**COURSE INFORMATION SHEET**

<table>
<thead>
<tr>
<th>COURSE TITLE</th>
<th>DEN 111 Dental Radiography</th>
</tr>
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<tbody>
<tr>
<td>SEMESTER</td>
<td>Fall 2007</td>
</tr>
<tr>
<td>PROFESSOR</td>
<td>Nancy Rivaldo</td>
</tr>
<tr>
<td>OFFICE</td>
<td>8-412</td>
</tr>
<tr>
<td>PHONE</td>
<td>292.2763</td>
</tr>
<tr>
<td>EMAIL</td>
<td><a href="mailto:nrivaldo@monroecc.edu">nrivaldo@monroecc.edu</a></td>
</tr>
<tr>
<td>OFFICE HOURS</td>
<td>TBA and by appointment</td>
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</table>

**REQUIRED TEXT:**


**FILM:**

Film to be used during DEN 111 Laboratory must be purchased by the student. Information regarding the film will be discussed with the students during DEN 111 Lecture.

**PEN FLASHLIGHT:**

To be used for slide quizzes and final. May be purchased in Book Store. It is suggested that you should have two flashlights with you during an exam.

**RELATED PROGRAM COMPETENCIES:** (bolded portions apply to this course)

1. The graduate will be able to apply a professional code of ethics in all endeavors using the highest professional knowledge and *ethical principles* within the context of the New York State Dental Hygiene Practice Act.
2. The graduate will **collect, analyze**, and record data on the general, oral, and health status of patients using methods consistent with medical and legal principles.

**COURSE DESCRIPTION:**

An introduction to physics and biology of radiation; radiation hygiene; equipment and materials; film exposure and processing, technique and chemistry. Intra-oral projections only.

**COURSE OBJECTIVES:**

Upon successful completion of this course, the student should be able to:

- apply the basic principles and concepts of radiation
- identify the component parts and workings of the dental x-ray machine and the production of x-rays
- identify factors affecting the quality of the x-ray beam and the radiographic image
- identify the effects of ionizing radiation on living tissues
- identify radiation protection procedures for the operator and the patient
- demonstrate intraoral techniques for bitewings and periapicals
- demonstrate the basic steps for taking panoramic surveys
- demonstrate proper film processing and handling

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**Respect** for self and others in words and deeds  
**Responsibility** for self, community, and the need for acceptanceability
SPECIFIC COMPETENCIES:
Will be listed under each lecture/laboratory topic.

GRADES AND EVALUATION FOR LECTURE AND LAB:

Both lecture and lab must each be passed. Please see your Student Manual for passing grade.

In the event that a student obtains less than a grade of "C" in either the lecture portion or the lab portion, the final grade recorded for the course shall be a "C-", "D+", "D", "D-" or "F" grade. **This final grade will be determined by the portion of the course that was less than a "C"**: Failure to complete x-ray requirements will result in an "F" for the course.

   Note - Students responsible for:
   1. Making up missed quizzes within 3 days after the quiz is given. Students must notify the instructor. Automatic "0" if not made up in 3 days. Each student is only allowed one make-up quiz.
   2. Following the reading assignments in the texts and completing assignments.
   3. Promptly completing any assigned reading packages and/or slides.

**LECTURE: 70% of final grade**
1. Quiz and test averages 60%
   (minus one (-1) will be deducted for each incorrect spelling of dental terminology)
2. Final examination (comprehensive) 40%
   *Quizzes, tests and exams will cover textbook material, class lecture and discussions, and laboratory activities, including slides and videos.*

**LAB: 30% of final grade**
1. CRS 20%
   a. 1 CRS - BSA technique using snap-a-ray
   b. 1 CRS - parallel technique
2. 6 sets BWX 20%
   a. 1 set vertical (tab)
   b. 5 sets tab (two ungraded)
3. 1 Panoramic evaluation pass/fail
   See last page of outline for panoramic evaluation form
4. Lab Final 60%
   (Last week of classes during regularly scheduled lab time)

All students must register for the web-enhanced coursespace DEN 111 – Dental Radiography. The web-enhanced learning environment coincides with the on-campus classroom activities. Each module is sequenced with the classroom topics. See Reading Assignments on hard copy course outline. Each module includes the classroom Powerpoint presentation. Please read the Course Information Document: Course Learning Activities to better utilize each document in each module. You may print any document or material you so desire. Course Space website: [http://sln.suny.edu/commons](http://sln.suny.edu/commons) - scroll and register for COURSESPACE, **NOT** SLN.
Powerpoint presentations and the Basic Dental Radiograph video (used in lab): are both available through E-Reserve. Following this path:

- MCC Web Page
- Quick Link
- Libraries
- Access E-Reserves
- E-Reserves
- Dental Hygiene
- Rivaldo
- Go/Search
- DEN 111
- Password
- ACCEPT

**Assignment**

- Create private folder -- Due date September 10, 2007
- Send a message to me, stating four-character code you would like me to use when posting grades. The code may be 4 numbers or 4 letters.
- Completed assignment adds one point to Quiz 1 grade. Incomplete assignment (failure to do by 09/10/07) results in one point deduction from Quiz 1 grade.
- Questions regarding assignment will be answered via private folder only.
- Students without a home computer have access to computers in the Electronic Learning Center - Room 11-106.
- The assignment MUST be completed through your private folder on course space.
- Assignments completed through personal e-mail accounts will not be accepted.

**Absence Policy**

Each student will be allowed (2) two hours of absence from lecture, with or without written excuse. After a student surpasses the (2) two hours, (2) two points will be deducted from the final lecture grade for each additional hour of absence. A student who is more than 15 minutes late for class is considered absent.

**Incident Report**

An Incident Report will be issued by the faculty to a student:

a. Whose professionalism/teamwork does not meet the expected standards for the course;

b. Who fails to implement safe care as evidenced by lack of knowledge or physical skill, poor judgment, omission of errors.

NOTE: All incident reports are handled the same as they are in clinic.
Student E-mail

I will use lecture, lab and e-mail as vehicles of communication for general class announcements. Please note that I check my account once a day, Monday through Friday, during scheduled class days. I do not check my account on a regular basis during a College recess. I will not use e-mail at this time for assignments.

In the event of instructor illness, security officers will post an official "Notice of Cancellation" on the classroom door prior to start of class. Exams scheduled for such a day, or assignments due on such a day, will be considered rescheduled for the next scheduled meeting of class.

DENTAL STUDIES LEARNING CENTER

Activities will be provided in the Dental Studies Learning Center. These activities will include slides, videos, radiographic manuals and exercises designed to enhance your understanding of the lecture and laboratory subject matter.

PREGNANT STUDENTS

According to New York State Sanitary Code, Chapter 1 - Part 16:53, dated April 18, 2001, the student/employee has the right to decide whether to declare her pregnancy or not. This written declaration must be voluntary and can be withdrawn at any time.

Student will need Radiographic Procedure section of Student Manual for Policies & Procedures.

Please refer to the MCC Catalog and Dental Studies Radiography Manual for the following:

** Attendance & Withdrawal Policies
** Academic Honesty
* Grading System
* Radiography Procedures
* Forms Used
* Learning Center
* Emergency Closings

* Refer to your Radiography Manual for Dental Studies Grading System. A minimum grade of "C" is required in all Dental Hygiene courses for continuation in the Dental Hygiene Program.

** Note: Students wishing to withdraw should consult the Student Handbook and follow MCC policy. Simply stopping attendance in class usually results in an "F". Health issues should be discussed with MCC Health Services in consideration of a withdrawal for health reasons. Financial aid issues and/or status relative to withdrawal should be discussed with Financial Aid Services.
STATEMENT ON ACADEMIC HONESTY

The College's policy on Academic Honesty also applies to online courses. You may review that policy in the MCC Catalog & Student Handbook. Should you not have a copy of that catalog, you may contact our Admissions Office at 585.292.2200 and they will send you one, or you may request one from the college's web site at www.monroecc.edu.

