X-Ray Training for Chiropractic Assistants

Our Mission:

To provide reliable education, resources and tools of practice

To advance your clinical expertise, business development, and professional growth.

Mark A. Davini, DC, DABCN

- 1981 graduate of Palmer College of Chiropractic
- 24 years in active practice
- Diplomate in Chiropractic Neurology
- Certified Chiropractic Industrial Consultant
- Past Chairman of the MA Board of Registration of Chiropractors
- Mass Chiropractic Society, Vice-President of Public Information and Education and Chairman of the state society Ethics Committee
- Lecturer for various state and national associations continuing education programs to include chiropractors, nurses, dentists and medical doctors.
- Awarded 3 U.S. patents for a brace on Carpal Tunnel Syndrome
- Active in the defense of chiropractors involved in malpractice and board litigation.
- Compliance Auditor and Clinical Monitor for practices across the country.
- Chiropractor of the Year by the Massachusetts Chiropractic Society in 1996.
- “Doctor of the Year” by the Worcester County Chiropractic Society in 1987.
- Co-Developer of T.O.P. Education, LLC with Paul Andrews, LMT, CCCA, CPCO

Table of Contents:

Course Description:

Phase I:

- This Phase consists of 22 hours of instruction and testing.
- Each Lesson will be presented in a recorded lecture format with safeguards to ensure attentiveness
- Practice quizzes or testing will be presented at the end of each section during Phase I.
- These lectures quizzes and test will present information necessary for a working understanding of the equipment, radiation, radiation safety, the production of X-Ray images in the chiropractic office and image processing.
- Monthly live Q&A webinar will be scheduled to answer any questions or concerns to date.
- The Q&A webinar is optional and will not count toward the 50 hour requirement.
- Phase I will serve as a prerequisite for Phase II and must be completed before moving on to Phase II.

Course Description:

Phase II:

- This Phase consists of 16 hours of instruction and testing.
- Each Lesson will be presented in a recorded lecture format with safeguards to ensure attentiveness.
- Practice quizzes or testing will be presented at the end of each section during Phase II.
- These lectures, quizzes and test will expand on Phases I with instruction on X-Ray positioning, and emergency procedures.
- Monthly live Q&A webinar will be scheduled to answer any questions or concerns to date.
- The Q&A webinar is optional and will not count toward the 50 hour requirement.
- Phase II will serve as a prerequisite for Phase III and must be completed before moving on to Phase III.

Course Description:

Phase III:

- This Phase will consist of 12 hours of live, in person training over two consecutive days focusing on all practical aspects of X-Ray positioning operation, technique, safety and processing.

Phase IV:

- Following the live 12 hour live seminar, a state board approved examination will be administered by representative of the North Carolina Board of Chiropractic Examiners.

Study Materials:

- CHIROPRACTIC RADIOLOGIC TECHNOLOGY STUDY GUIDE , 2016 edition: From the American Chiropractic Registry of Radiologic Technologists, 52 W. Colfax Street, Palatine, Illinois 60067

- T.O.P Education's download. This download will review all materials presented during the webinars.

Why:

Proposed Law:

Consumer-Patient Radiation Health and Safety Act of 1981:

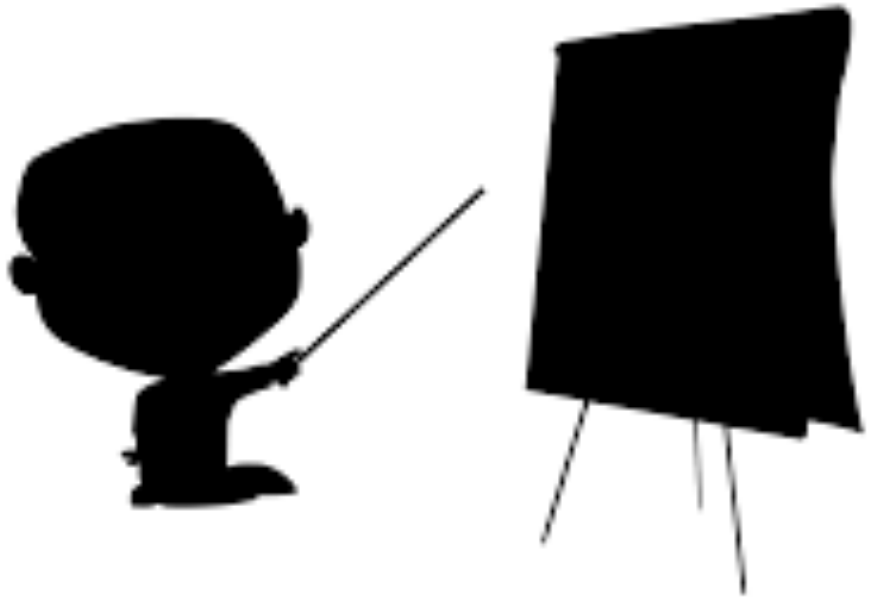
- Minimize unnecessary exposure to radiation for all procedures to patients and operators.
- Minimize unnecessary exposure to radiation for all procedures to the public.
- Support all required education regarding procedures and protocols as defined by state & federal law.
- Mandate demonstration of competency before being allowed to administer radiologic procedures.

Passed Law:

Two main provisions:

1. Provide for the establishment of minimum standards and education.
2. Ensure rigorous safety precautions and standards.

Always stay within your training…




TEAM WORK

What is a Professional?

- Positive and has a good attitude
- Accepts responsibility
- Self-directing
- Confident
- Inspiring
- Organized
- Supportive
- Enthusiastic
- Compassionate
- Flexible
- Mature
- Stable and in control
- Consistent
- Neat and clean
- Aware
- Does not abuse their authority
- Able to communicate
- Aware of boundaries

Use of Authority:

- The professional relationship between the CA and the doctor has an important influence on the patient and outcome of chiropractic care
- The professional relationship between the CA and the patient has an important influence on the patient and outcome of chiropractic care
- Creates an atmosphere of trust and confidence
- The CA should consider the patient to be their partner in the care process
- CAs are caregivers and therefore must be compassionate and sensitive to the patient's needs while recognizing the importance of good communication skills.
  - Provide appropriate and understandable explanations and instructions
  - Recognize and respond to patient feedback and questions and concerns
  - Recognize significant non-verbal signs and behaviors exhibited by the patient

Communication:

Confidentially Speaking:

HIPPO ~~HIPPO~~

HIPPA ~~HIPPA~~

HIPAA

Health Insurance Portability And Accountability Act of 1996

Confidentiality:

HIPAA
Health Insurance Portability And Accountability Act of 1996

Accountability:

- Standards and safeguards to maintain privacy that protect patients' health information provided to health plans, doctors, hospitals and other health care providers.

JUST THE FACT A PATIENT IS A PATIENT IS CONFIDENTIAL

Portability:

- Portability allows eligible insureds to *"port"* (continue) their Group Life insurance coverage when they are in danger of losing that coverage because their employment is being voluntarily or involuntarily terminated.

Communication:

P.I.	Private Information
P.H.I.	Protected Health Information
e.P.H.I.	Electronic Protected Health Information
T.P.O.	Treatment, Payment & Operations = Those procedures and protocols an office needs to perform daily business transactions, when sharing PHI – ePHI – PI.
Providers	Physicians (Chiropractors), Dentists, Nurses, Psychologists, Pharmacies, Labs, Nursing Homes, DME Suppliers.
Health Plans	Health insurance Companies, HMOs, Government Programs
Business Associates (BA)	All 3rd party vendors and business partners who works with your PHI and are not otherwise bound by HIPAA or state law.

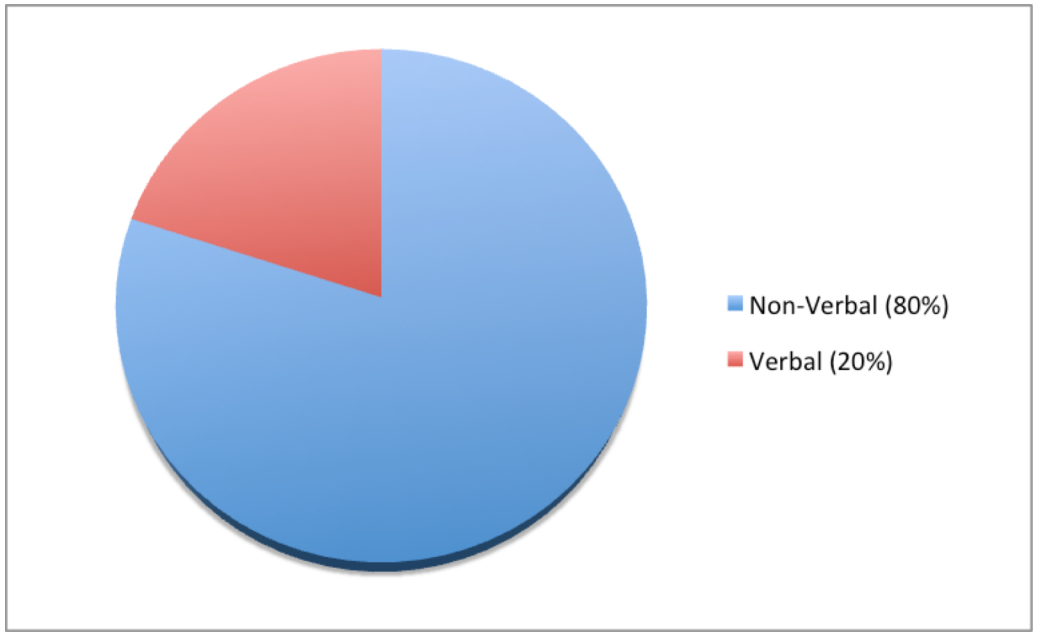
Communication:

- Be aware of the unique nature of the caregiver-patient relationship (Use of Authority)
- Ensure that only appropriate information is properly released to the doctor
- Maintain confidential space
- Connect-eye contact
- Use patient’s first name
- Care about their needs

Communication:

Verbal and Non-Verbal:

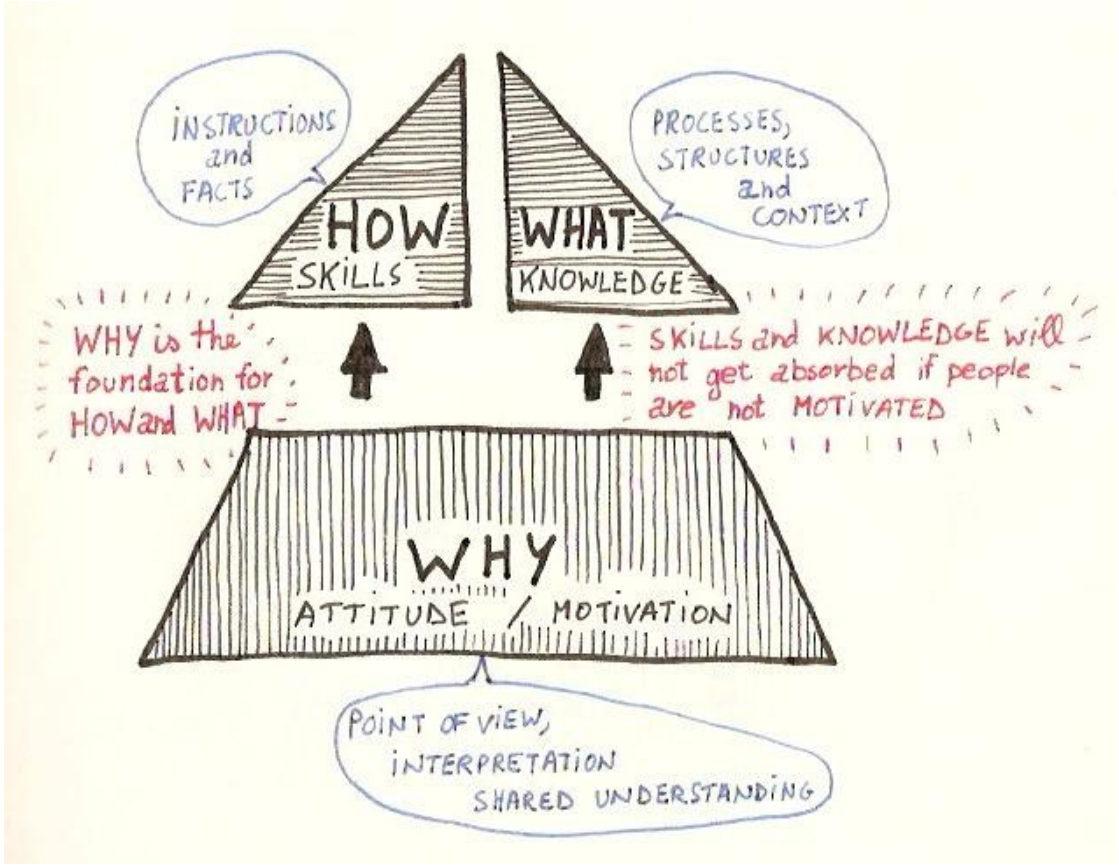
- What do your clothes say
- Where are your eyes
- Voice tone “how are you doing?”
- Be mindful of how you give compliments.



Communication:

Effective Communication Technique:

1. Tell them why you are doing it.
2. Tell them how you are going to do.
3. Tell them what you have done.
4. Ask if they have any questions or concerns.



Communication:

Consent:

- Implied Consent
- General Consent
- Informed Consent

Boundaries:

- Be positive and optimistic
- Respect for boundaries is the framework of successful patient interaction
- Attitude and demeanor
- Be aware of patient apprehension
- Avoid exclamatory statements and physical responses that may exacerbate patient concern
- Leave your problems outside the office
- Do not discuss personal issues with the patient
- Keep the conversation on the care
- Avoid controversial topics
- Stay focused and in present time consciousness

Boundaries:

Improper Comments:

- *Three Strike Rule:*
  - *Strike One* - *Overlook/Ignore*
  - *Strike Two* - *Make clear statement of inappropriateness*
    - Make doctor aware of encounter
  - *Strike Three* - *You're out - leave and get Doctor*

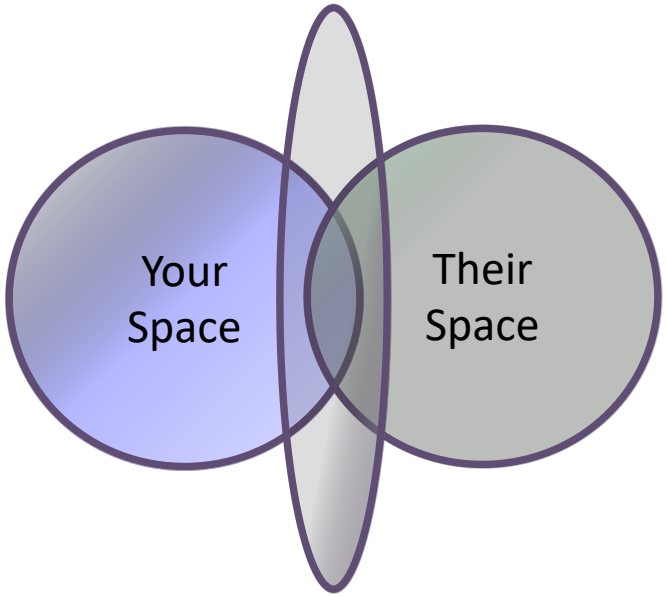
Boundaries:

Touching:

- A patient grants you permission to enter their personal space
- You must not abuse the privilege.
- The power of authority is more than you imagine.
    - Be aware of hand placement at all times
    - Use as few fingers as necessary to perform function
    - Patients feel vulnerable when face down and/or in a gown
    - Be careful your eyes may cross the line

If there is an incident of improper touching:

<u>One strike your out-get the doctor!</u>



Hygiene:

Universal Precautions:
(abridged for chiropractic office)

- New standard is BBE = Bare Below the Elbow
  - No long shirt sleeves
  - No watch
  - No jewelry
- Proper hand sanitation
  - Hand washing
  - Hand sanitizers
- Wear gloves - whenever there is a possibility of coming in contact with blood or other potentially infectious materials
- Dispose of all contaminated personal protective equipment in an appropriate container marked for bio-hazardous waste

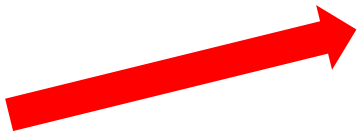
Hygiene:

Proper Glove Removal:

1. Pinch and hold the outside of the glove area by the wrist;
2. Pull downward away from the wrist and turn inside out;
3. Pull all the way off and place in palm of the other gloved hand;
4. With your ungloved hand slide two fingers under the wrist of the gloved hand careful not to touch the outside of the glove'
5. Peel downward over the palm with the other glove in it; and
6. Continue to pull the glove off with the other glove inside it and dispose of properly.

FYI

Chapter 1 - Sections 1-2-3-4 (with subsections)

Reference to text 

Reverence to review Questions Sections at the end of the chapters 

In the beginning…

Chapter 1 - Sections 1-2-3-4 (with subsections)

First discover in 1895 (same year as Chiropractic) by Wilhelm Conrad Roentgen.

In the old days you may have heard X Rays referred to Roentgenograms.

Because the rays produced were unknow he called them “X” rays.

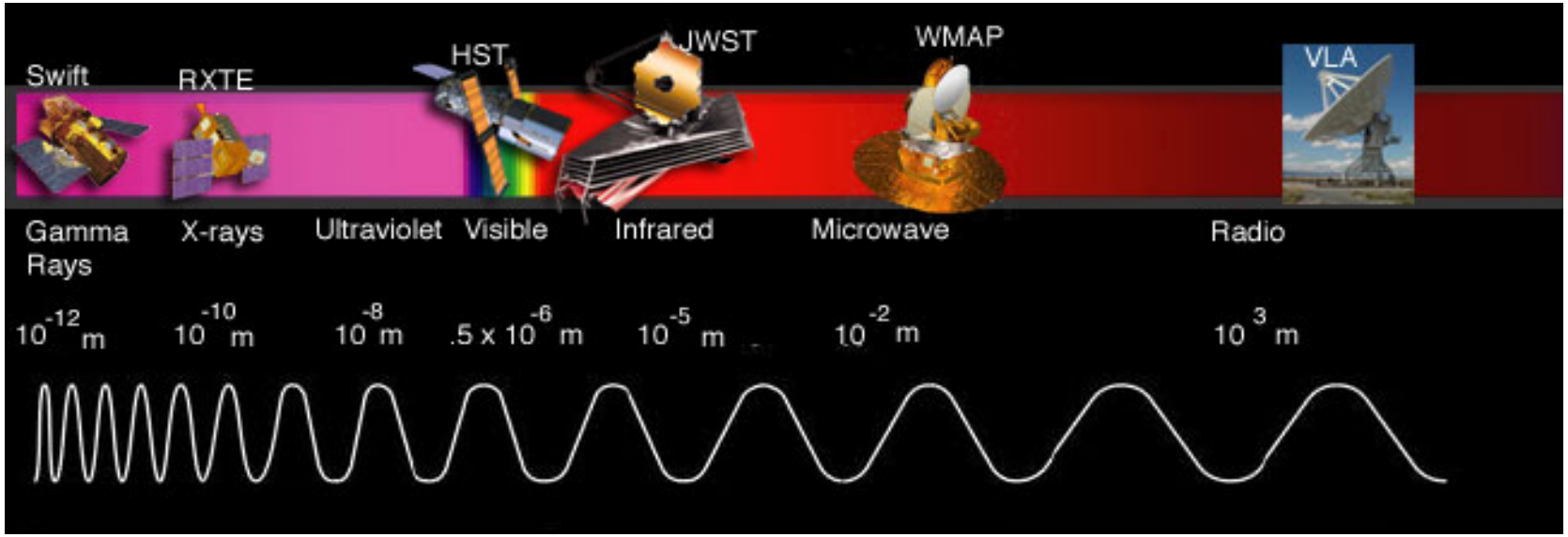
For his discovery he received the first Nobel Prize in Physics in 1901.

What is X Ray?

Chapter 1 - Sections 1-2-3-4 (with subsections)

Electromagnetic Radiation:

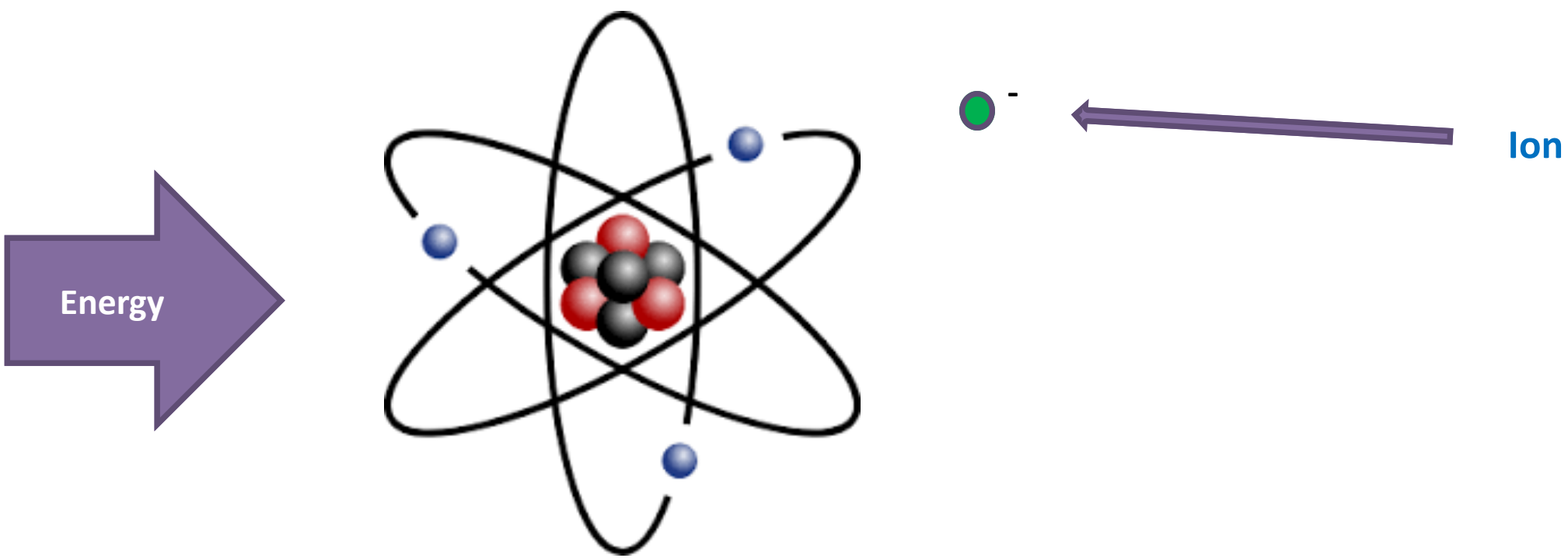
- Radiation = is the emission of energy in the form of waves and particles.
- Two ranges, Non-ionizing and Ionizing.
- Examples of Non-Ionizing Radiation are radio, tv, microwave and the visible spectrum (ROY G BIV)
- X-Ray is one form of Ionizing Electromagnetic Radiation with shorter wavelengths and higher frequencies therefore the stronger the radiation and penetration
- Radiation may be natural or man made.



What is X Ray?

Electromagnetic Radiation:

- Ionization = process of separating electrons in an atom creating the electrically charged particles called ions.



Types of X Ray Radiation:

Chapter 1 - Section 11 (with subsections)

a) Primary:
   - Radiation (made up of photons) directed toward an object.
     (You will learn about the Central Ray (CR) which is the Primary X Ray Beam)

b) Attenuated:
   - Primary Radiation that is weakened when passing though materials.
     (This is what happens when X Ray passes through filters)

c) Remnant:
   - Primary radiation that pass through the object being X-Rayed to the film itself.
     (This is the X Ray that creates the image)

d) Leakage:
   - Photons that escape from the tube housing.
     (Radiation goes throughout the room) and is one reason to be behind barriers)

e) Secondary/Scatter:
   - X Ray that is created by interaction with its surroundings.
     (Leakage is one form of Secondary/Scatter)

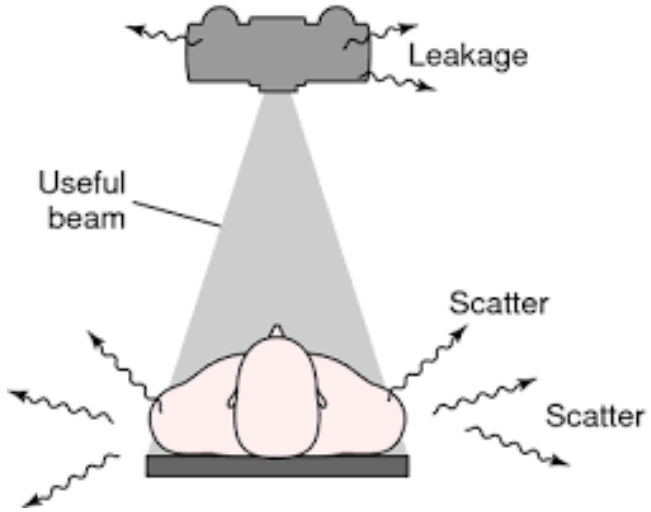
f) Absorbed:
   - Radiation that is attenuated and interacts and affects the body.

Types of X Ray Radiation:

Chapter 1 - Section 11 (with subsections)

Secondary or Scatter Radiation:

- All objects when exposed to radiation will create and give off its own radiation, it is called secondary or scatter radiation.
- Compton Effect = Radiation given off goes in all directions and is weaker because the wavelengths get longer.
- That radiation strikes all objects and creates even a weaker form (tertiary) scatter and so on until the force of the scatter is so weak it is totally absorbed.
- **The beam does not "BOUNCE"**. It is taken in, reacts with the molecules of the material and gives off its own radiation. This is why you should not be in the room during exposures.



Properties of X Ray Radiation:

Chapter 1 - Sections 1-2-3-4 (with subsections)

1. Travels at the speed of light (186,000 miles PER SECOND)
2. Greater energy photons (cells packets of energy) and a shorter wavelength that visible light.
3. Shorter wavelengths can get between cells easier therefore shorter wavelength radiation is stronger and more penetrating.
4. X-Rays emitted by the tube have varying strengths and qualities.
5. Like visible light, X-Rays can affect photographic film.
    - This is why X Rays were discovered. Remember Mrs. Roentgen's hand
6. X-Rays can cause certain chemicals to emit light (fluorescence).
    - This is how Intensifying Screens decrease exposure. (to be discussed)
7. Cannot be seen, heard or immediately felt.
8. Travels in a straight line from the source.
9. May scatter by other atoms they hit.
10. X-Ray obeys the Inverse Square Law (essentially the farther from the source the less energy)
11. X-Rays can ionize matter and living tissue.
12. X-Rays can result in positive and negative biological effects.

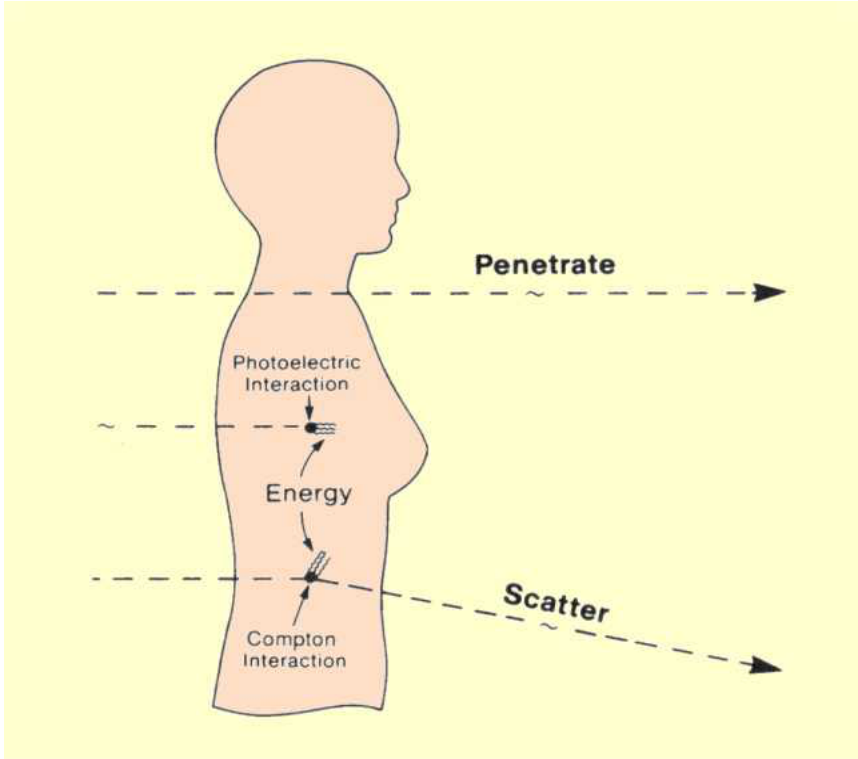
How X Rays Result in Biological Effects:

Chapter 1 = Sections 1-2-3-4 (with subsections)

X Rays Interact with all Matter in 3 ways:

1. Photoelectric Interaction = All energy transferred to the electron and may create ions.
2. **Compton Interaction of Scatter = Partial transfer, the rest goes out in all directions.**
3. Pair Production = All energy transferred to an electron and a positive electron (positron).

Stays within



Through the body

Partial escape from body

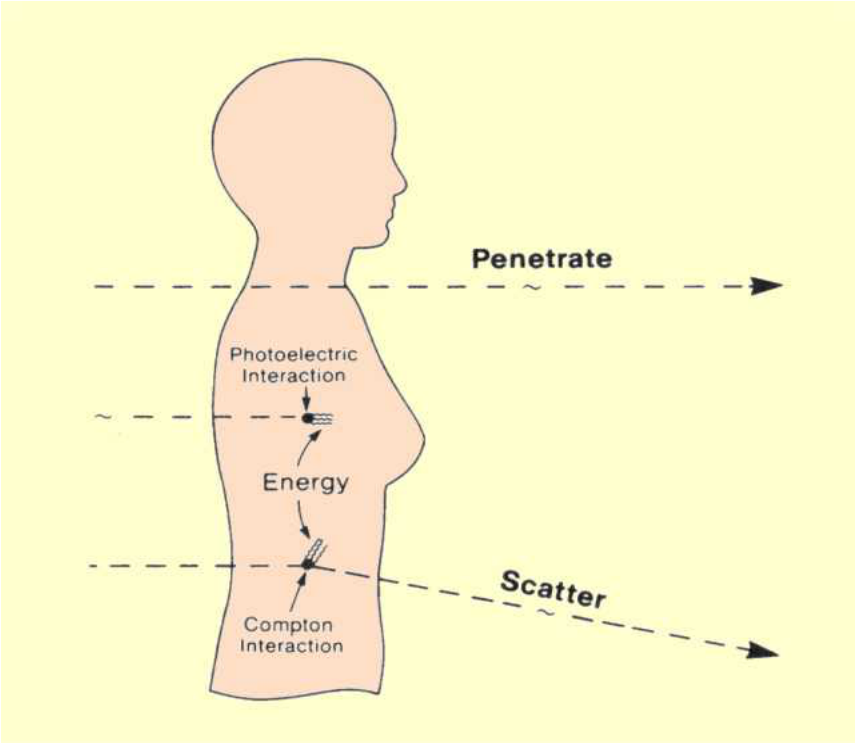
How X Rays Result in Biological Effects:

Chapter 1 = Sections 1-2-3-4 (with subsections)

Absorption:

- X Rays that become “Attenuated Radiation” by interacting with the cells of the body, becoming “Absorbed Radiation”.
- The rest passes through and helps create an image on film (“Remnant Radiation”).

Full Dose



Little Dose goes
Through body to create image

Limited Dose - Distorts image

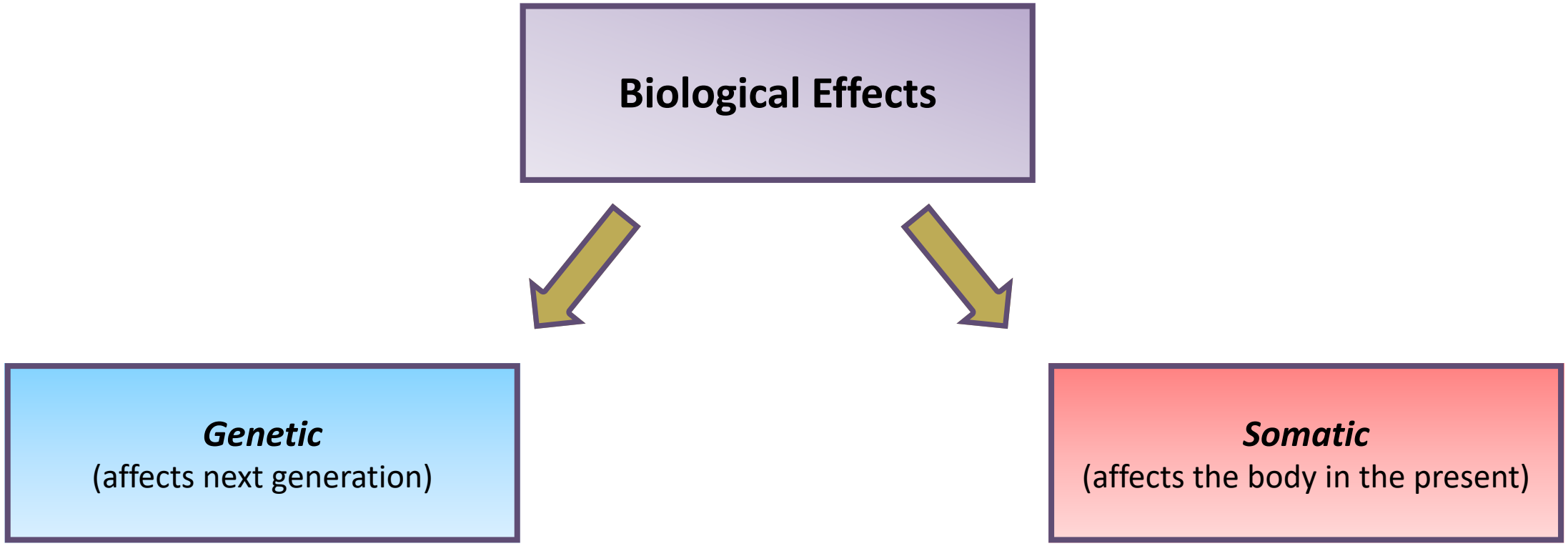
What Determines Severity of Biological Effects:

Chapter 3 - Section 1.3 and Section 2. 2.1 - 2.2.2 - 2.2.3

1. Rate of Absorption = less radiation, less intensity equals less absorption.
2. Area Exposed = smaller is better. Less area exposed at one time equals less absorption.
3. Variation in Species and Individual Sensitivity = Speaks for itself.
   - **Lethal Dose = varies by species and individual. Usually expressed in a ration, e.g. *LD 50/30* - kills 50% of the population in 30 days**
4. Latent Period: Once exposed, there is a time delay in signs or symptom.
   - Short Period = minutes to days or weeks
   - Long Period = years to decades and sometimes generations.
5. Recovery Period: = varies based on dose, tissue, degree of damage.
6. Variation in Cell Radiosensitivity = within the same individual there will be different response to exposure based on the tissue . Again fast growing (rapidly dividing) cells will be affected most.
   - Extreme = Immature Cells
   - High = White and Red Blood Cells Reproductive cells
   - Moderate = Epithelial Cells (skin cells think of sun burn)
   - Lower = Muscle and Nerve

Two Main **General** Categories of Biological Effects:

Chapter 3 - Sections 1-2-3-4-5-6-7 (with subsections)



Two Main **General** Categories of Biological Effects:

Chapter 3 - Sections 1-2-3-4-5-6-7 (with subsections)

A. **Genetic** = damage to DNA (chromosomes) in sperm and ova may damage future offspring. Mostly involve cells and tissues and may be temporary or permanent.

This is called the Genetically Significant Dose (GSD) or mutations. (*Mutagenic Effects)*

B. **Somatic** = Damage to individual not passed or transmitted on to future generations.

- May be short or long term depending on exposure and Latent Period
- May be immediate or delayed

1. Embryological = effects to immature and rapidly dividing cells. First 1 to 3 months are the most active and therefore most sensitive to radiation.
   - Predominant effect is to the CNS.
   - Death may occur during the period of organogenesis (time when major organs are developed). Generally weeks 2 to 6.
   - The most radiosensitive is 1 to 3 months of pregnancy.

3. Carcinogenic = Theories as to how include activation of a dormant virus, damage to chromosomes, mutation of somatic cells, formation of free radicals.

4. Cataractogenic = Cataracts

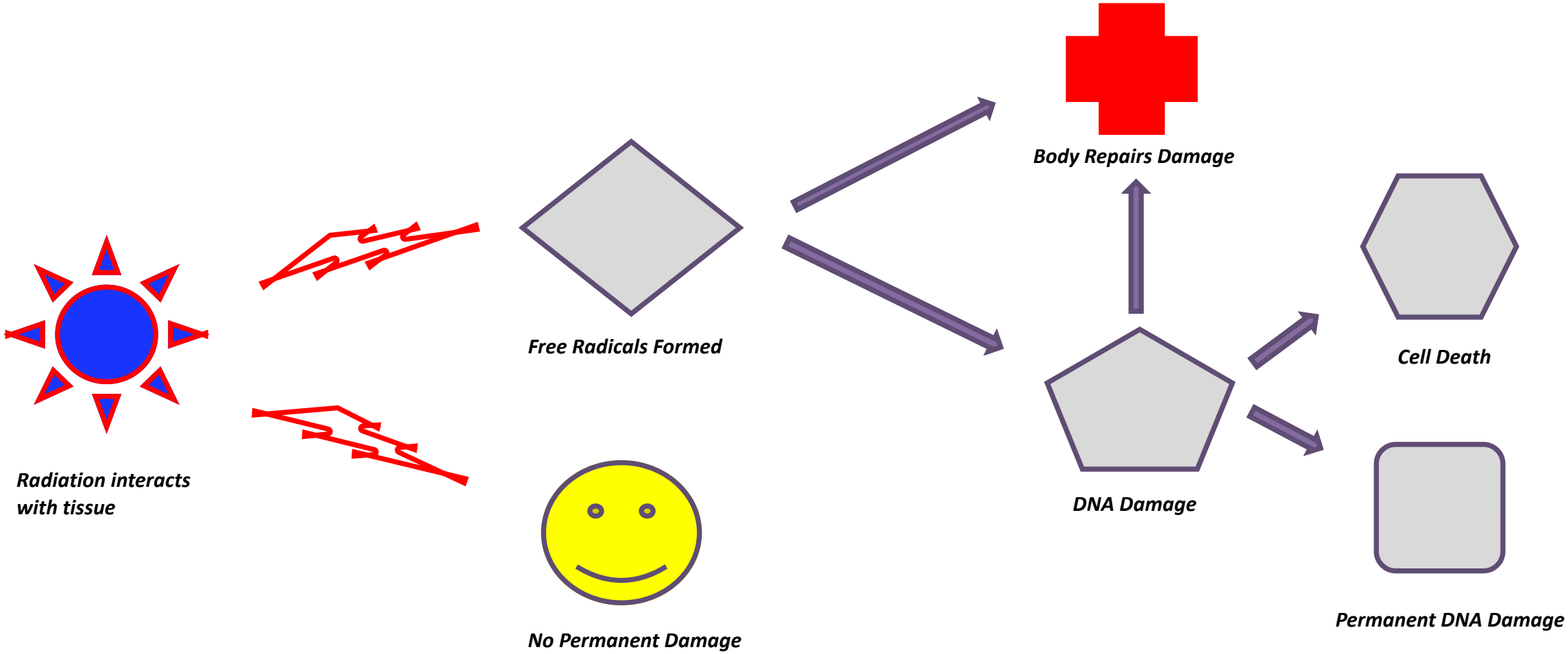
5. Life Span Shortening

Negative Biological Effects:

Chapter 3 - Sections 1-2-3-4-5-6-7 (with subsections)

1. **Molecular** = Molecules (multiple cells)
    - Direct Hit Theory = interacts directly with DNA and causes damage
    - Indirect Hit Theory = interacts with water in the cells, which then causes DNA damage
2. **Cellular:**
    - Instant cellular death (minutes)
    - Reproductive cellular death
    - Genetic or mitotic cellular death dies after division(s)
    - Chromosome damage
    - Permanent or Temporary
3. **Organic** = alteration and damage to tissue, e.g. cataracts and leukemia.
    - Amount of damage is dose dependent, i.e. the amount of radiation
    - How ionizing is the radiation
    - Sensitivity of part exposed
    - Amount of area exposed

Possible Outcomes:



How to Measure the Amount of X-Rays:

Chapter 1 - Section 12 (with subsections)

Units and Quantities:

- Exposure = The amount of ionization in an X-Ray beam in a specified amount of air.
- Roentgen (R) = Unit of Exposure.
- Milliroentgen (mR) = 1/1000 of a R
- Radiation (Roentgen) Equivalent in Man (rem) = Effective absorbed dose and how they affect humans.
- Quality Factor (Q) = Different types of radiation cause different effects, e.g. neutron radiation is a 10 and X-Ray is a 1.
- Modifying Factor (N) = The end result of all factors combined. e.g. X-Ray is a 1.
- Dose Equivalent (H) = D plus Q plus N.
- Exposure Rate or Intensity (R/Unit if time) = number of R produced by the machine per second, minute or hour.
- Radiation Absorbed Dose (rad) (Gy) = How much is absorbed by the patient. The more Rads, the more X-Ray absorbed, the greater potential damage to the patient.

