Slide 1

NATIONAL RADIOLOGIC TECHNOLOGY WEEK

Preparing for the ARRT Certification Exam (R) The Registry

FOR STUDENTS WHO:
Are preparing to sit for the exam for the first time
Have failed the exam and are planning to retest
Want a review of what's expected of a radiographer working today

Sunday, November 3, 2024
3:00 – 6:00 pm EST
$100.00

REGISTER AT
WWW.MERRYLFULMER.COM

Class will be recorded.
Time will be allotted for questions & answers.

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Slide 2

Who I am...

Your opportunities...

Advanced Imaging options...

What's coming up...

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Slide 3

- Program Director (s)
- Clinical Instructor (s)
- Tutor
- Clinical Research ACR
- Lectured at ASRT National Conference
- Past President of the PhilaSRT
- Many Registry Reviews at Colleges
- Created 4 Post-Primary Courses:
- Mammography
- Computed Tomography,
- Magnetic Resonance Imaging
- Vascular Interventional Technology

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Slide 4

Merryl Fulmer, R.T. (R)(M)(MR)(QM)(CT)
Diagnostic Imaging Specialist
www.merrylfulmer.com
I know how to take a test and pass it! I want to share those tips with you.

- Tips for Success on the Passing the Registry
  - Let me help you get on the right path.
  - I have so many inquiries that a brief Zoom meeting would help me reach you.
  - If you send me your e-mail I will send you a Zoom invitation
  - Let's plan on this Sunday
    - Aug 2, 10:00 am EST

Students Improve through Tutoring

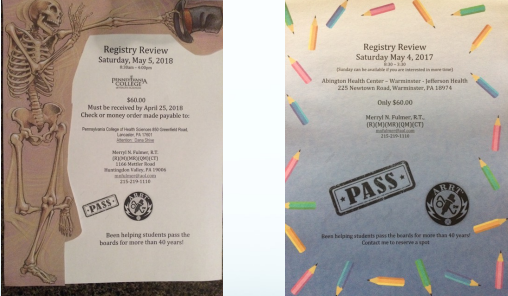ARRT Radiography Prep
Group · You and 2,673 others are members

4

Tips on
SUCCESS
for Passing
the Registry

Merryl N. Fulmer, B.S. R.T.
(R)(M)(MR)(QM)(CT)

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The most popular study tools:

- Rad Review Easy – On-line, book(s), flash cards
- Q & A
- Prep
- Corectec
- Mosby
- Kettering Review
- Rad Tech Boot Camp
- X-ray Coach
- SEAL Exams
- Hesi Exams

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The most popular study tools:

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- Hesi Exams

15

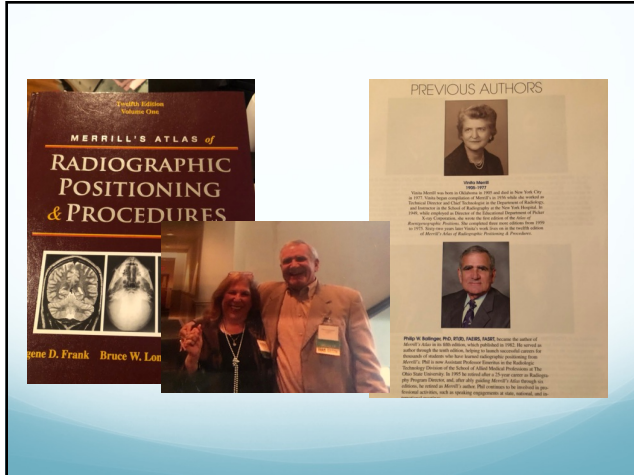## The most popular study tools:

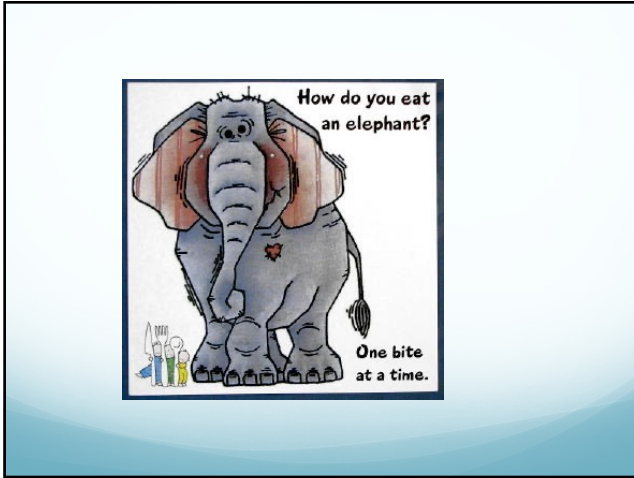- Rad Review Easy – On-line, book(s), flash cards
- Q & A
- Prep
- Corectec
- Mosby
- Kettering Review
- Rad Tech Boot Camp
- X-ray Coach
- SEAL Exams
- Hesi Exams

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What I hope to accomplish

- Review the Content Specifications and discuss why it is your "Bible" for exam preparation

- Outline the types & causes of test anxiety and discuss methods that can minimize them

- Discuss some test taking tips that can reduce testing errors

- Share my unique & quirky ways to separate & differentiate certain concepts & terms

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Slide 25
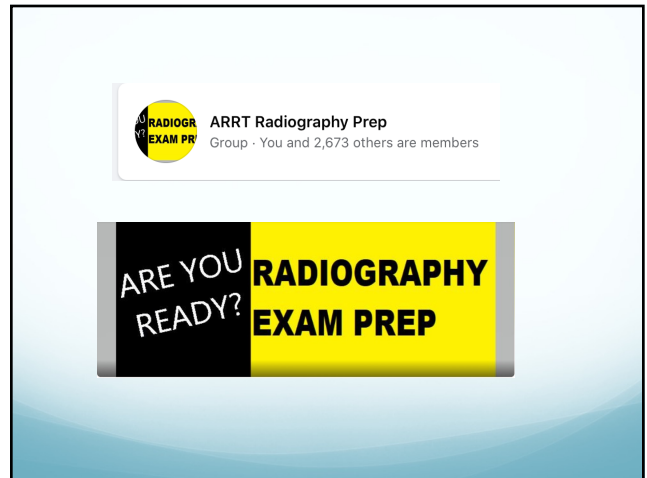
CONTENT SPECIFICATIONS FOR
THE RADIOGRAPHY EXAMINATION~~IN RADIOGRAPHY~~

ARRT® Board Approved: ~~Publication Date:~~   ~~August 2010~~January 2013
Implementation Date: January ~~2012~~2014

The purpose of The American Registry of Radiologic Technologists® (ARRT®) Radiography Examination is to assess the knowledge and cognitive skills underlying the intelligent performance of the tasks typically required of the staff technologist at entry into the profession. To identify the knowledge and skills covered by the examination, the ARRT periodically conducts practice analysis studies involving a nationwide sample of staff technologists[1]. The results of the most recent practice analysis are reflected in this document. The complete task inventory, which serves as the basis for these content specifications, is available from our website *www.arrt.org*.

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EXAMINATION CONTENT SPECIFICATIONS   ARRT® BOARD APPROVED: PENDING~~JANUARY 2016~~
IMPLEMENTATION DATE: **JANUARY 20171, 2022**

Radiography ~~Examination~~

The purpose of t~~T~~he ~~American Registry of Radiologic Technologists® (ARRT®) R~~radiography ~~E~~examination is to assess the knowledge and cognitive skills underlying the intelligent performance of the tasks typically required of radiographers at entry into the profession. The tasks typically performed were determined by administering a comprehensive practice analysis survey to a nationwide sample of radiographers.[1] ~~Using a nationwide survey, the ARRT periodically conducts a practice analysis to develop a task inventory which delineates or lists the job responsibilities typically required of radiographers.[1] An advisory committee then determines the knowledge and cognitive skills needed to perform the tasks on the task inventory and these are organized into the content categories within this document. The document is used to develop the examination. The results of the most recent practice analysis have been applied to this document. Every content category can be linked to one or more activities on the task inventory. The complete t~~ *The Task i*Inventory *for Radiography* ~~is available~~ may be found on the ARRT's website ~~at~~ (www.arrt.org).

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RADIOGRAPHY EXAMINATION   ARRT® BOARD APPROVED: **JANUARY 2016**
CONTENT SPECIFICATIONS   IMPLEMENTATION DATE: **JANUARY 2017**

Attachment C
ARRT Standard Definitions

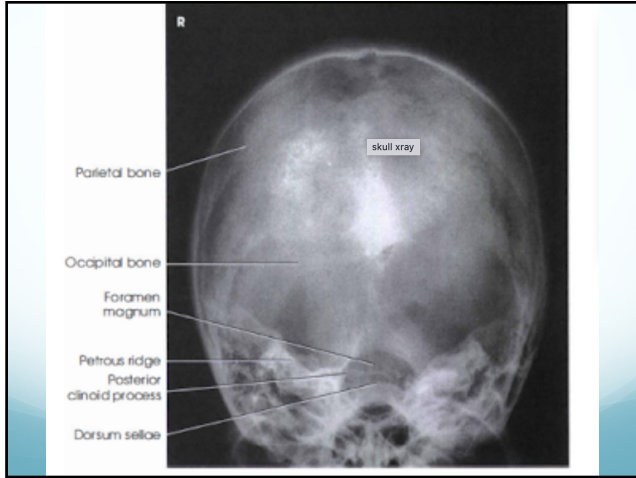|	
Digital Radiography	Digital Radiography includes both computed radiography and direct radiography
	Computed Radiography (CR) systems use storage phosphors to temporarily store energy representing the image signal. The phosphor then undergoes a process to extract the latent image.
	Direct Radiography (DR) systems have detectors that directly capture and readout an electronic image signal.
Spatial Resolution	The sharpness of the structural edges recorded in the image.
Receptor Exposure	The amount of radiation striking the image receptor.
Brightness	Brightness is the measurement of the luminance of an area in a radiographic image displayed on a monitor. It is calibrated in units of candela (cd) per square meter
Contrast	Contrast is the visible difference between any two selected areas of brightness levels within the displayed radiographic image. It is determined primarily by the processing algorithm (mathematical codes used by the software to provide the desired image appearance). The default algorithm determines the initial processing codes applied to the image data.
	Grayscale refers to the number of brightness levels (or gray shades) visible on an image and is linked to the bit depth of the system.
	Long Scale is the term used when slight differences between gray shades are present (low contrast) but the total number of gray shades is great.
	Short Scale is the term used when considerable or major differences between gray shades are present (high contrast) but the total number of gray shades is small.
Dynamic Range	The range of exposures that may be captured by a detector.
Receptor Contrast	The fixed characteristic of the receptor. Most digital receptors have an essentially linear response to exposure. This is impacted by **contrast resolution** (the smallest exposure change or signal difference that can be detected). Ultimately, contrast resolution is limited by the **quantization** (number of bits per pixel) of the analog-to-digital convertor.
Exposure Latitude	The range of exposures which produces quality images at appropriate patient dose.
Subject Contrast	The magnitude of the signal difference in the remnant beam as a result of the different absorption characteristics of the tissues and structures making up that part.

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Don't lose your head over headwork!

- Remember... there are only 5 basic skull positions
  - PA/PA Caldwell Method
  - Towne Method
  - Lateral
  - SMV/BASE
  - Waters Method
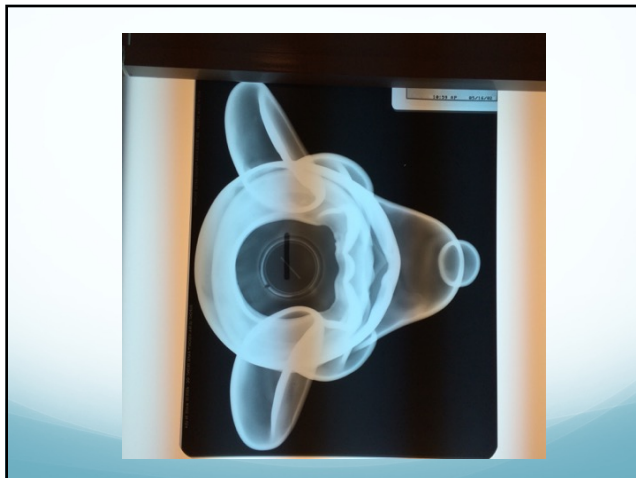
- Recommended Position to know
  - Rhese Method

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Parietal bone

skull xray

Occipital bone

Foramen magnum

Petrous ridge

Posterior clinoid process
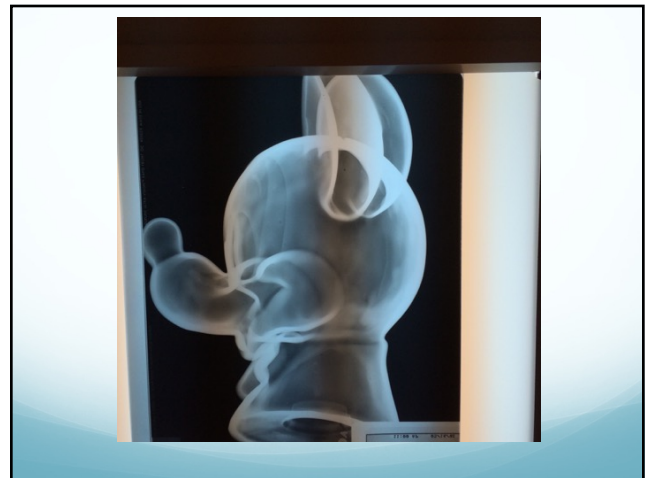
Dorsum sellae

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Red Flag Questions

- If you go from a 14 x17 to a 10 X 12 what will happen to receptor exposure, contrast, & scatter?

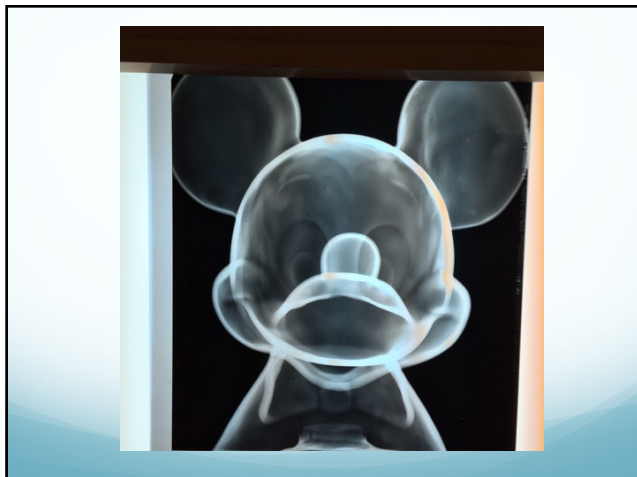- If you increase the kVp, what will happen to the speed of the x-rays?
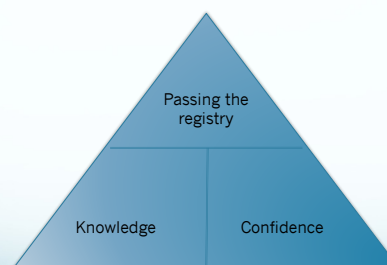
30

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100 mR/hr @ 1 meter
1 mGy/hr @ 1 meter

- What is a mR or mGy?
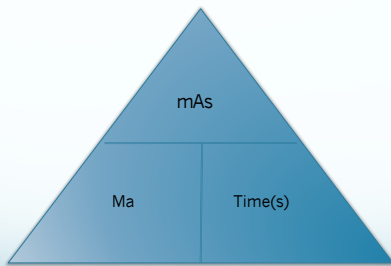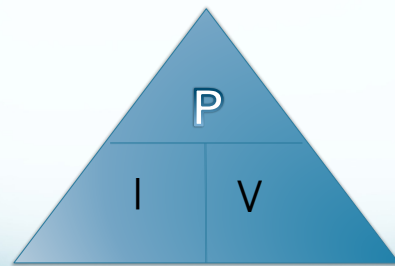- How big is 1 meter
- What is a milli?
  - Memorizing vs. understanding the concept

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Handy Dandy's

Passing the registry

Knowledge

Confidence

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Handy Dandy
ma X time = mas

mAs

Ma — Time(s)

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Handy Dandy
Power = Current x Voltage
P = I x V

P

I — V

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Handy Dandy's
Pixel Size
Pixel Size = FOV/Matrix
FOV = Pixel Size x Matrix
Matrix = FOV/Pixel Size

FOV

Matrix — Pixel Size
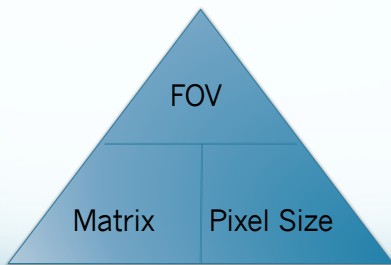
39

Handy Dandy's
Ohm's Law
I = V/R
V = I x R
R = V/I

V

I — R
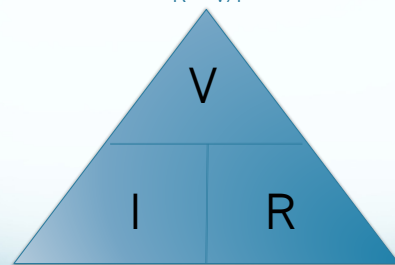
40

TRADITIONAL	SI
RAD	GRAY
REM	SIEVERT

41

100 Rad = one *gray* dollar

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Our system without the prefix to their system with the prefix......

