
# SOPHIA COLLEGE (AUTONOMOUS)

Affiliated to

UNIVERSITY OF MUMBAI

**Programme: Microbiology**

**Programme code: SMCB**

MSc-I Microbiology

(Choice Based Credit System with effect from the year 2023-2024)

Based on the National Education Policy 2020

**Programme Outline:** MSc-I Microbiology (SEMESTER I)

| Course code | Unit No | Name of the Unit | Credits |
|---|---|---|---|
| Mandatory 1 SMCB511MJ | | VIROLOGY AND CELL BIOLOGY-I | 4 |
| | 1 | Bacteriophages | |
| | 2 | Plant Viruses | |
| | 3 | Plasma membrane, Mitochondria and Chloroplast | |
| | 4 | Endomembrane system | |
| Mandatory 2 SMCB512MJ | | GENETICS-I | 4 |
| | 1 | Bacterial Cell Division, Chromosome partitioning and Gene expression | |
| | 2 | Recombination, Mutation and Genetic Complementation | |
| | 3 | Regulation of gene expression in bacteria | |
| | 4 | Eukaryotes gene expression – Regulation and epigenetic modifications | |
| Elective SMCB511E | | MICROBIAL BIOCHEMISTRY | 2 |
| | 1 | Bioorganic molecules | |
| | 2 | Analytical Biochemistry | |
| SMCB511RM | | RESEARCH METHODOLOGY | |
| | 1 | Basics of Research | 4 |
| | 2 | Sampling, data collection, interpretation and report writing | |
| | 3 | Scientific writing and ethics in research and publication | |
| | 4 | Biostatistics | |
| | | PRACTICALS | |
| Mandatory 1 SMCB511MJP | | VIROLOGY AND CELL BIOLOGY-I | 2 |
| Mandatory 2 SMCB512MJP | | GENETICS-I | 2 |
| Elective SMCB511EP | | MICROBIAL BIOCHEMISTRY | 2 |

**Programme Outline:** MSc-I Microbiology (SEMESTER II)

| Course code | Unit No | Name of the Unit | Credits |
|---|---|---|---|
| Mandatory 1 SMCB523MJ | | VIROLOGY AND CELL BIOLOGY-II | 4 |
| | 1 | Human Viruses | |
| | 2 | Tumor viruses and Prions | |
| | 3 | Cytoskeleton and Development of multicellular organisms | |
| | 4 | Cellular reproduction, Signaling, Communication and Programmed cell death | |
| Mandatory 2 SMCB524MJ | | GENETICS-II | 4 |
| | 1 | Mendelian Genetics, Extensions of Mendelian Genetics and Extranuclear Inheritance | |
| | 2 | Population Genetics, Transposable genetic elements and Cancer | |
| | 3 | Genomics | |
| | 4 | Bioinformatics | |
| Elective SMCB522E | | FOOD MICROBIOLOGY | 2 |
| | 1 | Applications of Microorganisms in food industry | |
| | 2 | Microbiological quality of Food | |
| SMCB521OJT | | Field Project/On Job Training (OJT) | 4 |
| | | PRACTICALS | |
| SMCB523MJP | | Virology and Cell Biology-II | 2 |
| SMCB524MJP | | Genetics –II | 2 |
| SMCB522EP | | Food Microbiology | 2 |

PREAMBLE:

The M.Sc program at Sophia College (Autonomous) is open to both female and male students. The M.Sc course is an extension of the undergraduate curriculum dealing with all the branches of Microbiology at a considerable depth and blends the upcoming fields as well as advances in the subject. Research is an integral aspect of the curriculum and includes planning and execution of a dissertation. The outcomes of a number of the dissertations have been published in peer reviewed journals.Participation and presentations - both oral and posters in conferences, workshops and research meets is encouraged. Field projects, Educational visits and short-term internships are also included. The students who complete the postgraduate programme in Microbiology are well trained in the subject and find employment in areas like Quality control, Research and Development, Clinical Research, Teaching etc.

**Program Objectives**

| | |
|---|---|
| **PO1** | To provide in depth knowledge to the learners in the conventional and emerging areas of Microbiology. |
| **PO2** | To help learners plan and execute research projects. |
| **PO3** | To train the learners to communicate the findings of the research projects effectively. |
| **PO4** | To create awareness among the learners about regulatory requirements and compliance, IPR and ethics. |

**PROGRAMME SPECIFIC OUTCOMES**

| | |
|---|---|
| **PSO1** | The learner will gain and apply knowledge about recent developments in Genetics, Virology, Cell Biology, Microbial Biochemistry, Medical Microbiology and Immunology, Environmental Microbiology, Food and Dairy Microbiology etc in order to solve problems affecting mankind. |
| **PSO2** | The learner will acquire knowledge about research methodology, plan and execute experiments using good laboratory practices, and interpret the experimental results effectively. |
| **PSO3** | The learner will be able to communicate their findings by virtue of doing poster /oral presentations in conferences/workshops, writing thesis, research papers, reports etc |
| **PSO4** | The learners will gain knowledge of regulatory compliance in various fields like clinical research, IPR and ethics by attending value added courses/seminars/webinars etc which may lead to employability. |

## SEMESTER 1

| | | |
|---|---|---|
| NAME OF THE COURSE | VIROLOGY AND CELL BIOLOGY-I | |
| CLASS | MSc- I | |
| COURSE CODE | SMCB511MJ (Mandatory 1) | |
| NUMBER OF CREDITS | 4 | |
| NUMBER OF LECTURES PER WEEK | 4 | |
| TOTAL NUMBER OF LECTURES PER SEMESTER | 60 | |
| EVALUATION METHOD | CONTINUOUS ASSESSMENT | SUMMATIVE ASSESSMENT |
| TOTAL MARKS | 50 | 50 |
| PASSING MARKS | 20 | 20 |

**COURSE OBJECTIVES:**

| | |
|---|---|
| CO 1 | To explain and describe the replication and regulation of transcription of bacteriophages. |
| CO 2 | To discuss the life cycle and other details of plant viruses and agents that infect plants such as Viroids. |
| CO 3 | To develop an understanding of cell biology of eukaryotic microorganisms and higher eukaryotes. |
| CO 4 | To explain cell biology of humans and animals in order to understand the life cycle of human and animal viruses. |

**COURSE LEARNING OUTCOMES:**

| | |
|---|---|
| CLO 1 | The learner will be able to explain and compare replication and regulation of gene expression of various bacteriophages. |
| CLO 2 | The learner will be able to explain the structure, replication and life cycle of specific plant viruses and prevention and control of plant viral infections. |
| CLO 3 | The learner will be able to describe the role of membrane proteins and transport, mitochondrial ETC, ATP synthesis and chloroplast in eukaryotes. |
| CLO 4 | The learner will be able to explain and discuss eukaryotic nuclear pore complex, Endoplasmic reticulum, Golgi complex and vesicle transport. |
| CLO 5 | The learner will be able to elaborate vacuoles of eukaryotic microorganisms such as algae and amoeba. |
| CLO 6 | The learner will be able to apply the knowledge of cell biology concepts such as endocytosis, clathrin coated vesicles, transport of mRNAs from nucleus to cytoplasm to understand the life cycle of human viruses in semester 2. |

| | |
|---|---|
| UNIT 1 | Bacteriophages (15 Lectures) |
| 1.1 | *E.coli* Phage T7: Genetic organization, regulation of transcription, DNA replication and maturation |
| 1.2 | a. *E.coli* Phage φX174: Replication, transcription, packaging<br>b. Filamentous DNA phages- M13: Attachment and entry, replication, assembly and release |
| 1.3 | Single stranded RNA phages MS-2 and Qβ: Genetic organization and life cycle |
| 1.4 | a. Lambda phage: lytic and lysogenic cycle<br>b. Bacteriophage Mu: Properties, Genetic organization and replication. |
| UNIT 2 | Plant Viruses (15 Lectures) |
| 2.1 | Viruses causing plant diseases: history, structure, transmission, symptoms, detection, prevention and control |
| 2.2 | Life cycles- overview Tobacco Mosaic Virus and Brome Mosaic Virus- Life cycle, host range, transmission, symptoms, diagnosis and control |
| 2.3 | Antiviral plant defense mechanisms: physical factors and RNA interference |
| 2.4 | Plant satellites and Viroids |
| UNIT 3 | Plasma membrane, Mitochondria and Chloroplast (15 Lectures) |
| | *Students to revise basic properties of cells, different classes of cells and functions of plasma membrane* |
| 3.1 | Plasma membrane<br>a. Chemical composition of membranes- (in brief) - Membrane lipids (phosphoglycerides, sphingolipids, cholesterol), carbohydrates<br>b. Structure and functions of membrane proteins - Integral membrane proteins, peripheral membrane proteins, lipid anchored membrane proteins<br>c. Movement of substances across cell membranes - Diffusion of substances through membranes (Voltage-gated channels, Ligand-gated channels, Mechano-gated channels), Facilitated diffusion, Active transport |
| 3.2 | Mitochondria<br>a. Mitochondrial structure and function- membrane and matrix<br>b. Oxidative metabolism in the mitochondrion<br>c. Role of mitochondria in the formation of ATP - Electron transport, types of electron carriers, Establishment of proton motive force<br>d. Machinery for ATP formation - Structure of ATP synthase, basis of ATP formation, Rotational catalysis |
| 3.3 | Chloroplast<br>a. Chloroplast structure and function<br>b. Photosynthetic metabolism |

| | |
|---|---|
| | c. Photosynthetic pigments, Photosynthetic units and reaction centers - PSII operations, PSI operations, and Photophosphorylation |
| UNIT 4 | Endomembrane system (15 Lectures) |
| 4.1 | Nuclear envelope, Structure of the Nuclear Pore Complex and its role in Nucleocytoplasmic exchange |
| 4.2 | The endoplasmic reticulum, The smooth endoplasmic reticulum , Functions of the rough endoplasmic reticulum- synthesis and processing of proteins |
| 4.3 | The Golgi complex, Types of vesicle transport and their functions- Cop II-coated vesicles, Cop I-coated vesicles and Endocytic pathway |
| 4.4 | Lysosomes, Contractile Vacuoles in algae and amoeba |
| 4.5 | Exosomes |

