M.Sc. in Radiation Biology (2 Years, 4 Semesters)

Overview

The M.Sc. in Radiation Biology is a specialized postgraduate program that provides an in-depth understanding of the biological effects of radiation, its medical applications, and radiation protection principles. This interdisciplinary program integrates radiobiology, oncology, nuclear medicine, and radiation safety to equip students with expertise in medical radiation sciences, radiation therapy, and radiological research.

With the increasing use of radiation in healthcare, research, and industry, there is a growing demand for experts who can manage radiation exposure, optimize therapeutic radiation applications, and conduct research in radiological sciences. The program covers radiation physics, cellular and molecular radiation biology, dosimetry, radiation protection, and its applications in cancer treatment and diagnostic imaging.

Affiliated Institution: School of Medical Sciences and Technology, Malla Reddy Vishwavidyapeeth (Deemed to be University)
Eligibility: A pass in B.Sc. (Biotechnology, Radiology, Medical Physics, Life Sciences, or related fields) with at least 50% marks in the qualifying examination.

Key Highlights

- **Comprehensive Training in Radiation Biology** – Covers radiation physics, radiobiology, and radiation safety.
- **Multidisciplinary Approach** – Collaboration with oncologists, medical physicists, radiologists, and nuclear medicine experts.
- **Clinical Exposure** – Hands-on training in radiation oncology centers, nuclear medicine labs, and research institutions.
- **Advanced Techniques & Applications** – Training in radiation therapy, dosimetry, nuclear imaging, and radiation protection.
- **Research & Evidence-Based Practice** – Conducting studies on radiation effects, cancer therapy, and radioprotective agents.

Course Curriculum

The program spans two years, comprising theoretical coursework, practical training, clinical internships, and research projects.

Year 1

Core Modules:

- **Fundamentals of Radiation Physics** – Basics of ionizing and non-ionizing radiation, X-rays, and nuclear physics.

- **Cellular & Molecular Radiation Biology** – Mechanisms of radiation interaction with cells, DNA damage, and repair mechanisms.
- **Radiation Chemistry & Free Radical Biology** – Radiation-induced chemical reactions, oxidative stress, and radioprotective compounds.
- **Radiation Dosimetry & Measurement Techniques** – Radiation detection, dose calculation, and radiation quality assurance.
- **Medical Applications of Radiation** – Diagnostic radiology, nuclear medicine, and therapeutic radiation oncology.
- **Radiation Protection & Safety Regulations** – Radiation shielding, exposure limits, and regulatory guidelines (ICRP, IAEA, AERB).

Clinical Training:

- Hands-on training in radiology and nuclear medicine departments.

Year 2

Advanced Modules:

- **Radiation Carcinogenesis & Cancer Biology** – Mechanisms of radiation-induced cancer and tumor radiobiology.
- **Advanced Radiotherapy Techniques** – Intensity-modulated radiotherapy (IMRT), stereotactic radiotherapy, and brachytherapy.
- **Nuclear Medicine & Molecular Imaging** – PET, SPECT, radioisotope applications, and theranostics.
- **Environmental & Space Radiation Biology** – Effects of cosmic radiation, radiation exposure in space, and radiation ecology.
- **Research Methodology & Biostatistics in Radiation Sciences** – Conducting radiobiology research and statistical analysis.
- **Entrepreneurship & Industrial Applications of Radiation** – Radiation use in industry, agriculture, and pharmaceuticals.

Dissertation & Research Project:

- Independent research on radiation effects, therapy optimization, or radiation protection.

Internships & Clinical Practice:

- Specialized training in radiation therapy centers, nuclear medicine facilities, and radiobiology research labs.

PROGRAM OUTCOMES (POs)

PO	Program Outcomes
PO-1	Understand radiation interactions with biological systems at cellular and molecular levels.
PO-2	Assess and mitigate radiation risks in medical and environmental settings.
PO-3	Apply radiation biology in cancer treatment, imaging, and therapy optimization.
PO-4	Utilize radioprotective measures and adhere to radiation safety standards.
PO-5	Conduct research on radiation effects for therapeutic advancements.
PO-6	Contribute to policy-making and public awareness on radiation exposure.