OURS	THEIRS
Rem	Sievert
Millirem	Millisievert

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SIMPLY

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Move one decimal place to the right!!!!!!!

OURS	THEIRS
Rem	Sievert
Millirem	Millisievert

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Therefore...

- 5 rem   =   50 mSv (whole body)

- 15 rem   =   150 mSv (eyes)

- 50 rem   =   500 mSv (hands, feet & skin & thyroid gland)

46

If 5 rem (50 mSv) is whole body, then

- 3rd eye
  - 3 X 5 = 15
  - 15 rem or 150 mSv
  - EYES

- 10 fingers/toes
  - 10 X 5 = 50
  - 50 rem or 500 mSv
  - Hands, feet & skin that covers them

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Filtration

Protection

- Inherent
- Added
- Total

Image Production

- Compensating
  - Wedge
  - Trough
  - Boomerang
  - Ferlic

    - Chap't 2 Vol 1 Merrills
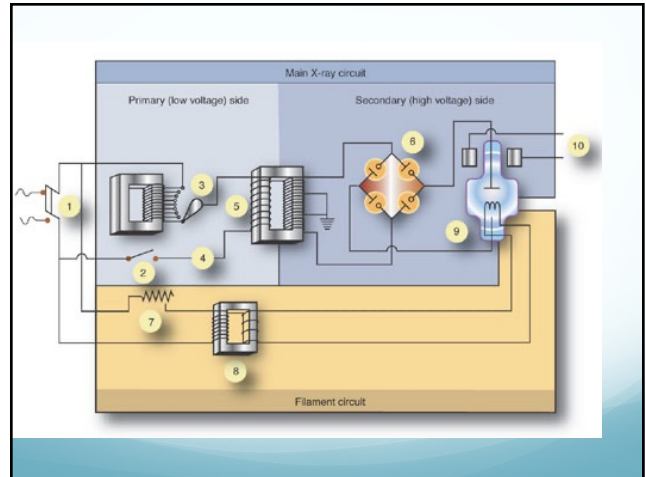
48

Low energy x-rays

Filter

High energy x-rays

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Filtration

- 1. 10kVp
- 2. 20 kVp
- 3. 30 kVp
- 4. 40 kVp
- 5. 50 kVp
- 6. 60 kVp
- 7. 70 kVp
- 8. 80 kVp
- 9. 90 kVp
- 10. 100 kVp

Average of the ten photons = 55 kVp

50

Filtration

- 1. 10kVp
- 2. 20 kVp
- 3. 30 kVp
- 4. 40 kVp
- 5. 50 kVp
- 6. 60 kVp
- 7. 70 kVp
- 8. 80 kVp
- 9. 90 kVp
- 10. 100 kVp

Average of the remaining six photons = 75 kVp

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Filtration

- So filtration
  - Increases the average effective energy
    - 55 kVp $\longrightarrow$ 75 kVp
    - "Hardens" the beam
  - Reduces the quantity while increasing the quality
    - 10 photons $\longrightarrow$ 6 photons
  - With respect to image quality..
    - Decreases receptor exposure (density)
    - Decreases contrast

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Image Intensifier (II)

Figure 7-18

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Electricity

What it is	What it's called	How to measure it	Unit that represents it
# of electrons-quantity	Current	Amp or amperes	I or A
Push, force or strength of the electrons	Electromotive force or potential difference (voltage)	Volt or voltage	V
Hinders or slows electrons	Resistance	Ohm	R

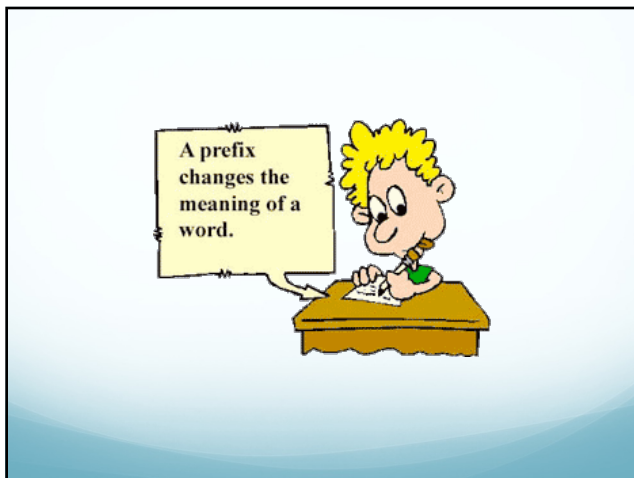56

Change this number to seconds

.000375 ms

57

ms to seconds; sec to ms
What do I do with the decimal point?
To the left?
To the right?
How many decimal places?

58

A prefix changes the meaning of a word.

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Tera — LEFT

Giga

Mega

Kilo

Hecto

Deka

BASE — Meter, Volt, Second, Sievert, Gray, Amp

Deci

Centi

Milli

Micro

Nano

Pico — RIGHT

60

Slide 61

LEFT

BASE

RIGHT

61

Slide 62
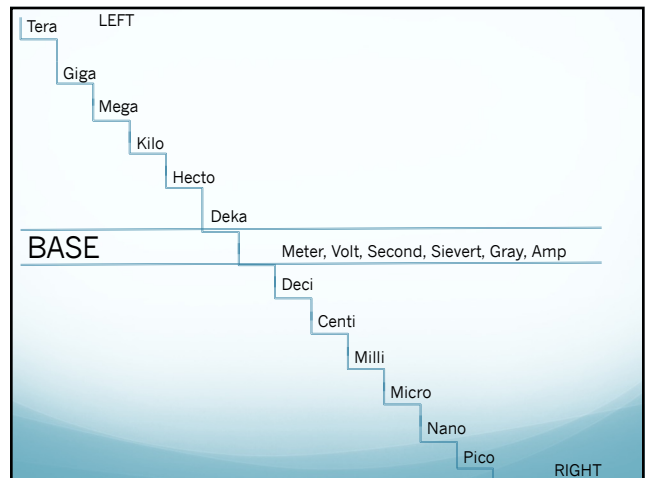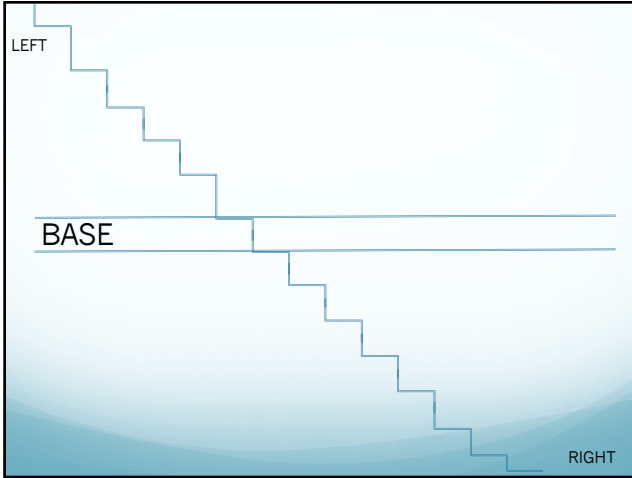
SI PREFIXES		
Multiple or Submultiple	Prefix	Symbol
10^{18}	exa	E
10^{15}	peta	P
10^{12}	tera	T
10^{9}	giga	G
10^{6}	mega	M
10^{3}	kilo	k
10^{2}	hecto	h
10	deca	da
10^{-1}	deci	d
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	mu
10^{-9}	nano	n
10^{-12}	pico	p
10^{-15}	femto	f
10^{-18}	atto	a

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Frequently Used Scientific Prefixes

Multiple	Prefix	Symbol
10^{6}	mega	M
10^{3}	kilo	k
10^{-2}	centi	c
10^{-3}	milli	m
10^{-6}	micro	μ

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Prefix	Symbol for Prefix		Scientific Notation
exa	E	1 000 000 000 000 000 000	10^{18}
peta	P	1 000 000 000 000 000	10^{15}
tera	T	1 000 000 000 000	10^{12}
giga	G	1 000 000 000	10^{9}
mega	M	1 000 000	10^{6}
kilo	k	1 000	10^{3}
hecto	h	100	10^{2}
deka	da	10	10^{1}
----	--	1	10^{0}
deci	d	0.1	10^{-1}
centi	c	0.01	10^{-2}
milli	m	0.001	10^{-3}
micro	μ	0.000 001	10^{-6}
nano	n	0.000 000 001	10^{-9}
pico	p	0.000 000 000 001	10^{-12}
femto	f	0.000 000 000 000 001	10^{-15}
atto	a	0.000 000 000 000 000 001	10^{-18}

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In words (long scale)	In words (short scale)	Prefix (Symbol)	Decimal	Power of ten	Order of magnitude
quadrillionth	septillionth	yocto- (y)	0.000 000 000 000 000 000 000 001	10^{-24}	−24
trilliardth	sextillionth	zepto- (z)	0.000 000 000 000 000 000 001	10^{-21}	−21
trillionth	quintillionth	atto- (a)	0.000 000 000 000 000 001	10^{-18}	−18
billiardth	quadrillionth	femto- (f)	0.000 000 000 000 001	10^{-15}	−15
billionth	trillionth	pico- (p)	0.000 000 000 001	10^{-12}	−12
milliardth	billionth	nano- (n)	0.000 000 001	10^{-9}	−9
millionth	millionth	micro- (μ)	0.000 001	10^{-6}	−6
thousandth	thousandth	milli- (m)	0.001	10^{-3}	−3
hundredth	hundredth	centi- (c)	0.01	10^{-2}	−2
tenth	tenth	deci- (d)	0.1	10^{-1}	−1
one	one	–	1	10^{0}	0
ten	ten	deca- (da)	10	10^{1}	1
hundred	hundred	hecto- (h)	100	10^{2}	2
thousand	thousand	kilo- (k)	1000	10^{3}	3
million	million	mega- (M)	1 000 000	10^{6}	6
milliard	billion	giga- (G)	1 000 000 000	10^{9}	9
billion	trillion	tera- (T)	1 000 000 000 000	10^{12}	12
billiard	quadrillion	peta- (P)	1 000 000 000 000 000	10^{15}	15
trillion	quintillion	exa- (E)	1 000 000 000 000 000 000	10^{18}	18
trilliard	sextillion	zetta- (Z)	1 000 000 000 000 000 000 000	10^{21}	21
quadrillion	septillion	yotta- (Y)	1 000 000 000 000 000 000 000 000	10^{24}	24

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SI PREFIX	SI SYMBOL	SI UNIT CONVERSION FACTOR (STANDARD FORM)	FACTOR (POWER)	FACTOR LANGUAGE
yotta	Y	1 yottametre = 1 000 000 000 000 000 000 000 000 metres	10^{24}	septillion
zetta	Z	1 zettametre = 1 000 000 000 000 000 000 000 metres	10^{21}	sextillion
exa	E	1 exametre = 1 000 000 000 000 000 000 metres	10^{18}	quintillion
peta	P	1 petametre = 1 000 000 000 000 000 metres	10^{15}	quadrillion
tera	T	1 terametre = 1 000 000 000 000 metres	10^{12}	trillion
giga	G	1 gigametre = 1 000 000 000 metres	10^{9}	billion
mega	M	1 megametre = 1 000 000 metres	10^{6}	million
kilo	k	1 kilometre = 1 000 metres	10^{3}	thousand
hecto	h	1 hectometre = 100 metres	10^{2}	hundred
deca	da	1 decametre = 10 metres	10^{1}	ten
		1 metre = 1 metre	10^{0}	one
deci	d	1 decimetre = 0.1 metres	10^{-1}	tenth
centi	c	1 centimetre = 0.01 metres	10^{-2}	hundredth
milli	m	1 millimetre = 0.001 metres	10^{-3}	thousandth
micro	μ	1 micrometre = 0.000 001 metres	10^{-6}	millionth
nano	n	1 nanometre = 0.000 000 001 metres	10^{-9}	billionth
pico	p	1 picometre = 0.000 000 000 001 metres	10^{-12}	trillionth
femto	f	1 femtometre = 0.000 000 000 000 001 metres	10^{-15}	quadrillionth
atto	a	1 attometre = 0.000 000 000 000 000 001 metres	10^{-18}	quintillionth
zepto	z	1 zeptometre = 0.000 000 000 000 000 000 001 metres	10^{-21}	sextillionth
yocto	y	1 yoctometre = 0.000 000 000 000 000 000 000 001 metres	10^{-24}	septillionth

Chart of SI prefixes

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If you can't explain it **simply**, you don't understand it well enough.

– Albert Einstein

PictureQuotes.com

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Slide 68

The Fat Cat – Anode Heel Effect
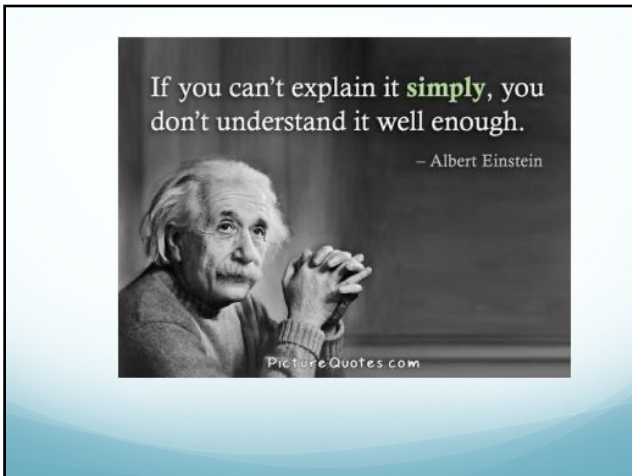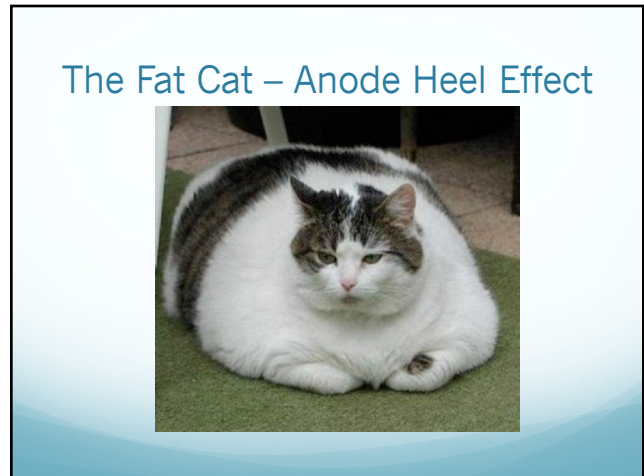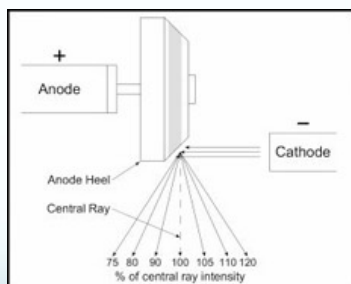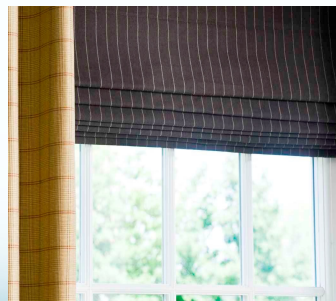
68

Anode Heel Effect

Figure 13: Schematic illustration of the heel effect
(after Carlton and Adler, 1996)

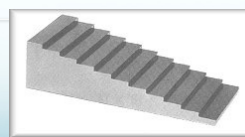69

Collimation!!!