REFERENCES

Mandatory Paper 1 SMCB511MJ


1. Freifelder, David. (2004). Molecular Biology, 2nd edn. *Narosa Publishing House.*
2. Willey, Joanne M., Sherwood Linda M., Woolverton Christopher J. (2014) Prescott's Microbiology, 9th edn, *McGraw-Hill Higher Education.*
3. Madigan, M., Martinko, J., Bender, K., Buckley, D., and Stahl, D. (2015). Brock Biology of Microorganisms 14th edn. *Pearson.*
4. Shors, Teri. (2009). Understanding viruses, 1st edn. *Jones and Bartlett Publishers.*
5. Shors, Teri. (2016). Understanding viruses, 3rd edn. *Jones and Bartlett Publishers.*
6. Fields, Bernard N., Knipe, David, M., Howley, Peter.M., Griffin, Diane E. (2001). Fields Virology 4th edn, *Lippincott Williams and Wilkins*
7. Mahy, Brian WJ., and Regenmortel, Marc HV Van. (2010). Desk Encyclopedia of General Virology. *Elsevier.*
8. Cann, Alan. (2015). Principles of Molecular Virology, 6th edn. *Academic Press.*
9. Karp, Gerald. (2010). Cell and Molecular Biology, 6th edn. *John Wiley & Sons, Inc*.
10. Becker, William M., Kleinsmith, Lewis J., & Hardin, Jeff. (2019). Becker World of Biology, 11th edn, *Pearson.*
11. Lodish, Harvey., Berk, Arnold., and Kaiser, Chris A. (2007). Molecular Cell Biology, 6th edn. *W.H. Freeman & Co Ltd.*

| | | |
|---|---|---|
| NAME OF THE COURSE | GENETICS-I | |
| CLASS | MSc- I | |
| COURSE CODE | SMCB512MJ | |
| NUMBER OF CREDITS | 4 | |
| NUMBER OF LECTURES PER WEEK | 4 | |
| TOTAL NUMBER OF LECTURES PER SEMESTER | 60 | |
| EVALUATION METHOD | CONTINUOUS ASSESSMENT | SUMMATIVE ASSESSMENT |
| TOTAL MARKS | 50 | 50 |
| PASSING MARKS | 20 | 20 |

**COURSE OBJECTIVES:**

| | |
|---|---|
| CO 1 | To explain coordination of DNA replication, septum formation and chromosome partitioning in bacteria. |
| CO 2 | To describe the molecular details of gene expression and its regulation in bacteria and eukaryotes. |
| CO 3 | To discuss recombination at the molecular level in bacteria and eukaryotic microorganisms such as yeast. |
| CO 4 | To explain the complementation test and its significance in mapping of genes. |
| CO 5 | To understand the lac operon and develop critical thinking skills |
| CO 6 | To gain knowledge of epigenetic modifications of genes in eukaryotes. |

**COURSE LEARNING OUTCOMES:**

| | |
|---|---|
| CLO 1 | The learner will be able to explain the role of bacterial proteins in septum formation and segregation of chromosomes and also in partitioning of plasmids. |
| CLO 2 | The learner will be able to describe molecular details of transcription, RNA processing, splicing and translation. |
| CLO 3 | The learner will be able to explain the DSB repair model of recombination, role of proteins in bacterial and eukaryotic recombination, mating type switching in *Saccharomyces cerevisiae* and compare homologous recombination in bacteria and eukaryotes. |
| CLO 4 | The learner will be able to explain the complementation test and fine structure mapping and their significance. |
| CLO 5 | The learner will be able to distinguish between different mechanisms of regulation of bacterial operons |
| CLO 6 | The learner will be able to compare different mechanisms of eukaryotic gene regulation. |

| | |
|---|---|
| UNIT 1 | Bacterial Cell Division, Chromosome partitioning and Gene expression (15 Lectures) |
| 1.1 | Cell division and chromosome partitioning in bacteria<br>a. Replication and cell cycle<br>b. Septum formation in bacteria, Function of FtsZ, MinCD and MinE<br>c. Partitioning of Chromosomes<br>d. Partitioning of single copy plasmids |
| 1.2 | Gene expression- Transcription<br>a. Bacterial Transcription<br>b. Eukaryotic Transcription |
| 1.3 | RNA molecules and processing -<br>a. Messenger RNA- Structure, processing, addition of the 5' Cap, addition of the Poly (A) tail, RNA splicing, self splicing introns, Alternative processing pathways, RNA editing<br>b. Transfer RNA- Structure of transfer RNA, tRNA gene structure and processing<br>c. Ribosomal RNA- Structure of the ribosome, rRNA gene structure and processing. |
| 1.4 | Gene expression - Translation<br>a. The process of translation- The binding of amino acids to transfer RNAs<br>b. Initiation, elongation and termination of translation<br>c. Posttranslational modifications of proteins |
| UNIT 2 | Recombination, Mutation and Genetic Complementation (15 Lectures) |
| 2.1 | Recombination<br>a. DSB repair model - steps<br>b. Proteins involved in Homologous recombination in prokaryotes - RecBCD, RecA, RuvA, RuvB and RuvC<br>c. Homologous recombination in eukaryotes and proteins involved in the same<br>*d.* Mating type switching in *Saccharomyces cerevisiae* (Gene conversion)<br>e. Concept of linkage |
| 2.2 | Mutation<br>a. Somatic mutation and germline mutation<br>b. Study of mutants |
| 2.3 | Genetic Complementation - Complementation test and fine structure mapping |
| UNIT 3 | Regulation of gene expression in bacteria (15 Lectures) |
| 3.1 | Operons<br>a. The *lac* operon of *E. coli* - Experimental evidence for the regulation of *lac* genes, mutations in the protein-coding and regulatory genes, and positive control of the *lac* operon |

| | |
|---|---|
| | b. The *ara* operon of *E. coli*: Positive and negative control<br>c. The *trp* operon of *E. coli*- Attenuation |
| 3.2 | Other regulatory mechanisms **-** Antisense RNA, Riboswitches, Sigma factor switching- Sporulation in *Bacillus subtilis.* |
| UNIT 4 | Eukaryotes gene expression – Regulation and epigenetic modifications (15 Lectures) |
| 4.1 | Gene regulation in Eukaryotes-<br>a. Changes in chromatin structure and histone modifications<br>b. Regulation of transcription factors and activators<br>c. RNA Processing- Examples- SV40, sex differentiation in Drosophila, Degradation of RNA, RNA interference (in brief)<br>d. Processes that affect translation and modification of proteins. |
| 4.2 | Epigenetic modifications that alter gene expression<br>a. Dosage compensation of genes on X chromosomes- mechanism of X chromosome inactivation<br>b. Gene Imprinting – Mechanisms and imprinting disorders<br>c. Noncoding RNAs<br>d. DNA Methylation |

REFERENCES Mandatory Paper 2 SMCB512MJ


1. Lewin, Benjamin. (2004). Genes VIII. *Pearson*.
2. Lewin, Benjamin. (2007). Genes IX. *Jones and Bartlett publishers.*
3. Pierce, Benjamin A. (2003). Genetics- A Conceptual approach, *Worth Publishers Inc., US.*
4. Pierce, Benjamin A. (2013). Genetics- A Conceptual approach, 5th edn, *W.H. Freeman*
5. Watson, James D., Baker, Tania A., Bell, Stephen P., Gann A., Levine, M., Losick., R. (2003). Molecular Biology of the Gene, 5th edn. *Cold Spring Harbor Laboratory Press.*
6. Watson, James D., Baker, Tania A., Bell, Stephen P., Gann A., Levine, M., Losick., R. (2013). Molecular Biology of the Gene, 7th edn. *Pearson.*
7. Stanier, Roger Y., Adelberg, Edward A., and Ingraham, John L. (1976). General Microbiology, 4th edn. *Macmillan.*
8. Russell, Peter J. (2010). iGenetics: A Molecular Approach, 3rd edn. *Pearson.*
9. Tamarin, Robert H. (2002). Principles of Genetics, 7th edn. *McGraw-Hill.*
10. Weaver, Robert F. (2012). Molecular Biology, 5th edn. *McGraw-Hill*.
11. Watson, James D., Caudy Amy A., Myers, Richard M., and Witkowski Jan A. (2007) Recombinant DNA, Genes and Genomics - A short course, 3rd edn. *W.H. Freeman and Company.*
12. Brooker, Robert. (2017). Genetics: Analysis and Principles, 6th edn. *McGraw-Hill Higher Education*

| | | |
|---|---|---|
| NAME OF THE COURSE | MICROBIAL BIOCHEMISTRY | |
| CLASS | MSc- I | |
| COURSE CODE | SMCB511E (Elective) | |
| NUMBER OF CREDITS | 2 | |
| NUMBER OF LECTURES PER WEEK | 2 | |
| TOTAL NUMBER OF LECTURES PER SEMESTER | 30 | |
| EVALUATION METHOD | CONTINUOUS ASSESSMENT | SUMMATIVE ASSESSMENT |
| TOTAL MARKS | 50 | - |
| PASSING MARKS | 20 | - |

