## B.Sc. in Radiation Biology 4 Years (8 Semesters)

**Overview:** B.Sc. in Radiation Biology is an undergraduate program that explores the biological effects of ionizing radiation on living organisms. This program focuses on understanding the interactions between radiation and biological systems, particularly at the cellular and molecular levels. Students learn how radiation can affect DNA, cellular functions, and tissue health, as well as the role of radiation in medicine, environmental sciences, and cancer research. The program also covers radiation safety, regulations, and the therapeutic applications of radiation in medical treatments, such as radiation therapy for cancer patients.

The knowledge gained through this program is essential for careers in radiation therapy, nuclear medicine, environmental protection, research, and healthcare industries. Graduates can work in medical settings, research institutions, radiation safety and protection sectors, as well as nuclear industries.

**Affiliated Institution**: School of Medical Sciences and Technology, Malla Reddy Vishwavidyapeeth (Deemed to be University)****** The minimum eligibility for B.Sc. Radiation Biology is a pass in 10+2 with at least 50% marks in Physics, Chemistry and Biology from a recognized board (CBSE/ISC/PUC) or equivalent

## Key Highlights:

- **Understanding Radiation Effects**: The program provides a comprehensive understanding of the biological effects of radiation on cells, tissues, and DNA.
- **Interdisciplinary Curriculum**: Students receive training in molecular biology, physics, and medical applications of radiation.
- **Research Opportunities**: Students are encouraged to participate in research projects related to radiation biology, cancer therapy, radioprotection, and the environmental impact of radiation.
- **Radiation Safety Training**: The program includes training in radiation protection standards, safety protocols, and regulatory practices in radiation use.
- **Career Prospects**: Graduates are prepared to work in hospitals, nuclear power plants, research laboratories, and public health sectors, where radiation plays a crucial role.

## Course Curriculum:

The B.Sc. in Radiation Biology is typically a three-year program, with an emphasis on both theoretical knowledge and practical laboratory experience.

**Year 1:**

- **Introduction to Radiation Biology**
- **General Biology and Cell Biology**
- **Principles of Radiation Physics**

- **Biochemistry and Molecular Biology**
- **Introduction to Medical Physics**
- **Human Physiology**
- **Introduction to Radiation Protection**

**Year 2:**

- **Radiation Interaction with Matter**
- **Molecular Mechanisms of Radiation Damage**
- **Radiation Oncology and Radiotherapy**
- **Radiation Effects on Human Health**
- **Environmental Radiation and Pollution**
- **Radiobiology of Cancer**
- **Radiation Detection and Measurement Techniques**
- **Radiation Protection and Safety**

**Year 3:**

- **Radiation Biology in Cancer Treatment**
- **Advanced Radiation Toxicology**
- **Radiation and DNA Damage Repair**
- **Radiation-Induced Mutagenesis**
- **Environmental Impact of Radiation**
- **Radiological Protection in Industry**
- **Research Project or Internship in Radiation Biology**

**Additional/Optional Modules:**

- **Radiation and the Immune System**: Understanding the effects of radiation on immune function.
- **Nuclear Medicine**: Exploring the use of radioactive isotopes in medical diagnostics and treatment.
- **Radiation Therapy in Oncology**: In-depth exploration of radiation therapy techniques used in cancer treatment.
- **Space Radiation Biology**: Studying the effects of space radiation on human health for astronauts.
- **Medical Imaging Techniques**: Learning about medical imaging technologies that use radiation, such as X-rays, CT scans, and PET scans.

## Career and Academic Opportunities:

**Career Opportunities:**

Graduates of B.Sc. in Radiation Biology can pursue a wide range of careers in healthcare, research, industry, and environmental sectors. Some potential career paths include:

- **Radiation Safety Officer**: Ensuring radiation safety protocols are followed in hospitals, research labs, and nuclear facilities.

- **Radiation Biologist/Researcher**: Conducting research on the biological effects of radiation, developing new radiation therapies, and improving safety standards.
- **Radiation Therapist**: Working in oncology departments, administering radiation therapy to cancer patients, and collaborating with medical professionals for treatment planning.
- **Medical Physicist**: Applying physics principles to radiation medicine, such as ensuring accurate dose delivery in radiation therapy.
- **Nuclear Medicine Technologist**: Working with radioactive materials in medical imaging, diagnostics, and therapy.
- **Environmental Radiation Specialist**: Managing radiation pollution, monitoring radiation levels, and ensuring compliance with environmental safety standards.
- **Radiation Protection Specialist**: Ensuring compliance with radiation protection regulations in industrial settings, including nuclear power plants and research facilities.
- **Radiological Health Officer**: Working in public health agencies to monitor and mitigate the effects of radiation exposure on communities.