LEARNING CENTER REFERRAL STATEMENT

MCC has a number of Learning Centers at Brighton (for example, Accounting, Math, Nursing, Psychology, Writing, the Electronic Learning Center, Interdisciplinary Programs, which includes Foreign Languages, etc.) and at Damon (the Integrated Learning Center).

Learning Centers are staffed with instructional personnel and may be equipped with computers to assist students. It is recommended that students use these Learning Centers to get additional assistance with concepts learned in the classroom.

Information is available online or a brochure with details is available at:

Brighton - the Brighton Learning Center, Bldg. 11 Room 106
Damon - the Damon Integrated Learning Center in 4-130 and the Student Services Office on the fifth floor

EMERGENCY CLOSINGS

If the College is closed due to inclement weather or some other emergency, all Rochester area radio and televisions stations will be notified no later than 5:30 a.m. In addition, the homepage on the MCC website (www.monroecc.edu) will display a message indicating the college is closed. Please do not call the College to avoid overloading the telephone lines.

Class cancellation information is available daily on the web or through the telephone. Simply go to the MCC website (www.monroecc.edu) and under the "Quick Links" window on the homepage, click on "Class Cancellations". Additionally, class cancellation information is available by dialing 585.292.2066, press "1" for the Brighton Campus and "2" for the Damon Campus. If possible, please use the web as there could be delays in the voice recordings based on the number of cancellations.
<table>
<thead>
<tr>
<th>LECTURE/SLIDE TOPICS</th>
<th>READING ASSIGNMENTS</th>
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<tbody>
<tr>
<td><strong>TOPIC I</strong></td>
<td></td>
</tr>
<tr>
<td>Dental X-ray Films and Film Holders</td>
<td></td>
</tr>
<tr>
<td>1. Differentiate between the various types of x-ray films and their specific uses.</td>
<td>Chapter 7 supplement pp.16-18 Course Space-Module 2</td>
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<tr>
<td>2. Describe the 3 basic types of intraoral film.</td>
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<tr>
<td>3. List each part of the dental film packet and identify the purpose of each part.</td>
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<td>4. Describe emulsion and state its purpose.</td>
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<td>5. Describe what is meant by film speed.</td>
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<tr>
<td><strong>TOPIC II</strong></td>
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<tr>
<td>Bisecting Angle Technique</td>
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<tr>
<td>1. Describe the principles of bisecting angle technique.</td>
<td>Chapter 12, 13 Supplement p.21 Manual p. 11-20 Course Space-Module 3</td>
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<tr>
<td>2. Identify correct film placement.</td>
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<tr>
<td>3. Identify correct horizontal - vertical angulation.</td>
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<td>4. Identify the errors that result from incorrect angulation.</td>
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<tr>
<td>5. Identify the correct point of entry.</td>
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<tr>
<td><strong>TOPIC III</strong></td>
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<tr>
<td>Paralleling Technique</td>
<td></td>
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<tr>
<td>1. Describe the principles of paralleling technique</td>
<td>Chapter 12, 13 Supplement p. 21 Manual p. 11, 12, 19-20 Course Space-Module 3</td>
</tr>
<tr>
<td>2. Identify correct film placement.</td>
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<td>3. Identify correct horizontal and vertical angulation.</td>
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<tr>
<td><strong>TOPIC IV</strong></td>
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<tr>
<td>The X-Ray Tube and Its Components and Basic X-ray Machine Operation</td>
<td></td>
</tr>
<tr>
<td>1. Name the basic parts of an x-ray unit.</td>
<td>Chapter 2, 3 supplement pp. 23-27 Course Space-Module 4</td>
</tr>
<tr>
<td>2. List the elements of the x-ray tube needed to generate x-rays.</td>
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<td>3. Identify the high voltage potential.</td>
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<td>4. List the source of electrons in the tube.</td>
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<td>5. Describe the thermionic emission effect.</td>
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<tr>
<td>6. Discuss the production of x-rays within the x-ray tube.</td>
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<tr>
<td>7. Discuss controlling factors to be considered during exposure: a) kilovoltage b) milliamperes c) time of exposure</td>
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<td>8. Discuss filtration and collimation.</td>
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<td>9. Discuss quality and quantity of x-rays.</td>
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<tr>
<td><strong>TOPIC V</strong></td>
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<tr>
<td>Bisection of Angle and Paralleling Techniques and Principles of Shadow Casting</td>
<td></td>
</tr>
<tr>
<td>1. Define CRS and list films used for adult, child and edentulous patients.</td>
<td>Chapter 12, 13, plus pp. 37-38, 138-146 supplement pp. 19-20 Course Space-Module 5</td>
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<tr>
<td>2. Discuss the advantages and disadvantages of bisection of angle technique.</td>
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<td>3. Discuss the advantages and disadvantages of the paralleling technique.</td>
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<td>4. List the 5 basic principles of shadow casting.</td>
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<tr>
<td>5. Discuss the principles of shadow casting related to the paralleling</td>
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<tr>
<td>LECTURE/SLIDE TOPICS</td>
<td>READING ASSIGNMENTS</td>
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<td>and bisection of the angle techniques</td>
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<tr>
<td><strong>TOPIC VI</strong></td>
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<tr>
<td><strong>Bitewings</strong></td>
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<tr>
<td>1. List the 3 primary purposes of bitewings.</td>
<td>Chapter 14</td>
</tr>
<tr>
<td>2. Describe the principles of tab technique.</td>
<td>Manual p. 17-18</td>
</tr>
<tr>
<td>3. Describe the vertical bitewing and indications for use.</td>
<td>Course Space-Module 3</td>
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<tr>
<td>4. Identify correct film placement.</td>
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<tr>
<td>5. Identify correct horizontal and vertical angulation for both horizontal and</td>
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<tr>
<td>vertical bitewings.</td>
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<tr>
<td>6. Identify the errors that result from incorrect angulation.</td>
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<td>7. Identify the point of entry.</td>
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<tr>
<td><strong>TOPIC VII</strong></td>
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<tr>
<td><strong>Chemistry of Development and Fixation and Mounting</strong></td>
<td></td>
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<tr>
<td>1. Identify the latent image and how it becomes visible.</td>
<td>Course Space-Module 6</td>
</tr>
<tr>
<td>2. State the function and composition of the developer.</td>
<td>Chapter 8</td>
</tr>
<tr>
<td>3. List the components of the fixing bath and the action of each.</td>
<td>supplement pp. 28-29</td>
</tr>
<tr>
<td>4. List the correct procedure for film processing.</td>
<td>Manual-Infection Control</td>
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<tr>
<td>5. Define the proper maintenance of the darkroom.</td>
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<tr>
<td>6. Identify the convex side of the dot on the film as correlating with the</td>
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<td>buccal side of the film.</td>
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<td>7. Using an x-ray viewer, identify various anatomical landmarks to help place the</td>
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<td>film in the appropriate mount window.</td>
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<tr>
<td>8. Mount a complete radiographic survey &amp; properly label the mount.</td>
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<td>9. Mount a horizontal bitewing survey and properly label the mount.</td>
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<tr>
<td>10. Mount a vertical bitewing survey and properly label the mount.</td>
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<tr>
<td><strong>TOPIC VIII</strong></td>
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<tr>
<td><strong>Common Exposure Errors</strong></td>
<td>Chapter 4, 16</td>
</tr>
<tr>
<td>1. List the qualities of acceptable radiographs.</td>
<td>supplement pp. 30-38</td>
</tr>
<tr>
<td>2. Differentiate between contrast, density, sharpness, detail and distortion.</td>
<td>Course Space-Module 7</td>
</tr>
<tr>
<td>3. Define &quot;subject contrast&quot; and identify what it is dependent on.</td>
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<tr>
<td>4. Identify errors caused by incorrect film positioning.</td>
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<td>5. Differentiate between foreshortening and elongation and explain why these</td>
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<td>distortions occur.</td>
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<td>6. Identify the cause of cone-cutting.</td>
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<tr>
<td><strong>TOPIC IX</strong></td>
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<tr>
<td><strong>Common Processing Errors</strong></td>
<td>Chapter 16</td>
</tr>
<tr>
<td>1. Identify errors caused by faulty processing techniques.</td>
<td>supplement pp. 30-38</td>
</tr>
<tr>
<td>2. Explain processing procedures used to develop films (traditional manual</td>
<td>Course Space-Module 7</td>
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<td>processing and automatic processing).</td>
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<tr>
<td>3. Demonstrate proper maintenance of the dental darkroom.</td>
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<tr>
<td><strong>TOPIC X</strong></td>
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<tr>
<td><strong>Basic Principles of X-Ray Generation</strong></td>
<td>Chapter 1, 2, 3, 4 (review)</td>
</tr>
<tr>
<td>1. Recognize Wilhelm K. Roentgen's discovery and contributions to the field of</td>
<td>supplement pp. 39-43</td>
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<tr>
<td>radiology.</td>
<td>Vocabulary</td>
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<tr>
<td>2. Explain characteristics and properties of Roentgen rays</td>
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<td>3. Explain the concept of matter and its relationship to x-ray production.</td>
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<td>4. Identify electricity as the primary source of energy for the x-ray machine.</td>
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<td>5. Define voltage, ampere and transformer.</td>
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<td>6. Discuss electromagnetic radiations.</td>
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<td>7. Define and discuss the quality of the x-ray beam.</td>
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<tr>
<td>8. Define and discuss the quantity of the x-ray beam.</td>
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<tr>
<td>LECTURE/SLIDE TOPICS</td>
<td>READING ASSIGNMENTS</td>
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<tr>
<td><strong>9.</strong> Define the inverse square law and explain its relationship and significance to the intensity of the x-ray beam.</td>
<td><strong>10.</strong> Identify 3 factors which determine the extent to which x-rays are absorbed by a material.</td>
</tr>
<tr>
<td>1. Understand the relationship between radiation and the environment.</td>
<td>2. Identify the biologic effects of radiation.</td>
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<tr>
<td>3. Identify the ways to measure radiation.</td>
<td>4. Discuss the effects of background radiation.</td>
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<tr>
<td>5. Explain the necessary procedures to protect the patient, the operator, and the environs.</td>
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<tr>
<td>1. Identify the permissible exposure allowed.</td>
<td>2. List the exposure units used to describe the quantity of radiation.</td>
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<tr>
<td>3. List the sensitivity of cells and the factors which affect the sensitivity.</td>
<td>4. Compute the maximum permissible dose to whole body radiation.</td>
</tr>
<tr>
<td><strong>TOPIC XIII</strong> Radiation Safety and Hygiene</td>
<td>Chapter 5, 6 supplement pp. 13-15, 44 Course Space-Module 10</td>
</tr>
<tr>
<td>1. Identify health hazards of x-rays in relation to dental personnel and patients.</td>
<td>2. List and explain the necessity of safety procedures concerning dental radiation equipment.</td>
</tr>
<tr>
<td>3. List the preventive devices that are used for patients and personnel.</td>
<td>4. Explain the ALARA concept</td>
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<tr>
<td>5. List image-recording factors that can be controlled by the office personnel.</td>
<td>6. List criteria for acceptable complete radiographic survey.</td>
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<tr>
<td>7. List common questions and answers the patient may have regarding -rays.</td>
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</table>