How Much is Too Much:

Chapter 3 - Sections 12 and 13 (with subsections)

Maximum Permissible Dose (MPD):

- Maximum Permissible Dose = the amount of ionizing radiation that an individual can absorb without having biological effects or damage.
- Laws that protect the workers were established by the Nuclear regulatory Commission (NRC).
- rad = NON Occupational situations.
- rem = for occupational situations.
- This is an absorbed dose not an exposure amount.
  - For most critical organs:
    - 1.25 rems per calendar quarter
    - Total cumulative amount 5 rem for each year after the age of 18
    - Max Cumulative Whole Body Dose: 5(N-18)
    - N equals the age in years since last birthday
    - Less critical organs the dose limit is higher
- Cumulative MPD = If you have not been exposed to radiation for so many years after 18, you can bank them and add that amount each year up to 12 REMs.
- Cumulative MPD can be calculated based on age and exposure (see Chapter 3.13)

How Much is Too Much:

Chapter 3 - Sections 1-2-3-4-5-6-7 (with subsections)

Short Term Effects:

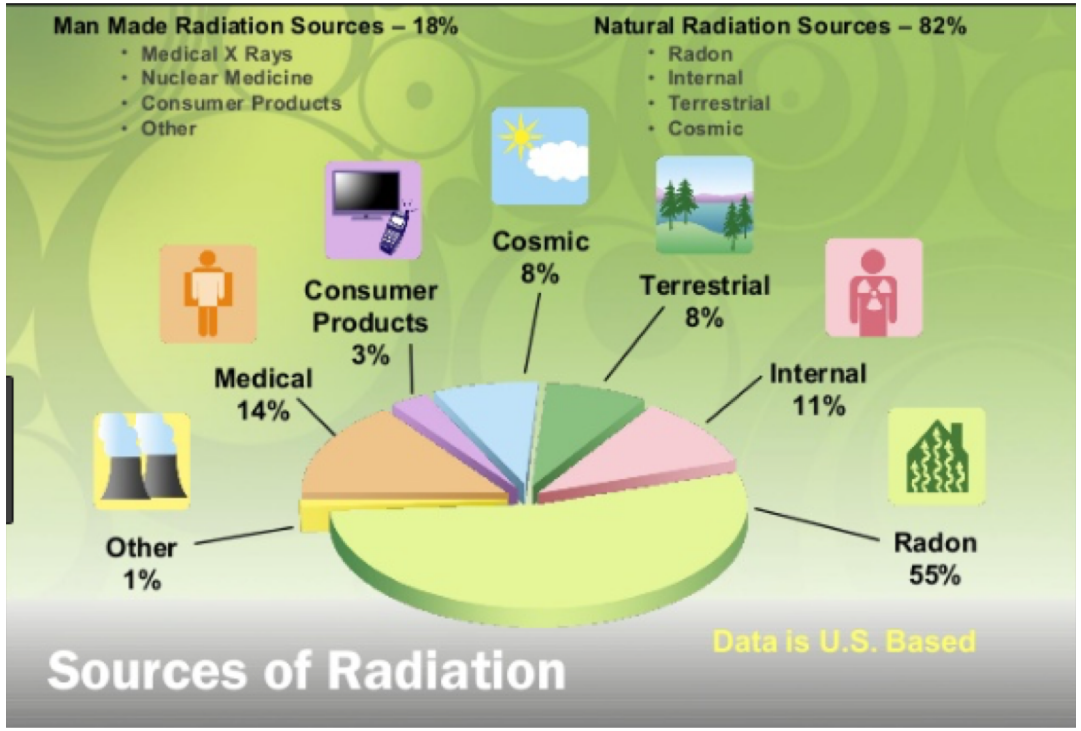
- Acute dose of radiation delivered to the whole body.
- Shorter latent periods
    - Acute Radiation Syndrome = result of radiation to the whole body.
        - Stages:
            - Prodromal = onset within 48 hours
            - Latent = onset after 48 hours and usually improve within a week
            - Manifest Illness = Symptoms depends on type may last hours to months
            - Recovery or Death = if not a LD may take weeks or months to heal
- Types:
    - Cerebrovascular (CV & CNS) = death within days from breakdown of CV and CNS.
    - GIGU = death within 15-30 days, digestive lings damaged.
    - Hematopoietic = death occurs up to 30 days from blood damage.

How Much is Too Much:

Chapter 3 - Sections 1-2-3-4-5-6-7 (with subsections)

Long Term Effects:

- Manifest months or years later.
- May be from previous acute exposure of chronic low level exposure
- There are many every days sources of radiation



What Makes A Good X-Ray:

Chapter 4 - Sections 1-2-3-4-5-6-7(with subsections)

- There are a number of factors that affect the quality of the final product.
- The more procedure, control and routine in place the more consistent you will be in good images.
- Remember the image must of diagnostic quality.
- Primary Exposure Factors:
    A. Beam Factors
    B. Source-to-Distance (SID)
    C. Photographic Properties

What Makes A Good X-Ray:

Chapter 4 - Sections 1-2-3-4-5-6-7(with subsections)

Primary Exposure Factors:

A. **Beam Factors** = There are 3 concerns regarding the X Ray Beam:

1. Quality - kVp (kilovolt peak)

   Strength of the Beam. Energy of the photons and wavelength. The more voltage the shorter the wavelength the more penetrating power of the beam. This is controlled by kVp. Although it affects Density of the image it is not the primary factor as it also will potentially decrease contrast.

2. Quantity - mA (milliamperes)

   The number of photons (X Ray) being emitted by the tube.

3. Time - mAs (milliamperes per second)

   The number of photons (X Ray) being emitted by the tube per second, mAs.

   Since photons cannot be directly measured they are quantified by the number of electrons hitting the target measured by the current or mA (milliamperes) over time of exposure expressed in fractions of a seconds “s”. Therefore the amount of photons per second is the milliamperes per second (mAs).

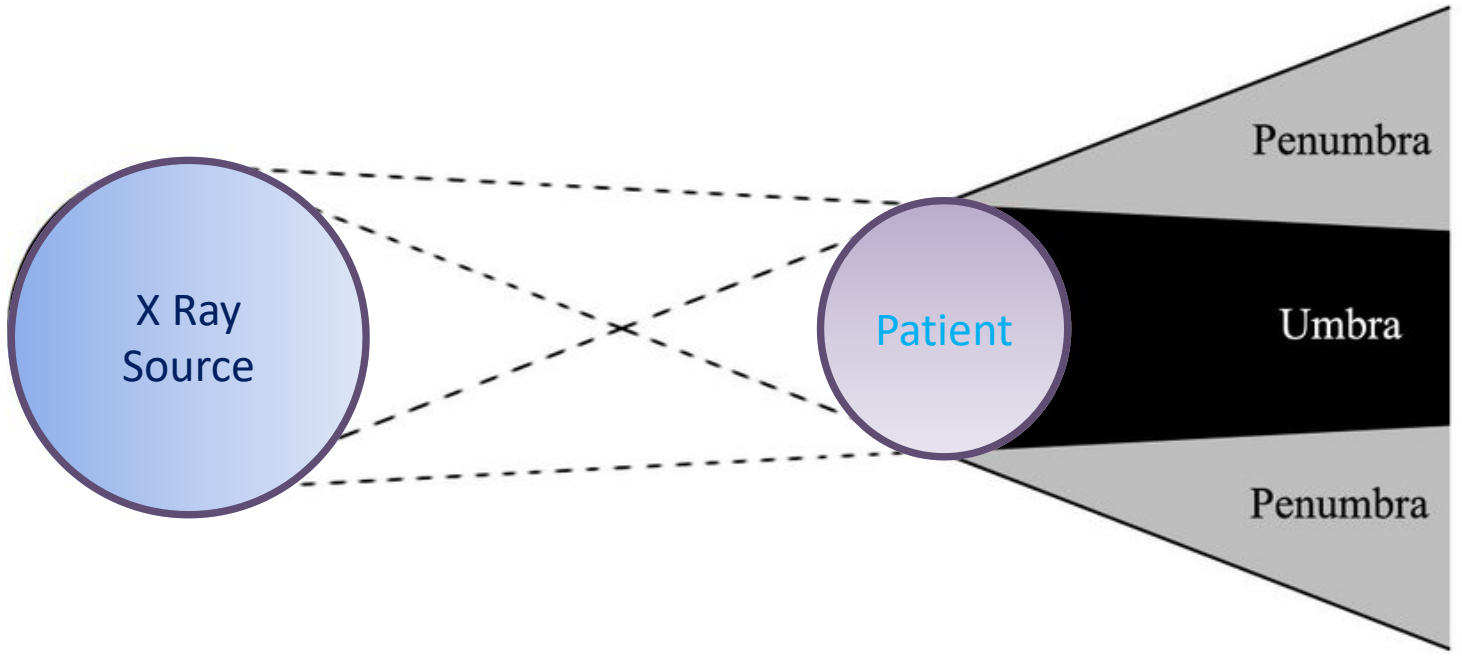
What Makes A Good X-Ray:

Primary Exposure Factors continued:

B. SID

Advantages of a long SID:

1. Minimizes fuzziness. The longer the SID the more you are able to collimate down to the center beams closer to the patient **(umbra**) and eliminate more divergent rays beyond the patient **(penumbra).**

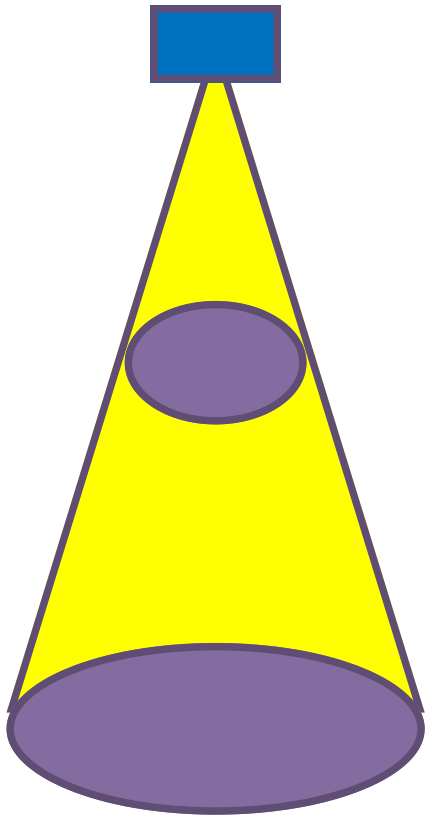


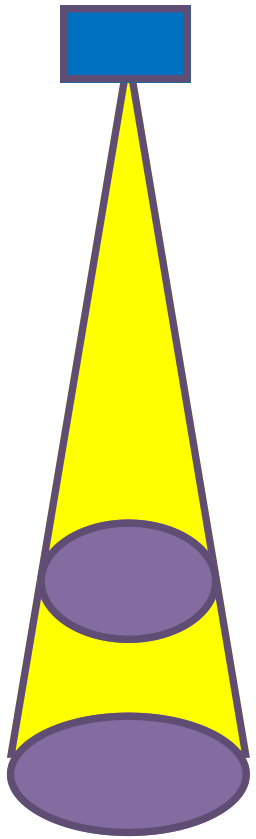
What Makes A Good X-Ray:

Primary Exposure Factors continued:

Advantages of a long SID continued:

2. The more parallel the rays the more direct outline of the patient by the beam.



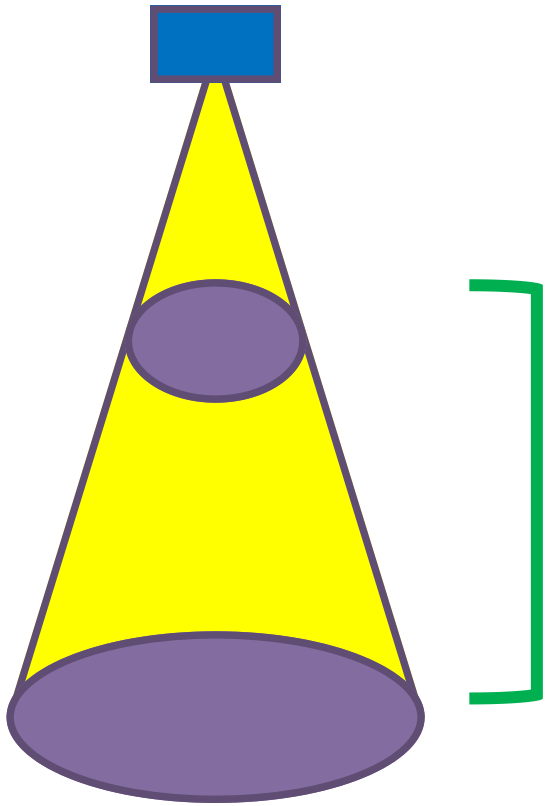


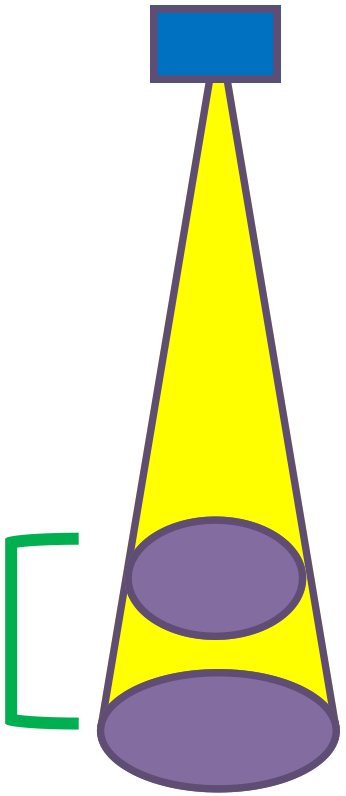
What Makes A Good X-Ray:

Primary Exposure Factors continued:

Advantages of a long SID continued:

3. The more divergent rays continue to get wider in the distance between the patient and the film/detector **(Object-to-Film Distance (OFD).**





What Makes A Good X-Ray:

Chapter 4 - Sections 1-2-3-4-5-6-7(with subsections)

Primary Exposure Factors continued:

Disadvantages of a Long SID:

1. Increase in mA or
2. Increase the time.
3. Therefore the longer the SID the more X-Ray is needed to create a good image.
4. The more X-Ray is needed to make a good image the more exposure.
5. **This change is calculated by the Inverse Square Law.**

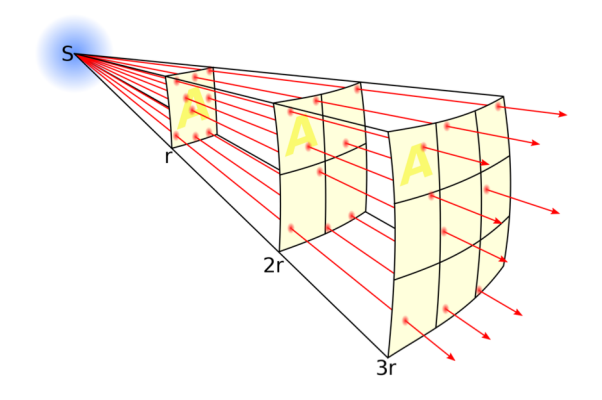
What Makes A Good X-Ray:

Chapter 4 - Sections 1-2-3-4-5-6-7(with subsections)

Primary Exposure Factors continued:

Inverse Square Law:

- Distance is affected by the Inverse Square law.
- Inverse Square Law = the farther away from the source the more divergent and weaker the beam. This means the more distance between the tube and the patient will require more X Ray (radiation) to complete the exposure. It also means the beam at the outside are more angled and less parallel.
- Since the beam is weakened the farther away from the source. The amount of photons (mAs) also has to increase according to the inverse Square. To calculate a change in mAs when the distance is changed use the formula below:



New Exposure Equals
New Distance Squared divided by Old Distance Squared
multiplied by old mAs

Do the math…
If you double the distance, the exposure would quadruple.

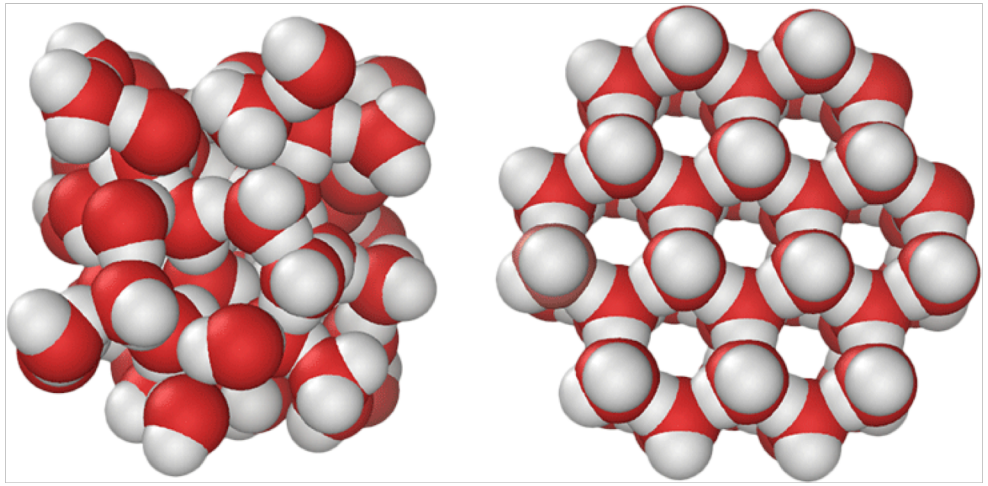
What Makes A Good X-Ray:

Chapter 4 - Sections 1-2-3-4-5-6-7(with subsections)

C. Photographic Properties that affect the Radiograph/Image:

Density:

The amount of black is a visual representation of the amount of radiation absorbed by the film based on the compactness of the part being imaged.



What Makes A Good X-Ray:

Chapter 4 - Sections 1-2-3-4-5-6-7(with subsections)

C. Photographic Properties that affect the Radiograph/Image:

Density

Most affected by:

- mAs = This is the most likely factor. Since there are two components (mA and time) changes in either will make a difference. Example if if you want to double the exposure, either double the mA or double the time. There are pluses and minuses to both ways, e.g. longer exposure time increases the chance of the patient moving, but higher mA causes more heat to the anode (target) Density is most affected by mAs.

What Makes A Good X-Ray:

Chapter 4 - Sections 1-2-3-4-5-6-7(with subsections)

C. Photographic Properties that affect the Radiograph/Image:

Density:

Less affected by:

- Source-to-Image Distance (SID)
- Film/screen combo
- Grids, filters
- Fog
- Artifacts
- Patient
- Anode Heel Effect
- kVp = The more voltage the shorter the wavelength the more penetrating power of the beam. This is controlled by kVp. Although it affects Density of the image it is not the primary factor.

Synopsis of Density:

- Increase mA and the film gets darker
- Decrease mA and the film gets lighter
- You need a 25% change in mA to see a difference on the final image

What Makes A Good X-Ray:

Chapter 4 - Sections 1-2-3-4-5-6-7(with subsections)

C. Photographic Properties that affect the Radiograph/Image Review:

Contrast: The degrees of difference between light and dark.

- The shades of gray that show the difference between thin parts (black) and thick parts (white).
- You need at least two types of densities to form an image.
- The highest contrast is black and white or thin and thick differences or another way to say it least dense to most dense, e.g. lungs to spine.
- Short Scale Contrast = Few shades of gray. Used with High Contrast parts, e.g. like your hand. Lot of bone, little tissue, clear borders. Less flexibility in use.
- Long Scale Contrast = Multiple shades of gray. Use in Low Contrast parts, e.g. your abdomen, mussy organs and soft borders. Greater flexibility in use.
- Film Contrast = Manufacturers produce film to cater one or the other contrast scale.
- To maintain the best contrast a set fixed kVp for each part should be maintained and mAs should vary as the need arises.
- The technique Charts will direct you to the proper settings.

What Makes A Good X-Ray:

Chapter 4 - Sections 1-2-3-4-5-6-7(with subsections)

C. Photographic Properties that affect the Radiograph/Image continued:

Contrast:

Most affected by:

- kVp:
  1. Increased kVp results in more penetration less absorption by the object.
  2. Increased kVp results in more exposure to film, cassette etc. after the object creates scatter radiation fogging the image. Film Processing can affect contrast, i.e. excessive heat, light leaking in, poor chemicals, etc.

Less affected by:

- Screens choice between detail screens or a lesser quality.
- Beam restriction as state the less collimation the more penumbra and less contrast.
- Grid ratio
- Filters affect the beam strength hardening it to be more like a high kVp settings.
- Patient density and or movement.
- Anode Heel Effect
- Contrast media – Affect absorption. N/A in a chiropractic office.

What Makes A Good X-Ray:

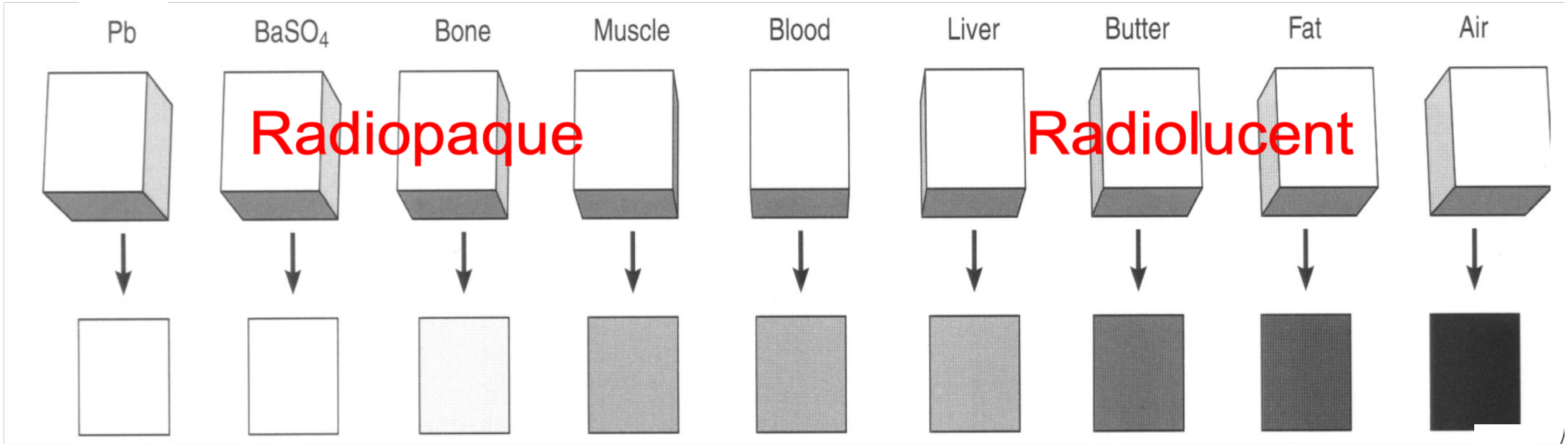
Chapter 4 - Sections 1-2-3-4-5-6-7(with subsections)

The four body DENSITIES that determine CONTRAST:

	Material	***Color***	***Example***
MOST DENSE	**Metals/Minerals**	**White**	**Bone**
	**Water**	**Lighter Grays**	**Muscles/Cartilage**
	Oil/fat	**Darker Grays**	**Organs**
LEAST DENSE	**Air/Gas**	**Black**	**Lungs**

Greatest contrast of black to white is when Metal to Air are next to each other, e.g. Spine to lungs.

What Makes A Good X-Ray:



What Makes A Good X-Ray:

Chapter 4 - Sections 2.2.1

Synopsis of Contrast:

- Low kVp with high mAs = high contrast, short scale (black and whites mostly), narrow latitude (flexibility of parts to be imaged).
- High kVp with low mAs = low contrast, long broad scale (many grays), broad latitude.
- Changes of 4 to 7 % of kVp can be seen on the final image.

Rules of Thumb:

- To get more grays (broaden the scale), increase kVp by 16% AND decrease mAs by 50%
- and conversely to get less grays (more black and white), decrease kVp by 16% AND double mAs.
- Generally the kVp should be fixed for the anatomical region and the mAs should vary.

What Makes A Good X-Ray:

Chapter 4 - Sections 3(with subsections)

C. Photographic Properties that affect the Radiograph/Image continued:

Detail:

Generally Affected By:

- Object-Film-Distance (OFD)
  - Secondary radiation
  - Collimation and Field size
  - Positive Beam Limitation Device
  - Light Localizer
  - Grids
- Motion = Use of immobilizing Devices like sandbags may be helpful.
- Penumbra Effect

Loss of Detail By:

- Exposure time too long and allows movement
- Darkroom concerns
- Grid ratio and distance off
- OFD too great
- SID (FFD) too short
- Old screens
- Too fast a screen

What Makes A Good X-Ray:

Chapter 4 - Sections 4 (with subsections)

C. Photographic Properties that affect the Radiograph/Image continued:

Distortion:

Limit Distortion By:

1. Object-Film-Distance (OFD)
2. Patient Position = If patient is not flat against Bucky/Detector the part out of contact gets distorted.
3. Tube Displacement = Poor alignment of tube and Bucky/Detector
   - Film/screen comb
   - Focal Spot Size
   - Tube Angling
   - Source-to-Image Distance (SID)
   - Motion
4. **Limiting Motion to Maximize Sharpness:**
   - Immobilizing Devices, e.g. sand bags, retention bands
   - Short Exposure Times
   - Utilize Large Focal Spot to aid in shorter times by increasing mA

What Makes A Good X-Ray:

Chapter 2 - Sections 7-8-9 (with subsections)

C. Photographic Properties that affect the Radiograph/Image continued:

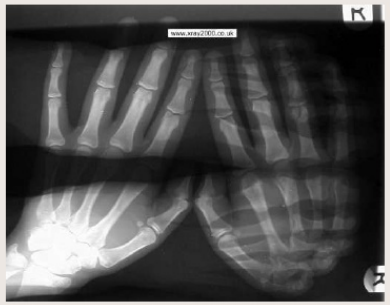
Artifacts: Basically anything on a film you do not want

3 Types:

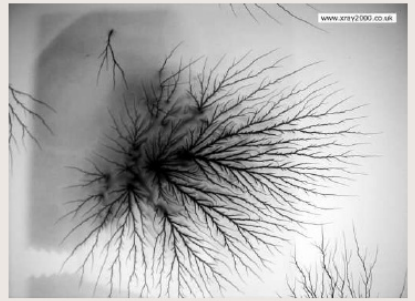
- Exposure = Error from procedure or equipment during the taking of the film
- Processing = Error from procedure or equipment during developing the film
- Handling or Storage = Before or after exposure and processing, error from procedure or equipment during handling or storage of the film

What Makes A Good X-Ray:

DOUBLE EXPOSURE

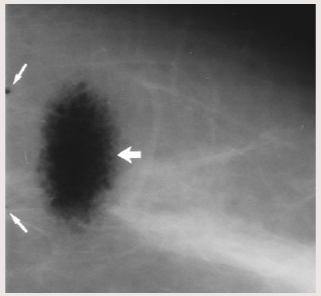


STATIC



SCATTER FOG

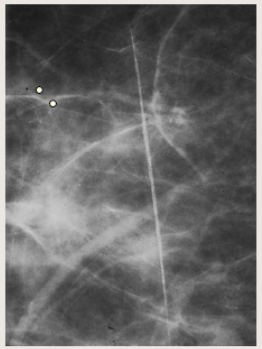
WARPED CASSETTE-LIGHT LEAK



What Makes A Good X-Ray:

JEWELRY

DIRT ON THE SCREEN

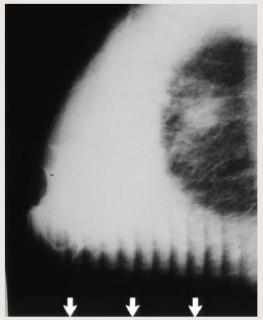


UMBILICAL RING

STRAP

What Makes A Good X-Ray:

ROLLER MARKS



WATER STAIN

FILMS STUCK TO EACH OTHER DURING PROCESSING

SCRATCHES

What Makes A Good X-Ray:

Chapter 4 - Sections 1-2-3-4-5-6-7(with subsections)

General Properties that affect the Radiograph/Image:

- Subject Contrast = Different parts, different patient absorb different amounts of X-Ray.
- Selective Absorption = BLOCKING the parts behind them, e.g. Femur blocks out parts behind them.
- The greater the difference in densities, the better the contrast.
- There are four densities that determine contrast.
- The least dense areas allow the beam to pass through and more X Ray absorbed by the film, therefore more black (and vice versa).

Safety, Safety, Safety:

Chapter 3 - Sections 8-9-10-11 (with subsections)
Chapter 4 - Section 6 (with subsections)

General Precautions for X Ray Radiation Reduction:

- Good procedure
- Proper film size and collimation
- Use of filters
- Fast screen/film combination
- Shielding
- Use of Technique Charts
- That utilize high kVp Technique = reduces absorption by use of a stronger beam.
- Anatomically Programmed Radiography
- Underexposure. Avoid re-takes a film. A re-take is 100% additional radiation!

What Makes A Good X-Ray:

Chapter 5 – Section 5.4 and 5.5

Precautions and Troubleshooting:

- No extraneous personnel in room at time of exposure.
- Operator must be behind shielding at all times, never reach or look around.
- Never expose a person for demonstration or training.
- Restrict exposing sensitive areas if not clinically necessary. Use shielding, collimation, etc.
- Be mindful of potential pregnancies, Ten Day Rule, etc.
- Maintain all procedure, protocols, cautions to avoid re-takes.
- Rooms must be properly labeled with a CAUTION sign on the hallway door and a WARNING PREGANCY sign in the room.

What Makes A Good X-Ray:

Chapter 5 – Section 5.4 and 5.5

Remember Everything Affects Everything, However:

- There are 3 Primary Exposure Factors-Beam-SID-Photographic Properties
- kVp is penetrating power of the beam
- mA is the amount of X Ray
- mAs is the amount magnified by time
- Long SIDs decrease magnification, limit Penumbra, but increase kVp-mAs significantly
- Density affected by mA, change mA by 25% changes image
- Contrast affected by kVp, change by 4% to 7% changes image
- Want more grays increase kVp by 16% decrease mA by 50%.
- Less dense the tissue-more black on the film, e.g. lungs
- Order of least dense to most dense - Air/Gas - Oil/Fat – Water - Metal/Mineral
- Detail affected by OFD – Motion – Penumbra
- Distortion affected by Patient Placement (affecting OFD) – Tube Placement

Reasons for Re-Takes:

1. Failure to read and follow doctor's orders
2. Wrong exposure factors
3. Wrong breathing instructions
4. Do not use immobilization devices when indicated
5. Fail to mark the film properly
6. Bad positioning
7. Bad processing

Safety, Safety, Safety:

3 Main General Safety Concerns:

Time

Distance

Shielding

REMEMBER A.L.A.R.A.
As Low As Reasonably Achievable

Safety, Safety, Safety:

Chapter 3 – Sections 8-9-10-11 (with subsections)

Rules of Protection:

1. Always stand behind protective barriers
2. Wear protective shields
3. Never stand in primary beam
4. Never allow a pregnant person to hold a patient
5. If another person must assist, use as much protection as possible
6. No unnecessary personnel in the room
7. As the operator, never hold the patient during exposure
8. Keep exposure times short
9. Maintain as much distance as possible between you and the source.

Safety, Safety, Safety:

Chapter 3 - Sections 8-9-10-11 (with subsections)

Four reasons that determine Dose to the Operator/Technologist:

1. The bean direction in reference to the operator's position.
2. The distance from the source of radiation, primary or secondary
3. Shielding (or lack thereof) between the operator and the beam
4. Exposure time is minimized, **ALARA (As Low As Reasonably Achievable)** balanced out with AHARA (As High As Reasonably Achievable) to obtain a quality film

Sources of Operator/Technologist Exposure:

1. Accidental or unavoidable exposure
2. Scatter from the patient
3. Scatter from everything else
4. Tube leakage

Safety, Safety, Safety:

Chapter 3 - Sections 8-9-10-11 (with subsections)
Chapter 6 - Section 8 (with subsections)

Radiation Safety for the Operator/Technologist:

1. Primary bean is directed away from the operator
2. As much distance as practice from the patient
3. Protective shielding/barriers
4. Total cumulative Time or exposure
5. Control panel is behind a protective wall or leaded glass
6. Dead Man Switch (need you hand holding the switch on to operate)
7. Never hold a patient when not emergent. Use mechanical devices when possible. If absolutely necessary someone not working in an industry with radiation should hold the patient. Use all possible shielding, e.g. lead gloves, aprons etc.
8. Policies should be developed regarding:
    - Use of shielding of patients.
    - When and who would be allowed to hold a patient
    - Personnel monitoring
    - Pregnant worker
9. Dosimetry = Device to detect any possible exposure.

Safety, Safety, Safety:

Chapter 3 - Sections 8-9-10-11 (with subsections)

Dosimetry:

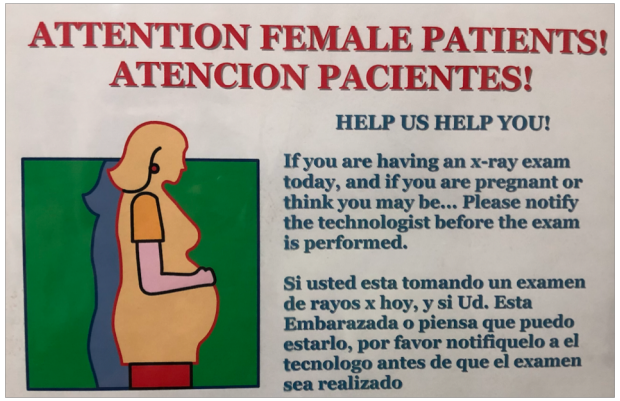
- Film Badges or Monitors
  - In the past, film was placed in a small badge and worn by the operator.
  - The newest version are digital and can be downloaded though the internet.
  - These should be worn at the waist or chest.
  - Usually there is a second “control” badge placed in a neutral spot to detect radiation outside the X-Ray area.
  - After a period of time (monthly or quarterly) they are evaluated and a report with the readings is created.
- Thermoluminescent Dosimeter (TLD) = similar to badges but instead of film they contain small crystal, Lithium Fluoride and activated calcium Fluoride). Also, like badges, after a period of time (monthly or quarterly) they are sent out to be evaluated and a report with the readings is created.
- Pocket Dosimeter = a device that measures cumulative dose.

Safety, Safety, Safety:

Chapter 3 - Sections 8-9-10-11 (with subsections)

Radiation Safety Specific for the Patient:

- Adequate collimation
- High kVp and lower mA
- Filters when applicable
- Females with unsuspected Pregnancies:
  - "Ten Day Rule" = X-Ray only during the 10 days following the ONSET of the menstrual cycle unless diagnostically vital
  - If pregnancy cannot be ruled out utilize lead apron around pelvis
  - The Date of the first day of the Last Menstrual Period (DLMP) should be listed in the record with exposure factors.
- Lead shielding to sensitive tissue,
- Fast film speeds
- Increased SID (source image distance)
- Good technique
- Warning Light/Signage



Safety, Safety, Safety:

Do you?

- Self Check?
- Know where the electrical shut off for the X-Ray is?
- Know (from additional training) Emergency Procedures?
- Know where the Fire Extinguishers and how to use them?
- Know how to operate an (AED) Automated External Defibrillator (if office has one)?
- Know your Emergency Action Plan?
- Know where the local emergency numbers are?
- Know where the emergency exit are?
- Know your equipment?

The Equipment:

Control Panel	Location of the controls
Electrical Circuitry	Pathways of electricity
Generators	Modifies the electricity as needed for the machine
X-Ray Tube	Creates the X-Ray Beam
Collimator	Device that limits the primary X-Ray Beam and scatter radiation
Filtration	Devices to change the strength of the X-Ray Beam
Shielding	Radiopaque material that covers body parts and/or reproductive organs
Cassettes	Component that holds the film
Intensifying Screens	Component in cassettes that exposes film
Film	Images are preserved on film
Markers	Defines side and orientation
Calipers	Used to measure the patient
Positioning Blocks	Used to support and position patient
Technique Charts	A list of exposure techniques for each view
Bucky/Detector/Tray	Component that holds the Cassettes or Detector
Grids	Component in the Bucky that filters scatter radiation
Imaging Systems	“The X Ray Machine”
Darkroom	Room for processing of the expose film.