COURSE STRUCTURE – M.Sc. Radiation Biology

SEMESTER – I

Sl. No.	Broad Category	Course Code	Name of the Subject/Practical	Contact hours/week			Credits
				L	T	P	
1.	**Major (Core)**	MSRB101	Fundamentals of Radiation Biology	2	1	0	3
2.		MSRB102	Cellular Radiation Biology	2	0	2	3
3.		MSRB103	Molecular Effects of Radiation	2	1	0	3
4.		MSRB104	Radiation Physics & Dosimetry	2	1	0	3
5.	**Minor** Select any two minor courses, each worth 3 credits, for a maximum of 6 credits per semester	MSRB105	1. Radiobiological Techniques 2. Radiation Detection & Measurement Lab 3. Imaging Technologies 4. Radiation Oncology 5. Radiation Protection 6. Research Methodology & Biostatistics	2 2	0 0	2 2	6

6.	**Skill Enhancement Courses**	MSRB106	1. Handling of Radiation Therapy Equipment	0	0	2	2
			2. Laboratory Techniques in Radiation Biology	0	0	2	
Total				12	3	10	**20**
Total Contact Hours				**25**			

Course outcome design for B.Sc. Radiation Biology MAJOR- Fundamentals of Radiation Biology

Sr. No.	Course Outcome	Description
1	Understand the Basic Principles of Radiation Biology	Explain the interaction of ionizing radiation with biological tissues.
2	Describe the Types and Sources of Radiation	Learn about natural and artificial radiation sources, including X-rays, gamma rays, and alpha/beta particles.
3	Explain Radiation-Induced Cellular and Tissue Responses	Understand direct and indirect effects of radiation on cells and tissues.
4	Analyze the Dose-Response Relationship in Radiation Biology	Learn about deterministic and stochastic effects, dose thresholds, and radiation sensitivity.
5	Understand Acute and Chronic Radiation Effects on Human Health	Explain radiation-induced carcinogenesis, genetic mutations, and organ-specific damage.
6	Describe Radiation Adaptation and Repair Mechanisms	Learn about DNA repair pathways, adaptive responses, and radioresistance.
7	Explain the Concept of Radiation Hormesis and Low-Dose Effects	Understand the controversial aspects of low-dose radiation exposure and biological responses.

Sr. No.	Course Outcome	Description
8	Apply Knowledge of Radiation Biology in Clinical and Research Settings	Develop skills in radiation risk assessment, safety protocols, and biomedical applications.

Course outcome design for B.Sc. Radiation Biology MAJOR- Cellular Radiation Biology

Sr. No.	Course Outcome	Description
1	Understand the Cellular Response to Radiation Exposure	Explain DNA damage, cell cycle arrest, and apoptosis.
2	Describe Radiation-Induced Genetic and Chromosomal Alterations	Learn about point mutations, deletions, and chromosomal aberrations.
3	Explain Cellular Repair Mechanisms and Radiosensitivity	Understand the role of homologous recombination and non-homologous end joining (NHEJ).
4	Analyze the Effects of Radiation on Cell Proliferation and Differentiation	Learn how radiation alters stem cell function, differentiation, and senescence.
5	Understand the Role of Hypoxia in Radiation Response	Explain the oxygen enhancement ratio (OER) and tumor hypoxia effects on radiotherapy.
6	Describe the Concept of Cell Survival Curves in Radiobiology	Learn about dose-survival relationships and models like the linear-quadratic equation.
7	Explain the Impact of Radiation on the Immune System	Understand radiation-induced immunosuppression and immune modulation.
8	Apply Knowledge of Cellular Radiation Biology in Oncology and Medical Research	Develop skills in evaluating radiation-induced cellular damage and protection strategies.