**LAST WEEK OF SEMESTER - FINAL EXAMINATION** The final will be comprehensive and include both lecture and laboratory material.
**LABS**

**Lab I**

Orientation
1. Demonstrate proper care of Dexter.
2. Demonstrate proper care in the maintenance of radiology equipment and rooms.
3. Identify the various sizes of film packets and where they are used.
4. Identify the contents of a film packet and purpose of each part.
5. Describe emulsion.
6. List the preventive measures used in protection of the patient and operator.

**Lab II**

Basic Science of Dental Radiology
1. Identify the basic parts of the x-ray unit.
2. Demonstrate the ability to expose and process a film to produce an image.

**Lab III**

Introduction to Periapical Radiography
1. Describe the basic principle used in bisection of the angle technique.
2. Demonstrate the basic principle used in paralleling technique.
3. Demonstrate the ability to place, expose and process diagnostically acceptable periapicals using the bi-section of the angle technique and the paralleling technique.

**Lab IV**

Introduction to Panoramic Radiography
1. Introduction to Panoramic Radiography
2. Begin practice patient positioning for completing a panoramic survey
3. Continuation of Lab III

**Lab V**

Mounting of Periapical Radiographs
1. Identify normal anatomical landmarks as seen on radiographs.
2. Identify the basic parts of the x-ray tube.
3. Continuation of placing, exposing and processing PAX on Dexter.
4. Continuation of patient positioning for panoramic survey.
**Lab VI**

*Introduction to Bite-wing Radiographs*

1. List the 3 main purposes of bite-wing radiographs.
2. Understand the basic principles used in taking bite-wing radiographs.
3. Demonstrate the ability to correctly place film for bite-wings on Dexter.
4. Demonstrate on Dexter the ability to place, expose and process diagnostically acceptable bite-wing radiographs utilizing tab technique.
5. Understand and demonstrate proper mounting of bite-wing radiographs.

**Lab VII**

*Introduction to Vertical Bite-wing Techniques and Mounting of Bite-wings*

1. Demonstrate the ability to place, expose and process diagnostically acceptable vertical bite-wings utilizing tab techniques on Dexter.

**Lab VIII**

*Evaluation of Periapical Technique*

1. Identify the most common pitfalls in taking periapical radiographs and how to correct such errors.
2. Continuation of placing, exposing and processing PAX on Dexter.
3. Continuation of patient positioning for panoramic survey.

**Lab IX**

*Bite-wing Technique Evaluation*

1. Identify the most common pitfalls in taking bite-wing radiographs and how to correct such errors.
2. Continuation and practical application of BWX application.

**Lab X**

*Evaluation of Processing Techniques*

1. Identify the most common pitfalls in processing radiographs and how to correct such errors.
2. Continuation of placing, exposing and processing x-rays on Dexter.
3. Continuation of patient positioning for panoramic survey.
Lab XI-XV

Continuation of CRS & BW Requirements

1. Demonstrate the ability to place, expose and process diagnostically acceptable periapicals using the paralleling technique.
2. Last week of classes will be Lab Final.

Upon completion of lab requirements the following exercises will be assigned.

1. Periapicals using Rinn positioning devices
2. Rectangular Collimation
3. Partners-place film and aiming devices on student partner-DO NOT EXPOSE

NOTE: LAB FINAL WILL BE THE LAST WEEK OF CLASSES DURING YOUR REGULARLY SCHEDULED LAB TIME.

LAB ATTENDANCE

Each student will be permitted two (2) lab absences with or without excuses. For each lab absence that surpasses the (2) two allowable absences, (2) two points will be deducted from the final lab grade. A student who is more than 15 minutes late for lab is considered absent.