70

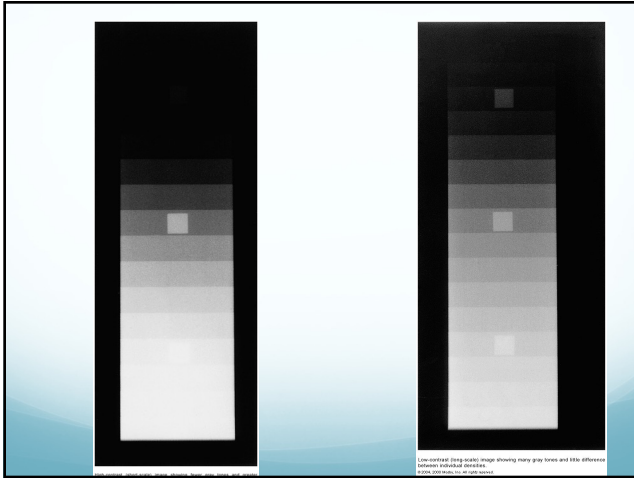## Words of Wisdom...

" Less and more are *measurements*
not *judgments*"

71

The more the k's (kVp)
the more the grays
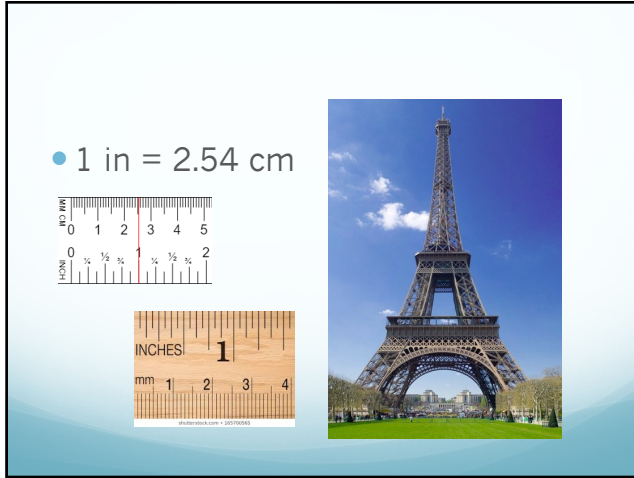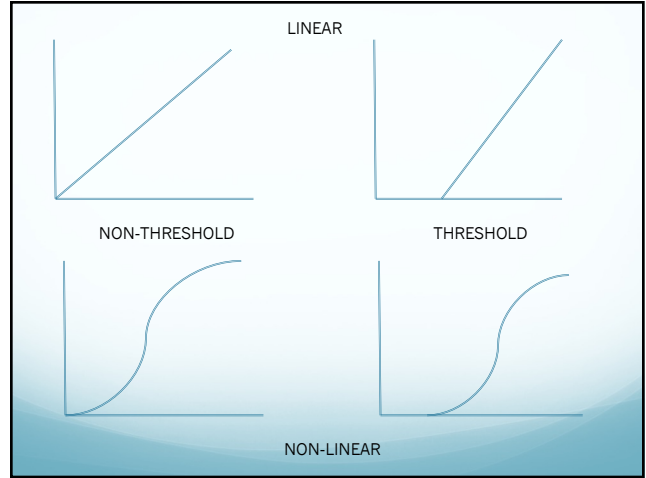

72

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High kVp
DOES NOT EQUAL
High Contrast

74
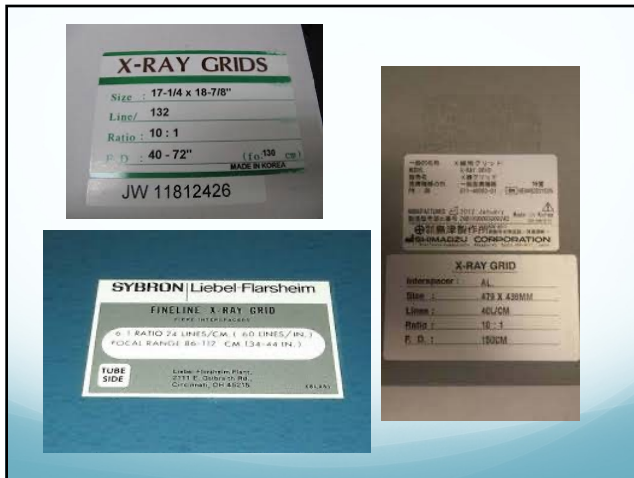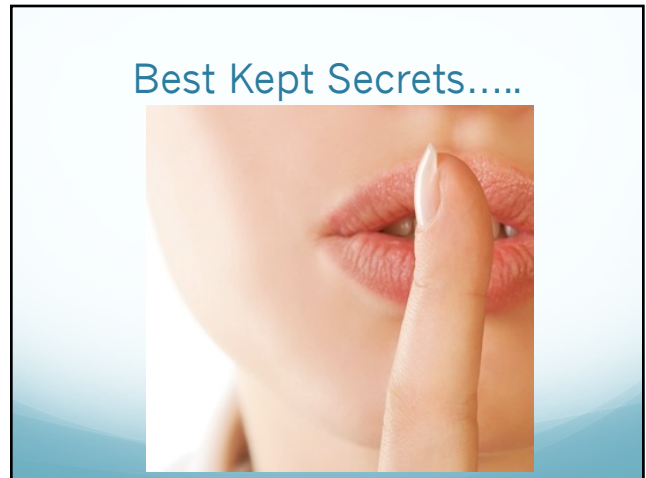

75

10 What???
Inches or
centimeters

76

• 1 in = 2.54 cm

77

LINEAR

NON-THRESHOLD   THRESHOLD

NON-LINEAR

78

79

Best Kept Secrets…..

80

The Best Kept Secret

- The Subspecialty List following the answer key in the Appleton & Lange, Saia prep book

81

82

Corectec

The purpose of this preview is to help you decide if you want to purchase the entire Radiography Online Course. Below is your navigational page, a small sampling of the material presented in the course. You can GO to any lesson, exercise, quiz, or the practice exam. A blue X will appear next to the correct answer in the exercises, quizzes, and practice exam. When you complete a lesson the checkbox will be checked. When an exercise, quiz, or the exam is completed the field will display your score. Since this is just a preview, your scores will not be stored in a database. In the actual review course, the lessons, exercise scores, quiz scores and exam scores will be stored so you can easily see which areas have been completed and which ones need to be completed when you return day after day. Good luck!

Lessons			Exercises		Quizzes	
GO	Radiation Protection		GO		GO	
GO	Equipment Operation		GO		GO	
GO	Image Acquisition		GO		GO	
GO	Imaging Procedures		GO		GO	
GO	Patient Care		GO		GO	
GO	Practice Exam 1					

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- C
- T
- L
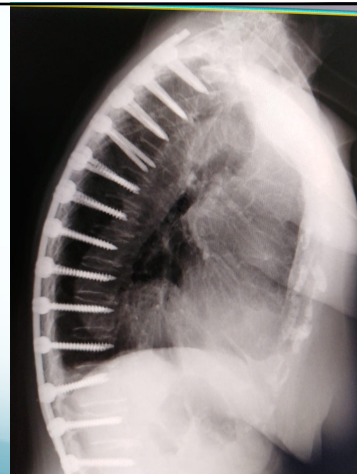
Breakfast @ 7
Lunch @ 12
Dinner @ 5

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3 Vertebrae/3 Issues

- C
- T
- L

- Side up or side down?
- Intervertebral foramina or zygapophyseal joints?
- Degree of obliquity?

86

Intervertebral foramina or zygapophyseal joints?

87

Holes or Scotty Dogs?

88

- Side up or side down?
- Intervertebral foramina or zygapophyseal joints?
- Degree of obliquity?

89

Sacrum vs. Coccyx

Sacrum 15 degrees cephalad

Coccyx 10 degrees caudad
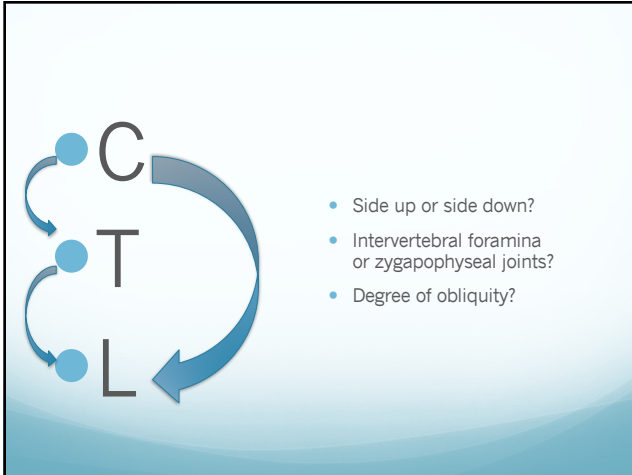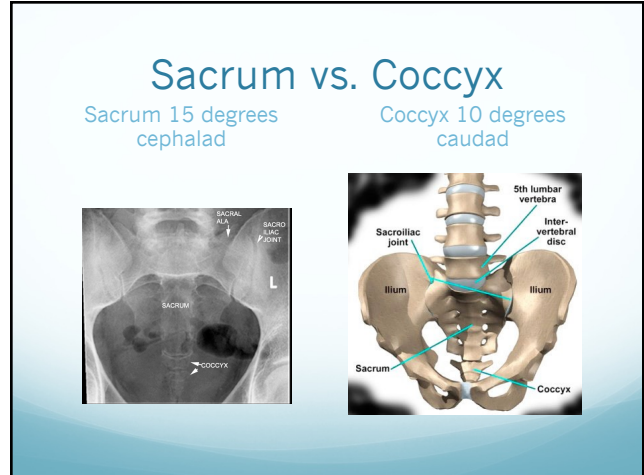
90
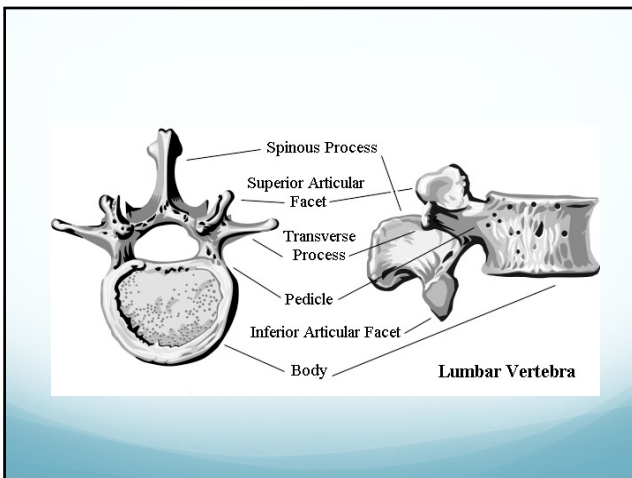
91
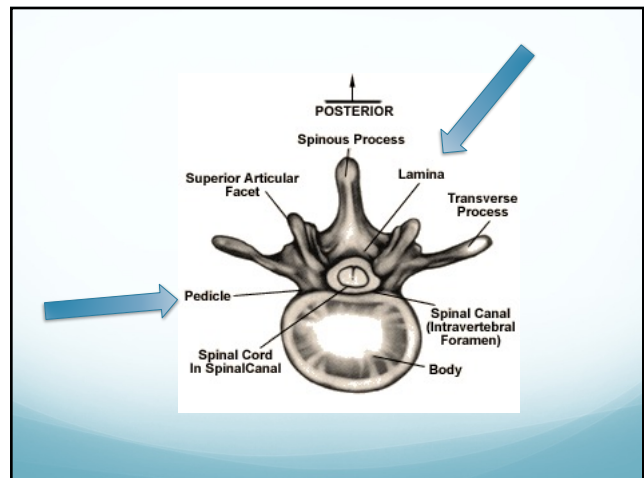
92

- Obturator foramen vs. acetabulum
- Rotation occurs – C1 & C2
- Flexion and extension – Base of skull atlantoccipital & C-1

93

(a) Lateral view
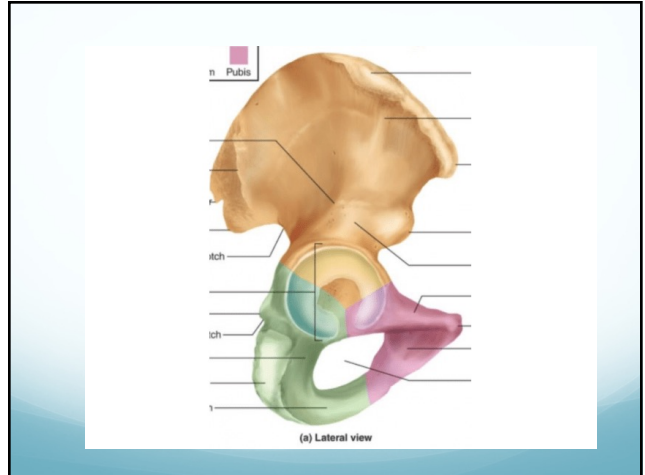
94

Some lovers try positions that they can't handle!!!!!

95

Steve left the party
to take Carol home

96

Carpal Bones

- Some – Scaphoid
- Lovers – Lunate
- Try – Triquetrum
- Positions – Pisiform
- That – Trapezium
- They – Trapezoid
- Can't – Capitate
- Handle - Hamate

97

98
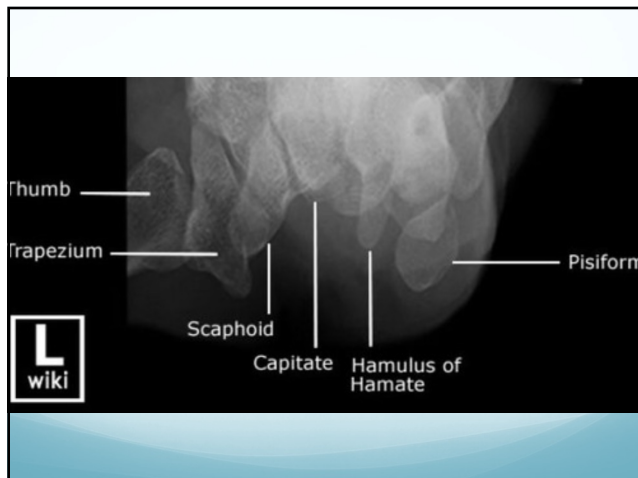
99
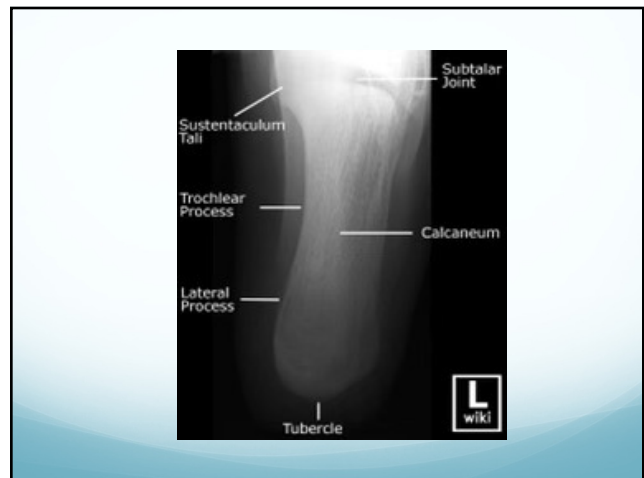
100

Carpal Bones

Proximal – Lateral to medial

- Some – Scaphoid
- Lovers – Lunate
- Try – Triqetrium
- Positions – Pisiform

Distal – Lateral to medial

- That – Trapezium
- They – Trapezoid
- Can't – Capitate
- Handle - Hamate

101

Come to Cuba Next 3 Christmas

102

Classifications of bones

- Long
- Short
- Flat
- Irregular
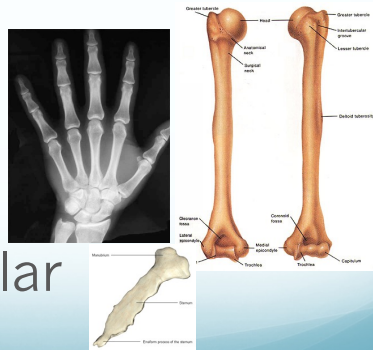
103

Joints
Structural vs. Functional

Classification by type of tissue:	Classification by degree of movement:
• Fibrous – bones connected by fibrous tissue. • Cartilaginous – bones connected by cartilage. • Synovial – articulating surfaces enclosed within fluid-filled joint capsule.	• Synarthrosis – immovable. • Amphiarthrosis – slightly moveable. • Diarthrosis – freely moveable.