Course outcome design for B.Sc. Radiation Biology MAJOR- Molecular Effects of Radiation

Sr. No.	Course Outcome	Description
1	Understand the Molecular Mechanisms of Radiation Damage	Explain direct and indirect radiation effects on biomolecules.
2	Describe Radiation-Induced DNA Damage and Repair Pathways	Learn about single-strand breaks (SSBs) and double-strand breaks (DSBs).
3	Explain the Role of Reactive Oxygen Species (ROS) in Radiation Effects	Understand oxidative stress, free radical formation, and antioxidant defenses.
4	Analyze Radiation-Induced Gene Expression and Epigenetic Changes	Learn about radiation-induced mutations, methylation changes, and non-coding RNAs.
5	Understand the Role of Molecular Markers in Radiation Response	Explain the role of ATM, p53, and H2AX phosphorylation in DNA damage response.
6	Describe the Molecular Basis of Radiation-Induced Cancer and Carcinogenesis	Learn about oncogene activation, tumor suppressor gene inactivation, and radiation-induced transformation.
7	Explain the Applications of Molecular Radiation Biology in Radiotherapy	Understand personalized radiotherapy, radiosensitizers, and radioprotectors.
8	Apply Molecular Radiation Biology in Cancer Research and Radiation Medicine	Develop skills in molecular diagnostics and therapeutic strategies for radiation-related diseases.

Course outcome design for B.Sc. Radiation Biology MAJOR- Radiation Physics & Dosimetry

Sr. No.	Course Outcome	Description
1	Understand the Principles of Radiation Physics	Explain the properties of ionizing and non-ionizing radiation.
2	Describe the Interaction of Radiation with Matter	Learn about photoelectric effect, Compton scattering, and pair production.

Sr. No.	Course Outcome	Description
3	Explain the Concepts of Radiation Dosimetry	Understand absorbed dose, equivalent dose, and effective dose.
4	Analyze Radiation Measurement Techniques	Learn about ionization chambers, TLDs, and semiconductor detectors.
5	Understand Radiation Quality and Linear Energy Transfer (LET)	Explain LET, RBE, and their implications in radiation biology.
6	Describe the Basics of Radiation Shielding	Learn about the materials used for radiation protection in medical and industrial applications.
7	Explain Dosimetric Considerations in Radiation Therapy and Imaging	Understand fractionation, dose limits, and treatment planning.
8	Apply Radiation Physics in Clinical and Research Environments	Develop skills in radiation monitoring, dose calculations, and treatment optimization.

Course outcome design for B.Sc. Radiation Biology MINOR- Radiobiological Techniques

Sr. No.	Course Outcome	Description
1	Understand In Vitro and In Vivo Radiobiological Models	Explain cell culture techniques and animal models in radiation research.
2	Describe Radiation-Induced Cytogenetic Assays	Learn about micronucleus assay, FISH, and chromosome aberration studies.
3	Explain Molecular Techniques in Radiation Biology	Understand PCR, Western blotting, and sequencing for radiation response assessment.
4	Analyze Flow Cytometry Applications in Radiobiology	Learn about apoptosis detection and cell cycle analysis.
5	Understand Radiation-Induced Oxidative Stress Measurement	Explain methods like ROS assays, comet assay, and lipid peroxidation tests.

Sr. No.	Course Outcome	Description
6	Describe Radiosensitization and Radioprotection Strategies	Learn about radioprotectors, mitigators, and sensitizing agents.
7	Explain the Applications of Radiobiological Techniques in Oncology	Understand tumor radiosensitivity testing and biomarker identification.
8	Apply Laboratory Techniques in Radiation Research	Develop skills in radiation exposure experiments and biomarker validation.

