfare.

PO6. Apply knowledge and skills of immunology, bioinformatics, computational modelling ofproteins, drug design and simulations to test the models and aid in drug discovery.

PO7. Critically analyse, interpret data, and apply tools of bioinformatics and multi omics invarious sectors of biotechnology including health and Food.

PO8. Demonstrate communication skills, scientific writing, data collection and interpretationabilities in all the fields of biotechnology.

PO9. Learning and practicing professional skills in handling microbes, animals and plants anddemonstrate the ability to identify ethical issues related to recombinant DNA technology,genetic engineering, animals handling, intellectual property rights, biosafety, andbiohazards.

PO10. Exploring the biotechnological practices and demonstrating innovative thinking inaddressing the current day and future challenges with respect to food, health, andenvironment.

PO11. Thorough knowledge and application of good laboratory and good manufacturingpractices in biotech industries.

PO12. Understanding and application of molecular biology techniques and principles inforensic and clinical biotechnology.

PO13. Demonstrate entrepreneurship abilities, innovative thinking, planning, and setting upsmall-scale enterprises or CROs.

Assessment:

Weightage for assessments (in percentage)

Type of Course	Formative Assessment / IA	Summative Assessment
Theory	40	60
Practical	25	25
Projects	-	-
Experiential Learning (Internships etc.)	-	-

Contents of Courses for B.Sc. Biotechnology as Major

Model II A

Semester	Course code	Course Category	Theory/Practical	Credits	Paper Title	Marks	
						S.A	I.A
3.	**BTC: 103**	DSC- 7	Theory	3	Biomolecules	60	40
			Practical	2	Biomolecules	25	25
		OE- 3	Theory	3	Nutrition and Health	60	40
4.	**BTC:104**	DSC- 8	Theory	3	Molecular Biology	25	25
			Practical	2	Molecular Biology	60	40
		OE- 4	Theory	3	Intellectual Property Rights	25	25

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Model Curriculum

Program Name	**BSc Biotechnology**		Semester	**Third Sem**
Course Title	**Biomolecules**			
Course No.	**BTC: 103**	**DCS -3T**	No. of Theory Credits	**4**
Contact hours	**56 hrs**		Duration of ESA/Exam	**2.30 Hours**
Formative Assessment Marks	**40**		Summative Assessment Marks	**60**

Course Pre-requisite (s):

Course Outcomes (COs): At the end of the course the student should be able to:

1. Acquire knowledge about types of biomolecules, structure, and their functions
2. Will be able to demonstrate the skills to perform bioanalytical techniques
3. Apply comprehensive innovations and skills of biomolecules to biotechnology field

Content	Hrs
Unit–I – a) Carbohydrates:	**14**
Introduction, sources, classification of carbohydrates. Structure,function and properties of carbohydrates. Monosaccharides – Isomerism and ring structure, Sugar derivatives – amino sugars and ascorbic acid Oligosaccharides – Sucrose and Fructose Polysaccharides – Classification as homo and heteropolysaccharides, Homopolysaccharides - storage polysaccharides (starch and glycogen- structure, reaction, properties), structural polysaccharides (cellulose and chitin-structure,properties),Heteropolysaccharides - glycoproteins and proteoglycans (Brief study). Metabolism:Glycolysis and gluconeogenesis, Kreb's cycle, oxidative phosphorylation. **b) Amino Acids, Peptides and Proteins** Introduction, classification and structure of amino acids. Concept of – Zwitterion, isoelectric point, pK values. Essential and nonessential amino acids. Peptide bond and peptide, classification of proteins based on structure and function, Structural organization of proteins[primary, secondary (α,□), tertiary and quaternary]. Fibrous and globular proteins, Denaturation and renaturation of proteins General aspects of amino acid metabolism:Transamination, deamination, decarboxylation and urea cycle.	
Unit -II a) Lipids	**14**
Classification and function of lipids, properties (saponification value, acid value, iodine number, rancidity), Hydrogenation of fats and oils Saturated and unsaturated fatty acids. General structure and biological functions of - phospholipids, sphingolipids, glycolipids, lipoproteins, prostaglandins, cholesterol, ergosterol. Metabolism: Beta oxidation of fatty acids. Biosynthesis of cholesterol. b) **Enzymes** Introduction, nomenclature and classification, enzyme kinetics, factors influencing enzyme activity,metalloenzymes, activation energy and transition state, enzyme activity, specific activity. Coenzymes and their functions (one reaction involving FMN, FAD, NAD). Enzyme inhibition- Irreversible and reversible (competitive, non-competitive and uncompetitive inhibitionwith an example each) Zymogens (trypsinogen, chymotrypsinogen and pepsinogen), Isozymes (LDH, Creatine kinase, Alkaline phosphatase and their clinical significance).	