104

Coronoid vs. coracoid??
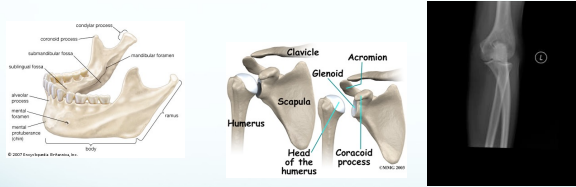
"A sea (C) between two nations"

105

What's wrong with this pic?
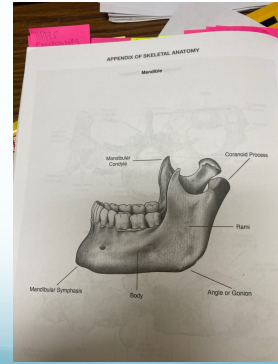
106

Ilium vs. Ileum
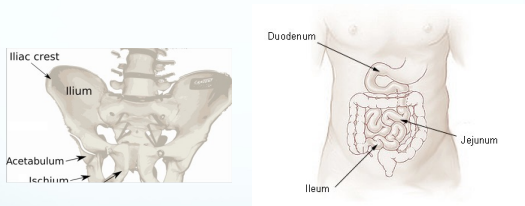
107

Ampule vs. Vial

108

Decubs
Chest   Abdomen
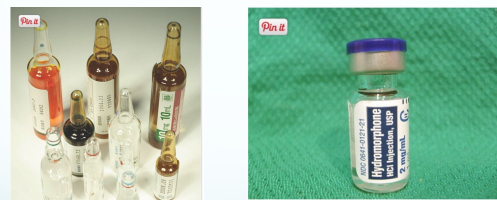
109

Dysphagia vs. Dysphasia
Dysplasia vs. dyspnea

110

Libel vs. Slander

111

Assault vs. Battery

112

Inlet vs. Outlet

113

Axial vs. Appendicular

114

Caudad vs. Cephalad

115

Cau**dad** vs. Cephalad

Dad has big feet and feet are down

116

Flexion vs. Extension

Flexion you
look at
your feet

117

Urethra vs. Ureter
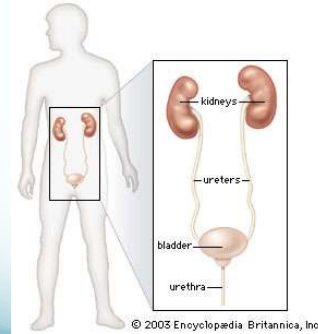
118

Thymus is not Thyroid

119
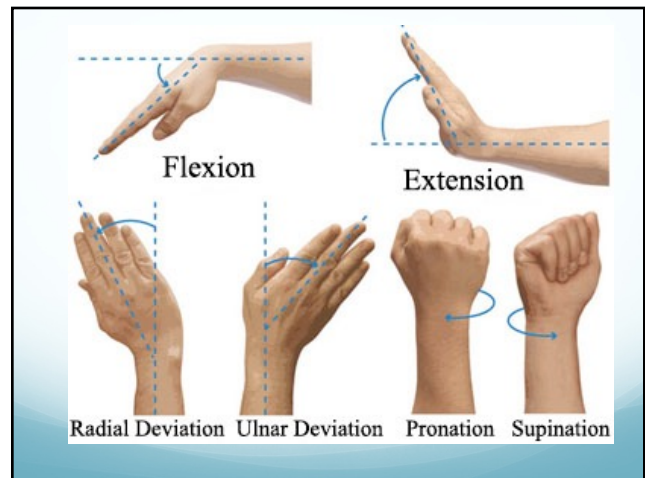
120
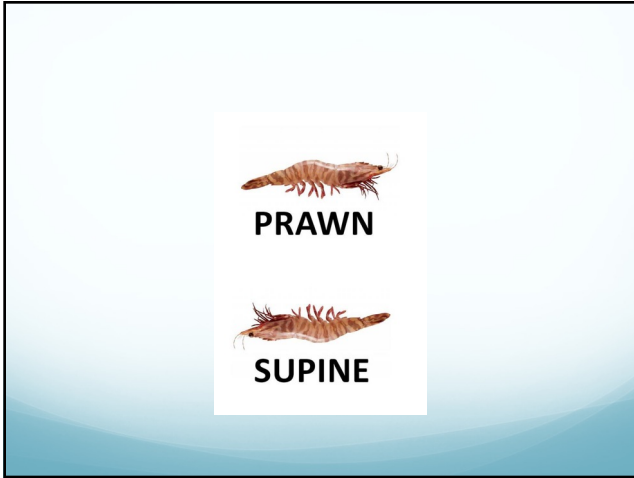
121

SUPINE

- RPO – splenic or left colic flexure
- LPO – hepatic or right colic flexure

122

Meiosis vs. Mitosis

123

Grainy vs. Blurry

124

Can you spot the differences?

Hmmmmmmmmm........

Notice how similar they look!

Patella of Intercondyloid Fossa?????
Can you name these different methods?
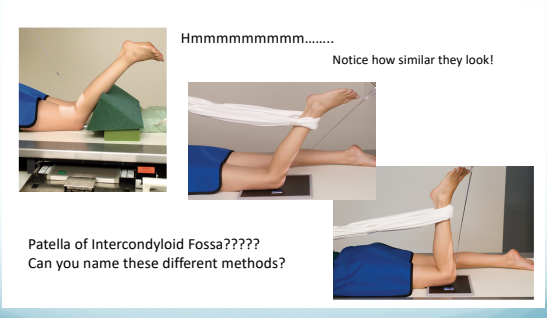
125

Ligament vs. Tendon

126

Shoulder Girdle

Acromion
Humeral Head
Humerus
Clavical
Scapula
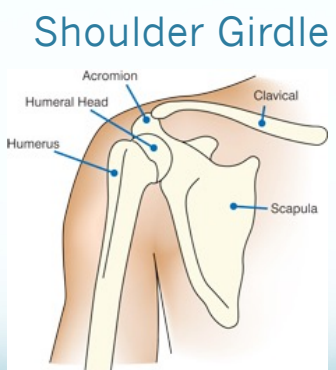
127

Largest organ vs. Largest Solid organ

128

Try before you buy!!!

- Tri before you bi
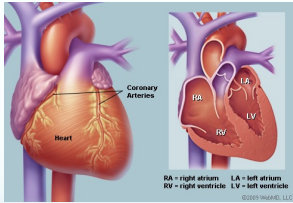
129

AEC vs. APR

130

Mastitis vs. Mastoiditis

131

Windowing

Level	Width
• Density or brightness	• Contrast

132

Windowing

Level   Width

- Density or brightness
- Contrast

133

Biggest Foramen??
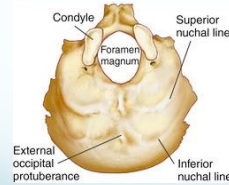
Foramen Magnum   Obturator Foramen
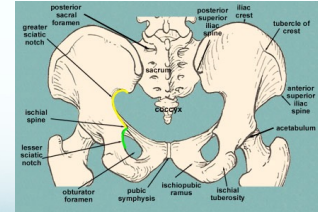
134

ERCP
Biliary/Pancreas
Tube through mouth

Enteroclysis
Small Intestine
Tube through nose

135

Do it in reverse or What is it Not Game

Screens   Collimation
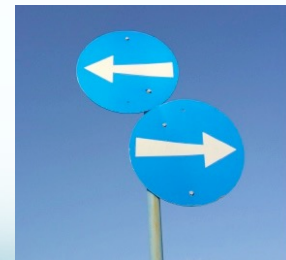
136

Centering Point??
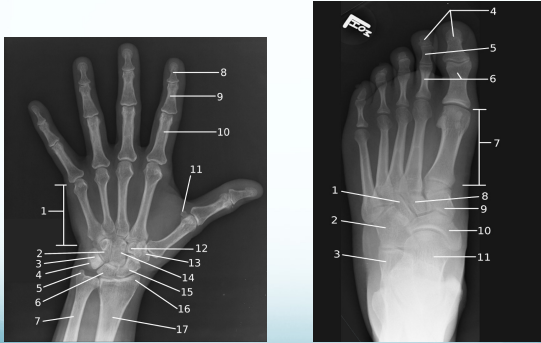
137

Ulnar vs. Radial Deviation

138

HOW TO DO MATH:
1. WRITE DOWN PROBLEM
2. CRY.

139

The Formulas

15 % rule

Grids

Inverse square Law

Unsharpness

Density Maintenance

Magnification

Tool Kit
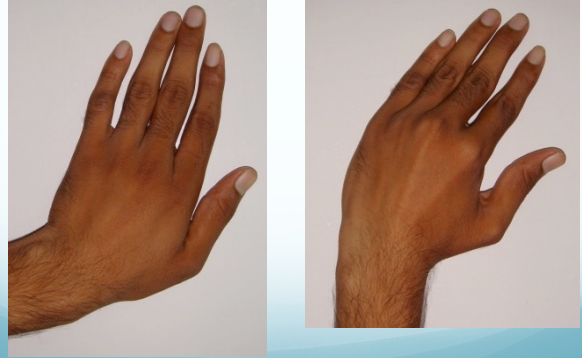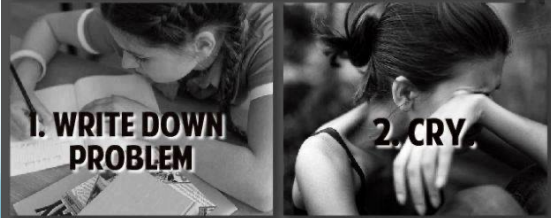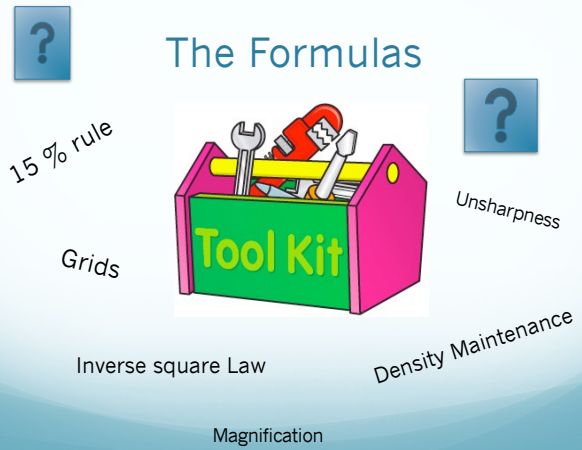
140

More number tricks

.1 % = .001 = 1/1000 = milli

141

Occupational Radiation Exposure

100 rem = 1 Sv

10 rem = 100 mSv

1 rem = 10 mSv

100 mrem = 1 mSv

10 mrem = 100 µSv

1 mrem = 10 µSv

142

142

Radiologic Units

Quantity	Customary Units (United States)		SI Units (International)	
	Name	Symbol	Name	Symbol
Exposure	Roentgen	R	Air kerma	Gy_a
Absorbed Dose	Rad	Rad	Gray	Gy_t
Effective Dose	Rem	Rem	Sievert	Sv
Radioactivity	Curie	Ci	Becquerel	Bq

143

143

Maximum Electrons per Shell

Max # electrons=$2n^2$

(n = shell number)

Shell Number	Shell Symbol	Number of Electrons
1	K	2
2	L	8
3	M	18
4	N	32
5	O	50
6	P	72
7	Q	98

144

144

145

146

147

148

Inverse Square Law

4 mR

1 mR

3 ft

6 ft
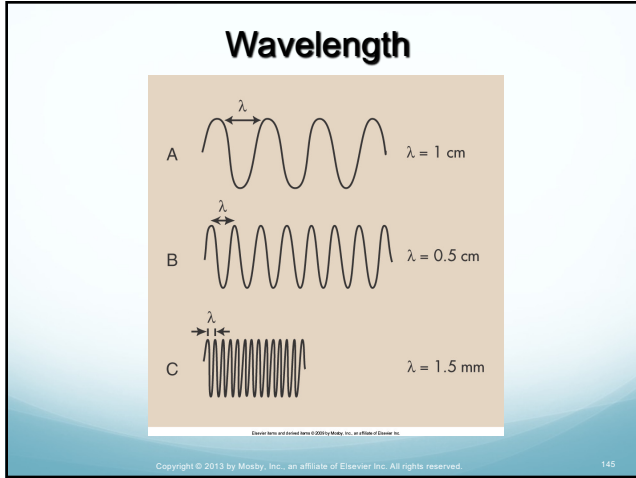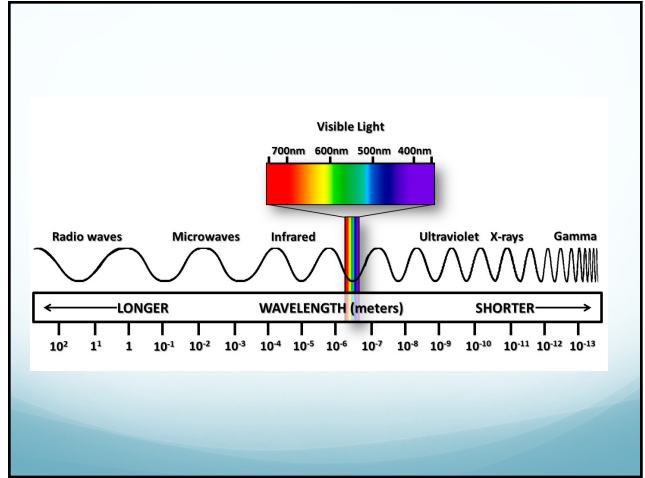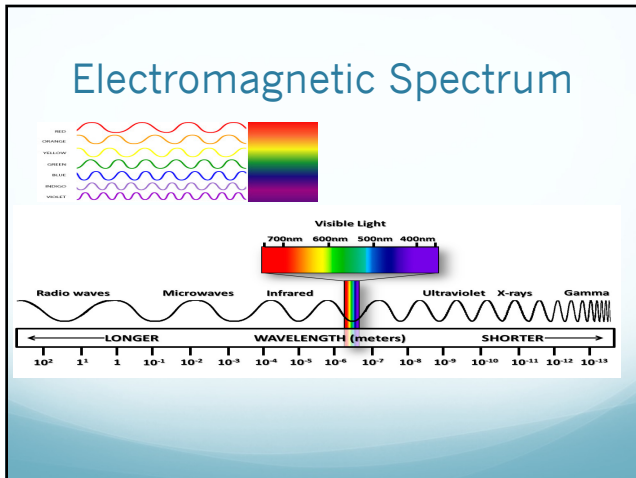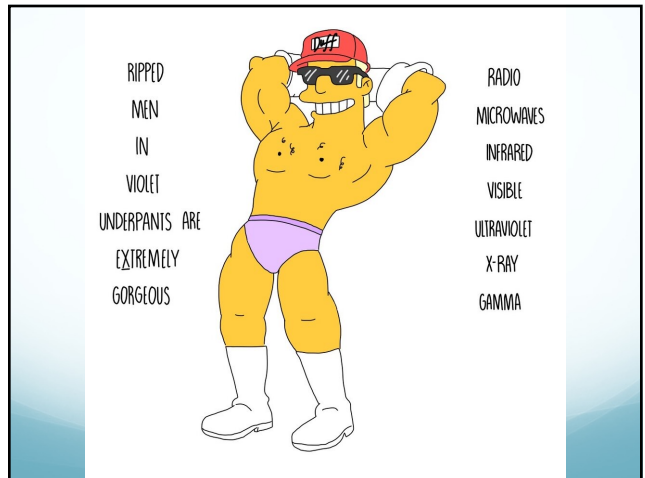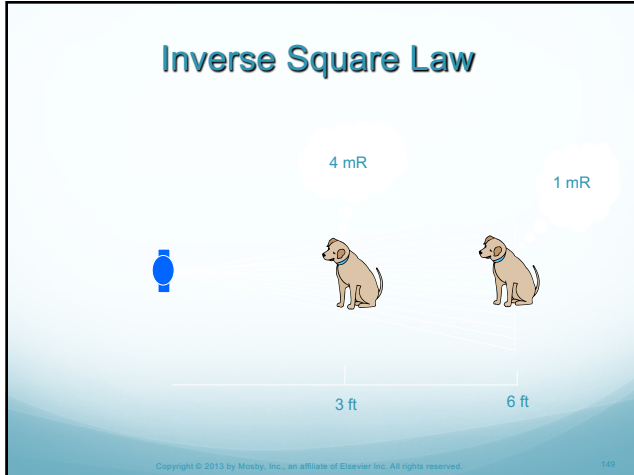
149