**COURSE OBJECTIVES:**

| | |
|---|---|
| CO 1 | To revise the structure, properties and functions of important macromolecules. |
| CO 2 | To develop understanding of different analytical methods for studying macromolecules |
| CO 3 | To assimilate the principles behind common methods of extraction , purification and study of proteins |
| CO 4 | |

**COURSE LEARNING OUTCOMES:**

| | |
|---|---|
| CLO 1 | The learner will be able to describe the correlation between structure and functions of cellular macromolecules like proteins, lipids, carbohydrates. |
| CLO 2 | The learner will be able to explain the details of extraction & purification of proteins by salt precipitation and dialysis and separating mixture of proteins by chromatography and electrophoresis. |
| CLO 3 | The learner will be able to elaborate on protein folding mechanism in cells |
| CLO 4 | The learner will be able to discuss the principle and applications of spectroscopic techniques and X ray diffraction analysis done to characterize proteins. |
| CLO 5 | The learner will be able to outline use of radioisotopes in biology experiments |

| UNIT 1 | Bioorganic molecules (15 Lectures) |
|---|---|
| 1.1 | Structure and function of Proteins: Peptide bond and its stability, Ramachandran plot. Factors determining primary, secondary, tertiary and quaternary structure of proteins, thermodynamics of folding, role of disulfide |

| | |
|---|---|
| | bonds, dynamics of globular protein folding, chaperonins. Motifs and domains, protein families, protein stability, protein-protein interactions. |
| 1.2 | Glycobiology: Types of carbohydrates, glycosidic bond and its stability, Structure and functions of glycoconjugates, proteoglycans, glycoproteins, glycolipids and homopolysaccharides. |
| 1.3 | Lipids: Classification of lipids, structure and functions of glycerolipids, ether lipids, galactolipids, sulfolipids, lipids in archaebacteria, sphingolipids, terpenes, isoprenoids. |
| UNIT 2 | Analytical Biochemistry (15 Lectures) |
| 2.1 | General methods of purification of proteins: Use of salting out / salting in, organic solvents, column chromatography, electrophoresis. |
| 2.2 | Spectroscopic methods: Principle, Instrumentation and applications of Raman spectroscopy, IR spectroscopy, FTIR, Circular dichroism, NMR, ESR, X ray diffraction and mass spectroscopy |
| 2.3 | Radiolabeling techniques: Different types of radioisotopes, their detection, measurement and clinical applications. |

REFERENCES

ELECTIVE SMCB511E


1. Nelson, D., & Cox, M., (2005) Lehninger: Principles of Biochemistry, 4th edn., *New York, W.H. Freeman & Co.*
2. Segel, I.R., (2004). Biochemical calculations, 2nd edn. *John Wiley and Sons.*
3. Pratt-Cornley. (2013). Essential Biochemistry (illustrated), 3rd edn. *Wiley.*
4. White, David. (2011). The physiology and biochemistry of prokaryotes, 4th edn, *Oxford University Press.*
5. N. Price J. Naira. (2009). Exploring proteins: Student's guide to experimental skills and methods. *Oxford University Press.*
6. Conn and Stumpf. (2006). Outlines of Biochemistry, 5th edn, *Wiley India Edition.*
7. Jayaraman. Laboratory manual in biochemistry. *New Age International Publishers.*
8. Wilson, K., Walker, J. (1994). Principles and techniques of practical biochemistry, 4th P edn, *Cambridge University Press*.
9. Beedu, Rao., Deshpande, S. Experimental biochemistry –A student companion. *IK international Pvt. Ltd.*

| | | |
|---|---|---|
| NAME OF THE COURSE | RESEARCH METHODOLOGY | |
| CLASS | MSc- I | |
| COURSE CODE | SMCB511RM | |
| NUMBER OF CREDITS | 4 | |
| NUMBER OF LECTURES PER WEEK | 4 | |
| TOTAL NUMBER OF LECTURES PER SEMESTER | 60 | |
| EVALUATION METHOD | CONTINUOUS ASSESSMENT | SUMMATIVE ASSESSMENT |
| TOTAL MARKS | 50 | - |
| PASSING MARKS | 20 | - |

**COURSE OBJECTIVES:**

| | |
|---|---|
| CO 1 | To learn about the process of research, types of research and research design. |
| CO 2 | To learn about different types of sampling methods, sampling designs and variables. |
| CO 3 | To learn about methods of data collection, interpretation and report writing. |
| CO 4 | To learn about scientific writing and ethics in research and publication. |
| CO 5 | To use ICT as a tool to assist in writing research proposals and research outcomes. |
| CO 6 | To learn about the use of biostatistics software in interpretation of data. |

**COURSE LEARNING OUTCOMES:**

| | |
|---|---|
| CLO 1 | The learner will be able to design a research proposal. |
| CLO 2 | The learner will be able to use appropriate methods of sample collection, methods of carrying out the research and write a report on the same. |
| CLO 3 | The learner will be able to use anti plagiarism software to check if the proposal is acceptable, prepare a manuscript |
| CLO 4 | The learner will be able to present research in a written / oral format using ICT. |
| CLO 5 | The learner will be able to learn the use of biostatistics software so that it can be applied to the data collected for validity and interpretation. |

| | |
|---|---|
| UNIT 1 | Basics of Research (15 Lectures) |
| 1.1 | Meaning and objectives of research, research and scientific method, research process, research methods vs methodology.<br>Criteria of good research, Problems encountered by researchers in India. |
| 1.2 | Types of research: |

| | |
|---|---|
| | conceptual vs empirical, applied vs fundamental, descriptive vs analytical, qualitative vs quantitative. |
| 1.3 | Research designs: Features of a good research design, different research designs.<br>Case study, cross over study, case control design, cohort study design, multifactorial design, ex post facto |
| UNIT 2 | Sampling, data collection, interpretation and report writing. (15 Lectures) |
| 2.1 | Sampling and sampling design:<br>Steps and different types of sample design.<br>Methods of sampling: non probability, simple random, systematic, stratified, quota, cluster and area sampling, multistage and sequential sampling. Problems due to unintended sampling, ecological and statistical population in the laboratory.<br>Variables: Nominal, ordinal, discontinuous and continuous. |
| 2.2 | Collection of data:<br>Methods and techniques of data collection.<br>Types of data collection: Primary and Secondary. Methods of primary data collection: Observation, Experimentation, Questionnaire, Interview, Schedules, Case pilot study etc.<br>Methods of secondary data collection- Internal and External. |
| 2.3 | Interpretation and report writing:<br>Techniques of interpretation and different steps involved in report writing, types of report, mechanics of writing a research report. |
| UNIT 3 | Scientific writing and Ethics in research and publication (15 Lectures) |
| 3.1 | Abstract, Writing of Literature review, Aim and Objectives Methodology, References/ Bibliography and Preparation of manuscript for publication of research/ review paper.<br><br>Peer reviewed, UGC CARE listed, indexed journals, citation index and role of citation, impact factor of a journal.<br><br>Use of open sources such as Mendeley reference manager, LaTeX as writing software, storage using Google drive/ Dropbox. Science journalism. |
| 3.2 | Use of computer in research:<br>Computer technology, computer and researchers, software tools in the structure, design and preparation of thesis, layout, labeling of figures, legends, preparation of tables, layout, etc.<br>Preparation of oral presentation and posters. |

| | |
|---|---|
| 3.3 | Ethics in research and publication:<br>Citations, acknowledgement, conflict of interest, plagiarism, plagiarism checking tools.<br>Overview of ethics in research: Overview of legislation and regulation, ethical guidelines in animal and clinical research. IPR and patent law. |
| UNIT 4 | Biostatistics (15 Lectures) |
| 4.1 | Basics of Biostatistics:<br>Measure of central tendencies, mean, mode, median. Measure of dispersion, Standard deviation, Standard error of means, P value concept.<br>Use of appropriate software for computation of statistical data. |
| 4.2 | Types of hypothesis: Basics concepts, types of hypothesis - Null and Alternate hypothesis, levels of hypothesis and testing of hypothesis.<br>Parametric test: Z test, t test (1 tailed and 2 tailed test) of hypothesis.<br>Different types of ANOVA test<br>Non parametric test |
| 4.3 | Correlation analysis & Regression analysis: interpolation and extrapolation, nonlinear data fitting, probit analysis etc.<br>Software used for all of the above. |
| | Student activity: A hands-on workshop will be organized to help students learn about the various biostatistics softwares.<br><br>A talk will be organized to inform students on how to go about writing scientific articles to promote science journalism as a career choice. |

