



# SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar

NAAC 'A' Grade (10-01-2023 To 09-01-2028)

NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

## M.Sc. Biomedical Science SEM. II

| Course Type | Course Code  | Course Title                      | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|-------------|--------------|-----------------------------------|--------------------------|----------------------|----------------|
|             |              |                                   | L-P-T                    |                      |                |
| DSC         | P2T02NCBMS01 | Biomaterials & Tissue Engineering | 4-0-1                    | 120                  | 04             |

### • Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

**CLO1:** Demonstrate understanding of tissue engineering principles, including stem cell biology, morphogenesis, cellular signaling, and scaffold design for tissue regeneration.

**CLO2:** Analyse the characteristics, sources, potency, and differentiation pathways of stem cells, and evaluate their applications in regenerative medicine.

**CLO3:** Apply knowledge of biomaterials, including their classification, properties, and biological responses, to assess their suitability for biomedical applications.

**CLO4:** Evaluate different implant materials (metallic, polymeric, ceramic, and composite) based on their structure, properties, and performance in biological environments.

**CLO5:** Analyse the interaction between biomaterials and host tissues, including biocompatibility, degradation, and mechanical behavior for effective clinical applications.

| Unit | Course Content  | Learning Pedagogies*                                   | CLO(s) |
|------|---|--|--------|
| I    | Tissue engineering Introduction, Stem cells, Morphogenesis, Generation of tissue in the embryo, Tissue homeostasis, Cellular signaling, Extracellular matrix as a biologic scaffold for tissue engineering, Scaffold fabrication, bioactive scaffold, Natural polymers in tissue engineering applications, Degradable polymers for tissue engineering.  | Lectures, ICT tools, demonstrations                    | CO1    |
| II   | Stem Cells: Introduction, hematopoietic differentiation pathway Potency, and plasticity of stem cells, sources, embryonic stem cells, hematopoietic and mesenchymal stem cells, Stem Cell markers, FACS analysis, Differentiation, Stem cell systems- Liver, neuronal stem cells, Types & sources of stem cell with characteristics: embryonic, adult, haematopoietic, fetal, cord blood, placenta, bone marrow, primordial germ cells, cancer stem cells induced pluripotent stem cells. | Case-based learning, research discussions, simulations | CO2    |
| III  | Biomaterials: Introduction-definition of biomaterials, applications of biomaterials, classification of biomaterials, Comparison of properties of some common biomaterials. Effects of physiological fluid on the properties of biomaterials. Biological responses (extra and intra- vascular system). Surface properties of materials, physical properties of materials, mechanical properties.   | Problem-solving, data analysis, group learning         | CO3    |



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|    |   |  |          |
|----|---|--|----------|
| IV | <b>Implant materials:</b> Metallic (stainless steel, Co-based, Ti alloys) with corrosion behavior, stress-corrosion cracking, and passive films; polymeric materials (classification: thermosets, thermoplastics, elastomers; polyolefins, polyamides, acrylics, fluorocarbons, silicones, acetals) with molecular structure, hydrophilic/hydrophobic properties, and physicochemical characteristics; biopolymers and biodegradable polymers for medical use, controlled drug delivery, and synthetic membranes; ceramic materials (bioceramics: alumina, glass-ceramics, carbons) including bioactive and bioresorbable types, wear resistance, fracture toughness, and tissue interactions; composite materials with fiber reinforcement (short/long fibers, pull-out mechanisms) and property enhancement principles. | Case studies, presentations, experiential learning | CO4, CO5 |
|----|---|--|----------|

### (\* Learning Pedagogies/Methods

Notes:

(1) The following list is suggestive. Any other learning pedagogies relevant to discipline-specific requirements can be added.

(2) Acronyms/abbreviations of the terms can be placed in the above table.

- (a) Interactive Classroom Lecture
- (b) Classroom Lecture (CL)
- (c) Seminars (Student-led and Faculty-moderated)
- (d) Micro-Projects/Mini Research Tasks
- (e) Industrial Visit/Field Visit/Institutional Visit
- (f) Problem-Based Learning (PBL)
- (g) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
- (h) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
- (i) Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
- (j) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
- (k) Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
- (l) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

### • Assessment Methodologies

#### (A) Internal Assessment

##### a. Internal Formative assessment (20)

- (a) Mid-term tests
- (b) Assignment, Self-learning and Terms work
- (c) Seminar/Presentation
- (d) Quiz

##### b. Internal Summative Assessment (30)

- (a) End of Term Examination
- (b) Laboratory performance
- (c) Viva-voce



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## M.Sc. Biomedical Science SEM. II

### (B) Weightage of Learning Efforts for External Assessment

| Unit | Aligned COs | Total Learning Hours | Approximate weightage (Marks) to Learning levels (BT) |                   |                                  | Total Marks |
|------|-------------|----------------------|---|-------------------|----------------------------------|-------------|
|      |             |                      | Remember (R)  | Understanding (U) | Application/ Analyse & above (A) |             |
| I    | CO1         | 30                   | 1   | 1                 | 12                               | 14          |
| II   | CO2         | 32                   | 1   | 1                 | 10                               | 12          |
| III  | CO3         | 28                   | 1   | 1                 | 10                               | 12          |
| IV   | CO4, CO5    | 30                   | 1   | 1                 | 12                               | 14          |
|      |             | <b>120</b>           | <b>04</b>   | <b>04</b>         | <b>34</b>                        | <b>50</b>   |

#### • Assessment and Evaluation

| Sr.No. | Assessment/Evaluation          | Component  | Weightage (%) |
|--------|--------------------------------|--|---------------|
| 1      | Continuous Internal Evaluation | Seminars, Assignments, Quizzes, Class Regularity,                          | 50%           |
| 2      | End-Semester Examination       | Written Exam/Practical Exam Project Evaluation(Report, Presentation, Viva) | 50%           |

### (B) CLOs – PLOs Matrix

| CLO  | PLO  |      |      |      |      |      |      |      |      |       |
|------|------|------|------|------|------|------|------|------|------|-------|
|      | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 |
| CLO1 | 3    | 2    | 1    | -    | 2    | 1    | -    | -    | 1    | 2     |
| CLO2 | 3    | 2    | 1    | -    | 2    | 2    | -    | -    | 1    | 2     |
| CLO3 | 3    | 2    | 2    | 1    | 3    | 2    | -    | -    | 1    | 1     |
| CLO4 | 3    | 2    | 1    | 2    | 3    | 2    | -    | 1    | 1    | 2     |
| CLO5 | 2    | 2    | 1    | 2    | 2    | 3    | -    | 2    | 1    | 1     |