**Academic Opportunities:**

Graduates can pursue higher education to specialize further in areas of radiation biology, medical physics, or radiation oncology:

- **Master's in Radiation Biology**: A postgraduate program focusing on advanced topics in radiation effects, therapeutic applications, and radiation safety.
- **Master's in Medical Physics**: Specializing in the use of radiation in medicine, including the development of radiation therapy techniques and radiation safety protocols.
- **Master's in Nuclear Medicine**: Focusing on the use of radioactive isotopes for diagnosis and treatment.
- **Master's in Environmental Science (Radiation Focus)**: Studying the environmental impacts of radiation and learning about radiation protection and decontamination methods.
- **Master's in Oncology**: Specializing in cancer biology and radiation therapy for cancer treatment.

For those interested in research or academia, pursuing a **Ph.D. in Radiation Biology**, **Medical Physics**, or **Radiation Oncology** can lead to advanced research positions in universities or specialized research institutions.

## Professional Opportunities:

- **Certified Radiation Protection Professional (RPP)**: Certification for professionals ensuring safety standards in environments where radiation is used.
- **Radiation Safety Officer Certification**: A certification that enables professionals to oversee radiation safety protocols in hospitals, clinics, and laboratories.
- **Medical Radiation Technologist Certification**: For professionals working in clinical settings with radiation-based medical imaging technologies.

- **Certified Medical Physicist (CMP)**: A certification for those working in medical physics, particularly in radiation therapy and diagnostic radiology.
- **Nuclear Regulatory Commission (NRC) Certification**: A certification for professionals working with nuclear materials, ensuring compliance with regulatory guidelines.

### Higher Education and Research Prospects:

- **Research Opportunities**: Graduates can engage in research to better understand radiation's effects on biological systems, developing new radiation therapies, or investigating environmental impacts of radiation. Research opportunities are available in academic institutions, government agencies, and private sector labs.
- **Postgraduate Studies**: Graduates can pursue **Master's programs** in specialized fields like **Medical Physics**, **Radiation Oncology**, or **Radiation Protection** to gain deeper knowledge and practical skills.
- **Ph.D. Programs**: Those interested in academic research can pursue a **Ph.D.** in **Radiation Biology**, **Medical Physics**, or **Cancer Research**, focusing on radiation therapies, diagnostic techniques, or environmental radiation protection.
- **Interdisciplinary Research**: Graduates may contribute to interdisciplinary projects that involve radiation in cancer treatment, environmental monitoring, space exploration, and emerging medical technologies like proton therapy.

### Conclusion:

The **B.Sc. in Radiation Biology** is an interdisciplinary program designed for students interested in the biological and medical applications of radiation. The increasing use of radiation in medicine, as well as the need for safety and regulation in environments that use radiation, means that this field offers diverse career opportunities.

Graduates can contribute to advancements in medical diagnostics, therapeutic radiation, environmental protection, and public health. Additionally, the program offers numerous opportunities for higher education and research, allowing students to specialize in emerging fields like radiation therapy, nuclear medicine, and radiation safety.

With the growing demand for professionals in radiation-related fields, the B.Sc. in Radiation Biology is an excellent choice for students interested in the intersection of biology, physics, and medicine.

# Labs

### 1. Radiation Physics & Dosimetry Lab

- **Purpose**: Understanding radiation types, interactions, and dose measurements.
- **Equipment & Facilities**:
    - ✓ Geiger-Müller (GM) counters
    - ✓ Ionization chambers

- ✓ Thermoluminescent dosimeters (TLDs)
- ✓ Scintillation detectors
- ✓ X-ray and gamma-ray sources
- ✓ Radiation shielding materials

## 2. Radiobiology & Cellular Effects Lab

- **Purpose**: Studying radiation effects on biological cells and tissues.
- **Equipment & Facilities**:

  - ✓ Cell culture incubators
  - ✓ Microscopes for cytogenetic analysis
  - ✓ Comet assay setup (for DNA damage assessment)
  - ✓ Flow cytometers for apoptosis studies
  - ✓ Gamma irradiation chamber for biological samples