REFERENCES

SMCB511RM


1. Kothari, C.R. (2004). Research Methodology - Methods and Techniques, 2nd Revised edn, *New Age International Publishers.*
2. Kumar, Ranjit.(2014). Research Methodology: A Step-by-Step guide for beginners, 5th edn, *SAGE Publications*
3. Pandey, P., Pandey, M. Mishra. (2015) Research Methodology: Tools And Techniques. *Bridge Center.*
4. Yip, C., Han, N.L.R., and Sng, B. L. (2016). Legal and ethical issues in research. *Indian J Anaesth.* 60(9): 684–688.
5. Daniel, W. W., Cross, C. L. (2019). Biostatistics: A Foundation For Analysis In The Health Sciences, 10th edn, *Wiley Publications.*
6. Le, Chap T. (2003). Introductory Biostatistics. *John Wiley and Sons Ltd.*

**Practicals- Semester 1**

| | | |
|---|---|---|
| NAME OF THE COURSE | VIROLOGY AND CELL BIOLOGY-I PRACTICAL | |
| CLASS | MSc-I | |
| COURSE CODE | SMCB511MJP (Mandatory 1) | |
| NUMBER OF CREDITS | 2 | |
| NUMBER OF LECTURES PER WEEK | 4 | |
| TOTAL NUMBER OF LECTURES PER SEMESTER | 60 | |
| EVALUATION METHOD | CONTINUOUS ASSESSMENT | SUMMATIVE ASSESSMENT |
| TOTAL MARKS | - | 50 |
| PASSING MARKS | - | 20 |

**COURSE OBJECTIVES**

| | |
|---|---|
| CO 1 | To train students in Virology practicals i.e. enumeration of bacteriophages by plaque assay, one step growth curve and studying lysogeny in order to develop their practical skills |
| CO 2 | To train students in Cell Biology experiments such as studying the integrity of cell membranes and isolation of mitochondria and chloroplasts in order to equip them with basic eukaryotic cell biology practical skills |

**COURSE LEARNING OUTCOMES**

| | |
|---|---|
| CLO 1 | The learner will be able to use the plaque assay to enumerate bacteriophages and calculate plaque forming units/ml |
| CLO 2 | The learner will be able to perform one step growth curve experiment |
| CLO 3 | The learner will be able to apply the fundamentals and concepts of lysogeny for other bacteriophages |
| CLO 4 | The learner will be able to assess the integrity of cell membrane using neutral red uptake method |
| CLO 5 | The learner will be able to perform the extraction of mitochondria and chloroplast from eukaryotic cells |

| Sr. No | Name of the experiment |
|---|---|
| 1 | Enumeration of coliphages by plaque assay. |
| 2 | Study of one step growth curve of a bacteriophage. |
| 3 | Study of lysogeny in *E. coli.* |
| 4 | Assignment on any plant virus (other than TMV and BMV). |
| 5 | Study of cell membrane integrity using uptake of neutral red. |
| 6 | Isolation of mitochondria |
| 7 | Isolation of chloroplasts. |

| | | |
|---|---|---|
| NAME OF THE COURSE | GENETICS-I PRACTICAL | |
| CLASS | MSc-I | |
| COURSE CODE | SMCB512MJP (Mandatory 2) | |
| NUMBER OF CREDITS | 2 | |
| NUMBER OF LECTURES PER WEEK | 4 | |
| TOTAL NUMBER OF LECTURES PER SEMESTER | 60 | |
| EVALUATION METHOD | CONTINUOUS ASSESSMENT | SUMMATIVE ASSESSMENT |
| TOTAL MARKS | - | 50 |
| PASSING MARKS | - | 20 |

**COURSE OBJECTIVES**

| | |
|---|---|
| CO 1 | To provide learners with practical training in running agarose gels and understanding its applications in separating nucleic acids. |
| CO 2 | To familiarize learners with the experimental procedure of studying bacterial conjugation and its role in horizontal gene transfer. |
| CO 3 | To equip learners with skills in analyzing the mutations induced by UV radiation and in selective culturing and identification of streptomycin-resistant mutants |
| CO 4 | To train learners to enrich and isolate auxotrophic mutants using selection and screening methods such as penicillin enrichment and replica plate techniques respectively. |
| CO 5 | To enhance understanding of the utility of colorimetric assays such as the β-galactosidase assay in measuring gene expression and promoter activity. |

| | |
|---|---|
| CO 6 | To promote problem-solving skills and apply critical thinking to lac operon-related scenarios. |

**COURSE LEARNING OUTCOMES**

| | |
|---|---|
| CLO 1 | The learner will be able to prepare agarose gels, load DNA samples, run electrophoresis, visualize the separated DNA bands and interpret the gel image to understand the plasmid topology and size. |
| CLO 2 | The learner will be able to perform experimental procedures to study bacterial conjugation and analyze the order of the gene transfer. |
| CLO 3 | The learner will be able to perform the necessary steps to expose microorganisms to UV radiation for mutagenesis and isolate streptomycin-resistant mutants using selective culturing techniques. |
| CLO 4 | The learner will be able to enrich and isolate auxotrophic mutants using penicillin enrichment and replica plate techniques and determine the proportion of auxotrophic mutants |
| CLO 5 | The learner will be able to perform the β-galactosidase assay and acquire skills in quantifying and analyzing β-galactosidase activity. |
| CLO 6 | The learner will be able to explain the regulation of Lac operon and apply critical as well problem-solving skills to lac operon-related analytical questions. |

| **Sr. No** | **Name of the experiment** |
|---|---|
| **1** | Separation of plasmid or genomic DNA using agarose gel electrophoresis |
| **2** | Bacterial conjugation |
| **3** | UV mutagenesis |
| **4** | Penicillin enrichment technique |
| **5** | β- galactosidase assay |
| **6** | Problems on *lac* operon |

| | | |
|---|---|---|
| NAME OF THE COURSE | MICROBIAL BIOCHEMISTRY PRACTICAL | |
| CLASS | MSc-I | |
| COURSE CODE | SMCB511EP (Elective) | |
| NUMBER OF CREDITS | 2 | |
| NUMBER OF LECTURES PER WEEK | 4 | |
| TOTAL NUMBER OF LECTURES PER SEMESTER | 60 | |
| EVALUATION METHOD | CONTINUOUS ASSESSMENT | SUMMATIVE ASSESSMENT |
| TOTAL MARKS | 50 | - |
| PASSING MARKS | 20 | - |

**COURSE OBJECTIVES**

| | |
|---|---|
| CO 1 | To enable the learner to extract , separate, identify and determine the level of unsaturation of fats |
| CO2 | To enable the learner to analyze samples for sugar, fat and polyphenol content |
| CO3 | To familiarize the learner with performing enzyme assays. |

**COURSE LEARNING OUTCOMES**

| | |
|---|---|
| CLO 1 | The learner will be able to extract cholesterol, separate fats by chromatography and determine iodine number of oils |
| CLO 2 | The learner will be able to isolate lactose and detect it using osazone test as well as estimate total sugar content by phenol sulphuric acid method |
| CLO 3 | The learner will be able to estimate polyphenol concentration in food stuff. |
| CLO 4 | The learner will become competent in extracting, purifying and performing assay of enzyme amylase. |

| Sr. No | Name of the experiment |
|---|---|
| **1** | Extraction of total lipids. |
| **2** | Isolation of cholesterol and lecithin from egg yolk. |
| **3** | Identification of fatty acids and other lipids by TLC. |
| **4** | Determination of degree of unsaturation of fats and oils. |
| **5** | Isolation of lactose from bovine milk. |
| **6** | Estimation of total sugars by phenol-sulphuric acid method. |
| **7** | Isolation of glutamic acid from gluten. |
| **8** | Isolation, Purification of Beta amylase from fungi using salting out and dialysis |
| **9** | Estimation of beta amylase activity using the DNSA method. |
| **10** | Estimation of protein content of beta amylase and calculation of specific activity. |
| **11** | Estimation of polyphenols/tannins by Folin-Denis method |
| **12** | Visit to an Instrumentation facility |

**ASSESSMENT PATTERN AND EVALUATION**
**For NEP PG**

**A. Evaluation of Mandatory, Elective Courses and Common Course (Research Methodology) for MSc Part -1**:

Assessment and evaluation pattern would be 50:50. There will be two subheads, namely, Summative Assessment (SA) and Continuous Assessment (CA) of 50 marks each for Mandatory courses.

1. Mandatory, elective and practical will have **separate heads of passing**.
2. A student needs to secure 40% marks for passing individually in SA and CA.
3. If a student fails, he/she will have to appear for an ATKT examination.
4. Students who have missed the SA for a genuine reason (supported with a document subject to approval by the authorities) will appear for an **Additional SA of 50 marks.** This Additional/ATKT SA will be held after the declaration of the respective semester results and at the discretion of the PG exam committee.
5. Students will be declared FAIL if she scores less than 20 marks out of 50 marks.
6. Staff will show assessed answer papers of SA to students and discuss the rubric of assessment with them on a day fixed by the PG Exam Committee.
7. Grievance Redressal Mechanism for addressing grievances related to SA:

   Students may apply for Reassessment, Photocopying and Revaluation of the SA answer books after the declaration of results in response to the notice posted by the College Office for the same.
8. Students with learning disabilities (LD) will be given extra time for SA as per the University rules.