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

| CLO – PLO correlation | Value |
|-----------------------|-------|
| Strong                | 3     |
| Moderate              | 2     |
| Low                   | 1     |
| No correlation        | -     |

#### • Suggested Learning Materials Books:

| Sr.No. | Title  | Author(s)   | Edition/Year                  | Publisher             |
|--------|--|---|-------------------------------|-----------------------|
| 1      | Tissue Engineering   | Bernhard O. Palsson, Sangeeta N. Bhatia                         | 1 <sup>st</sup> Edition, 2004 | Pearson Prentice Hall |
| 2      | Fundamentals of Tissue Engineering and Regenerative Medicine | Ulrich Meyer, Thomas Meyer, Jörg Handschel, Hans Peter Wiesmann | 1 <sup>st</sup> Edition, 2009 | Springer              |



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|   |                                      |                |                               |                         |
|---|--------------------------------------|----------------|-------------------------------|-------------------------|
| 3 | Biomaterials Science and Engineering | Joon B. Park   | 1 <sup>st</sup> Edition, 1984 | Springer                |
| 4 | Biomaterials                         | Sujata V. Bhat | 2 <sup>nd</sup> Edition, 2013 | Narosa Publishing House |

- **Online Resources (Open Source)**

| Sr. No. | Description of Resource(s)                        | Weblink   |
|---------|---|---|
| 1       | NPTEL – Tissue Engineering Lectures               | <a href="https://nptel.ac.in">https://nptel.ac.in</a>   |
| 2       | Nature – Tissue Engineering Collection            | <a href="https://www.nature.com/subjects/tissue-engineering">https://www.nature.com/subjects/tissue-engineering</a> |
| 3       | ScienceDirect – Biomaterials & Tissue Engineering | <a href="https://www.sciencedirect.com">https://www.sciencedirect.com</a>   |
| 4       | NIH – Regenerative Medicine Resources             | <a href="https://www.nih.gov">https://www.nih.gov</a>   |



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## M.Sc. Biomedical Science SEM. II

| Course Type | Course Code  | Course Title                     | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|-------------|--------------|----------------------------------|--------------------------|----------------------|----------------|
|             |              |                                  | L-P-T                    |                      |                |
| DSC         | P2T02NCBMS02 | Animal and Medical Biotechnology | 4-0-1                    | 120                  | 04             |

### • Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

**CLO1:** Explain the principles of animal cloning, transgenic animal production, and reproductive biotechnological techniques such as embryo transfer and artificial insemination.

**CLO2:** Describe stem cell biology, types of stem cells, therapeutic cloning, and ethical issues associated with stem cell technology.

**CLO3:** Discuss nucleic acid therapeutics, protein therapeutics, recombinant biopharmaceuticals, and microbial delivery systems for therapeutic agents.

**CLO4:** Analyze the concepts, applications, and ethical aspects of gene therapy in treatment of inherited, cancerous, and neurological disorders.

**CLO5:** Evaluate principles and biomedical applications of nanobiotechnology, nanoparticles, Nano biosensors, drug/gene delivery systems, and associated risks.

**CLO6:** Interpret the role of pharmacogenomics, DNA fingerprinting, and integration of Indian Knowledge Systems with modern biotechnology and personalized medicine.

| Unit | Course Content  | Learning Pedagogies*  | CLO(s)     |
|------|---|---|------------|
| I    | Animal Cloning: Concept of animal cloning, cloning from embryonic and adult cells, Creation of Dolly, Molly and Polly<br>Transgenic Animals: Transfection methods-DNA microinjection, Retroviral and embryonic stem cell methods, Application of transgenic animals-mice, sheep, pigs, goats, cows, fish  | Interactive Classroom Lecture, ICT-Enabled Learning, Assignments, | CLO1       |
| II   | Embryo transfer Technology: Superovulation and embryo transfer in cattle, artificial insemination, advantages of embryo transfer<br>Stem Cell Technology: Definition and meaning of stem cells, function, adult and embryonic stem cells, hematopoietic, mesenchymal and neural stem cells, therapeutic cloning for embryonic stem cells, ethical issues.   | Virtual Labs, Demonstrations, Interactive Lecture, Seminars       | CLO1, CLO2 |
| III  | Nucleic Acid Therapeutics -Antisense RNA, Ribozyme, Aptamers, DNazymes, RNAi, Zinc Finger Nucleases<br>Protein Therapeutics-Pharmaceuticals (Tumour Necrosis Factor, Human Growth Hormone, Interferon etc),<br>Recombinant Antibodies (Human Monoclonal Antibodies, Hybrid Human- Mouse Monoclonal Antibody, Anticancer Antibodies), Enzymes (DNase, Alginate Lyase, Alpha 1 Antitrypsin, Phenyl Ammonia Lyase, Glycosidases); Use of Lactic Acid Bacteria for delivery of therapeutic agents | Research-Oriented Learning, Group Discussion, Presentations,      | CLO3, CLO4 |



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|    |  |   |      |
|----|--|---|------|
|    | (Interleukin-10, Leptin, An HIV Inhibitor, Insulin)<br><u>Gene Therapy</u> : Types of gene therapy, Augmentation Gene therapy, Targeted gene therapy, gene therapy for SCID, Cancer, Neurological disorders, Ethical issues  |   |      |
| IV | Nanobiotechnology: Introduction, types and synthesis of Nanoparticles, Protein based nanostructures, applications of nanoparticles Nano biosensors, drug and gene delivery, disease diagnostics and therapy; risk potential of nanomaterials <b>Correlation of Indian Knowledge System with Biotechnology: Comparative analysis of ancient and Modern drug formulations. Bhasma and Nanoparticles: Advances in modern nanotechnology aspired by a by ancient practices. Application of Ancient in Contemporary Research.</b> Pharmacogenomics: concept, Role of Genetic Variations in different responses of individuals to drugs, Pharmacogenomics and industry, personalized Medicine, DNA fingerprinting in Forensic sciences | Interactive Classroom Lecture, ICT-Enabled Learning | CLO5 |

- (\*) **Learning Pedagogies/Methods**

Notes:

(3) The following list is suggestive. Any other learning pedagogies relevant to discipline-specific requirements can be added.

(4) Acronyms/abbreviations of the terms can be placed in the above table.