## 3. Radiation Therapy & Medical Physics Lab

- **Purpose**: Understanding therapeutic radiation applications in cancer treatment.
- **Equipment & Facilities**:

  - ✓ Linear accelerator (LINAC) simulator (if available)
  - ✓ Brachytherapy applicators
  - ✓ Radiation therapy planning software
  - ✓ Phantoms for dose distribution analysis
  - ✓ Film dosimetry kits

## 4. Radiation Protection & Safety Lab

- **Purpose**: Training in radiation shielding, monitoring, and regulatory compliance.
- **Equipment & Facilities**:

  - ✓ Lead aprons and radiation protection barriers
  - ✓ Personal dosimeters (TLD badges, film badges)
  - ✓ Radiation survey meters
  - ✓ ALARA (As Low As Reasonably Achievable) compliance training kits
  - ✓ Controlled radiation exposure chambers

## 5. Nuclear Medicine & Imaging Lab

- **Purpose**: Learning diagnostic applications of radiation in medicine.
- **Equipment & Facilities**:

  - ✓ Gamma camera and PET scanner models
  - ✓ Radioisotope preparation units
  - ✓ Radionuclide dose calibrators
  - ✓ SPECT imaging simulation software
  - ✓ Radiopharmaceutical handling safety equipment

## 6. Environmental & Industrial Radiation Lab

- **Purpose**: Assessing natural and artificial radiation exposure in the environment.
- **Equipment & Facilities**:

  - ✓ Radon detectors
  - ✓ Environmental gamma spectrometry units
  - ✓ Contamination monitoring tools
  - ✓ Radiation shielding material testing kits
  - ✓ Industrial radiography training units

## 7. Radiation Chemistry & Molecular Effects Lab

- **Purpose**: Studying radiation-induced chemical and genetic changes.
- **Equipment & Facilities**:

  - ✓ Spectrophotometers for radiation-induced free radical detection
  - ✓ DNA damage assessment kits
  - ✓ Electron paramagnetic resonance (EPR) spectrometry
  - ✓ Pulse radiolysis setup (if available)

# PROGRAM OUTCOMES (POs)

| PO | Program Outcomes |
|---|---|
| PO-1 | **Fundamental Knowledge in Radiation Biology**<br><br>Develop a strong understanding of radiation physics, radiation interactions with biological systems, and radiation safety principles to ensure effective application in medical and research fields. |
| PO-2 | **Radiation Protection and Safety**<br><br>Apply radiation protection protocols, regulatory guidelines, and best practices to minimize radiation exposure risks to patients, personnel, and the environment in clinical and industrial settings. |
| PO-3 | **Technical and Analytical Skills**<br><br>Utilize modern radiation detection, measurement, and imaging technologies for diagnosing and treating diseases while ensuring accuracy, precision, and quality assurance in radiation-based procedures. |
| PO-4 | **Research and Innovation in Radiation Sciences**<br><br>Engage in scientific research and innovation related to radiation biology, including radiotherapy, radiobiology, and radiation genetics, to contribute to advancements in healthcare and biotechnology. |
| PO-5 | **Ethical and Professional Responsibility**<br><br>Demonstrate ethical responsibility, professional conduct, and effective communication in multidisciplinary teams while addressing societal and environmental concerns related to radiation sciences**.** |

**COURSE STRUCTURE – B.Sc. Radiation Biology**

## Semester 1

| Sl. No. | Broad Category | Course Code | Name of the Subject/Practical | Contact hours/week | | | Credits |
|---|---|---|---|---|---|---|---|
| | | | | L | T | P | |
| 1. | Major (Core) | BSRB101 | Fundamentals of Radiation Biology | 2 | 1 | 0 | 3 |
| 2. | | BSRB102 | Principles of Radiation Physics | 2 | 1 | 0 | 3 |
| 3. | | BSRB103 | Cellular & Molecular Effects of Radiation | 2 | 1 | 0 | 3 |
| 4. | | BSRB104 | Introduction to Radiation Safety & Protection | 1 | 0 | 2 | 2 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **5.** | **Minor** Select any two minor courses, each worth 2 credits, for a maximum of 4 credits per semester | BSRB105 | 1. Basic Human Anatomy & Physiology<br>2. Radiation Chemistry &Free Radical Biology<br>3. Medical Imaging & Radiological Techniques<br>4. Radiation & Cancer Biology<br>5. Environmental Radiation & Public Health | 1<br>1 | 1<br>1 | 0<br>0 | 4 |
| **6.** | **Skill Enhancement Courses** | BSRB106 | 1.Handling & Calibration of Radiation Detectors<br>2.Fundamentals of Radiation Therapy Equipment | 0<br>0 | 0<br>0 | 2<br>2 | 2 |
| **7.** | **Ability Enhancement Courses** | BSRB107 | 1. English Communication Skills<br>2. Medical Ethics & Regulatory Guidelines in Radiation Biology | 0 | 0 | 2 | 1 |
| **8.** | **Value-Added Courses** | BSRB108 | 1. Radiation & Its Impact on Human Health<br>2. Basics of Nuclear Medicine & PET Imaging | 1 | 0 | 2 | 2 |
| | | | **Total** | 10 | 5 | 10 | **20** |
| **Total Contact Hours** | | | | **25** | | | |

