DISCIPLINE SPECIFIC CORE COURSE – 4: Bacterial Diversity and Systematics

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MICROB-DSC201: **Bacterial Diversity and Systematics**	**4**	**3**	**0**	**1**	**Class XII pass with Biology/ Biotechnology/ Biochemistry**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this course is for students to acquire in-depth knowledge of bacterial cell structure and organization, cultivation methods and growth patterns, and reproduction.
- Further, the student gains insights into the vastness of bacterial diversity and its significance

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to describe the classification of bacteria based on their modes of nutrition, and the diverse physiological types of bacteria as determined by variable environmental factors.
- Student will be able to describe the fundamental concepts and terminology of taxonomic organization and parameters used in classifying bacteria, and the molecular analytic approaches used to classify diverse bacteria. Student will be avle to discuss about the use of rRNA analysis as a means of developing phylogenetic relationships.
- Student will be able to describe the major groups of archaea, their stand-out physiological and structural features, as well as their ecological niches and economic significance.
- Student will be able to discuss the major groups of eubacteria, including bacteria with special features such as mycoplasma, rickettsia, chlamydia and spirochetes.

- Student will be able to demonstrate bacteria count by serial dilution and identify different types of bacteria using various media.
- Student will be able to analyze bacteria microscopically using various staining methods.

SYLLABUS OF DSC-4

UNIT – I (1 Week)

Bacterial diversity based on nutritional and physiological factors: Classification of bacteria based on nutrition: lithotrophs, organotrophs, phototrophs, chemotrophs. Diversity based on physiological factors: solutes, pH, temperature, oxygen, pressure, radiation.

UNIT – II (4 Weeks)

Bacterial systematics: Definitions: Concepts of systematics, taxonomy, taxa, species, strains. Conventional and modern approaches to classification: Phenetic, phylogenetic, genotypic classification, evolutionary chronometers, rRNA oligonucleotide sequencing (ribotyping) and signature sequences, nucleic acid hybridization, genomic fingerprinting, MLSA, RFLP to study polyphasic bacterial taxonomy, FAME analysis

UNIT – III (4 Weeks)

Diversity of Archaea: General characteristics with reference to genera belonging to Crenarchaeota (*Sulfolobus*) and Euryarchaeota: Methanogens (*Methanobacterium)*, thermophiles (*Pyrococcus)*, acidophiles (*Picrophilus*) and halophiles (*Halobacterium*). Key features of other groups: Thaumarchaeota, Lokiarchaeota, Nanoarchaeota

UNIT – IV (6 Weeks)

Diversity of Eubacteria: Key features and significance of the following genera: Deeply Branching Bacteria**:** *Thermotoga, Deinococcus.* Proteobacteria: Classes and Types. Alphaproteobacteria: *Rhizobium, Ricketssia.* Betaproteobacteria: *Neisseria, Thiobacillus.* Gammaproteobacteria: *Escherichia, Yersinia.* Deltaproteobacteria: *Myxococcus* and *Bdellovibrio.* Epsilonproteobacteria: *Campylobacter, Helicobacter.* Zetaproteobacteria: *Mariprofundus ferrooxydans.* Non-Proteobacteria: Chlamydia, Spirochaetes. Gram Positive bacteria having genomes of low GC content: Firmicutes *Clostridium, Bacillus.* Tenericute *Mycoplasma.* Gram Positive bacteria having genomes of high GC content: *Mycobacterium, Streptomyces*

Practical component

UNIT 1: (5 Weeks)

Use of McConkey agar medium as a differential medium to distinguish between lactose- fermenting and lactose-nonfermenting gram negative bacteria. Enumeration of viable bacterial / CFU count using serial dilution and spread plate method/pour plate method.

Unit 2: (10 Weeks)

Bacterial staining methods: Use of light microscope to observe bacteria. Simple staining, Gram staining, Negative staining and Acid-fast staining (permanent mount). Endospore staining using malachite green. Observation of bacterial capsules by negative staining. Demonstration of bacterial motility by hanging drop method/flagellar staining.