Due to maximum lab enrollment it is impossible to make-up a missed lab.
<table>
<thead>
<tr>
<th>LAB #</th>
<th>X-RAYS DUE</th>
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<tbody>
<tr>
<td>LAB I</td>
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<td>LAB II</td>
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<td>LAB III</td>
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<td>LAB IV</td>
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<td>LAB V</td>
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<tr>
<td>LAB VI</td>
<td>Anterior exposures (BSA &amp; parallel)</td>
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<td>Lab VII</td>
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<td>Lab VIII</td>
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<td>Lab IX</td>
<td></td>
</tr>
<tr>
<td>Lab X</td>
<td>CRS-BSA</td>
</tr>
<tr>
<td></td>
<td>CRS-parallel</td>
</tr>
<tr>
<td>Lab XI</td>
<td>1 set BWX (ungraded)</td>
</tr>
<tr>
<td>Lab XII</td>
<td>1 set BWX (ungraded)</td>
</tr>
<tr>
<td>Lab XIII</td>
<td>2 sets BWX - horizontal (graded)</td>
</tr>
<tr>
<td>Lab XIV</td>
<td>1 set BWX-horizontal (graded)</td>
</tr>
<tr>
<td></td>
<td>1 set BWX - vertical (graded)</td>
</tr>
<tr>
<td>Lab XV</td>
<td>Lab Final - Panoramic evaluation completed (last week of classes)</td>
</tr>
</tbody>
</table>
BASIC RADIATION PROTECTION

All types of radiation can affect the body. It is imperative, therefore, that certain criteria be followed in protection of the patient and the operator. When referring to biologic response is referring to radiation injury caused by ionization. The cumulative effects of radiation are an important consideration to both the operator and the patient. Practicing good radiation safety is essential for protection of both the operator and the patient. In Dental Studies the ALARA (As Low As Reasonably Achievable) principle is employed.

Relative to pregnant students or students who become pregnant during your course of study in Dental Studies please note: According to New York State Sanitary Code, Chapter 1—Part 16:53, dated April 18, 2001, the student/employee has the right to decide whether or not to declare her pregnancy or not. This written declaration must be voluntary and can be withdrawn at any time.

Relative to patients it is mandatory to inquire about the possibility of pregnancy. DO NOT expose any radiographs if the patient is pregnant.

The following questions and answers provide a brief summary of considerations you must be thinking about as you begin your course of study in dental radiography. Each of these concepts and principles will be integrated and elaborated upon during the course of study.

1. What is meant by the biologic effects of radiation?

**ANSWER:** X-rays can affect living tissue. X-rays are capable of detaching and removing certain subatomic electric charges from the atoms that make up the molecules of tissue. This is referred to as ionization. Ionization creates an electrical imbalance within normally stable cells. During ionization, the balance of structure is altered and a cell may be damaged or destroyed. Therefore, when we refer to biologic response we are referring to injury from radiation caused by ionization.

2. What is meant by the term cumulative effect?

**ANSWER:** Cumulative effect of radiation relates to the fact that whenever a tissue is exposed to radiation there is some injury which is followed by repair. Because the repair of every cell is not complete some residual injury remains. Each exposure to radiation adds to this residual damage. These increments of residual damage are the cumulative effect.

3. What do we mean by ALARA (As Low As Reasonably Achievable)?

**ANSWER:** You should use the least amount of radiation to get the best diagnostic quality.
4. What procedures may be employed to protect the patient and the operator when taking x-rays?

**ANSWER:** Following general safe practice guidelines will provide the necessary protection needed when taking x-rays. You, as the operator, should always avoid the primary beam. That means you will never hold the film, PID (position indicating device) or the tubehead during an exposure. When taking an x-ray you will either remain behind appropriate shielding and/or stand a minimum of 6 feet from the source of radiation. To ensure your safety you should wear a film badge or dosimeter to monitor any unnecessary exposure.

To protect the patient first and foremost you never take an x-ray without a good reason. The dentist is the only person that can authorize dental x-rays. Before any x-rays are taken a thorough medical, dental and radiographic history, including frequency of x-rays, must be completed on the patient. If the decision is made to take an x-ray the fastest and most appropriate film for the best diagnosis must be employed. Before the intraoral exposure is taken the patient must be shielded with a lead apron and thyroid collar. You must use good film exposure and processing techniques so you do not have to retake the exposure and subject the patient to more radiation. Lastly, employing increased tube-patient distance, the use of film holding devices, open-ended PID and proper filtration and collimation will further help protect the patient during an exposure.

The above is a brief summary of basic radiation protection and will be continually discussed and employed in all x-ray procedures throughout your course of study in the Dental Studies Program.
The cumulative effects of radiation is an important consideration to both the operator and the patient. Practicing good radiation hygiene is essential for protection of both the operator and the patient. **ALARA** = As Low As Reasonably Achievable

| Protection of the Operator | Protection of the Patient |
INTRODUCTION
As a dental hygienist, you will be frequently called upon to perform radiographic services. Radiographs provide a means of studying underlying structures not visible to the eye. A basic knowledge of radiation physics and chemistry plus a high degree of skill and radiation safety techniques are required in order to produce diagnostically acceptable dental radiographs.

DENTAL X-RAY FILMS
The films that will be used in Dental Radiography I are termed intraoral films which mean the films are placed within the oral cavity. Intraoral film is of the non-screen type (exposed directly to the x-rays). There is an emulsion coated on both sides of the film's base. The emulsion consists of silver halide (or bromide) embedded in gelatin.

Note: Nonscreen = film emulsion exposed directly to the x-rays -- direct imaging
Screen = exposure of film by light

The film Packet - The film is wrapped in a light tight water-proof packet. The film is further protected by a black paper sheath and backed by a thin sheet of lead foil. Lead backing/foil will absorb most of the x-rays that have passed through the object and film. This helps protect the patient by reducing exposure of tissues behind the film and prevents "back scatter". An embossed dot at one corner of the film packet identifies the "tube side" of the film. If the film is placed "backwards", the pattern stamped on the lead foil will appear on the processed film.

FILM SELECTION
Insight (F speed) film is used because it requires less exposure time. Intraoral film sizes range from size 0 to size 4. In Dental Radiology I, size 2 film will be used.

"Pedo" film for BWX or PAX
Used for child (BWX or PAX) and anteriors of some adults (PAX)
FILM SELECTION

Adult film for BWX or PAX
Used on young child for occlusal

Adult-BWX only

Occlusal – Adult or Child

Three basic intraoral exposures:
1. Periapical - detailed examination of entire tooth and surrounding structures. (Diagnostically acceptable periapical has both the crown and root completely visible and at least 3 millimeters of normal and/or pathology surrounding the apices.)

2. Interproximal (bitewing) - used to examine crowns of the teeth, alveolar crests and proximal surfaces (the coronal portions of both maxillary and mandibular teeth are on the same film).

3. Occlusal - buccal/lingual view.

   X-ray Film -
   
   • thin, rigid, but flexible
   • clear or blue-tinted base
   • base covered with photographic emulsion on both sides

   Emulsion -
   
   • x-ray sensitive crystals of silver halide (bromide) embedded in gelatin
   • crystal size determines film speed
   • larger the grains, the faster and more sensitive the film and the poorer the definition
   • film sensitivity = A-F - higher the letter the faster and less radiation needed
   • gelatin keeps silver halide grains evenly suspended over the base
PRINCIPLES OF SHADOW CASTING

1. The source of radiation should be as small as possible.
   a. yields more parallel x-rays
   b. reduces penumbra
   c. enhances image sharpness

2. The distance from the radiation source to the object should be as long as possible.
   a. results in use of more parallel x-rays
   b. decreases image magnification
   c. enhances image sharpness
   d. prevents adumbration

3. The distance from the object to the recording surface on which the shadow is cast should be as short as possible.
   a. decreases image magnification
   b. enhances image sharpness

4. Object and film should be in a parallel relationship.
   a. reduces image distortion

5. Radiation should strike both object and film at right angles.
   a. reduces image distortion

Umbra = actual shadow

Penumbra
- relates to definition
- produced by size of focal spot
- also influenced by:
  - source-object distance
  - object-film distance

Adumbration
- relates to distortion (magnification)
RULES OF SHADOW CASTING EXERCISE

Armamentarium: penlight, fork and paper

Directions:

1. Project the image of the fork on a paper on which the actual size of the fork has been traced.

2. Vary the distance and angles at which the light strikes the fork and observe how you can produce a variety of images.

RULES OF SHADOW CASTING

1. The distance from the source of radiation to the object should be as long as possible. (Move the fork [object] closer to the light [radiation source] and the image will become enlarged.