Course outcome design for B.Sc. Radiation Biology MINOR- Radiation Detection & Measurement Lab

Sr. No.	Course Outcome	Description
1	Understand the Principles of Radiation Detection	Explain different types of radiation detectors and their working principles.
2	Describe Gas-Filled Detectors for Radiation Measurement	Learn about ionization chambers, Geiger-Muller counters, and proportional counters.
3	Explain Scintillation and Semiconductor Detectors	Understand the principles and applications of NaI(Tl) detectors, photomultiplier tubes, and silicon detectors.
4	Analyze Thermoluminescent Dosimeters (TLD) and Optically Stimulated Luminescence (OSL)	Learn about their use in personnel dosimetry and environmental monitoring.
5	Understand Calibration and Quality Control of Radiation Detectors	Explain methods for calibrating radiation measuring instruments to ensure accuracy.
6	Describe Methods of Radiation Dose Measurement and Monitoring	Learn about absorbed dose calculations, equivalent dose, and effective dose measurements.
7	Explain Radiation Spectroscopy and Energy Discrimination Techniques	Understand gamma spectroscopy, X-ray fluorescence, and pulse-height analysis.

Sr. No.	Course Outcome	Description
8	Apply Radiation Detection Techniques in Medical, Industrial, and Research Settings	Develop skills in handling and interpreting radiation measurements.

Course outcome design for B.Sc. Radiation Biology MINOR- Imaging Technologies

Sr. No.	Course Outcome	Description
1	Understand the Basics of Medical Imaging	Explain the principles of diagnostic imaging, including X-ray, CT, MRI, and ultrasound.
2	Describe the Physics and Technology of X-Ray Imaging	Learn about radiography, fluoroscopy, contrast agents, and image acquisition techniques.
3	Explain the Working Principles of Computed Tomography (CT)	Understand CT image reconstruction, Hounsfield units, and dose optimization.
4	Analyze Magnetic Resonance Imaging (MRI) Technology	Learn about proton relaxation times, gradient coils, and functional MRI (fMRI).
5	Understand the Role of Ultrasound in Medical Imaging	Explain the physics of sound waves, Doppler imaging, and echocardiography.
6	Describe Nuclear Medicine Imaging Techniques	Learn about PET, SPECT, and radionuclide imaging for functional assessment.
7	Explain Image Processing and Enhancement Techniques	Understand digital image reconstruction, noise reduction, and 3D visualization.
8	Apply Knowledge of Imaging Technologies in Clinical and Research Environments	Develop skills in selecting appropriate imaging modalities for diagnosis and treatment planning.

Course outcome design for B.Sc. Radiation Biology MINOR- Radiation Oncology

Sr. No.	Course Outcome	Description
1	Understand the Principles of Radiation Therapy	Explain the biological and physical basis of radiotherapy for cancer treatment.
2	Describe Different Types of Radiation Therapy	Learn about external beam radiation therapy (EBRT), brachytherapy, and stereotactic radiation.
3	Explain Tumor Response to Radiation	Understand radiosensitivity, fractionation, and tumor microenvironment effects on treatment efficacy.
4	Analyze Radiation Treatment Planning and Delivery	Learn about CT simulation, contouring, and dose optimization in radiation therapy.
5	Understand Advanced Techniques in Radiation Oncology	Explain intensity-modulated radiotherapy (IMRT), volumetric modulated arc therapy (VMAT), and proton therapy.
6	Describe Radiation-Induced Side Effects and Their Management	Learn about acute and late toxicities in normal tissues and supportive care strategies.
7	Explain the Role of Radiotherapy in Multimodal Cancer Treatment	Understand how radiation integrates with surgery, chemotherapy, and immunotherapy.
8	Apply Radiation Oncology Knowledge in Clinical Practice	Develop skills in patient assessment, treatment planning, and quality assurance in radiotherapy.

Course outcome design for B.Sc. Radiation Biology MINOR- Radiation Protection

Sr. No.	Course Outcome	Description
1	Understand the Principles of Radiation Protection	Explain ALARA (As Low As Reasonably Achievable) principles.
2	Describe Radiation Exposure Limits and Regulatory Guidelines	Learn about ICRP, NCRP, and national regulatory standards.