Unit -III -a. **Vitamins** Water and fat soluble vitamins, dietary source and biological role of vitamins Deficiency manifestation of vitamin A, B, C, D, E and K a) **Nucleic acids** Structures of purines and pyrimidines, nucleosides, nucleotides in DNA Denovo and salvage pathway of purine and pyrimidine synthesis. b) **Hormones** Classification of hormones based on chemical nature and mechanism of action. Chemical structureand functions of the following hormones: Glucagon, Cortisone, Epinephrine, Testosterone and Estradiol.	**14**
Unit –IV - Bioanalytical tools : **a) Chromatography :** Principle, procedure and applications of - paper chromatography, thin layer chromatography, adsorption chromatography, ion exchange chromatography, gel filtration chromatography, affinity chromatography, gas liquid chromatography and high performanceliquid chromatography. **b) Electrophoresis:** Principle, procedure and applications of electrophoresis (paper electrophoresis, gel electrophoresis -PAGE, SDS- PAGE &agarose electrophoresis) and isoelectric focusing. **c) Spectroscopy:** UV-Vis spectrophotometry; mass spectroscopy, atomic absorption spectroscopy.	14

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	**Program Outcomes (POs)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Acquire knowledge about types of biomolecules, structure, and their functions	✓				✓							✓
Will be able to demonstrate the skills to perform bioanalytical techniques			✓								✓	✓
Apply comprehensive innovations and skills of biomolecules to biotechnology field	✓				✓							✓

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz and Assignments

Summative Assessment = 60 Marks	
Formative Assessment Occasion / type	Weightage in Marks
Attendance	10
Seminar	10
Debates and Quiz	10
Test	10
Total	60 marks + 40 marks = 100 marks

Course Title	**Biomolecules**		Practical Credits	**2**
Course No.	**BTC:103**	**DSC-3P**	Contact hours	

Content

1. Introduction to basic instruments (Principle, standard operating procedure) with demonstration.
2. Definitions and calculations:Molarity, Molality, Normality, Mass percent % (w/w), Percent byvolume (% v/v), parts per million (ppm), parts per billion (ppb), Dilution of concentrated solutions. Standard solutions, stock solution, solution of acids. Reagent bottlelabel reading and precautions.
3. Preparation of standard buffers by Hendersen-Hasselbach equation – Acetate, phosphate,Tris and determination of pH of solution using pH meter.
4. Estimation of maltose by DNS method
5. Determination of α-amylase activity by DNS method
6. Estimation of proteins by Bradford method
7. Estimation of amino acid by Ninhydrin method
8. Extraction of protein from soaked/sprouted green gram by salting out method
9. Separation of plant pigmentsby circular paper chromatography
10. Separation of amino acids by thin layer chromatography
11. Native PAGE
12. Determination of iodine number of lipids

Practical assessment

Assessment			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Practical Exam**	
Record	5	25	**50**
Test	10		
Attendance	5		
Performance	5		
Total	**25**	**25**	

References	
1	An Introduction to Practical Biochemistry, 3rd Edition, (2001), David Plummer; Tata McGraw Hill Edu.Pvt.Ltd. New Delhi, India
2	Biochemical Methods,1st Edition, (1995), S.Sadashivam, A.Manickam; New Age International Publishers, India
3	Introductory Practical biochemistry, S. K. Sawhney&Randhir Singh (eds) Narosa Publishing. House, New Delhi, ISBN 81-7319-302-9
4	Experimental Biochemistry: A Student Companion, BeeduSasidharRao& Vijay Despande(ed).I.K International Pvt. LTD, NewDelhi. ISBN 81-88237-41-8
5	Standard Methods of Biochemical Analysis, S. K. Thimmaiah (ed), Kalyani Publishers, Ludhiana ISBN 81-7663-067

Program Name	**BSc Biotechnology**		Semester	**Third Sem**
Course Title	**Nutrition and Health**			
Course Code		**OE-3**	No. of Theory Credits	**3**
Contact hours	**Lecture**		Duration of ESA/Exam	**Hours**
	Practical			
Formative Assessment Marks			Summative Assessment Marks	

Course Pre-requisite(s):	
Course Outcomes (COs): At the end of the course the student should be able to: 1. Study the concepts of food, nutrition, diet and health 2. To apply the best practices of food intake and dietary requirements 3. Acquire knowledgeabout various sources of nutrients and goodcooking practices	
Content	**45 Hrs**
Unit–I - Introduction	**14 Hrs**
Concepts of nutrition and health. Definition of Food, Diet and nutrition, Food groups. Food pyramids. Functions of food. Balanced diet. Meal planning. Eat right concept. Functional foods, Prebiotics, Probiotics, and antioxidants	
Unit -II - Nutrients	**14 Hrs**
Macro and Micronutrients - Sources, functions and deficiency.Carbohydrates, Proteins, Fats – Sources and calories. Minerals –Calcium, Iron, Iodine. Vitamins – Fat soluble vitamins –A, D, E & K. Water soluble vitamins – vitamin C Thiamine, Riboflavin, Niacin. Water–Functions and water balance. Fibre –Functions and sources. Recommended Dietary Allowance, Body Mass Index and Basal Metabolic Rate.	
Unit -III – Nutrition and Health	**14 Hrs**
Methods of cooking affecting nutritional value. Advantages and disadvantages. Boiling, steaming, pressure cooking. Oil/Fat – Shallow frying, deep frying. Baking. Nutrition through lifecycle. Nutritional requirement, dietaryguidelines:Adulthood, Pregnancy, Lactation, Infancy-Complementary feeding, Pre-school, Adolescence, geriatric. Nutrition related metabolic disorders- diabetes and cardiovascular disease.	