## Course Outcomes for B.Sc. Radiation Biology MAJOR- Fundamentals of Radiation Biology

| Sr. No. | Course Outcome | Description |
|---|---|---|
| 1 | Understand the Basics of Radiation Biology | Define radiation biology and explain its importance in understanding the biological effects of ionizing radiation on living organisms at cellular, tissue, and organism levels. |
| 2 | Study Radiation Interaction with Biological Systems | Learn how radiation interacts with biological systems, focusing on the ionization and excitation of molecules and their consequences on cells, tissues, and organs. |

| Sr. No. | Course Outcome | Description |
|---|---|---|
| 3 | Explore the Types of Ionizing Radiation | Understand the different types of ionizing radiation (alpha, beta, gamma, X-rays) and how each affects biological tissues differently. |
| 4 | Learn About the Biological Effects of Radiation at Different Doses | Examine the effects of radiation exposure at various dose levels, including acute and chronic biological responses, and the threshold levels for tissue damage. |
| 5 | Investigate DNA Damage and Repair Mechanisms | Study how ionizing radiation causes DNA damage (e.g., strand breaks, base damage) and the cellular repair mechanisms that help mitigate the damage. |
| 6 | Explore the Cellular and Tissue-Level Responses to Radiation | Learn about the cellular responses to radiation, including apoptosis, cell cycle arrest, and the impact on tissue regeneration or dysfunction. |
| 7 | Understand the Role of Radiation in Mutagenesis and Carcinogenesis | Examine the role of radiation-induced mutations and their potential to lead to carcinogenesis, focusing on genetic mutations and the development of cancer. |
| 8 | Apply Knowledge of Radiation Biology in Medical and Environmental Fields | Understand how radiation biology is applied in medical practices such as radiotherapy, radiology, and environmental health studies to assess and mitigate radiation risks. |

## Course Outcomes for B.Sc. Radiation Biology MAJOR- Principles of Radiation Physics

| Sr. No. | Course Outcome | Description |
|---|---|---|
| 1 | Understand the Basics of Radiation Physics | Define radiation physics and explain the fundamental principles of ionizing radiation, including the nature of radiation, its properties, and interactions with matter. |
| 2 | Study the Different Types of Radiation | Learn about the various types of radiation (alpha, beta, gamma, X-rays) and their physical properties, including energy, penetration abilities, and ionizing capabilities. |
| 3 | Explore Radiation-Matter Interactions | Understand the processes that occur when radiation interacts with matter, such as ionization, excitation, and energy deposition in biological and non-biological materials. |

| Sr. No. | Course Outcome | Description |
|---|---|---|
| 4 | Understand the Concept of Absorbed Dose and Dose Measurement | Learn how radiation dose is measured and calculated, including concepts such as absorbed dose, equivalent dose, and effective dose in radiation protection and safety. |
| 5 | Study the Relationship Between Energy, Wavelength, and Frequency | Understand the relationship between the energy, wavelength, and frequency of different types of radiation, and how these properties affect their interactions with materials. |
| 6 | Apply the Concepts of Radiation in Medical Applications | Explore the applications of radiation physics in medicine, including diagnostic imaging (X-ray, CT scans) and therapeutic uses (radiotherapy). |
| 7 | Investigate the Role of Shielding in Radiation Protection | Study the principles of radiation shielding, including how different materials (e.g., lead, concrete) can attenuate or block radiation to ensure safety in clinical and environmental settings. |
| 8 | Explore Radiation Detection and Measurement Techniques | Learn about the various tools and techniques used to detect and measure ionizing radiation, such as scintillation counters, dosimeters, and ionization chambers. |