Essential/recommended readings

Theory:

1. Brock Biology of Microorganisms by M.T. Madigan,J. Aiyer,D. Buckley,W.Sattley and D. Stahl.16th edition. Pearson, USA. 2021.
2. Prescott's Microbiology by J. M. Willey, K. Sandman and D. Wood. 11th edition. McGrawHill Higher Education, USA. 2019.
3. Microbiology: Principles and Explorations by J.G. Black and L.J. Black. 10th edition. Wiley, USA. 2019.
4. Microbiology: An Introduction by G.J. Tortora, B.R. Funke,and C.L. Case. 13th edition. Pearson, USA. 2018.
5. Principles of Microbiology by R. M. Atlas. 2nd edition. W.M.T. Brown Publishers, USA. 1997.
6. Microbiology by M. J. Pelczar, E. C. S. Chan and N. R. Krieg. 5th edition. McGraw Hill, USA. 1993.

Practicals:

1. Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition. Pearson Education, USA. 2020.
2. Basic Lab Manual of Microbiology, Biochemistry and Molecular Biology by A. Ray and R. Mukherjee. Taurean Publisher, India. 2019.
3. Benson's Microbiological applications: Laboratory manual in general microbiology by A.E. Brown and H. Smith H. 15th edition. McGraw-Hill Education, USA. 2022.
4. Manual of Microbiology: Tools & Techniques by A.K. Sharma. 1st edition. Ane Books, India. 2007.

Suggestive readings

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.

DISCIPLINE SPECIFIC CORE COURSE – 5: Biochemistry of Nucleic Acids and Proteins

CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MICROB-DSC202: **Biochemistry of Nucleic Acids and Proteins**	**4**	**3**	**0**	**1**	**Class XII pass with Biology/ Biotechnology/ Biochemistry**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this course is to enable the students to develop a clear understanding of the structures and properties of biomolecules: proteins, lipids, carbohydrates and nucleic acids, and lays the foundation for a basic understanding of cellular processes.
- The students will gain an understanding of the principles of thermodynamics and bioenergetics, and will be introduced to the basic concepts of enzymes and enzyme kinetics.
- This course will empower the students with essential knowledge to support learning in subsequent courses offered in the program.

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to describe the chemical structures of the building blocks of nucleic acids and the structures of the different types of DNA.
- Student will be able to describe the composition of proteins, and the structure and chemical properties of the different amino acids.
- Student will be able to describe the structural attributes of some classical proteins.
- Student will be able to analyze the constituents of an active enzyme, the interactions at enzyme active sites, and steady- state kinetics, allosteric regulation, and will be able to describe many different forms of enzymes found in living cells.

- Student will be able to analyze the structures of biomolecules using different types of models.
- Student will be able to analyze proteins qualitatively and quantitatively using different biochemical tests.

SYLLABUS OF DSC-5

UNIT – I (3 Weeks)

Nucleic acids: Introduction to importance of nucleic acids. Structures of purines and pyrimidines, nucleosides and nucleotides. Formation of DNA chains by phosphodiester bonds. Structure of DNA: the double helix. Types of DNA: A, B and Z. Properties of DNA. Types of RNA:rRNA, mRNA, tRNA

UNIT – II (3 Weeks)

Composition of Proteins: Introduction to the importance of proteins. Amino acids as building blocks: structures and properties of standard amino acids. Zwitterion, titration curves of amino acids, and determination of pKa and pI of monocarboxylic amino acid. Ninhydrin reaction. Essential amino acids, non-protein amino acids: beta-alanine, D-alanine and rare amino acids: selenocysteine, hydroxyproline. Oligopeptides: structure and functions of glutathione and aspartame

UNIT – III (2 Weeks)

Protein structure: primary, secondary (α helix, β sheets), super secondary (collagen), tertiary (myoglobin) and quaternary (haemoglobin). Structure of insulin

UNIT – IV (7 Weeks)

Enzymes: Concept of holoenzyme, coenzyme and apoenzyme. Cofactors: prosthetic group, Coenzyme: NAD, metal cofactors. Enzyme nomenclature and classification. Active site and activation energy. Lock and key hypothesis, induced fit hypothesis. Concept of steady state kinetics, Vmax and Km, significance of hyperbolic and double reciprocal plots. Enzyme unit, specific activity and turnover number. Temperature and pH effects on enzyme activity. Michaelis-Menten kinetics versus kinetics of allosteric enzymes. Competitive, non-competitive and uncompetitive enzyme inhibition. Allosteric enzymes: Phosphofructokinase. Multienzyme complex: pyruvate dehydrogenase. Isozyme: lactate dehydrogenase. RNA as enzymes: Hammerhead ribozyme

Practical component

UNIT 1: (5 Weeks)

Study of biomolecules with the help of models: The use of different types of models for visualizing molecular structures of biomolecules: Space filling models, Ball and stick models, Ribbon Models. Study of protein secondary and tertiary structures with the help of photographs/ models: collagen, myoglobin, hemoglobin.