The Equipment continued:

Chapter 1 - Section 5 (with subsections 1-2-3-4-5-6-7)

Control Panel:

- Main Unit Power Switch = on and off switch.
- Timer = amount of time the beam is being projected. The more time, the more electrons delivered to the patient.
- Voltage Compensator Switch = Corrects for the line voltage from the electricity source.
- Exposure Status Light = One light to indicate rotor to speed, one for exposure.
- Exposure Switch = must be continuously held to the length of the timer setting. If released the exposure is cut short
- (Dead Man's Switch)
- Milliamperes (mA) = quantity - or amount of X-Ray electrons in the beam. The more mA the more electrons emitted.
- Kilovolt Peak kVp) = quality – or penetration power of beam or quality. The more kVp the faster the electrons travel, the more they penetrate
    - Major kVp control = steps of 10 kVp
    - Minor kVp control= steps of 2 kVp

The Equipment continued:

Major and Minor kVp

Exposure Status

Timer

Main Unit
Power Switch

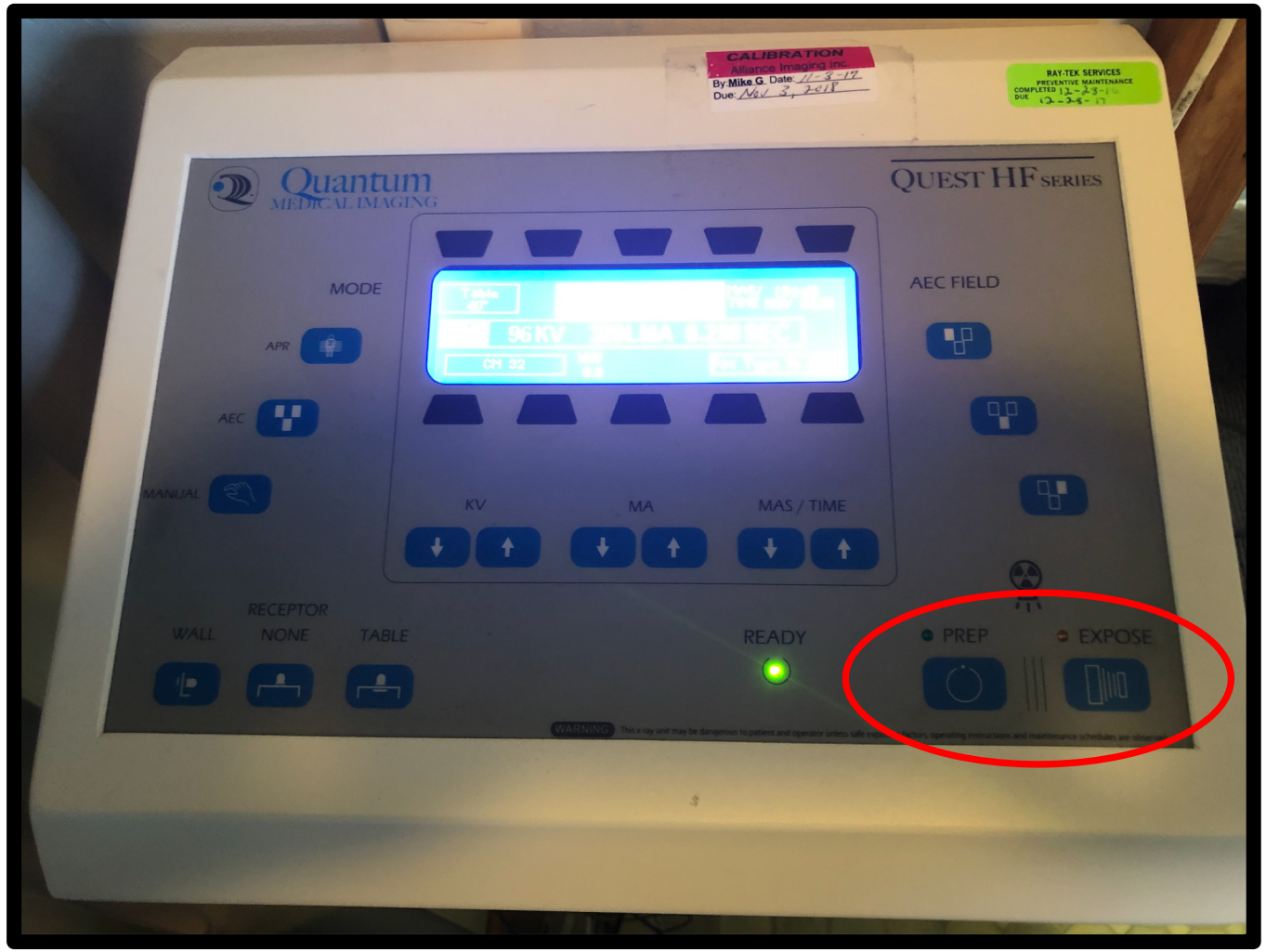
Exposure Button

Voltage Compensator

mA

Dead Man's Switch

The Equipment continued:



The Equipment continued:

Chapter 1 Section 5 (with subsections 1-2-3-4-5-6-7)

Electrical Circuitry <u>Outside</u> Control Panel:

- Line Voltage Source = Electric source (plug in the wall)
- Circuit Breaker to Power Source

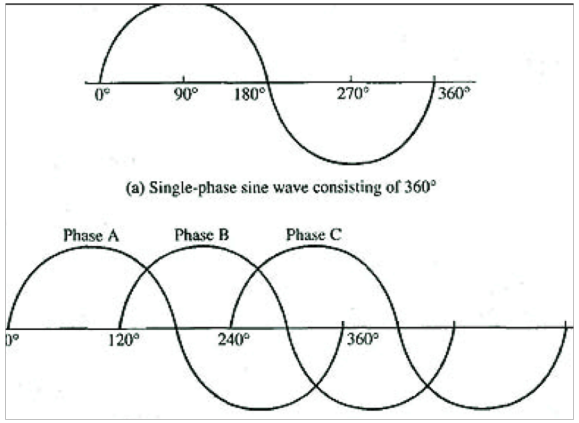
The Equipment continued:

Chapter 1 - Section 5 (with subsections 1-2-3-4-5-6-7)
Chapter 5 - Section 7

Electrical Circuitry <u>Outside</u> Control Panel:

Generator = Modifies the electricity from the source:

- Transformers are within the Generator. They produce voltage (energy).
  - Step-up transformer = increases voltage from the line source
  - Step-Down Transformer = decrease voltage from the line source
- Rectifiers are also within the Generator to maintain + and – polarities by changing AC to DC.
  - Example of (AC) Alternating Current is wall current
  - Example of (DC) Direct Current is battery current
- For X Ray, 200 mA/100 kVp capacity minimum. 300 mA/125 kVp preferred
- Single Phase = Emitted at peak of the wave of electricity
- Three Phase = More waves more peaks



The Equipment continued:

Chapter 1 Section 5 (with subsections 1-2-3-4-5-6-7)

Electrical Circuitry Inside Control Panel:

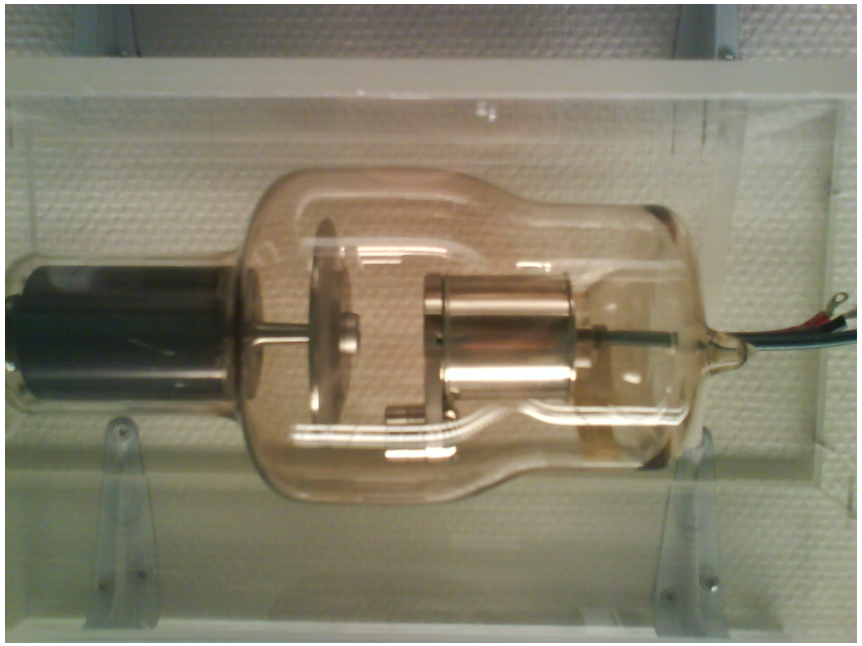
- High Voltage Circuit:
  - Primary Side of Circuit = kVp selector switch, exposure switch (timer) and kVp meter
  - Secondary Side of Circuit = Contains Step-Up transformer, rectifier, radiographic tube, mA meter
- Autotransformer Circuit = ”cleans” up fluctuations in 220 volts from the line source by either increasing or decreasing voltage (both a step up and down transformer).
- Filament Circuit = produces high current with low voltage
- Timing Circuit = Determines length of time circuit is active and therefore affects quantity of X-Ray

The Equipment continued:

Chapter 1 Section 6-7-8-9-10 (with subsections)

Tube:

- The actual production the X-Ray beam takes place in the vacuum tube
- The tube is enclosed in a shield of heavy metal to avoid X-Ray going to undesired places
  - Tube Current = The flow of electrons across the Tube, also the mA.
  - Filament Current = Electric current used to heat the filament and produce electrons.

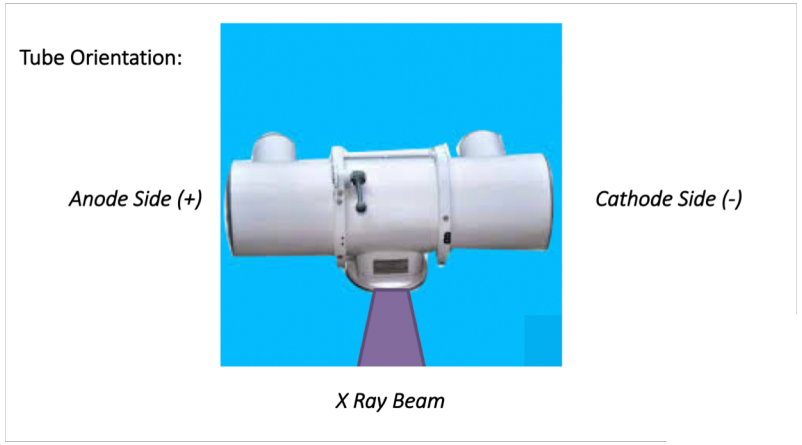


The Equipment continued:

Chapter 1 Section 6-7-8-9-10 (with subsections)

Tube continued:

- Two opposite ends with opposite charges:
  - Cathode (contains Filament) = Negative end of the tube
    - The Filament = coil also made of of Tungsten wire
    - Focusing Cup = condenses the electrons produce by the filament
    - Filament Current = controls the X-Ray tube current determined by mA. Lower the mA the smaller the patient.
  - Anode (contains Target) = Positive end of the tube, also called the Target,

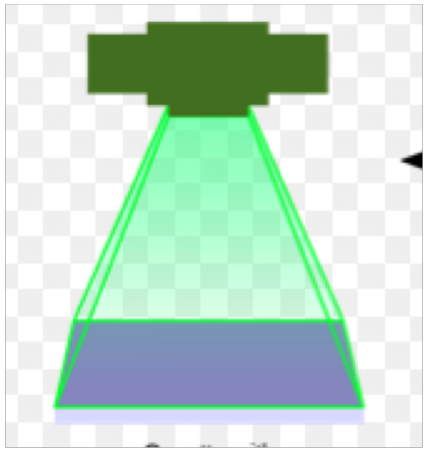


The Equipment continued:

Chapter 1 - Sections 6-7-8-9-10 (with subsections)

Tube continued:

- High Voltage is run through a filament in the Cathode heating the filament producing negatively charged High Velocity Electrons and heat called thermionic emissions.
- The quantity of High Velocity Electrons are controlled by the mA setting, focused to the Target by the focusing cup are attracted to the positively charged Anode Target, (in physics opposites do attract).
- The speed of the electrons impact (penetrating power) is controlled by the kVp.
- The X-Ray is projected through a small opening in the tube and directed to the patient.

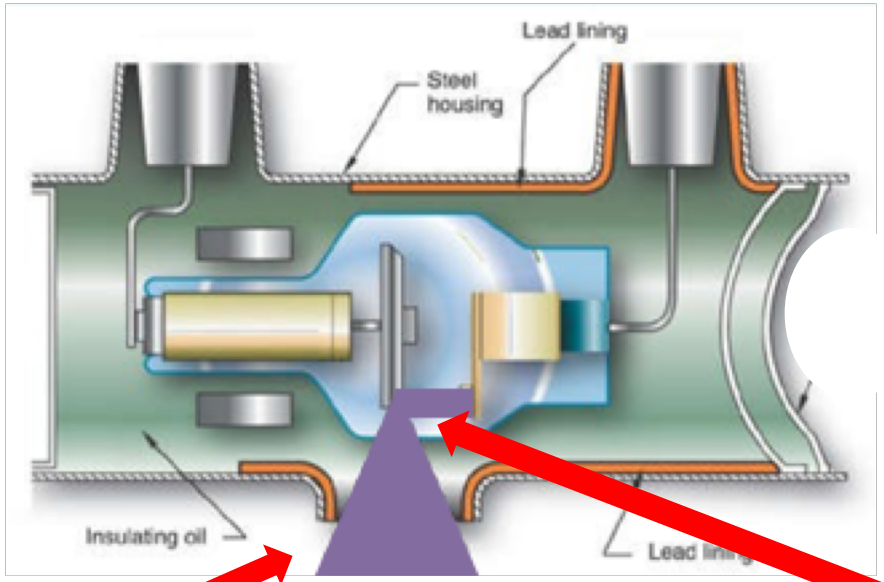


The Equipment continued:

Chapter 1 Section 6-7-8-9-10 (with subsections)

Tube Target:

- Filament & Target = requires strong material (Tungsten) because 99% of the process creates heat.
- Tube Housing = is the metal casing surrounding the tube.
- X Ray Composition = Radiation too weak to escape the tube
- Focal Spot = point on the target struck by the electrons.



Anode Side +

Cathode Side -

X Ray Beam

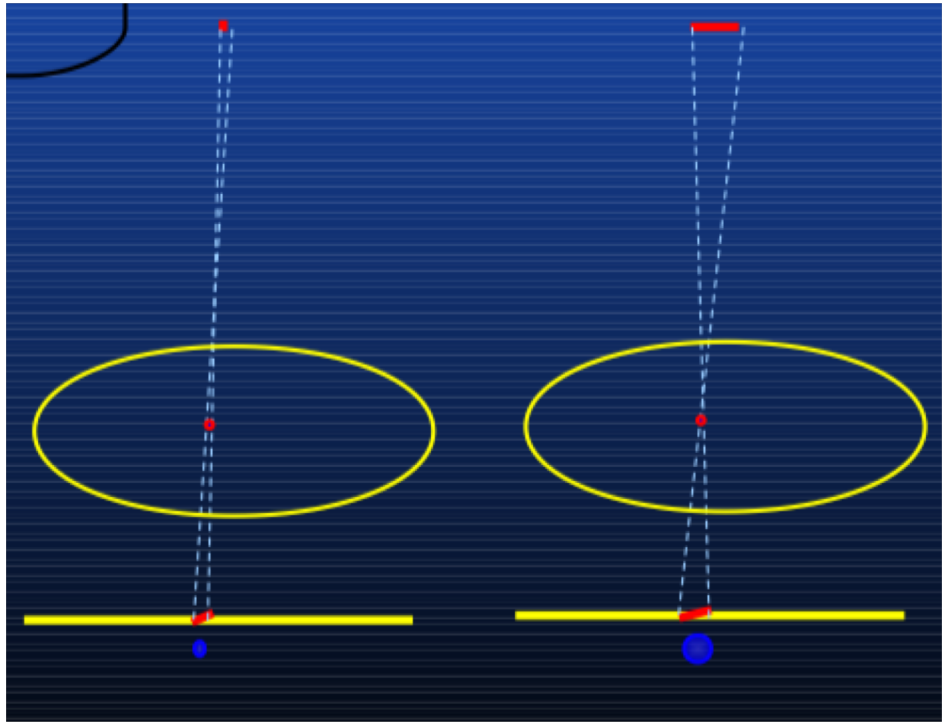
Focal Spot

The Equipment continued:

Chapter 1 Section 6-7-8-9-10 (with subsections)

Tube Target continued:

- Smaller the Focal Spot, better quality beam, less heat.
- Most X-Rays machine have Duel Focus Targets, large and small Focal Spots.



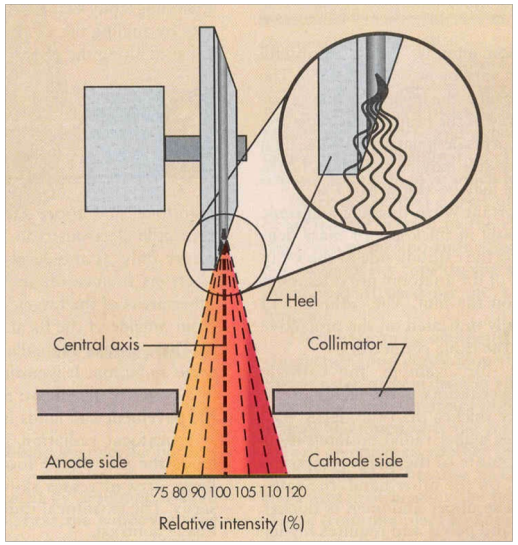
The Equipment continued:

Chapter 4 - Sections 1-2-3-4-5-6-7 (with subsections)

Tube Target continued:

Anode Heel Effect:

- By angling the Target you can make the Focal Spot smaller and still get a wide beam.
- Increase the surface area therefore more cooling.
- Decreases the the focal spot size.
- However there is inconsistent beam strength. The anode heel absorbs photons weakening the anode side of the beam.
- This can be helpful when imaging a patient or part with varying densities.

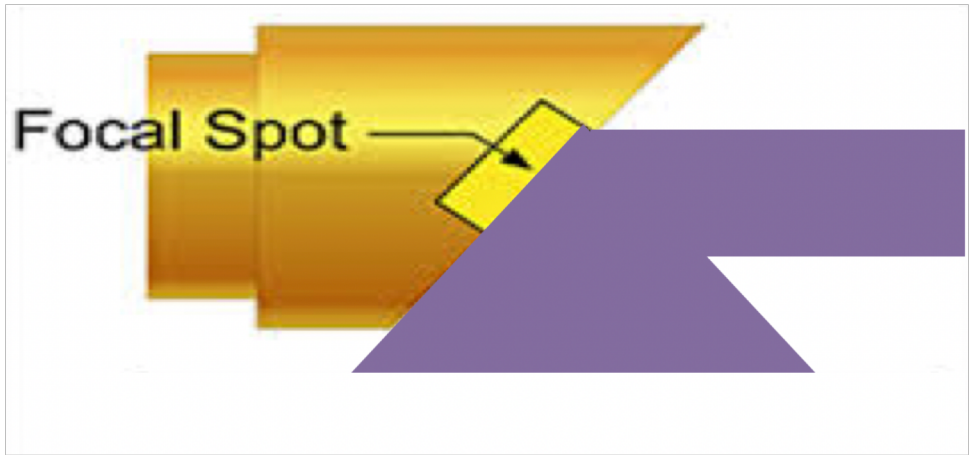


The Equipment continued:

Chapter 1 Section 6-7-8-9-10 (with subsections)

Tube Target continued:

- Two Types of Targets:
    1. **Stationary** = Less power, less heat. Mostly in dental rays

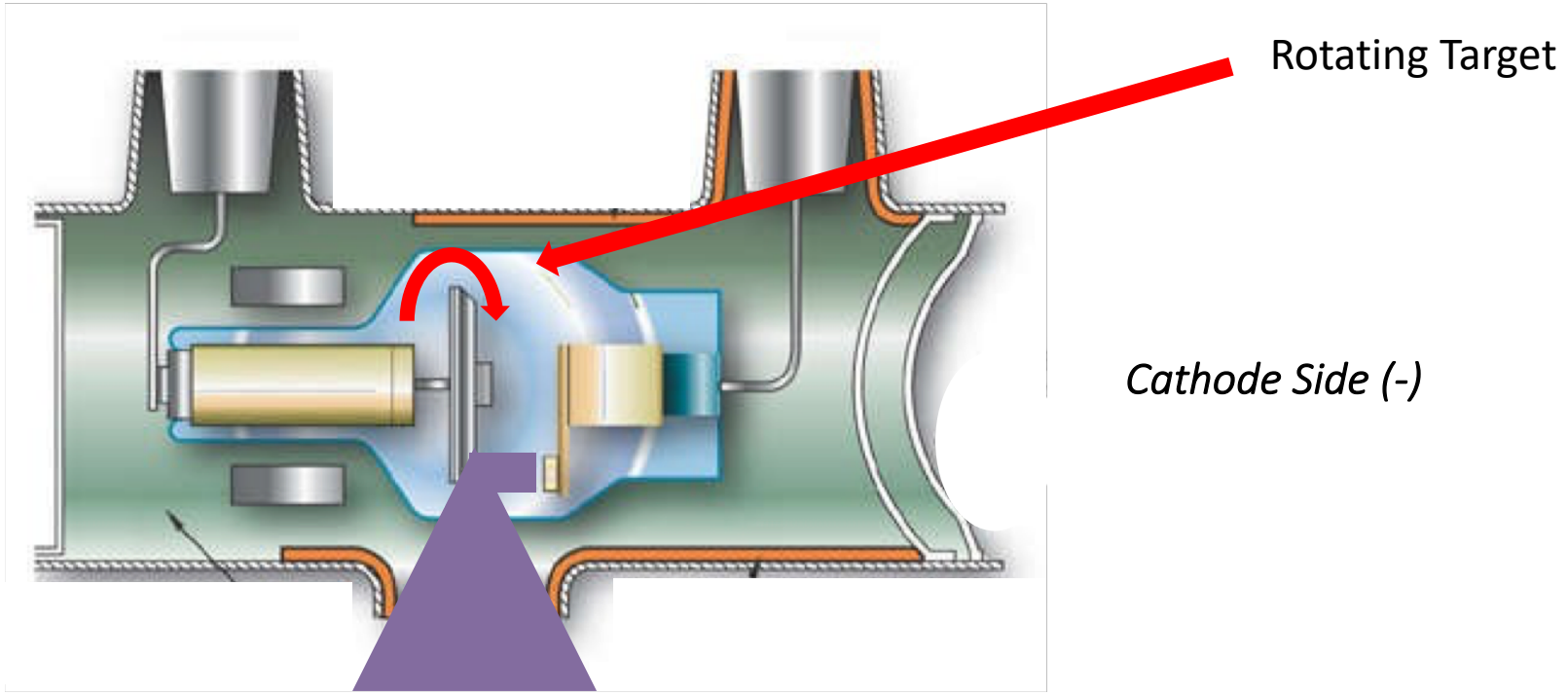


The Equipment continued:

Chapter 1 Section 6-7-8-9-10 (with subsections)

Tube Target continued:

2. **Rotating** = this is the spinning noise you hear when taking an X-Ray). To minimize the burnout of the Target the rotating Anode last longer because the electrons are not hitting the same spot all the time. Approximately 4000 RPMs

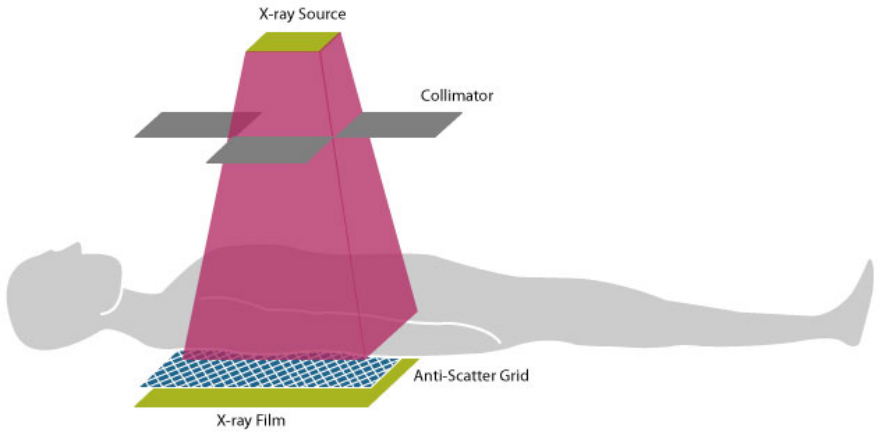


The Equipment continued:

Chapter 1 - Section 13.10.1
Chapter 4 - Section 4.3.1.2 and 6.2

Collimator:

- Device to limits field size and shape of primary X-Ray Beam and limits scatter radiation.
- Collimators are equipped with a light and mirrors that project out from the opening.
- This assembly is know as a Light Localizer defined area being exposed with light on Bucky.
- Beam is restricted BEFORE reaching the patient
- Ensures film alignment.



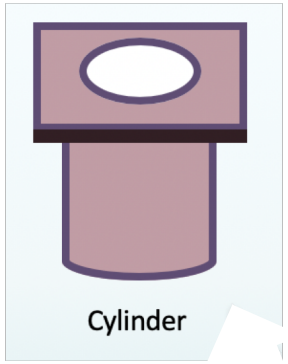
The Equipment continued:

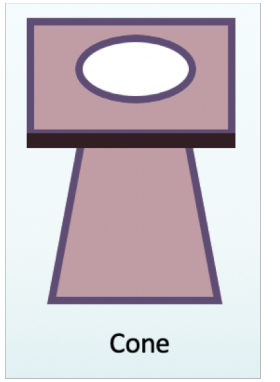
Chapter 1 - Section 13.10.1
Chapter 4 - Section 4.3.1.2 and 6.2

Collimators:

Types:

- May be adjustable or fixed to a specific film size.
- Shape of fixed collimator determines exposure shape





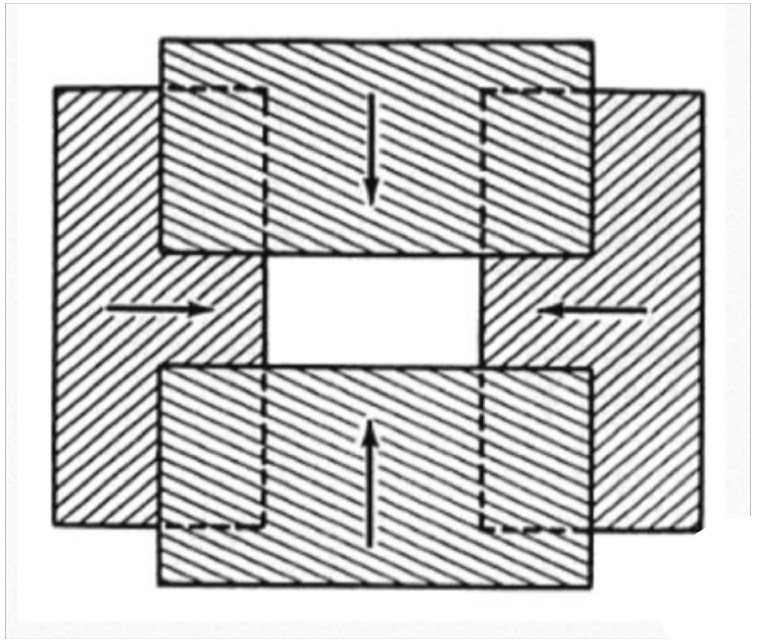
The Equipment continued:

Chapter 1 - Section 13.10.1
Chapter 4 - Section 4.3.1.2 and 6.2

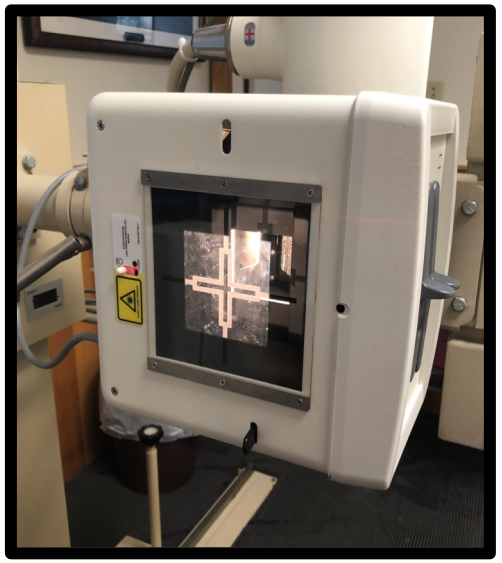
Collimators continued:

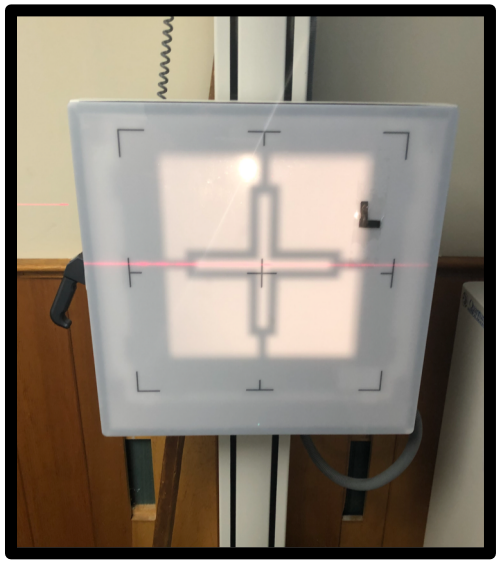
Types continued:

- Positive Beam Limitation Device = automatically adjusts to cassette size.
- Manual Adjustable Rectangular Collimator:
  - is used in most facilities.
  - Limits height and width of beam with lead flaps or doors



The Equipment continued:





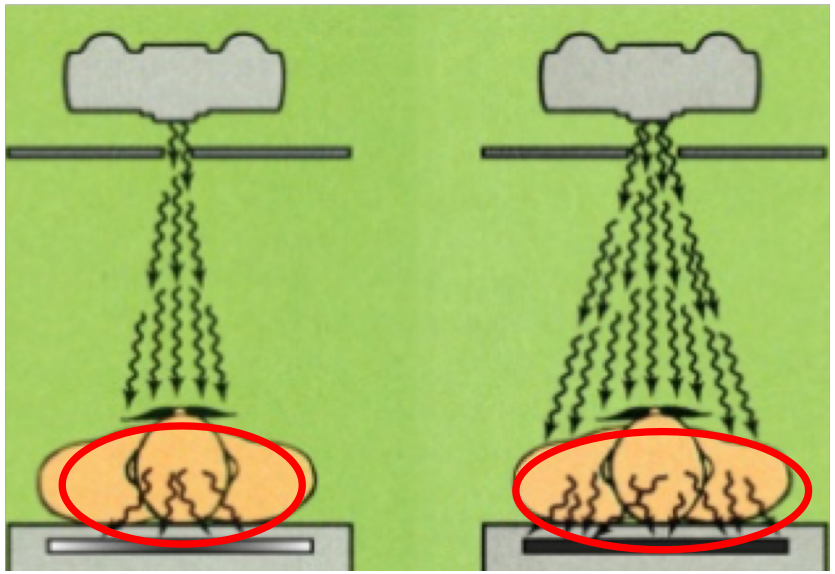
The Equipment continued:

Chapter 4 - Sections 1-2-3-4-5-6-7(with subsections)

Collimator continued:

Less Scatter:

1. Lower kVp settings, less Compton effect. This is a balance of other factors.
2. Less part thickness (something you really can't control).
3. Decrease field size through tight collimation.



The Equipment continued:

Chapter 1 - Section 10.10 and 10.1
Chapter 4 - Section 6.3

Filtration:

- Filter = Devices to improve the X-Ray Beam by alteration in the strength of the beam.
- The filter is attached to the tube/collimator.
- Therefore the filter affects the beam BEFORE it reaches the patient.

The Equipment continued:

Chapter 1 - Sections 10 (with subsections)

Filtration continued:

Lower energy X Rays are absorbed by the material

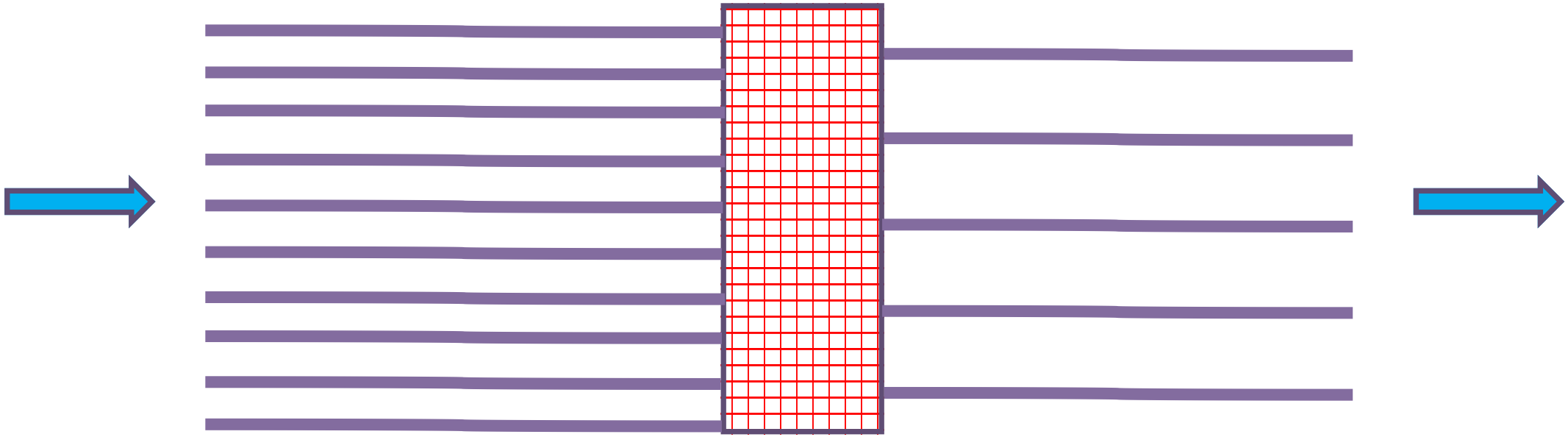
Higher energy X Rays are absorbed by the material

The Equipment continued:

Chapter 1 - Sections 10 (with subsections)

Filtration continued:

- On the other side of the opening is the collimator. Other filters may be added to weaken or "soften" only a part of the beam projected.
- Half-Value Layer (HVL) = The thickness of any material necessary to reduce the radiation by half. The principle which states that varying intensities of an X-Ray using filters create images that has more contrast/clarity since some will be absorbed and others pass through. Filtration is expressed in terms of Half-Value layer and the material used as the filter.

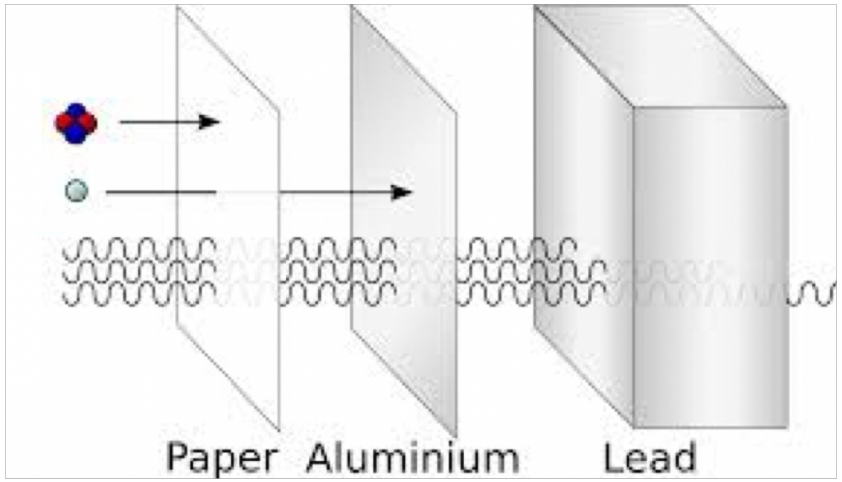


The Equipment continued:

Chapter 1 - Section 10.10 and 10.1
Chapter 4 - Section 6.3

Filtration continued:

- Aluminum is the most common material.
- As the beam passes through the filter and photons are absorbed by the aluminum filter. That part of the beam is then "softened" or made weaker. That part of the beam is less penetration while the rest of the beam remains at full strength.
- This is helpful when a small and large body part are on the same film. For example a cervical thoracic film.
- Inherent Filtration = since the beam must pass through the materials that make up the tube etc., a certain attenuation of the beam happens and is beyond control.



The Equipment continued:

Chapter 3 - Section 10.3
Chapter 5 - Section 5.2.3

Shielding:

- Lead lined walls and barriers protect the operator.
- Lead glass for all windows
- All attempts to limit the field of exposure should be a priority to the patient.
- A.L.A.R.A. As Little As Reasonably Allowable

The Equipment continued:

Chapter 3 - Section 10.3
Chapter 5 - Section 5.2.3

Shielding continued:

- Removable lead shielding to radiosensitive tissue, e.g. eyes, glands, gonads, Lymph Nodes, Epiphyseal Growth Centers essentially all fast growing cells are sensitive to radiation and results in DNA damage
    - Lead Aprons = full and partial that cover large areas of the body
    - Gonad Shields = Radio-opaque materials placed over sensitive tissue, e.g. the ovaries or testes when not interfering with necessary anatomy, eyes, thyroid
        - Two types of Gonad Shields:
            - Shadow Shield = Blockage is from a shield placed at the tube
            - Contact Shield = Blockage is placed on the patient, e.g. strapped on or place in a pocket in briefs, glasses or eye cups, collars

The Equipment continued:

Chapter 2 - Section 4 (with subsections)
Chapter 6 - Section 6
Chapter 5 - Section 7

Cassettes:

- X-ray film is light sensitive and therefore must be protected from exposures
- The film is kept in holders called cassettes and sometimes in a carboard holder if the film needs to curve, e.g. dental film
- Never open a cassette with an exposed image in any place but a darkroom.
- On both the front and back of a cassette are intensifying Screens (Back screens are thicker).
- Standard sizes and recommended number. Remember each size requires separate overhead
  - 8” x 10” (7 for a complete cervical study)
  - 10” x 12 “ (2 for lumbar obliques, skull/sinuses and extremities
  - 14” x 17 “ (4 for all others)
  - 14” x 36” (2 non gradient for full spine)
  - 7” x 17 “ (option)
  - Cardboard film packs for no screen extremities

The Equipment continued:

Chapter 2 - Section 4 (with subsections)
Chapter 6 - Section 6

Intensifying Screens:

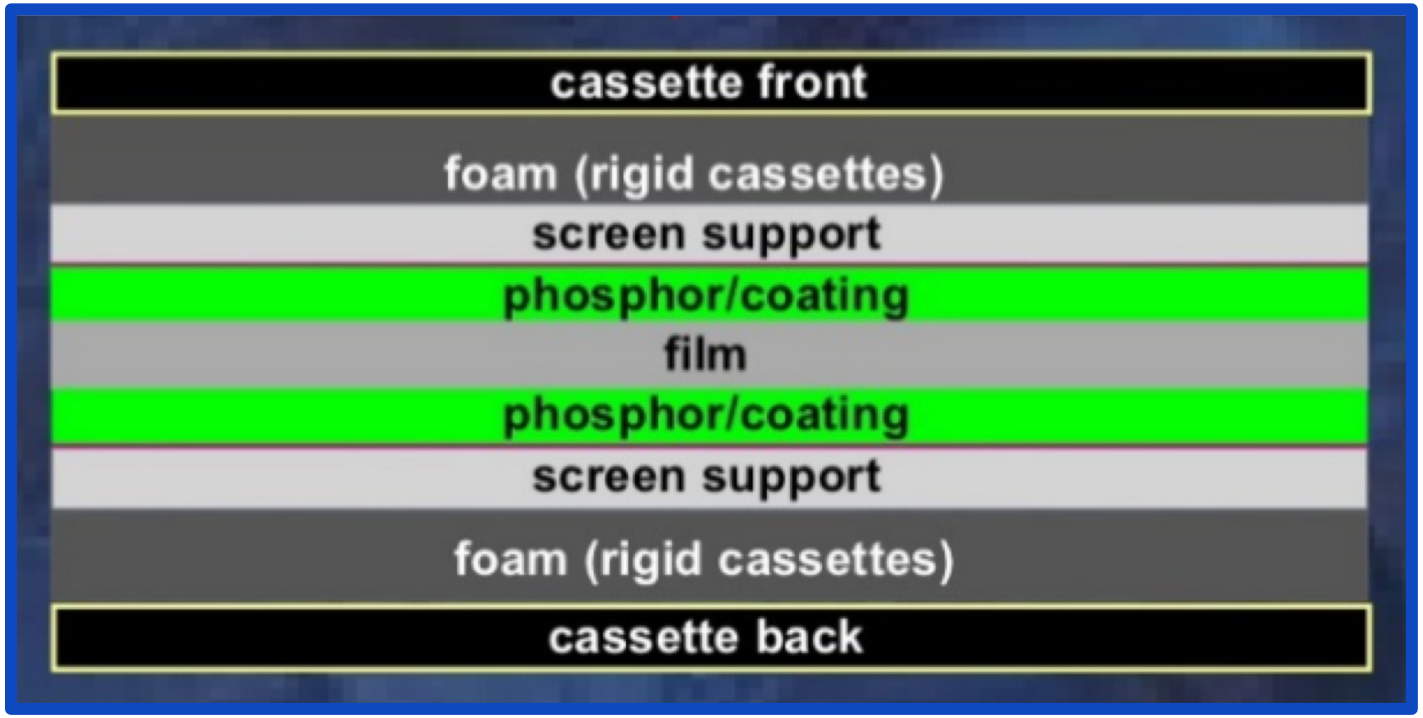
- Screens allow for considerably less radiation to make an image than if you exposed the film directly without them.
- Screens consist of a a white enamel layer to reflect the florescent light or reflective layer), a phosphor layer and a transparent coating **on both sides.**
- When struck with X-Ray the phosphor glows.
- The image is created by the glow exposing the film.
- The image is created by the glow exposes the film.
- There are different screen speeds or intensifying factors, (the amount of X-Ray it takes to cause it to glow:
    - detail
    - slow
    - medium (par)
    - fast (hi-Speed)
    - ultra-fast which use Calcium Tungstate and emit a bluish light
    - rare earth which emits a greenish (sometime violet-blue).
- Both the cassette and screens must be periodically cleaned.

The Equipment continued:

Chapter 2 - Sections 2-3-4 (with subsections)

Film:

- Film, like Intensifying Screens, also differ in speed and should be matched to the screens.
- The choice of screen and film speed combinations affect the amount of exposure and contrast of the film.
- Most commonly, Rare Earth screens are used in a chiropractic office.