(n) Interactive Classroom Lecture

(o) Classroom Lecture (CL)

(p) Seminars (Student-led and Faculty-moderated)

(q) Micro-Projects/Mini Research Tasks

(r) Industrial Visit/Field Visit/Institutional Visit

(s) Problem-Based Learning (PBL)

(t) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)

(u) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)

(v) Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)

(w) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)

(x) Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)

(aa) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

- Assessment Methodologies**

- (B) Internal Assessment**

- c. Internal Formative assessment (20)**

(e) Mid-term tests

(f) Assignment, Self-learning and Terms work

(g) Seminar/Presentation

(h) Quiz

- d. Internal Summative Assessment (30)**

(d) End of Term Examination

(e) Laboratory performance (f) Viva-voce



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### (B) Weightage of Learning Efforts for External Assessment

| Unit | Aligned COs | Total Learning Hours | Approximate weightage (Marks) to Learning levels (BT) |                   |                                  | Total Marks |
|------|-------------|----------------------|---|-------------------|----------------------------------|-------------|
|      |             |                      | Remember (R)  | Understanding (U) | Application/ Analyse & above (A) |             |
| I    | CO1, CO2    | 30                   | 1   | 1                 | 12                               | 14          |
| II   | CO2, CO3    | 32                   | 1   | 1                 | 10                               | 12          |
| III  | CO3, CO4    | 28                   | 1   | 1                 | 10                               | 12          |
| IV   | CO5, CO6    | 30                   | 1   | 1                 | 12                               | 14          |
|      |             | <b>120</b>           | <b>04</b>   | <b>04</b>         | <b>34</b>                        | <b>50</b>   |

### • Assessment and Evaluation

| Sr. No. | Assessment/Evaluation          | Component   | Weightage (%) |
|---------|--------------------------------|---|---------------|
| 1       | Continuous Internal Evaluation | Seminars, Assignments, Quizzes, Class Regularity,                                 | 50            |
| 2       | End-Semester Examination       | Written Exam/Practical Exam<br>Project Evaluation<br>(Report, Presentation, Viva) | 50            |

### (E) CLOs – PLOs Matrix

| CLO  | PLO  |      |      |      |      |      |      |      |      |       |
|------|------|------|------|------|------|------|------|------|------|-------|
|      | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 |
| CLO1 | 3    | 2    | 1    | 2    | -    | 2    | 2    | -    | -    | -     |
| CLO2 | 3    | 2    | 2    | 2    | 1    | 2    | 2    | 1    | -    | 1     |
| CLO3 | 3    | 3    | 2    | 2    | 1    | 2    | 2    | -    | 1    | 1     |
| CLO4 | 3    | 2    | 3    | 3    | 1    | 3    | 2    | 1    | 1    | 1     |
| CLO5 | 2    | 2    | 2    | 3    | 2    | 2    | 2    | 2    | 1    | -     |
| CLO6 | 2    | 1    | 2    | 3    | 1    | 3    | 1    | 3    | 2    | 2     |

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

| CLO – PLO correlation | Value |
|-----------------------|-------|
| Strong                | 3     |
| Moderate              | 2     |
| Low                   | 1     |
| No correlation        | -     |



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- Suggested Learning Materials Books:**

| Sr. No. | Title  | Author(s)                                   | Edition/Year | Publisher            |
|---------|--|---|--------------|----------------------|
| 1       | Principles of Gene Manipulation and Genomics | Primrose & Twyman                           | Latest Ed.   | Blackwell Publishing |
| 2       | Molecular Biotechnology                      | Glick, Pasternak & Patten                   | Latest Ed.   | ASM Press            |
| 3       | Animal Biotechnology                         | M. M. Ranga                                 | Latest Ed.   | Agrobios             |
| 4       | Stem Cells: Scientific Facts and Fiction     | Christine Mummery et al.                    | Latest Ed.   | Academic Press       |
| 5       | Gene Therapy                                 | Nancy Smyth Templeton                       | Latest Ed.   | CRC Press            |
| 6       | Introduction to Nanobiotechnology            | Vinod Labhassetwar & Diandra Leslie-Pelecky | Latest Ed.   | Wiley                |
| 7       | Pharmaceutical Biotechnology                 | Crommelin, Sindelar & Meibohm               | Latest Ed.   | Springer             |
| 8       | Pharmacogenomics                             | Yui-Wing Francis Lam & Howard McLeod        | Latest Ed.   | Elsevier             |
| 9       | Biotechnology                                | U. Satyanarayana                            | Latest Ed.   | Books & Allied       |
| 10      | Recombinant DNA                              | Watson et al.                               | Latest Ed.   | W.H. Freeman         |

- Online Resources (Open Source)**

| Sr. No. | Description of Resource(s)  | Weblink   |
|---------|---|---|
| 1       | NPTEL Courses – Biotechnology, Stem Cells, Gene Therapy, Nanotechnology | <a href="https://nptel.ac.in">https://nptel.ac.in</a>                               |
| 2       | Nature Education Scitable – Genetics, Cloning, Stem Cells, Therapeutics | <a href="https://www.nature.com/scitable">https://www.nature.com/scitable</a>       |
| 3       | NCBI Bookshelf – Molecular Biotechnology and Gene Therapy Resources     | <a href="https://www.ncbi.nlm.nih.gov/books">https://www.ncbi.nlm.nih.gov/books</a> |
| 4       | Khan Academy – Biotechnology and Genetics Basics                        | <a href="https://www.khanacademy.org">https://www.khanacademy.org</a>               |
| 5       | MIT OpenCourseWare – Biological Engineering and Nanobiotechnology       | <a href="https://ocw.mit.edu">https://ocw.mit.edu</a>                               |



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| Course Type | Course Code  | Course Title        | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|-------------|--------------|---------------------|--------------------------|----------------------|----------------|
|             |              |                     | L-P-T                    |                      |                |
| DSC         | P2T02NCBMS03 | Genetic Engineering | 4-0-1                    | 120                  | 04             |

### • Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

**CLO1:** Explain the principles, tools, enzymes, vectors, and methodologies used in genetic engineering and recombinant DNA technology.

**CLO2:** Demonstrate understanding of cloning strategies, DNA library construction, host transformation, screening, and hybridization techniques used in molecular biology.

**CLO3:** Analyze different PCR techniques, sequencing methods, mutation detection systems, and their applications in diagnostics and research.

**CLO4:** Evaluate applications of genetic engineering in plants, animals, microbes, medicine, gene therapy, metagenomics, and metabolic engineering with emphasis on biosafety and regulations.