Sr. No.	Course Outcome	Description
3	Explain Radiation Shielding Methods	Understand shielding design for X-ray rooms, nuclear reactors, and radiotherapy centers.
4	Analyze Occupational Radiation Protection Measures	Learn about personal protective equipment (PPE), dosimetry badges, and exposure monitoring.
5	Understand Emergency Response to Radiation Incidents	Explain protocols for radiation spills, nuclear accidents, and radiological terrorism.
6	Describe Radiation Safety in Medical Imaging and Therapy	Learn about dose optimization, justification, and quality assurance.
7	Explain Public Health Measures for Radiation Exposure Control	Understand risk assessment, communication, and radiation hazard mitigation.
8	Apply Radiation Protection Strategies in Clinical and Industrial Settings	Develop skills in radiation monitoring, safety compliance, and regulatory adherence.

Course outcome design for B.Sc. Radiation Biology MINOR- Research Methodology & Biostatistics in Radiation Sciences

Sr. No.	Course Outcome	Description
1	Understand the Fundamentals of Research Design in Radiation Science	Explain hypothesis formulation, study design, and literature review.
2	Describe Data Collection and Radiation Exposure Assessment Methods	Learn about radiation exposure surveys and dosimetric analysis.
3	Explain the Basics of Biostatistics	Understand probability, sampling, and statistical tests.
4	Analyze Radiation Dose-Response Data Using Statistical Methods	Learn about regression analysis and survival analysis in radiation studies.

Sr. No.	Course Outcome	Description
5	Understand the Applications of Epidemiology in Radiation Exposure Studies	Explain cohort studies and risk assessment models.
6	Describe Scientific Writing and Publication in Radiation Research	Learn about manuscript preparation and ethical considerations.
7	Explain the Role of AI and Big Data in Radiation Medicine	Understand predictive modeling in radiotherapy and imaging.
8	Apply Research Techniques in Radiation Biology and Medicine	Develop skills in data interpretation, statistical software, and experimental design.

Career and Academic Opportunities

Career Opportunities:

- **Radiation Biologist** – Researching the biological effects of radiation and radioprotective agents.
- **Medical Physicist** – Ensuring safe and effective use of radiation in diagnosis and treatment.
- **Radiotherapy Specialist** – Optimizing radiation treatment plans in oncology centers.
- **Nuclear Medicine Scientist** – Conducting imaging and therapeutic applications of radioactive tracers.
- **Radiation Safety Officer (RSO)** – Managing radiation protection and regulatory compliance.
- **Researcher in Radiation Biology & Oncology** – Investigating new therapies, biomarkers, and radiation-induced effects.
- **Radiopharmaceutical Scientist** – Developing and testing new radiotracers for diagnostics and therapy.
- **Environmental Radiation Consultant** – Assessing and mitigating radiation exposure in environmental settings.

Higher Education & Research Prospects:

- **Ph.D. in Radiation Biology & Oncology** – Advanced research in cancer therapy and radiation sciences.
- **Fellowship in Radiation Oncology or Medical Physics** – Specialization in therapeutic radiology and radiation dosimetry.
- **Master of Public Health (MPH) in Radiological Health** – Focusing on radiation safety policies and epidemiology.

Labs & Training Facilities

- **Radiation Physics & Dosimetry Lab** – Measuring radiation doses and quality control of radiotherapy equipment.
- **Cellular & Molecular Radiobiology Lab** – Studying radiation effects on cells, DNA repair mechanisms, and radioprotectors.
- **Nuclear Medicine & Imaging Lab** – Hands-on experience in PET, SPECT, and radioisotope-based diagnostics.
- **Radiation Oncology & Therapy Lab** – Training in IMRT, brachytherapy, and proton therapy planning.
- **Environmental Radiation & Space Biology Lab** – Investigating radiation exposure in different environments.
- **Clinical Research & Biostatistics Lab** – Conducting radiation science-focused research and data analysis.