Film placement in cassette (Side View)

The Equipment continued:

Chapter 1 - Section 13.10.6
Chapter 5 - Section 5.2.5
Chapter 7.1

Markers:

- All films should display a right or left marker.
- Preferably a Mitchell Markers which defines side and orientation.
- On side views, “R” or “L” markers indicate body part closest to the film.
- Never place marker in an area that obscures desired anatomy.
- Additional markers should be used when performing dynamic or special studies:
    - Neutral — Neu
    - Flexion — Flex
    - Extension — Ext
    - Oblique
        - R or left Posterior Oblique — RPO or LPO
        - R or left Anterior Oblique — RAO or LAO

The Equipment continued:

Chapter 4 – Section 8-9 (with subsections)

Calipers:

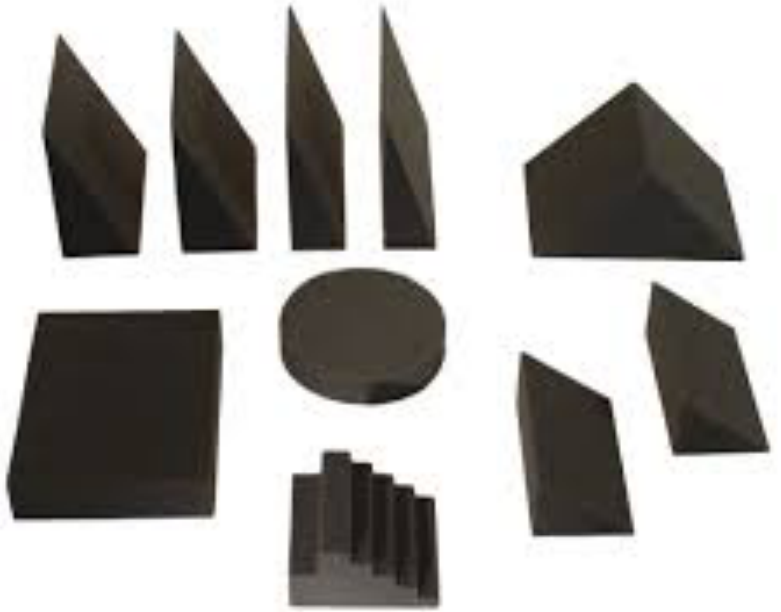
- Used to measure the patient. The thickness in either centimeters or inches, will correspond to the technique chart

The Equipment continued:

Chapter 4 – Section 8-9 (with subsections)

Positioning Blocks and Stabilizers:

- Used to help support and position patient correctly.
- May be made of foam so they do not show up on the final image.
- Poles to hold for side views, belts, etc.

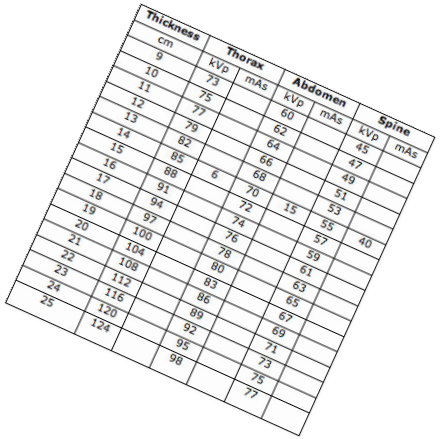


The Equipment continued:

Chapter 4 – Section 6.8

Technique Charts:

- Technique Charts are required by most states.
- They aid in the selection of the proper settings for each exposure.
- Techniques are based on part thickness and density of part, e.g. bone is more dense than muscle.
- The best type of chart is based on equipment, screens/film speed combinations set by the manufacturer.
- The Technique Chart must be posted with the control panel.
- Techniques will be based on measured thickness of part. Other factors may come into play to adjust the technique as needed, e.g. age, fat versus muscles
- Use of a device like a SuperTech or a strep wedge can help refine you Technique Chart



Thickness	Thorax		Abdomen		Spine	
cm	kVp	mAs	kVp	mAs	kVp	mAs
9	73		60		45	
10	75		62		47	
11	77		64		49	
12	79		66		51	
13	82		68		53	
14	85		70		55	
15	88	6	72	15	57	40
16	91		74		59	
17	94		76		61	
18	97		78		63	
19	100		80		65	
20	104		83		67	
21	108		86		69	
22	112		89		71	
23	116		92		73	
24	120		95		75	
25	124		98		77	

The Equipment continued:

Chapter 4 – Section 6.8 and 4.9

Technique Charts continued:

- There are four types:
  1. Variable Kilovolts = Fixed mAs and variable kVp based on part thickness. (2 kVp per centimeter)
  2. Fixed Kilovolt = Fixed kVp based which part and variable mAs based on thickness.
     - Most used
     - Usually less patient dose
     - More variation for each part
  3. High Kilovolt = Reserved for high kVp exposures not common in Chiropractic., e.g. barium studies.
  4. Automatic Exposure = Computer assisted timer or Phototimer. Usually a pre selected kVp. The time is shut off once optical density is achieved as determined by the sensors in the cassette
- Anatomically Programmed Radiography (APR) = New Technology that is a more advance for of computer assisted technology. The computer determines the techniques based on information entered into the system, e.g. part being X Rayed, size of part etc.

The Equipment continued:

Bucky and Tray:

- Bucky or Potter Bucky Diaphragm = Device that holds the Grids and Tray.
- A Bucky may be Stationary or Reciprocating (Oscillating) moving back and forth)
- The purpose of the Bucky:
    1. Is to hold the Grid and Cassette in Alignment
    2. If it is a movable Bucky it will move the Grid
- The outside of the Bucky is what a patient sees.
- Behind the outside is the grid, then the Cassette.
- The Tray holds the Cassettes centered to the Bucky.

The Equipment continued:

Chapter 2 - Sections 2-3-4 (with subsections)

Tray:

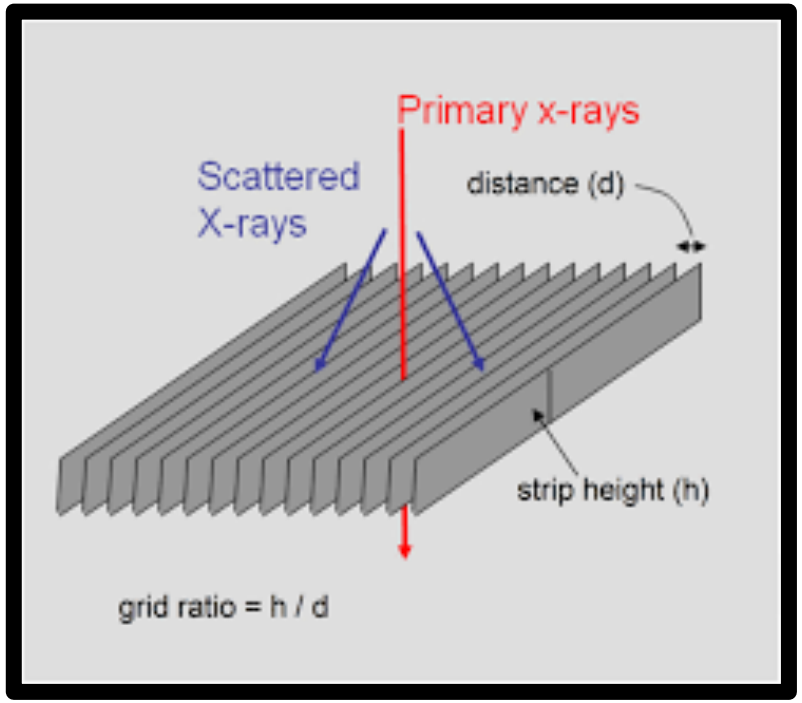
- Trays hold the cassettes and adjust the individual size.
- The center of the tray usually marked with a line or notch

The Equipment continued:

Chapter 4 – Section 3.1.5
Chapter 5 – Section 7

Grids:

- Grids are devices that limit scatter radiation.
- They are made up of thin strips of lead that are parallel to each other, similar to a venetian blind.
- As the X Ray passes through the grid the lead strips stop the scatter beam from reaching the film at odd angles.

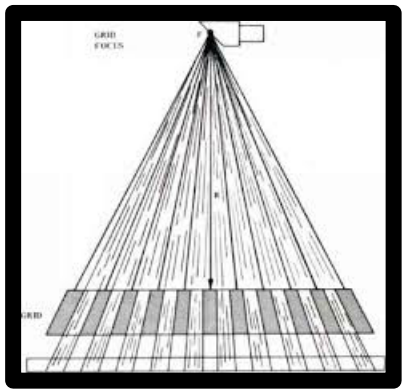


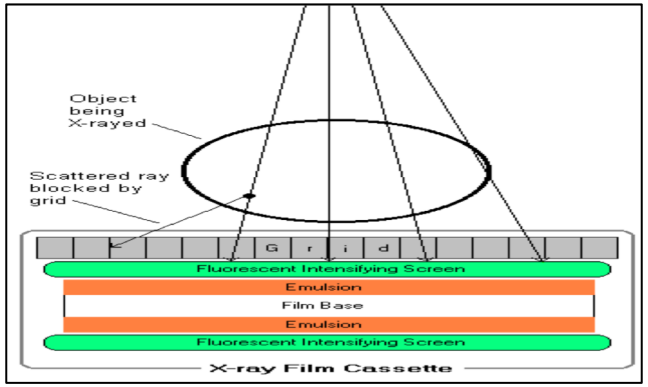
The Equipment continued:

Chapter 4 – Section 3.1.5
Chapter 5 – Section 7

Grids continued:

- Types
  - Stationary Grids:
    - Parallel Stationary = are parallel to match the diverging beam like the light from a flashlight the bean diverges the farther away from the source.
    - Focused Stationary = Angled is set to a specific orientation and tube distance (Focal Distance or Grid Ratio).





  - Oscillating Grids:
    - Move back and forth across the film
    - This blurs out the Grid Lines in the image.

The Equipment continued:

Chapter 4 – Section 3.1.5
Chapter 5 – Section 7

Grids continued:

- Grid Ratio = The height of the strips compared to the distance between them.
  - Example is if height was 8 mm and the space was 1 mm, the ratio is 8:1.
  - The higher the ratio the more X Ray is absorbed and the less scatter.
- Grid Frequency or Strip Density = The number of lead strips per inch.
  - **Desired ratio is 12:1, 60-Lines**

The Equipment continued:

Chapter 1 - Section 13 (with subsections)

Imaging Systems:

1. **Conventional Analog System** = creates images by exposing film in cassettes requiring processing
2. **Digital Imaging Acquisition System (DIAS)** = creates images digitally
   - Computed Radiography (CR) = utilized a cassette but instead of film in the cassette it has a IRP (image receptor plate).
   - Direct Radiography (DR) = the digital image is captured directly to the computer. Does not use cassettes. The image is created by a detector that is behind the patient similar to a Bucky which contains an IRP.

The Equipment continued:

Chapter 1 - Section 13 (with subsections)

1. *Conventional Analog Radiology:*

- Uses X-Ray film and intensifying screens within a cassette holder.
- Film is placed between intensifying screens and when struck by X-Ray will glow or fluoresce exposing the film directly to the light.
- The exposure is based on the amount of light produced by the screens
- The film is developed in a darkroom similar to regular film photography, producing an image on the film.
- The film is read by the doctor and/or radiologist for interpretation.
- Films must be stored properly

The Equipment continued:

2. DIAS continued:

Computed Radiography (CR):

- Utilized a cassette but instead of film in the cassette it has a IRP (image receptor plate).
- The IRP is made of multiple layers (main photostimulable phosphor layer is Barium Flourohalide.)
- The image production is a 2 step process:
  - Exposure to the IRP and then
  - Computer Reading the info, (scans the IRP).
- The IRP stores the energy from the exposure and then later transfers it through a table top device to a computer caller a CR Reader.
- Difference from Conventional:
  - CR is faster than conventional X-Ray
  - Most older generators can use the system
  - Generally no change in technology for up to 400 speed systems
  - Image production is slower than DR (below)
  - Requires cassettes and a CR Reader.
  - More steps to produce image
  - Cassettes are expensive so you may have limited number
  - Cassettes need to be downloaded and erased.
  - Images can be manipulated, e.g. rotated, lightened, darkened, annotated, measured, anatomy removed. This is called subtraction
  - Images can be stored digitally.

The Equipment continued:

DIAS continued:

Direct Radiography (DR):

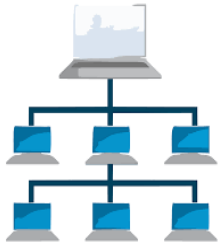
- Digital image is captured directly to the computer.
- Does not use cassettes.
- The image is created by a detector that is behind the patient similar to a Bucky which contains an **imaging plate.**
- Image Generation: can be created by:
  - **Indirect Conversion** (2 step process; light to an electric signal)
  - **Direct Conversa**tion photons (light) are absorbed by an amorphous (no defined shape) photoconductor (Selenium). More than a million pixels can be read and converted to an image.
- Differences:
  - Better throughput times, e.g. Images are produced without cassettes within 3 to 5 seconds.
  - More expensive than conventional and CR.

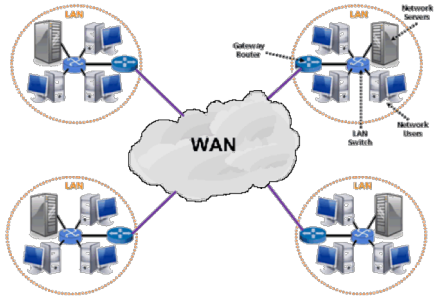
The Equipment continued:

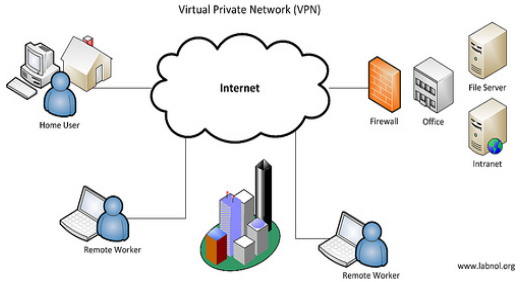
Chapter 1 - Section 13 (with subsections)

Unique to digital imaging:

- LUT (Look Up Tables) = Unlike conventional systems, kVp and mA may still influence the contrast and density of the image, however with digital Radiography the LUTs (algorithms in the software) do most of the work.
- EI (Exposure Indicators) = relative amount of exposure reaching the imaging plate influencing under or over exposures.
- Images can be manipulated, e.g. rotated, lightened, darkened, annotated, measured, anatomy removed This is called subtraction).
- Images can be sent anywhere through the internet or other digital formats:
  - LAN (Local Area Network) = Computers and devices on a single network.
  - WAN (Wide Area Network) = Multiple connected networks covering a large geographical area.
  - VPN (Virtual Private Networks) = Private and secure internet connections







The Equipment continued:

Chapter 1 - Section 13 (with subsections)

Special Technique and Considerations Using Either CR or DR:

- Collimation = Collimated edges may influence the image due to increased sensitivity by DIAS.
- Settings for kVp and mA are less influential as in conventional due to… (spot quiz)
- Part Centering = part being X-Rayed must be over the sensor portions of the detectors.
- PACS (Picture Archiving and Communication Systems):

The Equipment continued:

Chapter 2 - Sections 2-3-4 (with subsections)

The Darkroom:

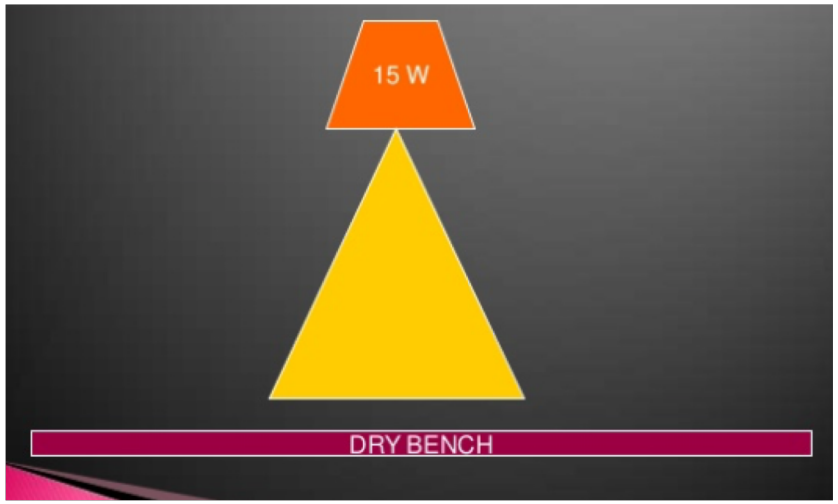
- Location where processing films takes place.
- More specifically, takes the Latent Image (the invisible image on a film before processing) is turned into the Manifest Image (the now visible image)
- Should be light tight.
- Should have a safelight.
- Should have ventilation.
- Location for Film Identification Flasher.
- Location of Processor (or tanks).

The Equipment continued:

Chapter 2 - Sections 2

Safelight:

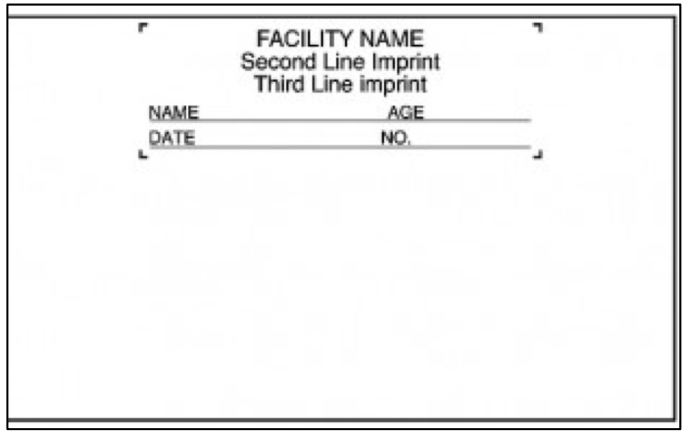
- Low intensity light bulb, 7 to 15 watts.
- Light is filtered with an amber to dull orange hue or red color wavelength Wratten 6B filter or Kodak BGX)
- Film is not very sensitive to these wavelengths and therefore for short periods of time they can be exposed without impact on the images.
- If let under a safelight for greater than 1 minute it will fog the image.
- Light should be 4 feet from the film. Film is not as sensitive to the light emitted



The Equipment continued:

Flash Card Imprinter:

- Device that puts identifying information on films
- Identification is flashed (exposed) through a “Flash Card” onto a film utilizing a “flash card imprinter”.
- The minimal information on the “flash card” and ultimately the film:
  - Patient’s name and ID number
  - Age/Date of Birth
  - Date study is completed
  - Location film is completed, e.g. office name and city
- Make sure card is aligned:



The Equipment continued:

Chapter 2 - Sections 2

Signage and/or Signal:

The Equipment continued:

Chapter 2 - Sections 7-8-9 (with subsections)

The 3 steps to process (develop) an exposed film:

1. The Developer = Coverts the latent image (not visible) into a picture by changing the exposed crystals of silver bromide into grains of silver left on the film where there the film was exposed by photons.
    - Composed of:
        - Reducing Agent = removes the bromide from the silver bromide
        - Accelerator = allows chemicals to enter the film surface
        - Restrainer = helps reduce fog
        - Preservative = slows oxidation and extends life of developer
2. The Fixer = Hardens remaining emulsion on the film making image permanent.
    - Composed of:
        - Fixing Agent = converts left over silver bromide to a soluble form
        - Acid = needed to neutralize the alkali in the developer
        - Hardener
        - Preservative

    (An Interim wash takes place with hand developing)
3. The Wash and Dry =Removes residual chemicals
    - Composed of:
        - water
        - warm air blower

The Equipment continued:

Chapter 2 - Sections 7-8-9 (with subsections)

Manual Processing:

- This methods utilized 3 or 4 tanks filled with developer, stop bath, fixer and wash. The operator must control the temperature and time in each. The films are place in “hangers” and submersed in each tank and then hung to dry.
- This method is beyond out dated and should not be used. Please read the section on Manual processing as background.

Chapter 2-Sections 8 (with all subsections)

The Equipment continued:

Chapter 2 - Sections 7-8-9 (with subsections)

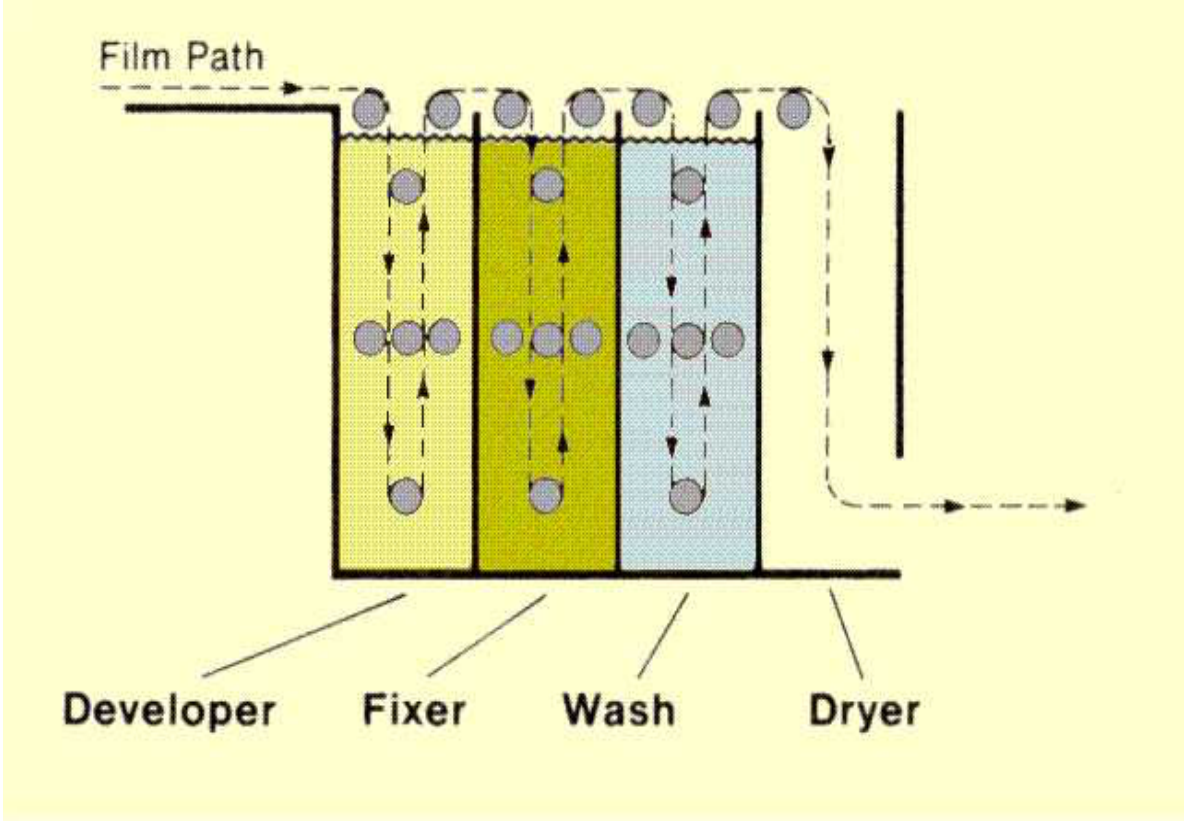
Automatic Processing:

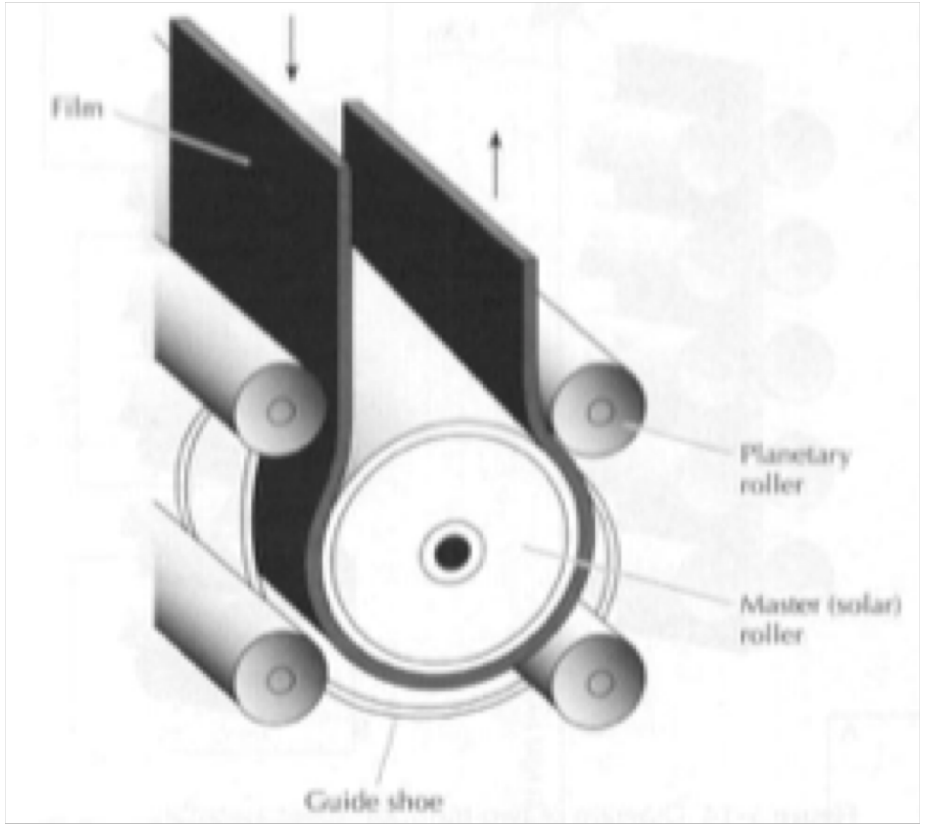
- This method utilizes a machine to pass the film through the developer, fixer, wash and dryer by a series of rollers.
  - Systems:
    1. Transport = consists of feed tray, rollers and motors that move the film through the processor.
    2. Replenishment = Refreshes automatically the chemicals from reservoirs as needed.
    3. Temperature Regulation = Generally hotter than manual
    4. Recirculation = Keeps chemicals mixed, at temperature and in contact with the film
    5. Water = Washes the film
    6. Dryer = A blower dries the film as it passes through.
    7. Silver Reclaimer = Removes and stores silver from the waste.

The Equipment continued:

Chapter 2 - Sections 7-8-9 (with subsections)

Automatic Processing continued:





The Equipment continued:

Chapter 2 - Sections 7-8-9 (with subsections)

Automatic Processing continued:

- Total processing time is 45 seconds to 7 minutes
- Still requires a darkroom
- Temperatures are higher and maintained by the machine
- Requires regular service and chemical replenishing.
- Rollers may get dirty and stain the film
- Chemicals are “replenished” automatically by surplus chemicals connected to the machine and drawn in as needed
- Films are dried as the final step

How Processor Affects Speed of Film:

Film Speed Increased:

- Increased developer temperature
- Increased water temperature
- Faulty thermostat causing above
- Poor or no water flow
- No starter with new developer or no starter film run with old
- Chemicals improperly mixed
- Developer over replenished
- Film fog by General means

Image Quality Decreased:

- Low developer temperature
- Low water temperature
- Excessive starter
- Faulty thermostat causing above
- Film fog by General means
- Calibration of sensitometer and/or densitometer
- Chemicals contaminated
- Developer under replenished
- Recirculation problems

How Processor Affects Film Contrast:

Chapter 6 – Sections 4

Image Contrast Too Much (increased):

- Improper developer temperature
- Improperly mixed chemicals
- Incorrect replenishment rates

Image Contrast Too Little (Decreased):

- Improper developer temperature
- Depleted developer
- Contaminated developer
- Improperly mixed developer
- No starter with new developer or no starter film run with old
- Incorrect replenishment rates
- Safelight issues
- Outdated film
- Loss of circulation in processor

Rules for Film Handling:

Chapter 4 - Section 6.6
Chapter 5 - Section 2

1. Light Sensitive: Film needs to be stored in a light tight receptacle or bin.
2. Age: Film has a shelf life.
3. Temperature, Moisture and Radiation Sensitive: Take note of expiration dates Ideal storage temperature is 68 degrees F or lower with a relative humidity or 30% - 60 %. Location of film storage should be away from direct or scatter X-Rays.
4. Scratch and Perspiration Sensitive: The surface of film are not resilient. Handle with care.
5. Static Electricity Sensitive: A small static spark can expose film.
6. Boxes of film should be stored on edge as they are pressure sensitive.
7. Cleanliness: Avoid collecting area contaminants from hands on film.

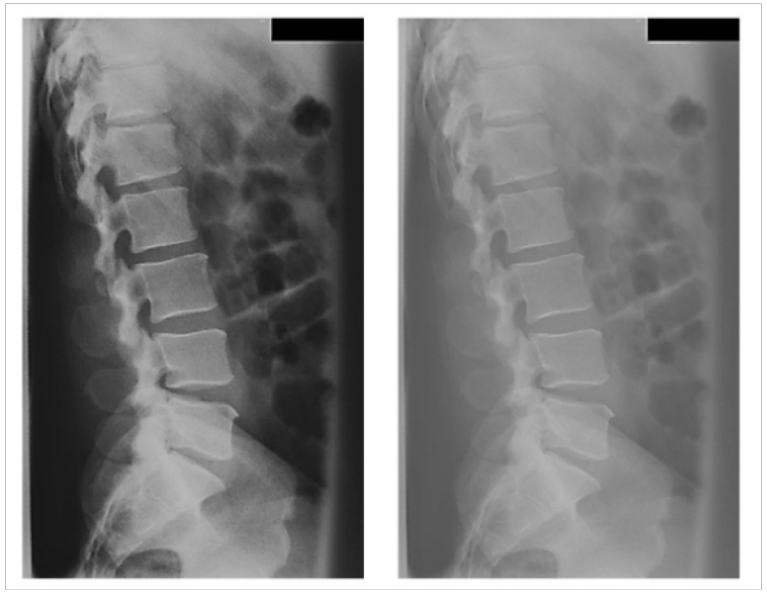
Rules for Film Handling:

Talk to Me…

Chapter 2 - Sections 7-8-9 (with subsections)

Chapter 6 – Sections 4

Generally:



1. Base Fog or Haze:
    - Film is out of date
    - Film exposed to excessive heat
    - Film exposed by scatter
    - Safelight too bright
    - Developer temperatures too high
    - Developer old or contaminated
    - Overdeveloped
    - Inadequate fixing time
    - Incomplete rinse between solutions
    - No starter with new developer or no starter film run with old
    - Incorrect replenishment rates
    - Loss of circulation in processor
    - Depleted fixer

Talk to Me…

Chapter 2 - Sections 7-8-9 (with subsections)

Generally continued:

2. Streaks = inadequate initial agitation or insufficient mixing of solutions.
3. Crinkle Marks = Small Black or white curved lines from bending of film (thumbnail size).
4. Semi-Opaque Smudges = Fingers marks, perspiration, pressure marks.
5. Small Round Spot = Water drops left after dryer (hand developing).
6. Static Marks = Tiny black dots or lighting bot zigzag or chicken feet marks from static charge to the film made by friction.
7. White Dots, White Hairlines, Uneven White Area = Due to foreign bodies on film before exposure, e.g. hair, dust.
8. Reticulations = Pattern of connected fine line similar to crack paint. Significant Temp difference between steps (mostly manual).
9. Weak Image and Little Contrast = under expose or underdeveloped.

Talk to Me…

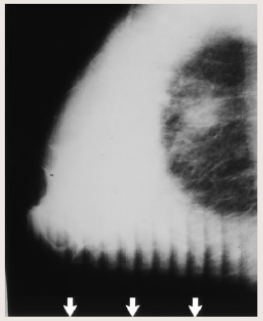
Chapter 2 - Sections 7-8-9 (with subsections)

Specifically for Automatic Processor:

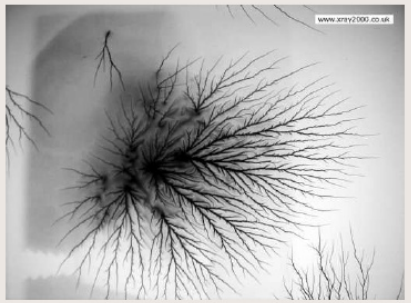
1. Uneven Spots = inadequate squeegeeing of film by the rollers
2. Small Clear Spots = Dirt on the screen
3. Drying Streaks = Dirty air tubes or out of position
4. Scratch Marks = rollers not seated, faulty thermostat or temp regulator
5. Fog from Processor = Lights leaks, chemical contamination
6. Mottling = developer too concentrated
7. Lack of Clarity = fixer too concentrated
8. Yellow Smudges = fixer too weak or old
9. Artifact = marks or images on films from procedure
   e.g. processing, exposure handling

Talk to Me…

ROLLER MARKS



STATIC



WATER STAIN

FILMS STUCK TO EACH OTHER DURING PROCESSING

SCRATCHES

Things to Control:

Chapter 2 - Sections 7-8-9 (with subsections)

1. Cleanliness
2. Light
3. Temperature if developing manually
4. Artifacts

- Exposure = Error from procedure or equipment during the taking of the film
- **Processing = Error from procedure or equipment during developing the film**
- Handling or Storage = Before or after exposure and processing, error from procedure or equipment during handling or storage of the film
- If you must step out of the Darkroom, close one eye if you have to leave for second
- Leave the processor lid open when done at the end of the day

Quality Control and Assurance:

Chapter 6 – Sections 1-2-3-4-5-6-7-8-9-10-11-12

Quality:

- Control = Policies and program that outlines and defines quality.
- Assurance = Procedures whose purpose is to provide assurance of Quality Control program has been implemented, identification of errors with corrective actions protocols.

Quality Assurance Testing:

- Defined program of equipment inspection and maintenance.
- Three Areas that require regular testing and maintenance:
    1. X Ray Machine
    2. Cassettes and Screens
    3. Darkroom

Quality Control and Assurance continued:

Chapter 6 – Sections 7

1. *X Ray Machine:*

- SID (FFD) accuracy = Distance from focal spot on the anode to the Bucky Tray, + or – 2%.
- X Ray Field Alignment = When collimated to film size, light is aligned with film, + or – 2%.
- X Ray & Bucky Alignment = Central Ray is center of Bucky, + or – 2%.
- Collimator Dial Accuracy = What the dial says and what it shows are the same, + or – 2%..
- Reproducibility = Same mA, time and kVp gives the same outcome each time, + or – 5%.
- mR/mAs = Determine exposure to patient and make attempts to minimize. Similar to Reproducibility but from the patients' perspective not the final image, *This is tested by your X Ray company through Annual Calibrations* + or – 10%

Quality Control and Assurance continued:

Chapter 6 – Sections 7

1. *X Ray Machine continued:*

- Linearity = mR/mAs testing through varied ranges of techniques, + or – 10%
- Timer Accuracy = What is says it what it does.
- Half-Value Layer = The amount of aluminum filtration necessary to reduce the exposure by ½ with fixed kVp and mAs. This defines the "hardness" of the beam. The Center for Medical Devices and Radiological Health requires that the minimum HVL is 2.3 mm of aluminum at 80 kVp.

  3.0 mm is recommended.
- kVp Accuracy = Annual Calibration, + or – 4 to 5%
- Phototimer Reproducibility = Exposure terminated at the designated time, + or – 5%
- Posted Safety Procedures

Quality Control and Assurance continued:

Chapter 6 – Section 3
Chapter 6 - Section 6
Chapter 6 – Sections 6

2. *Cassette and Intensifying Screens:*

- All Darkroom equipment should be placed on a regular maintenance schedule with logs.
- Assign each cassette a number and maintain a log.
- Rotate use of the cassettes. Do not always use the same one if possible.
- Clean Annually at a minimum
- Poor screen contact can be assessed by the "wire mesh Test". Place a wire mesh on the cassette and take an exposure. Poor screen/film contact areas will show as a blur on the film.
- Causes for poor screen contact:
    - Loose, bent, or broken hinges on the cassette
    - Loose, bent, or broken latches on the cassette
    - Warped screens
    - Warped cassette front
    - Sprung or cracked cassette frame
    - Foreign matter under the screen

Quality Control and Assurance continued:

Chapter 6 – Sections 4

3. Darkroom

- Requires frequent maintenance and checking.
- To maintain viable chemicals through film replenishment, 25 to 50 sheets of 14” x 17” must be developed daily (can be the same one reused. This replenishes the entire chemicals volume every 16 hours
- Base-Plus Fog = This means density of unexposed portions after processing equals 0.15 to 0.20 on a densitometer.
- Check for light leaks.
- Safelight bulb may fade over time. Also check for cracks that may let white light escape.