## Course Outcomes for B.Sc. Radiation Biology MAJOR- Cellular & Molecular Effects of Radiation

| Sr. No. | Course Outcome | Description |
|---|---|---|
| 1 | Understand the Basic Cellular and Molecular Effects of Radiation | Define the cellular and molecular effects of ionizing radiation, including DNA damage, cell death, mutation, and the role of molecular signaling in response to radiation. |
| 2 | Explore DNA Damage Induced by Radiation | Learn about the various types of DNA damage caused by radiation, including single- and double-strand breaks, base damage, and cross-linking, and how these lead to mutations. |
| 3 | Investigate the Molecular Mechanisms of Radiation Repair | Understand the repair mechanisms activated in cells to fix radiation-induced DNA damage, such as base excision repair, homologous recombination, and non-homologous end joining. |

| Sr. No. | Course Outcome | Description |
|---|---|---|
| 4 | Study the Role of Cell Cycle Arrest in Radiation Response | Explore how radiation triggers cell cycle checkpoints, leading to cell cycle arrest, allowing cells time to repair damage before proceeding to cell division. |
| 5 | Examine Radiation-Induced Apoptosis and Necrosis | Investigate the pathways leading to programmed cell death (apoptosis) and necrosis in response to severe radiation damage, and how these processes impact tissues and organs. |
| 6 | Understand the Molecular Mechanisms of Radiation-Induced Carcinogenesis | Study the molecular changes in cells, such as mutations and genomic instability that lead to cancer following exposure to ionizing radiation. |
| 7 | Learn the Impact of Radiation on Cellular Signaling Pathways | Explore how radiation influences cellular signaling pathways (e.g., PI3K/Akt, p53, NF-kB) and how these alterations affect cell survival, repair, and transformation. |
| 8 | Apply Knowledge of Radiation Effects to Clinical and Environmental Settings | Investigate how understanding cellular and molecular radiation effects is applied in medical treatments (radiotherapy) and environmental monitoring (radiation exposure risk). |

## Course Outcomes for B.Sc. Radiation Biology MAJOR- Introduction to Radiation Safety & Protection

| Sr. No. | Course Outcome | Description |
|---|---|---|
| 1 | Understand the Principles of Radiation Safety | Define the principles of radiation safety, including the concepts of time, distance, and shielding, and explain how they are used to minimize radiation exposure. |
| 2 | Study the Regulatory Frameworks and Safety Standards | Learn about the key regulations and standards for radiation safety set by organizations such as the International Commission on Radiological Protection (ICRP) and the Nuclear Regulatory Commission (NRC). |
| 3 | Explore Radiation Protection Techniques in Medical Settings | Understand how radiation protection is implemented in healthcare settings, including shielding, dosimetry, and safety protocols for radiology, radiotherapy, and diagnostic imaging. |

| Sr. No. | Course Outcome | Description |
|---|---|---|
| 4 | Learn About Personal Protective Equipment (PPE) for Radiation Exposure | Study the types of personal protective equipment (PPE) used to protect workers and patients from radiation exposure, including lead aprons, gloves, and eye protection. |
| 5 | Investigate Radiation Monitoring and Dosimetry Techniques | Learn how radiation exposure is monitored using dosimeters and other devices, and understand the concept of dose limits for both workers and the public. |
| 6 | Examine the Role of ALARA (As Low As Reasonably Achievable) in Radiation Protection | Understand the ALARA principle and its importance in reducing radiation exposure to the lowest possible levels while maintaining effectiveness in medical or industrial applications. |
| 7 | Apply Radiation Safety Knowledge to Clinical and Environmental Settings | Investigate how radiation safety principles are applied in real-world scenarios, such as in hospitals, research labs, and environmental monitoring to prevent overexposure. |
| 8 | Understand Emergency Procedures for Radiation Incidents | Learn the appropriate emergency procedures for handling radiation accidents or incidents, including containment, decontamination, and exposure management. |

