Mission Statement:

The Mission of the Medical Dosimetry Program is to optimize the knowledge, attitudes and skills of our students by maximizing their potential and introspection while enabling them to heighten their critical thinking in an effort to meet the daily challenges of a medical dosimetrist in the dynamic field of radiation oncology. Through clinical work and didactic lessons, students will hone the skills that are required to serve our patients in the community, while maintaining ethical standards and professionalism in and out of the clinic. They will become an integral part of the health care team in the battle against cancer.

2012/2013 MEDICAL DOSIMETRIST PROGRAM

Program Director:

Laura Borghardt, M.S., CMD

Clinical Coordinator:

Sandeep Ailawadi, M.S., C.M.D.

Clinical Faculty:

J. Baker, Ph.D

B. S. Kim, M.D.

A. G. Meek, M.D.

E.J. O'Connell, B.S., M.S.

T. L. Park, M.D.

E. S. Valentine, M.B.A., M.D.

E. Van Wei, M.S.

T. E. Weiss, M.S., M.D.

M. Worth, M.S.

Z. Xu, Ph.D.

CLINICAL ROTATION INSTRUCTIONS

On the first day of rotation, the dosimetry student will report to the Chief Dosimetrist for assignment to one or a pair of clinical instructors. The student will report in with the assigned clinical instructor(s) to sign in and out on the time sheet each clinic day. At the end of each month, place the completed time sheet in the Chief Dosimetrist's mail box. Students will be e-mailed on a daily basis and are expected to check their Lotus e-mail accounts regularly. At the end of the week students must e-mail the Chief Dosimetrist with a log of their progress and status on their assigned work. **Only the hospital email system is an acceptable form of electronic communication.**

Your duties on each rotation are to learn to perform as many of the daily dosimetry tasks as possible as well as accomplish your competencies. You should participate in daily checks, transfers of information to the paper and electronic chart, peer review, conference with physicians, Sim and CT, calculations, conference with radiation therapists, etc. You are expected to attend any in-service as directed by the clinical coordinator or program director while you are in the clinic. When you report in each clinic day, ask what you can do to help you clinical instructor. If you clinical instructor has nothing for you, ask the other dosimetrists if you can help them.

To accomplish your competency, your clinical instructor will demonstrate treatment planning for the service and will assign you an image set to practice with. You should take notes any time any procedure is demonstrated for you. You may refer to your notes and ask for clarification and help during your practices. After a minimum of two practice attempts, and when you feel you can produce an acceptable treatment plan without help from a dosimetrist, report to your clinical instructor that you are ready to perform the competency. Each attempt will be graded. While you are performing you may not ask for advice from anyone. Print out your plan and hand it in to your clinical instructor. Your clinical instructor will grade each task and compile the scores to add up to a Pass or Fail and initial the printed out plan. The clinical instructor will turn these into the Chief Dosimetrist. A copy of the score sheet and the printed plan will be returned to the student. A Pass means that you may concentrate on you next competency. A Failing grade means that you must practice and improve in the area that was unsuccessful and attempt the competency again. Two failures on the same competency will be followed by a conference with the Chief Dosimetrist and Program Director to construct remediation. All competencies shall be completed by the end of April.

Student will complete at least two competencies with a passing grade each month. If this expectation is not met then the student will be placed on probation. If by the beginning of the Spring Semester the student is still on probation he/she will not be allowed to continue in the program.

All students will be expected to accompany the dosimetrists in their brachytherapy duties. This includes, but is not limited to, going to the OR for prostate seed implants, HDR planning and assaying sources. Although direct patient care is limited, students will maintain their professionalism at all times

R-

12/2/2010

Medical Dosimetry Program

Orientation and Policy Review

1. **Administrative Issues**: Most of these topics are covered in the Policy and Procedures (PP) manual distributed to each student.
    a. Tuition
    b. Dress Code
        i. "Whites" must be worn at all times according to the PP manual
    c. Working Hours
        i. Students are expected to arrive <u>on time!</u>
        ii. Attendance sheets must be signed daily on arrival by the senior dosimetrist
        iii. The working day is 8AM to 5PM with 60 minutes for lunch
    d. Vacation and Leave Policy
    e. E-mail Accounts
        i. Much of the communications regarding work flow is carried out via e-mail. As such, Students will be given university e-mail accounts and are required to check their accounts for e-mail on a daily basis.
    f. Use of Internet and Web.
        i. Students may not "surf the web" or check personal e-mail during working hours.
    g. Attendance and Evaluations
        i. Students will be evaluated on a monthly basis as to their clinical performance and professional behavior by the senior dosimetrist (clinical coordinator).
        ii. <u>Evaluation will be based upon the quality of work, productivity, professional attitude and behavior, attendance, and completion of treatment plan competency forms, completion of peer review conference summary reports.</u>
    h. Attendance at Department Meetings
        i. On-time attendance at the weekly peer review conferences is mandatory
        ii. On-time attendance at all visiting professor lectures is mandatory
            1. Students will arrive at the talks at least 10 minutes in advance
    i. Minimum Grade and Performance Requirement
        i. Students will receive numerical grades in class, however transcript grades will be documented as Pass/Excellent Performance, Pass/Satisfactory Performance, Incomplete, or Fail
        ii. Students are expected to receive Pass/Satisfactory Performance or higher in all of their didactic course work and competencies in order to complete the program.

j. Warning and Probation
    i. If a student is not meeting program performance expectations, the student will receive a "warning" notice by October 1, and be considered as "on probation". If sufficient improvement is not demonstrated by January 1, the student will be asked to leave the program.
    ii. The warning recommendation will be sent by the clinical coordinator/senior dosimetrist to the program director.
    iii. The clinical coordinator and the program director will meet with and inform the student in question.
k. Notify Program Director of interviews and review of resumes.
    i. A draft of the CMD exam application will be sent to the program director for review at least 2 weeks in advance of submission.
l. Job Application Reference by the Program Director

2. Course Curriculum and Syllabus

3. Clinical Training

4. Policy and Procedure Manual

5. Personal Portfolio Requirements

a. <u>All</u> treatment planning must be logged. The section should include for each case:
    i. Treatment plan report must be completed
    ii. Manual MU calculation must be performed and compared for 2 fields
    iii. Copies of Isodose maps and field information
b. Competency forms must be completed and evaluated by the Senior Dosimetrist for specified treatment plan categories.
    i. At least 2 competency forms completed and approved by Senior Dosimetrist each month
    ii. All completed by end of April
    iii. At least 2 cases completed prior to the case used for competency review
    iv. Student is responsible for finding and completing cases from the teaching database as well as current patients.
    v. All forms should be kept anonymous for patient privacy
c. Attendance at the weekly peer review conference is mandatory
    i. Each student must generate a one page report on a case presented at the peer review conference.
    ii. The report should include the definitions and explanations of at least two new words and concepts brought up at the meeting
    iii. The report should be graded and initialed by a senior dosimetrist and included in the personal portfolio

R-11/30/2010

POLICY ON TUITION

Medical Dosimetrist Program

One-Year Post BSHS Clinical Practicum

Tuition payment must be received, in full, before the end of the first week.

Payment Procedure:

Payment is made by to the Bursars office through SOLAR on-line. Monies due will appear on students SBU account. This will include fees for medical insurance and additional technology fees of approximately $167.10.

Refund Policy: (includes full or partial payment)

Tuition Refund:

Week 1	100%
Week 2	70%
Week 3	50%
Week 4	30%
Week 5 or after	0%

Uniforms, books, and parking fees are the responsibility of the student.

Student must be current with University required immunizations (titers). PPD must be current within one year.

R12/2/2010

POLICY ON CLINICAL ATTENDANCE AND PUNCTUALITY

The presence of students in the clinical facility must in no way alter the routine work schedule of the department or inconvenience the patients or staff. Therefore, dependability and punctuality are essential.

A. Attendance

1. Each student will receive a clinical schedule. Students are allowed in the patient treatment area only on their assigned days.

2. Each student is responsible for signing in at the time of arrival at the clinic. Failure to do so may result in the student not being credited with the time spent in the department.

3. Each student is responsible for signing out and obtaining the appropriate Clinical Instructor Supervisor's signature at the end of the day. Failure to do the preceding will result in lost time!

4. No student will be allowed to have clinical assignments on hospital holidays or weekends.

5. Students are not allowed to earn more than forty hours of clinical time in one week.

6. Only full eight-hour days are given credit unless previously authorized by Clinical Supervisor.

B. Absence

1. In case of absence due to illness the student must notify the Clinical Supervisor by telephone within the first half hour of the clinic's working day.

2. Clinic absence must be reported to Program Director's office by the Clinical Supervisor.

3. An excess of three days absence in any one semester will be sufficient reason to have the student's participation in the program reviewed.

4. No student will absent themselves from their clinical schedule for the purposes of studying for examinations.

5. Time missed due to inclement weather may need to be made-up; this will be at the discretion of Program Director.

4/30/2010

POLICY ON MONTHLY MEETINGS WITH PROGRAM DIRECTOR

Monthly Meeting with Program Director

Each student will meet with the Program Director within 1 week of the end of each month. The Students will be prepared to submit and discuss the following at this meeting:

1. Monthly attendance sheet with all appropriate signatures

2. Monthly evaluation sheet signed by the Program Clinical Coordinator

3. Record of completed treatment plans

4. Record of currently completed competency forms.

12/5/2010

POLICY ON PROFESSIONAL CONFIDENTIALITY

One of the major restrictions that a health care profession imposes upon you is the need to maintain strict confidentiality of medical and personal information about a patient. Medical records, including histories, diagnostic images and all radiographic film records are considered part of the medical record. They must be handled confidentially, for example, a patient's chart and cannot be revealed to the patient, family, or others outside the department without the direct consent of the patient's physician. Medical information should only be shared with individuals who are involved in the patient's care and must know for treatment purposes. Information should never be discussed with your own family or friends in even the most general terms because you would be violating the patient's rights.

An invasion of privacy can be as obvious as releasing medical information to the press or as subtle as discussing a patient's condition with a co-worker in a public place. Maintain confidentiality and ensure the privacy of each patient.

POLICY ON GENERAL RULES OF CONDUCT AND SAFETY

Students are expected to conduct themselves in a professional manner at all times.

CONDUCT

- Students are expected to observe the guidelines set forth in the directives issued by the New York State Department of Health, Radiologic Technology, Bureau of Environmental Radiation Protection.

- Students must abide by the standard rules and regulations of the Program and all affiliated Clinical Education Centers. Please see attached website: http://healthtechnology.stonybrookmedicine.edu/faculty/policies

- Students will address the staff, patients and fellow students by their appropriate title and/or last name.

- Eating and drinking are permitted in designated areas only.

- Stony Brook University and Medical Center is a smoke-free facility. There is no smoking allowed anywhere on site.

- Personal relationships with staff and patients are not encouraged.

- Personal conversation and discussions with classmates or staff while interacting with patients are in poor taste and should be limited to off duty hours.

- Grievances and personal dislikes should be aired in private and with the appropriate persons.

SAFETY

- Students are required to acquaint themselves with the routine radiation and electrical safety rules.

- Accidents involving students or patients will be reported immediately to the Program Director. (Please see attached Incident Report form)

- Film badges will be worn at all times while in the clinical facility.

- Gross and willful negligence in the use of radiation and/or in the handling of radioactive substances which endangers the health of the student or patient will result in immediate dismissal.

SCHOOL OF HEALTH TECHNOLOGY & MANAGEMENT
SAFETY INCIDENT REPORT

PROCEDURE

(to be filled out and filed by the faculty member)

Please keep a copy of the attached form within your class material for each class so that it is readily available for your reference. The form should be filled out and signed by you and by the student involved.

NOTE: THIS REPORT SHOULD BE FILED AS SOON AFTER AN INCIDENT HAS OCCURRED AS IS REASONABLY POSSIBLE (24-48 HRS). THIS REPORT IS CONFIDENTIAL TO THE DEPARTMENT CHAIR AND THE DEAN'S OFFICE AND AS SUCH SHOULD NOT BE AVAILABLE TO ANY OTHER PERSON.

It is suggested that, as soon as possible, in addition to this report you request the student or faculty member, (not the patient or guest), to write out his/her perception of the incident and add this to your report.

****EMERGENCY PHONE NUMBERS****

Dial 333 or 911 UNIVERSITY POLICE from campus phone for Fire, Police, Medical, or Environmental
Dial 444-7767 for EMPLOYEE HEALTH

The supervising faculty member must report all untoward incidents:

(1) involving the health of a patient under student or faculty care; or
(2) incidents involving the health of students, faculty or guests, which occur within the school environment or at a clinical practice site. The report must be in writing to the department chair AND through the department to the office of the Dean within 24-48 hours.

PRACTICE SITE: _____ FILING DATE: _____ TIME: _____

Student Involved: _____ SBU ID#: _____

Program: _____ Was this person on clinical assignment? _____

Name of other person directly involved: _____

Is this person a: (circle one) patient student faculty member other _____

Date of incident: _____ Time of incident: _____

Was a witness present when this incident occurred?_____. If yes, give name & address of this person:

Name: _____ Relationship to site: _____

Address: _____

Exact Location where incident occurred: _____

Description of incident (Detail what person was doing, and what procedures, instruments, equipment, structures, or fixtures were involved): _____

(Continued on page 2)

POLICY ON DRESS CODE

Prescribed Uniform for Students

- A student must wear a white uniform top and white uniform pants (no white jeans).
- White shoes and socks are required (no athletic type shoes).

Required Accessories

- A nametag that includes the name of the school must be worn. It must contain the word "Student"
- Radiation badges can be worn at belt-level or on collar or pocket above waist on same side as ID.

Professional Appearance

- Uniforms and shoes must be clean and in good repair.
- Sweaters, if worn, must be white or navy.
- Long hair must be pulled back in a neat fashion.
- Beards and mustaches must be neatly trimmed.
- Excessive jewelry and excessive use of cosmetics and bizarre clothing are inappropriate.
- White shirts are not considered uniform tops
- Long fingernails pose a health and hygiene hazard and are inappropriate in the clinical setting.
- Careful attention must be paid to personal hygiene when attending clinic.

Failure to Dress Properly

A student who reports to the clinic not in proper attire may be sent home at the discretion of the Clinical Supervisor. No clinic hours will be credited.

R-4/30/2010

POLICY ON PROFESSIONAL BEHAVIOR

Performance Skills and Attitudes Assessment Procedures

In **addition to** mastery of cognitive skills and knowledge, students will be evaluated on their performance skills and attitudes. These include:

- adherence to the University Code of Conduct
- ability to work with and relate to peers, faculty and other members of the health care team
- attitude
- attendance and punctuality
- appearance and professional demeanor

Successful completion of each course requires that the student continuously maintain high standards. This means that regardless of one's level of achievement in cognitive skills and knowledge, if one's professional behavior is not appropriate, he/she may not meet minimum requirements for successful completion of the course.

Unsatisfactory **Performance** Skills **or Attitudes**

Unsatisfactory behavior such as disruption of class activities, expression of derogatory, disrespectful remarks to the instructor, inability to work with peers, or excessive unexcused absences may be cause for warning or further action.

A student who has exhibited unsatisfactory behavior that may affect his or her final evaluation and academic standing shall receive a written warning that stated behavior may jeopardize successful completion and lead to failure of the course.

The details of these policies and procedures can be found in the Academic Standing Policy of the School of Health Technology & Management. All students are also expected to adhere to the University's Student Conduct Code (copies available in the BSHS office). As well, students are expected to uphold the stricter guidelines outlined in their Medical Dosimetry clinical Policy and Procedure handbook.

R-

12/2/2010

POLICY ON PROBATION AND TERMINATION

- **All students** enrolled in the program will be placed on program probation for academic performance of a grade(s) lower than 75% or Pass/ Satisfactory Performance in any undergraduate, didactic course or competency within the Program curriculum**.** The Program Director will review the situation and will submit written documentation that the student has failed to maintain the requirements of the program and termination will be requested.

- **Post B.S.** For students who fail (less than 75% or Fail/Unsatisfactory grade) two or more courses, the Program Director will review the situation and will submit written documentation to the Chair of the Health Science Program that the student has failed to maintain the requirements of the program and termination will be requested.

- Unsatisfactory and/or unethical clinical performance will also result in a probationary status and possible termination from the Medical Dosimetrist Program

- Any student will be recommended for termination from the program if, while on probation their academic grade(s) falls below the grade of 75% or Pass/Satisfactory Performance or receive a grade of ***unsatisfactory*** in any clinical Monthly Behavioral Objections Evaluation.