**CLO5:** Interpret the relevance of Indian Knowledge Systems (IKS), ancient scriptures, bioethics, biopiracy, patents, and traditional knowledge in the context of modern biotechnology.

| Unit | Course Content  | Learning Pedagogies*  | CLO(s) |
|------|---|---|--------|
| I    | <b>Overview of Ancient Indian Scriptures with Biotechnological Relevance Genetic engineering analogies in Mahabharata,</b> Impact of genetic engineering in modern society. General requirements for performing a genetic engineering experiment – restriction endonucleases and methylases, DNA ligase, Klenow enzyme, T4 DNA polymerase, polynucleotide kinase, alkaline phosphatase. Cohesive and blunt end ligation, linkers, adaptors, homopolymer tailing. Labelling of DNA - nick translation, random priming, radioactive and non-radioactive probes. Construction of libraries; Introduction of DNA into host cells; screening and selection methods for recombinant clones. Hybridization techniques - northern, southern, south-western, far-western, colony hybridization, and fluorescence <i>in situ</i> hybridization. | Classroom Lecture (CL),<br>ICT-Enabled Learning,<br>Self-Directed Learning,<br>Inquiry-Based Learning | CLO1   |
| II   | Plasmids, Bacteriophages, M13mp vectors, pUC19 and pBluescript vectors, phagemids, Lambda vectors, Insertion and Replacement vectors, Cosmids, Artificial chromosome vectors (YACs and BACs). pMal, GST, pET-based vectors. Intein-based vectors. Mammalian expression and replicating vectors, Baculovirus and <i>pichia</i> vectors system, plant-based vectors, Ti and Ri as vectors, yeast vectors, shuttle vectors. Salient features of expression vectors for heterologous expression in <i>E. coli</i> , Yeast, Insect and Mammalian   | Classroom Lecture (CL),<br>ICT-Enabled Learning,<br>Guided Learning,<br>Self-                         | CLO2   |



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|     |  |  |            |
|-----|--|--|------------|
|     | system, factors influencing heterologous gene expression, Principles for maximizing gene expression in vectors. Protein purification - His-tag, GST-tag, MBP-tag <i>etc.</i> Introduction to CRISPER/Cas9 plasmids.  | Directed Learning  |            |
| III | Principles of PCR, primer design, fidelity of thermostable enzymes, DNA polymerases. Types of PCR - multiplex, nested, real time PCR, touchdown PCR, hot start PCR, colony PCR. Cloning of PCR products, T – vectors. Proof reading enzymes. PCR based site specific mutagenesis. PCR in molecular diagnostics, viral and bacterial detection. Chemical synthesis of oligonucleotides. Mutation detection - SSCP, DGGE, RFLP. Sequencing methods - enzymatic DNA sequencing, chemical sequencing of DNA, automated DNA sequencing, RNA sequencing.   | Classroom Lecture (CL), ICT-Enabled Learning,  | CLO3       |
| IV  | Applications of Genetic engineering in improvement of plants, animals and microbes; Gene editing and its applications; Metagenomics and Metabolic engineering; Human disorders and Gene therapy; Restriction and regulations for the release of GMOs; Biosafety and levels of Physical and Biological containment; The Indian Guidelines for release and use of GM organisms. <b>Bioethics and cloning perspectives from Scriptures Integration of IKS with Modern Scientific and Biotechnological Paradigms: Biopiracy, patents, and traditional knowledge validation, Bioethical reflections from epics in modern biotech debates.</b> | Classroom Lecture (CL), ICT-Enabled Learning, Self-Directed Learning, Reflective Practices | CLO4, CLO5 |

- (\*) **Learning Pedagogies/Methods**

Notes:

(1) The following list is suggestive. Any other learning pedagogies relevant to discipline-specific requirements can be added.

(2) Acronyms/abbreviations of the terms can be placed in the above table.

- Interactive Classroom Lecture
- Classroom Lecture (CL)
- Seminars (Student-led and Faculty-moderated)
- Micro-Projects/Mini Research Tasks
- Industrial Visit/Field Visit/Institutional Visit
- Problem-Based Learning (PBL)
- Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
- Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
- Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
- ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
- Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
- Self-Directed Learning (Guided Readings, Concept Exploration Tasks)



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- Assessment Methodologies

- (C) Internal Assessment

- e. Internal Formative assessment (20)

- (i) Mid-term tests
    - (j) Assignment, Self-learning and Terms work
    - (k) Seminar/Presentation
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- f. Internal Summative Assessment (30)

- (f) End of Term Examination
    - (g) Laboratory performance
    - (h) Viva-voce

- (B) Weightage of Learning Efforts for External Assessment

| Unit | Aligned COs | Total Learning Hours | Approximate weightage (Marks) to Learning levels (BT) |                   |                                  | Total Marks |
|------|-------------|----------------------|---|-------------------|----------------------------------|-------------|
|      |             |                      | Remember (R)  | Understanding (U) | Application/ Analyse & above (A) |             |
| I    | CO1         | 30                   | 1   | 1                 | 12                               | 14          |
| II   | CO2         | 32                   | 1   | 1                 | 10                               | 12          |
| III  | CO3         | 28                   | 1   | 1                 | 10                               | 12          |
| IV   | CO4, CO5    | 30                   | 1   | 1                 | 12                               | 14          |
|      |             | <b>120</b>           | <b>04</b>   | <b>04</b>         | <b>34</b>                        | <b>50</b>   |

- Assessment and Evaluation

| Sr. No. | Assessment/Evaluation          | Component   | Weightage (%) |
|---------|--------------------------------|---|---------------|
| 1       | Continuous Internal Evaluation | Seminars, Assignments, Quizzes, Class Regularity,                           | 50            |
| 2       | End-Semester Examination       | Written Exam/Practical Exam Project Evaluation (Report, Presentation, Viva) | 50            |

### CLOs – PLOs Matrix

| CLO  | PLO  |      |      |      |      |      |      |      |      |       |
|------|------|------|------|------|------|------|------|------|------|-------|
|      | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 |
| CLO1 | 3    | 2    | 1    | -    | 2    | -    | -    | -    | -    | 2     |
| CLO2 | 3    | 3    | 2    | -    | 3    | 1    | -    | -    | 1    | 2     |
| CLO3 | 3    | 3    | 3    | -    | 2    | 1    | -    | -    | 2    | 2     |
| CLO4 | 3    | 3    | 2    | 2    | 2    | 2    | 1    | 1    | 2    | 3     |
| CLO5 | 3    | 2    | 1    | 2    | 1    | 2    | 1    | 3    | 2    | 3     |



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## M.Sc. Biomedical Science SEM. II

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

| CLO – PLO correlation | Value |
|-----------------------|-------|
| Strong                | 3     |
| Moderate              | 2     |
| Low                   | 1     |
| No correlation        | -     |