Examples of Electric Circuit Elements

TABLE 4-2	Symbol and Function of Electric Circuit Elements	
Circuit Element	**Symbol**	**Function**
Resistor		Inhibits flow of electrons
Battery		Provides electric potential
Capacitor		Momentarily stores electric charge
Transformer		Increases or decreases voltage by fixed amount (AC only)
Diode		Allows electrons to flow in only one direction

150

Circuit Diagram of Imaging System
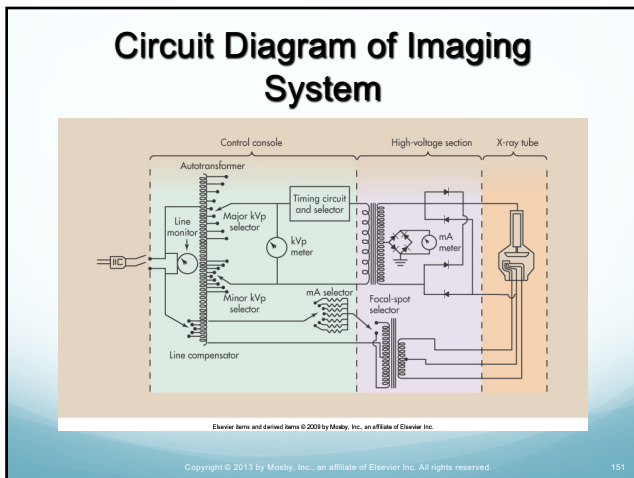
151

Voltage Waveforms

Single phase

Rectification Type	Ripple
Half wave	100%
Full wave	100%

Rectified 3-phase

Rectification Type	Ripple
Three phase, 6 pulse	13%
Three phase, 12 pulse	4%
Three phase, high frequency	<1%

152

Automatic Exposure Control (AEC): Photodiode vs. Ion Chamber
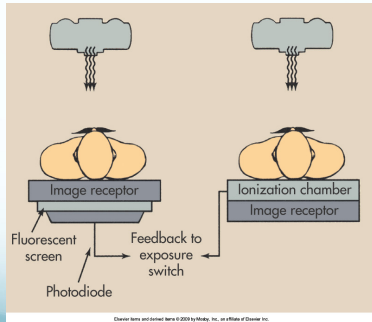
Image receptor

Ionization chamber
Image receptor

Fluorescent screen

Feedback to exposure switch

Photodiode

153

Line Focus Principal
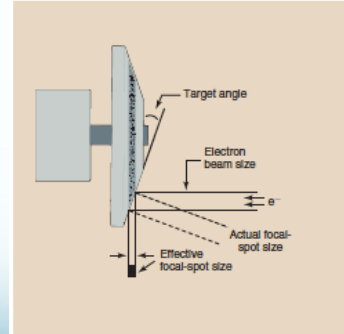
Target angle

Electron beam size

e⁻

Actual focal-spot size

Effective focal-spot size

154
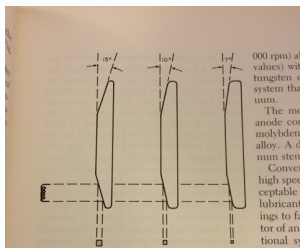
Fig. 1-3. Target angle and effective focal spot size. With the advent of modern direct enlargement technics using smaller tube filaments it became necessary to increase tube loading. Because decreasing the tube filament also decreases the electron stream, a smaller area of the target surface is bombarded. It is interesting to note that the same size filament (therefore, electron stream) is used for all three targets, meaning that the differences in the effective focal spot sizes are due to the three different target angles.

155

The Anode

- Tungsten
  - High atomic #
  - Thermal conductivity
  - High melting point
- Molybdenum and Graphite
  - Lower mass density (lighter)
  - High melting point
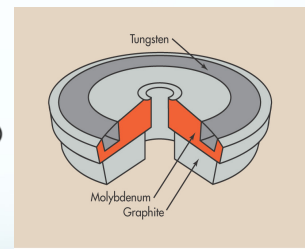
Tungsten

Molybdenum
Graphite

156

Spatial Resolution

Motion

Materials

Focal Spot

OID

SID

Geometry

157

APEX VS.BASE

Apex @ Bottom

Apex @ Top

158

Sad Pucker

Retroperitoneal organs (mnemonic)

Dr Aditya Shetty and Dr Henry Knipe et al.

A useful for **mnemonic** to remember which organs are retroperitoneal is:

- SAD PUCKER

Mnemonic

- **S:** suprarenal (adrenal) gland
- **A:** aorta/IVC
- **D:** duodenum (second and third part)
- **P:** pancreas (except tail)
- **U:** ureters
- **C:** colon (ascending and descending)
- **K:** kidneys
- **E:** (o)esophagus
- **R:** rectum

159

GI Pathology
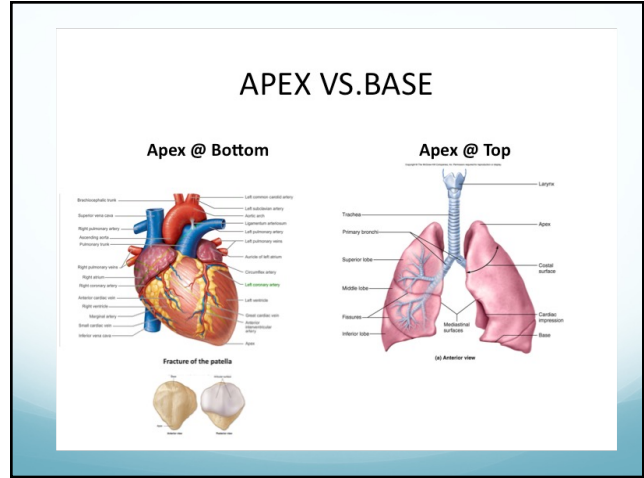
Polyps
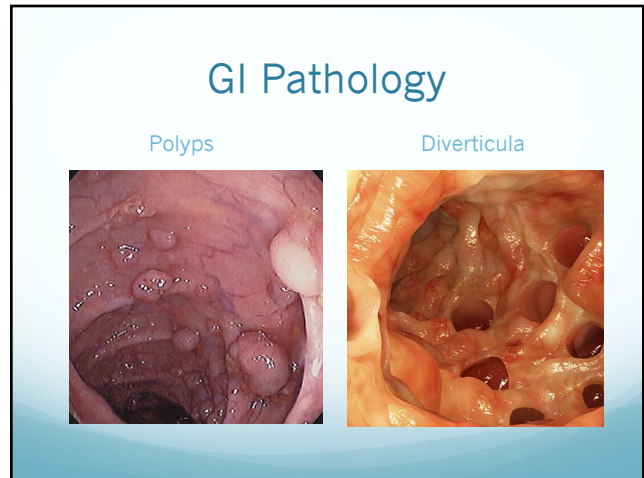
Diverticula

160

Polyps
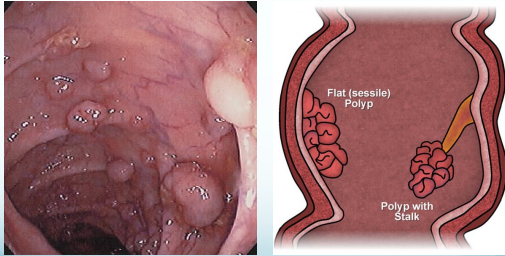
161

Diverticula
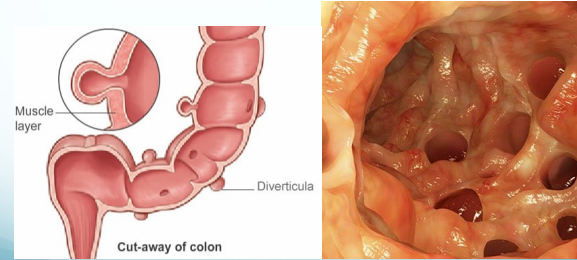
162

Large Intestine
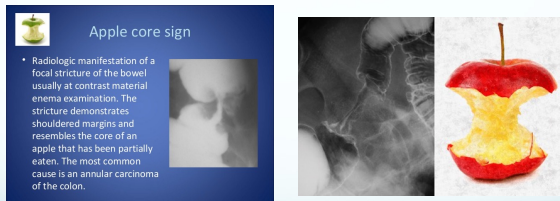
163

Flattening vs.Blunting of the diaphrgam
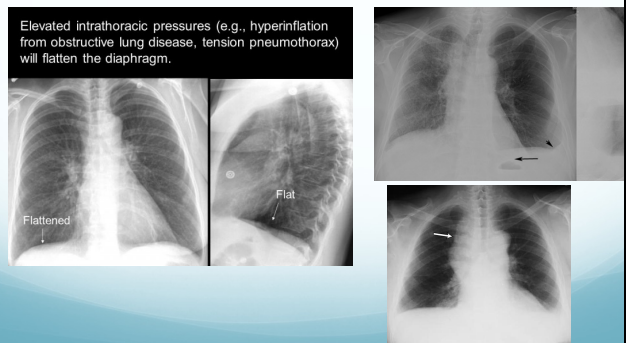
164

Do you know?

- Pathogen
- DNR
- Pharmaceutical
- Extravasation
- Radiopharmaceutical
- Ambu bag

- Differentiate between mortise & medial obl ankle
- Bolus
- Pectus excavatum vs. pectus caritinatum
- Moire effect
- Pulse Oximeter

165

166

Male vs. Female
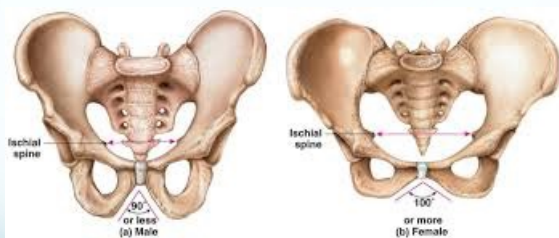
167
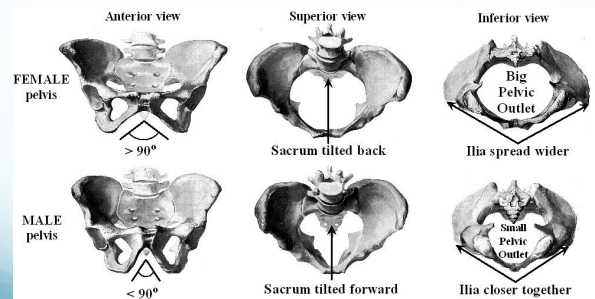
168

Lateral Knee vs. Lateral Patella

169

Orthopnea vs. Orthostatic

170

Underexposed/Overexposed

vs.

Underpenetrated/Overpenetrated

171

AP toes vs. AP foot

172

myeloma Vs. myoma

173

- 2^n
- Vs.
- $2(n)^2$

174

NCRP 102 Vs. NCRP 116

175

ROI vs. FOV

176

Clavicle above apices
vs.
Apices above clavicles

177

calcaneous vs. calculous

178

Grid Ratio vs. Grid Radius

179

- Malleolus vs. Malleus

Distal Ends of Tibia and Fibula
Showing Medial and Lateral
Malleolus

lateral malleolus   medial malleolus
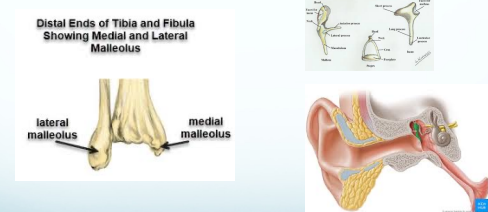
180

Scapular Y for Scapula vs. Shoulder

181

182

183

184

185

Figure 3-3 A bremsstrahlung interaction.

186

Figure 3-4 A characteristic interaction.

187
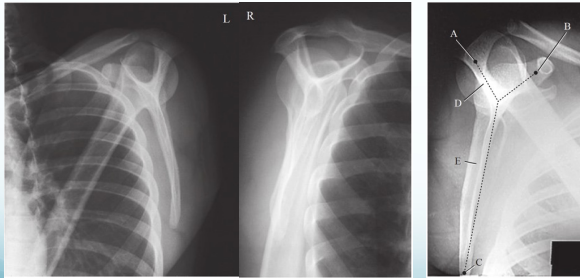
Bremsstrahlung Radiation Production
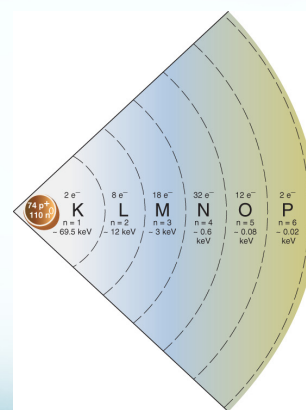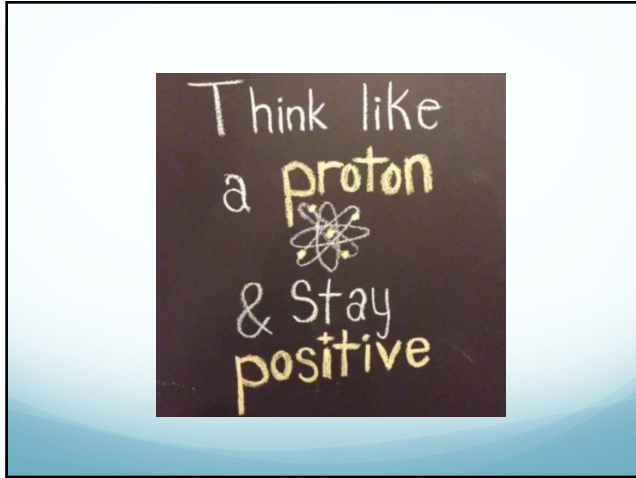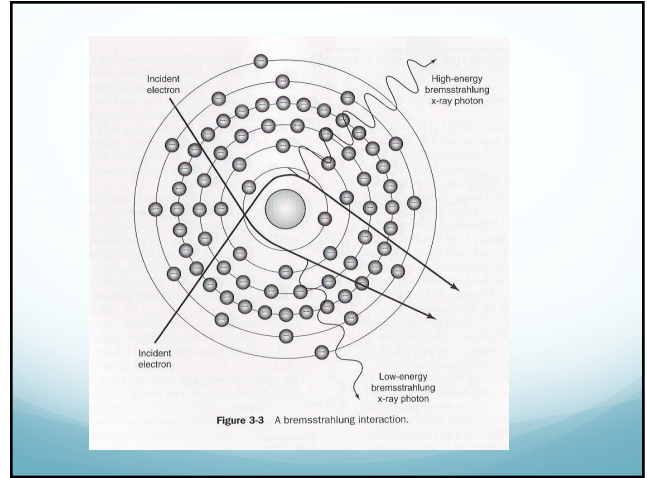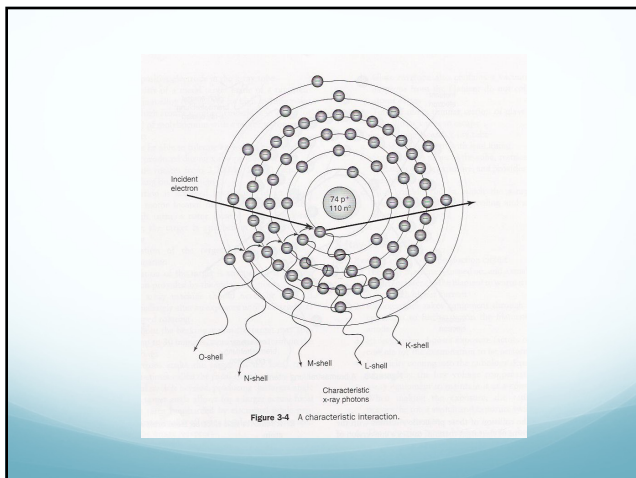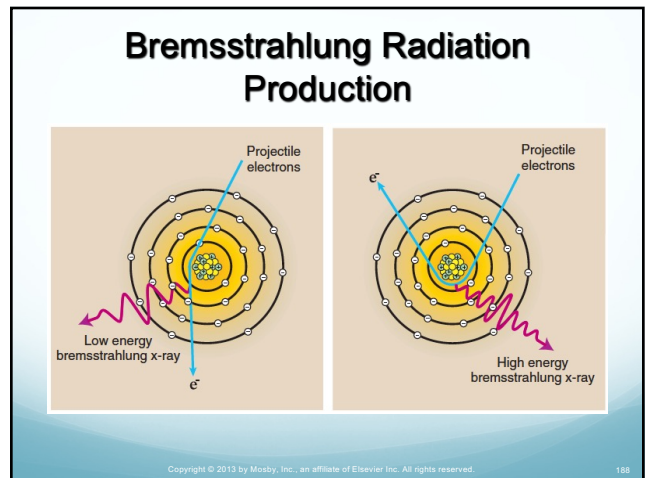
188