POLICY ON REGULATIONS

MEDICAL DOSIMETRIST
STUDENT / DOSIMETRIST REGULATIONS

1. Student may not perform patient related duties except under the direct supervision of a staff dosimetrist, physicist, physician or radiation therapist. This includes, but is not limited to, calculations, treatment plans, simulations, fabrication of immobilization devices, etc.

2. Any behavior on the part of a student which could result in an unsafe condition for a patient, staff member, or other students should be immediately corrected by the supervising Radiation Physicist/Dosimetrist and reported to the Clinical Supervisor and the Program Director.

3. Any injuries involving a student should be written up as an incident report.

4. Student assignments should be educational in purpose. Students should not be used to augment staff shortages. However, this does not imply that students may not perform tasks useful to the department.

5. The Medical Dosimetry Program's Clinical Supervisor should complete student evaluations at the end of the month.

6. All problems which cannot be resolved by discussion between the staff dosimetrist and the student should be communicated to the Clinical Supervisor and / or the Program Director, so as not to interfere with the operations of the Radiation Oncology Department.

7. Any questions which arise as to Dosimetrist or student responsibilities should be discussed with the Clinical Supervisor.

POLICY ON VACATION DAYS, HOLIDAYS AND PERSONAL DAYS

The students in 2nd year of the Medical Dosimetry Program will be allotted the following days off:

1) Holidays when the Department of Radiation Oncology is closed:

a) Independence Day
b) Labor Day
c) Thanksgiving Day
d) Christmas Day
e) New Year's Day
f) Washington's Birthday

2) Additional days: holidays or adjoining holidays:

a) Day after Thanksgiving

3) Winter break:

The winter vacation will generally begin on December 24 and extend through New Year's Day, January 1.

4) Spring break:

A one-week spring break (5 working days) can be scheduled within the calendar period allotted for spring recess on the SHTM academic calendar *or* for the week of the medical dosimetrist refresher course given at MD Anderson Hospital or other approved review course.

The student ***must*** notify the Program Director and the Clinical Coordinator which week he/she will be taking off for Spring break at least one month prior.

5) Personal days:

Each student will be entitled to 6 personal days to be used for reasons of vacation, minor illness, family needs, etc. Student ***must*** notify the Program Director *and* the Clinical Coordinator ***at least 48 hours prior***, unless due to illness.

R – 5/1/08

POLICY ON DISABILITIES

Americans with Disability Act

If you have a physical, psychological, medical or learning disability that my impact your course work, please contact Disability Support Services, ECC (Educational Communications Center) Building, room 128, (631) 632-6748/TT. They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential. Students requiring emergency evacuation are encouraged to discuss their needs with their professors and Disability Support Services. For procedures and information, go to the following web site. http://www.ehs.sunysb.edu/fire/disabilities/asp.

POLICY ON DECLARATION OF PREGNANCY

I, _____, do hereby make this voluntary declaration of Pregnancy. My estimated date of conception was _____201___.

It has been explained to me that I am making this voluntary Declaration of Pregnancy. I understand that this means the Radiation Therapy Dosimetry Program/Licensee must take measures to ensure that the total dose to the embryo/fetus during the entire pregnancy from occupational exposure does not exceed 0.5 rem (5 mSv). If as of this date, the total dose to the embryo/fetus is 0.45 rem (4.5 mSv) or greater, the total dose to the embryo/fetus during the remainder of the pregnancy shall not exceed 0.05 rem (0.5 mSv). I also understand that there will be no modifications to my clinical rotation by declaring my pregnancy.

It has been explained to me that if I receive 0.5 mSv or higher I may choose the reassignment of my clinical rotations and corresponding learning objectives to those that will result in lower occupational exposure or the placement of certain restrictions on the duties that I perform. I understand that by choosing a reassignment it will result in the delay of my program completion.

It has also been explained to me that I may revoke the declaration of pregnancy at any time and that the revoking of the declaration must be in writing.

_____ _____

Student Medical Dosimetry Date

_____ _____

Radiation Safety Officer Date

*****Sample Document*****
(Not to be used as an official form)

1/20/12

POLICY ON RADIATION PROTECTION

Subpart B -- Radiation Protection Programs

Source: 56 FR 23396, May 21, 1991, unless otherwise noted.

§20.1101 Radiation Protection Programs.

(a) Each licensee shall develop, document, and implement a radiation protection program commensurate with the scope and extent of licensed activities and sufficient to ensure compliance with the provisions of this part. (See §20.2102 for record keeping requirements relating to these programs.)

(b) The licensee shall use, to the extent practicable, procedures and engineering controls based upon sound radiation protection principles to achieve occupational doses and doses to members of the public that are as low as is reasonably achievable (ALARA).

(c) The licensee shall periodically (at least annually) review the radiation protection program content and implementation.

(d) To implement the ALARA requirements of §20.1 101(b), and notwithstanding the requirements in §20.1301 of this part, a constraint on air emissions of radioactive material to the environment, excluding Radon-222 and its daughters, shall be established by licensees other than those subject to §50.34a, such that the individual member of the public likely to receive the highest dose will not be expected to receive a total effective dose equivalent in excess of 10 mrem (0.1 mSv) per year from these emissions. If a licensee subject to this requirement exceeds this dose constraint, the licensee shall report the excess as provided in §20.2203 and promptly take appropriate corrective action to ensure against recurrence.

[56FR23396, May2l, 1991, amended at 6l FR 65127, Dec. 10. 1996]

§20.1208 Dose to an Embryo/Fetus.

(a) The licensee shall ensure that the dose to an embryo/fetus during the entire pregnancy, due to occupational exposure of a declared pregnant woman, does not exceed 0.5 rem (5 mSv). (For record keeping requirements, see §20.2106.)

(b) The licensee shall make efforts to avoid substantial variation above a uniform monthly exposure rate to a declared pregnant woman so as to satisfy the limit in paragraph (a) of this section.

(c) The dose to an embryo/fetus shall be taken as the sum of--

(1) The deep-dose equivalent to the declared pregnant woman; and

(2) The dose to the embryo/fetus from radionuclides in the embryo/fetus and radionuclides in the declared pregnant woman.

(d) If the dose to the embryo/fetus is found to have exceeded 0.5 rem (5 mSv), or is within 0.05 rem (0.5 mSv) of this dose, by the time the woman declares the pregnancy to the licensee, the licensee shall be deemed to be in compliance with paragraph (a) of this section if the additional dose to the embryo/fetus does not exceed 0.05 rem (0.5 mSv) during the remainder of the pregnancy.

- For further information on the Stony Brook University Hospital Environmental Health and Safety Policy and Procedure Manual please see:

  http://naples.cc.sunysb.edu/Admin/HRSForms.nsf/pub/EHSD0112/$FILE/EHSD0112.pdf

POLICY ON PROGRAM GOALS

Program Goals and Outcomes

- Students will demonstrate clinical competence by producing treatable plans and demonstrating and understanding of basic science concepts required for site specific treatment planning.

- Students will practice critical thinking skills by adequately responding to challenges about the optimal nature of their treatment plans and showing the ability to perform multiple tasks in a timely manner.

- Students will practice with professional values by displaying professional conduct and demonstrating lifelong learning.

- Students will display effective communication skills by demonstrating written and oral communication skills.

EDUCATION POLICIES AND PROCEDURES

The application of theory learned in the classroom is applied to the clinical environment throughout the student's clinical education sessions.

The clinical instructor(s) maintains all ongoing processes where the student must:

- Observe the Instructor perform the specific procedure.
- The student will assist the instructor perform the specific procedure.
- Have the instructor observe the student enact the same procedure.
- Have the instructor critique and correct any possible errors.
- Prior to the student's attempt to satisfy a specific performance objective, the instructor must observe the student successfully perform the procedure a minimum of three times.
- Having satisfied the above criteria, the student can request, at their own discretion, the Instructor evaluate their performance of objective(s).
- The student must perform each step of the procedure correctly to be successful in satisfying any attempted objective.
- Competencies must begin in the fourth month of the clinical component of the program.

Clinical competency evaluation forms are maintained to record student grades and progress and to communicate their performance. All records are maintained in the Program Director's Office. A student not successful in completing their clinical requirements will be **ineligible** for graduation. The program uses the clinical behavioral evaluation form, performance objectives, and clinical testing schedule to document and evaluate the clinical practicum.

All educational activities of the Medical Dosimetry Program are maintained with various channels of communication. Methods of communication include, but are not limited to, scheduled clinical site visits by the program director, intermittent telephone calls, written correspondence, advisory committee meetings, and formal and informal conversations with the Clinical Supervisor, and formal student/program director meetings.

Any claims by a student that there has been a violation, misinterpretation, or inequitable application of any existing policy, procedure, regulation or grade challenge within the clinic shall be documented in writing and given to the Program Director. It will be reviewed with a recommendation submitted within 7 days. If upon review the student is unsatisfied with said results the claim shall be submitted in writing to the Chair of the Health Science Department. All grievances will be reviewed by the Chair within 30 days. If the Chair cannot adjudicate the issue, it will be brought to the Academic Standing Committee as is documented in the School of Health Technology and Management's Policy and Procedure Manual under the academic standing policy. A record of the grievance and its resolution will be maintained.

FACULTY POLICY: CLINICAL OBJECTIVES AND ASSIGNMENTS EVALUATIONS

The Program Educational Coordinator or Program Director will explain all objectives and assignments to the student at the beginning of each clinical phase when appropriate.

1. Clinical education is provided by a series of clinical assignments. Each student will have assignments that include treatment planning for each of the following:

a. Head and Neck
b. Lung
c. GU
d. IMRT
e. Lymphoma
f. Breast
g. Brachytherapy
h. GI
i. Gyn
j. Melanoma/Sarcoma
k. CNS

2. The clinical assignments will be graded using the following criteria:
Student performance of standard tasks on each service will be evaluated using competency test. Each competency test consists of performing all dosimetric services required for a selected patient treated with a given treatment technique.
The competency should be completed by the end of the rotation on the service. The student is required to practice the entire task and then, with the clinical instructor, choose a patient submitted for dosimetry or a specified patient data set
to be the competency test case. The student will then be required to perform all necessary dosimetric services for that patient - beam on time or monitor unit calculations, computer plans, etc. - with all work checked by the Clinical Instructor. The clinical competency tests will be evaluated by the Clinical Instructor on the basis of Pass/Fail (P/F). A failure must be repeated. Each task in the competency will be assigned a score of Exceeds expectation (A), Satisfactory (B), Needs Improvement (C), or Unsatisfactory (F). The letter grade for the competency will be determined from these scores. The clinical course

grade will be determined from the competency grades earned during the semester.

Competency tests are listed below:

Brachytherapy

1. Tandem and Ovoid Implant
2. Prostate Seed Implant

Breast

3. Intact Breast Tangentials
4. Chest Wall Tangentials: Bolus and Non Bolus
5. Intramammary Chain Composite GI
6. 3-Field Pelvis with Wedges
7. 4-Field Pancreas or Abdomen

Head and Neck

8. Head and Neck Plan: Primary, Off Cord, Boost, Supraclav
9. Electron Planning

Lymphoma

10. Mantle/Mini Mantle
11. Para-aortic or Lower Nodal XRT
12. Thorax Sagittal for Gapped Fields

Melanoma/Sarcoma

13. Sarcoma Limb

Thoracic

14. 4 Field Lung (Primary and Off Cord)
15. CNS

CNS Conformal/Image Fusion

16. Cranio-Spinal with Gaps and Feathered Borders GU
17. IMRT/Conformal Prostate

Head and Neck or Breast or Lymphoma

18. IRREG Calculation

3. Student Supervision

All students will work under the direct supervision of a Qualified Medical Dosimetrist. The supervising Medical Dosimetrist must verify the accuracy of any work performed by a student, and sign the work before it is used for patient treatment. All work will then be checked by another Medical Dosimetrist before use. Under no circumstances is the student allowed to be the only person to sign work that is included in a patient record or used for patient treatment.

4. Evaluation

The student will receive an evaluation for each area of competency within the clinical schedule. All professional staff that had the opportunity to work with the student will be asked to provide input in the student's written evaluation.

The student will review the evaluation with the Program Director or Program Clinical Coordinator. The student will, upon request, have an opportunity to meet with the specific evaluators. This process is intended to promote open discussion of the student's clinical progress. Frequent feedback to the student is a vital part of his/her professional success.

Each student will be requested to complete a general evaluation of the clinical instructor at the end of each clinical phase. The clinical instructor evaluations must be completed and turned in with the competencies for grading. These evaluations will provide valuable feedback to the appropriate personnel within the institution.

5. Clinical Competencies

A competency checklist/evaluation for each category and/or a course grade is used to assess student performance. Students must meet clinical competencies in all categories to be eligible for program completion. If the required number of clinical competencies is not completed in a reasonable time frame, the student will be placed on clinical probation. At that point he/she must successfully complete his/her next three rotations. Only one clinical probation period is allowed for each student during his/her tenure as a student.

6. Grading

The Program Director or the Program Clinical Coordinator, with input from other appropriate personnel, is responsible for submitting the final grade for each evaluation and rotation. This final grade will be based on the performance evaluation, clinical assignments, and overall professional conduct as referred to in that section of the student handbook.

R-12/8/2010

ICRU 50/62 GUIDELINES

Dosimetry students must fully understand the following concepts in depth while doing their competency in respective anatomical sites.

- Volumes are defined:
  - Gross Tumor Volume (GTV): Gross palpable or visible/demonstrable extent and location of malignant growth
  - Clinical Target Volume (CTV): Anatomical concept. Tissue volume that contains a GTV and/or subclinical microscopic malignant disease, which has to be eliminated. This volume has to be treated adequately in order to achieve the aim of therapy: cure or palliation. The CTV is an anatomical-clinical concept, that has to be defined before a choice of treatment modality and technique is made
  - Planning Target Volume (PTV): Geometrical concept. Defined to select appropriate beam sizes and beam arrangements, taking into consideration the net effect of all the possible geometrical variations and inaccuracies in order to ensure that the prescribed dose is actually absorbed in the CTV. Its size and shape depend on the CTV but also on the treatment technique used, to compensate for the effects of organ and patient movement, and inaccuracies in beam and patient setup
  - Treated Volume: Volume enclosed by an isodose surface (e.g. 95% isodose), selected and specified by radiation oncologist as being appropriate to achieve the purpose of treatment. Ideally, Treated Volume would be identical to PTV, but may also be considerably larger than PTV
  - Irradiated Volume: Tissue volume which receives a dose that is considered significant in relation to normal tissue tolerance. Dose should

be expressed either in absolute values or relative to the specified dose to the PTV

- Organs at Risk: Normal tissues whose radiation sensitivity may significantly influence treatment planning and/or prescribed dose
- Recommendations for Reporting Dose
  - ICRU Reference Point:
    - Dose at the point should be clinically relevant and representative of the dose throughout PTV
    - The point should be easy to define in a clear and unambiguous way
    - The point should be selected where the dose can be accurately determined (physical accuracy)
    - The point should be selected in a region where there is no steep dose gradient
    - ICRU Reference point should be located at the center of the PTV and when possible at the intersection of the beam axes
    - The dose at the ICRU Reference Point is the ICRU Reference Dose
  - Dose at/near center of PTV, maximum dose to PTV, and minimum dose to PTV should always be reported
  - Maximum Dose: Highest dose in PTV. A volume is considered clinically meaningful if its minimum volume exceeds 2cc; however, if it occurs in a small organ (e.g. the eye, optic nerve, larynx), a dimension smaller than 2cc has to be considered.
  - Minimum Dose: Lowest dose in PTV. In contrast to Maximum Dose, no volume limit is recommended.
  - Hot Spots: Volume outside the PTV which receives dose larger than 100% of the specified PTV dose. In general considered significant only if minimum diameter exceeds 15 mm; however, if it occurs in a small organ (e.g. the eye, optic nerve, larynx), a dimension smaller than 15 mm has to be considered
  - Levels of Dose Evaluation for Reporting:
    - Basic: Only dose at ICRU Reference Point and its variation along a central beam axis is available

- Advanced: Dose distribution can be computed for plane(s)
- Developmental: Dose distribution can be computed for volume(s)

The minimum criterion to derive an optimal plan is that on average more than 99% of the CTV should at least get 95% of the prescription dose and the heterogeneity in dose delivery to the PTV should be kept within 95 and 107% (ICRU-50, p. 20).

In addition the student will be tested on the following measures and concepts (ICRU 62) for the competency plan generated.