Unit 2: (10 Weeks)

Qualitative and quantitative analysis of proteins: Qualitative analysis of proteins using Xanthoproteic Test, Millon's Test, Biuret Test, Ninhydrin Test. Quantitative estimation of proteins by Lowry's method using bovine serum albumin as the standard. Demonstration of enzyme activity (amylase / urease / catalase) and effect of temperature, pH and heavy metal salt on activity.

Essential/recommended readings

Theory:

1. Lehninger Principles of Biochemistry by D.L. Nelson and M.M. Cox. 8th edition. W.H. Freeman and Company, UK. 2021.
2. Biochemistry by J.M. Berg, J.L.Tymoczko, G.J. Gatto, and L. Stryer. 9th edition. W.H. Freeman and Company, UK. 2019.
3. Biochemistry by T.A. Brown and S.N. Mukhopadhyay. 1st edition. Viva Books, India. 2018.
4. Fundamentals of Biochemistry by D. Voet, J.G. Voet and C.W. Pratt. 5th edition. John Wiley and Sons, UK. 2016.

Practicals:

1. Practical Biochemistry by R.C. Gupta and S. Bhargava. 5th edition. CBS Publishers and Distributors, India. 2018.
2. An Introduction to Practical Biochemistry by D. Plummer. 3rd edition. McGraw Hill Education, India. 2017.
3. Introduction to Practical Biochemistry (ebook) by G. Hegyi, J. Kardos, M. Kovacs, A. Malnasi-Csizmadia, L. Nyitray, G. Pal, L. Radnai, A. Remenyi and I. Venekei. Eotvos Lorand University. 2013.
4. Modern Experimental Biochemistry by Rodney Boyer.3rd edition. Pearson, India. 2002.

Suggestive readings

Note: Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time. **CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE**

DISCIPLINE SPECIFIC CORE COURSE – 6: Food and Dairy Microbiology

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/ Practice		
MICROB-DSC203: Food and Dairy Microbiology	**4**	**3**	**0**	**1**	**Class XII pass with Biology/ Biotechnology/ Biochemistry**	**NIL**

Learning Objectives

The Learning Objectives of this course are as follows:

- The main objective of this course is to familiarise students with the importance of microorganisms in food spoilage as well as in preparation of certain foods, and to acquaint the students with quality control and safety indices used in the food industry

Learning outcomes

The Learning Outcomes of this course are as follows:

- Student will be able to evaluate the factors governing microbial growth in foods and sources of food contamination.
- Student will be able to discuss the factors that govern spoilage of some common foods due to microbial activity.
- Student will be able to describe various physical and chemical methods used for food preservation.
- Student will be able to analyse the role of microorganisms in the production of fermented dairy and non-dairy food products. Will understand the health benefits of prebiotics, probiotics and synbiotics.
- Student will be able to discuss on the common food-borne diseases and preventive measures to be used, as well as methods for detection of food-borne pathogens.
- Student will be able to determine the importance of quality control in the food industry and describe various indices being used to measure quality and safety in the food industry.

SYLLABUS OF DSC-6

UNIT – I (3 Weeks)

Foods as a substrate for microorganisms: Natural microflora and contamination sources of foods. Factors impacting growth and survival of microbes in foods. Intrinsic : pH, moisture content, nutrient availability, Eh values, antimicrobial substances and biological structures. Extrinsic: temperature, relative humidity and gaseous storage. Spoilage of foods by microorganisms: Factors responsible for food spoilage. Non- perishable, -semi perishable and - highly perishable foods. Spoilage of vegetables, fruits, meat, eggs, milk, butter, bread, and canned foods

UNIT – II (3 Weeks)

Food preservation methods: Physical methods of food preservation: Temperature control (low: refrigeration, freezing; high: boiling, blanching, pasteurization, UHT, aseptic packaging). Canning: home and commercial. Dehydration: natural drying, artificial drying, freeze drying, smoking and tying of water molecules, reduced water activity products. Irradiation: radicidation, radurization, radappertization. Hydrostatic pressure, high voltage pulse, microwave processing. Chemicals used in food preservation: salt, sugar, organic acids, SO2, nitrites and nitrates, ethylene oxide, antibiotics and bacteriocins

UNIT – III (3 Weeks)

Fermented dairy and non-dairy foods: Starter cultures. Fermented foods: yogurt, acidophilus milk, kumiss, kefir, dahi, cheese, bread, dosa, kanji, sauerkraut, soy sauce, tempeh, and fermented meat (sausages). Concept, health benefits and limitations of prebiotics, probiotics and synbiotics. Selection criteria for probiotic. Probiotic foods available in the market.