**Course outcomes for B.Sc. Radiation Biology MINOR-Basic Human Anatomy & Physiology**

| Sr. No. | Course Outcome | Description |
|---|---|---|
| 1 | Understand the Levels of Structural Organization in the Human Body | Describe the structural organization of the human body, from cells to tissues, organs, and organ systems, and explain how they work together to maintain homeostasis. |
| 2 | Identify the Major Systems of the Human Body | Identify and describe the major systems of the human body, including the cardiovascular, respiratory, digestive, nervous, musculoskeletal, and endocrine systems. |
| 3 | Explain the Functions of the Cardiovascular and Respiratory Systems | Understand the anatomy and physiology of the cardiovascular and respiratory systems, focusing on blood circulation, gas exchange, and oxygen delivery to tissues. |
| 4 | Study the Digestive System and Nutrient Absorption | Learn the structure and function of the digestive system, and explain the processes of digestion, nutrient absorption, and the role of the gastrointestinal system in metabolism. |

| Sr. No. | Course Outcome | Description |
|---|---|---|
| 5 | Describe the Musculoskeletal System and Movement Mechanisms | Study the anatomy and physiology of bones, muscles, and joints, and understand how they work together to facilitate body movement and support. |
| 6 | Understand the Nervous System and Its Role in Body Control | Explore the structure and function of the nervous system, including the brain, spinal cord, and peripheral nerves, and understand how it regulates and coordinates bodily functions. |
| 7 | Investigate the Endocrine System and Hormonal Regulation | Learn about the major endocrine glands and the hormones they secrete, and understand their role in regulating metabolism, growth, and overall body function. |
| 8 | Explore the Renal System and Fluid Balance | Understand the structure and function of the kidneys and urinary system, and how they maintain fluid, electrolyte balance, and excrete waste products. |
| 9 | Analyze the Immune System and Body Defense Mechanisms | Study the anatomy of the immune system, including lymphatic tissues, and understand the physiological responses involved in defending the body from infections and diseases. |
| 10 | Apply Knowledge of Anatomy & Physiology in Clinical Settings | Integrate understanding of human anatomy and physiology to recognize signs and symptoms of diseases and apply this knowledge in clinical diagnostics and treatments. |

**Course outcomes for B.Sc. Radiation Biology MINOR-Radiation Chemistry & Free Radical Biology**

| Sr. No. | Course Outcome | Description |
|---|---|---|
| 1 | Understand the Basics of Radiation Chemistry | Define radiation chemistry and explain the fundamental principles behind chemical reactions induced by ionizing radiation, including the formation of free radicals and their reactivity. |
| 2 | Study the Formation of Free Radicals in Biological Systems | Learn about the generation of free radicals and reactive oxygen species (ROS) when biological systems are exposed to ionizing radiation, and how these species interact with cellular components. |
| 3 | Explore the Mechanisms of Radiation-Induced Chemical Reactions | Examine the processes involved in radiation-induced chemical changes, including ionization, excitation, and the subsequent formation of reactive intermediates and free radicals. |

| Sr. No. | Course Outcome | Description |
|---|---|---|
| 4 | Understand the Role of Free Radicals in Cellular Damage | Study the impact of free radicals and ROS on biomolecules such as lipids, proteins, and DNA, and understand their role in cellular damage and dysfunction. |
| 5 | Investigate the Molecular Mechanisms of Radiation-Induced DNA Damage | Explore how free radicals and other reactive species cause DNA damage, including single- and double-strand breaks, base modifications, and cross-linking. |
| 6 | Learn about the Antioxidant Defense Mechanisms in Cells | Understand the cellular defense mechanisms against oxidative damage, including the role of antioxidants (e.g., glutathione, superoxide dismutase) and DNA repair systems. |
| 7 | Explore the Biological Consequences of Radiation-Induced Free Radical Damage | Investigate how radiation-induced free radical damage can lead to cellular processes such as apoptosis, senescence, mutation, and carcinogenesis. |
| 8 | Apply Knowledge of Free Radical Biology in Radiation Protection | Apply the principles of free radical biology to understand strategies for mitigating radiation damage, including the use of radio protective agents and radiation shielding. |
| 9 | Examine the Role of Free Radicals in Radiation Therapy | Study the role of free radicals in the therapeutic use of radiation, including their role in cell killing during radiotherapy and strategies to enhance therapeutic outcomes. |