2. The distance from the object to the recording surface should be as short as possible. (Move the fork farther from the paper [recording surface] and the image becomes enlarged.)

Varying the angles of light changes the image = distortion.
### COMPARISON OF BISECTING ANGLE AND PARALLELING TECHNIQUE

<table>
<thead>
<tr>
<th>BISECTING</th>
<th>PARALLELING</th>
</tr>
</thead>
</table>
| 1. Film placement:  
  a. Film as close to teeth as possible  
  b. Creates an angle with the teeth  
  c. Object-film distance is as close as possible  
  2. Target-film distance is 8 inches  
  3. Vertical angle-central rays are directed perpendicular to imaginary bisector of the angle between the tooth and film  
  4. Horizontal angle-central ray directed through open embrasures  
  5. Seat patient upright | 1. Film placement:  
  a. Film placed farther from teeth  
  b. Placed parallel to long axis of teeth  
  c. Increased object-film distance  
  2. Increased target-film distance to 16 inches  
  3. Vertical angle-central rays are directed perpendicular to the long axis of the teeth and the film  
  4. Horizontal angle-central ray directed through open embrasures  
  5. Patient can be seated in any position |

<table>
<thead>
<tr>
<th>ADVANTAGES</th>
<th>ADVANTAGES</th>
</tr>
</thead>
</table>
| 1. Can be used in most situations | 1. Takes less time to direct rays.  
  2. Parallel rays eliminates magnification.  
  3. Less distortion since film plan remains flat  
  4. Longer target-film distance produces sharpness of detail  
  5. Parallel rays of vertical angle produces a more accurate dimensional reproduction of the teeth |

<table>
<thead>
<tr>
<th>DISADVANTAGES</th>
<th>DISADVANTAGES</th>
</tr>
</thead>
</table>
| 1. Difficult to estimate bisector at which rays are directed  
  2. Divergence of rays causes magnification  
  3. Distorted images due to bending of film  
  4. Shorter target-film distance causes diffusion of details  
  5. Elongation and foreshortening occur due to inaccurate vertical angels | 1. Anatomical landmarks may interfere with proper film placement |

An x-ray viewer should be used to sort films (right and left, buccal or lingual aspect). Raised dot on film is on buccal side of film. The convex side of the dot should face toward the operator. You are, therefore, looking at the films as if you were facing the patient, and the patient's right side is on your left. Anatomical landmarks are used to identify the maxillary and mandibular arches as well as the right and left. Radiopaque are areas which appear lighter in radiographs whereas radiolucent are areas which appear darker.
PARTS OF THE X-RAY MACHINE:

ARM
HEAD
YOKE
PID = Position Indicating Device (Cone)
Control Panel
- on/off switch
- exposure switch
- kVp and mAs selections

The structure that produces the x-rays is the "tube head" and is situated inside of the head of the x-ray machine. The x-ray tube is a glass enclosure and has a vacuum. Within the vacuum there are two electrodes: ANODE and CATHODE. The electrodes are supplied with a very high voltage electricity (60 - 90 kVp) from a step-up transformer situated in the tubehead.

When a dental x-ray machine is turned on, it is ready to produce x-rays. Turning on the machine completes the filament circuit and heats the tungsten filament. The electrons stay at the filament in what is called the electron cloud. The electrons will be attracted across the tube only when there is a difference in potential, when the potential circuit is completed. This high-voltage circuit is activated by the exposure switch and remains active for the length of time for which a timer is set.
The radiation is produced when the high-speed electrons bombard a tungsten target. The faster the electrons travel across the tube, the more energized and penetrating will be the x-rays produced. The speed of the electrons across the tube is determined by the difference in potential, or kilovoltage.

**Collimation**
- lead diaphragm
- controls size and shape of x-rays
- 2.75 inches

**Filtration**
- total filtration = inherent plus added
- aluminum sheets used to remove or filter out the longer, useless x-rays
- 1.5 mm. aluminum 69 or lower kVp
- 2.5 mm. aluminum 70 or higher kVp
The dental x-ray machine uses electricity to make or produce x-rays. Electrical energy is a flow or current of electrons. Electric current flows from negative to positive.

**Terminology Used:**
1. Voltage

2. Amperage

3. Collimation

4. Anode

5. Cathode

6. Filtration
   a. added
   b. inherent

7. Transformer
   a. step-up
   b. step-down
   c. auto

Three basic elements of an x-ray tube needed to produce x-rays are:
1.
2.
3.
I. Source of electrons
   • tungsten filament at the cathode
   • milliamperage control heats cathode filament and determines number of electrons
   • 1 mA = 1/1000 ampere
   • Ampere = unit of electrical current measurement
   • thermionic emission effects = creation of ions by heat

II. High Voltage potential to accelerate electrons across the tube
   • electric current flows from - to +
   • voltage = electrical potential (pressure)
   • volt = unit of measurement
   • kVp = kilovolt peak control (1,000 volts = 1 kilovolt)
   • kVp regulates electrical potential
   • greater kVp, the greater speed of electrons

III. Target to stop electrons
   • anode is tungsten embedded in copper stem

Time
   • Measured in seconds, fraction of seconds or impulses
   • 60 impulses = 1 second
The following is an FYI:

Seconds/Impulses
- 60 impulses per second
- To determine exposure time in seconds to be changed to impulses multiply the exposure time in seconds by 60
- To determine exposure time in impulses to be changed to seconds divide the number of impulses by 60

mAs, mA and exposure time:
To determine total number of x-rays generated (radiation quantity) use this formula:
    mA x exposure time = mAs
Note—above is exposure time in seconds—If exposure time in impulses then mA x exposure time = mAi

Formula to determine exposure time needed:
mAs/mA = Exposure time in seconds
Or
mAi/mA = Exposure time in impulses

NOTE: 1 IMPULSE = 1/60 SECOND

Formula to determine mA needed:
mA = mAs (mAi)/exposure time

mAs and density
Can obtain radiographs of the same density by using any of the following exposure times and mA setting because their products all equal 10 mAs:

    0.5 sec. at 20 mA = 10 mAs
    1.0 sec. at 10 mA = 10 mAs
    10.0 sec. at 1 mA = 10 mAs

Practice Problem
Exposure factors are 10mA, 0.6 seconds, 90 kvp and 16 inch focal-film distance. mA is increased to 15 and all other factors remain the same. What is the new exposure time needed to maintain the same density as the original radiograph?

Please note: There will be no testing on the formulas.

NR/brl
008:111
12/2004
What circuit regulates speed of electrons?

What circuit regulates the number or quantity of electrons?

What is the thermionic emission effect?

What is the purpose of the focusing cup?

Why is tungsten used as a target material?

Why is tungsten embedded in a copper step?

What is transference energy?

What is the cathode stream?

Define impulse.