1. Internal Margin and Set-up Margin

2. Combining margins

3. Planning Organs at Risk Volumes (PRV)

4. Conformity Index

Stony Brook University Hospital
Department of Radiation Oncology
Division of Medical Physics
4-2208 FAX: 4-7629

Interoffice Memo

To: E. J. O'Connell, S. Ailawadi, X. Chong, B. O'Grady, J. Baker, A. Meek, Z. Xu, M. Worth,

Date: June 1, 2011

From: L. J. Borghardt, CMD
Program Director, School of Medical Dosimetry

Subject: **COURSE GRADE PLAN**

Courses in the second "certificate year" will be graded on the basis of Exams, Class participation, and Homework. Attendance is mandatory and instructors must be notified in advance of any unavoidable emergencies, sickness etc.

Although students will receive numerical or letter grades on homeworks, exams, papers, projects etc. only Pass/Satisfactory Perfomance and Pass/Excellent Performance, Incomplete or Fail final grades will be given consistent with school policy and according to the numeric equivalents on the attached sheet. In addition, students will be evaluated according to subjective criteria (see grade sheet attached).

Instructors will hand in original signed grade sheet and evaluation to L. Borghardt within one week of the course's end to be part of the student's record. Note that copies of this evaluation will be given to the student to be part of his/her program folio. Thus, all comments on performance will be available to the student for self evaluation.

MEDICAL DOSIMETRIST CERTIFICATE PROGRAM
SCHOOL OF HEALTH TECHNOLOGY AND MANAGEMENT
STONY BROOK UNIVERSITY

2011-2012 Academic Year

GRADING SYSTEM:

A	**(93 - 100)**
A-	**(90 - 92)**
B+	**(87 - 89)**
B	**(83 - 86)**
B-	**(80 - 82)**
C+	**(77 - 79)**
C	**(73 - 76)**
C-	**(70 - 72)**
D+	**(67 - 69)**
D	**(60 - 66)**
F	**(<60)**

P/E – Pass / Excellent Performance - Will be applied for grades of 90 and above

P/S – Pass / Satisfactory Performance - Will be applied for grades of 75 and above

***I – Incomplete – Will be applied if there is missing grades for material assigned**

F – Fail - Will be applied if grades below 75

***This grade will be given at the discretion of the faculty preceptor and the approval of the program director. It is the responsibility of the student to arrange with the necessary faculty to complete work in the given timeline.**

R-5/27/11

This form must be completed (including appropriate signatures) each month and due on the first day of the following month. **Keep a copy of the completed form in your Clinical Handbook;give original to Marion Mraz.**

FACULTY POLICY ON MONTHLY BEHAVIORAL OBJECTIVES EVALUATION

*Clinical Supervisor: place X in appropriate box in left column

Student: _____ Month: _____

Attendance:

_____ The student has maintained good attendance and calls in at the specified time to notify staff of his/her absence(s).
_____ The student's attendance is marginal but calls in on time when absent.
_____ After repeated warnings the student's attendance remains poor and continues to call in late to notify staff of absence.

Punctuality:

_____ The student is on time each day and prepared to begin the clinical assignment.
_____ The student makes little effort to arrive on time after a verbal warning.
_____ The student is consistently more than five minutes late and unprepared to begin.

Perseverance:

_____ If the student is not successful in performing an assigned task for the first time, he/she will seek advice as to what they are doing wrong and make a second attempt to succeed without prodding. This student demonstrates initiative.
_____ If the student's first attempt at performing a patient procedure is unsuccessful, the student is reluctant to seek advice on what action is needed to perform the task correctly. It is only after the instructor offers advice, will the student make a second attempt to complete the procedure successfully. This student demonstrates a moderate level of initiative.
_____ Although receiving adequate instruction and supervision, the student becomes discouraged and frustrated when their first attempt at setting-up a patient procedure is unsuccessful. This student does not seek advice and assistance and when the instructor offers advice and/or assistance this student is often unwilling to make a second attempt for fear of failure. This student lacks initiative.

Evaluator's Comments:

_____
_____
_____
_____
_____
_____
_____

R-5/11/06

Clinical Supervisor's Signature **Side A**

This form must be completed (including appropriate signatures) each month and due on the first day of the following month. **Keep a copy of the completed form in your Clinical Handbook;give original to Pro. Dir.**

MONTHLY BEHAVIORAL OBJECTIVES EVALUATION

*Clinical Supervisor: place X in appropriate box in left column

Student: _____ Month: _____

Attendance:

_____ The student has maintained good attendance and calls in at the specified time to notify staff of his/her absence(s).
_____ The student's attendance is marginal but calls in on time when absent.
_____ After repeated warnings the student's attendance remains poor and continues to call in late to notify staff of absence.

Punctuality:

_____ The student is on time each day and prepared to begin the clinical assignment.
_____ The student makes little effort to arrive on time after a verbal warning.
_____ The student is consistently more than five minutes late and unprepared to begin.

Perseverance:

_____ If the student is not successful in performing an assigned task for the first time, he/she will seek advice as to what they are doing wrong and make a second attempt to succeed without prodding. This student demonstrates initiative.
_____ If the student's first attempt at performing a patient procedure is unsuccessful, the student is reluctant to seek advice on what action is needed to perform the task correctly. It is only after the instructor offers advice, will the student make a second attempt to complete the procedure successfully. This student demonstrates a moderate level of initiative.
_____ Although receiving adequate instruction and supervision, the student becomes discouraged and frustrated when their first attempt at setting-up a patient procedure is unsuccessful. This student does not seek advice and assistance and when the instructor offers advice and/or assistance this student is often unwilling to make a second attempt for fear of failure. This student lacks initiative.

Evaluator's Comments:

_____
_____
_____
_____
_____

_____

_____

Clinical Supervisor's Signature

R-4/30/2010
Side A

FACULTY POLICY ON THE OBSERVATION OF BEHAVIORAL AND PERFORMANCE SKILLS

Student: _____ Month: _____, 200_____

Instructor/Evaluator: please indicate performance by placing an X in the appropriate yes/no column. If a "No" is checked, please elaborate on the comments sheet.

		Yes	**No**
1.	Student consistently presents a neat and professional appearance and in required uniform to include film and student ID badges.		
2.	Does this student exhibit confidence in approaching new tasks?		
3.	Is this student generally helpful in assisting staff and patients?		
4.	Does student occasionally appear disoriented or inconsistent?		
5.	Does student generally display a logical "common sense" approach to performing required tasks?		
6.	Does student have difficulty focusing on required tasks?		
7.	Does this student follow instructions/directions and work well under pressure?		
8.	Is student's confidence level shaken after committing an error?		
9.	Does this student handle constructive criticism in a positive manner?		
10.	Does this student tend to rationalize, argue, blame others for, or deny their errors?		
11.	Is this student's professional behavior and clinical skills progressing in accordance with expectations?		
12.	Does student assist in keeping their assigned workplace neat and orderly?		
13a.	Does this student generally demonstrate professional behavior and courtesy?		
13b.	Does this student work well with others and volunteer to assist those in need?		
14a.	Student actively seeks learning experiences and appears eager to demonstrate acquired knowledge.		
14b.	Student generally anticipates what is required for each patient procedure and performs task(s) without prodding.		

Instructors / Evaluators Comments Sheet: (Attach additional sheet if needed)

Please use this form if you wish to elaborate upon the student's strengths and/or areas, that you feel, need improvement based upon the content of this evaluation and overall student/instructor/patient, interactions. And, to address any "No" answer(s) on page 3 of this student evaluation.

For this evaluation period the student's overall performance has been:

_____ Satisfactory _____ Unsatisfactory

Clinical Supervisor's Signature / Date: Student's Signature / Date:

_____ _____

R-9/20/07

Side B

C:\LER Work\Laura - Med. Dosim. Program - 2008-2009\F-8 - FACULTY POLICY ON THE OBSERVATION OF BEHAVIORAL AND PERFORMANCE SKILLS.doc

Student: _____ Month: _____, 201_____

Instructor/Evaluator: please indicate performance by placing an X in the appropriate yes/no column. If a "No" is checked, please elaborate on the comments sheet.

	Yes	No
2. Student consistently presents a neat and professional appearance and in required uniform to include film and student ID badges.		
2. Does this student exhibit confidence in approaching new tasks?		
3. Is this student generally helpful in assisting staff and patients?		
4. Does student occasionally appear disoriented or inconsistent?		
5. Does student generally display a logical approach to performing required tasks?		
6. Does student have difficulty focusing on required tasks?		
7. Does this student follow instructions/directions and work well under pressure?		
8. Is student's confidence level shaken after committing an error?		
9. Does this student handle constructive criticism in a positive manner?		
10. Does this student tend to rationalize, argue, blame others for, or deny their errors?		
11. Is this student's professional behavior and clinical skills progressing in accordance with expectations?		
12. Does student assist in keeping their assigned workplace neat and orderly?		
13a. Does this student generally demonstrate professional behavior and courtesy?		
13b. Does this student work well with others and volunteer to assist those in need?		
14a. Student actively seeks learning experiences and appears eager to demonstrate acquired knowledge.		
14b. Student generally anticipates what is required for each patient procedure and performs task(s) without prodding.		

Instructors / Evaluators Comments Sheet: (Attach additional sheet if needed)

Please use this form if you wish to elaborate upon the student's strengths and/or areas, that you feel, need improvement based upon the content of this evaluation and overall student/instructor/patient, interactions. And, to address any "No" answer(s) on page 3 of this student evaluation.

For this evaluation period the student's overall performance has been:

_____ Satisfactory _____ Unsatisfactory

Clinical Supervisor's Signature / Date: Student's Signature / Date:

_____ _____

Medical Dosimetry Program

Mini Course Grade

Course Name: _____

Instructor(s): _____

Semester: _____

Student Name: _____

Grade: _____

After each course, grades may be obtained from the Program Director.

Instructor's Signature: _____

Date: _____

Instructor: Please fill out reverse side.

R-8/30/07

Side A

Behavioral Objectives Evaluation

Instructor/Evaluator: place X in appropriate box in left column

Student: _____ Semester: _____

Attendance:

_____ The student has maintained good attendance and calls in at the specified time to notify staff of his/her absence(s).
_____ The student's attendance is marginal but calls in on time when absent.
_____ After repeated warnings the student's attendance remains poor and student continues to call in late to notify staff of absence.

Punctuality:

_____ The student is on time each day and prepared to begin the clinical assignment.
_____ The student makes little effort to arrive on time after a verbal warning.
_____ The student is consistently more than five minutes late and unprepared to begin.

Perseverance:

_____ If the student is not successful in performing an assigned task for the first time, he/she will seek advice as to what they are doing wrong and make a second attempt to succeed without prodding. This student demonstrates initiative.
_____ If the student's first attempt at performing a patient procedure is unsuccessful, the student is reluctant to seek advice on what action is needed to perform the task correctly. It is only after the instructor offers advice, will the student make a second attempt to complete the procedure successfully. This student demonstrates a moderate level of initiative.
_____ Although receiving adequate instruction and supervision, the student becomes discouraged and frustrated when their first attempt at setting-up a patient procedure is unsuccessful. This student does not seek advice and assistance and when the instructor offers advice and/or assistance this student is often unwilling to make a second attempt for fear of failure. This student lacks initiative.

Evaluator's Comments:

_____
_____
_____
_____
_____
_____

_____
Instructor's Signature

COMPETENCY FORM

DOSIMETRIST STUDENT TREATMENT PLANNING LOG

MR#	Date	Dosimetrist	Site	Diagnosis	Technique	Machine	Primary Dose	C/D Dose

Medical Dosimetry Certificate Program
School of Health Technology and Management
Stony Brook University

CURRICULUM SUMMARY

YEAR 2 – POST BSHS

2012-2013 YEAR 2 POST BSHS

Summer Semester – Year 2

1. Principles and Concepts of External Beam Treatment Planning/Introduction to Practical Medical Dosimetry

a. **Duration:** 24 hours
b. **Instructor:** TBA
c. **Text Book:** Physics of Radiation Therapy, Faiz M. Khan, Ph.D.
d. **Course Description:**

This course will introduce dosimetry parameters, outline radiation physics terminology, and present basic calculations that will be expected in the clinical setting. There will be a basic math review and lectures detailing clinical duties. The students will be instructed in the day to day duties of the clinical dosimetrist. The students will learn to read and understand patient radiotherapy treatment records, simulation parameters, patient setup and treatment parameters. They will learn skills such as estimating effective field size, checking charts, ascertaining match between prescription and chart dosing, and performing dosimetry calculations such as photon and electron beam monitor unit and point dose calculations. The instructor will provide many in class problems and examples. Clinical calculation forms and beam data tables and graphs will be provided.

2. Radiation Protection, Regulations and QA Programs

a. **Duration:** 18 hours
b. **Instructor:** TBA
c. **Text Book:** Physics of Radiation Therapy, Faiz M. Khan, Ph.D.
d. **Course Description:**

This course will introduce the students to the radiobiological effects of radiation from natural vs. synthetic sources. Students will gain knowledge of stochastic vs. non-stochastic effects and ALARA. Protection and regulations under the Homeland Security guidelines in accordance with SBUMC's guidelines and procedures will also be covered. Students will be taught about the quality factors of various radioactive particles used in radiation oncology (alpha/beta/neutrons).

Concepts of exposure in LDR vs. HDR sources along with annual dose limits for general public, radiation personnel, fetal monitoring and pregnancy guidelines will be reviewed.

3. Computerized External Beam Radiation Treatment Planning Techniques

a. **Duration:** 36 hours
b. **Instructor:** TBA
c. **Text Book:** N/A
d. **Course Description:**

This hands-on laboratory course in site specific treatment planning will cover a variety of radiation therapy disease sites. During the labs, students are assigned cases which have been carefully selected from an extensive anonymous patient data base. The specific goals for these assignments are established by the instructor, and the resulting plans are carefully reviewed and critiqued. Following the critiques, the students are expected to revise and improve their treatment plans before final submission. Student treatment plans are evaluated and graded according to the quality of the plan and how closely it meets the goals. Site Specific Planning Competency forms are used to document progress and are kept by each student as part of a clinical folio.

4. Introduction to Computer Systems and Networking

a. **Duration:** 12 hours
b. **Instructor:** TBA
c. **Text Book:** N/A
d. **Course Description:**

This course will introduce students to treatment planning computer concepts and transfer of data to remote sites following national protocols and guidelines. Hardware, software and networking terminology definitions and their applications in regards to radiation oncology will be reviewed.

5. Practical Work Experience in Medical Dosimetry

a. **Duration:** Ongoing – June through May (30 weeks FTE)
b. **Instructor/mentor:** Clinical Supervisor and Medical Dosimetrist and Medical Physics Staff
c. **Text Book:** Physics of Radiation Therapy, Faiz M. Khan, Ph.D.
d. **Course Description:**

Under direct supervision, trainees will assist with all medical dosimetrist duties including conventional simulation, manual contouring, fabrication of immobilization devices, fabrication of custom blocks, CT/Simulation, treatment preparation, isodose planning, chart review, MU calculation, record and verify (VARiS) data entry and review, brachytherapy source handling, electron cutout factor determination, and clinical diode dosimetry. After appropriate skills have been developed and cognitive goals have been reached actual patient treatment planning assignments will be completed, and documented. Students will

be responsible for all aspects of treatment planning including patient data acquisition, plan generation, presentation of plan to supervisor and responsible physician, monitor unit calculation, and chart review. Each student will be assigned a minimum of 3 treatment plans for each anatomic site listed in the appendix (appendix A – Treatment Planning site competencies). Completion of all of the treatment site competencies to the satisfaction of the Medical Dosimetrist Clinical Coordinator is a pre-requisite for graduation from this program with a certificate.

Fall Semester – Year -2

1. Quality Assurance and Measurement of Beam Characteristics

a. **Duration:** 18 hours

b. **Instructor:** TBA

c. **Text Book:** N/A

d. **Course Description:**

This course will provide the students with information regarding the concepts of acceptance testing, annual, monthly, and daily QA. The importance of these activities and the pass/fail tolerances of the QA procedures will also be taught. The relevance of such procedures and the effects on patient care will be discussed. Maintenance, commissioning, and daily usage of various radiation oncology equipment such as linear accelerators, CT simulators, planning systems, digitizers and survey meters will be reviewed and discussed in detail. Students will have the opportunity for "hands on" setup and use of ion chamber, diode, and film dosimetry. They will also observe the use of daily and monthly beam QA check devices.