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz and Assignments

Summative Assessment = 60 Marks	
Formative Assessment Occasion / type	Weightage in Marks
Attendance	10
Seminar	10
Debates and Quiz	10
Test	10
Total	60 marks + 40 marks = 100 marks

References	
1	Sri Lakshmi B, (2007), Dietetics. New Age International publishers. New Delhi
2	Sri Lakshmi B, (2002), Nutrition Science. New Age International publishers. New Delhi
3	Swaminathan M. (2002), Advanced text book on food and Nutrition. Volume I. Bappco
4	Gopalan.C., RamaSastry B.V., and S.C.Balasubramanian (2009), Nutritive value of Indian Foods.NIN.ICMR.Hyderabad.
5	Mudambi S R and Rajagopal M V, (2008), Fundamentals of Foods, Nutrition & diet therapy by New Age International Publishers, New Delhi

Program Name	**BSc Biotechnology**		Semester	**Fourth Sem**
Course Title	**Molecular Biology**			
Course No.	**BTC: 104**	**DCS -4T**	No. of Theory Credits	**4**
Contact hours	**56 hrs**		Duration of ESA/Exam	**2.30 Hours**
Formative Assessment Marks			Summative Assessment Marks	

Course Pre-requisite (s):

Course Outcomes (COs): At the end of the course the student should be able to:
1. Study the advancements in molecular biology with latest trends.
2. Will acquire the knowledge of structure, functional relationship of proteins and nucleic acids.
3. Aware about the basic cellular processes such as transcription, translation, DNA replication and repair mechanisms.

Content	Hrs
Unit–I - Molecular basis of life and Nucleic Acids An introduction RNA and experimental proof of DNA as genetic material and types of DNA.Structure and functions of DNA and RNA, Watson and Crick model of DNA and other forms of DNA (A and Z) functions of DNA and RNA including ribozymes.	**14 Hrs**
Unit -II - DNA Replication and Repair Replication of DNA in prokaryotes and eukaryote– Enzymes and proteins involved in replication, Theta model, linear and rolling circle model. Polymerases and all enzyme components. The replication complex: Pre-primming proteins, primosome, replisome, unique aspects of eukaryotic chromosome replication, Fidelity of replication DNA damage and Repair mechanism: photo reactivation, excision repair, mismatch repair and SOS repair.	**14 Hrs**
Unit -III - Transcription and RNA processing Central dogma, RNA structure and types of RNA, Transcription in prokaryotes RNA polymerase, role of sigma factor, promoter, Initiation, elongation and termination of RNA chains. Transcription in eukaryotes: Eukaryotic RNA polymerases, transcription factors, promoters, enhancers, mechanism of transcription initiation, promoter clearance and elongation RNA splicing and processing: processing of pre-mRNA: 5’ cap formation, polyadenylation, splicing, rRNA and tRNA splicing.	14 Hrs
Unit –IV - Regulation of gene expression and translation Genetic code and its characteristics, Wobble hypothesisTranslation- in prokaryotes and eukaryotes- ribosome, enzymes and factors involved in translation. Mechanism of translation- activation of amino acid, aminoacyl tRNA synthesis, Mechanism- initiation, elongation and termination of polypeptide chain. Fidelity of translation, Inhibitors of translation. Protein folding and modifications, Post translational modifications of proteins.	14 Hrs

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	Program Outcomes (POs)											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Study the advancements in molecular biology with latest trends	✓				✓							✓
Will acquire the knowledge of structure, functional relationship of proteins and nucleic acids					✓	✓						✓
Aware about the basic cellular processes such as transcription, translation, DNA replication and repair mechanisms	✓				✓				✓			✓

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz and Assignments

Summative Assessment = 60 Marks	
Formative Assessment Occasion / type	Weightage in Marks
Attendance	10
Seminar	10
Debates and Quiz	10
Test	10
Total	60 marks + 40 marks = 100 marks

Course Title	**Molecular Biology**		Practical Credits	**2**
Course No.	**BTC: 104**	**DSC-4P**	Contact hours	
Content				
1. Preparation of DNA model 2. Estimation of DNA by DPA method 3. Estimation of RNA by Orcinol method 4. Column chromatography – gel filtration (Demo) 5. Extraction and partial purification of protein from plant source by Ammoniumsulphate precipitation. 6. Extraction and partial purification of protein from animal source by organic solvents. 7. Protein separation by SDS-Polyacrylamide Gel Electrophoresis (PAGE) 8. Charts on- Conjugation, Transformation and Transduction, DNA replication, Types of RNA				

Practical assessment

Assessment			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Practical Exam**	
Record	5	25	**50**
Test	10		
Attendance	5		
Performance	5		
Total	**25**	**25**	