Characteristic X-ray Production
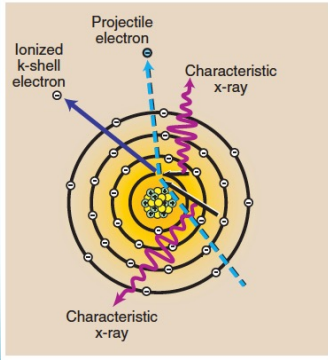
189

Brems (Bremsstrahlung) & Characteristic
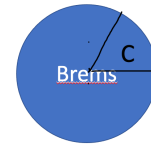
190

Factors Affecting X-ray Emission Spectrum

Factor	Change	Quantity	Quality
Current (mAs)	Increase	Increase	No change
Voltage (kVp)	Increase	Increase	Increase
Filtration	Increase	Decrease	Increase
Target Atomic #	Increase	Increase	Increase
Voltage Ripple	Increase	Decrease	Decrease

191

X-ray Emission Spectrum

192

48
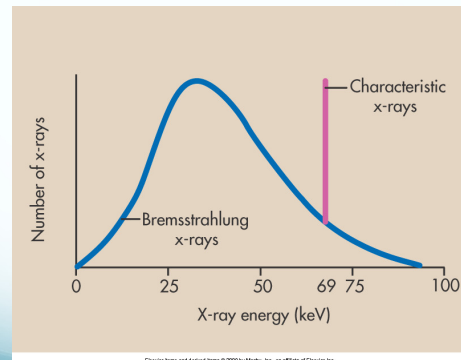
Factors Affecting X-ray Emission Spectrums
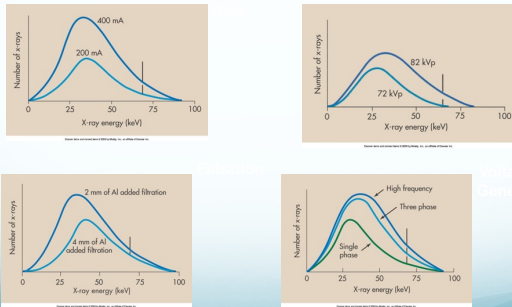
193

Factors Affecting Quantity and Exposure

Factor Increased	Beam Quantity	Image Receptor Exposure
mAs	Increased proportionately	Increased
kVp	Increased geometrically	Increased
Distance	Reduced geometrically	Reduced
Filtration	Reduced	Reduced

194

Voltage Waveforms

Half wave — 100%
Full wave — 100%
Three phase, six pulse — = 14%
Three phase, twelve pulse — = 4%
High frequency — = < 1%
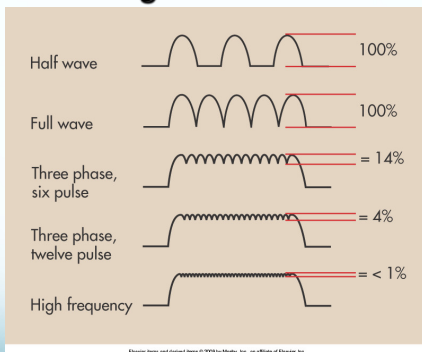
195

Total Filtration
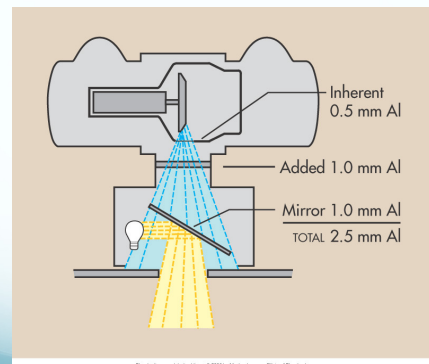
Inherent 0.5 mm Al
Added 1.0 mm Al
Mirror 1.0 mm Al
TOTAL 2.5 mm Al

196

49

Factors Affecting Quality and Quantity

Quantity increases with:
- Increased kVp
- Increased mAs
- Decreased distance
- Decreased filtration

Quality increases with:
- Increased kVp
- Increased filtration

197

X-ray Interactions with Matter

- Coherent Scatter (Classical or Thompson)
- Compton Effect
- Photoelectric Effect
- Pair Production
- Photodisintegration

198

Interactions made easy

- Coherent or unmodified scattering
  - Simply excites atom
- Compton scattering
  - Outer shell electron
- Photoelectric
  - Inner shell electron
- Pair Production
  - Approaches nucleus
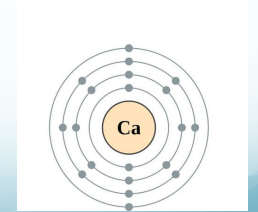- Photodisintegration
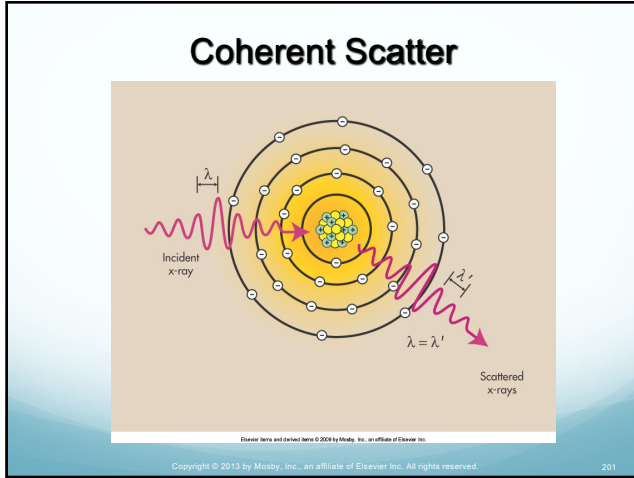 - Hits nucleus

199

Interactions made easy

- Coherent or unmodified scattering
- Compton scattering
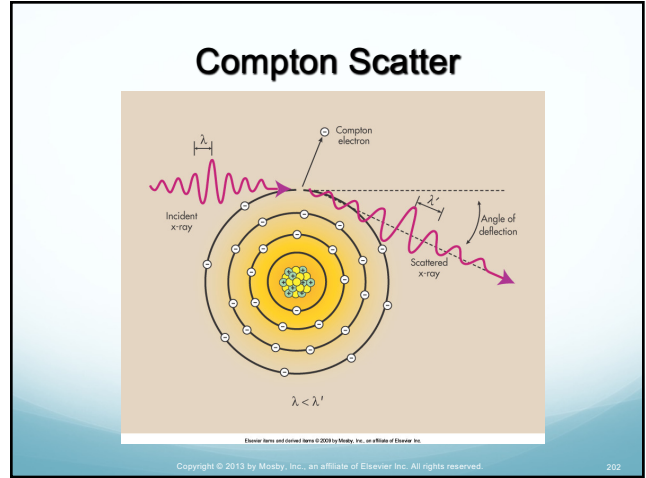- Photoelectric
- ~~Pair Production~~
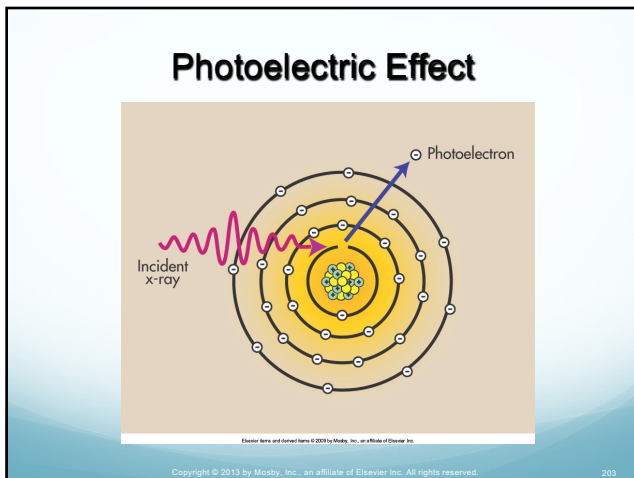- ~~Photodisintegration~~

20: Calcium   2,8,8,2
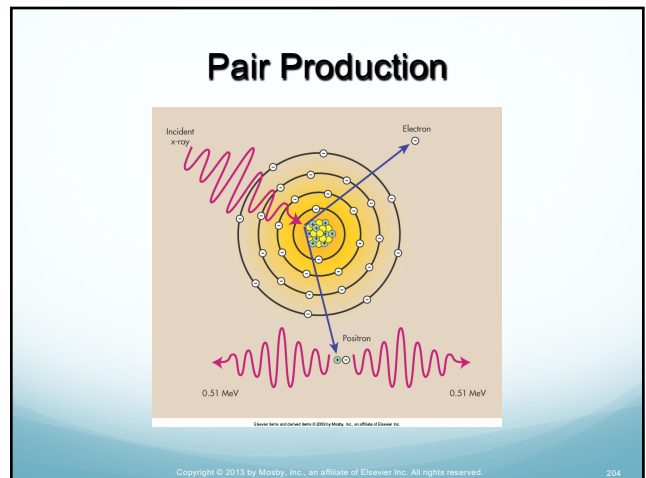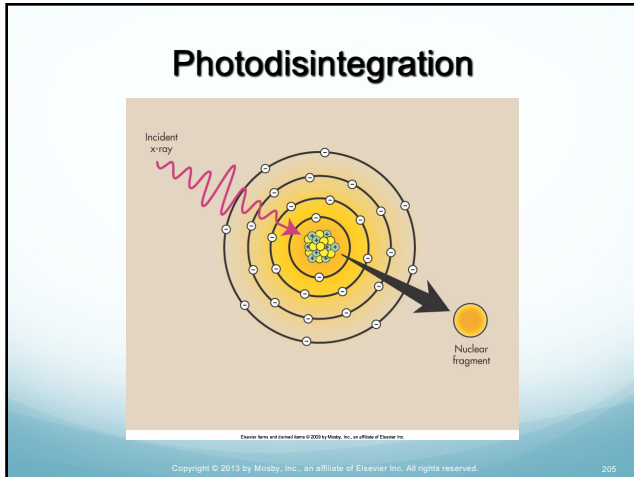
Ca

200

201

202

203

204

Photodisintegration

205

Differential Absorption and Image Production
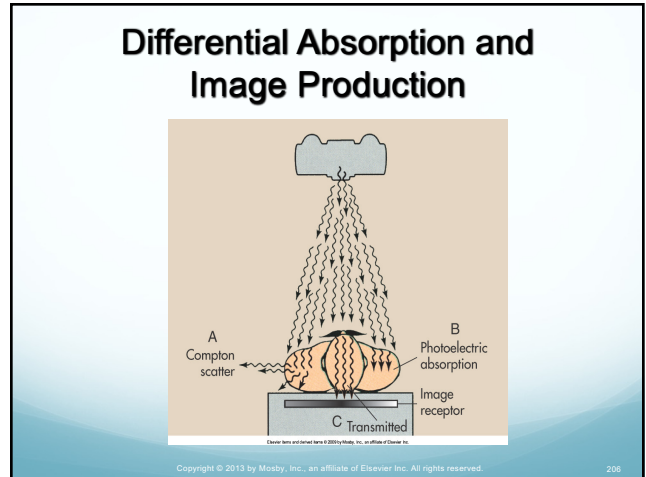

206

Factors Affecting Differential Absorption

- Higher atomic number (Z)
  - PE absorption greater in absorbers with higher Z
  - Compton scatter unaffected by Z number
- Increased kVp
  - PE absorption decreases sharply
  - Compton scatter remains proportionally greater
- Increased mass density
  - PE absorption increases
  - Compton scatter increases

207

How Increasing Factors Affect Differential Absorption

	Higher Atomic Number (Z)	Higher kVp	Higher Mass Density
PE absorption	↗	↘	↗
Compton scatter	unaffected	relatively ↗	↗
Transmitted x-rays	↙	↗	↙

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Photoelectric Interaction vs. Compton Scatter

Percent Interactions

kVp	Photoelectric	Compton	Total Interaction	Total Transmission
50	79	21	>99	<1
60	70	30	>99	<1
70	60	40	>99	<1
80	46	52	98	2
90	38	59	97	3
100	31	63	94	6
110	23	70	93	7
120	18	83	91	9

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Percent Interaction of X-rays Through Approximately 10 centimeters of Soft Tissue			
kVp	P.E. Effect	Compton Effect	% Transmission
50	79	21	<1
70	60	40	<1
90	36	60	4
120	19	71	10

The table above demonstrates the relative percent of photons undergoing the photoelectric effect, scattering, and transmission as the kVp increases.
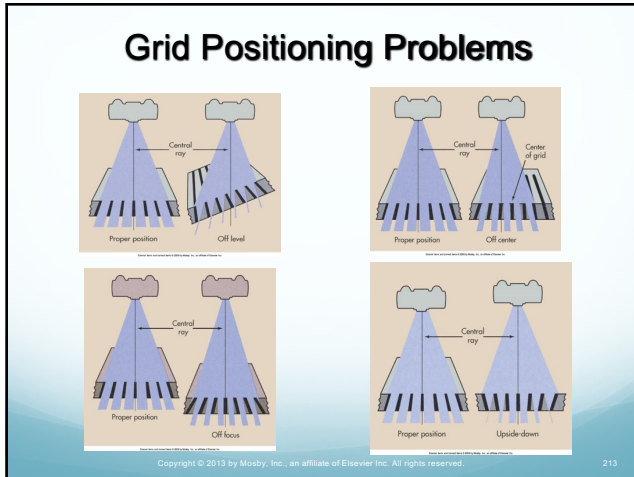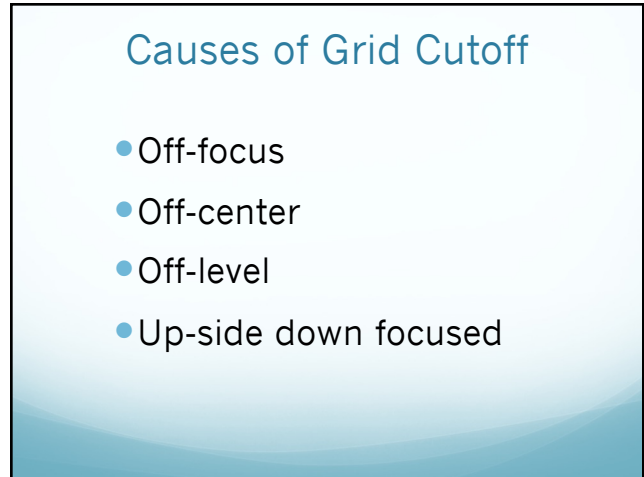
210

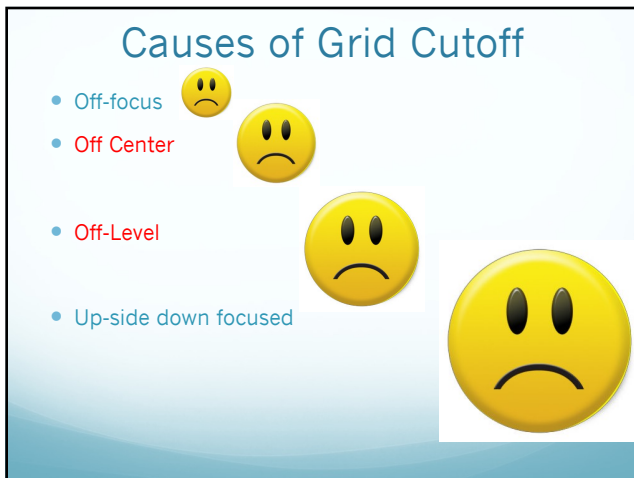
Three Types of Grids

Cross-hatch

211

Grid Ratio

$$\text{Grid ratio} = \frac{h}{D}$$

Grid ratio is the height of the grid strip (h) divided by the thickness of the interspace material (D). T = strip width.