2. Clinical Electron Beam Therapy Treatment Planning & MU Calculations.

a. **Duration:** 18 hours

b. **Instructor:** TBA

c. **Text Book:** N/A

d. **Course Description:**

This course allows students "hands on" opportunity to determine block correction factor (BCF) and inverse correction factor (ICF) by measurement methods. Students will also perform MU calculations. Particular attention will be paid to use of bolus and bolus compensators, the effect of oblique incidence, surface and internal shielding, effects of heterogeneities, electron/electron and electron/photon field matching, and energy selection.

Spring Semester – Year 2

1. **Advanced Techniques: Stereotactic Radiosurgery and IMRT**
    a. **Duration:** 18 hours
    b. **Instructor:** TBA
    c. **Text Book:** N/A
    d. **Course Description:**
    This course is the introduction of complex beam arrangements and algorithms for intra- and extra-cranial tumors from the perspective of hypofractionation. Concepts of Gamma Kinfe, Exact Trac, benign and malignant brain tumors, dose fractionation, schemes for tumors vs. organs at risk, integral doses will be identified and discussed. Immobilization, Winston-Lutz tests, isocenter verification and daily setup error concepts will be demonstrated.

2. **Radiobiology for Radiation Oncology**
    a. **Duration:** 15 hours
    b. **Instructor:** TBA
    c. **Text Book:** N/A
    d. **Course Description:**
    This course will provide the students with the necessary knowledge of Oncologic diseases, their algorithms, response rates, curative factors, etiology and histology thereof. They will receive a historical introduction in the form of ionizing radiation and biological review. They will learn Molecular effects of radiation, LET cellular effects of radiation, cell survival curves repair and radio sensitivity, RBE and Radiation effect.

3. **Clinical Brachytherapy Physics**
    a. **Duration:** 24 hours
    b. **Instructor:** TBA
    c. **Text Book:** N/A
    d. **Course Description:**
    This course will introduce the students to clinical and theoretical aspects of brachytherapy. They will be taught about the various radioactive sources used in the clinic and the appropriate handling methods under ALARA guidelines. Students will learn assay methods, wipe tests, source transfer and shielding methods. Instructor will update the class regarding new Homeland Security guidelines in relationship to Radioactive source storage and handling. They will be taught concepts regarding half-life, average-life, dose prescription for sources used in brachytherapy.

COMPETENCY CHECK LIST

Student Name:_____

Area of Competency	**Evaluator**	**Date Performed**	**Grade**
4 Field Pancreas			
3 Field Pelvis w/ Wedges			
Prostate			
Sarcoma Limb			
Head and Neck Primary, Off Cord, Sclav			
Electron Calc			
Intact Breast Tangents			
Chest Wall Tangents: Bolus			
Intra Mammary Chain			
4 Field Lung Primary and Off Cord			
Mantle/Mini Mantle			
Matching Fields: Gap Calc			
Para-aortic or Nodal Irradiation			
Cranio-Spinal w/ Gaps and Feathered Borders			
Larynx			
IRREG Planning			
Wing Field			
Tandem and Ovoid			
Prostate Implant			
HDR			
Observe SRS			

NOTE: Attendance at the following activities is *Mandatory*

1) **Peer Review/Chart Rounds – 1:15 P.M. - Every Wednesday**

2) **Monthly meeting with Program Director**

Calendar Schedule – Medical Dosimetry Program – 2nd Year: Summer 2012

Class Schedule:

Mini Course	Instructor	Week of	Days
Practical Medical Dosimetry 6 hr/wk x 6 = 36 **PMD – SA/LB**	S. Ailawadi L. Borghardt	June 4- July 13	MWF 10am-12pm
Computerized Treatment Planning Techniques 3 hr./wk x 12 = 36 **CTPT – SA/LB**	S. Ailawadi L. Borghardt	June 4-Aug 24	TTH 8-9:30am
Principles of Treatment Planning 6 hr. /wk x 6 = 36 **PTP – SA/LB**	S. Ailawadi L. Borghardt	July 16-Aug 24 .	MWF 10-12pm
Radiation Safety 3 hr. /wk x 6 = 18 **RS - EO'C/RS**	E. O'Connell R. Schurig	June 11-July 20	Th 2-5pm
Introduction to Computer Systems & Networking 2 hr/day x 7 **=** 14 **ICS-LB**	L. Borghardt	July 16-Sept 4	Th 2-4pm

NOTE: Attendance at the following activities is <u>Mandatory</u>

1) **Peer Review/Chart Rounds – 1:15 P.M. - Every Wednesday**

2) **Monthly meeting with Program Director**

CALENDAR SCHEDULE: FALL 2012

Mini Course	**Instructor**	**Week of**	**Days**
QA & Measurement -	M. Worth		
3 hrs/wk x 6 = 18 hrs.	J. Xu	Oct 29- Dec 14	MWF
QA & Meas. – MW/JX			4-5pm
Electron TX Planning -	M. Worth/		
3 hrs/wk x 6 = 18 hrs.	E. VanWie	Oct 29- Dec 14	TTH
ETP – MW/EV			8-9:30am

NOTE: Attendance at the following activities is *<u>Mandatory</u>***

1) **Peer Review/Chart Rounds – 1:15 P.M. - Every Wednesday**

2) **Monthly meeting with Program Director**

CALENDAR SCHEDULE – SPRING 2013

Mini Course	**Instructor**	**Week of**	**Days**
Advanced TX Techniques -	J. Baker	Jan 21-March 1	TTH
Stereotactic Radiosurgery			8-9:30am
3 hrs/wk x 6 = 18 hrs.			
ATT/SRS – JB/JX			

Radiobiology - 1 hr/wk x 15 = 15 hrs. **Radiobiol. – AGM**	A. G. Meek	Jan 21- May 10	F 1-2pm
Clinical Brachytherapy- 3 hrs/wk x 8 = 24 **Brachy – MW/EV**	M. Worth E. Van Wie	March 6- May 3	TTH 8-9:30

Introduction to Practical Medical Dosimetry (PMD)

Duration: 4 hours per week for 6 weeks = 24

Textbooks: Physics of Radiation Therapy, Faiz M. Khan, Ph.D.

Course Description:

This course will introduce dosimetry parameters, outline radiation physics terminology, and present basic calculations as will be expected in the clinical setting. There will be a basic math review and lectures detailing clinical duties. The students will be instructed in the day to day duties of the clinical Dosimetrist. The students will learn to read and understand patient Radiotherapy Treatment records, simulation parameters, patient setup and treatment parameters. They will learn skills such as estimating effective field size, checking charts, ascertaining match between prescription and chart dosing, and performing dosimetry calculations such as Photon and Electron Beam MU and point dose calculations. The instructor will provide many in class problems and examples. The instructor will provide clinical calculation forms and beam data tables and graphs.

Specific topics include:

I. Applied Mathematics

a) Geometry
b) Trigonometry
c) Area and Volume calculations
d) Solving simple algebraic equations
e) Exponential notation
f) Exponential and logarithmic functions
g) Scientific notation
h) Interpolation and double interpolation

II. Point Dose and Monitor Unit Calculation

a) SSD Technique
b) Isocentric Techniques
c) Extended Distance Techniques

III. Techniques for Estimation of Equivalent Square

IV. Gap Calculation

V. Data Tables and Calculation Parameters
PHOTON BEAM

a) PDD, TMR, TAR, BSF, $S_C S_P$
b) D_{max}
c) Tray factors and wedge factors
d) Off-axis factors

ELECTRON BEAM

a) PDD tables and graphs
b) Cutout Factors,
c) Effective SSD

VI. Understanding the patient treatment Record

a) Prescription page
b) Simulation set-up parameters
c) Radiotherapy record
d) Proper chart review procedures

Course Objectives

The student will be able to:

1. Define radiation with familiarity of electromagnetic radiation and X-rays.
2. Discuss radiation beams commonly used for therapeutic radiation.
3. Identify the various radiation producing treatment units used in radiotherapy
4. Explain the terms associated with patient set-up
5. Understand the relationship between machine setting and beam on time
6. Demonstrate knowledge of field size and field shaping
7. Identify and discuss factors for dose calculation such as depth attenuation factors, scatter factors, field size, accessory attenuation
8. Define electronic equilibrium and its relationship to skin sparing
9. Understand and identify isodose curves and distributions
10. Describe weighting and perform related calculations
11. Discuss the clinical duties of a medical dosimetrist
12. Estimate effective field size
13. Perform prescription to dose per fraction per field calculations
14. Look up parameters using table and graphs
15. Interpolate to achieve the appropriate parameter
16. Use formulas such as appear on hand calculation sheets
17. Perform the calculation indicated by the formulas

Principles of Treatment Planning (PTP)

Duration: 6 hours per week for 6 weeks = 36

Textbooks: Physics of Radiation Therapy, Faiz M. Khan, Ph.D.

Grading: Grades will be based on two exams, homework assignments and class participation

Course Description:

Organization:

A) Homework - all questions at the end of each chapter are to be completed and submitted at the beginning of each class.
B) Class will begin with questions from homework.
C) Exam topic will be announced 2 weeks earlier. Exam questions will be taken from assigned readings and class notes.
D) Class will end with any additional homework assignments, questions and introduction of following week's topic.
E) All reading is expected to be done ***BEFORE*** the next class.

Syllabus: (Chapters from Bentel Text)

Session#1: Chapter 6 - Isodose Charts and Typical Field Arrangeme

- Isodose charts-definition, Interpretation, correction for regular and irregular surfaces
- Inhomogeneity corrections
- Buildup region- changes caused by field size and energy(photon v. electron)
- Manual isodose interpretation-2 Field v. 4 Field
- Dose normalization- single field v. multi-field
- Weighting
- Depth of dose of varying energies
- 3F, 4F, wedged fields, pass pointing, Rotation Therapy(arc)
- Dose Rx-(ICRU) definition: GTV, PTV, CTV
- Gap calculations- equal/unequal adjacent fields
- Matching- photon/photon, electron/electron, photon/electron

Session #2: Chapter 7 - Target Localization, Treatment Uncertainties and Patient Immobilization

- Beam Divergence
- Magnification devices, factors
- Spatial Coordinate system and planes
- Contours: multilevel (H & N, pelvis)
- CT, CT/MRI, CT/PET fusion-virtual simulation
- Uncertainties-spatial coordinates/QA
- Patient positioning/immobilization

Session #3: Chapter 8 - Beam modifying devices and QA

- Internal shields
- Tissue compensators - bolus, superflab, wax, rice
- Documentation of treatment parameters- charts, R & V system

Session #4: Chapter 11- Treatment Planning Breast and Lung Breast

- Histology
- Immobilization/Simulation
- SSD v. SAD, mono-isocentric v. split beam/field in field technique
- Sclav
- Electron beam technique-scar boost v. chest wall
- Wedge- physical/ universal/ EDW
- Dose limiting structures

Lung/Esophagus

- Histology-Hodgkin's
- Immobilization/Simulation
- Sagittal cord dose
- AP/PA v. oblique (lung)
- Dose limiting structures
- Energy consideration
- Treatment techniques (esophagus)

Session #5: Chapters 9 & 10 - Treatment Planning Head and Neck

- Histology
- Immobilization/ Simulation
- Posterior tilt
- Dental impression/bite blocks
- Treatment techniques-SSD v. SAD
- Sclav
- Dose limiting structures
- Dose gradients
- Definition: borders and anatomy
- Nasal cavities
- Auditory canal/ middle ear
- Inhomogeneity corrections

Session #6: Review

Session # 7: Midterm

Session# 8: Chapter 12 - Treatment Planning of Abdomen (pancreas, gallbladder, stomach)

- Immobilization/Simulation
- Critical organs/dose limiting structures
- Dose under block

Session # 9: Chapter 13 - Treatment Planning of Pelvis (prostate, bladder, endometrial, uterus, colon, rectum, inguinal node)

- Immobilization/ Simulation
- Treatment techniques - blocking
- Dose limiting structures
- Testicular (hockey stick)
- Box plans
- (self read) Lymph drainage

Session # 10: Chapter 14 - Treatment Planning of Miscellaneous Treatment

- Extremities
- Sarcoma
- Metastatic disease, Palliative
- Emergency Treatment

Session# 11: Review

Session# 12: Final

Radiation Safety: Protection and Regulations for External Beam and Clinical Brachytherapy
Radiation Protection and Regulations

Duration: 3 hours per week for 6 weeks = 18 hours

Description: *Radiation Protection* topics I through VIII, and *Quality Assurance* topics I through III, *Clinical Brachytherapy* topics XI and XII, AAMD Curriculum Guidelines, v2.

R**adiation Protection and Regulations**

Radiation Protection

I. Dose Equivalent
- A. Defined
- B. Units
  1. Rem
  2. Sievert
  3. Quality factors

II. Protection Regulations (Dose Limits)
- A. Occupational
- B. Public
- C. Pregnant
- D. As low as reasonably achievable (ALARA)
  1. Defined
  2. Low-level radiation
  3. Stochastic effects
  4. Non-stochastic effects

III. Background Sources of Radiation
- A. Cosmic
- B. Terrestrial
- C. Internal
- D. Man made

IV. Structural Shielding Design
- A. Primary barrier
- B. Secondary barrier
  1. Scatter Radiation
  2. Leakage Radiation
  3. Calculations

V. Personnel Monitoring

A. Film badges
B. TLD
C. Pocket dosimeters
D. Documentation

VI. NRC Regulations

A. Agreement states
B. National Council of Radiation Protection and Measurements (NRCP)
C. License
D. Administrative requirements
    1. ALARA Program
    2. RSO
    3. Radiation Safety Committee
    4. Quality management program
E. Technical requirements
F. Teletherapy
G. Training and experience requirements

VII. Radiation Monitoring Instruments

A. Ionization chamber
B. Geiger Mueller counters
C. Neutron detectors
D. TLD
E. Photographic film
F. Scintillation detectors

VIII. Radiation Surveys

A. Equipment
B. Area
    1. Controlled
    2. Non-controlled
C. Patient
    1. Temporary implants
    2. Permanent implants
    3. Radiopharmaceuticals

IX. Clinical Brachytherapy Safety

A. Regulations/regulatory bodies
    1. Nuclear Regulatory Commission (NRC)
    2. International Electrotechnical Commission (IEC)
    3. International Commission on Radiation Units (ICRU)

4. State
5. Compliant vs. non-compliant state
6. Mandates vs. recommendations

B. Protocols
1. American Association of Physicists in Medicine (AAPM)
2. American College of Medical Physics (ACMP)
3. American College of Radiology (ACR)

C. Records
1. Patient
2. Department
3. Regulatory
4. Inventory
5. Contamination
6. Disposal

X. Radiation Safety

A. Safety principles
1. Time
2. Distance
3. Shielding
4. Responsibility
5. Radiation safety officer (RSO)
6. Records; misadministration
7. Spillage/breakage

B. Shipping and handling
1. Order placement
2. Transportation
3. Documentation
4. Loss
5. Sterilization methods
6. Sealed sources
   a. Preparation
   b. Source damage/contamination
7. Unsealed sources
   a. Preparation
   b. Inhalation
   c. Contamination/spillage
   d. Absorption
   e. Ingestion

C. Storage
1. Sealed vs. unsealed sources
2. Containment

3. Monitoring
4. Shielding
5. Security
6. Labeling

D. Emergency procedures

1. Sealed vs. unsealed sources
2. Damage
3. Spillage
4. Loss
5. Monitoring personnel
6. Monitoring patients
7. Safety committee/RSO
8. Responsibilities

E. Patient Care

1. Assessment
2. Monitoring
3. Intervention

COMPUTERIZED TREATMENT PLANNING TECHNIQUES

Duration: 3 hours per week x 12 weeks = 36 hours

Description: This hands-on laboratory course in site specific treatment planning will cover a variety of the typical radiation therapy disease sites. During the labs students are assigned cases which have been carefully selected from an extensive (anonymous) patient data base. The specific goals for these assignments are established by the instructor and the resulting plans are carefully reviewed and critiqued. Following the critiques the students are expected to revise and improve their treatment plans before final submission. Student treatment plans are evaluated and graded according to the quality of the plan and how closely it meets its goals. Site Specific Planning Competency forms are used to document progress and are kept by each student as part of a clinical folio (attached).