Quality Control and Assurance continued:

Chapter 6 – Sections 4

3. *Darkroom*

- Requires frequent maintenance and checking.
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- Check for light leaks.
- Safelight bulb may fade over time. Also check for cracks that may let white light escape.
- Processor Testing Requires:
  - Step Wedge = Varied thickness wedge to show differences in density.
  - Sensitometer = Device to produce consistent exposure control for testing purposes.
  - Densitometer = Used to measure the density of an exposure after processing.
  - Digital Thermometer = If hand developing (and you should not be hand developing)
  - Sensi-(Density) Strips = Allows for comparison on density testing. (page 117)
  - Processor Maintenance Log
  - Cleaner

Diagnostics and Maintenance Schedule Sample:

Chapter 6 – Sections 3

- **Daily:**
  - Clean Processor rollers and cross over racks
  - Check chemical levels
  - Check Processor replenisher levels
  - Compare sensitometer strips with master
- **Weekly:**
  - Check developer temperature
  - Compare exposure step-wedge with master
  - Inspect processor for leaks, noises and broken parts
  - Check darkroom for light leaks

Diagnostics and Maintenance Schedule Sample continued:

Chapter 6 – Sections 3

- **Monthly:**
  - Service processor and lubricate as needed *This is best completed by a professional.*
    - Processor cleaning
    - Replace fixer and developer chemicals in processor
    - Replace fresh water filter if it has one
    - Detailed examination of processor components
    - Check Processor replenisher rates
  - Inspect intensifying screens
  - Check darkroom for light leaks
  - Retake film analysis

Diagnostics and Maintenance Schedule Sample continued:

- Semi Annually:
  - *Processor*: ***This is best completed by a professional.***
    - Major Cleaning and lubrication
    - Drain cleaning solution
    - Major sensitometry review: film speed and contrast
  - *Image Receptors:*
    - Check film screen speeds
    - Clean all screens and replace if necessary
    - Check film/speed contact
  - *Other:*
    - Take X Ray of shields/aprons to detect leaks
    - Detailed Re-Take Analysis
    - Fine-Tune technique Chart if necessary

Diagnostics and Maintenance Schedule Sample continued:

Chapter 6 – Sections 3

- **Semi Annually continued:** ***This section requires a profession.***
  - *Generating Apparatus:*
    - Calibrate Generator and Control Panel
    - Grid alignment
    - mA/mAs linearity
    - kV reproducibility
    - Timer accuracy
    - Collimator alignment
    - mR/mAs output
    - Half-Value Layer
    - Focal Spot resolution
    - kV accuracy

Policies:

Chapter 3 - Sections 8-9-10-11 (with subsections)
Chapter 6 – Sections 8-9-10-11-12

- Gonad and other Shielding
- When and who would be allowed to hold a patient
- Personnel monitoring
- Over exposure reporting
- Pregnant Patients
- Personnel monitoring

Examples pages 122 to 124 patient and workers

Definitions/Terminology:

Common Prefixes:

a-	without
contra-	against
hyper-	increased
hypo-	decreased
infra-	below
inter-	between
Intra-	within
para-	beside
pre-	before
post-	after
sub-	under/less than
supra-	above
ultra-	beyond
osteo-	bone
myo-	muscle
arthro-	joint
patho-	disease
neuro-	nerve

Definitions/Terminology:

Common Suffixes:

-algia	pain
-itis	inflammation
-ology	study of
-opathy	disease

Commonly Encountered Abbreviations:

Hx	History
Sx	Symptom
Ex	Examination
Dx	Diagnosis
Px	Prognosis
Tx	Treatment
Rx	Prescription

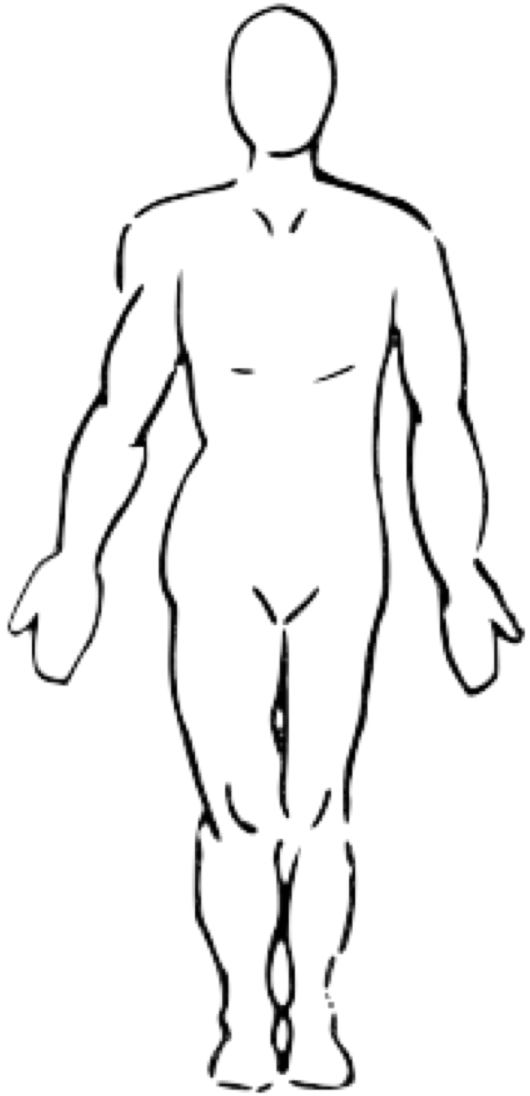
Definitions/Terminology:

Commonly Encountered Terms:

antalgic	posture or gait to avoid pain
Radiation Safety Officer	person responsible for radiology compliance
contraindications	not clinically appropriate
extremity	The end of something - arm or leg
diagnosis	determining disease/named disease
palpation	to examine by touch
inspection	to examine by observation
radiograph	x-ray
somatic	external structure/frame
visceral	internal organs
treatment	procedure/protocol to effect positive change

Anatomical Position

- Body Erect
- Eyes forward
- Arms at side
- Palms forward
- Feet forward

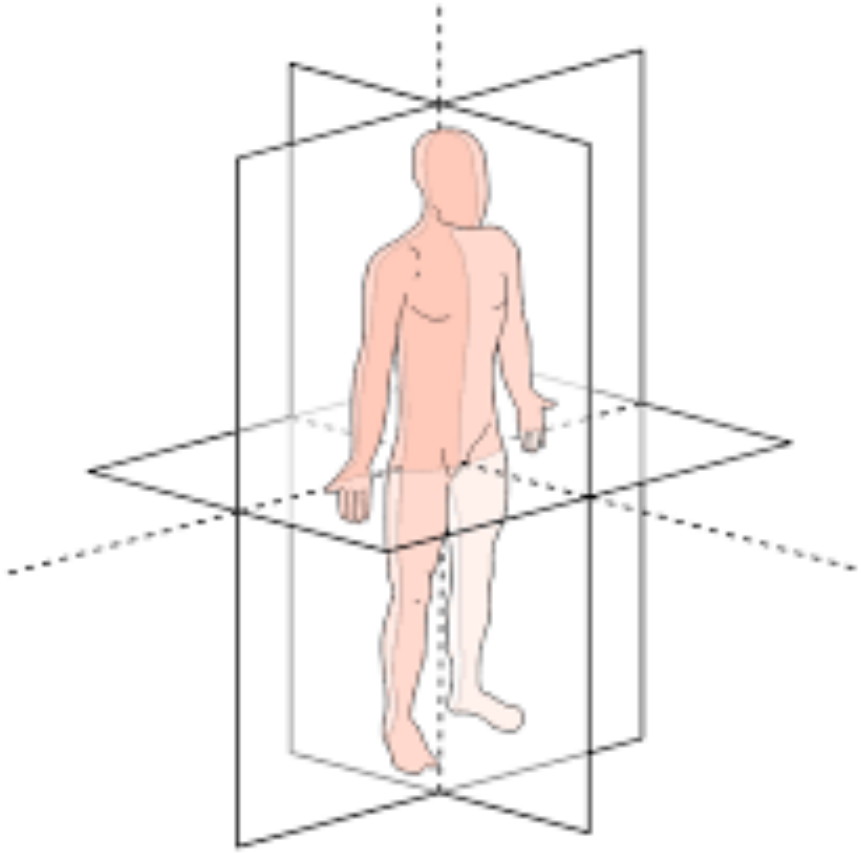


Positions and Directions:

Anterior	toward the front
Posterior	toward the back
Medial	toward the middle
Lateral	toward the side
Bilateral	Both sides
Coronal	toward the head
Caudal	toward the bottom
Superior	above
Inferior	below
Proximal	Closer to the trunk or midline
Distal	Further away from the trunk or midline
Erect	standing
Supine	lying flat face up
Prone	lying flat face down

Body Planes:

Sagittal	divides left and right where ever
Median or Mid-Sagittal	divides left and right equally
Frontal	divides front from back
Transverse	divides upper from lower



General Anatomy:

11 Organ Major Systems:

1. Nervous: Master controller.
   Maintains homeostasis.
   Computer of the body and
   Wiring connecting brain to the body and the body to the brain.
2. Muscular: Creates movement.
3. Circulatory: Transports substances throughout body via arteries, veins, and heart.
4. Lymphatic: Transports lymph fluid throughout the body.
   Removes excess fluid.
   Fights infection.
5. Respiratory: Brings Oxygen to the blood.
   Removes Carbon Dioxide.
6. Skin/Integumentary: Protects, regulates, and senses environment (largest).
7. Endocrine: Secretes and regulates hormones.

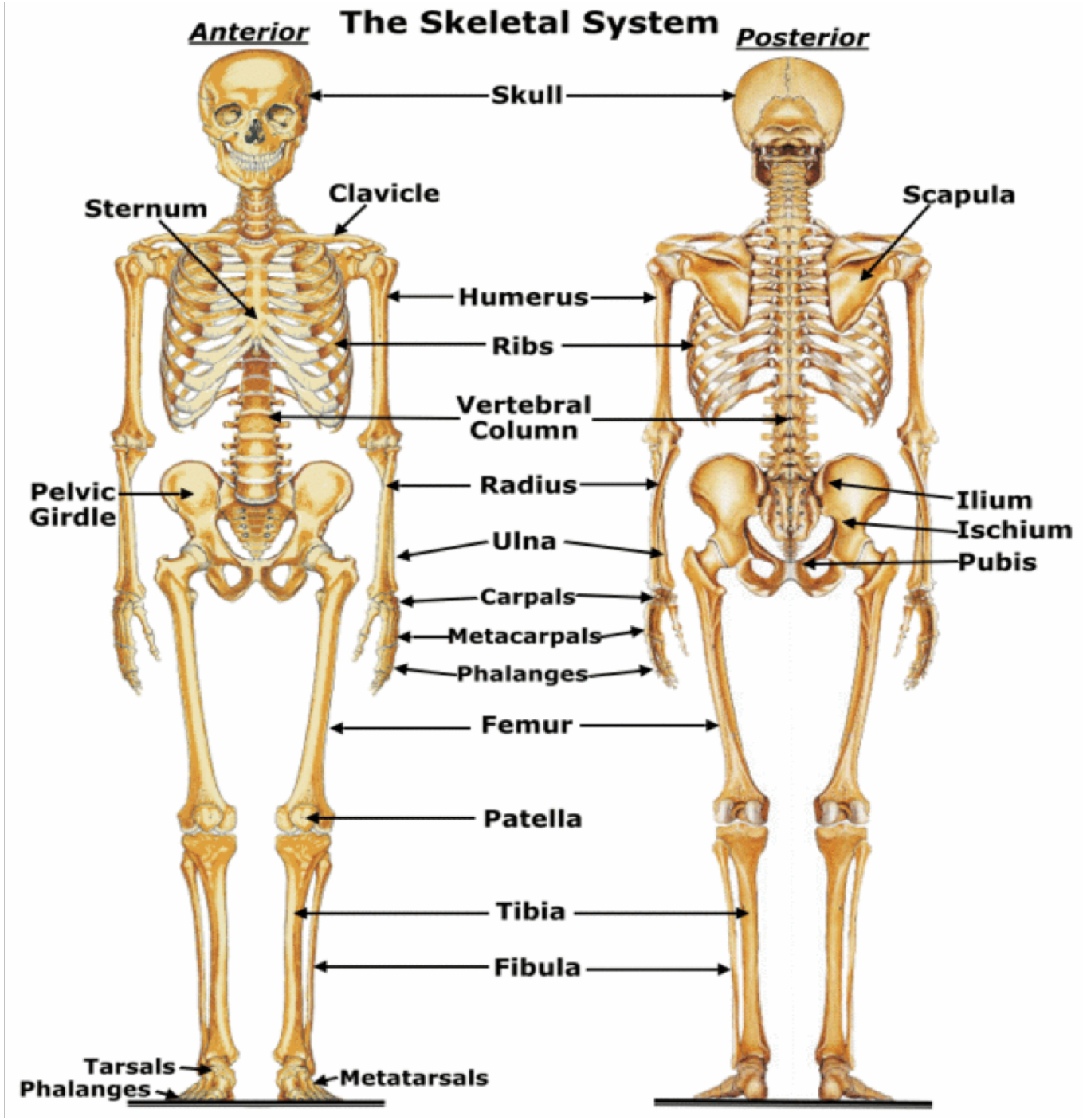
General Anatomy:

11 Organ Major Systems continued:

8.Digestive:	Breaks down food. Absorbs nutrients. Removes solid waste.
9.Urinary:	Cleans and balances the blood chemistry. Removes liquid waste.
10.Reproductive:	Produces and facilitates procreation.
11.Skeletal:	Support. Movement. Protection, Production of RBCs. Storage of minerals. Structure of the body. Hormone regulation (glucose regulation).

Skeletal Anatomy:

- Bone = Rigid Connective Tissue
- Cartilage = Tough flexible connective tissue lining joints.
- Ligaments = Tough flexible fibrous connective tissue that connects bone to bone.
- Tendon = Tough flexible but inelastic fibrous connective tissue that connects muscle to bone.
- Skeleton = Pectoral and pelvic girdles and extremities.
- Axial Skeleton = Head and trunk only.
- 206 bones in the human skeleton:
    - 64 upper extremity
    - 62 lower extremity
    - 51 trunk
    - 29 Head (skull)


The Skeletal System
Anterior
Posterior
Skull
Clavicle
Sternum
Scapula
Humerus
Ribs
Vertebral Column
Radius
Pelvic Girdle
Ilium
Ischium
Pubis
Ulna
Carpals
Metacarpals
Phalanges
Femur
Patella
Tibia
Fibula
Tarsals
Phalanges
Metatarsals

Skeletal Anatomy

Chapter 8 - Sections 3 (with subsections)

Head:

Common Name	Anatomical Name/Location
Head	Skull (made up of Frontal-Temporal-Parietal Occipital bones)
Jaw	Mandible
Eye Socket	Ocular orbit
Sinuses	Paranasal air sinuses (Cavities in skull)
Cleft of Chin	Junction of L & R mandibles
Nose	Nasal Protuberance
TMJ	Temporo-Mandibular Joint (Articulation of mandible & temporal bones)
Mastoid	Pointed process at the base of the Temporal Bone
Ear Canal	External Auditory Meatus (EOM)
Adam's Apple	Thyroid Cartilage

Skeletal Anatomy

Chapter 8 - Sections 3 (with subsections)

Thorax:

Common Name	Anatomical Name/Location
Rib Cage	Thoracic Cage (includes ribs-thoracic spine and sternum)
Angle of Rib	Most lateral part of the rib
Axillary Margin of the ribs	Part of rib aligned with armpit
Floating Ribs	Most often 12th (sometimes 11th) rib - not attached in front
Costal Cartilage	Attaches ribs to sternum
Breast Bone	Sternum (three parts Manubrium (top)-Body (middle-Xiphoid Process (bottom)

Skeletal Anatomy

Chapter 8 - Sections 3 (with subsections)

Spine:

Common Name	Anatomical Name/Location
Spine	Cervical, thoracic, lumbar, sacrum, pelvis and coccyx
Spinous Process	Bumps in the middle down the spine
Spinal Curves	Lordotic = Anterior curve (Neck =cervical & Low back = lumbar)
Spinal Curves	Kyphotic = Posterior curve (Mid back = thoracic & Base = sacrum)
Scoliosis	Lateral curvature of the spine
Hump Back	Increased mid back (thoracic) kyphosis
Sway Back	Increased low back (lumbar) lordosis
Flat Back	Decreased thoracic and lumbar curves
Hip Joint	Articulation of femur head (ball) and acetabulum (socket)
Hip Bone	Iliac crest of each ilium (just below waist)
Pubic Bone	Symphysis Pubis - Articulation of pubic bones
Large protuberance lateral to hip	Greater Trochanter of femur
Butt bone (what you sit on)	Ischial Tuberosity

Skeletal Anatomy

Chapter 8 - Sections 3 (with subsections)

Shoulder:

Common Name	Anatomical Name/Location
Shoulder	Articulation between the Humerus and Scapula
AC Joint	Articulation of the Clavicle and Scapula
Collar Bone	Clavicle
Wing Bone	Scapula
The Armpit	Axilla

Skeletal Anatomy

Chapter 8 - Sections 3 (with subsections)

Arm:

Common Name	Anatomical Name/Location
Arm	Humerus (shoulder to elbow)
Elbow	Articulation of the Humerus and ulna
Funny Bone	Medial epicondyle of elbow with nerve
Wrist	8 carpal bones
Hand	Wrist and metacarpals (palm) and Phalanges (fingers) (differ from text)
Fingers	Phalanges (differ from text)

Skeletal Anatomy

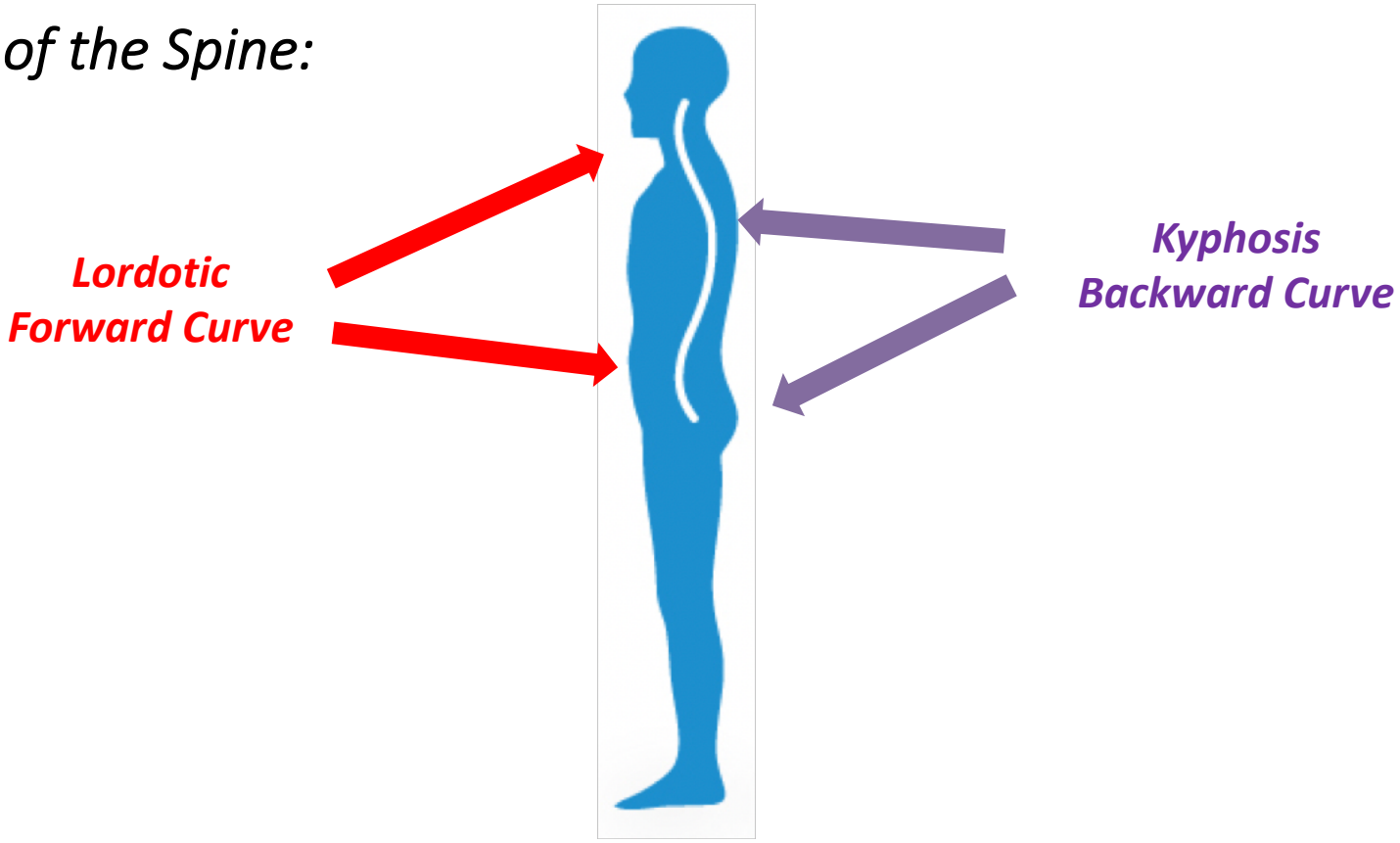
Chapter 8 - Sections 3 (with subsections)

Lower Extremity:

Common Name	Anatomical Name/Location
Thigh	Femur
Knee	Articulation of femur and Tibia
Leg	Tibia and Fibula
Shin Bone	Tibia
Foot	7 Tarsal bones
Arch of Foot	Plantar surface (bottom of foot) that is arched
Foot	Tarsals and Metatarsals
Toes	Phalanges (differ from text)
Heel of Foot	Calcaneus

Skeletal Anatomy

Normal Curves of the Spine:



Normal

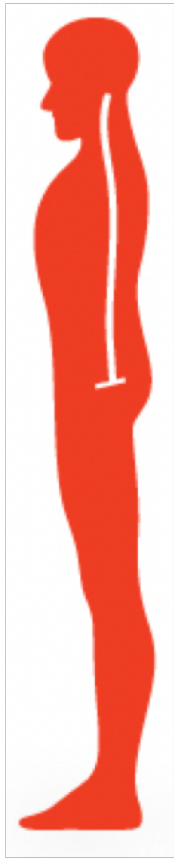
Skeletal Anatomy

Normal Curves of the Spine continued:

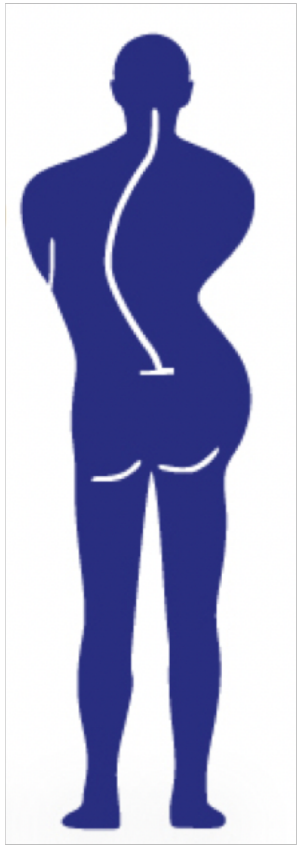
Normal

Hump Back

Sway Back



Flat back



Scoliosis

Skeletal Anatomy:

Chapter 8 - Sections 1-2 (with subsections)

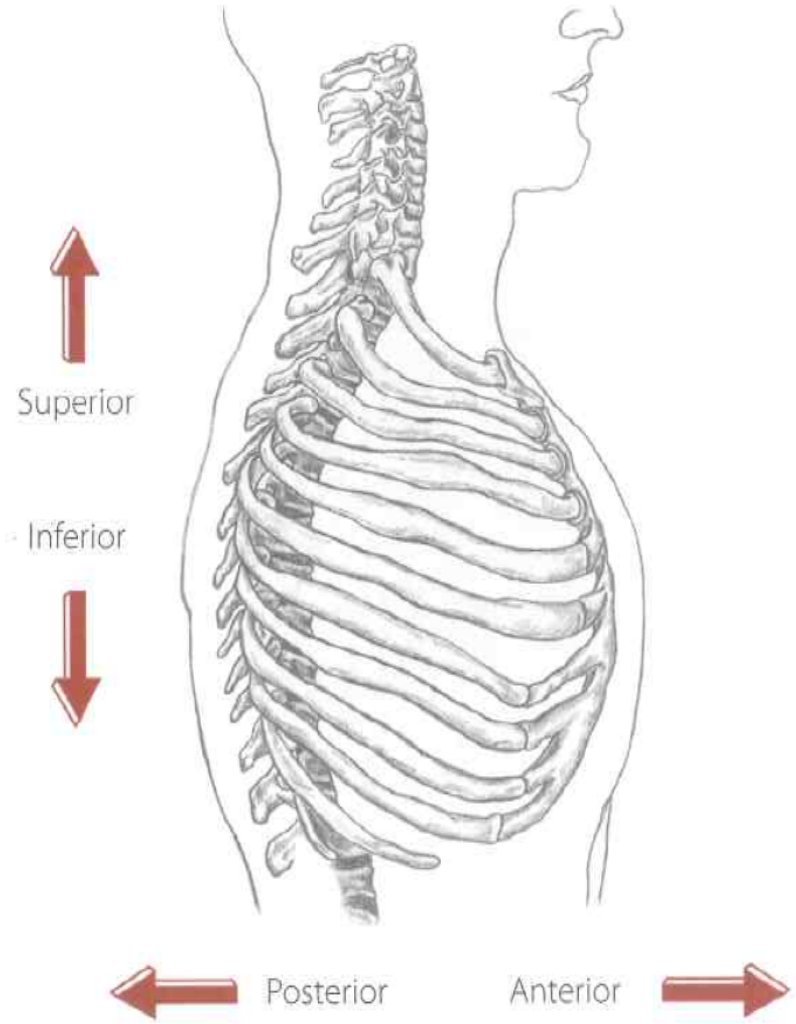
Joints (articulations):

- Area where two or more bones meet.
- There are 3 classes of joints:
  1. Synarthroses = Immoveable (maybe minor movement)
     Bony surfaces that are almost in direct contact with only connective tissue in between, e.g. The Skull
  2. Amphiarthroses = Slightly movable joints
     Two bony surfaces unites by cartilage. e.g. symphysis pubis
  3. Diarthroses = Freely Movable
     Boney surfaces that are limited in motion by ligaments
     Types:
     a) Hinge Joint, e.g. Fingers
     b) Pivot Joint e.g. C1 on C2
     c) Ball and Socket Joint e.g. Shoulder/Hip
     d) Gliding or Arthrodial Joint e.g. Vertebrae

Skeletal Anatomy:

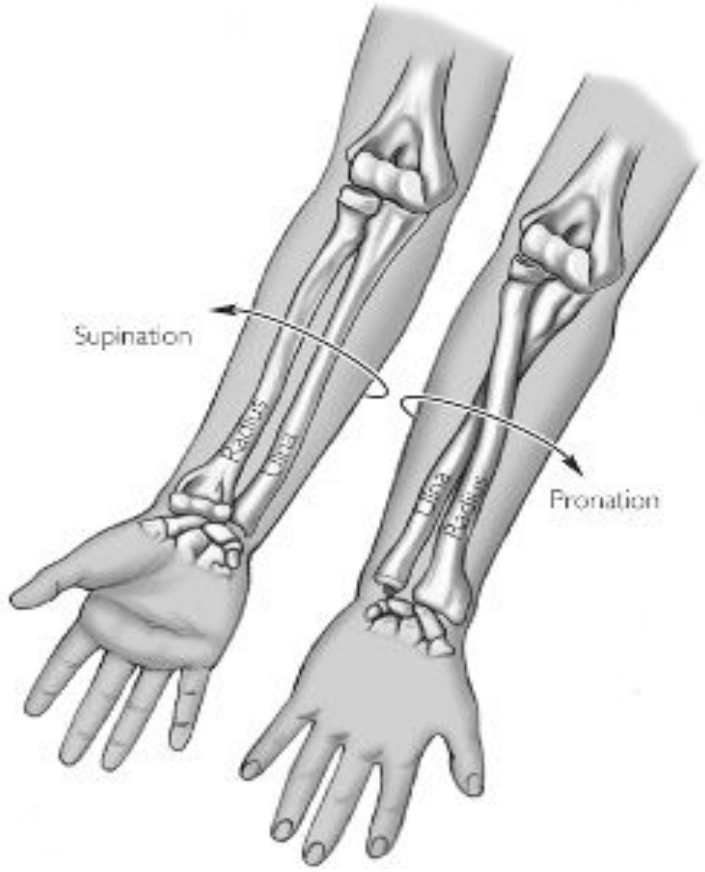
Joint Movement:

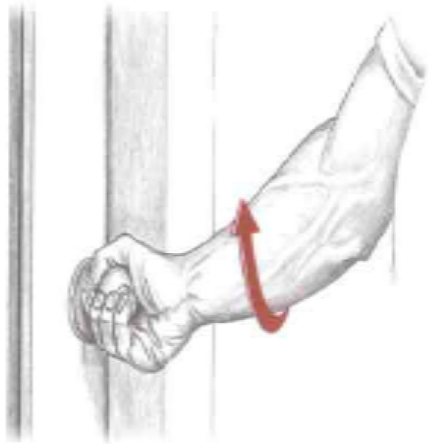
Flexion	bending forward
Extension	bending backwards
Lateral flexion	bending sideways
Rotation	turning
Medial Rotation	turning in towards midline
Lateral Rotation	turning away from midline
Adduction	brings limb medially (adding to body)
Abduction	moves a limb laterally (carry away)
Circumduction	Combo of flexion-extension-abduction-adduction, e.g. hip
Inversion	turn in
Eversion	turn out
Elevation	movement superiorly
Depression	movement inferiorly
Supination	rotating away from midline, e.g. palms up or forward on hands
Pronation	Rotating toward midline


Superior
Inferior
Posterior
Anterior

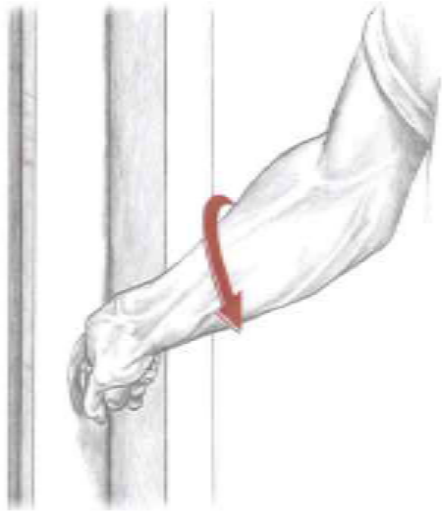
Adduction

Abduction

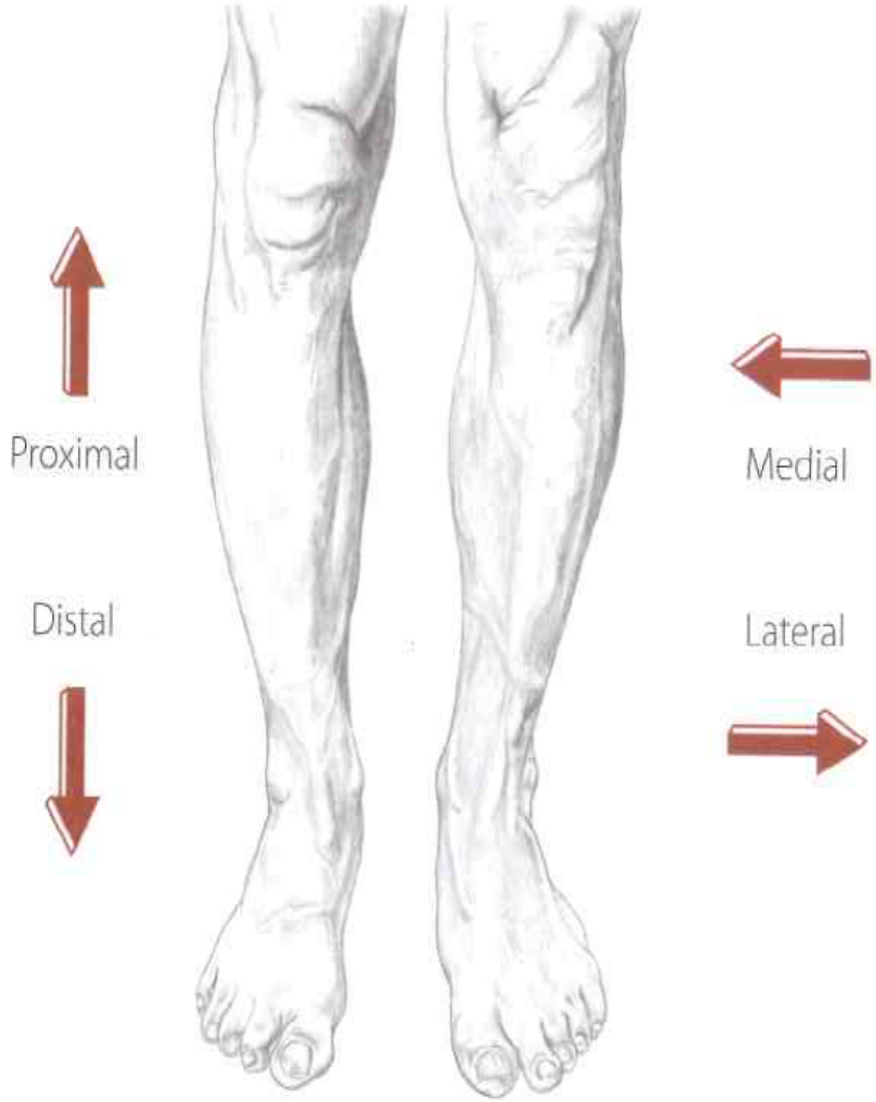


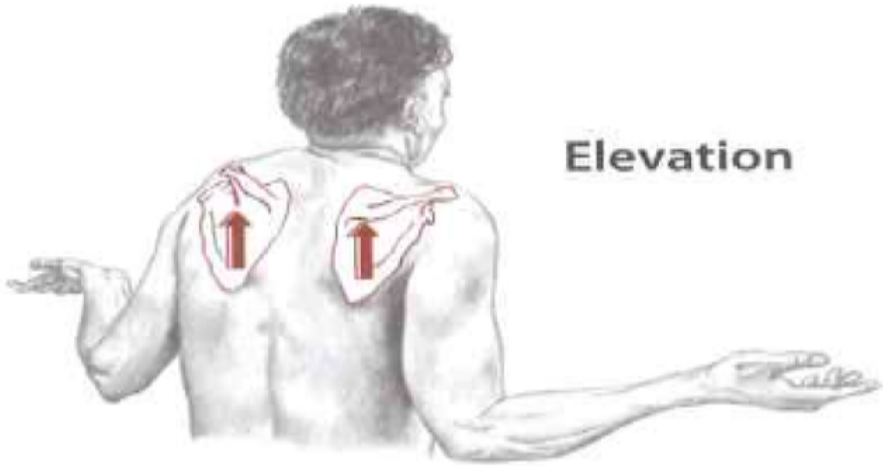


Supination of the forearm



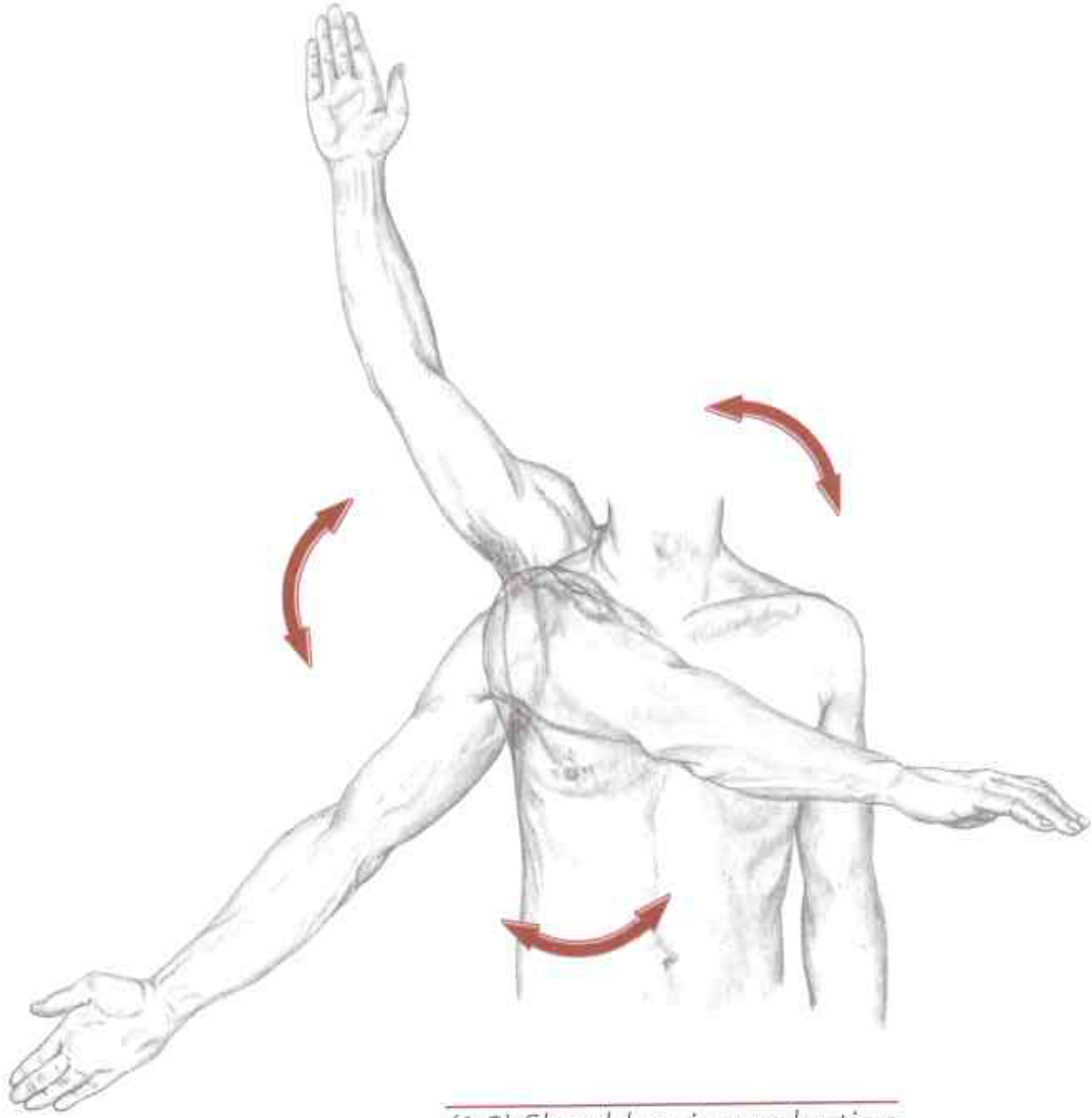
Pronation of the forearm


Proximal
Distal
Medial
Lateral



Elevation

Depression



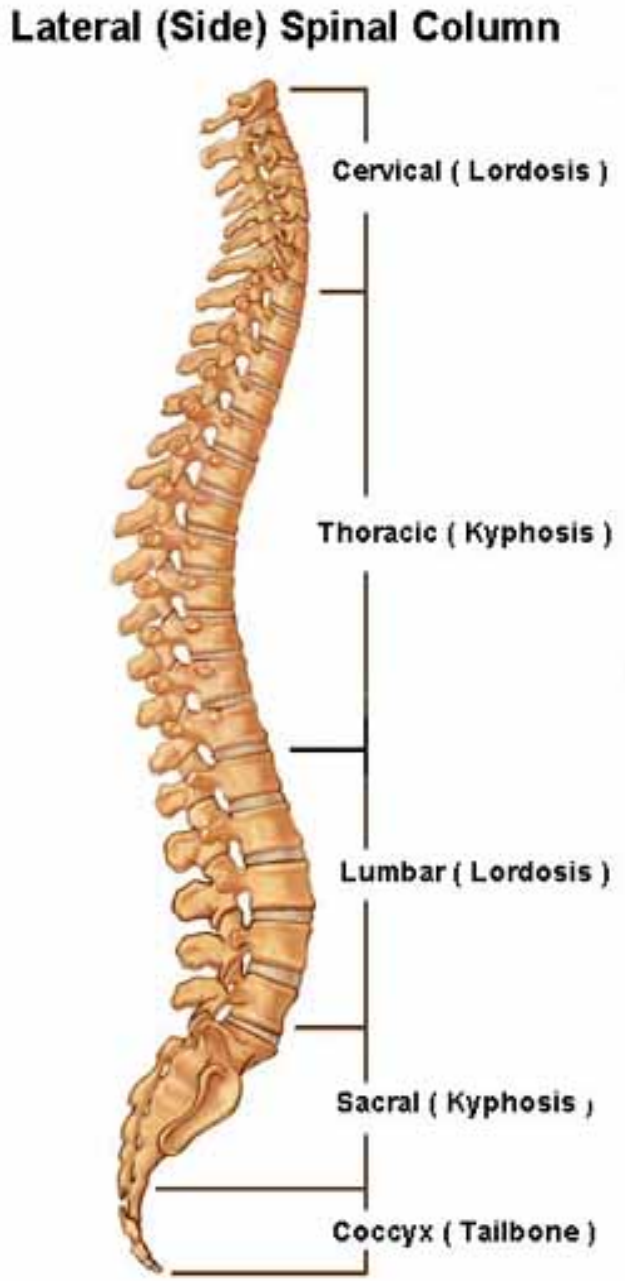
(1.9) Shoulder circumduction

Spinal Anatomy:

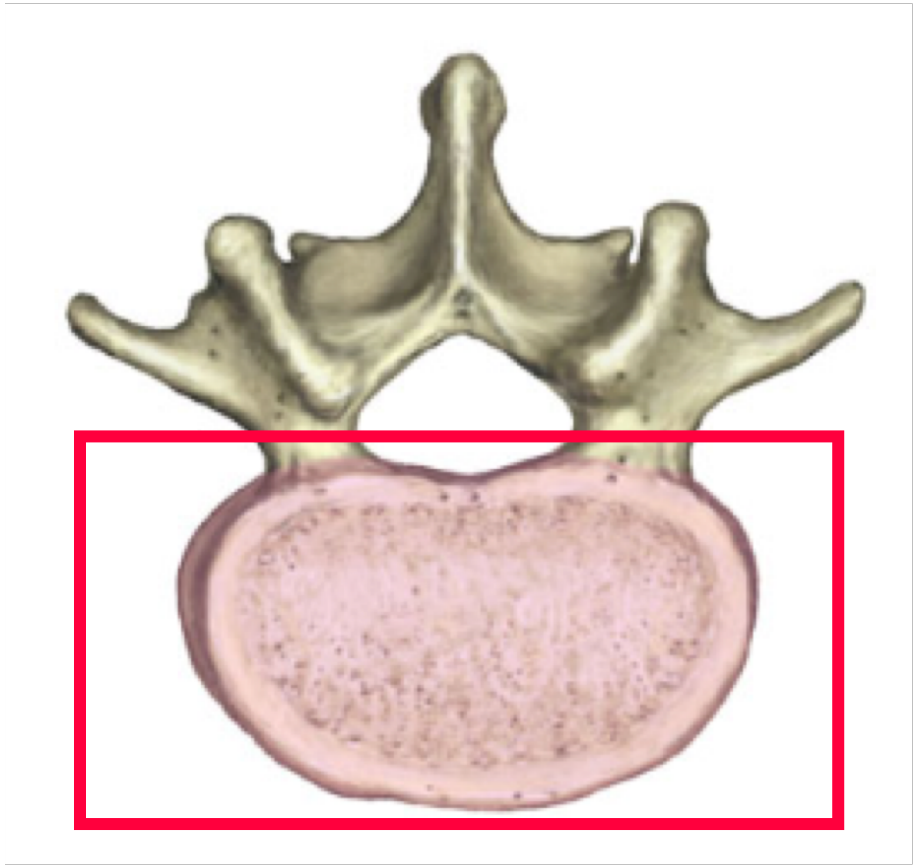
Spinal Column	31+ bony segments of the spine
Vertebra	bony segment of the spinal column
Vertebrae	plural of vertebra
Occiput	base of the skull
Atlas	first cervical vertebra
Axis	second cervical vertebra
Cervical	neck area
Thoracic (dorsal)	mid back area
Lumbar	low back area
Sacrum	base of spinal column
Coccyx	tailbone
Lordosis	anterior (forward) curve of the spine
Kyphosis	posterior (backward) curve of the spine
Scoliosis	lateral (side) curve of the spine

