Junior Radiology
Goals & Objectives

1. Short Course
2. Overview of radiology and its subspecialties
3. Lots of information
   1. Overwhelming
   2. Advanced
Attend lectures & Listen

1. Attempt to learn at least one new principle
2. Do not worry about the final exam
   1. Written
   2. Practical
3. Pay attention & you will pass with 100%
• Learning Radiology textbook

• http://www.learningradiology.com/
Goals & Objectives

1. Course Evaluation:
   1. Important
   2. We listen to what you want
   3. Please take your time to complete
Radiology

Diagnostic

Therapeutic
"Must See" diagnoses for medical students

1. Pneumoperitoneum: perf. viscus
2. Pyelonephritis “striate”/abscess
3. Cholelithiasis vs. Cholecystitis
4. Appendicitis (CT preferred)
5. Diverticulitis (LLQ pain)
6. Ischemic Colitis can get pneumotosis coli/ PV intrahep air
7. Hemorrhage= Leaking aneurysm
1895: Roentgen discovers X-rays (by accident)

www.xray.hmcc.psu.edu/rci/centennial.htm
What is an X-ray?

- X-rays are very short wavelength electromagnetic radiation. Shorter wavelength, greater energy/greater the ability to penetrate matter.
- X-rays are described as packets of energy called Quanta or **Photons**.
- Photons travel at the speed of light.
- Photon energy measured in **Electron Volts**.
X-ray beam absorption and attenuation

- X-Rays passing through matter become attenuated via absorption and scatter.

- For a given thickness, the greater the physical density (gm/cc) of a material, the greater its ability to absorb or scatter X-Rays.

Lead > Aluminum
More photons strike the film
⇒ film appears **BLACKER**

Fewer photons strike the film
⇒ film appears **whiter**
X-ray beam absorption and attenuation

- X-Rays passing through matter become ATTENUATED via absorption and scatter

- With increasing atomic number comes increasing attenuation by the material
Radiographic Densities

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Metal</td>
<td>Very White</td>
</tr>
<tr>
<td>Bone</td>
<td>White</td>
</tr>
<tr>
<td>Water</td>
<td>Gray</td>
</tr>
<tr>
<td>Fat</td>
<td>Gray-Black</td>
</tr>
<tr>
<td>Air</td>
<td>Black</td>
</tr>
</tbody>
</table>

*Metal is most Radiodense or Radiopaque*

*Air is most Radiolucent*
Hounsfield Unit Scale (CT Attenuation)

- Gas (Air) -1,000 HU
- Fat -100 HU
- Water 0 HU
- Soft tissue +20 to +100 HU
- Bone +1,000 HU
Ionization

An atom which loses an electron is ionized.

Photons having $\geq 15$ electron volts can produce ionization in atoms and molecules.

X-Rays, Gamma Rays, and certain types of UV Radiation are Ionizing Radiation.
LIMITING YOUR EXPOSURE: 

You do the math!

- Doubling your distance from the X-ray tube reduces your exposure by a factor of four.
- Tripling your distance from the X-ray tube reduces your exposure by a factor of nine!
RadTech uses **collimation** and **lead apron** to **reduce exposure**.
Patients undergoing these types of studies are exposed to Ionizing Radiation:

- Radiographs
- Fluoroscopy/Conventional Angiography
- CT
- Nuclear Medicine
Multi-Detector (Helical) CT multiple planes of detectors in the gantry

- Technical innovation allows
  - even faster scanning
  - over a much longer range
  - with even better image quality
- Radiation exposure greater than single-detector CT
- “Total body” CT in trauma pts
**Helical CT**: A volumetric examination

**synonym:**

Tube and table move:
- Tube: circular path
- Table: translocation

*CT computer creates discrete images from this volume of data*
MAIN ADVANTAGES OF CT OVER MRI

- Rapid scan acquisition
- Visualization of cortical bone and soft tissue calcifications
Exposure to Ionizing Radiation causes two types of effects

- **Deterministic Effects**: A minimum *threshold* dose must be attained for the effect to occur. Examples include cataract formation, skin reddening (erythema), and sterility. Also referred to as “non-stochastic” effects.

- **Stochastic Effects**: The effect may (potentially) occur following *any amount* of exposure – there is no threshold. Examples include cancer and genetic defects.
Normal bone scan

mets

Anterior

Posterior

Posterior

Anterior

Diethelm MD Lisa
Nuclear Medicine

- **Photons** emitted by radioisotopes are detected by Sodium Iodide crystals. Brightness of light emitted depends on the energy of the photon.

- **Photodetectors** convert the light into an electronic signal, which a computer converts to diagnostic images........
Nuclear Medicine

- Most imaging modalities detect changes in gross anatomy
- However, most NM exams rely on changes in physiology to detect disease.
- Radionuclides
  - Produce ionizing radiation
  - Administered I.V., orally, SubQ
PACS Training

- **Picture Archiving and Communication System**
- Digital system for storage, retrieval, and display of imaging studies
- ILH is completely filmless = PACS is your only access to your patients’ images
- Therefore, you are encouraged to learn to use PACS
Contrast Media

- Most viscera are of water-density or close to it.
- Contrast media are materials we introduce to better define anatomy and pathologic changes.
Barium enema

www.philips.com/
Main/products/xray/
Assets/images/dose
Wise/urf2_large.jpg
Angiography uses intravenous contrast medium
Iodinated Contrast Reactions

**Mild**  
Warmth, metallic taste, N/V, HA, Dizziness, Tachycardia, sneezing, coughing, erythema,

**Moderate**  
Agitation, bradycardia, hypotension, wheezing, urticaria ("hives"), itching

**Severe**  
Pulm edema, shock, CHF, cardiac arrest, laryngospasm, laryngeal edema, apnea, seizure, coma
Common Indications for IV Contrast in CT

- To visualize **blood vessels**
  (Aortic injury, Abdominal Aortic Aneurysm, Pulmonary Embolus)

- To evaluate for primary or metastatic **tumor**

- To evaluate for **infection** or **inflammatory** processes

- To evaluate for **traumatic** injury
CT

- Contrast resolution far superior to plain radiographs, but spatial resolution inferior to XR
- Thinly collimated x-ray beam passes through a “slice” of the patient’s body while the x-ray tube moves in an arc around the patient
- Electronic detectors, placed opposite the x-ray tube, convert the attenuated x-ray beam into electrical pulses. Computers convert this data to a gray-scale image
MRI Contrast

Media

- Gadolinium
  - Paramagnetic *(radiopaque)*
  - IV
  - NSF/ check GFR=renal function