### • Suggested Learning Materials Books:

| Sr. No. | Title   | Author(s)                                     | Edition/Year  | Publisher  |
|---------|---|---|---------------|--|
| 1       | Integrated Approaches Towards Drug Development from Ayurveda and Other Indian System of Medicines | Mukherjee, P. K.; Wahile, A.                  | 2006          | <i>Journal of Ethnopharmacology</i> , 103(1), 25–35                                      |
| 2       | Ayurveda and Traditional Knowledge: The Current Status  | Patwardhan, B.; Vaidya, A. B.; Chorghade, M.  | 2005          | <i>Current Science</i> , 89(9), 1339–1348  |
| 3       | A Glimpse of Contributions of Acharya Sushruta in Surgery   | Guleria, M.; Choudhary, K. R.                 | 2015          | <i>World Journal of Pharmaceutical and Pharmaceutical Sciences</i> , 9, 291–317          |
| 4       | Influence of Harvesting and Processing Methods on the Active Principles of Medicinal Plants       | Pushpan, R.; Kumari, H.; Nishteswar, K.       | 2012          | <i>International Journal of Pharmaceutical and Biological Archives</i> , 3(5), 1283–1286 |
| 5       | Genome  | Brown, T. A.                                  | 3rd Ed., 2006 | Garland Science  |
| 6       | Molecular Biotechnology   | Glick, B. R.; Pasternak, J. J.; Patten, C. L. | 4th Ed., 2010 | ASM Press  |
| 7       | Principles of Gene Manipulation   | Primrose, S. B.; Twyman, R.                   | 7th Ed., 2006 | Blackwell Publishing   |
| 8       | Applied Molecular Genetics  | Miesfeld, R. L.                               | 2nd Ed., 2015 | Wiley-Blackwell  |
| 9       | Biotechnology   | Das, H. K.                                    | 4th Ed., 2010 | Wiley India Pvt. Ltd.  |
| 10      | Recombinant DNA   | Watson, J. D. et al.                          | 3rd Ed., 2007 | W. H. Freeman and Company  |
| 11      | Molecular Cloning: A Laboratory Manual  | Green, M. R.; Sambrook, J.                    | 4th Ed., 2012 | Cold Spring Harbor Laboratory Press  |
| 12      | From Genes to Clones  | Winnacker, E. L.                              | 1st Ed., 1987 | VCH Publishers   |



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## M.Sc. Biomedical Science SEM. II

- **Online Resources (Open Source)**

| Sr. No. | Description of Resource(s)   | Weblink   |
|---------|--|---|
| 1       | NCBI Bookshelf – Molecular Biology and Genetic Engineering (Covers cloning, vectors, PCR, sequencing, and gene expression)   | <a href="https://www.ncbi.nlm.nih.gov/books">https://www.ncbi.nlm.nih.gov/books</a>                       |
| 2       | OpenStax Biology 2e (Concepts of recombinant DNA technology, gene cloning, PCR, and applications in biotechnology)   | <a href="https://openstax.org/details/books/biology-2e">https://openstax.org/details/books/biology-2e</a> |
| 3       | Nature Education – Scitable (Advanced topics including gene regulation, sequencing technologies, and gene editing)   | <a href="https://www.nature.com/scitable">https://www.nature.com/scitable</a>                             |
| 4       | NPTEL Biotechnology Courses (Lectures on cloning vectors, sequencing methods, metagenomics, and gene therapy)  | <a href="https://nptel.ac.in">https://nptel.ac.in</a>   |
| 5       | Digital Library of India Scriptures Archive – Access to Mahabharata, Ramayana, Vedas, Upanishads, and classical Indian texts relevant to bioethical and scientific interpretations | <a href="https://www.dli.gov.in">https://www.dli.gov.in</a>   |
| 6       | Sacred Texts Archive – English translations of Mahabharata, Ramayana, and other scriptures for comparative study of cloning analogies, ethics, and healing traditions              | <a href="https://www.sacred-texts.com">https://www.sacred-texts.com</a>                                   |
| 7       | Ministry of AYUSH, Government of India – Resources on Ayurveda, medicinal plants, Sanjeevani Booti references, and integration of traditional knowledge with biotechnology         | <a href="https://www.ayush.gov.in">https://www.ayush.gov.in</a>   |
| 8       | TKDL (Traditional Knowledge Digital Library) – Indian database on medicinal knowledge, biopiracy prevention, patents, and validation of traditional practices                      | <a href="https://www.tkdl.res.in">https://www.tkdl.res.in</a>   |
| 9       | CSIR India – Research on medicinal plants, biotechnology innovation, IKS integration, and traditional knowledge systems  | <a href="https://www.csir.res.in">https://www.csir.res.in</a>   |



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## M.Sc. Biomedical Science SEM. II

| Course Type | Course Code  | Course Title   | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|-------------|--------------|--|--------------------------|----------------------|----------------|
|             |              |  | L-P-T                    |                      |                |
| DSC         | P2T02NCBMS04 | Practicals Based on Biomaterials & Tissue Engineering and Animal & Medical Biotechnology | 0-8-0                    | 120                  | 04             |

### • Course Learning Outcomes (CLOs)

On completion of this course, students will be able to:

**CLO1:** Demonstrate proficiency in aseptic techniques, media preparation, and maintenance of animal cell culture systems.

**CLO2:** Apply cell culture methods including subculturing, cell counting, and viability assays to assess cell growth and functionality.

**CLO3:** Analyse cell behavior using assays such as MTT and cell adhesion studies for evaluating proliferation and biocompatibility.

**CLO4:** Design and develop biomaterial-based scaffolds (alginate, chitosan, hydrogels) for tissue engineering applications.

**CLO5:** Evaluate drug delivery systems using scaffold- and nanoparticle-based models, including drug loading and release studies.

**CLO6:** Apply bioinformatics and regulatory knowledge to interpret biological data and adhere to biosafety and stem cell research guidelines.

| Course Content  | Learning Pedagogies*                | CLO(s)     |
|---|-------------------------------------|------------|
| 1. Preparation of culture media (DMEM/RPMI)<br>2. Sterilization techniques (autoclaving, filtration)<br>3. Primary cell culture (fibroblast isolation – demo)<br>4. Subculturing (passaging) of animal cells<br>5. Cell counting using hemocytometer<br>6. Cell viability assay (Trypan Blue exclusion test)<br>7. MTT assay for cell proliferation<br>8. Cell adhesion assay<br>9. Alginate bead formation<br>10. Chitosan scaffold preparation<br>11. Hydrogel preparation (bioactive scaffold model)<br>12. Drug loading and release from scaffold (dye-based study)<br>13. Regulatory guidelines for stem cell use (India/ICMR)<br>14. Study of Indian biosafety guidelines (documentation practical)<br>15. Gene sequence retrieval from NCBI database<br>16. Case study: “Sanjeevani Booti” and herbal pharmacology (literature analysis)<br>17. Study of biopiracy cases (e.g., turmeric, neem)<br>18. Synthesis of silver nanoparticles using plant extract (green synthesis) | Lectures, ICT tools, demonstrations | CO1 to CO6 |



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## M.Sc. Biomedical Science SEM. II

|   |  |  |
|---|--|--|
| 19. UV-Vis spectroscopy analysis of nanoparticles                   |  |  |
| 20. Drug loading and release study using nanoparticles (model dyes) |  |  |
| 21. Preparation of liposomes (drug delivery model)                  |  |  |

### • (\*) Learning Pedagogies/Methods

Notes:

(1) The following list is suggestive. Any other learning pedagogies relevant to discipline-specific requirements can be added.