This laboratory course will include at least three practice plans from each of the following disease sites:

A) Head & Neck
B) Central Nervous System
C) Pituitary Gland
D) Thorax
E) Breast
F) Abdomen and Pelvis
G) Hodgkin's Disease
H) Extremities
I) Metastatic Disease
J) Benign Disease

For these practice plans the following general treatment planning principles will be emphasized and their application evaluated:

A) Beam Weighting – General Guidelines

1. Opposed fields
2. Multiple fields
3. Separation, depth consideration
4. Equal tumor dose, equal given dose (applied dose)
5. Adjustment of isodose distributions for weighted fields
6. Evaluation of dose uniformity
7. Hot spots, cold spots
    a. Definitions
    b. Corrections

B) Beam Normalization and Dose Specification, Optimization

1. General principles
2. SSD beams
3. Source-Axis Distance

(SAD)/Target-Axis Distance

(TAD) Beams

a. Stationary
b. Rotational

4. Dmax Comparisons
5. Location of Normalization
   a. Specified point
   b. Value
   c. Isodose line
   d. Maximum dose
   e. Other
6. Definitions
   a. Target volume
   b. Treatment volume
   c. Irradiated volume
   d. Maximum target dose
   e. Minimum target dose
   f. Mean target dose
   g. Median target dose
   h. Modal target dose
   i. Reference dose
   j. Tumor dose
   k. Entrance dose
   l. Exit dose
   m. Skin dose
   n. Dose at isocenter

C) New Trends in Organ Dose Calculations, Comparison and Optimization

1. Dose volume histograms
2. Dose optimization
3. Other new works in progress

Introduction to Computer Systems and Networking (ICS&N)

Duration: 2 hours per day x 6 days = 12

Description: Computers & Computer Networking

Topics I – III, AAMD Curriculum Guide, v.2

I. Hardware

A. Central processing unit (CPU)
B. Control unit
C. Arithmetic unit
D. Memory unit
    1. Random access memory (RAM)
    2. Read only memory (ROM)
    3. Flash
    4. Chemical memory operating system (CMOS)
E. Mother board
F. Hard drive
G. Input/output (I/O) and auxiliary peripheral devices
    1. Keyboard
    2. Video display terminal
    3. Digitizer
    4. Printer
    5. Plotter
    6. Mouse
    7. Trackball
    8. Spaceball
    9. Compact disk (CD) ROM drive
    10. Modulator-demodulator (modem)
    11. Optical scanner
    12. Network interface card (NIC)
    13. Other
H. Secondary memory/storage devices
    1. Floppy disk
    2. Magnetic disk
    3. Optical disk
        a. CD re-writable (CD-RW) disk
        b. CD recordable (CD-R)
    4. Magnetic tape
    5. Jaz drive

6. Zip drive
7. Other

II. Software

A. Bits, bytes, and words

B. Programs

1. Systems software and platforms
    a. Disk operating system (DOS)
    b. Windows
    c. Macintosh
    d. UNIX
    e. Linux
    f. Other
2. General applications programs
    a. Word processing
    b. Spreadsheets
    c. Data base
    d. Web browser
    e. Electronic scheduling
    f. Electronic mail (e-mail)
3. Algorithms and applications in radiation therapy planning (RTP)
    a. Virtual simulation
        1. Volume rendering
        2. Beam's eye view (BEV)
        3. Digitally reconstructed radiogrph (DRR)
    b. Photon beam methods
        1. Analytical
        2. Matrix techniques
        3. Clarkson scatter integration
        4. Differential scatter-air ratio calculation (dSAR)
        5. Heterogeneity corrections
            a. Ratio of tissue-air ratios (TAR)
            b. Power law tissue-air ratio
            c. Equivalent TAR
        6. Three-dimensional integration
            a. Monte Carlo
            b. Convolution
                i. Fast Fourier transfer (FFT)
                ii. Superimposition
    c. Electron beam methods
        1. Matrix techniques
        2. Pencil beam

d. Brachytherapy
e. Multi-planar reconstruction (MPR)
f. Dose volume histogram (DVH)

III. Networking

A. Introduction
1. Definitions
2. Characteristics
3. Interconnectivity
4. File transfer protocol (FTP)
5. Hypertext transfer protocol (HTTP)
6. Distribute e-mail
7. Remote printing

B. Network application
1. Resource sharing
2. Software
3. Hardware
a. Parallel and serial ports
b. Firewire
c. Universal serial bus (USB)
d. Ethernet cabling
e. Diacom image importing
f. Small computer system interface (SCSI) port
g. Communication (COM) port
4. Printer
5. Modem

C. Internet connection

D. Data acquisition
1. Record and verify
2. Electronic portal imaging devices (EPID)
3. Information management
a. Impac
b. VARiS
c. Other

E. Organization and centralization

F. Centralized data bases

G. Communication and convenience
1. E-mail and attachments
2. Messaging
3. Conferencing file share

H. Types of networks
1. Local area networks (LAN) and components

a. Server
b. Workstation
c. Networking operating system
d. Communication links

2. Metropolitan area networks (MAN)
3. Wide area networks (WAN)
4. Internet/world wide web (WWW)

I. Network topologies

1. Bus
2. Star
3. Ring
4. Daisy chain
5. Mesh
6. Switched.

Quality Assurance and Measurement of Beam Characteristics

Duration: 3 hours per week x 6 = 18 hours

Description:

QA Guidelines of AAPM TG40 and methodologies to comply with these guidelines with respect to medical LINAC, RT Simulator, Treatment Planning Systems. Students will have the opportunity for "hands on" setup and use of ion chamber, diode, and film dosimetry. They will also observe use of daily and monthly beam QA check devices.

I. Accelerator Beam Measurement and Treatment Planning Systems

A. TMR Dose calculation method

B. Basic Beam Measurement

i. Electrometers

ii. Ion chambers

1) Cylindrical
2) Parallel plate chambers

iii. Phantoms

3) Water tank
4) Plastic and Solid water
5) Non-water equivalent plastics

Polystyrene

Lucite

C. Acquiring Beam Data

i. PDD

ii. TMR

iii. Field Size Factors

LAB: PDD, TMR and FF measurement in solid water

II. Commissioning an Accelerator and Treatment Planning System

A. Beam Calibration

i. TG-21 (very brief)

ii. TG-51

iii. TG water tank

B. Scanning Water Tank Measurements

i. PDD
ii. Wedge Factors
iii. OAR
iv. Field Characteristics
v. Size
vi. Flatness
vii. Symmetry

C. Treatment Planning Commissioning

i. Golden Data, Clinical Data
ii. Typical commissioning procedures

LAB: TG-51 Water Tank Measurement

III. Clinical QA For Accelerators, Simulators And HDR

A. Daily QA

Linacs and Sim
HDR

B. Monthly QA

Linac
Sim
Treatment Planning System
HDR
Hot Lab

C. Annual QA

Linac
Sim

LAB: Daily QA measurement, monthly dose constancy and depth dose measurement

IV. Clinical QA Programs and TG40

A. TG-40

B. The cops

NRC
State agencies
Quality control committee
Inspections

C. TEST

Americans with Disabilities Act

If you have a physical, psychological, medical or learning disability that may impact upon your course work, please contact Disability Support Services, 128 ECC Building (631) 632-6748. They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential.

Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and Disability Support Services. For procedures and information, go to the following web site: http://www.ehs.sunysb.edu and search Fire Safety and Evacuation/Physical Disabilities.

R-4/30/2010

Clinical Electron Beam Planning & MU Calculations

Duration: 3 hours per week x 6 = 18 hours

Description: Clinical Electron Beam Treatment Planning & MU Calculations, Topics II – IV, AAMD Curriculum Guidelines, v.2. Students will be given "hands on" opportunity to determine BCF & DF by measurement methods. Students will also perform MU calculations. Particular attention will be paid to use of bolus and bolus compensator, effects of oblique incidence, surface and internal shielding, effects of heterogeneities, electron/electron and electron/photon function techniques and energy selection.

CLINICAL CHARACTERISTICS OF ELECTRON BEAMS

I. Depth Dose Curves

A. Shape of the CAX depth dose curve
   1. Skin sparing
   2. Shoulder
   3. Fall-off
   4. Tail

B. Isodose curve parameters
   1. Beam energy
   2. Collimation system
      a. Scattering foils
      b. Monitor chambers
      c. Collimator jaws
      d. Cones

C. Field flatness
   1 Definition
   2. Uniformity index
   3. Acceptable limits

D. Field symmetry
   1. Definition
   2. Acceptable limits

E. Field size dependence
   1. Output
   2. Acceptable limits
   3. Dose

F. Effective or virtual source skin distance
   1. Definition
   2. Measured

G. X-ray contamination
   1. Bremsstrahlung
   2. Clinical concerns

II. Treatment Planning

A. Energy and field size selection
   1. Target volume
   2. Depth
   3. Critical organ $TD_{5/5}$
   4. Isodose coverage of the target

B. Air gap and beam obliquity corrections
   1. Causes
   2. Considerations
      a. Inverse square correction on isodose curves
      b. Side scatter
      c. Sharp surface irregularities
      d. Bolus utilization to smooth irregularities and reduce beam penetration

C. Tissue inhomogeneities
   1. Interactions
      a. Bone
      b. Lung
      c. Air cavities
   2. Dose distributions within or around small inhomogeneities
   3. Dose at a point beyond the inhomogeneity
      a. Coefficient of equivalent thickness method (CET)
      b. $d_{eff} = d - z(1 - CET)$

D. Clinical application of bolus and absorbers
   1. Flatten out an irregular surface
   2. Reduce the penetration of the electronics
   3. Increase the surface dose
   4. Lucite beam spoiler
   5. Penumbra generator

E. Dosimetric problems with adjacent fields
   1. Abutting fields
   2. Field skin gap

III. Shaping of Treatment Fields

A. External shielding
   1. Lead cut-out or Lipowitz metal
      a. Placed directly on the skin
      b. End of treatment cone
   2. Energy vs. shield thickness requirements

B. Transmission curve measurements in a phantom
   1. Measurement depth
   2. Ionization current vs. shield thickness

C. Effect of blocking on dose rate
   1. Blocking extent
   2. Thickness of lead
   3. Electron energy

D. Internal shielding considerations

1. Uses
   a. Normal structures
   b. Reduction of transmitted dose
   c. Dose enhancement
2. Electron backscatter minimization
3. Minimum thickness of shields including measured transmission curves for the given field size and the depth of the structure shielded.

IV. Electron Arc Therapy

A. Advantages and disadvantages
B. Machine modifications
   1. Arc mode
   2. Electron collimation
      a. Beam-defining aperture
      b. Collimation close to the patient
   3. Beam calibration for arc therapy
   4. Treatment planning
      a. Beam energy selection
      b. Isocenter placement
      c. Field placement and shaping
      d. Isodose distribution
      e. Monitor unit calculations

V. Total Skin Irradiation

A. Clinical applications
   1. Mycosis Fungoides
   2. Other cutaneous lymphomas
B. Energy range of 2 – 6 MeV
C. Techniques used
   1. Translations technique
   2. Large field technique (Stanford Technique)
D. Physics measurements required for implementation
E. Monitor unit calculations

ADVANCED TREATMENT TECHNIQUES STEREOTACTIC RADIOSURGERY

Duration: 3 hours per week x 6 weeks = 18 Hours

A) Stereotactic Radiosurgery/Stereotactic Radiotherapy

1) Definitions
2) Patient Selection
3) Image Acquisition
4) Treatment Planning
5) Plan Evaluation
6) QA
7) Treatment Delivery

B) Intensity Modulated Radiotherapy (IMRT)

1) What is IMRT?
2) How Does IMRT compare to conventional radiotherapy
3) IMRT methods (MLC): Step and Shoot vs. DLMC
4) Fundamentals of leaf sequencing
5) Best candidates for IMRT
6) Patient benefits of IMRT

C) IMRT Treatment Planning

1) Image Acquisition and Import
2) Contouring – GTV, TTV, and OAR
3) Beam Orientations
4) IMRT Calculation Parameters
5) IMRT Plan Evaluation
6) TheraPlan Plus IMRT Treatment Planning

D) IMRT Treatment Delivery

7) Delivery data format
8) Treatment data export and delivery

E) IMRT Dosimetry

1) Patient specific QA requirements
2) Absolute dosimetry
3) Relative dosimetry
4) Data analysis

F) Future Considerations in IMRT

Radiobiology

Duration: 1 hour per week x 15 = 15 hours

Week 1

Definition of Radiobiology

The study of the interaction of ionizing radiation with living things.

Definition of Ionizing Radiation

Radiation of sufficient energy to disrupt the chemical bonds of molecules and produce biologically important changes.

How Are We Exposed to Ionizing Radiations?

Natural Sources

Man Made

Flight

Discovery of Ionizing Radiations

Roentgen

Becquerel

Curies

Chadwick

Early Applications for Ionizing Radiations

Diagnosis

Therapy

Types of Ionizing Radiations

Electromagnetic Rays
- Gamma Rays (intranuclear)
- X-rays (extranuclear)

Charged Particles
- Electrons (Beta Particles)
- Protons
- Alpha Particles
- Heavy Ions

Neutrons (Uncharged Particle)

Absorption of Radiation

Direct interaction with the atoms of the critical target.

Indirect interaction through intermediate free radical production.
- Photoelectric Effect
- Compton Effect
- Pair Production

Measurement of Radiation

Exposure
- Roentgen

Absorbed Dose
- Rad (radiation absorbed dose), 100 ergs/gm
- Gray, 1 joule/kg, equal to 100 rad

Dose Equivalent
- Absorbed dose multiplied by radiation weighting factor (W_R) (used to be called Quality Factor)
- Equivalent physical doses of different types of radiation may not cause equivalent biologic effects.
  - Analogy to fat, carbohydrates, protein.
- Rem (rad equivalent man) when dose in rad
- Sievert when dose in Gray

Collective Dose Equivalent
- For population exposure studies, multiply the average dose equivalent received by the # of individuals exposed.

Committed Dose Equivalent
- An estimate of the dose to be received in the future by the human population from a radiation release.

Special Considerations for Radioactive Materials
- Radio-activity is specified in disintegration's per second. Classical unit is the curie equal to 3.7×10^{10} disintegration's per second. Current unit is the Becquerel equal to 1 disintegration per second. The absorbed dose will be a function of this activity, the type of radiation emitted and its energy.
- Half-life equals the time for the radio-activity of a material to decrease by disintegration to one half of its value

Week 2

Review of Cell Biology

Hierarchy of multicellular organisms
Body

Systems
Organs

Tissues
Cells

Cytoplasm

Organelles

Nucleus

DNA

Chemical composition of the cell
Inorganic constituents
H_2O (70-85% of protoplasm)
Dispersion and transport of substances, temperature regulation
Mineral salts
Energy production, nerve conduction, maintaining osmotic pressure
Na (extracellular)
K (intracellular)
Ca
Other

Organic Constituents
Proteins (15%)
Have structural and regulatory functions
Macromolecules (polymers) composed of amino acids (22 known) linked by peptide bonds
Carbohydrates (1%)
Primary energy source
Mono-, di- and polysaccharides composed of C, H and O
Nucleic Acids (1%)
Information system
Complex polymer of a sugar, phosphoric acid and nitrogenous bases
Exists in two main forms: DNA and RNA
Lipid (2%)
Stores energy, acts as insulator, is important component of cell membranes and has various nutritional roles

Cell Structure
Cell Membrane

Cytoplasm
Matrix
Organelles

Endoplasmic Reticulum
Rough
Smooth
Ribosomes
Mitochondria
Lysosomes
Golgi Complex

Nucleus
Nuclear Envelope
DNA
Deoxyribose nucleotide
5 carbon sugar
Phosphoric acid
Nitrogenous base
2 Purines (A,G)
2 Pyrimidines (T,C)
Chromosomes
Genes
Somatic Cells
Germ Cells

Gene Activation
The activation of genes is regulated by two classes of proteins; those with suppressor and those with activating ability.
The activated gene is transcribed into MRNA (messenger RNA) which is transported to the cytoplasm.
The MRNA guides the manufacture of proteins on the ribosomes of the endoplasmic reticulum

Structural

Enzymatic

Secretory (e.g. growth factor)

Transcription factor (for another gene)

Cell division and the cell cycle
Somatic Cells—Mitosis
Phases of mitosis: Prophase→ Metaphase→ Anaphase→Telophase

Interphase occurs between each mitosis
DNA synthesis and rest phases
G_1 (variable)→ S (15 hrs)→G_2 (1-5 hrs)→ M (1 hr)
G_0, or Q cells.
Cyclins regulate the passage through the cell cycle

Germ Cells—Meiosis
Reduction of # chromosomes from 2n to n
Crossing over

Week 3

Basic Biologic Interactions of Radiation

LET (Linear Energy Transfer)

The greater the mass and charge of a radiation the higher the LET

RBE (Relative Biological Effect)

Equal doses of radiations of different LET's do not produce the same biological effect

Analogy to caloric content of fats, proteins & carbohydrates

Radiation Interaction with Cellular Targets

General Considerations

Radiation interaction with cells is a probability function and randomly deposited within the cells

It occurs extremely quickly (10^{-17} second)

The biologic consequences may occur immediately or remain latent for many years and may be difficult to distinguish from other causes of cellular damage.