What does the total number of x-rays produced depend upon?
CHEMISTRY OF DEVELOPMENT AND FIXATION:

A film that is exposed to x-radiation captures an image that is not visible (latent image). To make the image visible, the film must be processed. When the film is placed in the developer the halide is taken away from the silver. The black metallic silver remaining behind forms the image. The developer solution, therefore, allows the exposed area of the emulsion to be visible. After the film is developed the unexposed silver halide crystals must be removed. The fixer solution will remove the unexposed silver halide crystals and allow light to pass through the film so that the radiographic image can be viewed on a view box.

Steps in processing the latent image into a visible image:

1. Develop 5 minutes
2. Rinse 20 seconds
3. Fix 4 minutes (Processing times for 68°F)
4. Wash 10 minutes
5. Dry thoroughly

Before processing, the temperature and levels of solutions must always be checked. Both the developer and fixer solutions should be stirred. All films should always be opened on a dry counter. Careful handling of the films is a must in order to avoid scratching or bending of the films.

Automatic Processing

A variety of automatic processors are manufactured at this time. Some models, like the one at MCC processes only intraoral films. Others accept films up to 10 inches wide. The processors may produce either a wet or dry film.

During automatic processing the film is "carried" through the developer, fixer and rinse both either on a roller system or film carrier. The transport mechanism requires routine maintenance to insure that it will function properly.

The solutions in some units may be automatically replenished from attached reservoirs. The Phillips processor at MCC requires the operator to manually replenish the solution.

The greatest advantage of the automatic processor is the speed. On the average it takes 4 minutes to produce a dry processed radiograph. Another advantage is that most units have a daylight loader with a built-in safelight eliminating the need for the processor to be in a darkroom.
## TYPICAL DEVELOPER AND FIXER COMPOSITION

### MANUAL X-RAY DEVELOPER (NORMALLY USED AT 68 DEGREES F.)

<table>
<thead>
<tr>
<th>General Function</th>
<th>Chemical</th>
<th>Special Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reducing Agents</td>
<td>ELON</td>
<td>Quickly builds up gray tones in the image</td>
</tr>
<tr>
<td></td>
<td>HYDROQUINONE</td>
<td>Slowly builds up black tones and contrast in the image</td>
</tr>
<tr>
<td>Activator</td>
<td>SODIUM CARBONATE</td>
<td>Swells and softens the emulsion so that the reducing agents may work more effectively. Provides required alkalinity for reducing agents</td>
</tr>
<tr>
<td>Restrainer</td>
<td>POTASSIUM BROMIDE</td>
<td>Restrains the reducing agents from causing fog</td>
</tr>
<tr>
<td>Preservative</td>
<td>SODIUM SULFITE</td>
<td>Prevents rapid oxidation of the developing agents</td>
</tr>
<tr>
<td>Solvent</td>
<td>WATER</td>
<td>Liquid for dissolving chemicals</td>
</tr>
</tbody>
</table>

### AUTOMATIC X-RAY DEVELOPER (NORMALLY USED AT 80-84 DEGREES F.)

<table>
<thead>
<tr>
<th>General Function</th>
<th>Chemical</th>
<th>Special Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reducing Agents</td>
<td>PHENIDONE</td>
<td>Quickly builds up gray tones in the image</td>
</tr>
<tr>
<td></td>
<td>HYDROQUINONE</td>
<td>Slowly builds up black tones and contrast in the image</td>
</tr>
<tr>
<td>Activator</td>
<td>SODIUM CARBONATE</td>
<td>Swells and softens the emulsion so that the reducing agents may work more effectively. Provides required alkalinity for reducing agents</td>
</tr>
<tr>
<td>Hardener</td>
<td>GLUTARALDEHYDE</td>
<td>Controls emulsion swelling to allow better transportation of films through the processor</td>
</tr>
<tr>
<td>Preservative</td>
<td>SODIUM SULFITE</td>
<td>Prevents rapid oxidation of the developing agents</td>
</tr>
<tr>
<td>Solvent</td>
<td>WATER</td>
<td>Liquid for dissolving chemicals</td>
</tr>
</tbody>
</table>

### MANUAL X-RAY FIXER (NORMALLY USED AT 68 DEGREES F.)

<table>
<thead>
<tr>
<th>General Function</th>
<th>Chemical</th>
<th>Special Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fixing Agent</td>
<td>AMMONIUM THIOSULFATE</td>
<td>Clears away the unexposed silver bromide crystals</td>
</tr>
<tr>
<td>Acidifier</td>
<td>ACETIC ACID</td>
<td>Stops development by neutralizing developer; provides required acidity</td>
</tr>
<tr>
<td>Hardener</td>
<td>ALUMINUM CHLORIDE OR POTASSIUM ALUMINUM</td>
<td>Shrinks and hardens the emulsion</td>
</tr>
<tr>
<td>Preservative</td>
<td>SODIUM SULFITE</td>
<td>Maintains chemical balance of the fixer chemicals</td>
</tr>
<tr>
<td>Solvent</td>
<td>WATER</td>
<td>Liquid for dissolving chemicals</td>
</tr>
</tbody>
</table>

### AUTOMATIC X-RAY FIXER (NORMALLY USED AT 80 DEGREES F.)

<table>
<thead>
<tr>
<th>General Function</th>
<th>Chemical</th>
<th>Special Function</th>
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<td>WATER</td>
<td>Liquid for dissolving chemicals</td>
</tr>
</tbody>
</table>
Types of radiographs

In Dental Radiography I the student will learn to place, expose, and process bitewing and periapical radiographs.

Placement of film packet

Proper placement of the film packet is essential. All intraoral film is supplied in packets. The tubeside of the packet is placed toward the teeth (or tube head). The raised dot on the film packet identifies the so-called "tube side". When placing the film packet for periapical radiographs the raised dot should always be placed toward the incisal or occlusal edge. The proper teeth to be recorded are identified on page.

Bitewing radiographs

Show the coronal and cervical portions of both the maxillary and mandibular teeth as well as the alveolar borders of the region on the same film.

Purposes of bitewings:

1.

2.

3.

Periapical radiographs - The periapical radiograph is used primarily to examine the region around the apex of the root of the tooth. The periapical radiograph shows the full crown and full root of the tooth plus normal bone surrounding apices of all teeth or non-normal radiolucency or radiopacity.
A correctly exposed film is essential. The image on the radiograph may be light, dark, blurred, only partially there or no image at all.

Causes of light image -

Causes of dark image -

Causes of blurred image -

Causes of partial image -

Causes of no image -

Errors in technique can render the radiograph difficult or impossible to interpret. Proper placement of film or cone is controlled by the operator.

What is the probable cause and correction for the following placement errors:

1. Absence of apical structures
   
   Probable cause:

   Correction:

2. Absence of coronal structures
   
   Probable cause:

   Correction:
3. Absence of mesial structures
   Probable cause:
   
   Correction:

4. Absence of distal structures
   Probable cause:
   
   Correction:

5. Slanting/diagonal occlusal plane
   Probable cause:
   
   Correction:

6. Cusps appear at different heights and interproximal bones cast above CEJ
   Probable cause:
   
   Correction:
Radiographic quality or diagnostic quality is affected by the following:

Density:

- overall blackening of film
- affected by exposure time, mAs, kVp and developing time (directly proportional)
- factors indirectly proportional include:
  - target-to-film distance
  - patient-object thickness (density)
  - fixing

Contrast:

- visual differences in densities
- short scale contrast = high contrast
  - large differences in densities
  - low kVp
  - caries detection
- long scale contrast = low contrast
  - small differences in densities
  - high kVp
  - beginning pathologies
- subject contrast
- film contrast
**Rules for Changing Contrast and Maintaining the Same Density**

- **To increase contrast** and maintain original density
  1. Decrease original kVp by 15 kVp
  2. Use 2X the original exposure time