References	
1	Glick, B.R and Pasternak J.J (1998) Molecular biotechnology, Principles and application of recombinant DNA, Washington D.C. ASM press
2	Howe. C. (1995) Gene cloning and manipulation, Cambridge University Press, USA
3	Lewin, B., Gene VI New York, Oxford University Press
4	Rigby, P.W.J. (1987) Genetic Engineering Academic Press Inc. Florida, USA
5	Sambrook et al (2000) Molecular cloning Volumes I, II & III, Cold spring Harbor Laboratory Press New York, USA
6	Walker J. M. and Ging old, E.B. (1983) Molecular Biology & Biotechnology (Indian Edition) Royal Society of Chemistry U.K
7	Karp. G (2002) Cell & Molecular Biology, 3rdEdition, John Wiley & Sons; I

Program Name	**BSc Biotechnology**		Semester	**Fourth Sem**
Course Title	**Intellectual Property Rights**			
Course Code		**OE-4**	No. of Theory Credits	**3**
Contact hours	**Lecture**		Duration of ESA/Exam	**2.5 Hours**
	Practical			
Formative Assessment Marks			Summative Assessment Marks	

Course Pre-requisite(s): Semester I and II of composite Home Science.

Course Outcomes (COs): At the end of the course the student should be able to:

1. Knowledge about need and scope of Intellectual property rights
2. Acquire knowledge about filing patents, process, and infringement
3. Knowledge about trademarks, industrial designs, and copyright

Content	**45 Hrs**
Unit–I - Introduction to Intellectual property rights (IPR): Genesis and scope. Types of Intellectual property rights - Patent, Trademarks, Copyright, Design, Trade secret, Geographical indicators, Plant variety protection. National and International agencies – WIPO, World Trade Organization (WTO), Trade-Related Aspects of Intellectual Property Rights (TRIPS), General Agreement on Tariffs and Trade (GATT).	**14 Hrs**
Unit -II - Patenting, process, and infringement Basics of patents - Types of patents; Patentable and Non-Patentable inventions, Process and Product patent. Indian Patent Act 1970; Recent amendments; Patent Cooperation Treaty (PCT) and implications. Process of patenting. Types of patent applications: Provisional and complete specifications; Concept of "prior art", patent databases (USPTO, EPO, India). Financial assistance, schemes, and grants for patenting. Patent infringement- Case studies on patents (Basmati rice, Turmeric, Neem)	**14 Hrs**
Unit -III - Trademarks, Copy right, industrial Designs Trademarks- types, Purpose and function of trademarks, trademark registration, Protection of trademark. Copy right- Fundamentals of copyright law, Originality of material, rights of reproduction, industrial Designs: Protection, Kind of protection provided by industrial design.	**14 Hrs**

Pedagogy

Summative assessment = 40 marks theory paper, End semester Exam duration of exam 2 hours	
Formative Assessment Occasion / type	Weightage in Marks
Assignment	10
Seminar	10
Case studies	10
Test	10
Total	40 marks

References	
1	Manish Arora. 2007. Universal's Guide to Patents Law (English) 4th Edition) -Publisher: Universal Law Publishing House
2	Kalyan C. Kankanala. 2012. Fundamentals of Intellectual Property. Asia Law House
3	Ganguli, P. 2001. Intellectual Property Rights: Unleashing the knowledge economy. New Delhi: Tata McGraw-Hill Pub
4	World trade organization - http://www.wto.org
5	World Intellectual Property organization – www.wipo.intOffice of the controller general of Patents, Design & Trademarks - www.ipindia.nic.in

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Submitted to
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Learning outcomes specify what exactly the graduates are expected to know after completing a Programme of study. The expected learning outcomes are used as reference points to help formulate graduate attributes, qualification descriptors, Programme learning outcomes and course learning outcomes. Keeping the above objectives of higher education in mind the Learning Outcome-Based Curriculum Framework (LOCF) for the discipline of Microbiology has been prepared and presented here.

Government of Karnataka

Model Curriculum

Program Name	**B.Sc. Discipline**	Total Credits for the Program	**176**
Core	**Microbiology**	Starting year of implementation	**2021-22**

Program Outcomes: At the end of the program the student should be able to:

(Refer to literature on outcome-based education (OBE) for details on Program Outcomes)

PO1. Knowledge and understanding of concepts of microbiology and its application inpharma, food, agriculture, beverages, nutraceutical industries.

PO2. Understand the distribution, morphology and physiology of microorganisms anddemonstrate the skills in aseptic handling of microbes including isolation,identification and maintenance

PO3. Competent to apply the knowledge gained for conserving the environment andresolving the environmental related issues.

PO4. Learning and practicing professional skills in handling microbes and contaminantsin laboratories and production sectors.

PO5. Exploring the microbial world and analysing the specific benefits and challenges.

PO6. Applying the knowledge acquired to undertake studies and identify specificremedial measures for the challenges in health, agriculture, and food sectors.

PO7. Thorough knowledge and application of good laboratory and good manufacturingpractices in microbial quality control.

PO8. Understanding biochemical and physiological aspects of microbes and developingbroader perspective to identify innovative solutions for present and futurechallenges posed by microbes.

PO9. Understanding and application of microbial principles in forensic and workingknowledge about clinical microbiology.