Signs of radiation effect on cells

A nuclear signal from DNA damage occurs
Cytoplasmic factors respond to oxidative damage
Membrane changes occur due to lipid peroxidation
Proteins are induced following radiation; these can be studied to better understand the DNA → MRNA changes which occurred from the radiation

The microenvironment of the cell is important in inducing a wide range of genes and their protein products that may affect the behavior of normal and tumor cells and their response to radiation. Particularly important is chronic hypoxia (P53) and possibly the presence of free radical scavengers

Radiation Targets

Prime target appears to be DNA

Basic cellular constituents, cytoplasmic organelles and membranes are considered secondary targets

Damage occurs soon after damage to DNA through intercommunicating processes
e.g. membranes; low doses of radiation can affect K+ channel regulation in the membrane—this can be abolished by pretreatment with free radical scavengers

Initial Radiochemical Interactions

Direct Action: deposition of radiation energy directly in the critical target producing ionization or excitation of the target.

More likely with high LET radiations

Indirect Action: deposition of radiation energy in water producing reactive species which damage the target.

Predominant action of low LET radiations

Free radical production, especially OH·

X-ray→ e^-→ ion radical→ free radical→ chemical changes→biological changes

$HOH \rightarrow HOH^+ + e^-$ under the influence of radiation

$HOH^+ \rightarrow H^+ + OH\cdot$

Radiation Effects on DNA

Types of DNA Damage

Base Damage

Point mutations of variable consequence—infrequent

Single Strand Breaks

Generally efficiently repaired using opposite strand as template and rarely of long term consequence

Double Strand Breaks

If the damage is separated by considerable distance it can be repaired as separate single strand breaks

If however the damage occurs on both strands opposite each other or only separated by a dew base pairs then a double strand break may occur before repair can be completed

Double strand breaks form the basis for the most important biologic effects of radiation

Cell killing

Mutagenesis (heritable event in a germ cell)

Transformation of a somatic cell to a malignant state

Crosslinks

Of variable consequence based on difficulty in repair

Radiation Effects on Chromosomes

Induction of chromosomal breakage

Chromosomal aberrations (before DNA synthesis)

Chromatid aberrations (after DNA synthesis)

Structural changes

No change: Restitution (predominant)

Deletions

Acentric fragment
Could be associated with removal or inactivation of a suppresser gene leading to a solid tumor

Rearrangements
Ring and dicentric chromosomes
usually a lethal event

Translocations and Inversions
Could activate dormant oncogenes leading to leukemia or lymphoma

Week 4

Cellular Response to Radiation I

Effects of radiation on cells
How cells are studied
In vitro
Tissue cultures in bottles/tubes
In vivo
Skin erythema, hair loss, sperm count reduction

Dose dependency of the effect on cells
Doses of 1-5 cGy lead to mutations

Doses around 100 cGy cause mitotic delay

Doses around 300 cGy causes permanent mitotic inhibition and activation and deactivation of genes

Doses between 400 and 1000 cGy causes interphase death

Doses of 50,000 cGy causes instant death from protein coagulation

Division (mitotic) delay
Seen in both lethally and nonlethally irradiated cells
A generalized response of cells to DNA damage—radiation is just one of the causes

Mitotic index
Ratio of # cells in mitosis to total # cells in the population.

Mitotic delay
Cell cycle dependency: G_2 & early S
Synchronization
Dose dependency of mitotic index and length of division delay.

Delay allows for repair of radiation induced damage prior to proceeding into next division cycle.

Molecular checkpoint genes hold damaged cells in G_2 to check for integrity of chromosomes prior to allowing the cells to proceed into mitosis. A defective checkpoint gene is associated with a more radiosensitive cell. In contrast, one feature of radioresistant cells is a more prolonged G_2 delay

Restriction point in G_1 is a "switch" which allows cells to proceed into S phase once turned on; a number of stimuli including radiation can affect this switch.

Mitotic overshoot

Target: protein and/or DNA synthesis

Interphase (non-mitotic) death

Apoptosis

A general phenomenon which occurs spontaneously in all cells, healthy and diseased.

Occurs in cells that do not divide and are long lived and in rapidly dividing cells.

Small lymphocyte; serous acini of parotid, lachrymal glands

Cell type-dose dependency

Rapidly dividing cells, undifferentiated cells generally undergo apoptosis at a lower dose than non-dividing differentiated cells.

Mechanism not well understood

Not an unsuccessful attempt of a cell to divide.

Possibly related to membrane changes with Na-K fluxes.

Reproductive death

Loss of capacity to proliferate

Reproductive failure is the inability of the cell to undergo repeated divisions after irradiation. Most probably related to chromosomal (DNA) damage.

Energy deposition from radiation is randomly distributed among cells and within a cell.

Some cells will receive no damage to a critical site and will be unaffected.

Some cells will accumulate enough damage to be lethal and will die in the next division

Some cells will receive a sublethal amount of damage which largely can be repaired; however sublethal damage can accumulate with multiple exposures and become lethal.

Cell survival curves

Relationship between radiation dose administered and proportion of cells that survive to proliferate

Puck & Marcus

HeLa Cells

Dual exponential nature of mammalian survival curves

Initial slope in low dose region

Not all cells are damaged by low doses of radiation and most cells receiving sublethal damage can repair that damage.

Terminal slope in high dose region

Enough damage is sustained by the cell to be lethal (loss of reproductive integrity).

Classic Formula:

Surviving Fraction = $ne^{-D/Do}$

Components of the survival curve

Extrapolation number (n)

The number on the surviving fraction axis derived by extrapolating the linear portion of the survival curve back to dose = 0

For mammalian cells ranges from 2 to 10 and may represent # targets in the cell.

Quasi-threshold dose (D_q)

Defines the width of the shoulder of the survival curve and is equal to the dose where the linear portion of the survival curve extrapolates back to survival = 100%.

Repair of sublethal damage proportional to D_q

Terminal slope (D_0 = 1/ terminal slope)

The dose of radiation required to deliver an average of one potentially lethal hit to all the cells in a population.

Radiosensitivity is inversely proportional to D_0; in other words a larger D_0 means the cells are less sensitive to radiation.

Initial slope (D_1 = 1/ initial slope)

Linear quadratic model of cell survival curve

Surviving Fraction = $\alpha D + \beta D^2$ where D is dose

α may represent single hit killing

β may represent interaction of multiple sublethal lesions

The ratio α/β differs for different types of cells and is larger for cells with a "narrow shoulder" on the survival curve

Week 5

Cellular Response to Radiation II

Repair of radiation effect on cells

Sublethal damage repair

Time dependent repair of radiation damage; can usually be repaired unless another dose of radiation added

Repair half time in-vivo is from ½ to 1½ hours.

DNA single strand breaks probably responsible for sublethal damage.

Cells with broad shoulder on survival curve demonstrate more sublethal damage repair than those with narrow shoulders

Seen with sparsely ionizing (low LET) radiations (e.g. X-rays), not with densely ionizing radiations (e.g. neutrons).

Potentially lethal damage repair

Environment dependent delay of the expression of radiation damage (even after a single fraction); cells in suboptimal growth conditions have increased survival over those in nutritionally complete environment.

Probably because of delayed entry into mitosis cells have more time to repair sublethal damage

Seen with sparsely ionizing (low LET) radiations (e.g. X-rays), not with densely ionizing radiations (e.g. neutrons).

Radiosensitivity of cells to low LET radiation

Early Hypotheses

Hypothesis of Bergonie and Tribondeau (1906)

Ionizing radiation is more effective against cells that are actively dividing, less differentiated and have a long dividing future.

Differentiation: a differentiated cell is a mature cell with a specialized structure or function.

Modification by Ancel and Vitemberger (1925)

The inherent susceptibility of all cells to radiation is virtually the same but the expression of radiation induced damage depends on the rate of division (kinetics) of the cells.

The appearance or radiation damage is influenced by the biologic stress on the cell (most important) and the conditions the cell is exposed during and after radiation.

The greatest biologic stress on a cell is undergoing division.

Cells which divide quickly express radiation damage sooner and appear more sensitive than cells whose radiation damage is expressed later.

Cell populations and radiosensitivity in tissues

Three categories of cell types

Stem cells

Undifferentiated; goal is self renewal ("reserve cells") and source of transit cells

Transit cells

In transit between stem cell compartment and end cell compartment.

Static cells

Fully differentiated, mature cells

Week 6

Radiation Effects on Tissues

In general, after irradiation cells die attempting mitosis, either the subsequent or a later mitosis. Some cells die by apoptosis. Tissue damage may occur if the affected cells are critical target cells within that tissue.

Tissue response to radiation

The apparent radio responsiveness of a tissue depends on the inherent sensitivity of the cells composing it and the kinetics of these cell populations.

Tissue organization

Parenchymal compartment

Composed of cells from one or more of stem, transit and static categories

Stromal compartment

Connective tissue and vasculature

Two hypotheses of cause of radiation damage in normal tissues

Normal tissue damage is secondary to radiation induced stromal damage (vascular narrowing and occlusion).

Normal tissue damage is due to radiation induced depletion of critical parenchymal cells. As cell division is necessary for the expression of radiation damage, the time of appearance of radiation damage is a function of the division rate of the critical target cells within that tissue.

Acutely responding tissues (larger α/β ratio ≈ 10 Gy)

Radiation damage seen within a few months

Skin, intestine, testis, bone marrow

Late responding tissues (smaller α/β ratio ≈ 2 Gy)

Radiation damage seen 3 months or longer after radiation

Lung, spinal cord, brain, bladder

Measurement of radiation damage in tissues

Clonogenic assay

In situ assays: intestine, skin, testis, kidney
Transplantation assays: bone marrow, thyroid, mammary
Width of the shoulder on the survival curves varies by tissue

Functional assay
Dose-effect (response) curves rather than survival curves: skin, lung, spinal cord
Volume effect more critical when serial arrangement of functional subunits is present (e.g. spinal cord)

Lethality assay
Measurement of LD_{50} (isoeffect) and time to death (quicker for tissues with shorter turnover time of critical cell).

Week 7

Modification of Cell and Tissue Radiosensitivity

Physical, chemical and biologic factors present at the time of irradiation can affect the radio responsiveness of a cell population or tissue. In general these effects are greater for low LET radiations. Radiosensitizers decrease the shoulder and radioprotectors increase the shoulder on the survival curve.

Physical factors

LET

Irradiation of the same biologic system with radiations of different LET's will provoke a different biologic response

RBE relates quality (LET) of radiation to biologic response

The greater density of ionization with higher LET radiations leads to greater efficiency in injuring the cellular targets

Initial portion ("shoulder region") of survival curve is effected the most

RBE consequently is greater for doses given in this shoulder region (typical doses for clinical radiotherapy)
Cells with large shoulders will manifest a higher RBE with higher LET radiation compared to cells with smaller shoulders on their survival curves

Dose Rate

Low dose rates are less efficient in producing cellular damage than high dose rates (range of greatest effect is 0.01 to 1 Gy/min.)

It is hypothesized that lower dose rates allow for repair of radiation damage between target hits

High LET radiations do not exhibit a dose rate effect
Cells with large shoulders on their survival curve show a greater dose rate effect than those with small shoulders

Chemical factors

Radiosensitizers

Oxygen effect

Oxygen enhances radiation sensitivity

Oxygen administered simultaneously is much more effective than oxygen given before or after radiation

In the presence of oxygen more targets are damaged per given dose of radiation

Hypotheses of oxygen effect

Enhances the formation and effectiveness of radiation induced free radicals

Prevents the repair of radiation damage

Oxygen enhancement ratio: OER

The OER is between 2 to 1 and 3 to 1 for mammalian cells with low LET radiations

Greater for higher fractional doses of radiation

Lower for higher LET radiations (1.5 to 1)

Oxygen mimicking chemicals

Misonidazole

Halogenated pyrimidines

BUDR and IUDR

Replace thymidine in DNA rendering it more susceptible to radiation damage and decreasing ability to repair the damage

Chemotherapy agents

Alter distribution of cells in the cell cycle

Arrest in mitosis

Paclitaxel (Taxol)

Arrest at G_1-S phase border

Fluoropyrimidines

5-FU

Hydroxyurea

Inhibit DNA repair

Cisplatin

Radiation Protectors

Chemicals which if present at the time of radiation reduced the biologic damage of the radiation

Dose reduction factor (DRF)

Most effective with low LET radiations with little effect for high LET radiations

Hypotheses of mechanism of action

Absorb the radiation produced free radicals

Transferring a hydrogen atom to radiation ionized molecules and thus neutralizing the radiation effect

Sulhydryls

WR-2721

Biologic factors

Cell cycle

$M > G_2 > G_1 > S$

Cytokines

HGF (hepatocyte growth factor) and IL-11 (Interleukin 11) are radioprotective (in animal model) for bone marrow stem cells

Sublethal radiation damage repair

Fractionated radiation is less lethal than an equivalent dose given in a single fraction; the greater the time between fractions the greater this effect

The protective effect of fractionation against long term damage to normal tissues reaches a maximum after a 6 hour delay between fractions.

Week 8

Radiation Effects on Organs; Tolerance

Tolerance is the dose beyond which the probability of organ damage increases rapidly

$TD_{5/5}$ and $TD_{5/50}$

Cell depletion whether due to reproductive failure or interphase (apoptotic) death is the initial event that leads to organ pathology. The visible effects seen after radiation to an organ are not unique to radiation but may be seen with other types of trauma.

Definition of Radiation Effects

Acute Effects

Due to depletion of parenchymal cells

May occur at a variable period of time after radiation due to the turnover kinetics of the target cells

Skin & esophagus versus lung example

Basal cells versus type 2 pneumocytes

May be reversible or progress to chronic effects dependent on the degree of injury (radiation dose) and proliferative potential of the target cell within the parenchyma

Chronic Effects

Due either to progressive depletion of parenchymal cells (secondary chronic effect) or to depletion of nonparenchymal cells such as the stroma or vasculature (primary chronic effect)

May be seen years after radiation administered

Generally progressive and irreversible

Healing from Radiation Injury

Types of healing

Regeneration

- **Replacement of the depleted cells with the same cell type**
- **Responsible for reversibility of acute effects**
- **If an organ can regenerate depleted parenchymal cells then the chronic effects of radiation are due to nonparenchymal cell injury (primary chronic effect)**

Repair

- **Replacement of the depleted parenchymal cell with another cell type ("scar")**
- **The chronic effects can be a combination of secondary and primary types.**

Necrosis

When neither regeneration nor repair occur.

Influences on healing

Dose

- **Regeneration can be seen after low, moderate and high doses**
- **Repair generally seen after moderate to high doses**

Organ

- **Acutely responding organs more commonly heal by regeneration unless the dose is very high**
  - Skin, mucous membranes, bone marrow, small intestine
- **Late responding organs typically heal by repair as they have little regenerative capacity**
  - Lung, kidney

Volume

- **The larger the volume irradiated, the lower the tolerance**

Fractionation of radiation exposure

The more fractionated a course of radiotherapy the higher the tolerance dose

General Organ Effects

Hematopoietic system

Bone marrow

- **Stem cells most sensitive**
  - Erythroblasts>myeloblasts>megakaryocytes
- **Distribution of red marrow in adults**
  - Ribs, end of long bones, vertebrae, sternum and skull

Circulating blood

- **Generally resistant except for lymphocytes (? stem cells)**
- **Chromosomal changes may be seen at low doses**

Skin

Mature surface cells are insensitive, immature basal cells are sensitive

- **Acute effects: inflammation, erythema, dry desquamation, moist desquamation**
- **Chronic effects: atrophy, fibrosis, pigmentary changes, ulceration, necrosis, cancer**
- **Both volume and fraction size dependent**
- Von Essen

Accessory structures

- **Hair follicles sensitive → epilation**
- **Sebaceous and sweat glands relatively insensitive**

Digestive system

Sensitivity varies for the different organs

- **Small intestine>stomach>colon>esophagus>pharynx**
- Dose range 45 Gy to 75 Gy fractionated
- **Acute effects: inflammation, shortening of villi (small intestine)**
- **Chronic effects: atrophy, ulceration, fibrosis, stricture, obstruction, hemorrhage, perforation**

Reproductive System

Female

- **Intermediate follicles more sensitive than mature follicles > small follicles**
- **Dose > 6.25 Gy will cause sterility though dose needed decreases with age; induces menopause**
- **Potential chromosomal effects**

Male

- **Spermatogonia the target cell which is depleted with radiation**
- **Dose > 5 to 6 Gy will cause sterility but not impotence**
- **Potential chromosomal effects**

Eye

Lens

- **Cataracts seen after doses as low as 2 Gy, in almost all patients after fractionated doses of 12 Gy**

Retina

- **Progressive visual loss after 50 Gy**

Cardiovascular System

Vasculature

- **Endothelial cell occlusion and thrombosis with consequent hypoxia and malnutrition of the tissue**
- **Petechial hemorrhages, telangiectasia, vessel sclerosis**

Heart

- **EKG changes seen at low doses, pericarditis and pancarditis seen at higher ($\geq$ 40 Gy) doses**

Bone and Cartilage

Radiation can damage the parenchymal regenerating cells (osteoblasts and chondroblasts) and the blood vessels supplying the bone

In children growth and development may be affected

Liver

Liver cells have the capacity to regenerate. Radiation injury to the liver is a generally a chronic effect due to vascular changes (veno-occlusive disease, which is also seen after high dose chemotherapy such as for bone marrow transplant)

Respiratory System

Radiation pneumonitis is a delayed acute effect which is generally transitory; chronic changes may develop after fractionated doses of > 25 Gy and can be fatal if substantial portions of both lungs are irradiated.

