COURSE APPROVAL FORM, Graduate School
University of Arkansas for Medical Sciences

This form and attached materials are due in the Graduate School Office on the third Monday of the month. All forms will be submitted to the UAMS Graduate Council Curriculum Committee for review and approval prior to consideration by the Graduate Council.

This form is not required for minor stylistic or editorial corrections to the title or course descriptions. These may be made when revising the catalog copy.

1. **Program:** Pharmaceutical Sciences (*Department*) | P | S | G | P | 6 | 1 | 1 | 2 | (*Alpha (Department) Code*)

2. **Action proposed** (indicate one or more items): Effective term: Spring 2017

____	Add course	☐	Change title		
☐	Eliminate course (No outline needed)	☐	Change credit hours from:	____	to ____
		☐	Change course number from:	____	to ____
☒	Modify course structure and coordinator	____	Change description	____	____

3. **Course ID, title and description:**

P	H	S	C	6	1	1	2	Radiation Biology
prefix				number				title (20 characters)

Radiation Biology
catalog name (40 characters)

Scheduled offering: ☐ Fall X Spring ☐ Summer ☐ On demand

To cross list a course, use the Course Cross Listing Form.

Describe the course in sentence form using 50 words or less **as it is to appear in the catalog**. List prerequisites, co-requisites and possible off-site instructional opportunities or requirements.

This is a course designed as an introduction to the interaction of ionizing radiation (IR) and biological systems. Topics include the basic principles of radiation biology, including the effects of IR on macromolecules, cells, tissues, and organisms. It will also cover some of the topics regarding cancer radiotherapy and normal tissue protection.

4. **Justification:**

Justify this change in terms of course needs or curriculum improvement. State the effect of this change on any degree programs. Identify the courses to be eliminated, if any, if this course is approved. (Course Approval Forms must also be submitted for these courses) Identify any existing course or courses that would extensively overlap or be duplicated if the proposed curricular change occurs. Provide statements of concurrence with the change from the chairperson(s) and dean(s) of the programs/areas offering the affected courses.

The modifications relate to topic sequence and instructional approach. Also the course coordinator has been changed.

5. Course Information:
Course Title and Course number: Radiation Biology; PSGP 6112

Credit Hours: 3

Proposed Date/Semester: Spring 2017

Course Description: This is a course designed as an introduction to the interaction of ionizing radiation (IR) and biological systems. Topics include the basic principles of radiation biology, including the effects of IR on macromolecules, cells, tissues, and organisms. It will also cover some of the topics regarding cancer radiotherapy and normal tissue protection.

Course Goals or Objectives: This course is a three-hour credit course designed for graduate students. Upon completion of this course students should possess an understanding of the following topics:

- History/discovery of ionizing radiation and radioactivity;
- Basic knowledge about radiation physics and chemistry, including measurement quantities used to describe radiation exposure;
- Sources of ionizing radiation in nature and in medicine and their relative contributions to the average individual's exposure;
- Mechanisms of interaction of radiation with important biomolecules such as DNA and cells
- Biological responses of cells to radiation damage, including differential radio-sensitivity of various cell populations, particularly tumor cells vs. normal cells and influence of various physical, chemical, and biological factors affecting cellular response to IR;
- Acute and late biological effects of ionizing radiation on various tissues (such as, skin, vascular endothelium, cardiac, gastro-intestinal, brain, and hematopoietic) and the whole body, including acute radiation syndromes, carcinogenesis, and hereditary effects;
- Radiotherapy for cancer;
- Radiation protective and/or mitigating agents;
- Relative risk of radiation exposure as compared to other societal risks.

Course Prerequisites: The prerequisites include completion of undergraduate physics and chemistry courses and the graduate courses Biochemistry and Molecular Biology (3 Cr hours) and Cell Biology (3 Cr hours).

Attendance: Attendance is STRONGLY encouraged. They are expected to participate in any discussion postings put forward by the instructor on Blackboard and should check the class website **DAILY** for information and updates. In addition, students are encouraged to take part active discussion on the topics of the lectures and present a manuscript provided by the instructor. Students are expected to arrive on time to attend the class. Excused absences may be obtained only by permission from the course director.

Student Evaluation:

Students will be divided into small groups. At the beginning of each week (on Monday), the instructor will provide a review or research article to each group. Each group will write a think piece (not more than 600 words) on the article provided and will submit the think piece in the next class. On Wednesday, students and the instructor will discuss on the think piece. In the next class (Friday), each group will give a short presentation on the think piece. There will be a question-answer session at the end of presentation, where instructor and students from other group/s will take active participation. Length of presentation will be decided by the instructor based on number of groups. Students in each group will work together for preparing the presentation. Instructor will assign grade to each student based on the group presentation at a scale of 5 points. No extra credit will be given to the presenter and the presentation will be considered as a group effort. One particular student from the group is not allowed to present in each week; each student from the group will present in turn. Grading of oral presentations from 10 weeks (total scale of 50 points) will be averaged out at the end of the semester.

At the end of the semester, each student will submit a six page grant proposal. The proposal should have a title, project summary, research purpose, specific aims, significance, innovation, research approach, conclusions and anticipated results. No preliminary data is required. Each proposal will be evaluated by at least 3 instructors at a scale of 50 points.

Grading

Grading for oral presentation
For oral presentation grading will be assigned based on organization (2 points), content (2 points), and presentation (1 point).