PO10. Demonstrate the ability to identify ethical issues related to recombinant DNAtechnology, GMOs, intellectual property rights, biosafety and biohazards.

PO11. Demonstrate the ability to identify key questions in microbiological research,optimize research methods, and analyse outcomes by adopting scientificmethods, thereby improving the employability.

PO12. Enhance and demonstrate analytical skills and apply basic computational andstatistical techniques in the field of microbiology.

Assessment:

Weightage for assessments (in percentage)

Type of Course	Formative Assessment / IA	Summative Assessment
Theory	40	60
Practical	25	25
Projects	-	-
Experiential Learning (Internships etc.)	-	-

Contents of Courses for B.Sc. Microbiology as Major

Model II A

Semester	Course code	Course Category	Theory/Practical	Credits	Paper Title	Marks	
						S.A	I.A
3.	MBL-103	DSC- 7	Theory	4	Microbial Diversity	60	40
			Practical	2	Microbial Diversity	25	25
		OE- 3	Theory	3	Microbial Entrepreneurship	60	40
4.	MBL-104	DSC- 8	Theory	3	Microbial Enzymology and Metabolism	25	25
			Practical	2	Microbial Enzymology and Metabolism	60	40
		OE- 4	Theory	3	Human Microbiome	25	25

Government of Karnataka

Model Curriculum

Program Name	**BSc Microbiology**		Semester	**Third Sem**
Course Title	**Microbial Diversity**			
Course No.	**MBL-103**	**DCS -3T**	No. of Theory Credits	**4**
Contact hours	**56hrs**		Duration of ESA/Exam	**Hours**
Formative Assessment Marks			Summative Assessment Marks	

Course Pre-requisite (s):.

Course Outcomes (COs): At the end of the course the student should be able to:

1. Knowledge about microbes and their diversity
2. Study, characters, classification and economic importance of Pro-eukaryotic and Eukaryotic microbes.
3. Knowledge about viruses and their diversity

Content	Hrs
Unit–I	**06 Hrs**
Biodiversity and Microbial Diversity Concept, definition, and levels of biodiversity; Biosystematics – Major classification systems- Numerical and Chemotaxonomy. Study and measures of microbial diversity; Conservation and Economic values of microbial diversity.	
Unit -II	
Diversity of Prokaryotic Microorganisms General characters; Classification; Economic importance; Distribution and factors regulating distribution. **Bacteria and Archaea-** An overview of Bergey's Manual of Systematic Bacteriology.**Bacteria-** *Escherichia coli, Bacillus subtilis, Staphylococcus aureus* **Cyanobacteria**- *Nostoc, Microcystis, Spirulina* **Archea***Thermusaquaticus,* Methanogens **Actinomycetes:** *Streptomyces, Nocordia, Frankia* **Rickettsiae**- *Rickettsia rickettsi* **Chlamydiae –** *Chlamydia trachomatis* **Spirochaetes**- *Trepanemapallidum*	
Unit -III	
Diversity of Eukaryotic Microorganism **Diversity of Eukaryotic Microorganism**: General characters; Classification- Economic importance **Fungi:** Ainsworth classification- detailed study up to the level of classes, Salient features and reproduction. Type study: *Rhizopus, Saccharomyces, Aspergillus, Agaricus, Fusarium*	

Algae: Occurrence, distribution, and symbiotic association- Lichen; thallus organization and types. Type study: *Chlorella, Cosmarium,* Diatoms,*Gracilaraia,* **Protozoa:** Classification up to the level of classes. Type study: *Amoeba, Euglena, Trichomonas, Paramoecium, Trypanosoma*	
Unit -IV	
Diversity of Virus General properties and structure, Isolation and purification and assay of virus. Principles of Viral Taxonomy- Baltimore and ICTV and the recent trends. Capsid symmetry- Icosahedral, helical, complex **Animal:** HIV, Corona, Ortho and paramyxovirus, Oncogenic virus **Plants:** TMV, Ring spot virus **Microbial:** T4/T7/lambda/cyano/mycophages. Sub viral particles. Virans and Prions. Ortho and Paramyxo Virus. Oncogenic Virus.	

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	**Program Outcomes (POs)**											
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
Knowledge about microbes and their diversity		✓			✓			✓				
Study, characters, classification and economic importance of Pro-eukaryotic and Eukaryotic microbes		✓	✓		✓							
Knowledge about viruses and their diversity		✓				✓				✓		

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz and Assignments

Summative Assessment = 60 Marks	
Formative Assessment Occasion / type	**Weightage in Marks**
Attendance	10
Seminar	10
Debates and Quiz	10
Test	10
Total	**60 marks + 40 marks = 100 marks**

Course Title	**Microbial Diversity**		Practical Credits	**2**
Course No.	**MBL-103**	**DSC-4P**	Contact hours	