- **To decrease contrast** and maintain original density
  1. Increase original kVp by 15 kVp
  2. Use one half the original exposure time

**Factors affecting Radiographic Image**

<table>
<thead>
<tr>
<th>Radiographic Contrast</th>
<th>Sharpness</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subject Contrast</strong></td>
<td><strong>Film Contrast</strong></td>
</tr>
<tr>
<td>Subject</td>
<td>Film type</td>
</tr>
<tr>
<td>kVp</td>
<td>Exposure</td>
</tr>
<tr>
<td>Scattered</td>
<td>Processing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Geometric Factors</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Focal spot size</td>
</tr>
<tr>
<td>Target-film distance</td>
</tr>
<tr>
<td>Object-film distance</td>
</tr>
<tr>
<td>Motion</td>
</tr>
<tr>
<td>Screen thickness</td>
</tr>
<tr>
<td>Screen-film contact</td>
</tr>
</tbody>
</table>

**PLUS**

- crystal size

**Sharpness:**

- detail - used to denote image unsharpness caused by film factors
- definition - used to denote image unsharpness caused by projective geometry

**Distortion:**

- change in the shape of the image as compared to the object
RADIOGRAPHIC QUALITY

- Fog
  - Directly
  - Controlled by KvP -
  - As increase KvP, decrease contrast -
  - KvP is indirectly proportional

- Radiographic Contrast--
  - Indirectly
  - Controlled------

- Radiographic Density
  - Directly------
  - Controlled by mAs
  - SID (Source Image Distance)

- Definition
  - Sharpness
  - Controlled by SID
  - Motion

- Magnification and/or Distortion------
  - Directly
  - Controlled by ---

- Object of film distance
  - Size of focal spot

- Improper alignment of tube
  - Improper location of film
  - Alignment of part of film

SID - Subject-to-Image-Receptor Distance
## FACTORS AFFECTING RADIOGRAPHIC DETAIL  
**DIAGNOSTIC QUALITY**

<table>
<thead>
<tr>
<th>Radiographic Contrast</th>
<th>Film Contrast</th>
<th>Definition</th>
<th>Screen Mottle</th>
<th>Radiographic Mottle Film Graininess</th>
</tr>
</thead>
</table>
| A. Tissues            | A. kVp – photon energy | A. Image Sharpness  
1. Penumbra  
 c. focal spot  
 c. source-object distance  
 c. object-film distance  
 2. Motion  
 c. Tube  
 c. Object (patient)  
 c. Film | A. Type of screen  
1. speed  
2. film-screen contact | A. Film  
1. Grain size  
 c. speed  
 c. development |
| 1. Thickness          |               |            |               |                                    |
| 2. Density            |               |            |               |                                    |
| 3. Chemical composition |               |            |               |                                    |
| 4. Pathologic changes |               |            |               |                                    |
| 5. Age                |               |            |               |                                    |
| B. Photon energy radiation | B. Type of film (speed) | B. Image Enlargement  
1. Object-film distance  
2. Source-object distance | B. Quantum scintillation | B. Radiation type  
1. Light (screen)  
2. X-rays |
| C. Scattered radiation | C. Intensify screens  
1. Screen or direct exposure  
2. Screen contact | C. Image Distortion  
1. CR not directed through center of film  
2. Angle between CR and planes of object and/or film change screen film contact | C. Film type |                                    |
| 1. Photon energy      |               |            |               |                                    |
| 2. Volume of tissue irradiated |               |            |               |                                    |
| 3. Machine design-filtration, collimation, OFD-air gap, alignment of PID and object |               |            |               |                                    |
| D. Use of contrast agents | D. Density | D. Screen-film contact | D. kVp |                                    |
| E. Film processing    | E. Film processing  
1. Developing  
2. Times  
3. Temperature  
4. Agitation | | | |
| F. Fog                | F. Fog  
1. age  
2. radiation  
3. chemical  
4. light | | | |
<table>
<thead>
<tr>
<th>Quality</th>
<th>Direct Controls</th>
<th>Indirect Controls</th>
</tr>
</thead>
</table>
| Radiographic Contrast        | • kVp           | • Films  
• Processing  
• Filter  
• Screen Contact  
• Screens/Nonscreens  
• Contrast Media  
• Anode Heel Effect  
• Pathology  
• Tissue Thickness  
• Atomic composition  
• Specific Gravity  
• Alignment of tube  
• Alignment of object  
• kVp |
| Radiographic Density         | • mAs  
• SID (Source Image Distance) | • Films  
• Processing  
• Filter  
• Screen Contact  
• Screens/Nonscreens  
• Contrast Media  
• Anode Heel Effect  
• Pathology  
• Tissue Thickness  
• Atomic composition  
• Specific Gravity  
• Alignment of tube  
• Alignment of object  
• kVp |
| Definitions/Sharpness        | • Object-film distance  
• Size of focal spot  
• SID  
• Motion-voluntary or involuntary  
• Screen/Nonscreen  
• Screen contact  
• Film |                                                                    |
| Magnification and/or Distortion | • Object-film distance  
• SID | • Improper alignment of tube  
• Improper location of film  
• Alignment of part to film |
| Fog                          | • Film age  
• Light exposure  
• Chemical  
• Compton scatter  
• Radiation | • OFD - Air gap  
• PIDs  
• Diaphragm-collimation  
• Compression  
• Grids (moveable/stationary) |
ERRORS IN TECHNIQUE

1. Elongation -

2. Foreshortening -

3. Overlapping -

4. Double image -

5. Stretched appearance -

6. Bent film -

7. Radiation fog -
PROCESSING AND HANDLING PITFALLS

A correctly exposed film can become a faulty radiograph through processing. To be diagnostically acceptable, a radiograph must be handled and processed correctly. If the image on a radiograph is light, dark, or only partially present the radiograph can be difficult or impossible to interpret.

"Thin" image - difficult to interpret because too light.
Causes of thin image:
1. 
2. 
3. 
4. 
5. 

Dense images - difficult to interpret because too dark.
Causes of dark image:
1. 
2. 
3. 

Partial image - impossible to interpret because entire image not present
Causes of partial image:

Other factors and causes in film processing and handling:
1. Fog -
2. Reticulation -
3. Static electricity -
4. Emulsion scratch/torn emulsion -
5. Air bubbles -
6. Clip lines -
7. Fixer splash -
8. Fixer stain -
9. Faded film/insufficient washing -
10. Fingerprints -
BASIC SCIENCE OF DENTAL RADIOLOGY

X-rays were discovered by Wilhelm Conrad Roentgen in 1895. X-rays, therefore, are also called Roentgen rays and the unit used to measure radiation is called "Roentgen". X-rays which have no mass or weight, are a form of energy and the unit of this energy is called "quanta" (quantum is singular form). X-rays are in the electromagnetic radiation group. What other example of electromagnetic radiation can you list?

Electromagnetic Radiation
- Combination of electric and magnetic energy emitted in the form of rays or waves
- Differences between types of radiation are their wave lengths and frequencies
- Wavelength determined by measuring distance from crest of one wave to crest of next wave

Wave Length

- Frequency is determined by measuring the number of oscillations per second

Low Frequency

High Frequency
Electromagnetic radiations have a wave form pattern and move through space in straight lines.

The distance between two peaks (crests) is called "wavelength". Electromagnetic radiations vary in their wavelengths - some have short wavelengths and some have long wavelengths. In dental x-rays, x-rays with a short wavelength are preferred because x-rays with a shorter wavelength pass through matter easier than x-rays of longer wave-lengths.

Properties of Hard X-rays

Properties of Soft X-rays

Inverse Square Law

Intensity of radiation varies inversely as the square of the distance from its source.