Point scale grade	Letter grade
4.0—5.0	A
3.0—3.9	B
2.0—2.9	C
1.0—1.9	D

Grading system for grant proposal
For the grant proposal grading will be assigned based on the followings: a. concept of the project, b. project summary, c. research purpose, d. specific aims, e. significance, f. innovation, g. research approach, h. conclusion and anticipated results, i. feasibility of the project, and j. clarity of writing. Each section as mentioned above (from a through j) will be evaluated at a scale of 5 points each.

Point scale grade	Letter grade
4.0—5.0	A
3.0—3.9	B
2.0—2.9	C
1.0—1.9	D

Course Evaluation:
At the end of the course, students will be provided with a Course Evaluation Form to anonymously assess the content and delivery of the course. In addition, Students will evaluate the instructor using the Instructor Evaluation Form which covers the areas of knowledge, organization, instructional skill, and enthusiasm. Faculty will assess the course each term and make any appropriate modifications and updates.

Textbooks/Reading Materials: The following print materials relate to the course.

a. Radiobiology for the Radiologist, 7th Edition by Eric J. Hall & Amato J. Giaccia, Lippincott Williams & Wilkins, Mar 28, 2012

b. Essentials of Radiation, Biology and Protection, 2nd Edition by Steve Forshier

c. Basic Clinical Radiobiology, 4th Edition by Michael C. Joiner, Albert van der Kogel, March 27, 2009 by CRC Pres.

d. Biological Effects of Space Radiation by Honglu Wu

Course Director(s):

Rupak Pathak, PhD
Assistant Professor, Department of Pharmaceutical Sciences
College of Pharmacy
University of Arkansas for Medical Sciences

Tentative Course Schedule: A listing of topics to be covered is provided below.

a. **Introduction to radiation biology:** The introductory lectures will include most of the following topics. Historical perspective, common forms of ionizing radiation, the electromagnetic spectrum, direct and indirect action of radiation, timeline of radiation effects, stochastic vs deterministic effects of radiation. Radiation cell killing, cell survival curves (plating efficiency, surviving fraction, concept of D_{37}, extrapolation number, quasi-threshold dose, linear vs linear-quadratic model), relative biological effectiveness, mechanisms of cell killing (DNA as target, the bystander effect, apoptotic and mitotic death, autophagy and senescence), types of radiation damage (lethal, potentially lethal, and sub-lethal). Cellular radio-sensitivity, factors modulate cellular radiation sensitivity (age, sex, temperature, cell cycle, oxygen effect, radiation quality, mode of radiation delivery, biological system or endpoint), four R's of radiation biology.

b. **Radiation Physics:** Units of radiation, interaction of radiation with matters, radiation dosimetry. Radioactivity, radio-activation (for example, production of ^{60}Co radionuclide), modes of radioactive decay (alpha decay, beta decay, gamma decay, electron capture decay), electron interactions (stopping power, rate of energy loss), photon interactions (type of photon interactions, linear and mass attenuation coefficient, atomic and electronic cross section, pair production), effects following photon interactions.

c. **Free radicals and reactive oxygen species (ROS):** Introduction and chemistry of free radicals, antioxidants, and role of mitochondria in redox homeostasis. Endogenous and commonly encountered exogenous sources of ROS. Biological targets of ROS. ROS monitoring.

d. **Radiation effects on skin:** Effects of ionizing radiation on skin.

e. **Radiation effects on vascular endothelium:** Functions of vascular endothelium. Effects of ionizing radiation on vascular endothelial activation and dysfunction. Role of thrombomodulin in suppressing radiation-induced tissue damage.

f. **Radiation effects on cardiovascular system:** Pericardial disease, myocardial disease, vulvar dysfunction, Coronary artery disease, conduction abnormalities, potential measures to prevent, mitigate and treat radiation-induced injury.

g. **Space radiation and its effects on cardiovascular system:** Difference between space and terrestrial radiation, ground based space radiation model, acute and late of effect of space radiation on heart.

h. **Radiation effects on gastro-intestinal system:** Acute and delayed effects of radiation on gastro-intestine.

i. **Radiation effects on central nervous systems:** Effects of ionizing radiation on central nervous system.

j. **Radiation effects on the hematopoietic system:** The lecture will cover the acute and long-term effects of radiation on bone marrow stem cells and progenitor cells. In addition, it will discuss medical countermeasures that can be used to prevent, mitigate, and treat radiation-induced acute radiation hematopoietic syndrome and long-term bone marrow suppression.

k. **Radiation-induced carcinogenesis and epigenetic alterations:** Radiation-induced epigenetic alterations in various tissues. Risk of radiation-induced carcinogenesis.

l. **Radiation therapy:** Management and improve clinical techniques for delivering doses of radiation. Current equipment, procedures, and treatment planning. Time, dose, and fractionation of radio-therapy. Biological factors that can optimize radiation therapy.

6. **Program Approvals:**

Kim E. Light, PhD, Director PSGP 3/10/2017
(Print or type) Chairperson, Academic Department or Area Date:

(Signature) Chairperson, Academic Department or Area Date

LEM for Keith Ozdon 3/16/17
College Dean (Dean McGehee for College of Medicine) Date

7. **Graduate School Approvals**

3/16/2017
Chairperson, Graduate Council Date

3/16/2017
Dean of the Graduate School Date