(2) Acronyms/abbreviations of the terms can be placed in the above table.

- (a) Interactive Classroom Lecture
- (b) Classroom Lecture (CL)
- (c) Seminars (Student-led and Faculty-moderated)
- (d) Micro-Projects/Mini Research Tasks
- (e) Industrial Visit/Field Visit/Institutional Visit
- (f) Problem-Based Learning (PBL)
- (g) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
- (h) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
- (i) Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
- (j) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
- (k) Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
- (l) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

### • Assessment Methodologies

#### (A) Internal Assessment

##### a. Internal Formative assessment (30)

- (a) Journal Evaluation
- (b) Method of working
- (c) Attendance

##### b. Internal Summative Assessment (20)

- (a) Mid-Term
- (b) Viva-Voce

#### (B) External Assessment (50)

##### (a) End-Term

#### (B) Weightage of Learning Efforts for External Assessment

| Aligned COs | Total Learning Hours | Approximate weightage (Marks) to Learning levels (BT) |                   |                                 | Total Marks |
|-------------|----------------------|---|-------------------|---------------------------------|-------------|
|             |                      | Remember (R)  | Understanding (U) | Application/Analyse & above (A) |             |
| CO1 to CO6  | 120                  | 5   | 10                | 35                              | 50          |
|             | 120                  | 5   | 10                | 35                              | 50          |



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## M.Sc. Biomedical Science SEM. II

### (A) CLOs – PLOs Matrix

| CLO  | PLO  |      |      |      |      |      |      |      |      |       |
|------|------|------|------|------|------|------|------|------|------|-------|
|      | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 |
| CLO1 | 3    | 3    | 2    | 1    | 2    | 1    | -    | -    | -    | 1     |
| CLO2 | 3    | 3    | 3    | 2    | 2    | 1    | -    | -    | 1    | 1     |
| CLO3 | 2    | 3    | 2    | 2    | 1    | 1    | -    | -    | 1    | 1     |
| CLO4 | 2    | 1    | 2    | 3    | 3    | 2    | 1    | 2    | 2    | 2     |
| CLO5 | 3    | 3    | 2    | 3    | 2    | 2    | 1    | 2    | 1    | 2     |

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

| CLO – PLO correlation | Value |
|-----------------------|-------|
| Strong                | 3     |
| Moderate              | 2     |
| Low                   | 1     |
| No correlation        | -     |

### • Suggested Learning Materials Books:

| Sr. No. | Title  | Author(s)                       | Edition/Year  | Publisher               |
|---------|--|---------------------------------|---------------|-------------------------|
| 1       | Animal Cell Culture: A Practical Approach      | Freshney, R. Ian                | 7th Ed., 2016 | Oxford University Press |
| 2       | Culture of Animal Cells                        | Freshney, R. Ian                | 6th Ed., 2010 | Wiley-Blackwell         |
| 3       | Tissue Engineering                             | Clemens van Blitterswijk et al. | 2nd Ed.       | Academic Press          |
| 4       | Biomaterials Science                           | Ratner et al.                   | 3rd Ed.       | Elsevier                |
| 5       | Cell and Tissue Culture: Laboratory Procedures | Doyle & Griffiths               | Latest Ed.    | Wiley                   |

### • Online Resources (Open Source)

| Sr. No. | Description of Resource(s)                        | Weblink   |
|---------|---|---|
| 1       | NPTEL – Cell Biology & Tissue Engineering Courses | <a href="https://nptel.ac.in">https://nptel.ac.in</a>                   |
| 2       | ATCC Cell Culture Guide & Resources               | <a href="https://www.atcc.org">https://www.atcc.org</a>                 |
| 3       | Thermo Fisher Cell Culture Basics & Protocols     | <a href="https://www.thermofisher.com">https://www.thermofisher.com</a> |
| 4       | Nature Protocols – Cell Culture Methods           | <a href="https://www.nature.com/nprot">https://www.nature.com/nprot</a> |
| 5       | ICMR Guidelines for Stem Cell Research            | <a href="https://www.icmr.gov.in">https://www.icmr.gov.in</a>           |



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## M.Sc. Biomedical Science SEM. II

| Course Type | Course Code  | Course Title  | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|-------------|--------------|---|--------------------------|----------------------|----------------|
|             |              |   | L-P-T                    |                      |                |
| DSC         | P2T02NCBMS05 | Practicals Based on Genetic Engineering and Biostatistics | 0-8-0                    | 120                  | 04             |

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

**CLO1:** Demonstrate proficiency in molecular biology techniques including plasmid DNA isolation, restriction digestion, and bacterial transformation.

**CLO2:** Apply recombinant DNA technology methods such as competent cell preparation and screening of transformants using selection techniques.

**CLO3:** Analyse protein expression and characterization using techniques such as protein extraction and SDS-PAGE.

**CLO4:** Apply PCR-based techniques, including primer design, gene amplification, qPCR, and PCR product purification for genetic analysis.

**CLO5:** Analyse and interpret genetic data using bioinformatics tools such as sequence retrieval, alignment (BLAST), and DNA sequence analysis.

**CLO6:** Apply statistical methods to analyse experimental data and interpret results with accuracy and scientific validity.

| Practical Content  | Learning Pedagogies*                | CLO(s)     |
|--|-------------------------------------|------------|
| 1. Isolation of plasmid DNA and its quantification<br>2. Restriction digestion of plasmid DNA using restriction enzymes<br>3. Preparation of competent E. coli cells (CaCl <sub>2</sub> method)<br>4. Transformation of bacteria with plasmid DNA<br>5. Blue-white screening using pUC19 vector system/Selection of recombinants using antibiotic resistance markers<br>6. Protein extraction from bacterial cells<br>7. SDS-PAGE for protein analysis<br>8. Primer design for PCR (bioinformatics-based)<br>9. Basic PCR amplification of a gene<br>10. Real-Time PCR (qPCR demo)<br>11. PCR product purification<br>12. DNA sequence analysis using software tools<br>13. Sequence alignment using bioinformatics tools (BLAST)<br>14. Practical based on statistics | Lectures, ICT tools, demonstrations | CO1 to CO6 |

- **(\* Learning Pedagogies/Methods)**

Notes:

(1) The following list is suggestive. Any other learning pedagogies relevant to discipline-specific requirements can be added.