212

Grid Positioning Problems

Proper position — Off level
Proper position — Off center
Proper position — Off focus
Proper position — Upside-down

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Causes of Grid Cutoff

- Off-focus
- Off-center
- Off-level
- Up-side down focused

214

Causes of Grid Cutoff

- Off-focus
- Off Center
- Off-Level
- Up-side down focused

215

216

Off-focus grid Cutoff vs. Off-focus radiation

217

Types of Technique Charts

- Variable kVp
- Fixed kVp
- High kVp

218

Spatial Resolution of Imaging Systems

Gamma camera	0.1 lp/mm
Magnetic resonance imaging	1.5 lp/mm
Computed tomography	1.5 lp/mm
Diagnostic ultrasound	2.0 lp/mm
Fluoroscopy	3.0 lp/mm
Digital radiography	3.0 lp/mm
Radiography	8.0 lp/mm
Mammography	12.0 lp/mm

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Dynamic Range

Screen Film Imaging
- OD zero to 3.0
- Three orders of magnitude
- Dynamic range = 1000

Digital Imaging
- Bit capacity of each pixel
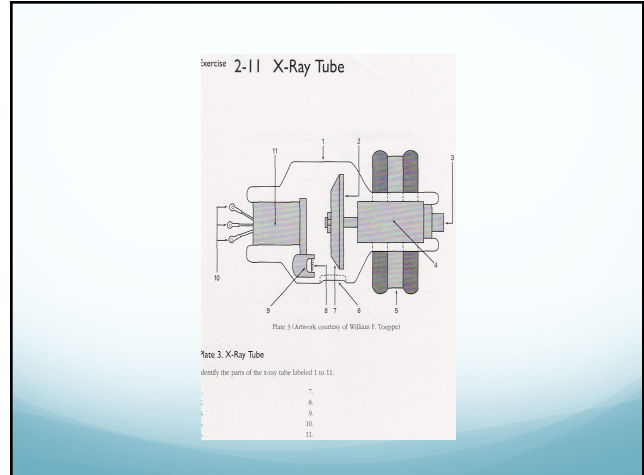- Four to five orders of magnitude
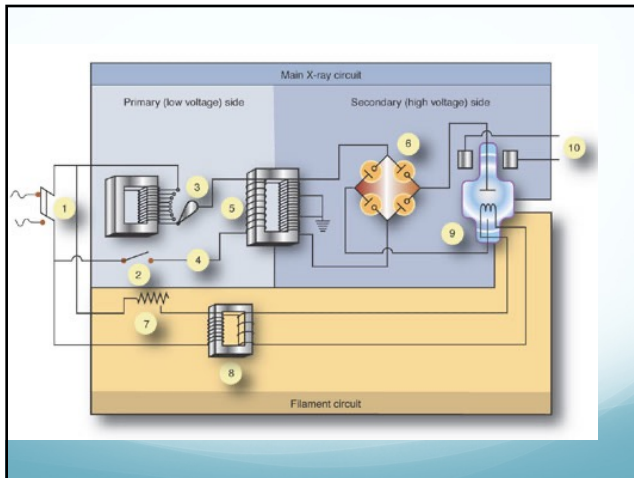- Dynamic range > 65,000

220

Digital File Sizes

Medical Image	Image Size	Exam Size
Nuclear medicine	0.25 MB	5 MB
Ultrasound	0.25 MB	8 MB
MRI	0.25 MB	12 MB
CT	0.5 MB	20 MB
Digital radiography	5 MB	20 MB
Digital mammography	10 MB	60 MB

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224

Slide 225

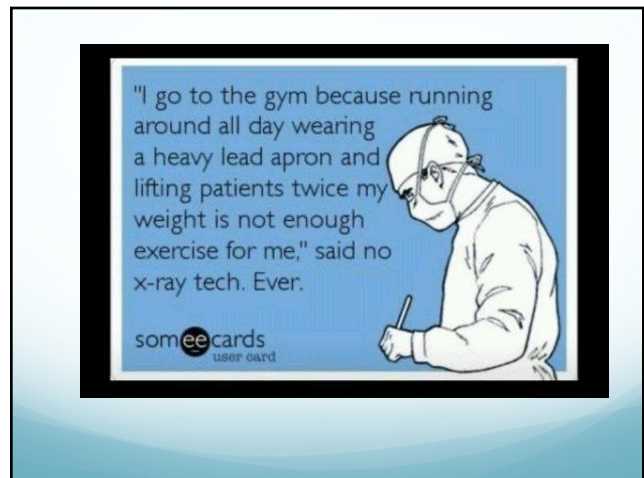| Maneuver	Adult (Puberty and Older)	Child (1 year to puberty)	Infant (< 1 year old)
The ABCD's of CPR			
Airway	Head tilt-chin lift (If trauma present, use jaw thrust)		
Breathing			
Initial	2 breaths at 1 second each		
Subsequent	1 breath every 5 to 6 seconds / 10 to 12 breaths per minute	1 breath every 3 to 5 seconds / 12 to 20 breaths per minute	
	Volume = enough to make the chest rise		
Airway Obstruction	Abdominal thrusts (Responsive – use Heimlich maneuver)		Back blows and chest thrusts
Remove object -- only if seen!	Responsive to unresponsive = 911 then CPR; check for object with each breath sequence	Responsive to unresponsive = CPR 5 cycles then 911 - check for object with each breath sequence	Unresponsive - 5 cycles CPR checking for object with each breath sequence
	Person (> 1 yr.) found unresponsive activate 911 then CPR; with each breath sequence check for object		
Circulation			
Pulse check (public looks for "signs of circulation" only, no pulse check)	Carotid (5 to 10 seconds) (reassess once after 5 cycles or 2 min.)		Brachial 5 to 10 sec. Initially then reassess every 5 cycles
Compression Landmarks	Center of breastbone between nipples (lower half of sternum)		Just below nipple line on breastbone
Compression Method	Heel of one hand w/ other hand on top	Heel of one hand	2 fingers / 2 thumbs-encircling-hands for 2 person
Compression Depth	1 1/2 to 2 inches	1/3rd to 1/2 the depth of the chest	
		1 to 1 1/2 inches	1/2 to 1 inch
Compression Rate	Rate of Approximately 100 per minute or faster		
Compression/Ventilation Ratio	30:2	One person 30:2 / Two person 15:2	
Defibrillation			
AED	Single rescuer- establish unresponsive activate EMS -- begin CPR – No pulse! Use AED	Single rescuer- provide 5 cycles of CPR then activate EMS and get the AED turn AED to child pads if an option	Do not use pads on infants less than one year of age
	Two rescuers- establish unresponsiveness, one begins CPR and the other activates EMS and gets AED. Continue CPR until pads in place	Two rescuers - same as adult / Use pediatric pads if available but adult ok, just ensure pads not touching	Not enough evidence to recommend

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Slide 226

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Slide 227

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### Slide 228
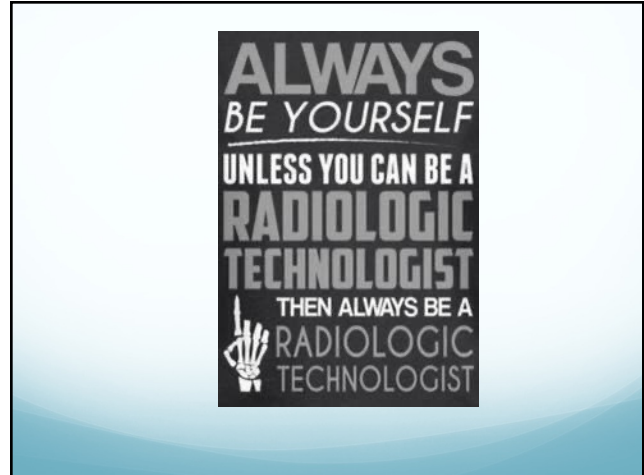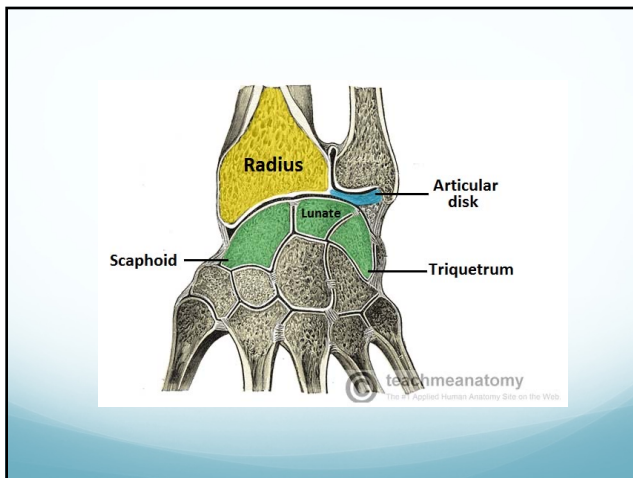
228

Name that study

229

230

Match the following:

A. The right to make decisions concerning one's own life.
B. The intent is to do good
C. Equal treatment and equal benefits
D. Honesty to patient
E. Duty to refrain from inflicting harm
F. Be faithful

- Veracity
- Justice
- Nonmaleficience
- Fidelity
- Beneficence
- Autonomy

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Basic Ethical Principles

- **Principal-based ethics** - use of moral principals as a basis for defending a chosen path of action in resolving an ethical dilemma (principlism)

1. Beneficence - "*bringing about good*"
2. Nonmaleficence - "*do no harm*"
3. Autonomy "*acting with personal self-reliance*"
4. Veracity "*telling the truth*"
5. Fidelity - "*being faithful*"
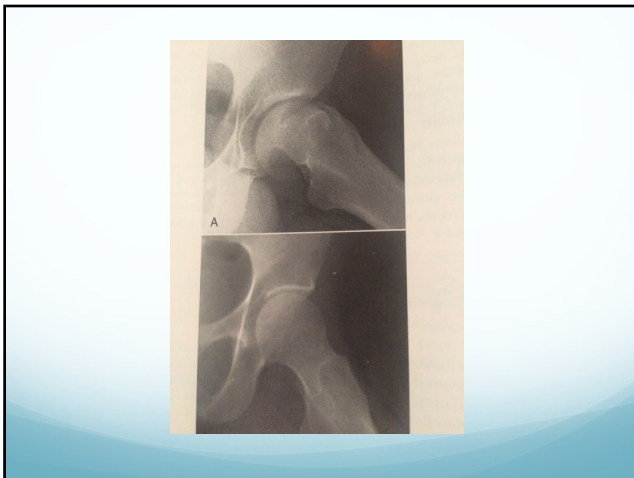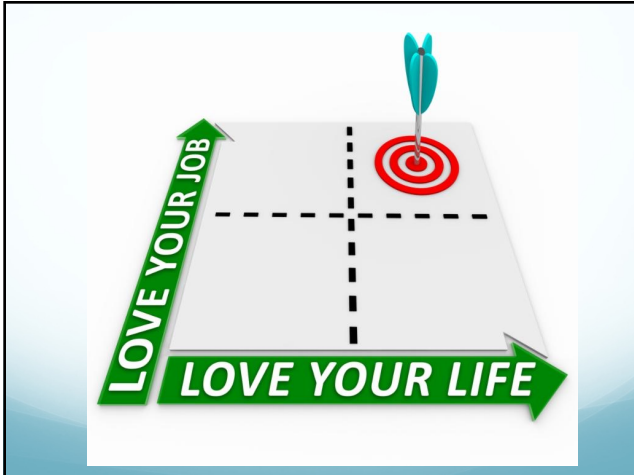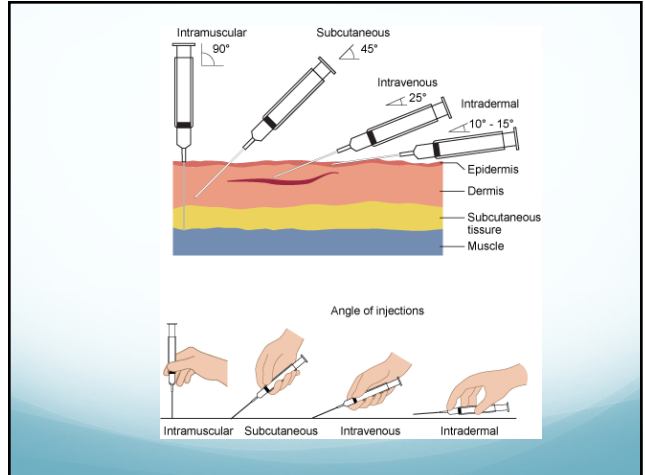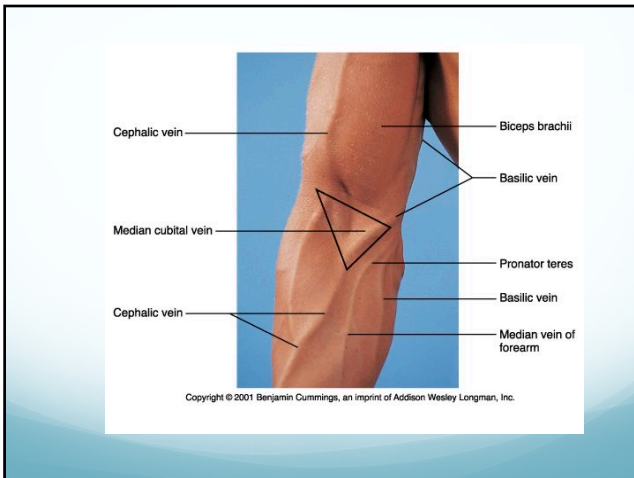6. Justice - "*acting with fairness*"

232
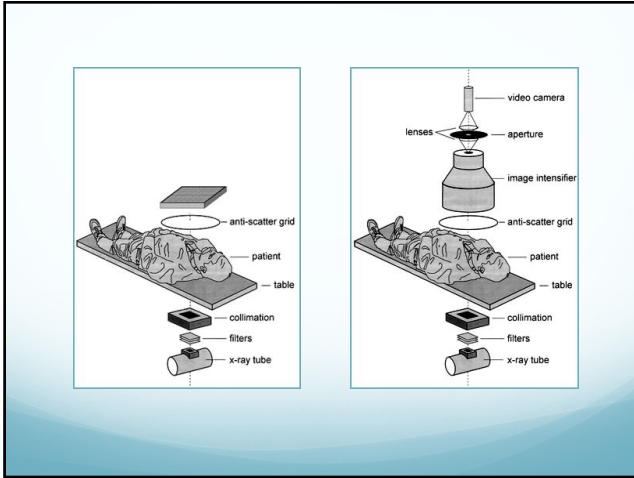
233

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Thymus vs. Thyroid
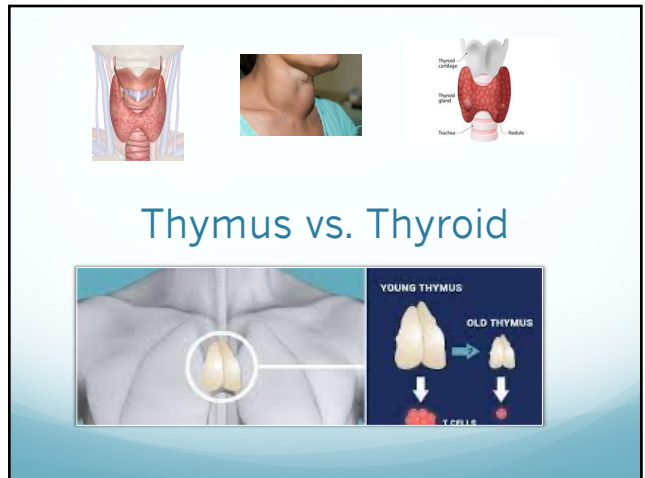
240

Urethra vs. Ureter

241

Pulsed fluoro
vs.
Intermittent fluoro

242

Display Monitor QA

TG18QC   SMPTE
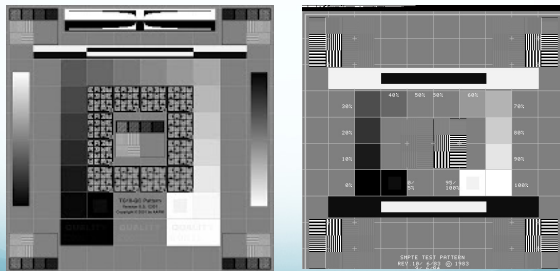
243

Neonate   Zygote

Fetus

EMBRYO

244

Zygote

Zygote

EMBRYO

Fetus

30-32 weeks

Neonate

Neonate

245

DAP
Dose Area Product

DAP = dose to air X area of field

$$DAP = Gy \times cm^2$$

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Figure 1: Range of exposures on analog film

Figure 2: Range of exposures on digital receptor
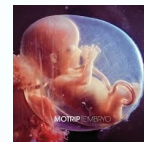
249

Histogram Analysis (Cont.)

- Exposure indicator: provides a numerical value indicating the level of radiation exposure to the digital image receptor.
  - ➢ Exposure indicator values should be within the optimum range for that digital imaging system.