Content

1. Study of morphology of bacteria
2. Isolation of bacteria from soil
3. Isolation of bacteria from air and water
4. Isolation of fungi from soil
5. Isolation of fungi from air and water
6. Cultivation of Cyanobacteria
7. Cultivation of actinomycetes
8. Measurement of microbial cell size by Micrometry
9. Cyanobacteria Nostoc, MicrocyctisSpirulina
10. Study of Algae Chlorella Diatoms, Gracilaria
11. Study of Fungi Rhizopus Saccharomyces Agaricus
12. Study of Protozoa Amoeba Paramoecium Euglena
13. Study of Photographs or Models
14. HIV, TMV, Corona virus T4Phage
15. Paramyxovirus Oncogenic viruses

Practical assessment

Assessment			
Formative assessment		**Summative Assessment**	**Total Marks**
Assessment Occasion / type	**Weightage in Marks**	**Practical Exam**	
Record	5	25	**50**
Test	10		
Attendance	5		
Performance	5		
Total	**25**	**25**	

References	
1	Black, J.G. 2002. Microbiology-Principles and Explorations. John Wiley and Sons, Inc. New York
2	Brock, T.D. and Madigan, M.T. 1988. Biology of Microorganisms, V Edition. Prentice Hall. New Jersey
3	Dimmock, N. J., Easton, A. J., and Leppard, K. N. 2001. Introduction to Modern Virology. 5thedn. Blackwell publishing, USA
4	Flint, S.J., Enquist, L.W., Drug, R.M., Racaniello, V.R. and Skalka, A.M. 2000. Principles of Virology- Molecular Biology, Pathogenesis and Control. ASM Press, Washington, D.C
5	Prescott, Harley, Klein's Microbiology, J.M. Willey, L.M. Sherwood, C.J. Woolverton, 7th International, edition 2008, McGraw Hill
6	Vashishta B.R, Sinha A.K and Singh V. P. Botany – Fungi 2005, S. Chand and Company Limited, New Delhi
7	Kotpal R.L Protozoa 5th Edition 2008, Rastogi Publications, Meerut, New Delhi.
8	Brock Biology of Microorganisms, M.T. Madigan, J.M. Martinko, P. V. Dunlap, D. P. Clark- 12th edition, Pearson International edition 2009, Pearson Benjamin Cummings

References	
9	Microbiology – An Introduction, G. J. Tortora, B. R. Funke, C. L. Case, 10th ed. 2008, Pearson Education
10	General Microbiology, Stanier, Ingraham et al, 4th and 5th edition 1987, Macmillan education limited
11	Microbiology- Concepts and Applications, Pelczar Jr. Chan, Krieg, International ed, McGraw Hill
12	Alexopoulos, C.J., Mims, C.W., and Blackwell, M. 2002. Introductory Mycology. John Wiley and Sons (Asia) Pvt. Ltd. Singapore. 869 pp
13	Vashishta, B.R Sinha A.K and Singh V. P. Botany - Algae 2005 S. Chand and Company Limited, New Delhi
14	A Textbook of Microbiology, R. C. Dubey, and D. K. Maheshwari, 1st edition, 1999, S. Chand & Company Ltd, New Delhi
15	Foundations in Microbiology, K. P. Talaro, 7th International edition 2009, McGraw Hill

Date: Subject Committee Chairperson

Government of Karnataka

Model Curriculum

Program Name	**BSc Microbiology**		Semester	**Third Sem**
Course Title	**Microbial Entrepreneurship**			
Course Code		**OE-3**	No. of Theory Credits	**3**
Contact hours	**Lecture**		Duration of ESA/Exam	**Hours**
	Practical			
Formative Assessment Marks	**40**		Summative Assessment Marks	**60**

Course Pre-requisite(s):	
Course Outcomes (COs): At the end of the course the student should be able to: 1. Demonstrate entrepreneurial skills 2. Acquire knowledge industrial entrepreneurship 3. Acquire knowledge about Healthcare Entrepreneurship	
CONTENT	**42 HRS**
Unit–I	**14 Hrs**
General Entrepreneurship Entrepreneurship and microbial entrepreneurship - Introduction and scope, Business development, product marketing, HRD, Biosafety and Bioethics, IPR and patenting, Government organization/ institutions/ schemes, Opportunities and challenges.	
UNIT -II	**14 HRS**
Industrial Entrepreneurship Microbiological industries – Types, processes and products, Dairy products, Fermented foods, Bakery and Confectionery, Alcoholic products and Beverages, Enzymes – Industrial production and applications. Biofertilizers and Biopesticides, SCP (Mushroom and Spirulina) etc.	
Unit -III -	**14 Hrs**
Healthcare Entrepreneurship Production and applications: Sanitizers, Antiseptic solutions, Polyhenols (Flavonoids), Alkaloids, Cosmetics, Biopigments and Bioplastics, vaccines, Diagnostic tools and kits.	