**Course outcomes for B.Sc. Radiation Biology MINOR-Medical Imaging & Radiological Techniques**

| Sr. No. | Course Outcome | Description |
|---|---|---|
| 1 | Understand the Fundamentals of Medical Imaging Techniques | Define medical imaging and understand the basic principles behind common imaging techniques such as X-ray, CT scans, MRI, and ultrasound. |
| 2 | Study the Principles and Applications of X-ray and CT Imaging | Learn how X-ray and computed tomography (CT) scans work, including the concepts of image formation, contrast, resolution, and their clinical applications in diagnosis. |
| 3 | Explore Magnetic Resonance Imaging (MRI) | Understand the principles behind MRI, including the role of magnetic fields and radio waves in producing high-resolution images of soft tissues, and its medical applications. |

| Sr. No. | Course Outcome | Description |
|---|---|---|
| 4 | Investigate Ultrasound Imaging Techniques | Study the basic principles of ultrasound, including the use of high-frequency sound waves to generate real-time images, and its clinical applications in diagnostics and treatment monitoring. |
| 5 | Learn the Principles of Nuclear Medicine and PET Scanning | Understand how nuclear medicine techniques, including positron emission tomography (PET), work by using radioactive tracers to visualize metabolic processes in the body. |
| 6 | Explore Radiation Safety in Medical Imaging | Study the safety protocols for minimizing radiation exposure during diagnostic imaging procedures, including techniques for patient and staff protection. |
| 7 | Analyze the Role of Imaging in Disease Diagnosis and Treatment Planning | Learn how medical imaging plays a critical role in detecting diseases, planning treatments (e.g., surgery, radiotherapy), and monitoring patient progress. |
| 8 | Understand the Role of Contrast Agents in Imaging Techniques | Learn about the different types of contrast agents used in imaging procedures, their mechanisms of action, and how they improve image quality for specific diagnostic purposes. |
| 9 | Apply Knowledge of Medical Imaging in Clinical Practice | Apply the knowledge of various imaging modalities to real-world clinical cases, and understand how to choose the appropriate imaging technique based on patient symptoms and conditions. |

**Course outcomes for B.Sc. Radiation Biology MINOR-Radiation & Cancer Biology**

| Sr. No. | Course Outcome | Description |
|---|---|---|
| 1 | Understand the Fundamentals of Radiation and Cancer Biology | Define the key principles of radiation biology and cancer biology, and explain the connection between radiation exposure and the initiation of cancer. |
| 2 | Study the Molecular Mechanisms of Radiation-Induced Carcinogenesis | Learn about the molecular changes (such as DNA mutations, chromosomal aberrations) that occur due to radiation exposure, leading to carcinogenesis. |
| 3 | Explore the Biological Effects of Radiation on Normal and Cancer Cells | Compare and contrast the effects of radiation on normal healthy cells and cancer cells, focusing on cellular responses to DNA damage, repair, and apoptosis. |

| Sr. No. | Course Outcome | Description |
|---|---|---|
| 4 | Investigate Radiation-Induced Genetic Mutations and Tumorigenesis | Study how radiation causes genetic mutations and genomic instability, and understand the mechanisms through which these mutations lead to tumor formation. |
| 5 | Learn about the Role of Tumor Microenvironment in Radiation Response | Understand the impact of the tumor microenvironment (e.g., oxygenation, extracellular matrix, immune cells) on radiation response and cancer progression. |
| 6 | Study the Impact of Radiation on Cancer Therapy and Resistance | Explore how radiation therapy affects cancer cells, the development of resistance mechanisms, and strategies to overcome radiation resistance in cancer treatments. |
| 7 | Examine the Role of Radiation in Combination Cancer Therapies | Investigate the synergistic effects of combining radiation therapy with other cancer treatments, such as chemotherapy, immunotherapy, and targeted therapy. |
| 8 | Apply Knowledge of Radiation & Cancer Biology in Cancer Prevention | Understand how knowledge of radiation-induced carcinogenesis can be used in the development of preventive strategies, including radiation protection and early detection. |
| 9 | Understand the Mechanisms of Radiation-Induced DNA Repair and Its Implications in Cancer | Learn about the DNA repair pathways activated by radiation, such as homologous recombination and non-homologous end joining, and their implications in cancer progression and therapy. |