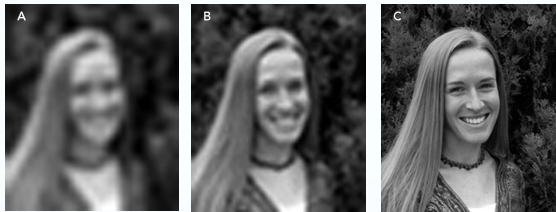| TABLE 4-1 Computed Radiography Vendor-Specific Exposure Indicators				
Vendor	Exposure Indicator	Value = 1 mR exposure	2× Exposure	½ Exposure
Fuji and Konica	Sensitivity (S)	200	100	400
Carestream (Kodak)	Exposure index (EI)	2000	2300	1700
Agfa	Log median value (lgM)	2.5	2.8	2.2

1

250
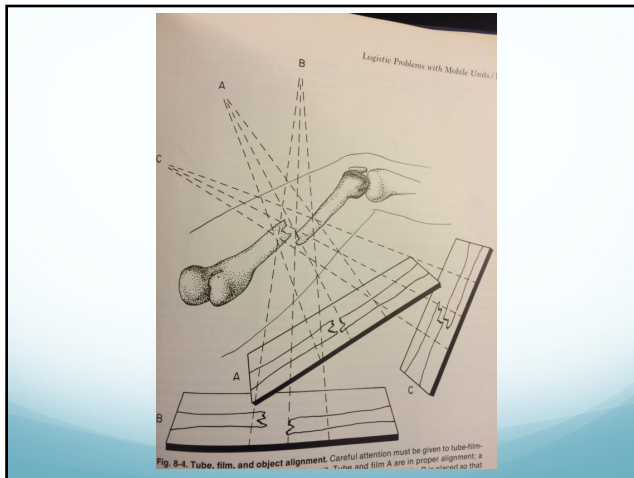
251

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- Image A = 26 X 36 pixel matrix
- Image B = 51 X 64 pixel matrix
- Image C = 200 X 251 pixel matrix

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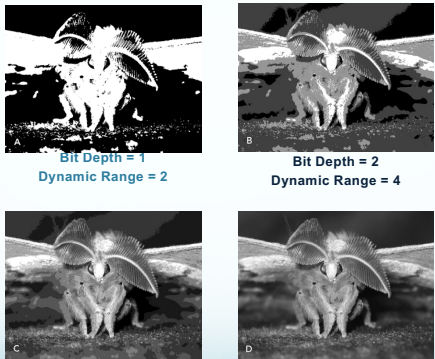## Bit Depth, Dynamic Range, and Gray Scale

Bit Depth:

- The maximum range of pixel values a computer, monitor or other hardware device can store, expressed as an exponent of base 2
    - "6 bits deep" = 2^6 = 64 values
    - "7 bits deep" = 2^7 = 128 values
    - "8 bits deep" = 2^8 = 256 values

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Bit Depth, Dynamic Range, and Gray Scale

- The human eye can only discern about 2^5 = 32 shades of gray or levels of brightness
    - By not using the *full* range of bit depth, image processing speed can be accelerated

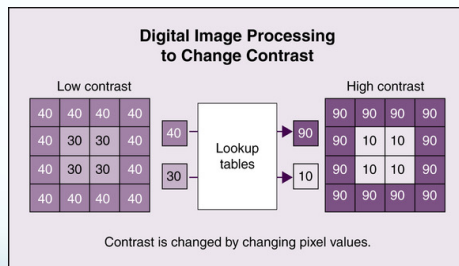255

Bit Depth = 1
Dynamic Range = 2

Bit Depth = 2
Dynamic Range = 4

Bit Depth = 3
Dynamic Range = 8

Bit Depth = 8
Dynamic Range = 256

256

Look Up Table

**Digital Image Processing
to Change Contrast**

Low contrast

40	40	40	40
40	30	30	40
40	30	30	40
40	40	40	40

| 40 |
| 30 |

Lookup
tables

High contrast

90	90	90	90
90	10	10	90
90	10	10	90
90	90	90	90

→ | 90 |

→ | 10 |

Contrast is changed by changing pixel values.

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File Size

- When many thousands of images are stored, the large *file size of* *medical images* can become a problem for the PACS administrator

- **Formula for** *file size:*

    File Size = Matrix Size X Bit Depth

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Three different ways to make adjustments to the original image:

1. **By re-processing the image under a different procedural algorithm**

2. **By** *Windowing*

3. **By applying special features**
    -*e.g., smoothing, edge enhancement, etc.*

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- **For each anatomical type of procedure, an ideal dynamic range and average gray level (brightness) is pre-programmed into the system**

- **These protocols are automatically engaged when the anatomical procedure is selected at the console. Radiographers have come to refer to them as procedural algorithms such as a "*foot algorithm,*" an "*abdomen algorithm,*" etc.**

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Windowing

= Adjusting the brightness and contrast of the image displayed at the monitor screen with controls at the console *as the image is viewed*

• *Windowing* provides more flexibility and accuracy than re-processing under a different algorithm
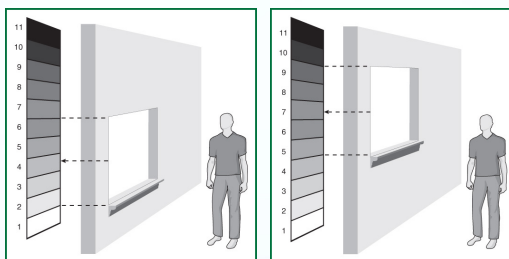
261

Window Level

= The overall or *average brightness* of the image (called *center* in some modalities)

• (Or, the older *average density* or overall darkness of the image)

• Does NOT change the number of gray levels (gray scale) in the image

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Raising the window *level,* we see an overall darker image, but the *range* of gray shades remains equal (5, in this example)

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Window Width

= Controls the length of *gray scale* in the image

• Increasing window width *lengthens* the gray scale, but does *not* alter the average brightness (or average density)

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Without changing the center or window level (arrow), the window *width* can be expanded, increasing the gray scale from 5 to 8 shades
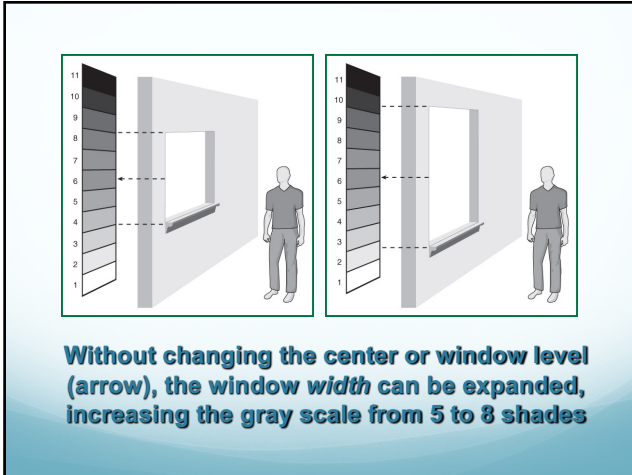
265

-Strictly speaking, as shown on the CT scans on the next slide:

- Increasing *Window Level* makes a radiographic image *darker*
  - *Window level is the opposite of brightness*

- Increasing *Window Width* gives a radiographic image *more gray scale*
  - *Window width is the opposite of contrast*

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CT Scans at:

**A: L = 40
       W = 400**

**B: L = 400
       W = 400**

**C: L = 45
       W = 97**

**D: L = 45
       W = 3500**

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Workstations and Display Stations

- ***Workstation:***

  A fully-equipped computer terminal that can manipulate image quality and permanently *save* changes made into the PAC system

  - For diagnosis, a *Class 1 workstation* requires two high-resolution (2000 X 2000 pixel) display monitors with peripherals for full communication and print-out

  - For technologist image review, a *Class 2 workstation* has a single lower-resolution (1000 X 1000 pixel) monitor

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A radiologist's diagnostic workstation, *(Class 1)* includes *two high-resolution* monitors

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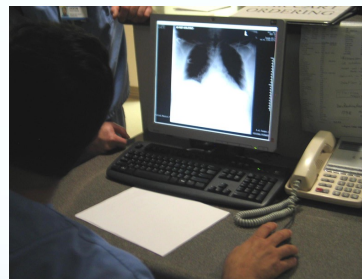
A radiographer's workstation with a single, lower-resolution *Class 2* display monitor

270

Workstations and Display Stations

- ***Display Station:***

  Limited to image display, with no ability to permanently change the image
  - Low resolution
  - Can be strategically placed throughout a hospital and in affiliated clinics to allow doctors ready access to images
  - All workstations and display stations must be located where ambient (room) lighting can be controlled. For adequate image contrast, ambient lighting must be subdued

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276
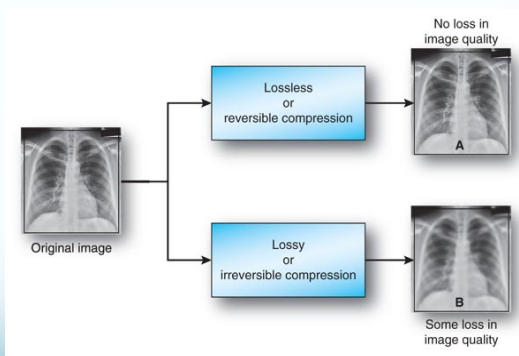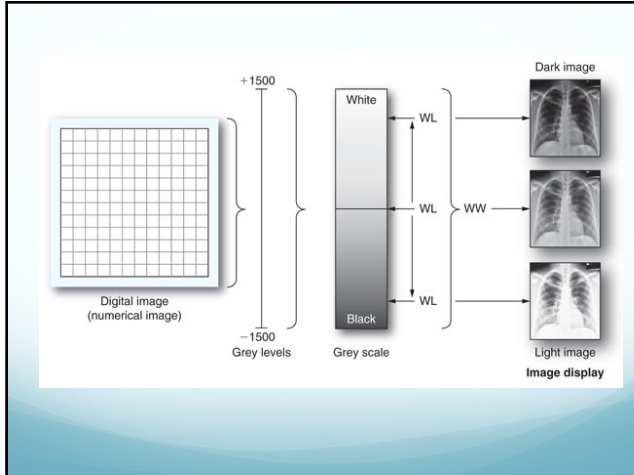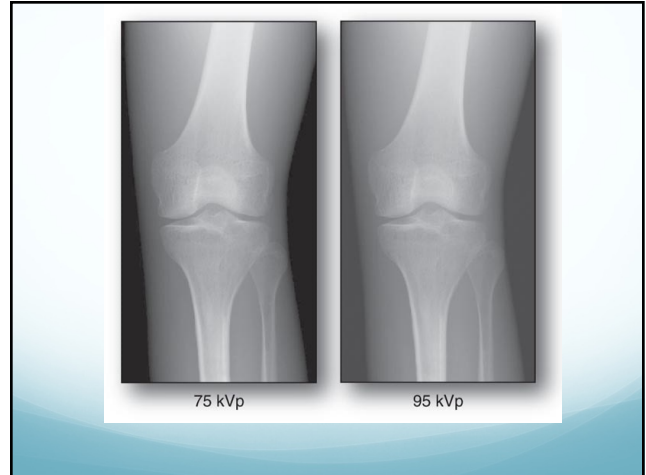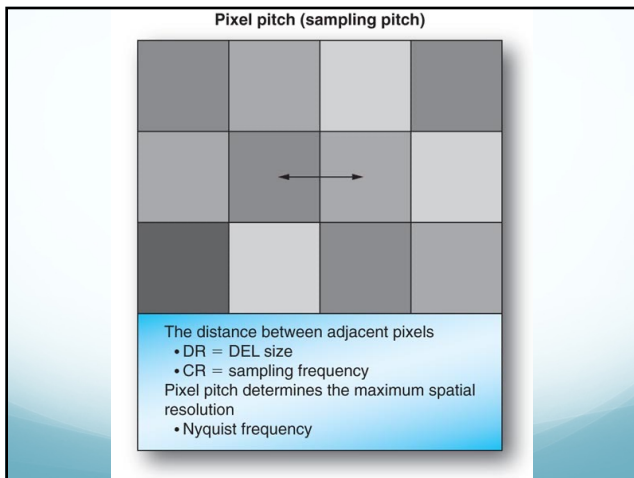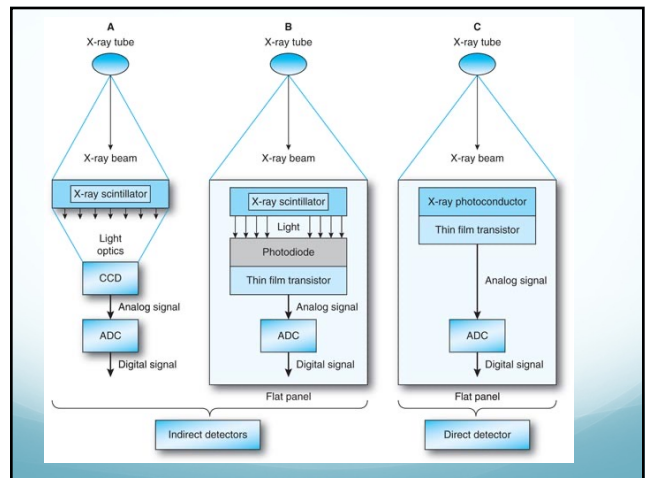
- It is important to understand that:

- Image *brightness (or average density)* can be changed *without* changing image contrast. They are NOT directly related.

- Image *contrast (or gray scale)* can be changed *without* changing image brightness. They are NOT directly related.

- (At *extreme* levels of brightness, contrast can be reduced, but this is the *exception,* not the rule)

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More Words of Wisdom...
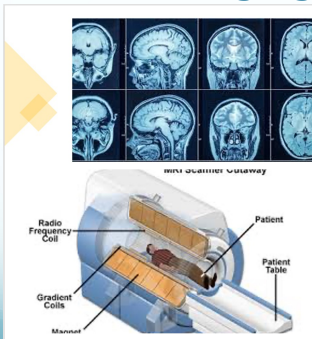
"Don't confuse a *pretty* image
with a *diagnostic* image"

279
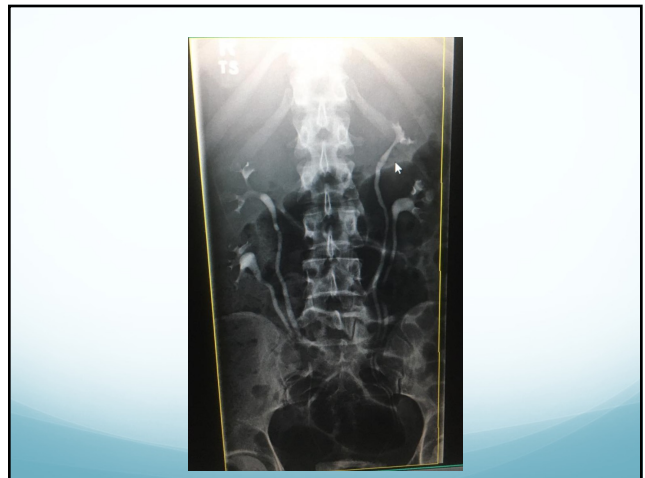
280

Magnetic Resonance Imaging (MR)

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Mammography (M)

282

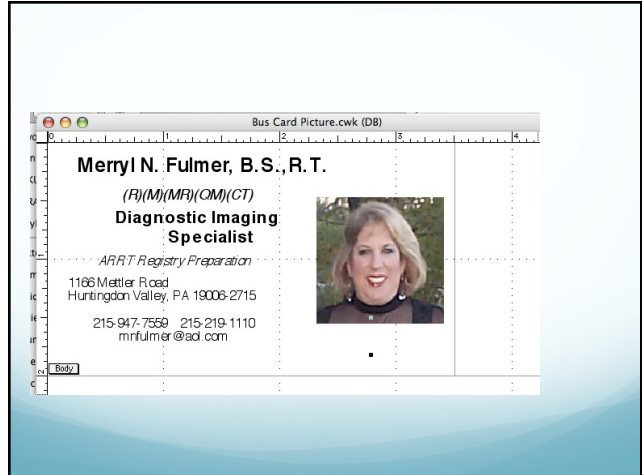

Computed Radiology (CT)

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Good Luck!!!

Thank you for giving me opportunity to teach you!!

Merryl N. Fulmer, BS, RT

(R)(M)(MR)(QM)(CT)

mnfulmer@aol.com

www.merrylfulmer.com

215-219-1110

Call or e-mail me for any questions, concerns, Skype or study sessions you may be interested in – or to share your Tips & Tricks with me!!

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Thank you & good luck!!

Merryl N. Fulmer, B.S.,R.T
(R)(M)(MR)(QM)(CT)
Diagnostic Imaging Specialist

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