(2) Acronyms/abbreviations of the terms can be placed in the above table.



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## M.Sc. Biomedical Science SEM. II

- (a) Interactive Classroom Lecture
- (b) Classroom Lecture (CL)
- (c) Seminars (Student-led and Faculty-moderated)
- (d) Micro-Projects/Mini Research Tasks
- (e) Industrial Visit/Field Visit/Institutional Visit
- (f) Problem-Based Learning (PBL)
- (g) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
- (h) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
- (i) Experiential Learning (Community Engagement, Internship-linked Activities, Practice- based Tasks)
- (j) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
- (k) Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
- (l) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

- **Assessment Methodologies**

- (A) **Internal Assessment**

- a. **Internal Formative assessment (30)**

- (n) Journal Evaluation
      - (o) Method of working
      - (p) Attendance

- b. **Internal Summative Assessment (20)**

- (c) Mid-Term
      - (d) Viva-Voce

- (B) **External Assessment (50)**

- (b) **End-Term**

- (A) **Weightage of Learning Efforts for External Assessment**

| Aligned COs | Total Learning Hours | Approximate weightage (Marks) to Learning levels (BT) |                   |                                  | Total Marks |
|-------------|----------------------|---|-------------------|----------------------------------|-------------|
|             |                      | Remember (R)  | Understanding (U) | Application/ Analyse & above (A) |             |
| CO1 to CO6  | 120                  | 5   | 10                | 35                               | 50          |
|             | 120                  | 5   | 10                | 35                               | 50          |

- **Assessment and Evaluation**

| Sr. No. | Assessment/Evaluation          | Component   | Weightage (%) |
|---------|--------------------------------|---|---------------|
| 1       | Continuous Internal Evaluation | Seminars, Assignments, Quizzes, Class Regularity,                           | 50            |
| 2       | End-Semester Examination       | Written Exam/Practical Exam Project Evaluation (Report, Presentation, Viva) | 50            |



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### (C) CLOs – PLOs Matrix

| CLO  | PLO  |      |      |      |      |      |      |      |      |       |
|------|------|------|------|------|------|------|------|------|------|-------|
|      | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 |
| CLO1 | 3    | 3    | 2    | 1    | 2    | 1    | -    | -    | -    | -     |
| CLO2 | 3    | 3    | 3    | 2    | 2    | 1    | -    | -    | 1    | 1     |
| CLO3 | 2    | 3    | 3    | 2    | 2    | 1    | -    | -    | 1    | 1     |
| CLO4 | 2    | 2    | 2    | 3    | 2    | 2    | 1    | 1    | 1    | -     |
| CLO5 | 2    | 2    | 2    | 3    | 2    | 2    | 1    | 1    | 1    | -     |

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

| CLO – PLO correlation | Value |
|-----------------------|-------|
| Strong                | 3     |
| Moderate              | 2     |
| Low                   | 1     |
| No correlation        | -     |

- Suggested Learning Materials Books:**

| Sr. No. | Title  | Author(s)                 | Edition/Year  | Publisher                  |
|---------|--|---------------------------|---------------|----------------------------|
| 1       | Molecular Cloning: A Laboratory Manual       | Green & Sambrook          | 4th Ed., 2012 | Cold Spring Harbor Press   |
| 2       | Principles of Gene Manipulation and Genomics | Primrose & Twyman         | Latest Ed.    | Blackwell Publishing       |
| 3       | Molecular Biotechnology                      | Glick, Pasternak & Patten | Latest Ed.    | ASM Press                  |
| 4       | Nanobiotechnology                            | Niemeyer & Mirkin         | Latest Ed.    | Wiley                      |
| 5       | Statistics for Biologists                    | Campbell                  | Latest Ed.    | Cambridge University Press |

- Online Resources (Open Source)**

| Sr. No. | Description of Resource(s)                              | Weblink   |
|---------|---|---|
| 1       | NCBI Database – Gene Sequences, BLAST, Literature       | <a href="https://www.ncbi.nlm.nih.gov">https://www.ncbi.nlm.nih.gov</a>       |
| 2       | NPTEL Biotechnology and Bioinformatics Courses          | <a href="https://nptel.ac.in">https://nptel.ac.in</a>                         |
| 3       | ExpASy Bioinformatics Resource Portal                   | <a href="https://www.expasy.org">https://www.expasy.org</a>                   |
| 4       | Nature Education Scitable – Molecular Biology Resources | <a href="https://www.nature.com/scitable">https://www.nature.com/scitable</a> |



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## M.Sc. Biomedical Science SEM. II

| Course Type | Course Code  | Course Title  | Teaching-Learning Scheme | Total Notional Hours | Course credits |
|-------------|--------------|---------------|--------------------------|----------------------|----------------|
|             |              |               | L-P-T                    |                      |                |
| DSC         | P2T02NCBMS06 | Biostatistics | 2-0-1                    | 60                   | 02             |

- **Course Learning Outcomes (CLOs)**

On completion of this course, students will be able to:

**CLO1:** Demonstrate understanding of Indian Knowledge Systems (IKS) and their relevance to statistical concepts and data interpretation.

**CLO2:** Apply fundamental biostatistical methods, including data collection, preprocessing, and descriptive statistics, to analyze biological data.

**CLO3:** Analyze probability concepts, distributions, correlation, and regression techniques for interpreting relationships in datasets.

**CLO4:** Apply statistical tools such as frequency distributions, histograms, ogives, and box plots for effective data representation.

**CLO5:** Analyze univariate data using measures of central tendency, dispersion, skewness, kurtosis, and moments.

**CLO6:** Evaluate the application of statistical methods, including predictive modeling and Mahalanobis distance, while considering ethical aspects in data analysis.

| Unit | Course Content  | Learning Pedagogie*                            | CLO (s) |
|------|---|--|---------|
| I    | <b>Indian Knowledge System (IKS): Concept and relevance to statistics. Mathematical Foundations: Zero, decimal system and place value system in calculations. Early statistical thinking and data representation in ancient India.</b> Biostatistics Basics: Types of data, data collection and preprocessing. Descriptive statistics (mean, median, mode, standard deviation). Probability concepts and distributions. Correlation and regression analysis. Applications: Predictive modelling concepts, introduction to Mahalanobis distance. Role of traditional knowledge in healthcare data classification (Ayurveda). Ethical aspects in data analysis. | Lectures, ICT tools, problem-solving exercises |         |
| II   | Frequency distributions, cumulative frequency distribution and their representation, histogram, frequency polygon and ogives. Stem and leaf chart. Box Plot, Univariate Data-Concepts of central tendency, dispersion and relative dispersion, moments, measures of skewness and kurtosis   | Lectures, ICT tools, problem-solving exercises |         |

- **(\* Learning Pedagogies/Methods**

Notes:

(1) The following list is suggestive. Any other learning pedagogies relevant to discipline-specific requirements can be added.