**B. Continuous Assessment (CA) for Mandatory Courses:**

1. CA activities will be planned and conducted by the respective departments.

   The departments are required to share the details of the CA activities with the Deputy Controller of PG exam and PG Co-ordinator (VP- Science).
2. Students' CA activity-related scores with assessed papers and feedback on their work (tests, other activities, assignments etc.) must be shared with students.
3. Format of **CA for Mandatory courses:** Two CA activities of 25 marks each.

   **CA 1: Test - 25 marks** (Duration for answering the Test: Max. 60 Minutes)

   **CA 2: Any Activity - 25 marks**
4. The minimum score to pass the Course will be 20 marks out of 50 marks.
5. If a student fails to pass (scores less than 20) then, the student will have to appear for

   ATKT – **one IA** Test of 25 marks and **one assignment** of 25 Marks.

**C. Evaluation for Elective and Common Courses (Research Methodology) under NEP:**

1. Format of **CA for Elective Courses:** Two tests of 25 marks each of **subjective type**.

   **Only CA is to be conducted with 50 marks.**

   **CA 1: Test - 25 marks** (Duration for answering the Test: Max. 60 Minutes)

   **CA 2: Test- 25 marks** (Duration for answering the Test: Max. 60 Minutes)

2. Format of **CA for Common Courses:**

   **CA 1: Test - 25 marks** (Duration for answering the Test: Max. 60 Minutes)

   **CA 2: Any Activity - 25 marks**

3. If a student fails to pass (scores less than 20) then, the student will have to appear for 50 marks ATKT – one **IA** Test of 25 marks and **one assignment** of 25 Marks.

4. The minimum score to pass the Course will be 20 marks out of 50 marks. Students' CA activity-related scores with assessed papers and feedback (tests, other activities, assignments etc.) will be shared individually with students.

5. Grievance Redressal Mechanism for addressing grievances related to CAS:

   Students will apply in a prescribed format to the respective Vice Principals. The grievance will be addressed by involving the concerned faculty and the other Exam Committee member/s deputed by the Principal.

# SEMESTER 2

| | | |
|---|---|---|
| NAME OF THE COURSE | VIROLOGY AND CELL BIOLOGY-II | |
| CLASS | MSc- I | |
| COURSE CODE | SMCB523MJ (Mandatory 1) | |
| NUMBER OF CREDITS | 4 | |
| NUMBER OF LECTURES PER WEEK | 4 | |
| TOTAL NUMBER OF LECTURES PER SEMESTER | 60 | |
| EVALUATION METHOD | CONTINUOUS ASSESSMENT | SUMMATIVE ASSESSMENT |
| TOTAL MARKS | 50 | 50 |
| PASSING MARKS | 20 | 20 |

**COURSE OBJECTIVES:**

| | |
|---|---|
| CO 1 | To explain, discuss and analyze molecular biology and the life cycle of human viruses. |
| CO 2 | To discuss the role of viruses in cancer and working with them in the research laboratory. |
| CO 3 | To develop an understanding of Prions and genetic experiments performed. |
| CO 4 | To describe cytoskeletal elements and their functions. |
| CO 5 | To summarize the development of multicellular organisms such as *Drosophila melanogaster.* |
| CO 6 | To explain eukaryotic cell cycle, mitosis and meiosis |
| CO 7 | To explain signalling and communication in eukaryotic microorganisms including the yeast *Candida albicans.* |
| CO 8 | To discuss programmed cell death in eukaryotes, bacteria and yeasts. |

**COURSE LEARNING OUTCOMES:**

| | |
|---|---|
| CLO 1 | The learner will be able to explain and analyze the replication and life cycle of different viruses, mechanism of retroviruses induce tumors, DNA tumor viruses, oncolytic viruses and Prion only hypothesis. |
| CLO 2 | The learner will be able to explain the structure and functions of Microtubules, Intermediate filaments and Microfilaments. |
| CLO 3 | The learner will be able to recall the development of model organism *Drosophila melanogaster* and role of different genes in its development. |
| CLO 4 | The learner will be able to explain the cell cycle and checkpoints and their significance, stages of mitosis and meiosis and connect the topics with the mandatory paper 2 topics such as Mendelian Genetics, Extensions of the same and Cancer. |
| CLO 5 | The learner will be able to explain and discuss cell signaling and signal transduction, MAP kinase pathway, and Ras signaling. |

| | |
|---|---|
| CLO 6 | The learner will be able to explain and compare programmed cell death in eukaryotes, bacteria and yeast |

| | |
|---|---|
| UNIT 1 | Human Viruses (15 Lectures) |
| | Structure, replication, life cycle and current affairs of the following viruses |
| 1.1 | dsDNA viruses - (04L)<br>a. Poxviruses (Variola major and Vaccinia)<br>b. Herpesviruses |
| 1.2 | dsRNA viruses- Rotavirus (02L) |
| 1.3 | Positive ssRNA viruses (05L)<br>a. Rhinovirus<br>b. Severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2)<br>c. Dengue virus |
| 1.4 | Negative ssRNA viruses (04L)<br>a. Rabies virus<br>b. Measles virus |
| UNIT 2 | Tumor viruses and Prions (15 Lectures) |
| 2.1 | Tumor viruses (09L)<br>*Students to revise important definitions related to Cancer and characteristics of transformed cells*<br>a. Molecular mechanisms of virally induced tumor formation by RNA tumor viruses (Retroviruses)<br>b. DNA tumor viruses - Hepatitis B virus, Human Papillomavirus, Adenoviruses, Simian Virus- 40<br>c. Oncolytic viruses |
| 2.2 | Prions (03L)<br>a. History, case studies<br>b. PRNP gene, Prion only hypothesis<br>c. Biochemical analysis of the prion amino acid sequence<br>d. Genetic Research and experiments with knockout mice |
| 2.3 | Working with viruses in the research laboratory (03L) |
| UNIT 3 | Cytoskeleton and Development of multicellular organisms (15 Lectures) |
| 3.1 | Cytoskeleton (11L)<br>a. Microtubules<br>i. Structure and composition<br>ii. Microtubule-associated proteins<br>iii. Motor proteins - kinesins, cytoplasmic dynein<br>iv. Microtubule-organizing centers (MTOCs) |

| | |
|---|---|
| | v. The dynamic properties of microtubules<br>b. Intermediate filaments<br>i. Intermediate filament assembly and disassembly<br>ii. Types and functions<br>c. Microfilaments<br>i. Microfilament assembly and disassembly<br>ii. Myosin: the molecular motor of actin filaments<br>e. Cytoskeletal elements in bacteria |
| 3.2 | Development of Multicellular Organisms (04L)<br>a. Genetics of Pattern formation in *Drosophila*<br>i. Egg-polarity genes<br>ii. Segmentation genes<br>iii. Homeotic genes<br>b. Homeobox genes in other organisms |
| UNIT 4 | Cellular reproduction, Signaling, Communication and Programmed cell death (15 Lectures) |
| 4.1 | Cellular Reproduction (05L)<br>a. The cell cycle<br>b. Control of the cell cycle<br>c. Mitosis<br>d. Meiosis |
| 4.2 | Signaling, communication and programmed cell death (10L)<br>a. The basic elements of cell signaling systems<br>b. G protein-coupled receptors and signal transduction by them<br>c. Protein tyrosine phosphorylation as a mechanism for signal transduction<br>d. Ras-MAP Kinase pathway<br>*e.* Ras signaling in pathogenic yeast *Candida albicans*<br>f. Apoptosis<br>g. Programmed cell death in *E.coli* and *Saccharomyces cerevisiae*<br>h. Lysis of the mother cell during sporulation of *Bacillus subtilis* |

REFERENCES

SMCB523MJ Mandatory 1


1. Shors, Teri. (2009). Understanding viruses, 1st edn. *Jones and Bartlett Publishers.*
2. Shors, Teri. (2016). Understanding viruses, 3rd edn. *Jones and Bartlett Publishers.*
3. Burrell, Christopher., Howard, Colin., and Murphy, Frederick. (2016). Fenner and White's Medical Virology, 5th edn. *Academic Press.*
4. McDonald, Sarah M., and Patton, John T. (2011). Assortment and packaging of the segmented rotavirus genome. *Trends Microbiol.* 19(3): 136–144.
5. Le Kerr, Shannic., Mathew, Cynthia., and Ghildyal, Reena. (2021). Rhinovirus and Cell Death. *Viruses.* 13, 629.