UNIT – IV (4 Weeks)

Food intoxications, food infections and detection of food borne pathogens. Causative agents, foods involved, symptoms and preventive measures in food-borne diseases caused by Clostridium botulinum, Shigella (bacillary dysentery), Vibrio cholerae, Escherichia coli, Yersinia enterocolitica, Salmonella (food infection), Entamoeba histolytica. Mycotoxins: aflatoxins (Aspergillus). Detection of food-borne pathogens: culture-based as well as rapid detection methods

UNIT – V (2 Weeks)

Quality control in the Food Industry: Total Quality Management (TQM): concepts and approaches. Hazard Analysis of Critical Control Point (HACCP) for food safety: principles and limitations. Indices of food quality (IFQ): FSSAI standard, ISO certification.

Practical component

UNIT 1: (7.5 Weeks)

Microbial spoilage of food and fermented foods:

Isolation and identification of spoilage fungi from various spoiled vegetables/ fruits: collection of spoilt food samples, point inoculation on suitable media, preparation of temporary mounts, and microscopic observations. Isolation and identification of spoilage fungi from spoiled breads using similar methods. Comparison of the fungi identified in the two categories of foods. Fermented

foods: Production of fermented foods using starter cultures and normal microflora of food. Preparation of yogurt / dahi. Preparation of sauerkraut / kanji. Preparation of buttermilk and butter. Preparation of kefir using kefir grains. Student research study project: unusual fermented foods from India and around the world.

Unit 2: (7.5 Weeks)

Food Quality Control :

Methylene Blue Dye Reduction Test (MBRT) to assess the microbiological quality of raw versus pasteurized milk: principle of the method, performance of the test with various samples of milk, evaluation and grading of milk quality based on the results obtained. Evaluation of milk quality by assessing its bacterial load using the standard plate count with serial dilutions of the milk. Clot on boiling (COB) test of milk samples: principle, performance of the test with milk samples, and evaluation of milk quality based on results obtained. Alkaline phosphatase test to check efficiency of pasteurization of milk: principle, performance of the test with various pasteurized milk samples, evaluation of milk quality based on results obtained.

Essential/recommended readings

Theory:

1. Antimicrobials in Foods edited by P.M. Davidson, T.M. Taylor, and J.R.D. David. 4th edition. CRC Press, UK. 2020.
2. Food Microbiology by W.M. Foster. CBS Publishers & Distributors Pvt. Ltd. 2020
3. Food Microbiology by W.C. Frazier, D.C. Westhoff, and N.M. Vanitha. 5th edition. TataMcGraw-Hill Publishing Company Ltd, India. 2017.
4. Food Microbiology by M.R. Adams, M.O. Moss and P. McClure. 4th edition. Royal Society of Chemistry, UK. 2015.
5. Fundamental Food Microbiology by B. Ray and A. Bhunia. 5th edition. CRC Press. 2013.
6. Basic Food Microbiology by G.J Banwart. 2nd edition. CBS Publishers and Distributors, India. 2004.
7. Modern Food Microbiology by J.M. Jay, M.J. Loessner and D.A. Golden. 7th edition. Springer, Switzerland. 2005.
8. The Microbiological Safety and Quality of Foods. Vol. 1-2 by B.M. Lund, T.C. Baird-Parker,and G.W. Gould. ASPEN Publication, USA. 2000.

Practicals:

1. Analytical Food Microbiology: A Laboratory Manual by A.E. Yousef, J.G. Waite-Cusic and J.J. Perry. 2nd Edition. Wiley Publishers, UK. 2022.
2. Laboratory Manual of Food Microbiology by N. Garg, K.L. Garg and K.G. Mukerji. Dreamtech Press, India. 2021.
3. Microbiology: A Laboratory Manual by J. Cappuccino and C.T. Welsh. 12th edition. Pearson Education, USA. 2020.
4. Laboratory manual of Microbiology and Biotechnology by K.R. Aneja. 2nd edition. Scientific International Pvt. Ltd., Delhi. 2018.

Suggestive readings

Note: **Examination scheme and mode shall be as prescribed by the Examination Branch, University of Delhi, from time to time.**