(2) Acronyms/abbreviations of the terms can be placed in the above table.



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## M.Sc. Biomedical Science SEM. II

- (a) Interactive Classroom Lecture
- (b) Classroom Lecture (CL)
- (c) Seminars (Student-led and Faculty-moderated)
- (d) Micro-Projects/Mini Research Tasks
- (e) Industrial Visit/Field Visit/Institutional Visit
- (f) Problem-Based Learning (PBL)
- (g) Research-Oriented Learning (Literature Review, Tool Construction, Data Analysis Exercises)
- (h) Collaborative Learning (Group Tasks, Peer Discussion, Joint Presentations)
- (i) Experiential Learning (Community Engagement, Internship-linked Activities, Practice-based Tasks)
- (j) ICT-Enabled Learning (LMS-based Tasks, Digital Resources, Virtual Labs/Webinars)
- (k) Reflective Practices (Learning Journals, Reflective Notes, Concept Mapping)
- (l) Self-Directed Learning (Guided Readings, Concept Exploration Tasks)

### • Assessment Methodologies

#### (A) Internal Assessment

##### a. Internal Formative assessment (15)

- (i) Quiz
- (j) Assignment
- (k) Seminar/Presentation
- (l) Group Task
- (m) Attendance

##### b. Internal Summative Assessment (10)

- (e) Mid-Term

#### (B) External Assessment (25)

##### (a) End-Term

### (A) Weightage of Learning Efforts for External Assessment

| Unit | Aligned COs   | Total Learning Hours | Approximate weightage (Marks) to Learning levels (BT) |                   |                                 | Total Marks |
|------|---------------|----------------------|---|-------------------|---------------------------------|-------------|
|      |               |                      | Remember (R)  | Understanding (U) | Application/Analyse & above (A) |             |
| I    | CO1, CO2      | 30                   | 1   | 1                 | 12                              | 14          |
| II   | CO3, CO4, CO5 | 30                   | 1   | 1                 | 10                              | 12          |
|      |               | <b>60</b>            | <b>02</b>   | <b>02</b>         | <b>22</b>                       | <b>26</b>   |



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## M.Sc. Biomedical Science SEM. II

- Assessment and Evaluation**

| Sr. No. | Assessment/Evaluation          | Component   | Weightage (%) |
|---------|--------------------------------|---|---------------|
| 1       | Continuous Internal Evaluation | Seminars, Assignments, Quizzes, Class Regularity,                                 | 50            |
| 2       | End-Semester Examination       | Written Exam/Practical Exam<br>Project Evaluation<br>(Report, Presentation, Viva) | 50            |

**(B) CLOs – PLOs Matrix**

| CLO  | PLO  |      |      |      |      |      |      |      |      |       |
|------|------|------|------|------|------|------|------|------|------|-------|
|      | PLO1 | PLO2 | PLO3 | PLO4 | PLO5 | PLO6 | PLO7 | PLO8 | PLO9 | PLO10 |
| CLO1 | 2    | 1    | 3    | -    | 1    | -    | -    | -    | 1    | -     |
| CLO2 | 2    | 2    | 3    | -    | 1    | -    | -    | -    | 1    | -     |
| CLO3 | 2    | 1    | 3    | -    | 1    | -    | -    | -    | 1    | -     |
| CLO4 | 2    | 2    | 3    | 1    | 1    | -    | -    | -    | 1    | -     |
| CLO5 | 2    | 1    | 3    | 1    | -    | -    | -    | -    | 2    | -     |

Values to CLO-PLO matrix are assigned by judging the importance of the particular CLO in relation to the PLOs.

| CLO – PLO correlation | Value |
|-----------------------|-------|
| Strong                | 3     |
| Moderate              | 2     |
| Low                   | 1     |
| No correlation        | -     |

- Suggested Learning Materials Books:**

| Sr. No. | Title   | Author(s)   | Edition/Year                  | Publisher                          |
|---------|---|---|-------------------------------|------------------------------------|
| 1       | Categorical Data Analysis                                     | Alan Agresti                                      | 2 <sup>nd</sup> Edition, 2002 | John Wiley and Sons, New York, USA |
| 2       | Statistics: A Beginner's Text, Vol. 1                         | Bhatt B. R., Srivenkatramana T., Rao Madhva K. S. | 1996                          | New Age International (P) Ltd.     |
| 3       | Fundamentals of Statistics, Vol. 1                            | Goon A. M., Gupta M. K., Das Gupta B.             | 1991                          | World Press, Calcutta              |
| 4       | Casarett and Doull's Toxicology: The Basic Science of Poisons | Curtis D. Klaassen (Ed.)                          | 8 <sup>th</sup> Edition, 2013 | McGraw- Hill Education             |



# SARDAR PATEL UNIVERSITY

Vallabh Vidyanagar

NAAC 'A' Grade (10-01-2023 To 09-01-2028)

NEP-2020 aligned Curriculum with effect from Academic Year 2026-27

## M.Sc. Biomedical Science SEM. II

|   |                          |   |                               |             |
|---|--------------------------|---|-------------------------------|-------------|
| 5 | Essentials of Toxicology | Curtis D. Klaassen  | 3 <sup>rd</sup> Edition, 2015 | McGraw-Hill |
| 6 | Microbial Toxins         | P.<br>Gopalakrishnakone,<br>Brad Stiles, Alberto<br>Alape-Girón, J. Daniel<br>Dubreuil, Manas<br>Mandal | 1 <sup>st</sup> Edition, 2016 | Springer    |

- **Online Resources (Open Source)**

| Sr. No. | Description of Resource(s)              | Weblink   |
|---------|---|---|
| 1       | NPTEL – Biostatistics Course            | <a href="https://nptel.ac.in">https://nptel.ac.in</a>   |
| 2       | Khan Academy – Statistics & Probability | <a href="https://www.khanacademy.org/math/statistics-probability">https://www.khanacademy.org/math/statistics-probability</a> |
| 3       | Open Intro Statistics (Free Textbook)   | <a href="https://www.openintro.org">https://www.openintro.org</a>   |
| 4       | CDC – Data & Statistics Resources       | <a href="https://www.cdc.gov/datastatistics">https://www.cdc.gov/datastatistics</a>   |