6. Jacobs, Samantha E., Lamson, Daryl M., St. George, Kirsten., and Walsh, Thomas J. (2013). Human Rhinoviruses. *Clinical Microbiology Reviews.* Volume 26 Number 1, p. 135–162.
7. Stobart, Christopher C., Nosek, Jenna M., and Moore, Martin L. (2017) Rhinovirus Biology, Antigenic Diversity, and Advancements in the Design of a Human Rhinovirus Vaccine. *Frontiers in Microbiology.* Volume 8, Article 2412
8. Rota, Paul A., Moss, William J., Takeda Makoto., de Swart, Rik L., Thompson, Kimberly M., and Goodson, James L. (2016). Measles. *Primer. Nature Reviews.* Volume 2, Article 16049.
9. Cann, Alan. (2015). Principles of Molecular Virology, 6th edn. *Academic Press.*
10. Karp, Gerald. (2010). Cell and Molecular Biology, 6th edn. *John Wiley & Sons, Inc*.
11. Hardin, Jeff., Bertoni, Gregory., Kleinsmith, Lewis J. (2016). Becker's World of the Cell, 8th Global edn. *Pearson.*
12. Graumann, Peter L. (2007). Cytoskeletal Elements in Bacteria. *Annu. Rev. Microbiol*. 61:589-618.
13. Pierce, B. (2008). Genetics- a conceptual approach, 3rd edn, *W.H. Freeman and company.*
14. Pentland, Daniel R., Piper-Brown, Elliot., Mühlschlegel, Fritz A., and Gourlay, Campbell W. (2017). Ras signalling in pathogenic yeasts. *Microbial Cell.* Vol 5(2):63-74.
12. Lewis, Kim. (2000). Programmed Death in Bacteria. *Microbiology and molecular biology reviews.* 1092(2172):503-514.
13. Farrugia, Gianluca., and Balzan, Rena. (2012). Oxidative stress and programmed cell death in yeast. *Front. Oncol.*
14. Hardin, J., Bertoni, G., & Kleinsmith, L. J. (2019). Becker's World of Cell Biology (9th ed.). *Pearson*

| | | |
|---|---|---|
| NAME OF THE COURSE | GENETICS-II | |
| CLASS | MSc- I | |
| COURSE CODE | SMCB524MJ (Mandatory 2) | |
| NUMBER OF CREDITS | 4 | |
| NUMBER OF LECTURES PER WEEK | 4 | |
| TOTAL NUMBER OF LECTURES PER SEMESTER | 60 | |
| EVALUATION METHOD | CONTINUOUS ASSESSMENT | SUMMATIVE ASSESSMENT |
| TOTAL MARKS | 50 | 50 |
| PASSING MARKS | 20 | 20 |

**COURSE OBJECTIVES:**

| | |
|---|---|
| CO 1 | To discuss Mendelian genetics, principles of inheritance and extensions of and deviations from Mendelian genetics and solve problems related to the topics. |
| CO 2 | To develop an understanding of concepts and principles associated with population genetics |
| CO 3 | To explain the genetic basis of cancer. |
| CO 4 | To describe the Transposable genetic elements in prokaryotes and eukaryotes. |
| CO 5 | To explain the techniques used for study of genetics. |
| CO 6 | To discuss basics and applications of bioinformatics. |

**COURSE LEARNING OUTCOMES:**

| | |
|---|---|
| CLO 1 | The learner will be able to explain the Mendelian principles and acquire knowledge of its extensions and deviations. |
| CLO 2 | The learner will be able to solve the problems on Mendelian Genetics and develop critical thinking. |
| CLO 3 | The learner will be able to discuss the principles of population genetics. |
| CLO 4 | The learner will be able to explain the genetic basis of cancer. |
| CLO 5 | The learner will be able to describe the Transposable genetic elements in prokaryotes and eukaryotes. |
| CLO 6 | The learner will be able to compare the techniques used for study of genetics. |
| CLO 7 | The learner will be able to explain the basics of computational biology and apply the knowledge to solve practical problems |

| | |
|---|---|
| UNIT 1 | Mendelian Genetics, Extensions of Mendelian Genetics and Extranuclear Inheritance (15 Lectures) |
| 1.1 | Mendelian Genetics (05 L)<br>a. Mendel's experimental design<br>b. Monohybrid crosses and Mendel's principle of Segregation<br>i. Branch diagram of monohybrid crosses<br>ii. Use of testcrosses<br>c. Dihybrid crosses and Mendel's principle of Independent Assortment<br>i. Branch diagram of dihybrid crosses<br>d. Trihybrid crosses<br>e. Mendelian genetics in Humans- Pedigree analysis<br>f. Problems on Mendelian Genetics |
| 1.2 | Extensions of and Deviations from Mendelian Genetic Principles (10 L)<br>a. Multiple Alleles<br>b. Modification of dominance relationships<br>i. Incomplete dominance<br>ii. Codominance<br>iii. Molecular explanations<br>c. Essential genes and lethal alleles<br>d. Gene expression and environment<br>e. Epistasis<br>i. Recessive epistasis<br>ii. Dominant epistasis<br>f. Problems on extensions of Mendelian Genetics<br>g. Extranuclear Inheritance (non-Mendelian)<br>i. Extranuclear genomes<br>ii. Rules of extranuclear inheritance<br>iii. Examples of extranuclear inheritance |
| UNIT 2 | Population Genetics, Transposable genetic elements and Cancer (15 Lectures) |
| 2.1 | Population Genetics (06 L)<br>a. Genotypic and allelic frequencies<br>b. Calculation of genotypic and allelic frequencies for autosomal and X linked loci<br>c. Hardy-Weinberg Law and calculation of genotypic frequency at Hardy Weinberg equilibrium<br>d. Factors affecting genotypic and allelic frequencies<br>e. Changes in genetics structure of populations (mutation, migration & gene flow, genetic drift and natural selection)<br>f. Measuring genetic variation |
| 2.2 | Transposable genetic elements (05 L)<br>a. Transposable elements in prokaryotes: An overview<br>b. The medical significance of bacterial transposons |

| | |
|---|---|
| | c. Transposable elements in eukaryotes<br>i. Ac and Ds elements in Maize<br>ii. P elements and hybrid dysgenesis in Drosophila<br>iii. Mariner, an ancient and widespread transposon<br>d. Retrotransposons<br>i. Retrovirus like elements<br>ii. Retroposons<br>e. The genetic and evolutionary significance of transposable elements<br>i. Transposons as mutagens<br>ii. Transposons and genome organization |
| 2.3 | Genetic basis of cancer (04 L)<br>a. Cancer- Introduction<br>b. Mutations in different types of genes<br>c. Change in chromosome number and structure,<br>d. Changes in DNA methylation<br>e. Sequential mutations |
| UNIT 3 | Genomics (15 Lectures) |
| 3.1 | Identifying genes (03)<br>a. Techniques<br>i. Positional Cloning<br>ii. Exon trapping and CpG Islands<br>b. Mutated genes associated with human disease- Huntington disease |
| 3.2 | Techniques in genomic sequencing (05)<br>a. Traditional DNA sequencing methods- Sangers sequencing (Dideoxynucleotide method) and Maxam-Gilbert Sequencing<br>b. Next Generation Sequencing (NGS) methods - Primer Walking, Pyrosequencing, Sequencing Using Reversible Chain Terminators and Sequencing by Ligation |
| 3.3 | Strategies for large-scale sequencing of genomes (02)<br>a. Shotgun Cloning Strategy<br>b. Cyclic Array Sequencing |
| 3.4 | Functional Genomics / Transcriptomics (02)<br>a. Gene Expression profiling- DNA microarrays<br>b. Serial Analysis of Gene Expression (SAGE) |
| 3.5 | Comparative Genomics (03)<br>a. Bacteria<br>i. Minimal/ small genome<br>ii. Horizontal gene transfer- significance in comparative genomics<br>b. Significance of comparative genomics in studying microbial evolution. |
| UNIT 4 | Bioinformatics (15 Lectures) |
| 4.1 | a. Introduction to bioinformatics, scope and applications<br>b. Databases and tools/software |

| | |
|---|---|
| | i. Nucleotide sequence databases<br>ii. Protein sequence databases<br>c. Sequence alignment and alignment scores<br>i. Pairwise – Global and local sequence alignment<br>ii. Algorithms - Needleman–Wunsch, Smith–Waterman, BLAST and FASTA<br>iii. Multiple sequence alignment- ClustalW<br>d. Identification of genes on prokaryotic DNA<br>e. Prediction of genes in genome sequences- insilico methods<br>f. Phylogenetic analysis<br>i. Distance based methods<br>ii. Maximum likelihood method<br>iii. Bayesian phylogenetics<br>iv. Parsimony-based methods<br>g. Protein classification and structure prediction<br>i. Domain identification and annotation (e.g., Pfam)<br>ii. Protein structure databases- PDB, CATH and SCOP<br>e. Structure visualization<br>f. Packages for genomic analysis<br>g. Introduction to Linux, Python and R programming |

REFERENCES

SMCB524MJ Mandatory 2


1. Russell, Peter J. (2010). iGenetics: A Molecular Approach, 3rd edn. *Pearson.*
2. Pierce, B. (2008). Genetics- a conceptual approach, 3rd edn, *W. H. Freeman and Company.*
3. Russell, Peter J. (1998). Genetics, 5th edn, *Benjamin Cummings.*
4. Snustad, Peter D., Simmons, Michael J. (2003). Principles of Genetics, 3rd edn. *John Wiley & Sons, Inc.*
5. Snustad, Peter D., Simmons, Michael J. (2012). Principles of Genetics, 6th edn. *John Wiley & Sons, Inc.*
6. Primrose, S. B., & Twyman, R. M. (2006). Principles of Gene Manipulation, 7th edn. *Blackwell Publishing*
7. Weaver, Robert F. (2012). Molecular Biology, 5th edn. *McGraw-Hill.*
8. Krane Dan E., Raymer Michael L. (2002). Fundamental Concepts of Bioinformatics, 1st edn. *Benjamin / Cummings.*
9. Attwood Teresa K., Parry-Smith David J. (1999). Introduction to Bioinformatics. 1st edn. *Addison Wesley Longman Limited.*
10. Klug William S., Cummings Michael R. (2000). Concepts of genetics. 6th edn. *Prentice Hall.*