**Course outcomes for B.Sc. Radiation Biology MINOR-Environmental Radiation & Public Health**

| Sr. No. | Course Outcome | Description |
|---|---|---|
| 1 | Understand the Basics of Environmental Radiation | Define environmental radiation and explain the sources, types, and distribution of naturally occurring and anthropogenic radiation in the environment. |
| 2 | Study the Impact of Radiation on Ecosystems and the Environment | Explore how radiation affects ecosystems, soil, water, air, and living organisms, with a focus on both short-term and long-term environmental impacts. |

| Sr. No. | Course Outcome | Description |
|---|---|---|
| 3 | Examine the Public Health Implications of Radiation Exposure | Learn about the health risks associated with exposure to environmental radiation, including cancer, genetic mutations, and other radiation-induced diseases. |
| 4 | Investigate Radiation Exposure Pathways in the Environment | Study the pathways through which radiation can reach humans and other organisms (e.g., ingestion, inhalation, and direct exposure) and the associated risks. |
| 5 | Explore the Role of Radiation Protection in Public Health | Understand the principles of radiation protection in the context of public health, including dose limits, risk assessment, and safety guidelines to reduce radiation exposure. |
| 6 | Study the Effects of Nuclear Accidents and Radiation Emergencies | Examine the public health consequences of nuclear accidents (e.g., Chernobyl, Fukushima) and radiation emergencies, including radiation exposure, contamination, and health responses. |
| 7 | Learn about Radiation Surveillance and Environmental Monitoring | Understand the techniques and technologies used to monitor radiation levels in the environment, including air, water, soil, and food, and their role in public health safety. |
| 8 | Analyze Risk Assessment and Epidemiology of Radiation Exposure | Study methods used to assess the risks of radiation exposure to populations, including epidemiological studies, risk models, and public health strategies. |
| 9 | Develop Public Health Strategies for Managing Radiation Risks | Apply knowledge to design public health strategies and policies aimed at minimizing radiation exposure and protecting communities, including education, regulation, and mitigation. |
| 10 | Examine the Global Standards and Regulations on Environmental Radiation | Learn about international and national regulations and standards set by organizations like the ICRP and WHO to manage environmental radiation and safeguard public health. |

**Program Details**

- **Duration**:4Years (8 Semesters)
- **Total Credits**: **160–180 credits**
- **Total Teaching & Training Hours**: **6,000–6,500 hours**
- **Mode**: Classroom, Laboratory, Clinical Training, and Internship
- **Assessment**: Continuous Internal Assessment (CIA), Semester-End Examinations, Practical Examinations, Clinical Case Presentations, and Research Project
- **Internship & Research**: **One-Year Clinical Internship (Final Year)**

**Total Hours Distribution**

- **Theory Classes** – 2,500–2,800 hours
- **Practical & Laboratory Training** – 1,500–1,800 hours
- **Clinical Training & Internship** – 1,000–1,200 hours
- **Research & Dissertation** – 300–500 hours

## 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, patient case studies, and literature reviews |
| **Seminars & Presentations** | **5%** (Part of CIA) | Oral/poster presentations on diabetes management and treatment approaches |
| **Practical Performance & Clinical Evaluation** | **5%** (Part of CIA) | Skill-based assessments in diabetic labs and clinical settings |
| **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, and clinical diabetes case handling |
| **Dissertation/Research Project (Final Year)** | **Mandatory** | Evaluated in the final year by internal & external examiners |
| **Clinical Internship/Training in Diabetes Care Centers** | **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/Clinical Scenarios | 3 (Attempt any 2) | 15 | 30 |
| **Section D** | MCQs/Objective Type | 10 (Compulsory) | 1 | 10 |
| **Total** | | | | **100** |

**Weightage:**

- Radiation Physics & Dosimetry – 40%
- Cellular & Molecular Effects of Radiation – 30%
- Research & Case Studies in Radiation Therapy – 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 Techniques | 20 |
| Lab-Based Examination (Radiation Exposure Measurement, Biological Effects Assessment) | 15 |
| Record Work (Logbook & Assignments) | 10 |
| **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.

### Recommended Books & E-Resources

## Textbooks

- **"Radiobiology for the Radiologist"** – Eric J. Hall & Amato J. Giaccia
- **"Fundamentals of Radiation Biology"** – D.J. Brenner
- **"Introduction to Health Physics"** – Herman Cember
- **"Radiation Protection and Dosimetry"** – Michael G. Stabin

## E-Resources & Journals

- **International Atomic Energy Agency (IAEA)** – www.iaea.org
- **Journal of Radiation Research**
- **International Journal of Radiation Oncology, Biology, Physics**
- **WHO Guidelines on Radiation Safety**

## Career Opportunities after B.Sc. in Radiation Biology

- Radiation Safety Officer in Hospitals & Research Institutes
- Clinical Radiobiologist in Oncology & Nuclear Medicine
- Radiation Protection Specialist in Industrial & Medical Facilities
- Research Scientist in Radiation Effects & Genetic Damage
- Consultant in Environmental & Occupational Radiation Safety