Strong volume and dose fractionation effects

Urinary System

Kidneys

Radiation causes a loss of tubules primarily rather than glomeruli; severe effects seen after doses > 25 Gy

Bladder

Similar effects as seen for digestive system though can probably tolerate somewhat higher doses

Central Nervous System

Brain

Nervous system cells relatively radioresistant (non-dividing, differentiated cells)

Acute effects thought secondary to radiation effect on glial cells

Chronic effects thought secondary to radiation effects on vasculature; seen at doses > 50 Gy fractionated

Volume and fraction size dependent

Spinal Cord

Similar considerations as for the brain; threshold dose between 45 and 50 Gy

Cervical and thoracic cord more sensitive than lumbar

Week 9

Radiation effects on the embryo and fetus

The embryo and fetus are more sensitive to the effects of ionizing radiation than is the organism at any other period of life. The fetal stage is less sensitive than the embryonic stage and the older the fetus the higher the dose of radiation necessary to produce an effect. Doses as low as 0.1 Gy can be damaging if received during sensitive phases of development, particularly the first 6 weeks of pregnancy.

The stages of gestation

Embryo

Preimplantation: conception to day 10

Organogenesis: day 10 to 42

Fetus

Day 42 to 270

Three general effects

Lethality

Prenatal death

Due to exposure during preimplantation and organogenesis

Neonatal death

Due to exposure during organogenesis

Congenital abnormalities

Due predominantly to exposure during organogenesis, particularly days 23 to 37

CNS is organ the most effected, followed by musculoskeletal

Late effects occurring after birth

Due predominantly to exposure during fetal life

Functional disorders (sterility, mental retardation, stunted growth) and cancers (especially leukemia) are seen

How pregnant humans are exposed to radiation

Diagnostic and therapeutic radiations

Occupational exposure

Accidental exposure

Atomic bomb survivors

Adult Whole Body Irradiation

Definition: Radiation exposure from external penetrating ionizing radiation occurring over a period of minutes to the whole body.

Decreased survival time is the main effect: expressed as $LD_{50/30}$ or $LD_{50/60}$, the dose that is lethal to 50% of the population in 30 or 60 days.

As the dose increases both the number of survivors and the length of survival decreases

Stages of whole body radiation syndrome

Prodromal → Latent → Manifest illness (syndrome)

Duration of these stages is dose dependent being shorter for higher doses

Whole body radiation syndromes

Bone Marrow (2 to 10 Gy)

Lower threshold about 2 Gy, death due to infection and hemorrhage

Can be salvaged with bone marrow transplantation (21/50 @ Chernobyl survived after transplantation)

Gastrointestinal (10 to 50 Gy)

Symptoms seen as low as 6 Gy; death due to infection, dehydration and electrolyte imbalance

Only 3 of 22 Chernobyl victims survived after receiving > 6 Gy; none of those receiving more than 10 Gy survived. Intestinal mucosa was unable to regenerate after dose of 10 Gy.

CNS Syndrome (> 50 Gy)

Symptoms as low as 20 Gy, fatal within 2 to 3 days with doses > 50 Gy; death due to combination of inflammation and secondary edema with increased intracranial pressure

Late effects of radiation: somatic and genetic

Late effects of radiation are those that appear years after exposure. These effects are insidious and may be difficult to distinguish from effects from other toxins. Somatic effects occur in the exposed individual; genetic effects occur in succeeding generations. Late effects occur in cells which "retain a memory" of the radiation exposure and are an "all or nothing" effect, i.e. the cell either transforms into a malignant one or not. This transformation can occur at extremely low doses, with little or no threshold, though the probability of it occurring increases with increasing dose. (Analogy with pregnancy)

Somatic effects

Carcinogenesis

Linear-quadratic model for estimating risk

Animal data suggest an increasing risk as dose increases to a point then risk decreases (sterilization)

Doses as low as 0.25 Gy may be carcinogenic; the latency from exposure ranges from 5 to 30 years. This latent period—particularly for solid tumors—is not necessarily a fixed time period but radiation induced cancers typically occur at the time in life when spontaneous cancers of the same type occur

Cancers seen in humans

Leukemia—typically seen 5 to 12 years post exposure

AML and CML in adults (occupational exposure—Curie's, atomic bomb), ALL in children (atomic bomb)

Solid tumors—typically seen 15 to 30 years post exposure

Thyroid (inappropriate use of radiation, atomic bomb), breast (diagnostic x-ray exposure, inappropriate use of radiation, atomic bomb), lung (miners), skin (occupational exposure), bone (radium watch dial painters)

Mechanism of radiation carcinogenesis

Radiation induced mutations

Radiation induced chromosomal translocations allowing expression of normally suppressed oncogenes (favored currently)

Radiotherapy and secondary malignancies

Difficult to accurately estimate the risk of secondary malignancies due to radiotherapy; perhaps causes 5% of second malignancies

Non-specific life shortening

Controversial, now thought not to be an effect of radiation exposure. Earlier deaths probably due to increase in cancer deaths.

Genetic effects

Radiation is a mutagen which can increase the spontaneous background mutation rate (estimated to range from 6 to 10%). Radiation does not cause any unique mutations. The estimated dose of radiation which will double the spontaneous mutation rate is 156 rem.

Radiation induced mutations are recessive-may not be exhibited for many generations

A linear relationship exists between dose and radiation induced mutations

A dose rate effect is noted in mammals, i.e. there may be some repair with low dose rate exposures

Males are more sensitive than females, particularly at low dose rates

Allowing time between exposure and conception reduced the risk of a genetic effect being expressed. Again perhaps some repair process at work. 6 months is the elapsed time suggested in humans

Week 10

Fractionation

Total delivered dose of radiation is administered in multiple fractions over a protracted period of time

The total dose, the size of the fractions, the number of fractions and the time over which the treatment are given are determined by both the tumor and the tolerance of the surrounding normal tissue.

A higher total dose is necessary to produce the same degree of biologic damage when the dose is fractionated than when it is given as a single dose

Generally, with a smaller fractional dose a higher total dose has to be administered to achieve the same effect

The four "R's" of radiotherapy

Redistribution

Redistribution between fractions of surviving cells into sensitive phases of the cell cycle (cells in G_2M are $\approx$ 5 times more sensitive than S phase cells)

Generally only occurs in tumors and rapidly proliferating normal tissues (e.g. skin, gastrointestinal tract and marrow)

Has little effect on late responding normal tissues because the cells in these tissues divide slowly (e.g. kidney and spinal cord)

Large proportion of these cells are probably in G_0 which is relatively resistant to small doses of radiation

Reoxygenation

Reoxygenation between fractions of hypoxic cells (hypoxic cells are two to three times more resistant to radiation than well oxygenated cells)

Has little effect on normal tissues (which are generally well oxygenated) and thus should selectively increase tumor cell kill thereby improving the therapeutic ratio

Regeneration

Regeneration between fractions of depopulated tumor and normal tissues

Generally seen only with rapidly proliferating normal tissues and tumors. Thus has both desirable (repopulation of normal tissues thereby improving tolerance) and undesirable (repopulation of tumor cells) effects

Repair

Repair between fractions by cells of sublethal and potentially lethal damage

Occurs in both rapidly and slowly proliferating normal tissues and in tumors

Normal tissues

Late responding (slowly proliferating) normal tissues have a broader shoulder on the cell survival curve which correlates with increased ability to repair small doses of radiation compared to early responding (more highly proliferative) normal tissues.

Linear quadratic model of cell survival curve

Surviving Fraction = $\alpha D + \beta D^2$ where D is dose

α May represent single hit killing

β May represent interaction of multiple sublethal lesions

The ratio α/β differs for different types of cells and is larger for cells with a "narrow shoulder" on the survival curve (early responding tissues)

Tumor tissues

Tumors react to radiation more like early responding normal tissues than late responding normal tissues (depopulation of actively dividing cells). α/β ratios should be high though none measured to date

Summary of fractionation effects

Fraction size is the dominant factor in determining late normal tissue effects; overall treatment time has little impact

Both fraction size and overall treatment time determine the effect on acutely responding normal tissues and on tumors

Thus prolonging overall time will spare early responding tissues but not late responding tissues; decreasing fraction size will spare both early responding and late responding tissues but the late ones more

Multiple fractions daily

Hyperfractionation

More than one fraction per day of a decreased dose per fraction (typically 60% of standard daily fraction dose) given over the same time as a standard course and with a higher total dose.

Goal is to spare late responding tissues by decreasing the fraction size

In clinical trials of head and neck cancers the acute effects were more severe with reduced late effects

Accelerated fractionation

Two standard size fractions given per day with the same total dose administered but in about half the time

Goal is to increase tumor cell kill by reducing the overall treatment time

In clinical trials severity of acute tissue reactions are limiting; late effects appear equivalent

Concomitant boost

Two standard size fractions per day with second fraction being given to smaller boost field without a time break

Isoeffect formulae

Nominal standard dose (NSD)

Total Dose = $NSD^{T^{\circ}11N^{\circ}24}$: Related an isoeffect dose to the total dose administered, the number of fractions and time over which administered

Now not utilized as did not accurately predict late responding tissue effects

Assumed that the capacity to repair sublethal damage is the same for all normal and malignant cells

Assumed that the effect of fractionation is the same for all normal tissues

Linear quadratic (α/β) model

Biologically effective dose: E/□ =nd (1+d/ (□/ß)) where n= # fractions, d=dose per fraction

□/ß assumed as 3 Gy for late responding tissues and 10 Gy for early responding tissues.

Recognizes the differences between the fractionation responses of acute and late responding tissues along with the effect of changing the fraction size

Week 11

Goal of Radiotherapy

To deliver a sufficiently high dose of radiation to sterilize the tumor cells while minimizing damage to the surrounding normal tissue. The result is a cure with sufficient normal tissue repair to allow for viability and functionality.

With radiation given to only a small portion of the body, doses in excess of whole body tolerance can be given.

When radiation passes through normal tissue or tumor tissue its probability of interacting with each is the same.

The amount of radiation used to treat most malignant tumors is limited by the tolerance of the surrounding normal tissue.

Therapeutic ratio: ratio of dose to cause a normal tissue complication and dose to control a tumor. Goal is to have >1.

Teletherapy

Most common form of radiotherapy; given via an external machine with one or more beams directed to the target volume.

Brachytherapy

Historically given as continuous low to moderate dose rates

Balance repair and proliferation during irradiation (decrease cytotoxicity) with continuous irradiation during the cell cycle treating cells cycling out of resistant phases (increase cytotoxicity)

High Dose Rate brachytherapy loses the advantage of continuous low dose rate radiation but takes advantage of geometric proximity to deliver higher dose to tumor than normal tissues

Tumor Radiobiology

Composition of tumors

Parenchymal compartment

Group 1: Well oxygenated, viable, actively proliferating (P-cells)
Group 2: Well oxygenated, viable, not proliferating (Q-cells)
Group 3: Hypoxic, viable cells (also Q-cells)
Group 4: Anoxic and necrotic, not viable

Stromal compartment

Blood and lymph vessels, connective and nerve tissue

Tumor growth (doubling time)

Tumor doubling (median for human tumors ≈ 60 days) is a balance of three major competing factors:

Cell cycle time (ranges from 1 to 5 days)
Growth fraction: the proportion of tumor cells that are actively proliferating (varies from ≈ 0.9 for lymphomas to ≈ 0.06 for adenocarcinomas)
Cell loss: loss of tumor cells from malnutrition (oxygen and other nutrients), apoptosis, immunologic attack, metastasis and exfoliation (averages ≈ 50%, being higher for tumors with higher growth fractions)

Radiosensitivity and Radiocurability

Tumors vary in their sensitivity to radiation. Sensitivity correlates reasonably well with the shape of the initial portion of the survival curve (D_q), not with the terminal part (D_o). Thus it may be differences in the repair capabilities of individual tumor cells that may determine tumor response.

In-vitro assays of human tumors
In-vitro assays of normal tissues

Alternate radiation modalities

Neutrons
Two biologic advantages of neutrons
Relatively oxygen independent
Less sublethal damage repair potential
RBE for neutrons greater for late responding than for early responding normal tissues
RBE of neutrons increases with decrease in dose per fraction
Neutrons most effective for slow growing tumors
Salivary gland, sarcomas and prostate

Boron neutron capture therapy

The principle is to deliver boron selectively to tumor tissue and then irradiate with neutrons of appropriate energy (epithermal). The boron "captures" neutrons and produces α particles—high LET and short range—thereby selectively damaging the tumor cells.

Protons
Radiobiologically virtually identical to x-rays
Have a dose distribution advantage: Bragg peak
Limited applications where such a dose distribution is an advantage

Heavy ions and pions
Radiobiologic advantage
Relatively oxygen independent
Less sublethal damage repair
Also have dose distribution advantage similar to protons
No trials have shown any clinical advantage yet; limited availability

Intraoperative radiotherapy

Large single doses given to exposed cancer while normal tissues have been temporarily moved out of the way

Total Body Irradiation

Utilized for bone marrow cancers, e.g. leukemia, in preparation for bone marrow transplantation
Best given at lowish dose rates and fractionated—in order to spare the lung which is the major toxicity limiting organ

Week 12

Integration of Radiotherapy with other Cancer Treatment Modalities

The cure of cancer requires both local and regional control and sterilization of any actual or potential disseminated disease. Combined modality therapy addresses these requirements while working to improve the therapeutic ratio, specifically preserving functional and anatomical integrity.

Principles of combining radiotherapy with surgery

The combination of radiotherapy and surgery is utilized in many disease sites to optimize local and regional control of disease.
e.g. rectal cancer, head and neck cancers, lung cancer, locally advanced breast cancer and soft tissue sarcomas

The combination of radiotherapy and surgery is utilized to improve the functional outcome in disease sites where one alone might be sufficient to control the disease but leave the patient impaired.
e.g. breast conservation for early stage breast cancer and limb preservation for soft tissue sarcomas

The incidence of complications is frequently increased with the use of two modalities but this can be minimized by careful treatment planning and delivery. The use of combined treatments should be applied to situations where the improved cancer outcome outweighs the increase in morbidity

Causes of loco-regional failure after properly executed surgery
Extent of tumor preoperatively (both primary tumor and nodes)
Margins

Causes of loco-regional failure after properly planned and delivered radiotherapy
Large size tumor and unsuspected extent of regional spread
Dose limitations imposed by adjacent normal tissues
Principles of careful treatment planning and shrinking field technique
Inherently radio-insensitive tumor (melanoma, hypernephroma)

Concluding principle: surgery must remove gross disease and radiotherapy must be delivered to the volume at risk in an adequate dose to sterilize microscopic disease

Preoperative versus postoperative radiotherapy

A number of advantages and disadvantages exist for both preoperative and postoperative radiotherapy and the sequence used for a given site at a given institution is largely based on historical development.