Course Structure & Syllabus

Total Course Duration: 2 Years (4 Semesters)

Total Credits: 80–100

Total Teaching & Training Hours: ~3,600

Assessment Methods

Assessment Component	Weightage (%)	Details
Continuous Internal Assessment (CIA)	**40%**	Includes internal exams, assignments, presentations, case studies, and practical performance
End-Semester Examination (ESE)	**60%**	Divided into theory (40%) and practical (20%)
Mid-Semester Exams	**20%** (Part of CIA)	Two internal tests per semester
Assignments & Case Studies	**5%** (Part of CIA)	Research-based assignments, literature reviews, radiation safety case reports

Assessment Component	Weightage (%)	Details
Seminars & Presentations	**5%** (Part of CIA)	Oral/poster presentations on radiation biology topics
Practical Performance & Lab Evaluation	**5%** (Part of CIA)	Skill-based assessments in radiation labs
Attendance & Participation	**5%** (Part of CIA)	Regularity in theory & practical sessions
Theory Examination (Final)	**40%** (Part of ESE)	Structured written paper covering subject knowledge
Practical Examination (Final)	**20%** (Part of ESE)	Includes viva, skill demonstration, radiation safety procedures
Dissertation/Research Project	**Mandatory**	Evaluated in the final year by internal & external examiners
Internship/Training in Radiation Biology	**Pass/Fail**	Logbook-based evaluation with mentor review

Marking System & Grading

Marks (%)	Grade	Grade Point (GPA/CGPA Equivalent)	Classification
90 - 100	O (Outstanding)	10	First Class with Distinction
80 - 89	A+ (Excellent)	9	First Class with Distinction
70 - 79	A (Very Good)	8	First Class
60 - 69	B+ (Good)	7	First Class
50 - 59	B (Satisfactory)	6	Second Class
<50 (Fail)	F (Fail)	0	Fail (Re-exam Required)

Pass Criteria:

- **Minimum 50% marks in each subject** (Theory & Practical separately).
- **Aggregate of 55% required for progression** to the next semester.
- **No more than two backlogs** allowed for promotion to the final year.

Exam Pattern for Theory & Practical

A. Theory Examination Pattern

Total Marks: 100 (Converted to 40% for End-Semester Assessment)
Duration: 3 Hours

Section	Question Type	No. of Questions	Marks per Question	Total Marks
Section A	Short Answer Type (SAQ)	10 (Attempt all)	2	20
Section B	Long Answer Type (LAQ)	5 (Attempt any 4)	10	40
Section C	Case-Based/Research Scenario	3 (Attempt any 2)	15	30
Section D	MCQs/Objective Type	10 (Compulsory)	1	10
Total				**100**

Weightage:

- Radiation Physics & Dosimetry – 40%
- Radiation Biology & Cellular Effects – 30%
- Research & Case Studies – 20%
- Radiation Protection & Safety – 10%

Passing Criteria: Minimum **50% (50/100 marks)**

B. Practical Examination Pattern

Total Marks: 100 (Converted to 20% for End-Semester Assessment)
Duration: 4–6 Hours

Component	Marks Distribution
Clinical Case Presentation & Radiation Safety Assessment	30
OSCE (Objective Structured Clinical Examination) – Skill Demonstration	25
Radiation Detection, Dosimetry & Protection Techniques	20
Lab-Based Examination (Radiation Exposure Measurement, Biological Effects Assessment)	15
Record Work (Logbook & Assignments)	10

Component	Marks Distribution
Total	**100**

OSCE (Skill-based Assessment) includes stations on:

- Radiation Protection & Shielding Techniques
- Handling of Radiation Detection Devices (Geiger Counter, Dosimeters)
- Radioactive Material Handling & Safety Procedures
- Interpretation of Radiation Dose Reports & Biological Effects

Passing Criteria: Minimum 50% (50/100 marks) in practicals.

Conclusion

The M.Sc. in Radiation Biology prepares graduates for specialized roles in radiological sciences, radiation oncology, and nuclear medicine. With the increasing demand for radiation safety experts and medical physicists, this program ensures strong expertise in radiation applications, safety protocols, and radiobiological research, offering vast opportunities in both clinical and research domains.