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz and Assignments

Summative Assessment = 60 Marks	
Formative Assessment Occasion / type	**Weightage in Marks**
Attendance	10
Seminar	10
Debates and Quiz	10
Test	10
Total	**60 marks + 40 marks = 100 marks**

References	
1	Srilakshmi B, (2007), Dietetics. New Age International publishers. New Delhi
2	Srilakshmi B, (2002), Nutrition Science. New Age International publishers. New Delhi
3	Swaminathan M. (2002), Advanced text book on food and Nutrition. Volume I. Bappco
4	Gopalan.C.,RamaSastry B.V., and S.C.Balasubramanian (2009), Nutritive value of Indian Foods.NIN.ICMR.Hyderabad.
5	Mudambi S R and Rajagopal M V, (2008), Fundamentals of Foods, Nutrition & diet therapy by New Age International Publishers, New Delhi

Date: Subject Committee Chairperson

Government of Karnataka

Model Curriculum

Program Name	**BSc Microbiology**		Semester	**Fourth Sem**
Course Title	**Microbial Enzymology and Metabolism**			
Course No.	**MBL:104**	**DCS -4T**	No. of Theory Credits	**4**
Contact hours	**56 hrs**		Duration of ESA/Exam	**2 ½ Hours**
Formative Assessment Marks	**40**		Summative Assessment Marks	**60**

Course Pre-requisite (s):.

Course Outcomes (COs): At the end of the course the student should be able to:

1. Differentiating concepts of chemoheterotrophic metabolim and chemolithotrophic metabolism.
2. Describing the enzyme kinetics, enzyme activity and regulation.
3. Differentiating concepts of aerobic and anaerobic respiration and how these are manifested in the form of different metabolic pathways in microorganisms

Content	**56 Hrs**
Unit–I	**14 Hrs**
Metabolism of Carbohydrates Chemoheterotrophic Metabolism- Anaerobic respiration and fermentation Concept of aerobic respiration, anaerobic respiration and fermentation. Sugar degradation pathways i.e. EMP, ED, Pentose phosphate pathway, Phosphoketolase pathway. TCA cycle. Fermentation - Fermentation balance, concept of linear and branched fermentation pathways. Fermentation pathways: Alcohol fermentation and Pasteur effect; Butyric acid and Butanol-Acetone Fermentation, Mixed acid and 2,3-butanediol fermentation, Propionic acid Fermentation (Succinate pathway and Acrylate pathway), acetate Fermentation Chemolithotrophic Metabolism:Chemolithotrophy - Hydrogen oxidation, Sulphur oxidation, Iron oxidation, Nitrogen oxidation. Anaerobic respiration with special reference to disimilatory nitrate reduction and sulphate reduction.	

Unit -II	14 Hrs
. **Metabolism of aminoacids, nucleotides and lipids** **1.Nitrogen Metabolism** Introduction to biological nitrogen fixation Ammonia assimilation. Assimilatory nitrate reduction, dissimilatory nitrate reduction, denitrification **2. Biosynthesis of ribonucleotides and deoxyribonucleotides** The de novo pathway. Regulation by feedback mechanisms. Recycling via the salvage pathway **3. Amino acid degradation and biosynthesis** **4. Lipid degradation and biosynthesis** **5.Metabolism of one carbon compounds:**Methylotrophs :i. Oxidation of methane, methanol, methylamines; ii. Carbon assimilation in methylotrophic bacteria and yeasts Methanogens: i. Methanogenesis from H_2, CO_2, CHOH, HCOOH, methylamines; ii. Energy coupling and biosynthesis in methanogenic bacteria Acetogens: Autotrophic pathway of acetate synthesis **6. Metabolism of two-carbon compounds:Acetate**: i. Glyoxylate cycle. **Acetic acid bacteria**: Ethanol oxidation, sugar alcohol oxidation. **Glyoxylate and glycolate metabolism**:i. Dicarboxylic acid cycle, ii. Glycerate pathway iii. Beta hydroxyaspartate pathway **Oxalate** as carbon and energy source	
Unit -III	**14 Hrs**
Basics of Enzymes **Definitions of terms** – enzyme unit, specific activity and turnover number, exo/ endoenzymes, constitutive/ induced enzymes, isozymes. Monomeric, Oligomeric and Multimeric enzymes. Multienzyme complex: pyruvate dehydrogenase; isozyme: lactate dehydrogenase. Ribozymes, abzymes **Structure of enzyme**: Apoenzyme and cofactors, prosthetic group-TPP, coenzyme, NAD, metal cofactors. Classification of enzymes, Mechanism of action of enzymes: active site, transition state complex and activation energy. Lock and key hypothesis and Induced Fit hypothesis. Multisubstrate reactions -Ordered, Random, Ping-pong. **Enzyme catalysis:**Catalytic mechanisms with type examples, catalytic mechanisms and testing - Serine proteases and Lysozyme	

Unit –IV	14 Hrs
Enzyme Kinetics and Regulation Enzyme Kinetics: Kinetics of one substrate reactions. i. Equilibrium assumptions ii. Steady state assumptions iii. Lineweaver-Burk, Hanes-Woolf, Eadie-Hofstee equations and plots.Kinetics of enzyme inhibition. Competitive, non-competitive and uncompetitive inhibition.Effect of changes in pH and temperature on enzyme catalysed reaction.Kinetics of two substrate reactions. Pre steady state kinetics. Kinetics of immobilized enzymes Enzyme regulation:Allosteric enzyme - general properties, Hill equation, KoshlandNemethy and Filmer model, Monod Wyman and Changeux model. Covalent modification by various mechanisms. Regulation by proteolytic cleavage - blood coagulation cascade. Regulation of multi-enzyme complex- Pyruvate dehydrogenase. Feedback inhibition.HIV enzyme inhibitors and drug design	