General guidelines on technical factors
The dose of radiation utilized postoperatively (50 - 65 Gy) is generally higher than that used preoperatively (45-50 Gy)
Postoperative radiotherapy should begin as soon as surgical wound healing is complete, generally 3 to 4 weeks. After full dose preoperative radiotherapy surgery should be done no sooner than 4 weeks post radiotherapy and probably no later than 7 weeks post radiotherapy. After short course lower dose preoperative radiotherapy surgery can be done within a week or two.
The volume of radiotherapy should encompass both the primary tumor site and regional lymphatics for both pre and post operative radiotherapy. For post operative radiotherapy generally the entire surgical field, scars and drain sites should be encompassed. Consequently the volume of irradiated tissue is generally larger with post operative radiotherapy.

Principles of combining radiotherapy and chemotherapy

The combination of radiotherapy and chemotherapy is utilized to improve local tumor control (e.g. lung and esophageal cancers), decrease the dose and/or need for radiotherapy

(e.g. pediatric cancers), to improve distant disease and overall survival (e.g. locally advanced breast and small cell lung cancers) and to improve functional outcome (e.g. anal and larynx cancers)

How radiotherapy and chemotherapy interact
Improved radiation killing through reoxygenation from chemotherapy induced tumor shrinkage
Chemotherapy enhancement of radiation cell sterilization (decrease D_0)
Chemotherapy inhibition of sublethal and potentially lethal radiation damage repair (decrease D_q)
Differential effectiveness of the two agents on cells in different portions of the cell cycle and "recruitment" of cells into sensitive phases
Improved drug delivery by radiation induced vascular dilatation
Decreased radiation toxicity by decreasing the volumes that need to be irradiated and the doses that need to be used.

Radiotherapy and chemotherapy may be given:
Sequentially: one followed by the other
Sandwiched: part of one followed by all the other then completion of the first
Concurrently: the two given together on the same days
Alternating: part of one followed by part of the other followed part of the first followed by part of the second, etc.

Principles of combined radiotherapy and chemotherapy
Spatial cooperation
Radiotherapy for local tumor and chemotherapy for systemic disease
Independence of toxicity
Organ tolerances to both agents has to be considered in designing combined regimens
Enhancement of tumor response
Chemotherapy can increase the effectiveness of radiotherapy on cells and vice-versa
Radioprotection
Some chemotherapy drugs may help protect normal tissues from radiation effects

Toxicity of combined radiotherapy and chemotherapy
Increased acute effects, especially on rapidly cycling cells (bone marrow, skin, mucosa, GI tract)
Increased late effects on late responding tissues (brain, lung, heart)
Second malignancies

Chemical Modifiers in Radiotherapy

Drugs that are not classically considered chemotherapy agents may be used to improve the therapeutic ratio of radiotherapy i.e. selectively sensitize the tumor or protect normal tissues.

Radiosensitizers
Drugs which increase the lethal effects of radiation when given in conjunction with it.
Hypoxic cell sensitizers
Given on the rationale that the presence of hypoxic cells limits the curability of cancers by radiation

Misonidazole

Of marginal benefit with dose limiting toxicity of peripheral neuropathy

New sensitizers in trials

SR2508 and RO03-8799

Less toxic than misonidazole and thus can deliver higher doses with probably greater beneficial effect

Halogenated pyrimidines

The structural analogs to thymidine, IUDR and BUDR, if present at the time of cell division may be incorporated into DNA rendering it more susceptible to radiation induced effects. The mechanism is thought to be an increase in free radical induction with radiation. The more rapidly cycling the cells, the more likely to be effected.

Glutathione modification

Glutathione is a radiation free radical scavenger present in cells. Some tumors have particularly high levels and providing a drug which inhibits its production may radiosensitize.

Radioprotectors

Drugs which decrease the effect of radiation on dose limiting normal tissues

WR-2721

Only radioprotective drug tested extensively in humans. May have a 10 to 20% protection factor, has dose limiting toxicity of hypotension and there is concern about potential tumor protection.

Week 13

Diagnostic Radiology; Radiation Protection and Population Effects of Radiation

Three general sources of ionizing radiations to humans

Unperturbed natural sources (e.g. radon)

Enhanced natural sources (e.g. high altitude jet travel)

Man made sources (e.g. diagnostic radiology)

The risks of low level radiation exposure are primarily stochastic (occurring randomly with increasing probability as exposure increases and not exhibiting a threshold)

Somatic, particularly carcinogenesis

Risk estimated by effective dose, which is the dose received weighted by the sensitivity of the particular organ receiving that dose

Genetic

Risk estimated by genetically significant dose, an average of the genetic effects over the whole population of childbearing age

Embryo and fetus

Special situation with risk for both somatic and genetic effects

Some functional effects from radiation exposure (e.g. mental retardation and growth retardation are deterministic rather than stochastic

Risks to patients from diagnostic radiology

Balance the risk with the benefit

Cancer: perhaps 1000 induced cases per year (compared with 1 million occurring spontaneously)

Thyroid, breast, salivary glands, leukemia

Genetic mutations: perhaps 3600 induced genetic disorders per year (compared with 368,000 occurring naturally)

The estimated genetically significant dose to the population from diagnostic radiology is 20 to 30 mrem; this compares with the estimated doubling dose for mutations of 100 rem and natural background radiation of 300 mrem (USA)

Use gonadal shields

Embryo and fetus

The embryo and fetus are very sensitive to radiation with doses as low as 0.1Gy damaging. Abortion frequently recommended if embryo receives this dose (1st 6 weeks of pregnancy)

10 day rule: elective radiology procedures should be performed during the 1st ten days of a woman's menstrual cycle

Risks to patients from nuclear medicine

Dose is a function of the physical characteristics of the radionuclide (energy, half life and type of radiation) and its biologic distribution and metabolism.

Cancer: no significant hazard found, possibly as many as 400 of the 1 million cancers that are diagnosed annually

^{131}I treatment of hyperthyroidism does not appear to cause either leukemia or thyroid cancer

Genetic: no significant burden expected

Genetically significant dose only 0.3 mrem

Embryo and fetus

No clear evidence of any damage though ^{131}I can cross placenta and concentrate in fetal thyroid and thus this therapy is contraindicated in pregnant patients

Occupational exposures

Maximum permissible dose: 5 rem in one year

Cumulative lifetime exposure should not exceed 1 rem times age in years

For pregnant worker the limit for the fetus is a total of 0.5 rem with no more .05 rem/month

Exposure is to be kept as low As Low As Reasonably Achievable (ALARA)

R-4/30/2010

Clinical Brachytherapy Physics

Duration: 3 hours per week x 8 = 24 hours

Description: Clinical Brachytherapy - Topics I – X, *Prostate Brachytherapy* Topics V – IX, AAMD Curriculum Guidelines v.2. Student will be given hands on opportunity for HDR planning.

I. Introduction/Units of Measurement

A. Historical perspective
B. Units used
   1. Traditional
   2. S.I. System
   3. Conversion
C. Symbols commonly used

II. Radioactive Sources

A. Common sources and their clinical use
   1. Radium-226 (Ra^{226})
   2. Cesium-137 (Cs^{137})
   3. Co^{60}
   4. Iridium-192 (Ir^{192})
   5. Gold-198 (Au^{98})
   6. Strontium-89 (Sr^{89})
   7. Iodine-125 (I^{125})
   8. Samarium-153 (Sm^{153})
   9. Palladium-103 (Pd^{103})
   10. Iodine-131 (I^{131})
   11. Strontium-90 (Sr^{90})
B. Physical properties
   1. Source specific, covering:
      a. Type of emission
      b. Exposure rate constant Γ
      c. Half life
      d. Source construction
      e. Photon energy
      f. Source specification
      g. HVL
      h. Average life
C. Clinical significance
   1. Hazards
   2. Advantages and disadvantages

III. Calibration

A. Source strength
   1. Concepts and definitions (NCRP)
   2. Activity
   3. Exposure rate
   4. Equivalent mass
   5. Apparent activity
   6. Air Kerma strength

B. Exposure rate calibration
   1. National Institute of Standards and Technology (NIST) Standards
   2. Traceability to NIST/AAPM – Accredited Dosimetry Calibration Laboratory (ADCL)

C. Methods
   1. Open air measurement
   2. Well-type ion chamber measurements
   3. Factors used in determination

IV. Treatment Planning/Clinical Dose Calculation

A. Objectives

B. Dose calculation systems
   1. Dose specification
   2. Distribution rules
   3. Tables
   4. Calculations
   5. Advantages and disadvantages
   6. Limitations

C. Manchester System
   1. Planar
   2. Two-plane
   3. Volume

D. Quimby/Paris/Memorial/Computer modeling

E. Pre-planning techniques
   1. Activity determination
   2. Source distribution

F. Post-implant planning
   1. Dose analysis
   2. Volume analysis

V. Implantation Techniques

A. Types
   1. Temporary
   2. Permanent
   3. Pre-loaded
   4. Afterloaded

5. Remote afterload

B. Applicators
C. Interstitial implants
D. Intracavitary implants (GYN)
    1. Historical perspective
    2. Milligram-hours (mg-hr) specification
    3. Determination
    4. Reference point determination
    5. Manchester vs. ICRU
    6. Clinical significance
E. Intercavitary
    1. Endobronchial
    2. Rectal
    3. Evolving techniques (intravascular)

VI. Implant Localization / Verification

A. Radiographic
    1. Projection
    2. Magnification
    3. Positioning
    4. Planar determination
B. Commonly used localization methods and considerations
    1. Orthogonal films
    2. Stereo-shift
    3. 3-Field technique
    4. CT Imaging

VII. High Dose Rate (HDR) Brachytherapy

A. Equipment
    1. Dose delivery system
    2. Applicators
    3. Mechanics of operation
B. Calculation
    1. Source localization
    2. Dwell position input
    3. Optimization / normalization
    4. Dose analysis

VIII. Prostate and Brachytherapy

A. Basic anatomy of the prostate
B. Protocol
C. Structures and tissue tolerance – LDR Brachytherapy – Permanent Seed Implants

D. I-125 vs. Pd-103
E. Recommended prescription dose guidelines
F. Current dosimetry methods
G. Seed distribution philosophies and techniques
H. N**omogram** approaches
I. Pre-planning and post-planning
J. HDR for prostate Brachytherapy

R – 4/30/2010

Medical Dosimetry Program **Class of 2010** **Clinical Assignment**

Clinical Time Sheet

Clinical Site: **Stony Brook University Medical Center - SUNY @ Stony Brook**

Attendance for the month of : **December 2008**

SAMPLE

Name: _____

		Time In:		**Time Out:**		**Student Signature**	**Supervisor/Instructor Signature**
Week 1	**Date**						
Monday	Dec. 1						
Tuesday	Dec. 2						
Wednesday	Dec. 3						
Thursday	Dec. 4						
Friday	Dec. 5						
Week 2							
Monday	Dec. 8						
Tuesday	Dec. 9						
Wednesday	Dec. 10						
Thursday	Dec. 11						
Friday	Dec. 12						
Week 3							
Monday	Dec. 15						
Tuesday	Dec. 16						
Wednesday	Dec. 17						
Thursday	Dec. 18						
Friday	Dec. 19						
Week 4							
Monday	Dec. 22						
Tuesday	Dec. 23						
Wednesday	Dec. 24						
Thursday	Dec. 25					HOLIDAY - CLOSED	
Friday	Dec. 26					Winter Break	
Week 5							
Monday	Dec. 29					W B	
Tuesday	Dec. 30					I R	
Wednesday	Dec. 31					N E	
Thursday						T A	
Friday						E K	
						R	
Chief Dosimetrist's Signature							

R – 5-28-08

Medical Dosimetry Program **Class of 2010** **Clinical Assignment**

Clinical Time Sheet

Clinical Site: **Stony Brook University Medical Center - SUNY @ Stony Brook**

Attendance for the month of : **December 2008**

SAMPLE

Name: _____

		Time In:		**Time Out:**		**Student Signature**	**Supervisor/Instructor Signature**
Week 1	**Date**						
Monday	Dec. 1						
Tuesday	Dec. 2						
Wednesday	Dec. 3						
Thursday	Dec. 4						
Friday	Dec. 5						
Week 2							
Monday	Dec. 8						
Tuesday	Dec. 9						
Wednesday	Dec. 10						
Thursday	Dec. 11						
Friday	Dec. 12						
Week 3							
Monday	Dec. 15						
Tuesday	Dec. 16						
Wednesday	Dec. 17						
Thursday	Dec. 18						
Friday	Dec. 19						
Week 4							
Monday	Dec. 22						
Tuesday	Dec. 23						
Wednesday	Dec. 24						
Thursday	Dec. 25					HOLIDAY - CLOSED	
Friday	Dec. 26					Winter Break	
Week 5							
Monday	Dec. 29					W B	
Tuesday	Dec. 30					I R	
Wednesday	Dec. 31					N E	
Thursday						T A	
Friday						E K	
						R	
Chief Dosimetrist's Signature							

R – 5-28-08

COMPETENCY FORM

DOSIMETRIST STUDENT TREATMENT PLANNING LOG

MR#	Date	Dosimetrist	Site	Diagnosis	Technique	Machine	Primary Dose	C/D Dose

4/27/09

TREATMENT PLANS/REPORTS

REMINDER: Place copies of all treatment plans in this section.

Attach completed treatment plan report and two manual MU Calculations to each isodose plan

Student Name:_____ Date: _____

Area of Treatment:_____

Clinical Competency Evaluation Form

Please assign each task a score of **E** (exceeds Expectations), **S** (satisfactory), **NI** (Needs improvement), or **U** (unsatisfactory) as well as an overall **P**ass or **F**ail. Please score each competency attempt. Failures must be repeated.

Task	Task Started	Task Finished	Grade
Observes Simulation			
Transfers patient images and loads on planning computer			
Successfully localizes the Iso Ctr/QA			
Chooses optimal Calculation point			
Creates prescription to accommodate wedge options			
Correctly generates plan using appropriate blocks/wedges			
Produces plan calculations to verify MU setting			
Produces and interprets DVH's for indicated organs			
Performs daily checks /calculation: DSS calc			
Manual Calculation performed			
Transfer of data			
Enters correct data in Record and Verify			

Evaluator comments: _____

_____

_____

Grade: _____

R-4/30/2010

Medical Dosimetry Program

Mini Course Grades

Course Name: _____

Instructor: _____

Dates: _____ to _____

Student Name: _____

Grade: _____

After each course, a listing of student grades will be posted on the bulletin board outside room 168.

Instructor's Signature: _____

Date: _____

Instructor: Please fill out reverse side.

Behavioral Objectives Evaluation

Instructor/Evaluator: place X in appropriate box in left column

Student: _____ **Month:**_____

Attendance:

_____ The student has maintained good attendance and calls in at the specified time to notify staff of his/her absence(s).
_____ The student's attendance is marginal but calls in on time when absent.
_____ After repeated warnings the student's attendance remains poor and student continues to call in late to notify staff of absence.

Punctuality:

_____ The student is on time each day and prepared to begin the clinical assignment.
_____ The student makes little effort to arrive on time after a verbal warning.
_____ The student is consistently more than five minutes late and unprepared to begin.

Perseverance:

_____ If the student is not successful in performing an assigned task for the first time, he/she will seek advice as to what they are doing wrong and make a second attempt to succeed without prodding. This student demonstrates initiative.
_____ If the student's first attempt at performing a patient procedure is unsuccessful, the student is reluctant to seek advice on what action is needed to perform the task correctly. It is only after the instructor offers advice, will the student make a second attempt to complete the procedure successfully. This student demonstrates a moderate level of initiative.
_____ Although receiving adequate instruction and supervision, the student becomes discouraged and frustrated when their first attempt at setting-up a patient procedure is unsuccessful. This student does not seek advice and assistance and when the instructor offers advice and/or assistance this student is often unwilling to make a second attempt for fear of failure. This student lacks initiative.

Evaluator's Comments:

_____
_____
_____
_____
_____
_____

_____
Instructor's Signature

R – 5/18/06

Side B

Patient Summary Reports

Patient MR Number: _____

Doctor Name: **Dosimetrist Name:**

Patient Status (include siste and disease:

Diagnosis, Stage, TNM:

Treatment Intent:

Prescription and why?(include machine and energy):

Expectation of disease progression w/ amd w/o Tx(i.e. Patterns of spread and failure):

Any Concurrent therapy:

Expected boosts or C/D:

Field arrangement and why:

Any other techniques considered, why and why not:

Any current, prior or future treatments, overlapping fields:

Target coverage % maximum and minimum:

What normal tissue or critical structures in area:

What are the dose limits and consequences if exceeded?

Observations from Simulation:

Observations from initial set-up/treatment (report any modifications in set-up that differ from plan, any modifications in the RTP plan and how closely did portal film agree with sim films or DRR):