11. Watson, J.D., Caudy, A.A., Myers, R.M., & Witkowski, J.A. (2007). Recombinant DNA - Genes and Genomes: A Short Course. 3rd edn. *W.H. Freeman and Company.*
12. Glick, Bernard R., Pasternak, Jack J., Patten, Cheryl L. (2010). Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th edn. *ASM Press.*
13. Xiong, Jin. (2006). Essential Bioinformatics. *Cambridge: Cambridge University Press*
14. Mount, David W. (2004). Bioinformatics: sequence and genome analysis, 2nd edn. *CSHL Press*

| | | |
|---|---|---|
| NAME OF THE COURSE | FOOD MICROBIOLOGY | |
| CLASS | MSc- I | |
| COURSE CODE | SMCB522E (Elective) | |
| NUMBER OF CREDITS | 2 | |
| NUMBER OF LECTURES PER WEEK | 2 | |
| TOTAL NUMBER OF LECTURES PER SEMESTER | 30 | |
| EVALUATION METHOD | CONTINUOUS ASSESSMENT | SUMMATIVE ASSESSMENT |
| TOTAL MARKS | 50 | - |
| PASSING MARKS | 20 | - |

**COURSE OBJECTIVES:**

| | |
|---|---|
| CO 1 | To list microorganisms that are commonly associated with fermented foods |
| CO 2 | To outline the process for making fermented foods & understand the benefits of using fermentation as a food processing method, also appreciate the similarities and difference among fermentations of dairy and vegetable products. |
| CO 3 | To evaluate claims about health benefits of probiotic bacteria. |
| CO 4 | To recognize the difference between methods available for microbiological analysis of food and compare the methods in terms of advantages and disadvantages. |
| CO 5 | To discuss the importance of HACCP system with respect to food safety and quality. |

**COURSE LEARNING OUTCOMES:**

| | |
|---|---|
| CLO 1 | The learner will be able to relate the steps of bread, cheese, idli & sauerkraut making to microbial fermentation and final characteristics. |
| CLO 2 | The learner will be able to prepare food samples for determination of microbial load, understand why some sampling plans are more stringent than others and choose appropriate sampling plans as per case number. |
| CLO 3 | The learner will be able to differentiate among conventional and rapid methods of detection of pathogens. |
| CLO 4 | The learner will be able to explain the basis of immunological, nucleic acid, and biochemical methods and recognize appropriate rapid method suitable for specific use |
| CLO 5 | The learner will be able to differentiate among the various microbiological criteria |

| | |
|---|---|
| CLO 6 | The learner will be able to recognize how indicator organisms are used in microbiological criteria |
| CLO 7 | The learner will be able to identify and list steps required to manage microbiological hazards in foods |
| CLO 8 | The learner will be able to outline the basic concepts of GMPs and recognize its limitations |
| CLO 9 | The learner will be able to understand the process for development of a HACCP program |
| CLO 10 | The learner will be able to identify role of national and international agencies involved in food safety and quality |

| UNIT 1 | Applications of Microorganisms in food industry (15 Lectures) |
|---|---|
| 1.1 | Microbiology of fermented foods (08L) :<br>a. Starter cultures: Bacterial, Yeast and molds.<br>Concentrated cultures, Problems in starter cultures and control methods<br>b. General method of production<br>i. Bread<br>ii. Idli<br>iii. Cheese – Types, Production of Cheddar, Swiss and Blue cheese<br>iv. Fermented vegetable products – Sauerkraut<br>v. Popular Oriental fermented foods: Kimchi, Soy sauce, Tempeh |
| 1.2 | Microbial products used in food industry (07L):<br>a. Enzymes in food processing,<br>b. Food grade pigments, Flavour compounds, Exopolysaccharides<br>c. Microbes used as Probiotics (Examples, properties and benefits) |
| UNIT 2 | Microbiological quality of Food (15 Lectures) |
| 2.1 | Detection and enumeration of microbes in food (08L):<br>a. Conventional Methods<br>i. Direct Enumeration :Microscopic Counts, Count using nonselective , selective, differential chromogenic media<br>ii. Indirect count : Dilution to extinction, MPN, Dye Reduction test<br>b. Detection of Microbial Toxins<br>c. Rapid and automated methods for detection of Pathogens: Metabolic Fingerprinting, Immunomagnetic Separation, Reverse Passive Latex Agglutination (RPLA) Method, Immunochromatographic Lateral Flow Assay, Hybridization Method , Microarrays and Mass-Spectrometry<br>d. Bacteriophage for detection of pathogens<br>e. Biosensors for detection of microbes in food. |
| 2.2 | Food Quality and Safety (07L)<br>a. New emerging food borne pathogens of concern. |

| | |
|---|---|
| | b. Control at source.<br>c. Indicator microorganisms : Characteristics, Coliform and enterococci.<br>d. Microbiological Criteria.<br>e. Sampling plan, Types (2 class and 3 class) and sampling procedures<br>f. HACCP system<br>g. Regulations and agencies monitoring microbiological safety of food: ICMSF, CDC, Food net, Codex Alimentarius, ISO22000, FSSAI |

REFERENCES

SMCB522E Elective


1. Montville, Thomas J., Matthews, Karl R., and Kniel, Kalmia E.(ed). (2012). Food Microbiology: An Introduction, 3rd edn. *ASM press.*
2. Ray, Bibek., Bhunia, Arun . (2014). Fundamental Food Microbiology 5th edn. *CRC Press.*
3. Varzakas, Theodoros., & Tzia, Constantina. (2016). Handbook of Food Processing, *CRC press-Taylor –Francis group.*
4. Jay, James M., Loessner, Martin J., Golden, David A. (2005). Modern Food Microbiology 7th edn, *Springer.*
5. Adams, M R., Moss, M O. (2007). Food Microbiology, 3rd edn. *New age international publishers.*

| | | |
|---|---|---|
| NAME OF THE COURSE | FIELD PROJECT/ON JOB TRAINING (OJT) | |
| CLASS | MSc- I | |
| COURSE CODE | SMCB521OJT | |
| NUMBER OF CREDITS | 4 | |
| NUMBER OF LECTURES PER WEEK | 30 HOURS PER WEEK (120 HOURS IN A MONTH) | |
| TOTAL NUMBER OF LECTURES PER SEMESTER | - | |
| EVALUATION METHOD<br><br>TOTAL MARKS<br>PASSING MARKS | CONTINUOUS ASSESSMENT<br>-<br>- | SUMMATIVE ASSESSMENT<br>-<br>- |

**COURSE OBJECTIVES:**

| | |
|---|---|
| CO 1 | To develop and establish practical skills during the internship/on job training at an industry, hospital, pathology laboratory etc. |
| CO 2 | To prepare a report on the same and present the experiments and skills learnt during the internship in the form of a Powerpoint presentation |

**COURSE LEARNING OUTCOMES:**

| | |
|---|---|
| CLO 1 | The learner will be able to develop skills and apply the knowledge in the future |
| CLO 2 | The learner will be able to write a report on the internship/On job training and present in the form of a Powerpoint presentation. |

**Practicals- Semester 2**

| | | |
|---|---|---|
| NAME OF THE COURSE | VIROLOGY AND CELL BIOLOGY-II PRACTICAL | |
| CLASS | MSc-I | |
| COURSE CODE | SMCB523MJP (Mandatory 1) | |
| NUMBER OF CREDITS | 2 | |
| NUMBER OF LECTURES PER WEEK | 4 | |
| TOTAL NUMBER OF LECTURES PER SEMESTER | 60 | |
| EVALUATION METHOD | CONTINUOUS ASSESSMENT | SUMMATIVE ASSESSMENT |
| TOTAL MARKS | - | 50 |
| PASSING MARKS | - | 20 |

**COURSE OBJECTIVES**

| | |
|---|---|
| CO 1 | To arrange a visit to a research institute such as National Institute for Research in Reproductive and Child Health (NIRRH) or Haffkine Institute or an Animal tissue culture laboratory to show Virology related work and animal cell lines so that students can correlate the same with the concepts learned in theory |
| CO 2 | To demonstrate inoculation of an embryonated egg and cultivation of an animal virus during the visit |
| CO 3 | To construct/write an assignment on viruses such as Ebola virus, Nipah virus, West Nile virus, Mumps virus , Hepatitis C virus etc emphasizing on the molecular biology, replication strategy, vaccines, emergence, reemergence etc. |
| CO 4 | To perform Mitosis and Meiosis |
| CO 5 | To perform experiments to show sporulation and germination in *Bacillus species* |