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs 1-12)

Course Outcomes (COs) / Program Outcomes (POs)	Program Outcomes (POs)											
	1	2	3	4	5	6	7	8	9	10	11	12
Differentiating concepts of chemoheterotrophic metabolim and chemolithotrophic metabolism		✓						✓			✓	
Describing the enzyme kinetics, enzyme activity and regulation.		✓						✓			✓	
Differentiating concepts of aerobic and anaerobic respiration and how these are manifested in the form of different metabolic pathways in microorganisms		✓						✓			✓	

Pedagogy: Lectures, Seminars, Industry Visits, Debates, Quiz and Assignments

Summative Assessment = 60 Marks	
Formative Assessment Occasion / type	**Weightage in Marks**
Attendance	10
Seminar	10
Debates and Quiz	10
Test	10
Total	**60 marks + 40 marks = 100 marks**

Course Title	**Microbial Enzymology and Metabolism**		Practical Credits	**2**
Course No.	**MBL:104**	**DSC-4P**	Contact hours	

Content

1. Handling of micropipettes and checking their accuracy
2. Isolation of cholesterol and lecithin from egg yolk
3. Identification of fatty acids and other lipids by TLC/GC
4. Determination of degree of unsaturation of fats and oils
5. Isolation of lactose from bovine milk
6. Estimation of total sugars by the phenol-sulphuric acid method
7. Estimation of DNA - DPA method & UV absorbance method
8. Estimation of RNA (Orcinol method)
9. Isolation of glutamic acid from gluten
10. Determination of molar absorption coefficient (ε) of l-tyrosine
11. Determination of the isoelectric point of the given protein
12. Estimation of polyphenols/ tannins by Folin- Denis method
13. Chemotaxis of *Pseudomonas*
14. Demonstration of alcoholic fermentation
15. Effect of variables on enzyme activity (amylase): a. Temperature b. pH c. substrate concentration d. Enzyme concentration e. Determination of Km of amylase (Lineweaver-Burke plot; Michaelis-Menton graph)

Practical assessment

Assessment			
Formative assessment		Summative Assessment	Total Marks
Assessment Occasion / type	Weightage in Marks	Practical Exam	
Record	5	25	50
Test	10		
Attendance	5		
Performance	5		
Total	25	25	

References	
1	Philipp. G. Mannual of Methods for General Bacteriology.
2	David T. Plummer. An Introduction to Practical Biochemistry
3	Biochemistry- A Problem Approach, Wood W. B. Wilson J.H., Benbow R.M. and Hood L.E.2nd ed., 1981, The Benjamin/ Cummings Pub.co
4	Biochemical calculations, Segel I.R., 2nd ed., 2004, John Wiley and Sons
5	Biochemical Calculations, Irwin H. Segel, 2nd Edition John Wiley & Sons

Date: Subject Committee Chairperson

Government of Karnataka

Model Curriculum

Program Name	**BSc Microbiology**		Semester	**Fourth Sem**
Course Title	**Human Microbiome**			
Course Code		**OE-4T**	No. of Theory Credits	**3**
Contact hours	**Lecture**		Duration of ESA/Exam	**Hours**
	Practical			
Formative Assessment Marks	**40**		Summative Assessment Marks	**60**

Course Pre-requisite(s):	
Course Outcomes (COs): At the end of the course the student should be able to: 1. Articulate a deeper understanding on biological complexities of human micro biome. 2. Understand broader goals of biological anthropology. 3. Compare and contrast the microbiome of different human body sites and impact human health promotion	
Content	**45 Hrs**
Unit–I	**14 Hrs**
INTRODUCTION TO MICROBIOME Evolution of microbial life on Earth, Symbiosis host-bacteria . Microbial association with plants and animals, Symbiotic and parasitic, Normal human microbiota and their role in heatlh. Microbiomes other than digestive system.	
Unit -II	**14 Hrs**
MICROBIOMES AND HUMAN HEALTH Microbiome in early life, Nutritonal modulation of the gut microbiome for metabolic health- role of gut mocrobiomes in human obesity, human type 2 diabetes and longevity. Probiotics-Criteria for probiotics, Development of Probiotics for animal and human use; Pre and synbiotics. Functional foods-health claims and benefits, Development of unctional foods.	

Unit -III	14 Hrs
CULTURING OF MICROBES FROM MICROBIOMES Culturing organisms of interest from the microbiome : bacterial, archaeal, fungal, and yeast, viral. Extracting whole genomes from the microbiome to study microbiome diversity **Microbiomes and diseases:** Microbiome and disease risks: The gut microbiome and host immunity, bacteriocins and other antibacterials. Human microbiome research in nutrition	

Pedagogy

Summative assessment = 40 marks theory paper,End semester Exam duration of exam 2 hours	
Formative Assessment Occasion / type	**Weightage in Marks**
Assignment	10
Seminar	10
Case studies	10
Test	10
Total	**40 marks**

References	
1	
2	
3	
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Date: Subject Committee Chairperson