- intensity of the x-rays becomes less with greater distance from the source
- as the distance from the object to the source of radiation is decreased, the x-ray intensity of the object increases
- if increase distance by double loose four times the intensity (if double target-film distance exposure time must be quadrupled)
- if distance reduced by half, the intensity is four times as great
- Formula:

\[
\frac{I_1}{I_2} = \left(\frac{d_2}{d_1}\right)^2
\]

\[
I_1 = \text{intensity of first distance (d 1) from source}
\]

\[
I_2 = \text{intensity of second distance (d 2) from source}
\]

- To calculate exposure time:

\[
\frac{mAs_1}{mAs_2} = \frac{SFD_1^2}{SFD_2^2}
\]

mAs = milliamperage per second (exposure time)

SFD = source film distance

Problems to calculate:

1. The intensity of the x-ray beam is 400 mR at 36 inches. If the distance is doubled what is the mR?

2. The intensity of the x-ray beam is 200 mR at 8 inches. If the SFD is changed to 4 inches what will the be the intensity?

3. 2.5 mAs is used at 8 inches. To maintain the same density at 16 inches, what must be the mAs?
**Half Value Layer**

- measurement of the average beam quality or penetrating quality
- amount of material needed (thickness of an absorber) to reduce the number of x-ray photons (intensity) to one-half
- standard set by federal government
- x-ray beam has HVL of 1.5 mm of aluminum for machines 69 kVp and below, 2.5 mm for 70 kVp and above
- As increase thickness of absorber decrease number of long wavelengths and beam is made up of more shorter wavelengths giving more penetrating quality.

Absorption, scattering and attenuation describe what happens to the x-ray beam when it interacts with matter.

**Absorption** - intensity of beam is reduced as it passes through matter
- extent x-rays absorbed depends on:
  1. wavelength
  2. thickness of material
  3. density of material
  4. atomic number of material

Define radiopaque.

Define radiolucent.

**Scattering** - type of secondary radiation
- there’s a change in direction of photons
- result of interaction

Attenuation = absorption plus scattering

**Ionizing radiation** - ability to create ions
- removing of $e^-$ from atoms creating ion pair
- electrical imbalance
- can cause molecular damage

**Cumulative effect** - radiation injury caused by ionization
- injury followed by repair
- repair of every cell never complete = residual injury
- added increments of residual damage = cumulative
Units of Radiation
- Traditional Units
- System International (SI)

Radiation measurement
- Roentgen, rad, rem, gray & sievert
- milliroentgen (mR), millirad (mrad), millirem (mrem)
- 1 rad = 1000 mrad or 1 mrad = \( \frac{1}{1000} \) rad
- gray (Gy) and sievert (Sv) = 100 rads or 100 rems
- 1R = 1 rad = 1 rem

Exposure or Exposure Rate
- measurement of ionization in air
- units for measuring are Coulomb per Kilogram (c/kg) or Roentgen (R)
- Roentgen measures amount of energy reaching organism

Roentgen
- unit used to measure amount of energy reaching organism
- amount of ionizing radiation being produced by the x-ray machine

Dose or Absorbed Dose
- amount of x-ray energy deposited in tissue
- units for measuring area gray (GY) and rad

RAD
- Radiation Absorbed Dose
- measurement of amount of energy each gram of tissue absorbed

Dose Equivalent
- compares biological effects of various types of radiation
- equal doses of different radiations produce different amounts of biologic damage

RBE
- Relative Biological Effectiveness
- measures damage produced by different types of radiation

LET
- Linear Energy Transfer
- amount of energy transferred to tissue
- higher the LET, the more damaging the biological effect

REM
- Roentgen Equivalent Man
- dose absorbed by total body weight
- overall effects of more than one kind of radiation

MPD
- Maximum Permissible Dose
- Radiation exposure not expected to cause appreciable bodily injury to a person at any given time during life
  - MPD of whole body radiation for occupational is:  5000 mrem (5 rem/50 mSv) per year
  - 3000 mrem (3rem) in 13 weeks or 100 mrem/week

MAD
- Maximum Accumulated Dose
- Maximum accumulated lifetime dose of occupationally exposed workers
- Determined by Formula 5(N-18): \( N = \text{age at last birthday}; \ 18 = \text{legal age for radiation work} \)
  - Example: \( 5(43-18) \)
  - \( 5(25) \)
  - \( 125 \) rem
UNITS OF RADIATION

TRADITIONAL

ROENTGEN (R)

RADIATION (Rad)

RADIATION EQUIVALENT MAN (Rem)

EXPOSURE (Radiation Exposure given to patient)

COULOMBS PER KILOGRAM (C/Kg)

INTERNATIONALE (SI)

ABSORBED DOSE (Amount of energy tissue absorbs)

GRAY (Gy)

DOSE EQUIVALENT (relative biological effect of various types of radiation absorbed in body tissue)

SIEVART (Sv)
RADIOBIOLOGY

All types of radiation can affect the body. It is imperative, therefore, that certain criteria be followed in protection of the patient and the operator. When refer to biologic responses are referring to radiation injury caused by ionization.

Tissue sensitivity or susceptibility

- the more mature a cell is, the more resistant to radiation
- the younger tissues and organs are the greater the radiosensitivity
- the higher the metabolic activity, the higher the radiosensitivity
- the greater the proliferation rate for cells and the growth rate for tissues, the greater the radiosensitivity
- the more differentiated (or specialized in function) a cell is, the more radioresistant it is

Radiosensitive  Radioresponsive  Radioreistant

Somatic = effect of radiation on body cells
Genetic = changes in hereditary material

Factors that determine amount of radiation injury:
1. total dose
2. dose rate
3. area exposed
4. variations in species and individual sensitivity
   a. lethal dose (LD)
      i. LD50-30 = dose required to kill 50% in a 30 day period
      ii. LD50-30 for man approximately 450 rads
5. variations in cell sensitivity
6. age

Sequence of events following exposure to ionizing radiation:

1. latent period
2. period of demonstrable effects
3. recovery period
   a. Acute Radiation Syndrome
      Some cells are more radiosensitive than others.
PANORAMIC RADIOGRAPHY

NAME ___________________________________________

Note: All infection control procedures used for intraoral radiography will be used for panoramic radiography. Upon patient arrival, load cassette in darkroom. Patient medical, dental and personal histories must be completed before exposure. All jewelry, appliances, etc. must be removed.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Performance</th>
<th>Yes</th>
<th>No</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Load cassette. Make sure to hear &quot;click.&quot;</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Turn unit on. Select Adult (A) or Child (C).</td>
<td></td>
<td></td>
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<tr>
<td>3. Input factors needed.</td>
<td></td>
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<tr>
<td>4. Place lead apron on patient. Explain procedure. Lead patient to front of unit facing the mirror and set unit approximately level with patient's height.</td>
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</tr>
<tr>
<td>5. Have patient place chin on chin rest, forehead to forehead rest, bite indentation on bite block, grasping hand holds, standing erect with feet together. Midsagittal plane perpendicular to floor.</td>
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<tr>
<td>7. Horizontal light beam (move control vertically and have patient follow chin rest to determine Frankfort Plane).</td>
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<tr>
<td>8. Vertical light beam (have patient grin broadly while biting and place vertical face light between lateral incisor and canine if occlusion normal).</td>
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<tr>
<td>9. Make sure rotation unit is in start position. Again, make sure on correct setting B A(Adult) C (Child)</td>
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<tr>
<td>10. Instruct patient to close lips, swallow with tongue to roof of mouth and hold for duration of exposure.</td>
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<tr>
<td>11. Activate exposure and observe in operation.</td>
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<td></td>
</tr>
</tbody>
</table>

NR/bh/brl
Outline:111
5/06