**COURSE LEARNING OUTCOMES:**

| | |
|---|---|
| CLO 1 | The learner will be able to correlate and recall the experiments done at the Virology Laboratories in the Research Institutes |
| CLO 2 | The learner will be able to recall the inoculation of an embryonated egg and cultivation of an animal virus observed during the visit |

| | |
|---|---|
| CLO 3 | The learner will be able to construct an assignment on any of the following viruses: Ebola virus, Nipah virus, West Nile virus, Mumps virus , Hepatitis C virus etc. |
| CLO 4 | The learner will be able to identify and distinguish between the different steps of Mitosis and Meiosis |
| CLO 5 | The learner will be able to detect sporulation and germination in *Bacillus species,* and use Haemocytometer to determine the spore count |

| **Sr. No** | **Name of the Experiment** |
|---|---|
| **1** | Visit to NIRRH or Haffkine research institute or Animal tissue culture laboratory. |
| **2** | Demonstration - Egg inoculation and cultivating animal virus in embryonated egg. |
| **3** | Assignment on any one of the following viruses - Ebola virus, Nipah virus, West Nile virus, Mumps virus , Hepatitis C virus. |
| **4** | Study of Mitosis. |
| **5** | Study of Meiosis. |
| **6** | Sporulation and germination in *Bacillus subtilis.* |

| | | |
|---|---|---|
| NAME OF THE COURSE | GENETICS-II PRACTICAL | |
| CLASS | MSc-I | |
| COURSE CODE | SMCB524MJP (Mandatory 2) | |
| NUMBER OF CREDITS | 2 | |
| NUMBER OF LECTURES PER WEEK | 4 | |
| TOTAL NUMBER OF LECTURES PER SEMESTER | 60 | |
| EVALUATION METHOD | CONTINUOUS ASSESSMENT | SUMMATIVE ASSESSMENT |
| TOTAL MARKS | - | 50 |
| PASSING MARKS | - | 20 |

**COURSE OBJECTIVES**

| | |
|---|---|
| CO 1 | To develop critical thinking and problem solving skills on Mendelian Genetics, Population Genetics and Restriction mapping |
| CO 2 | To perform DNA transformation and plasmid curing in order to develop molecular biology practical skills to operate these basic steps |

| | |
|---|---|
| CO 3 | To isolate genomic DNA from bacteria and lymphocytes and confirm its presence using UV-visible spectrophotometry |
| CO 4 | To design primers for amplifying the genes |
| CO 5 | To perform Bioinformatics practicals online in order to develop computational biology skills and apply the different softwares and tools |
| CO 6 | Students will choose and do any online course in Genetics or a workshop on Molecular Biology or Genetics in an institute |

**COURSE LEARNING OUTCOMES**

| | |
|---|---|
| CLO 1 | The learner will be able to analyze, classify and solve problems on Mendelian Genetics, Population Genetics and Restriction mapping |
| CLO 2 | The learner will be able to perform DNA transformation and plasmid curing experiments and apply these experiments in molecular biology research in future |
| CLO 3 | The learner will be able to isolate and purify genomic DNA from bacteria and lymphocytes and confirm its presence using UV-visible spectrophotometry |
| CLO 4 | The learner will be able to design primers to carry out the amplification of genes using Polymerase chain reaction |
| CLO 5 | The learner will be able to apply the tools and softwares of Bioinformatics in computational biology research |
| CLO 6 | The learner will be able to do a workshop or an online course in Molecular Biology or Genetics and apply the knowledge. |

| **Sr. No.** | **Name of the Experiment** |
|---|---|
| **1** | Problems on Mendelian genetics. |
| **2** | Problems on Population genetics. |
| **3** | DNA Transformation. |
| **4** | Curing of plasmids. |
| **5** | Isolation of genomic DNA from bacteria and lymphocytes. |
| **6** | Problems on restriction mapping. |
| **7** | Design of primer & PCR. |
| **8** | Bioinformatics practicals - i. Exploring DNA databases and analysis of gene record ii. Introduction to LINUX, R and Python commands, iii. Construction of Phylogeny Tree using Clustal omega |
| **9** | Online course related to any aspect of Genetics **OR** Workshop on Molecular Biology/Genetics in an institute. |

| | | |
|---|---|---|
| NAME OF THE COURSE | FOOD MICROBIOLOGY PRACTICAL | |
| CLASS | MSc-I | |
| COURSE CODE | SMCB522EP (Elective) | |
| NUMBER OF CREDITS | 2 | |
| NUMBER OF LECTURES PER WEEK | 4 | |
| TOTAL NUMBER OF LECTURES PER SEMESTER | 60 | |
| EVALUATION METHOD | CONTINUOUS ASSESSMENT | SUMMATIVE ASSESSMENT |
| TOTAL MARKS | 50 | - |
| PASSING MARKS | 20 | - |

**COURSE OBJECTIVES**

| | |
|---|---|
| CO 1 | To prepare sauerkraut and monitor microbial succession as the fermentation progresses and study the characteristics of the final product. |
| CO 2 | To cultivate probiotic bacteria from commercial foods and detect beneficial properties. |
| CO 3 | To screen for lipase/ amylase and protease producers |
| CO 4 | To instigate independent thinking and observation- interpretation skills through a small project on leavening of bread |
| CO 5 | To equip learners with practical skills in assessing microbiological quality of raw and processed liquid, solid, semisolid food as per prevailing food safety standards. |
| CO 6 | To impart hands-on experience of the quality control process and regulations for raw and pasteurized milk. |
| CO 7 | To isolate pathogenic microorganisms that are commonly associated with frozen raw foods. |
| CO 8 | To develop literature survey and writing skills and update the knowledge of food microbiology beyond textbooks through report writing |

**COURSE LEARNING OUTCOMES**

| | |
|---|---|
| CLO 1 | The learner will be able to determine the microbial load and changes in the population of lactic acid bacteria during Sauerkraut fermentation. |
| CLO 2 | The learner will be able to isolate probiotic bacterium from fermented dairy products using Rogosa agar and check its ability to produce bacteriocin. |
| CLO 3 | The learner will be able to detect microorganisms with lipase / amylase/ protease activity on Gorodkowa's, starch agar and milk agar respectively. |
| CLO 4 | The learner will be able to design and conduct an experiment to comment on the effect of any one parameter ( Temperature, time, ratio of ingredients, type of ingredients) on the leavening of bread by *Saccharomyces cerevisiae.* |
| CLO 5 | The learner will be able to prepare food samples for determination of microbial load and determine the APC and coliform count in carrot and apple juice, salad, mayonnaise to comment on hygienic quality and shelf life |
| CLO 6 | The learner will be able to carry out Quality Assessment and Analysis of Milk ( Raw, Packed) by performing DMC, RPT and SPC / LPC, Thermophilic/Psychrophilic, yeast-mold counts . |
| CLO 7 | The learner will be able to detect and identify pathogens associated with frozen fish/poultry/meat using specific selective / differential chromogenic media. |
| CLO 8 | The learner will be able to conduct literature survey on latest novel detection methods for food borne pathogens/ toxins. |

| **Sr. No.** | **Name of the experiment** |
|---|---|
| **1** | Microbiological study of fermented foods ( Sauerkraut ) |
| **2** | Isolation of Probiotic bacteria and checking the antimicrobial effect of the bacteriocin produced by probiotic organisms. |
| **3** | Production of Microbial Enzymes of commercial importance. |
| **4** | Student activity: Bread Production and studying the effect of various factors affecting Bread Production (5 marks) |
| **5** | Microbiological load in juices, salad, mayonnaise. |
| **6** | Quality Assessment and Analysis of food :Milk ( Raw, Packed ) |
| **7** | Detection of pathogens in frozen fish/poultry/meat |
| **8** | Report to be written in journal on Novel detection methods for food borne pathogens/ toxins. |

**ASSESSMENT PATTERN AND EVALUATION**
**For NEP PG**

**A. Evaluation of Mandatory, Elective Courses and Common Course (Research Methodology) for MSc Part -1**:

Assessment and evaluation pattern would be 50:50. There will be two subheads, namely, Summative Assessment (SA) and Continuous Assessment (CA) of 50 marks each for Mandatory courses.

1. Mandatory, elective and practical will have **separate heads of passing**.
2. A student needs to secure 40% marks for passing individually in SA and CA.
3. If a student fails, he/she will have to appear for an ATKT examination.
4. Students who have missed the SA for a genuine reason (supported with a document subject to approval by the authorities) will appear for an **Additional SA of 50 marks.** This Additional/ATKT SA will be held after the declaration of the respective semester results and at the discretion of the PG exam committe.
5. Students will be declared FAIL if she scores less than 20 marks out of 50 marks.
6. Staff will show assessed answer papers of SA to students and discuss the rubric of assessment with them on a day fixed by the PG Exam Committee.
7. Grievance Redressal Mechanism for addressing grievances related to SA:

   Students may apply for Reassessment, Photocopying and Revaluation of the SA answer books after the declaration of results in response to the notice posted by the College Office for the same.
8. Students with learning disabilities (LD) will be given extra time for SA as per the University rules.

**B. Continuous Assessment (CA) for Mandatory Courses:**

1. CA activities will be planned and conducted by the respective departments.

   The departments are required to share the details of the CA activities with the Deputy Controller of PG exam and PG Co-ordinator (VP- Science).
2. Students' CA activity-related scores with assessed papers and feedback on their work (tests, other activities, assignments etc.) must be shared with students.
3. Format of **CA for Mandatory courses:** Two CA activities of 25 marks each.

   **CA 1: Test - 25 marks** (Duration for answering the Test: Max. 60 Minutes)

   **CA 2: Any Activity - 25 marks**
4. The minimum score to pass the Course will be 20 marks out of 50 marks.

5. If a student fails to pass (scores less than 20) then, the student will have to appear for ATKT – **one IA** Test of 25 marks and **one assignment** of 25 Marks.

**C. Evaluation for Elective Courses under NEP:**

1. Format of **CA for Elective Courses:** Two tests of 25 marks each of **subjective type**.

   **Only CA is to be conducted with 50 marks.**

   **CA 1: Test - 25 marks** (Duration for answering the Test: Max. 60 Minutes)

   **CA 2: Test- 25 marks** (Duration for answering the Test: Max. 60 Minutes)