Spinal Regions:

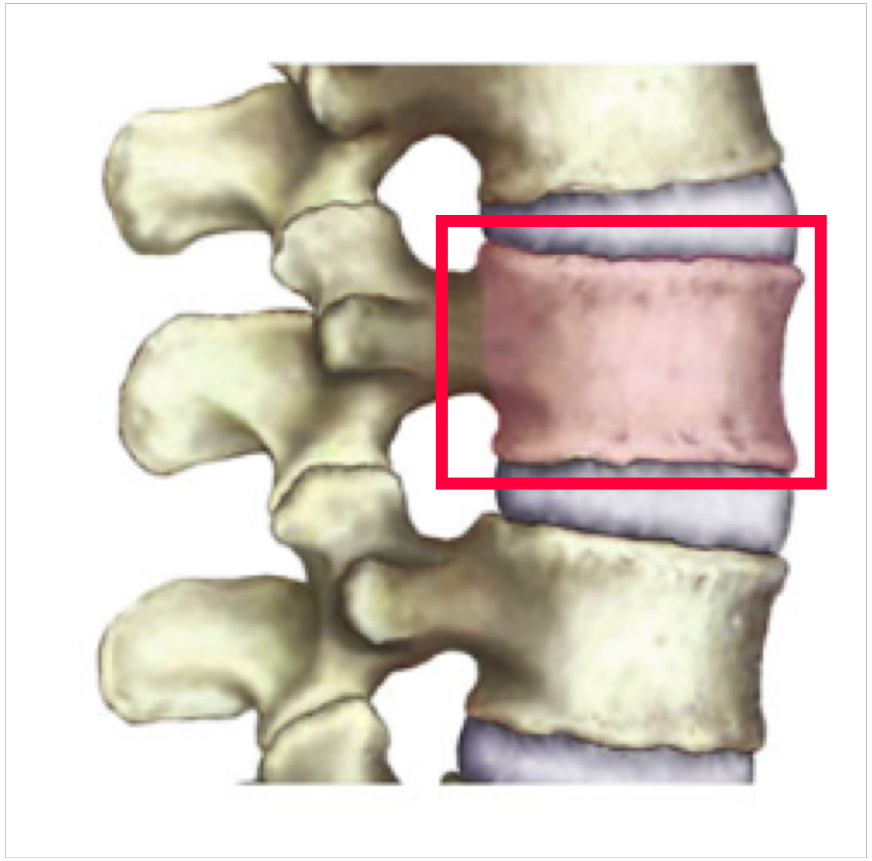
Area	*# of Segments*	*Designation*
Cervical	7	C1 to C7
Thoracic	12	T1 to T12
Lumbar	5	L1 to L5
Sacral fused	5	S1 to S5
Coccyx	2 to 4	
Total	**31 to 33**	



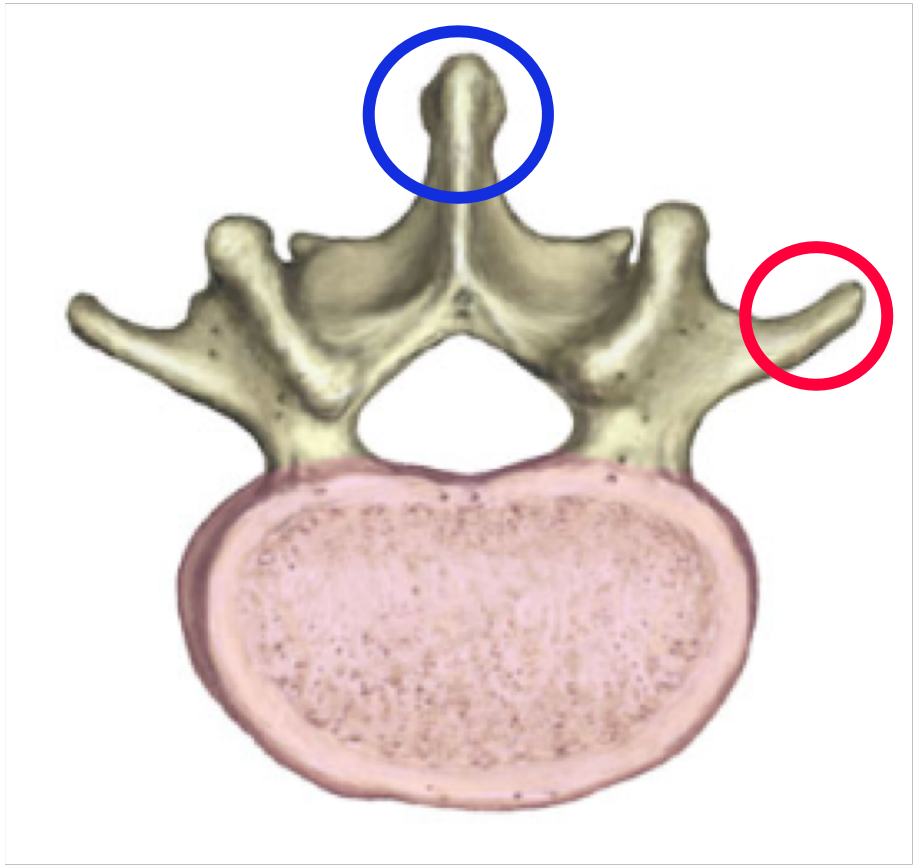
Vertebral Anatomy:



Vertebral Body



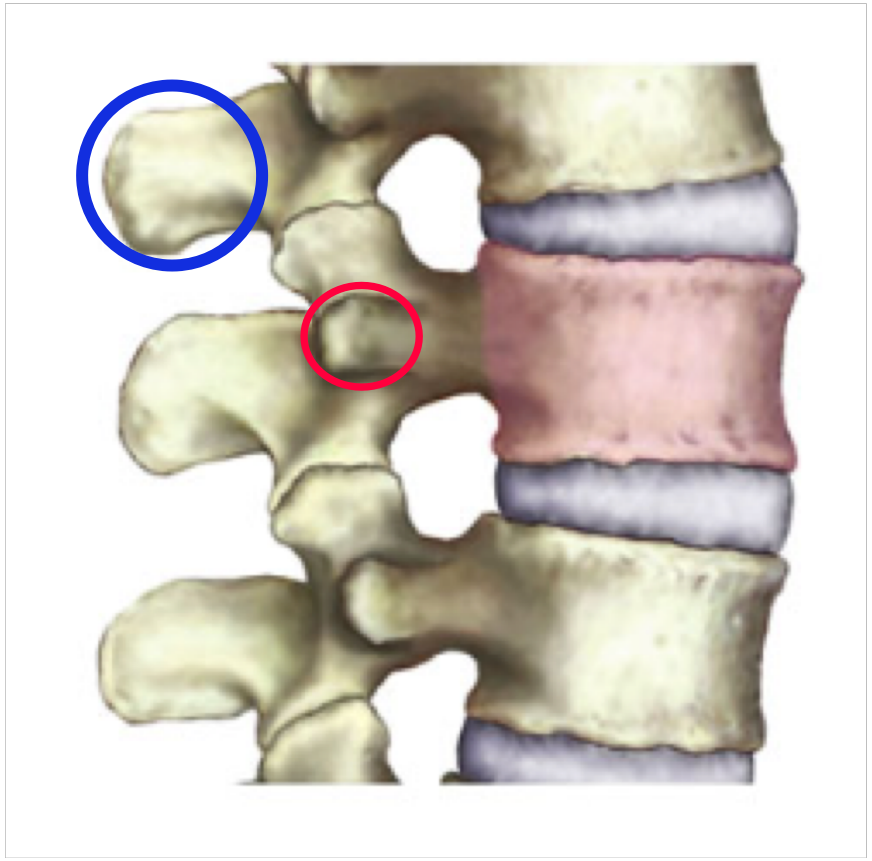
Vertebral Anatomy



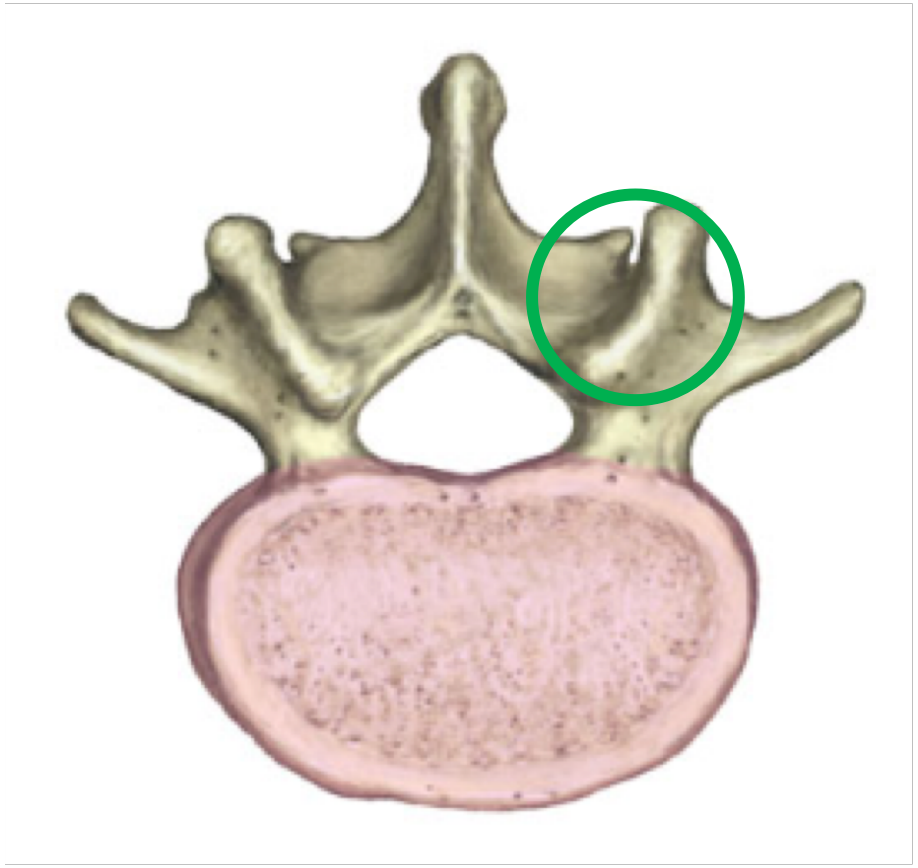
Spinous Process

Transverse Process

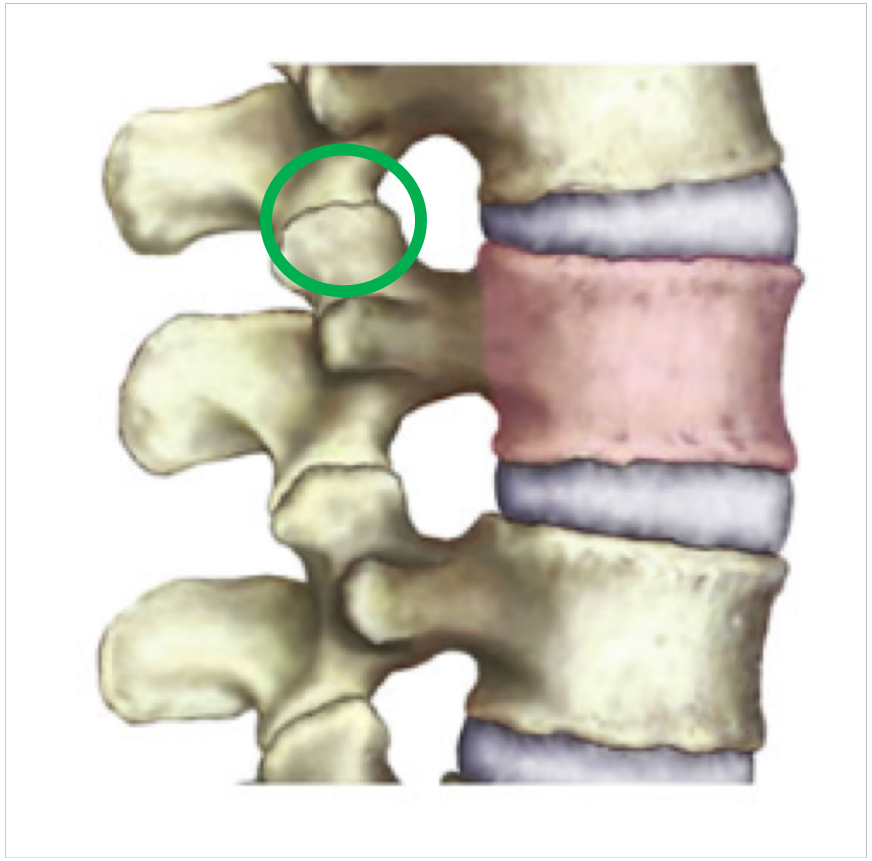
Processes



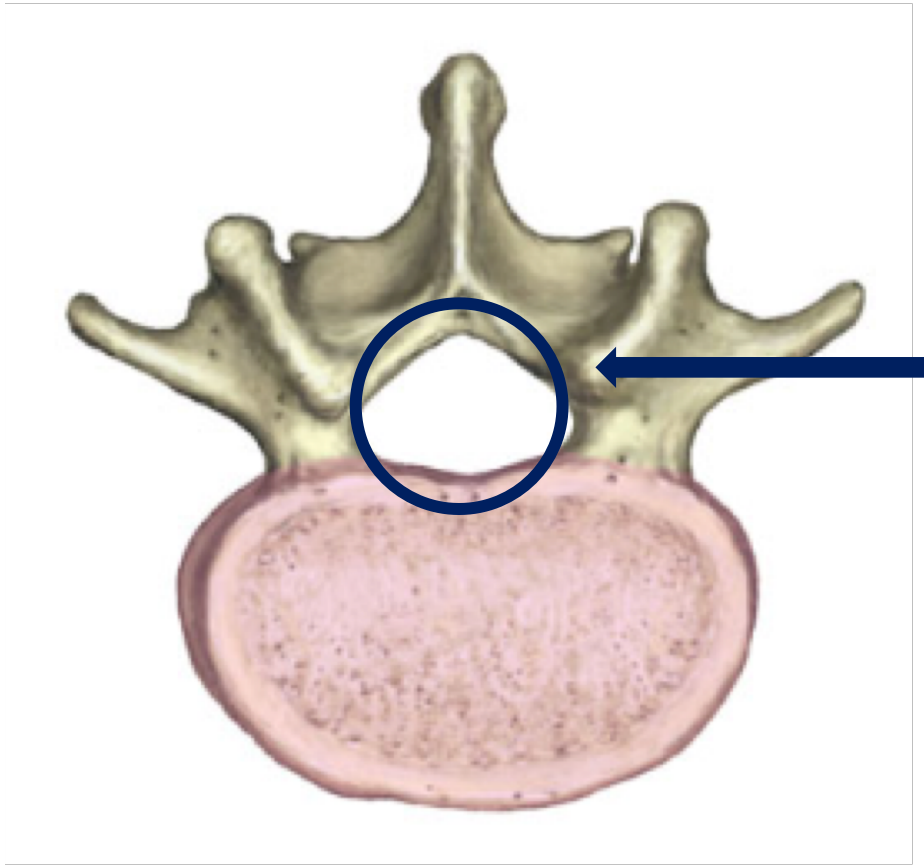
Vertebral Anatomy



Facet Joints



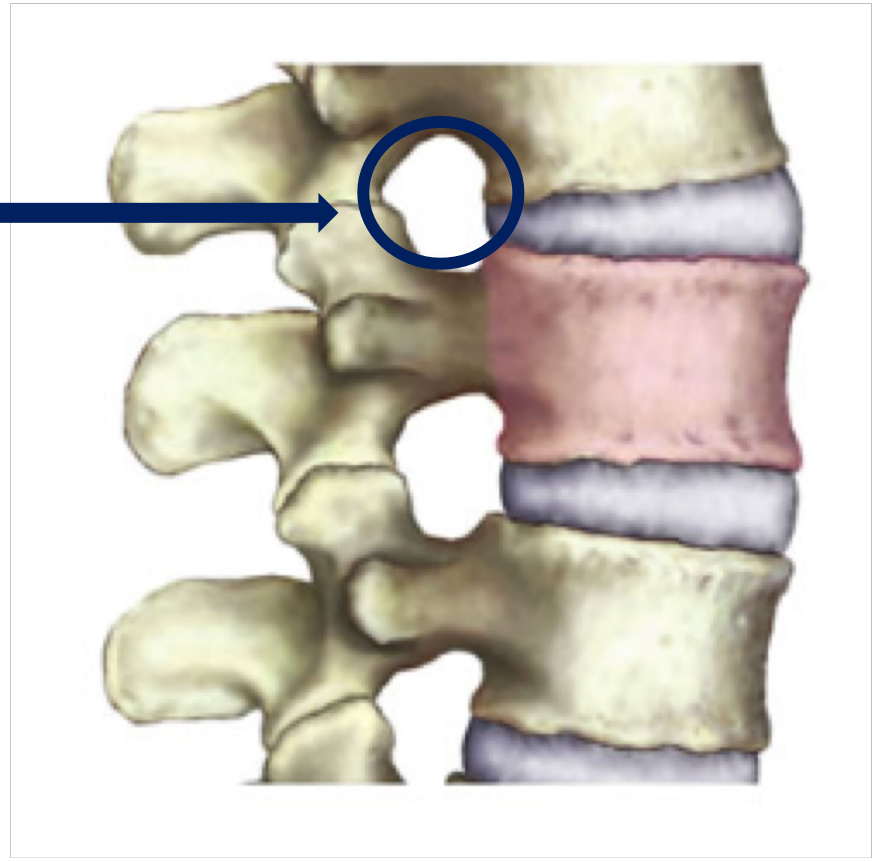
Vertebral Anatomy



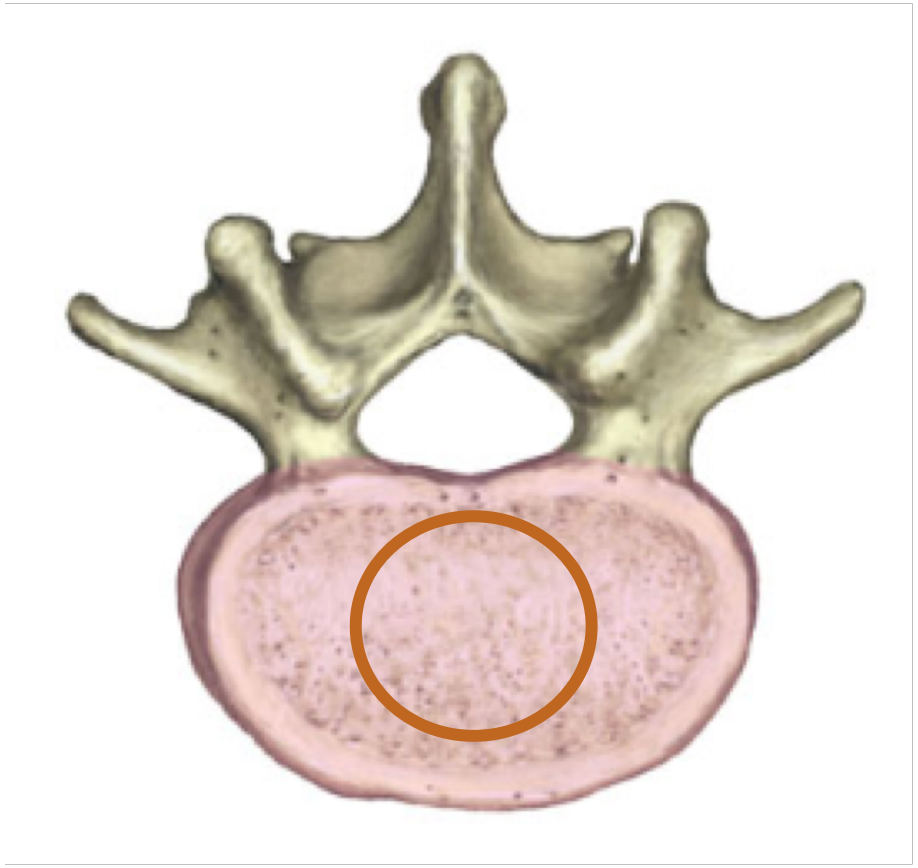
Intervertebral Foramen
IVF

Spinal Canal

Foramen

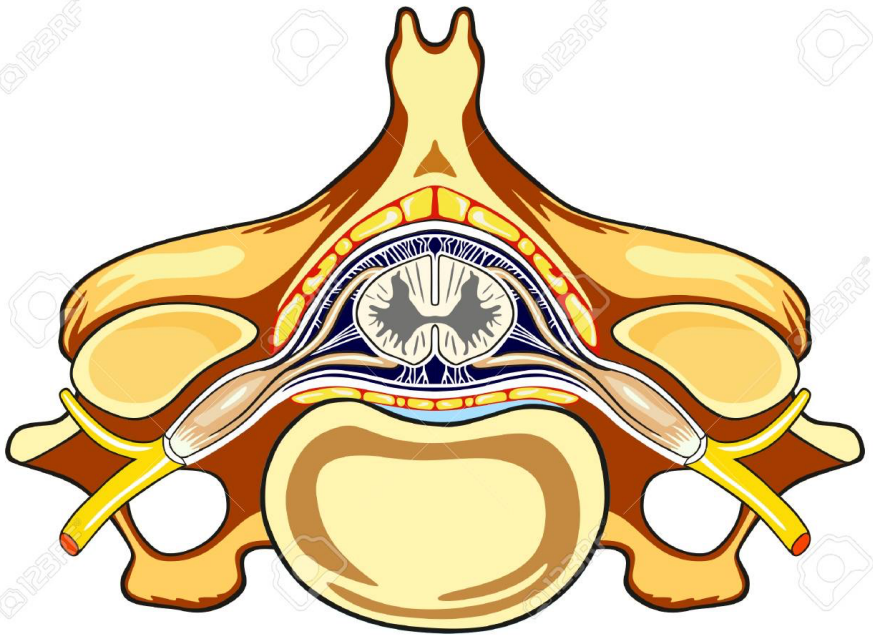


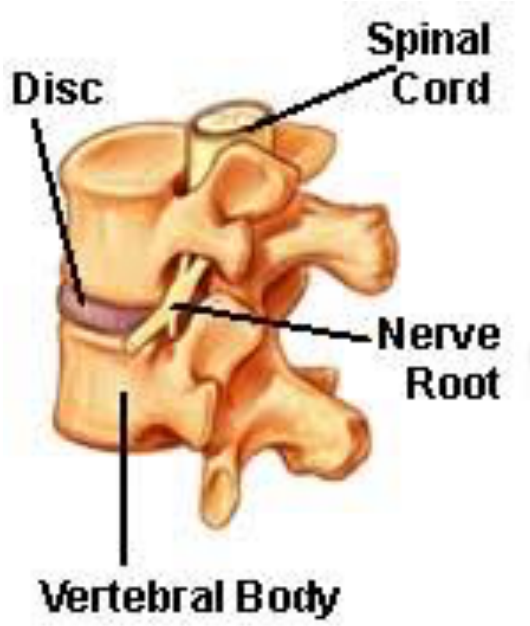
Vertebral Anatomy



Intervertebral Disc

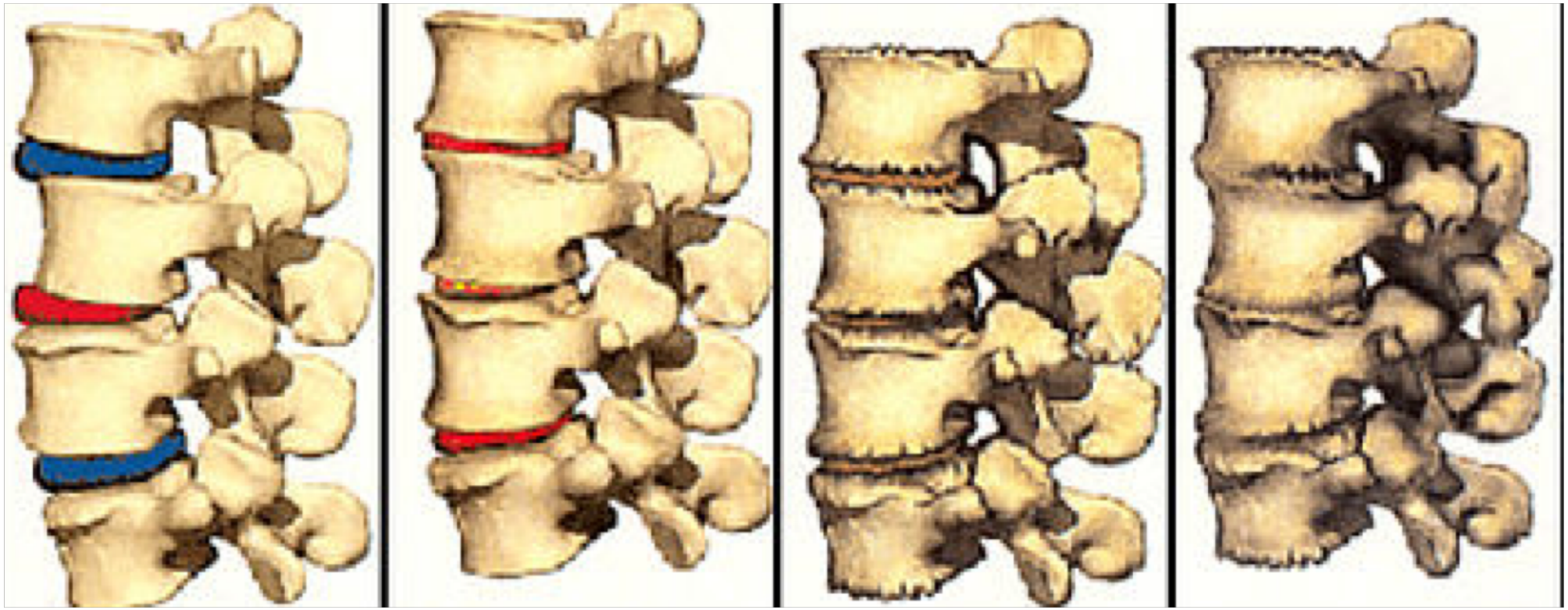
Vertebral Anatomy



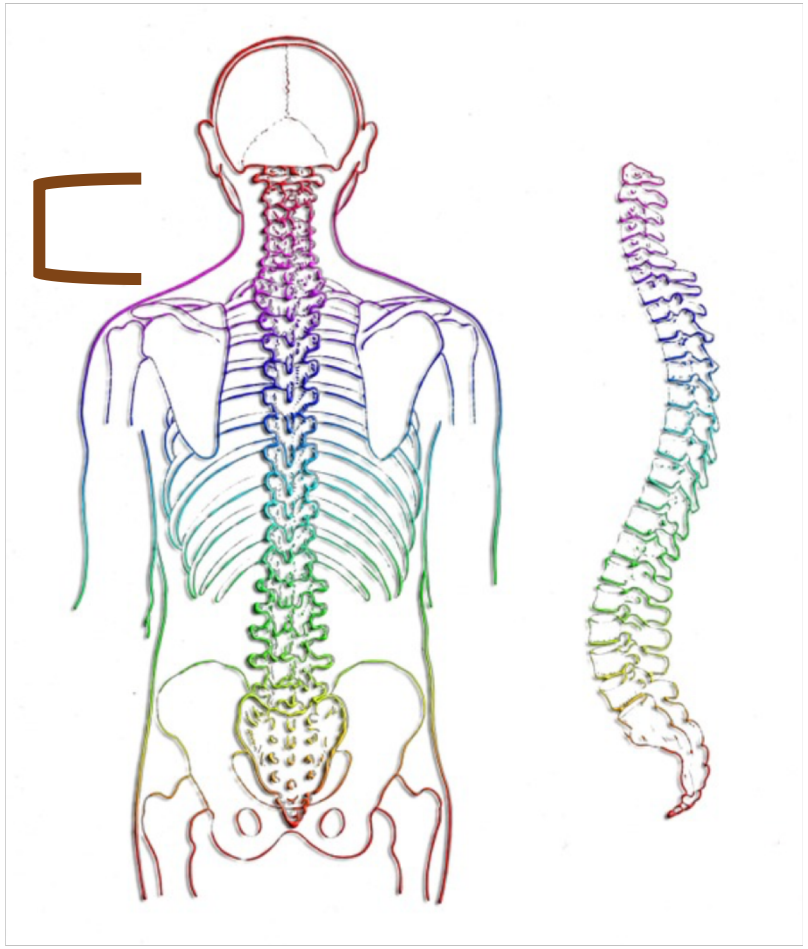


Vertebral Anatomy

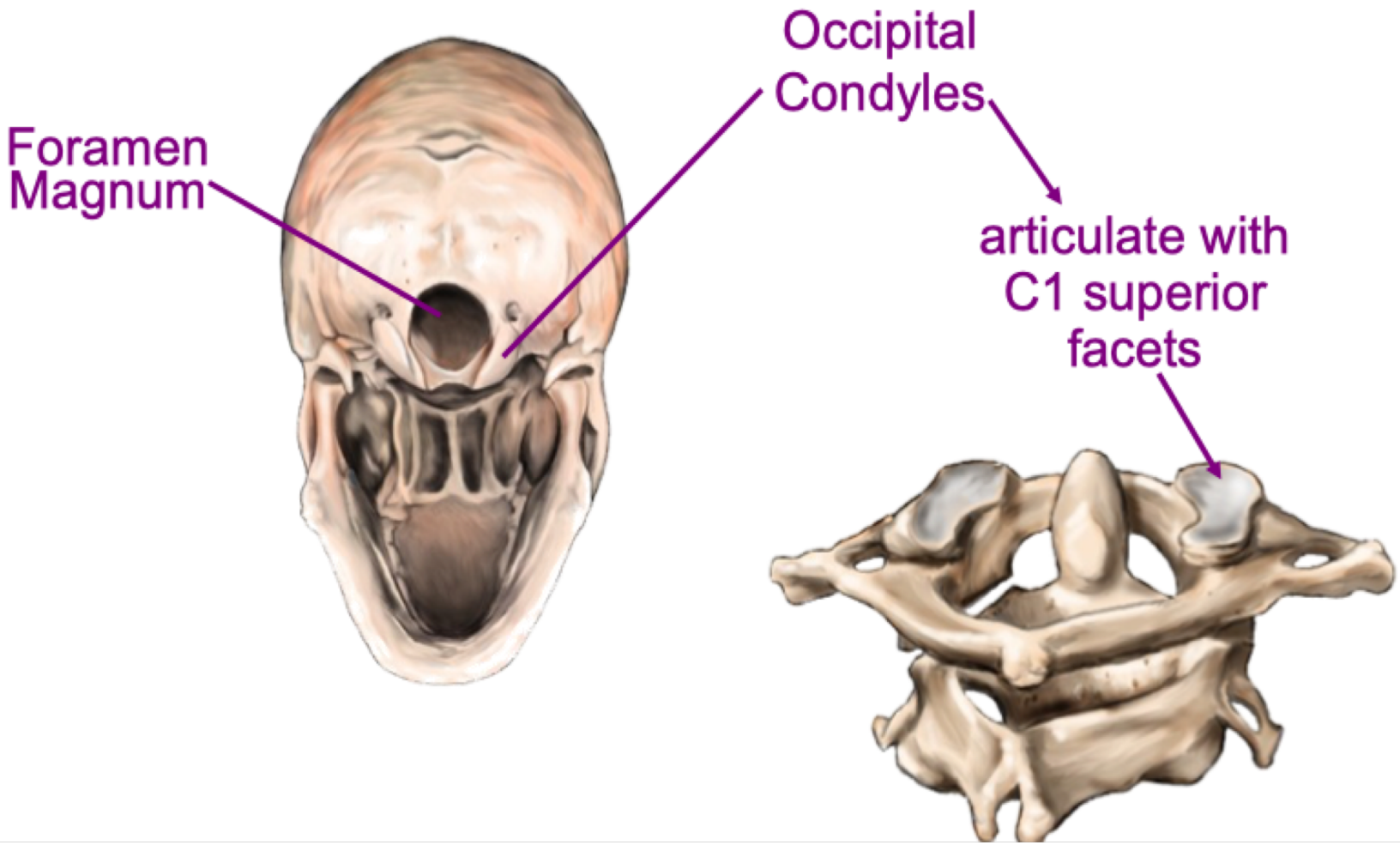
Vertebral Anatomy

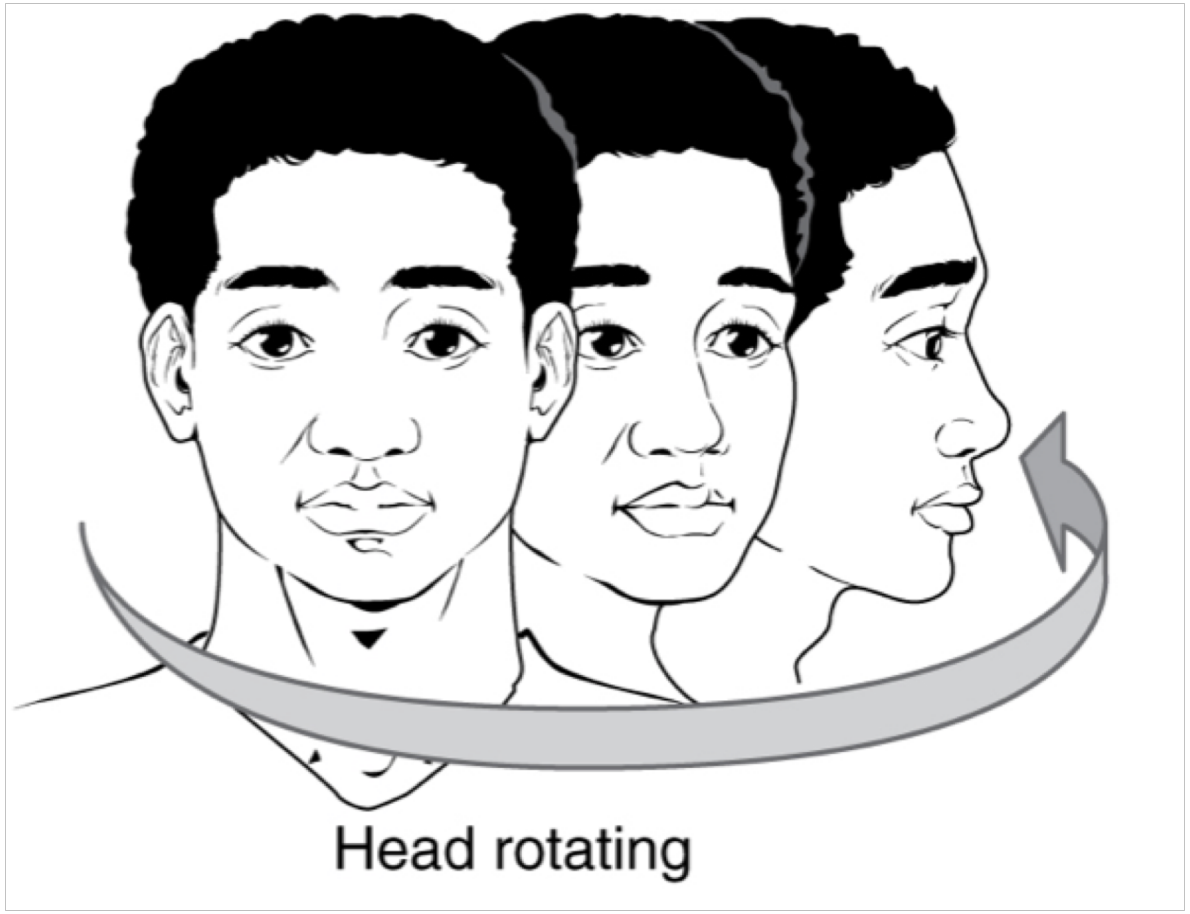


Cervical Vertebrae



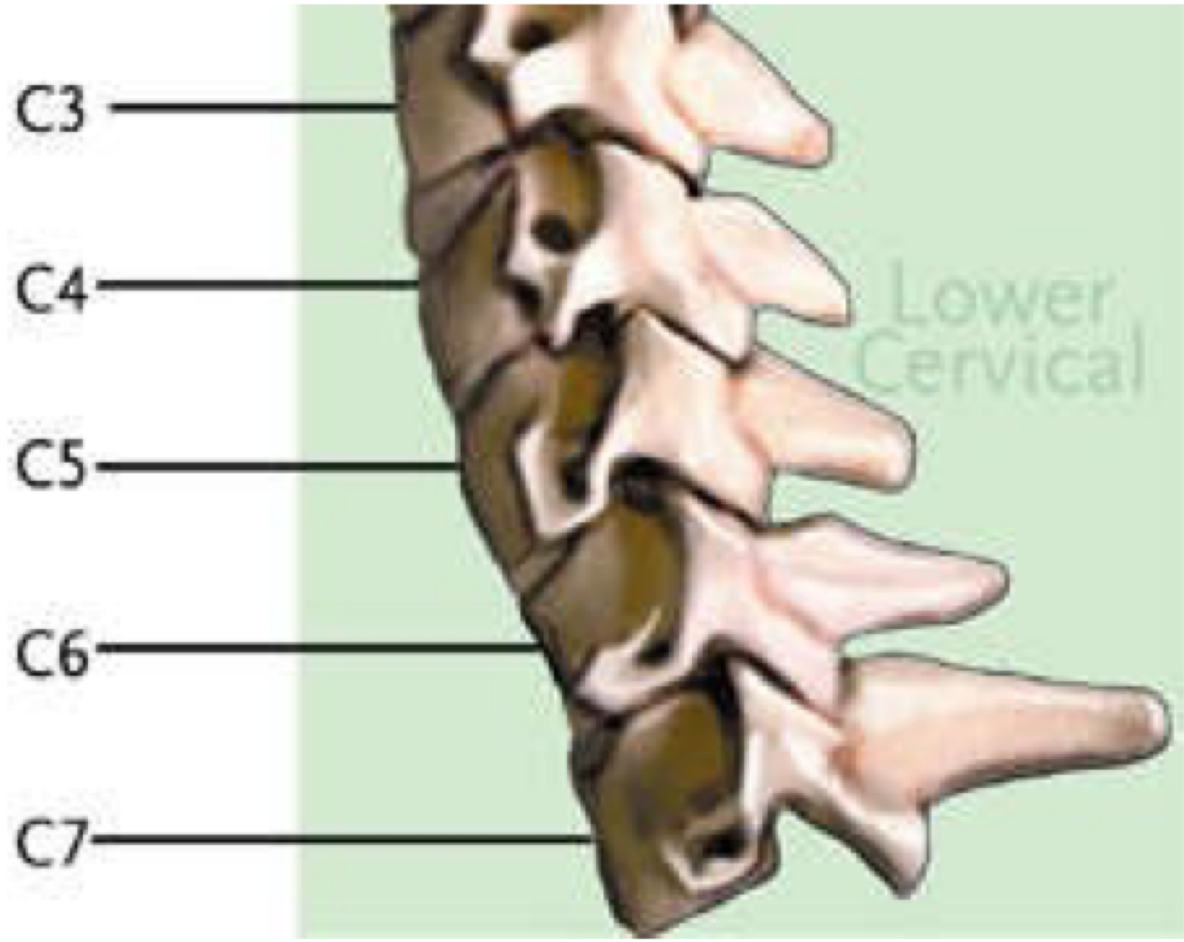
Occipitocervical Joint



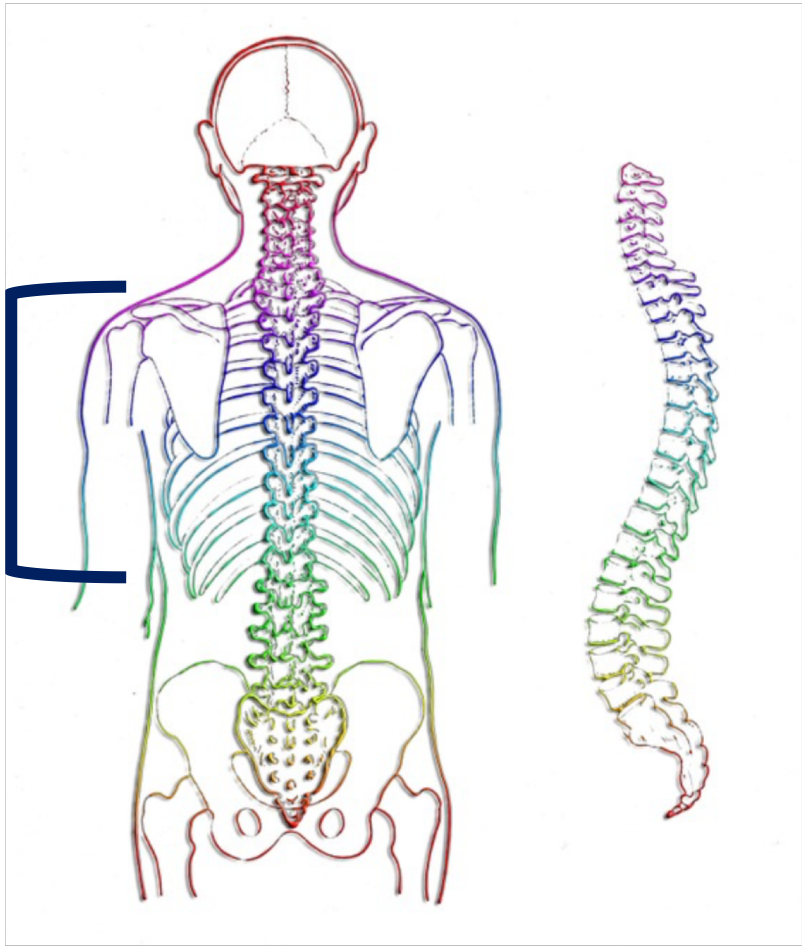

Head rotating

Lower Cervical Vertebrae

- C3 to C7
  - Disc at every level
  - Vertebral structures are similar



Thoracic Vertebrae

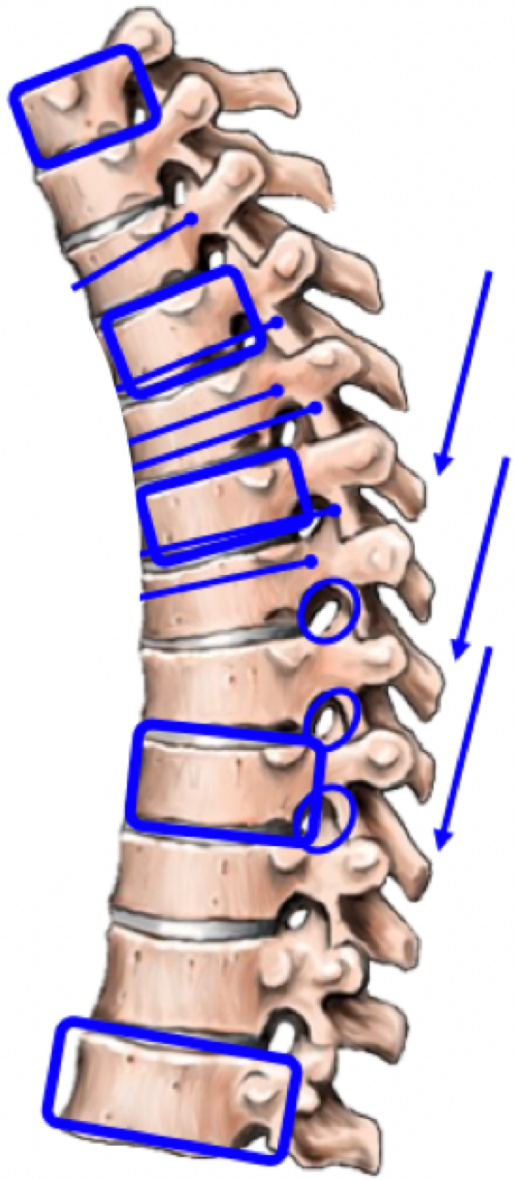


Thoracic Vertebrae

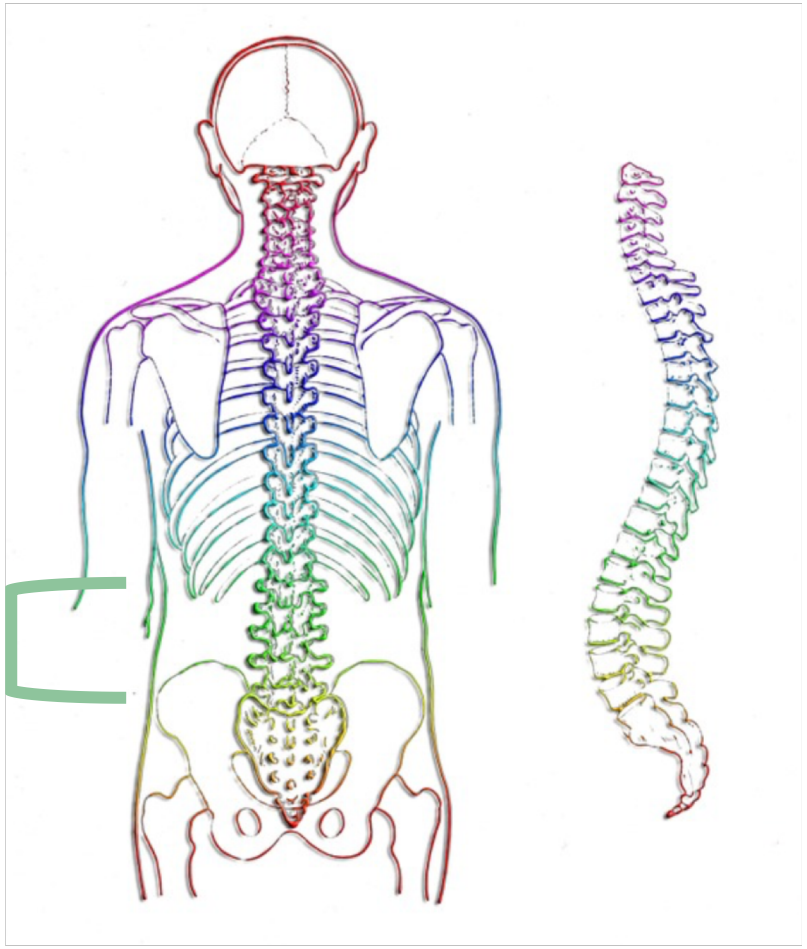
- Body - progressive increase in mass from T1 to T12

- Spinous processes - long, overlapping, projected downward

- Intervertebral foramen - larger, less incidence of nerve compression

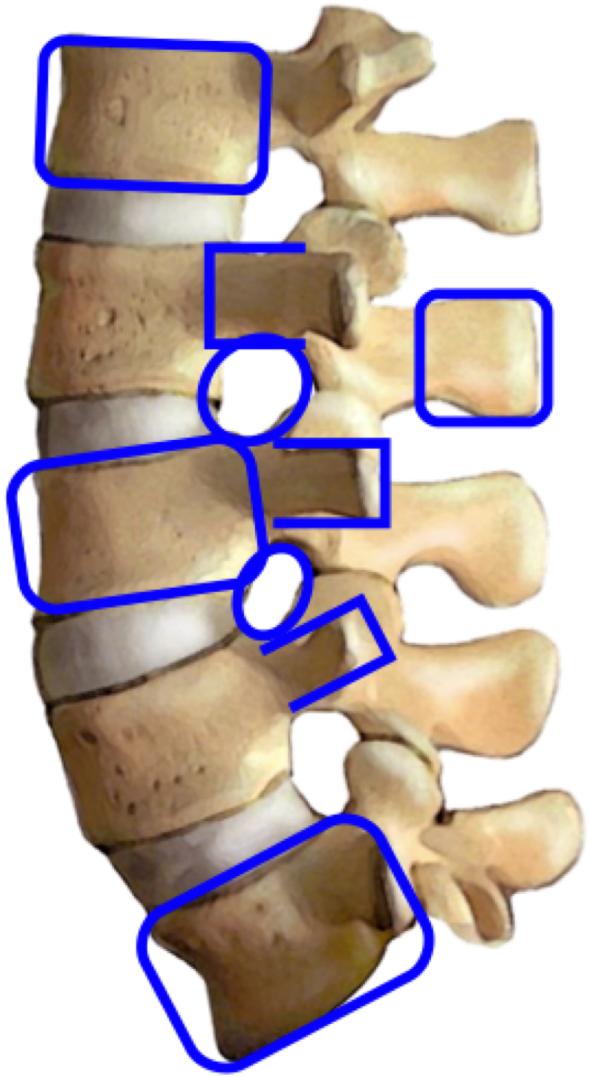


Lumbar Vertebrae

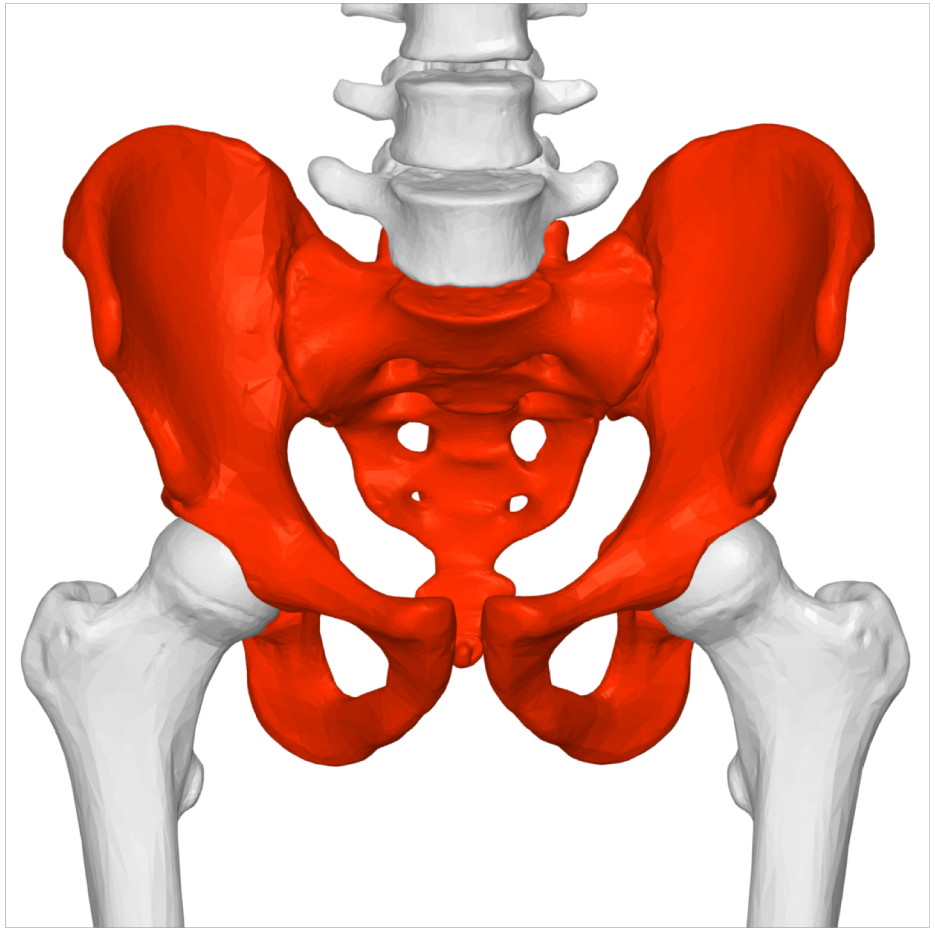


Lumbar Vertebrae, L1-L5

- Body - L1 to L5 progressive increase in mass
- Spinous processes - horizontal, square shaped
- Transverse processes - smaller than in thoracic region
- Intervertebral foramen - large, but with increased incidence of nerve root compression

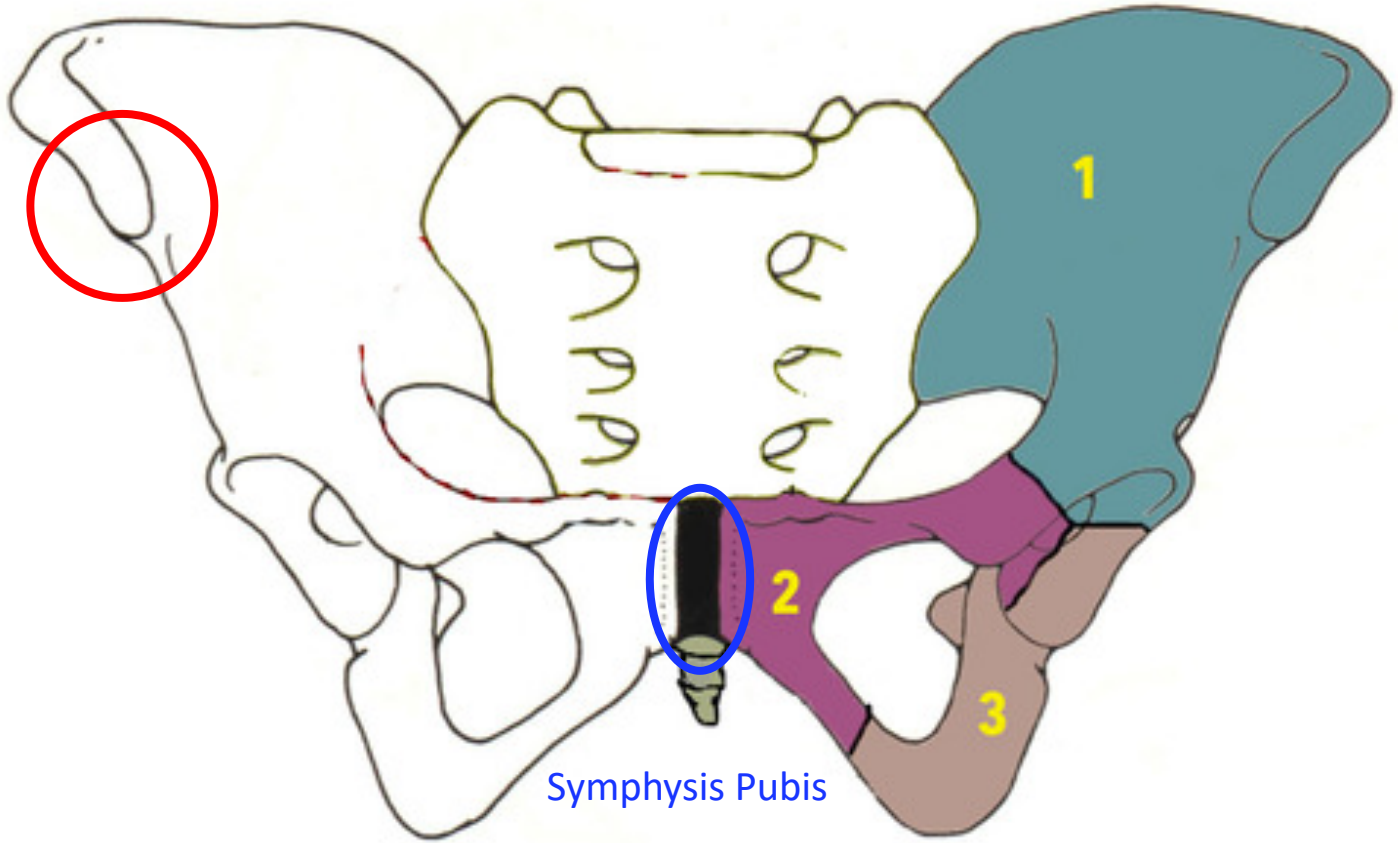


Pelvis



Pelvis

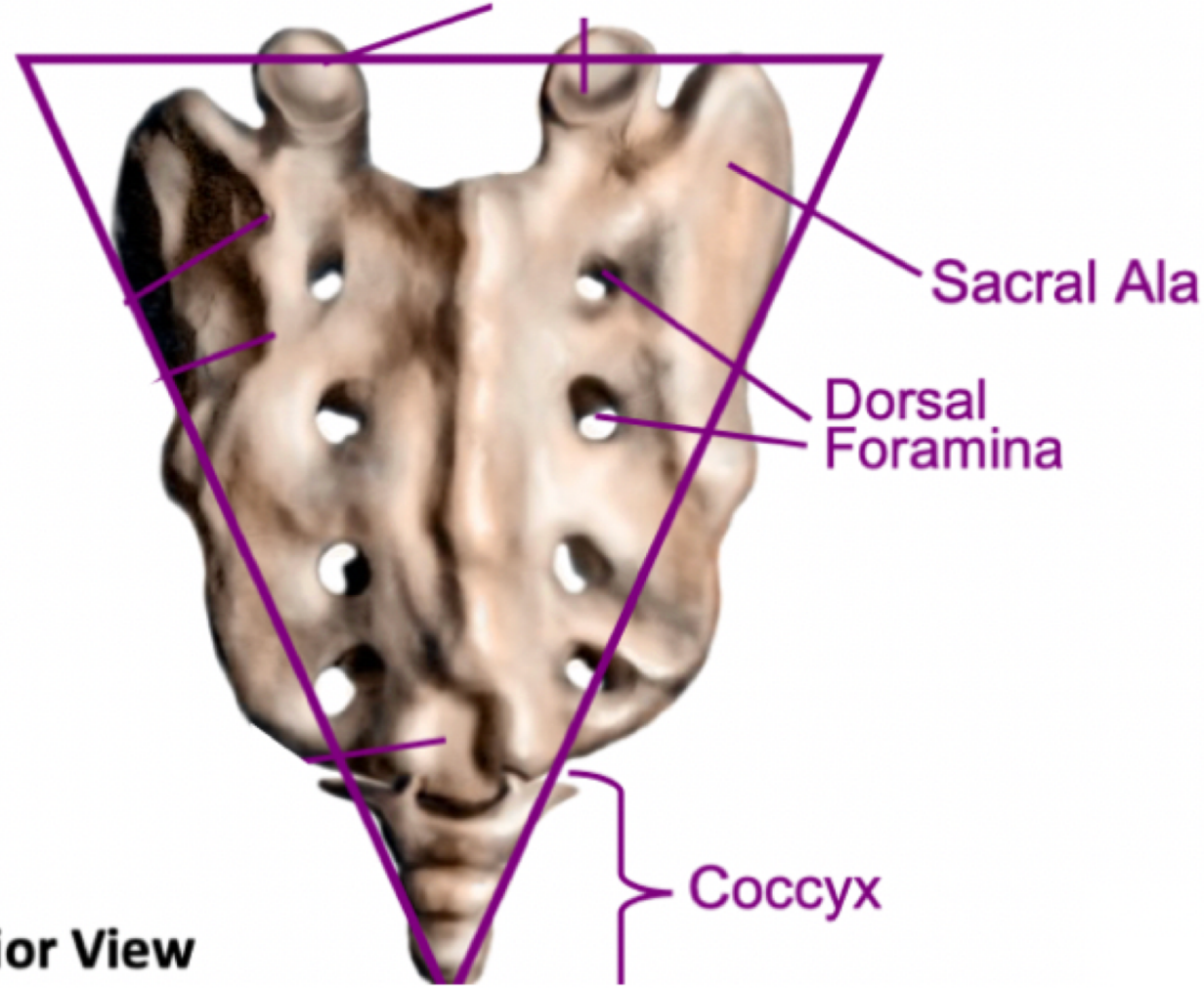
Anterior Superior Iliac Spine (ASIS)



1 Ilium
2 Pubis
3 Ischium

The Sacrum

Inverted triangle shape



Posterior View

General Positioning:

Spinal Radiographs – Weight Bearing v. Non-Weight Bearing:

- Chiropractic spinal films are routinely taken in the upright position when possible.
- This is not standard medical practice.
- Most Chiropractors place greater emphasis on the effects of gravity on alignment and position of the spine that can only be achieved with weight bearing views.
- If the effects of gravity on the part being examined is not a concern, and if the office is equipped with a table, non-weight bearing films should be the view of choice.
- Discussion

General Positioning:

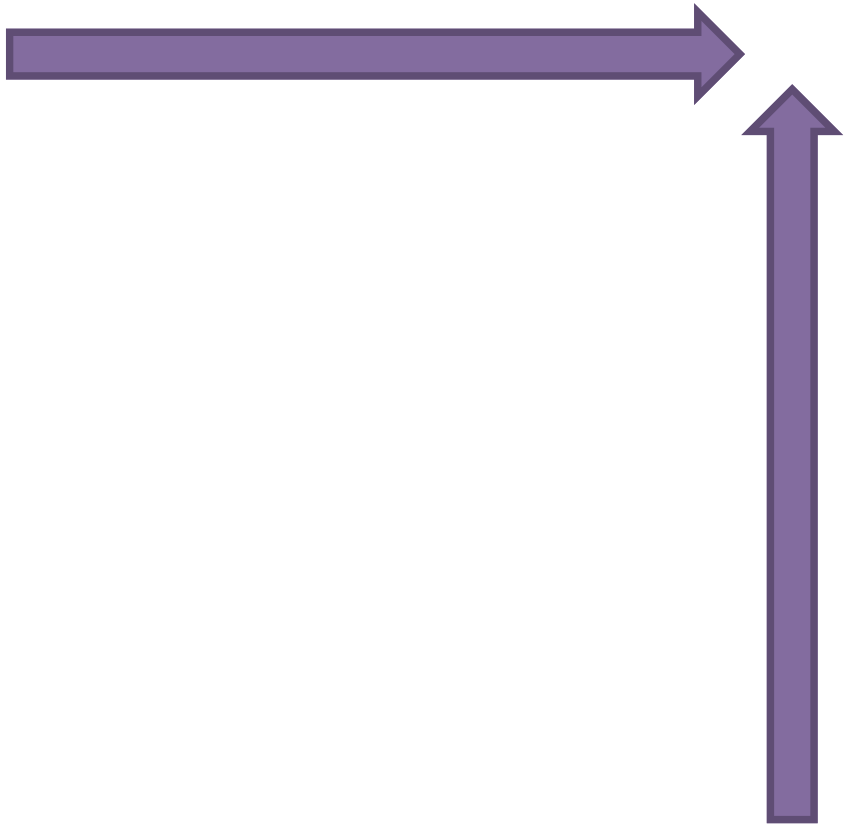
All Exposures have the following individual specifications:

- Projection (view)
- Cassette/Film Size
- Technique
- Source to Image Distance
- Tube Angle
- Collimation
- Patient Positioning
- Shielding and/or Filtration
- Central Ray Placement
- Markers
- Instruction

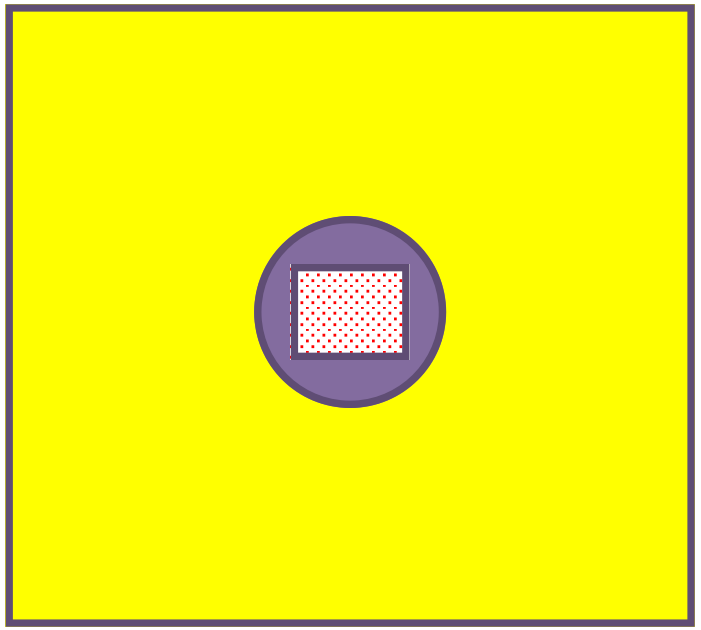
General Positioning:

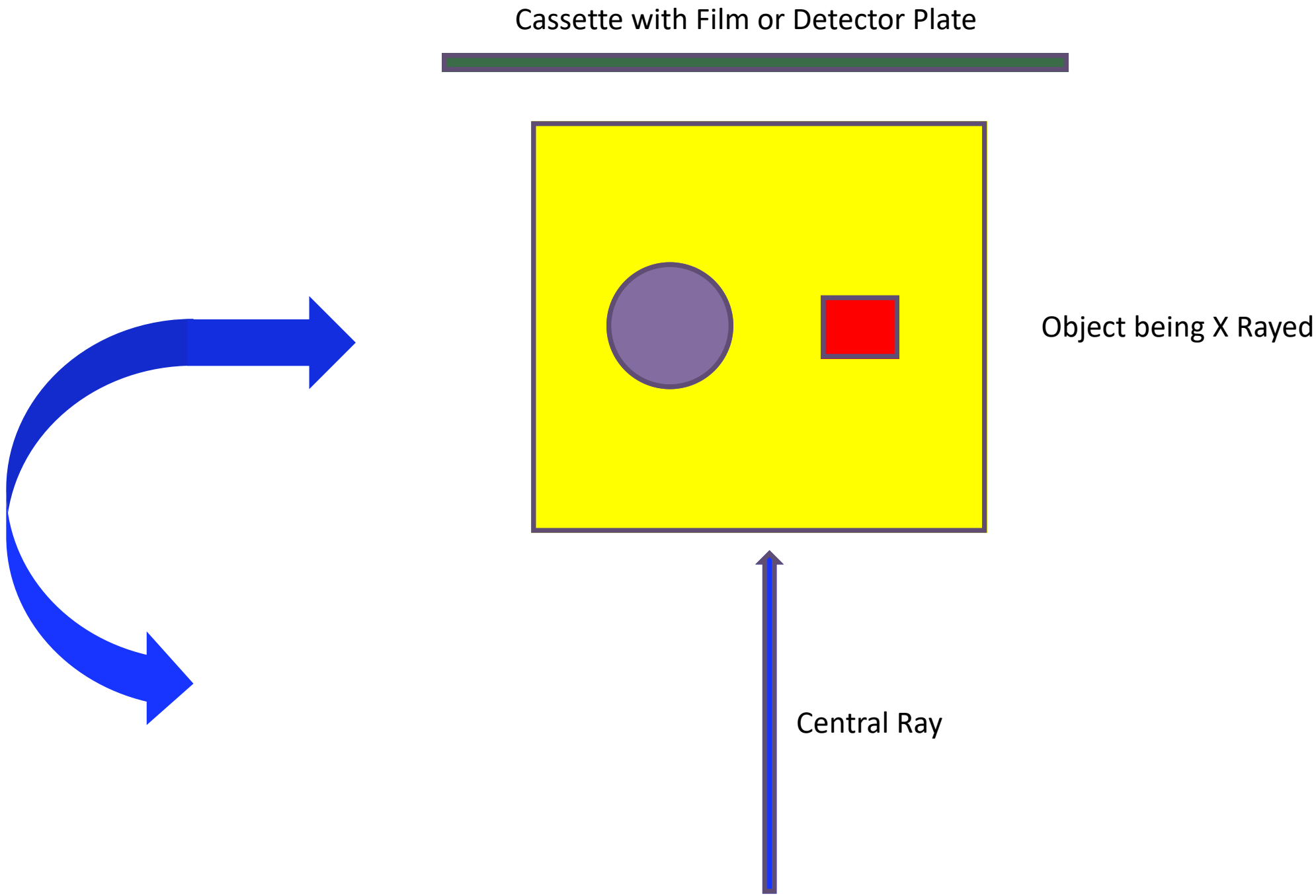
Minimum Study:

- *Consists of at least two views*
- *90 degrees to each other*

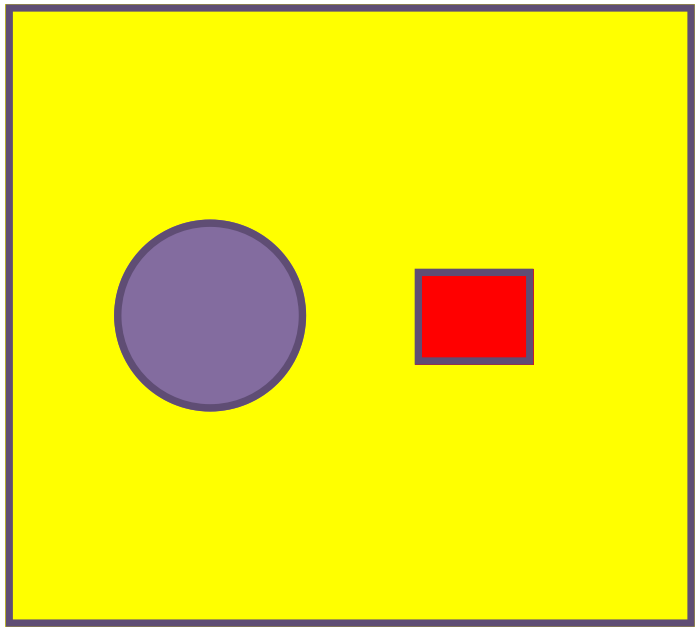


Final Image



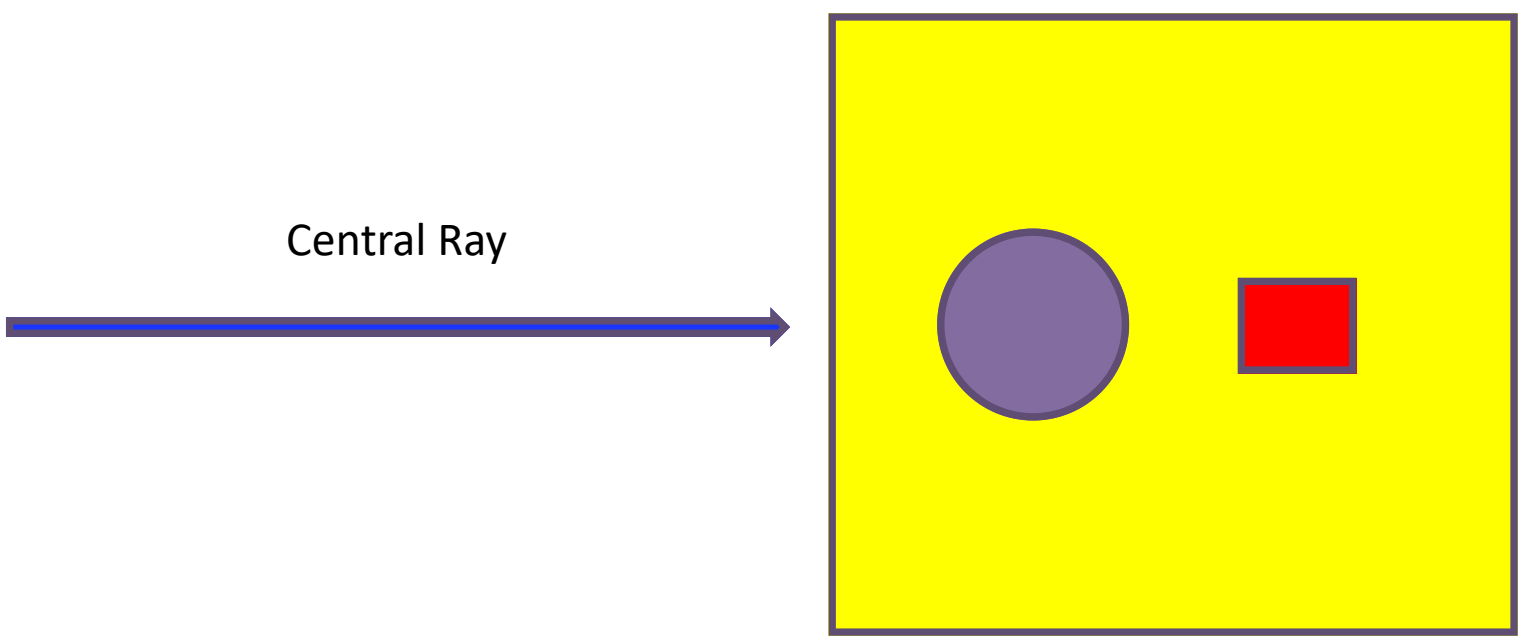

Cassette with Film or Detector Plate
Object being X Rayed
Central Ray

Final Image



Object being X Rayed

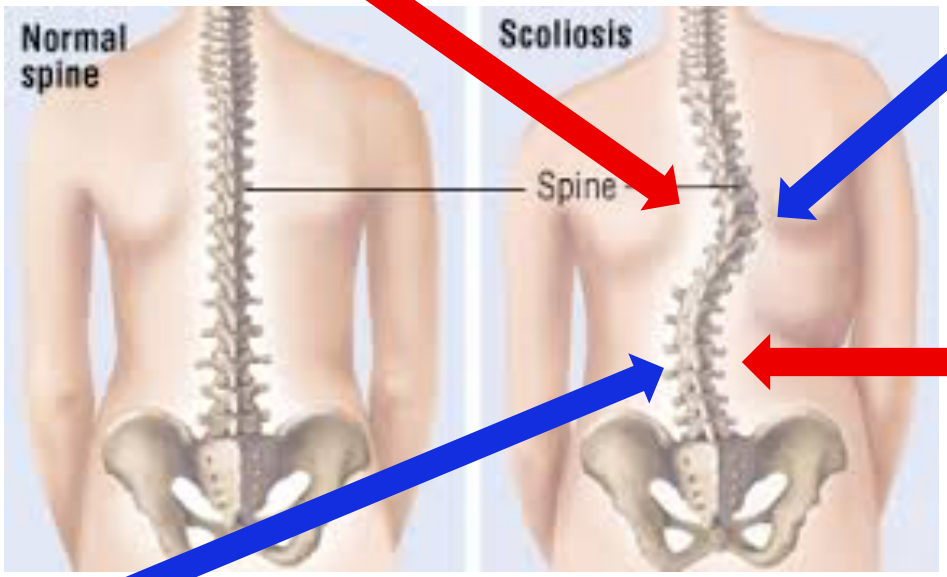
Central Ray



Cassette with Film
or
Detector Plate

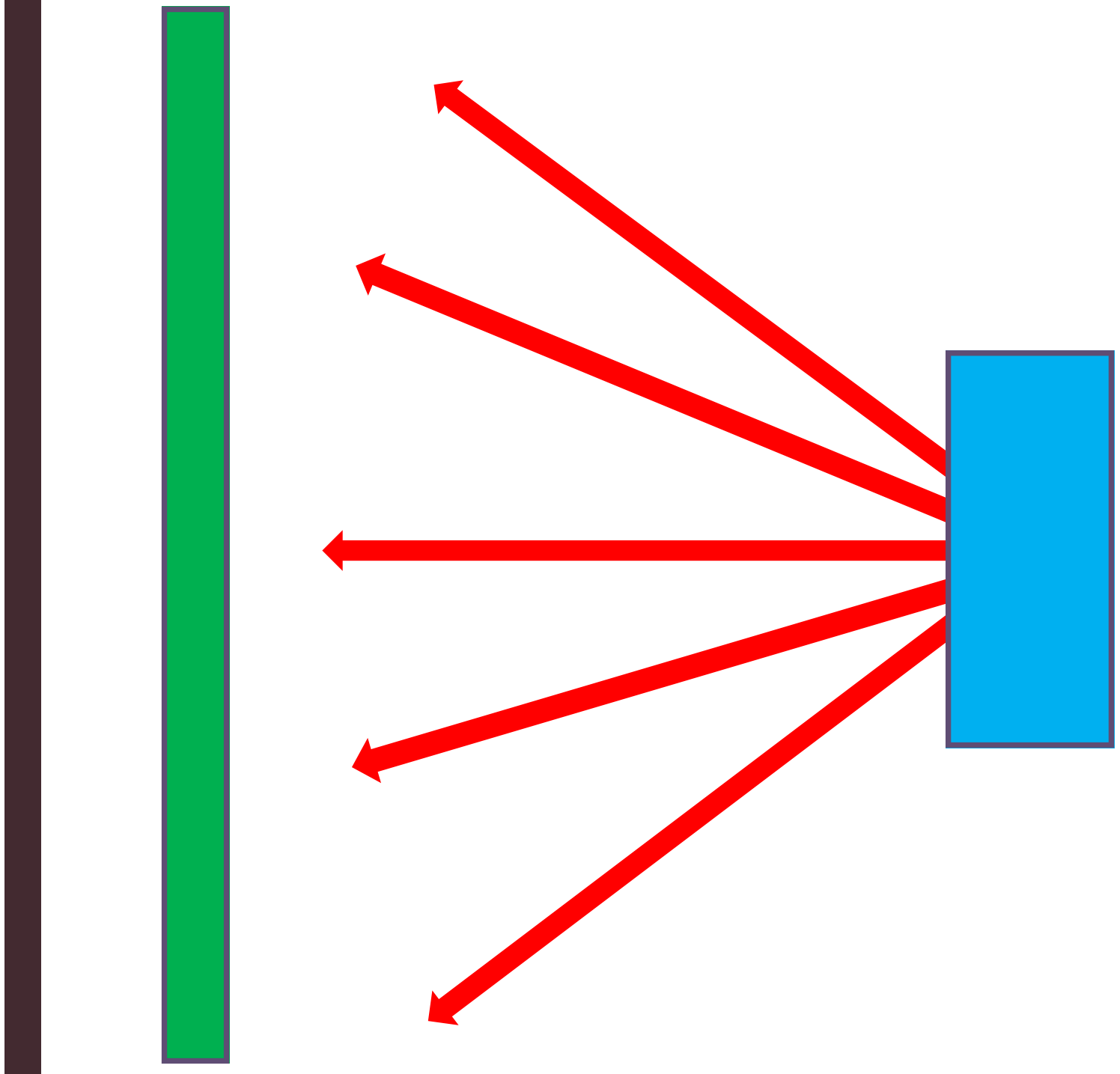
Concave Side

Convex Side

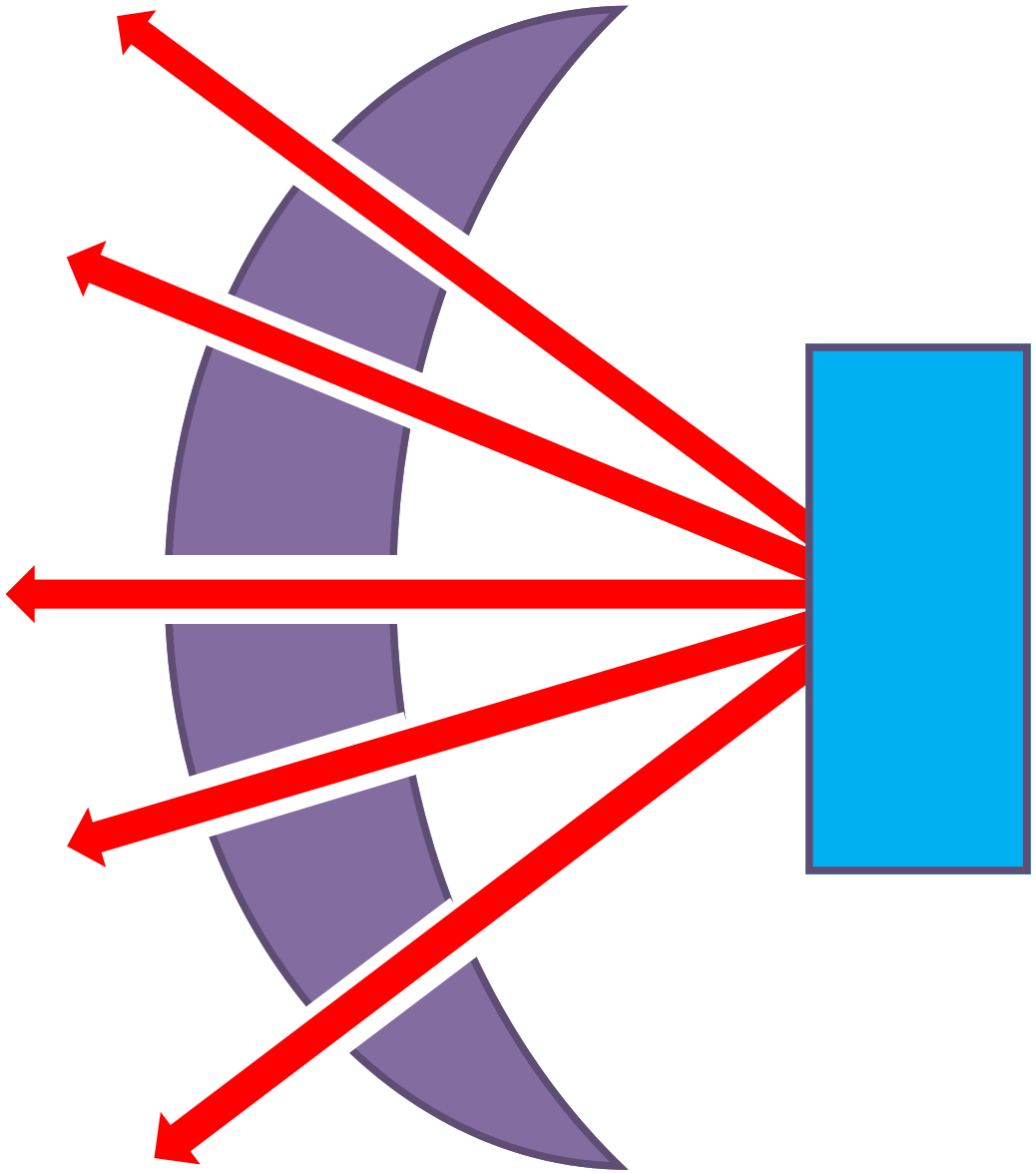


Concave Side

Convex Side



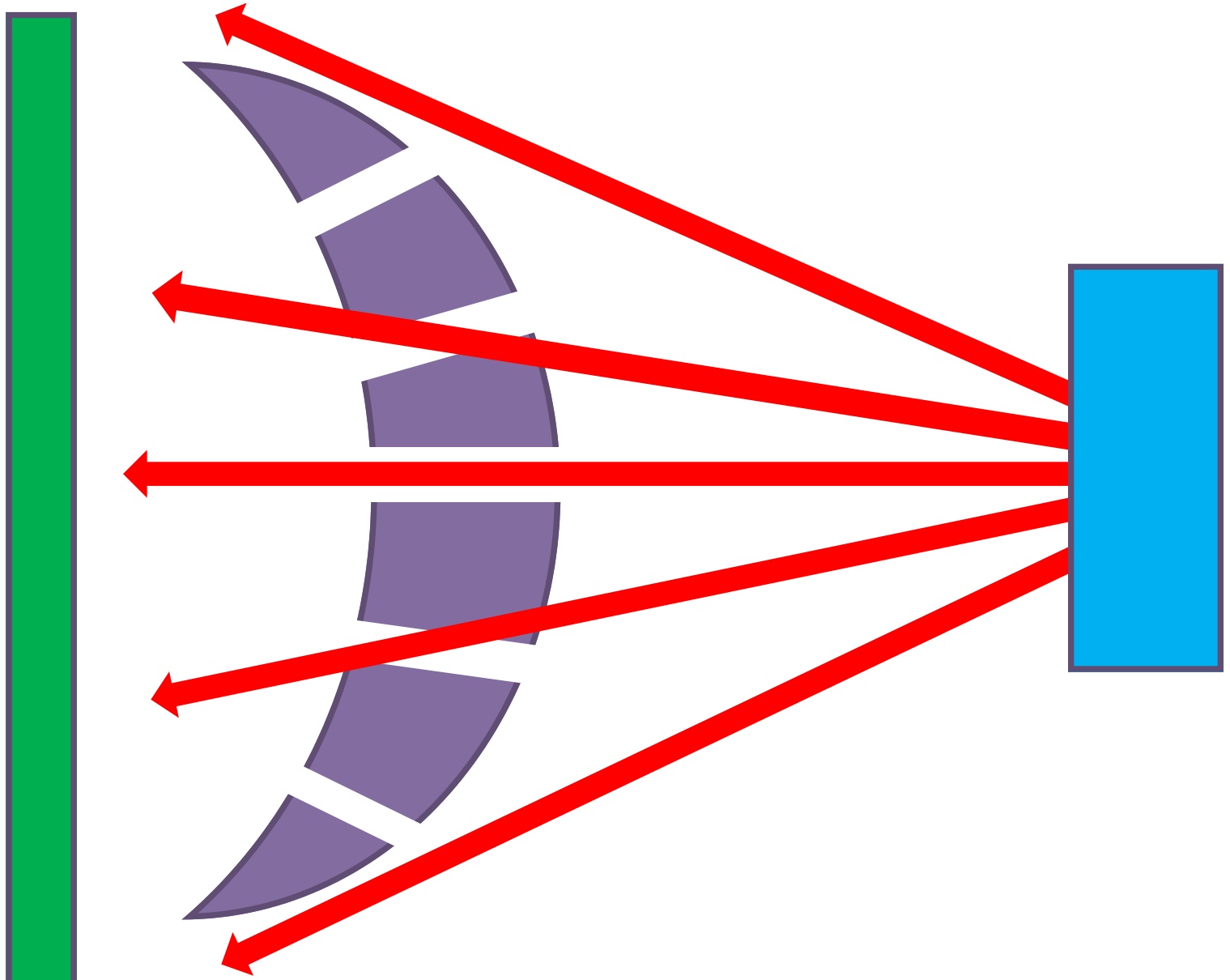
X Ray Diverge from the tube



Goal:

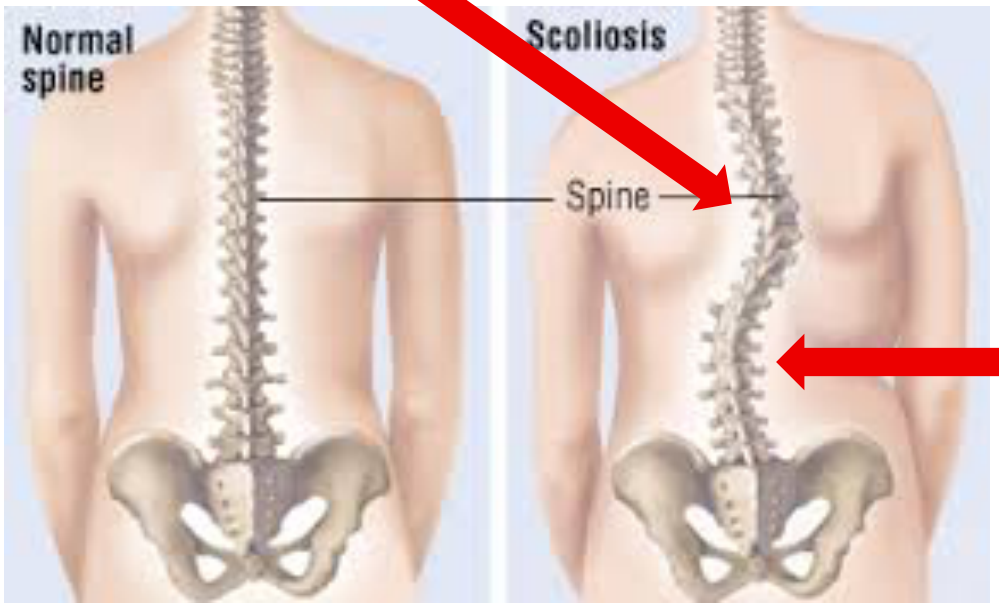
To align the CR as close through the joint plane as possible

CR into the Concave side



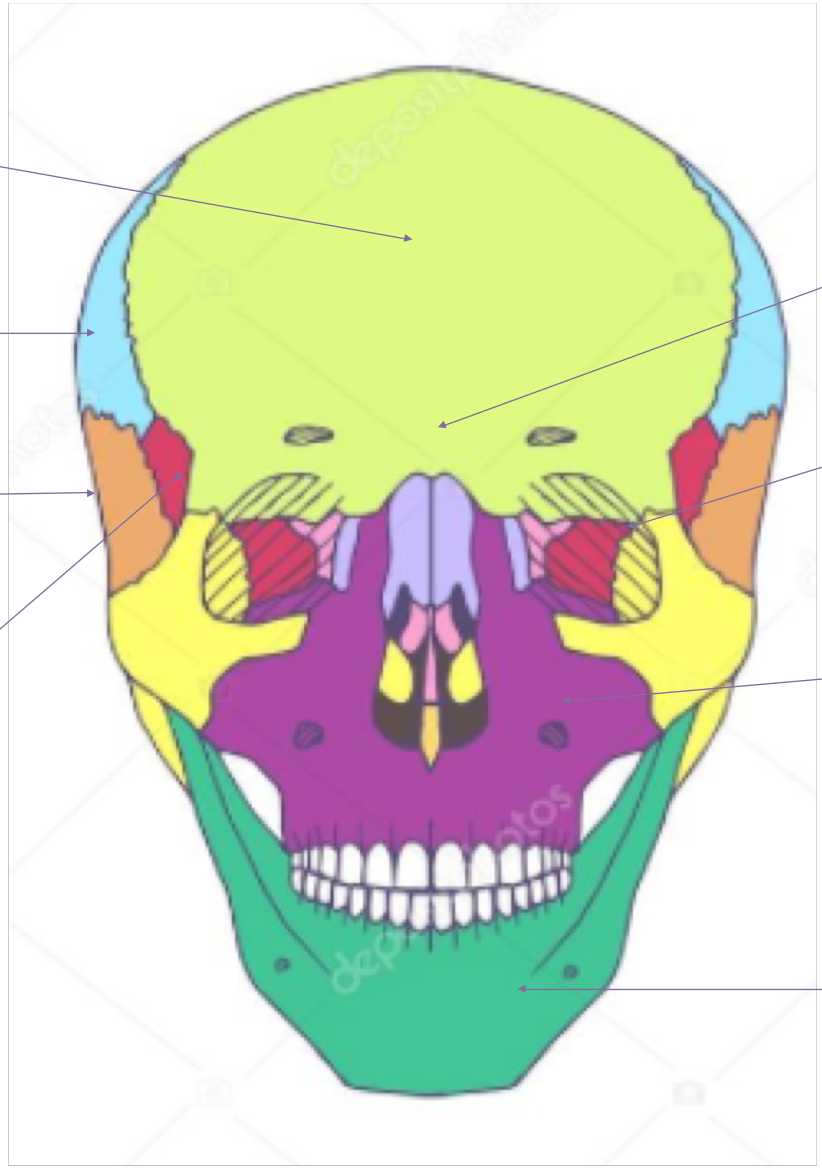
CR into the Convex side

Concave Side



Concave Side

Skull Positioning



Frontal

Parietal

Temporal Bone

Sphenoid Bone

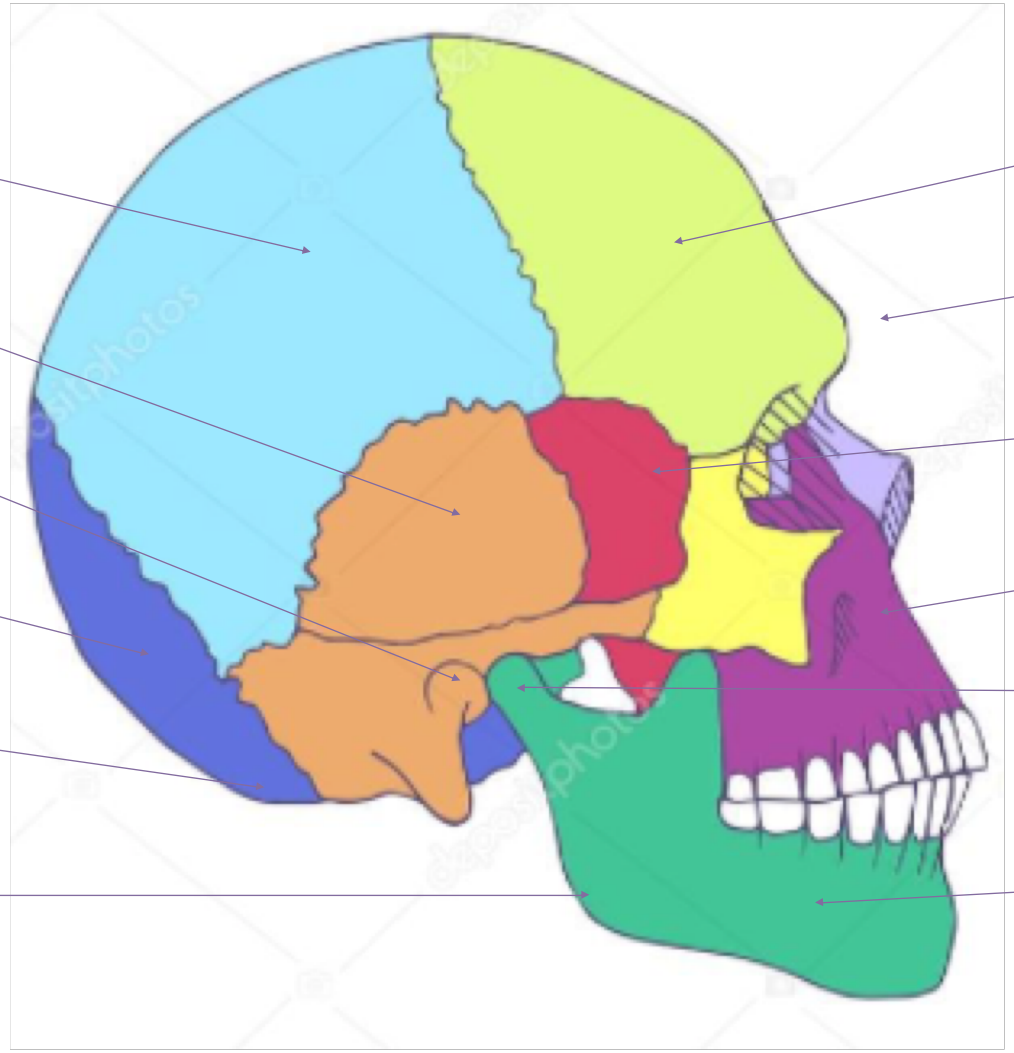
Glabella

Ocular orbit

Maxilla

Mandible

Skull Positioning



Parietal

Temporal

Internal
Acoustic Meatus

Occipital

External Occipital
Protuberance (EOP)

Angle of the Mandible

Frontal Bone

Glabella

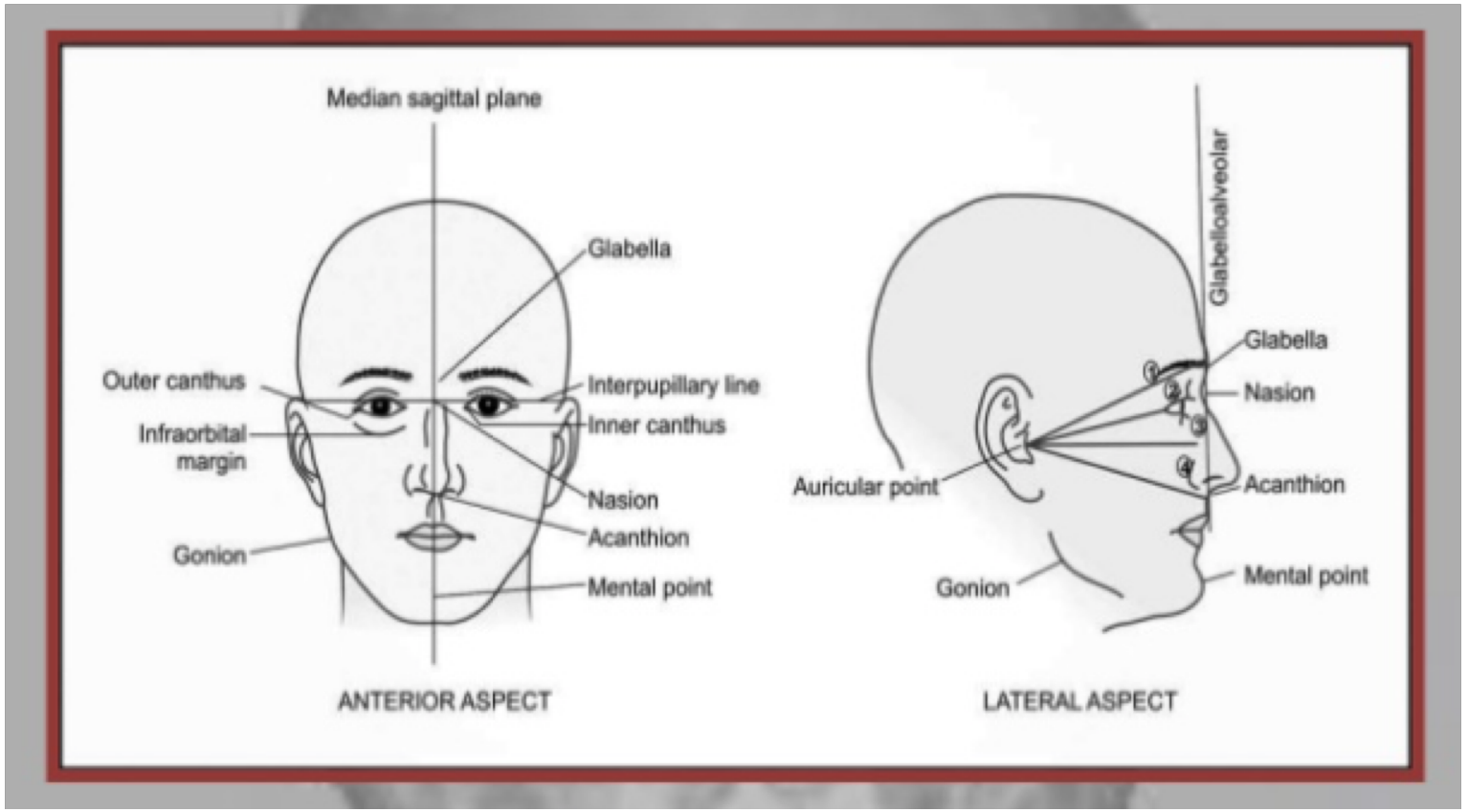
Sphenoid

Maxilla

TMJ

Mandible

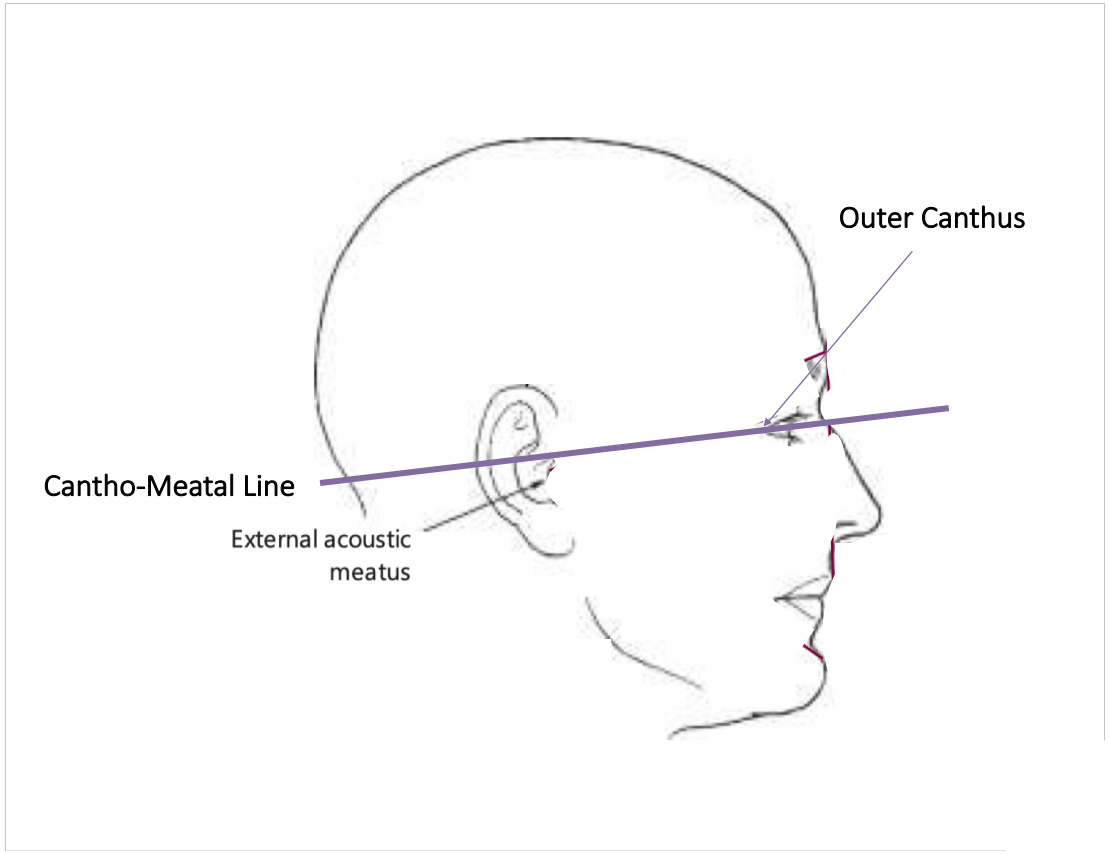
Skull Positioning

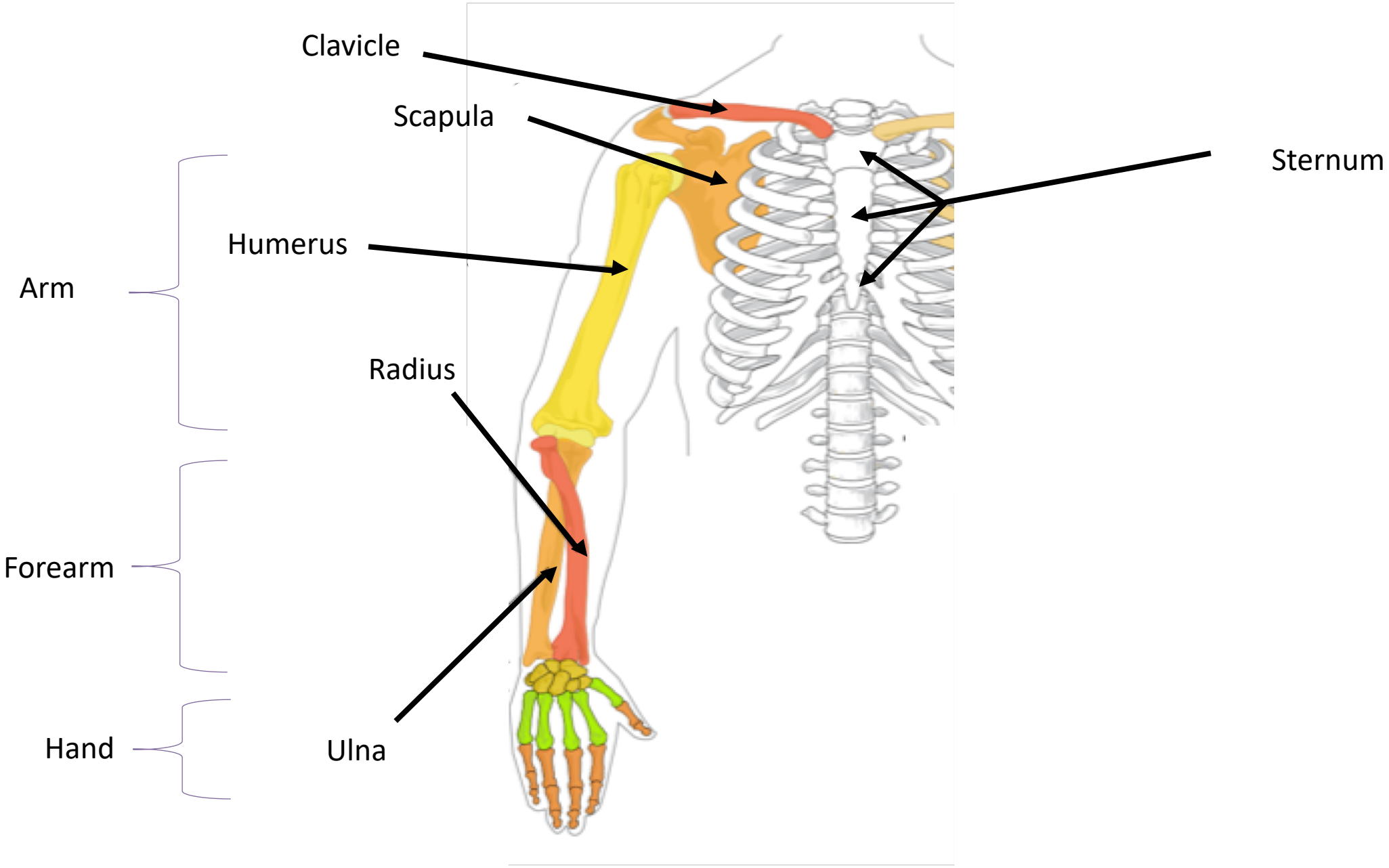


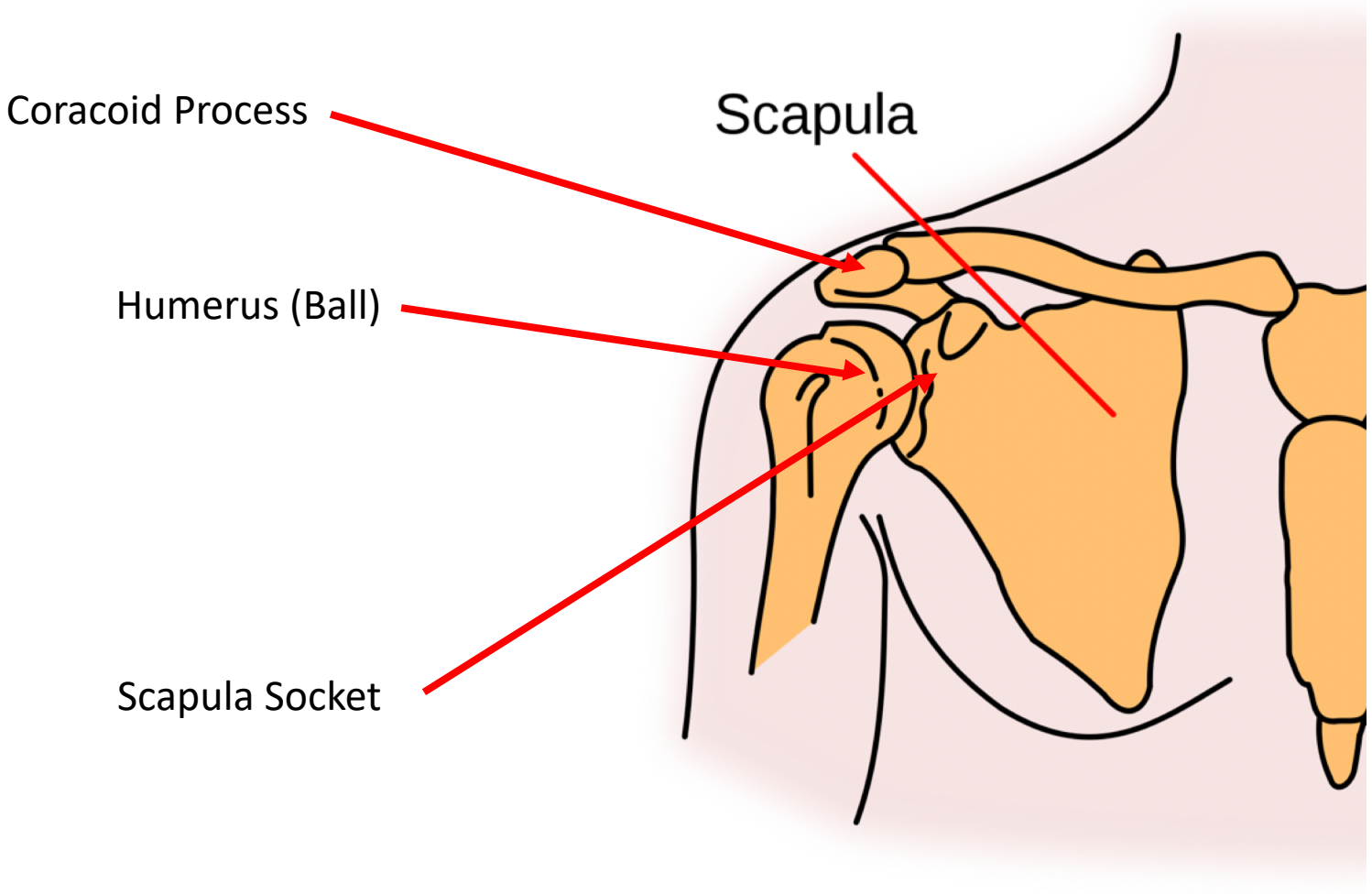
<u>Guide Lines</u>

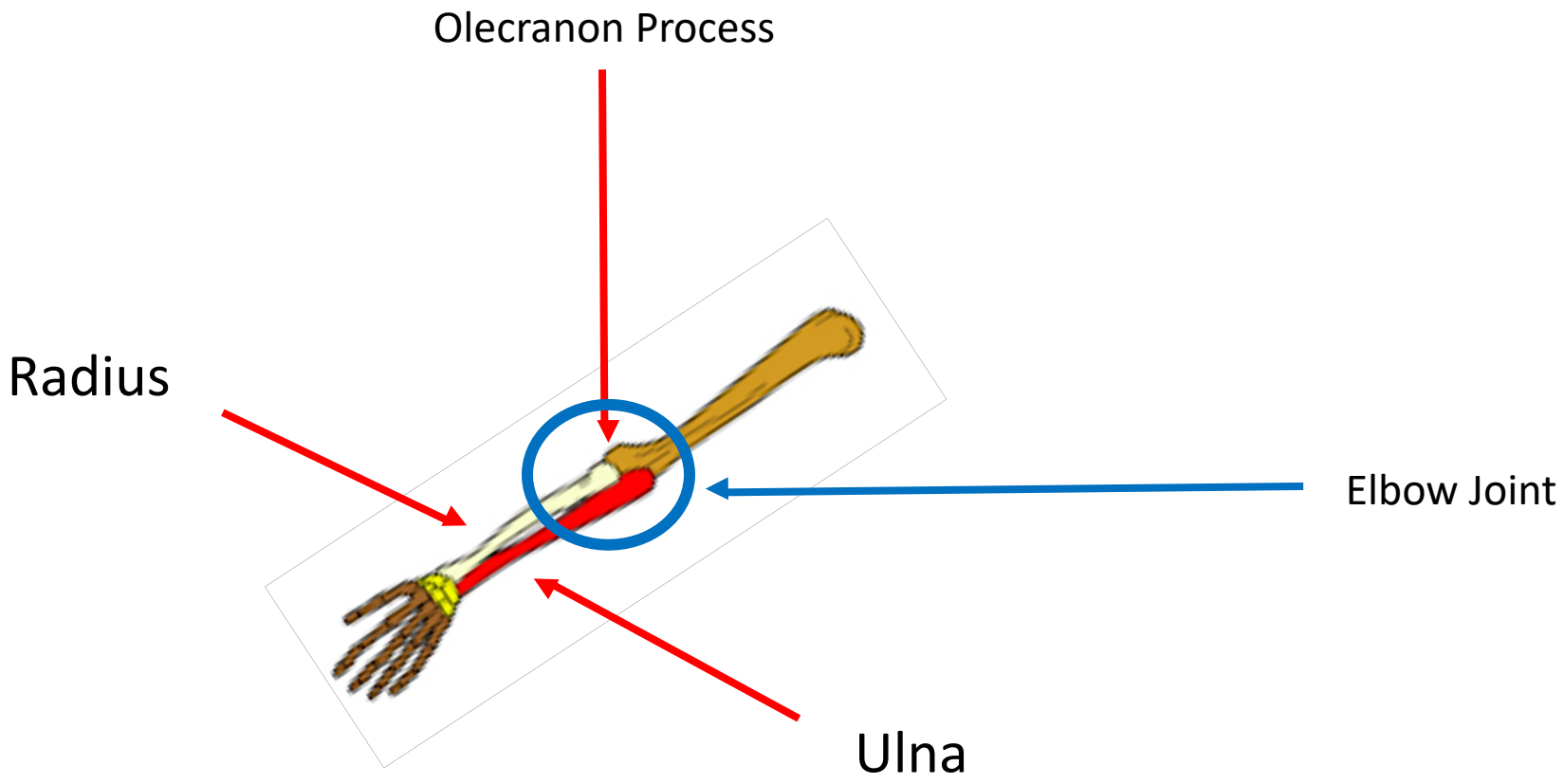
1) Glabellomeatal
2) Orbitomeatal
3) Inframeatal
4) Acanthomeatal

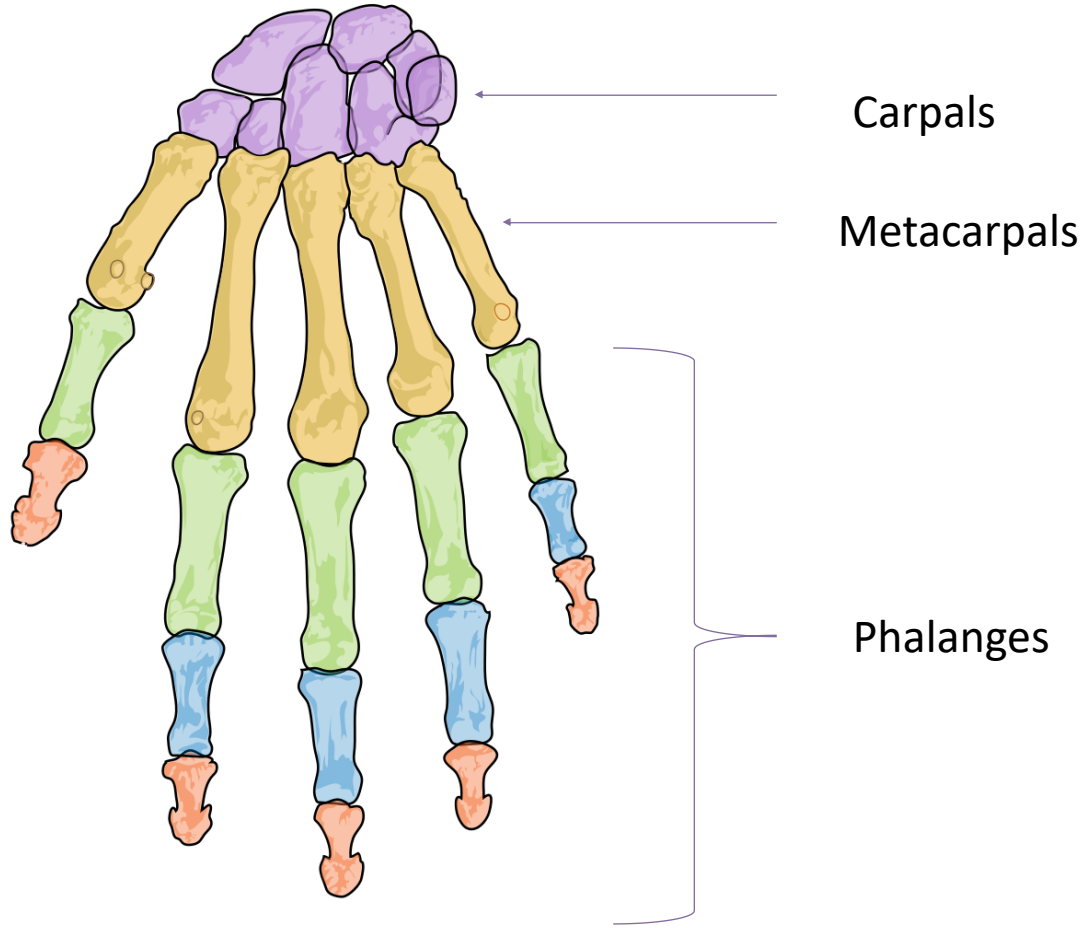
Skull Positioning



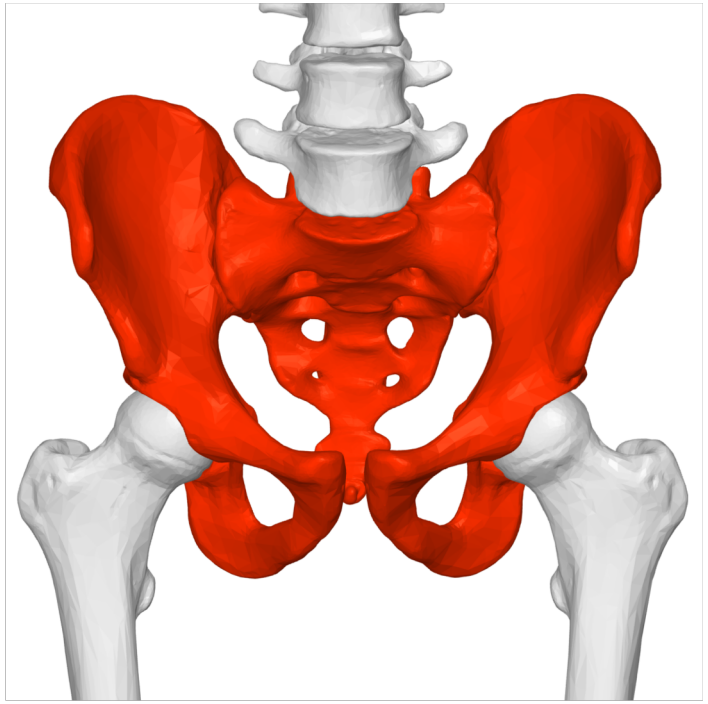

Clavicle
Scapula
Sternum
Humerus
Arm
Radius
Forearm
Hand
Ulna

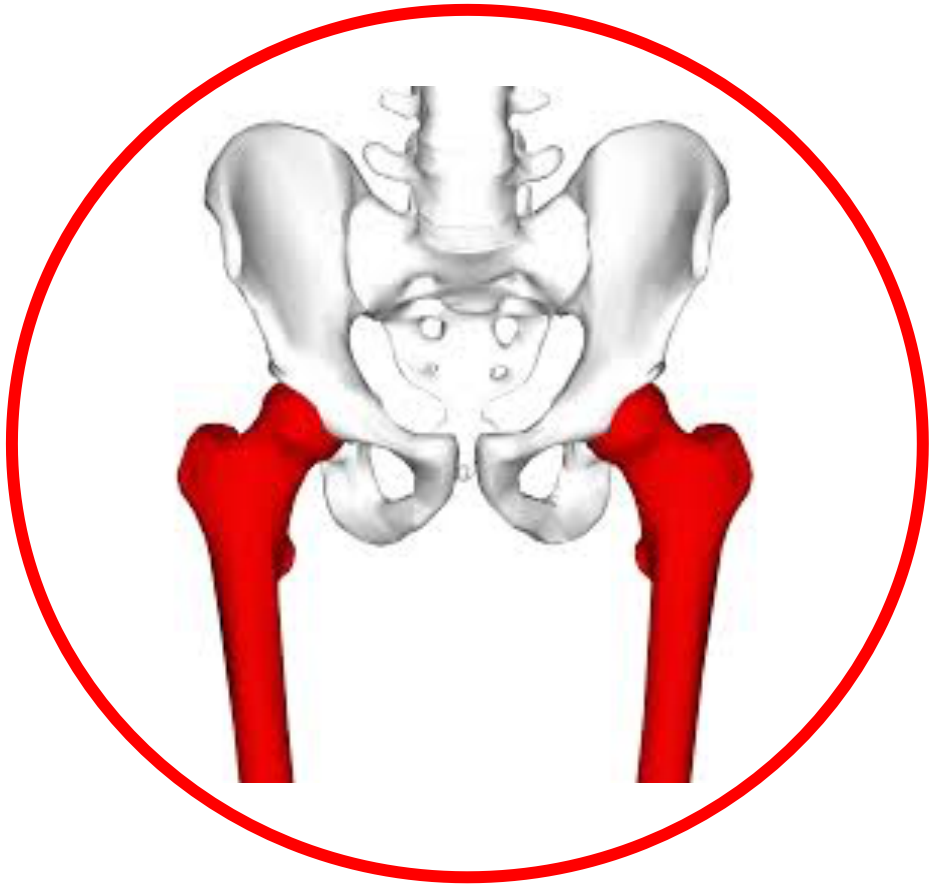

Coracoid Process
Scapula
Humerus (Ball)
Scapula Socket

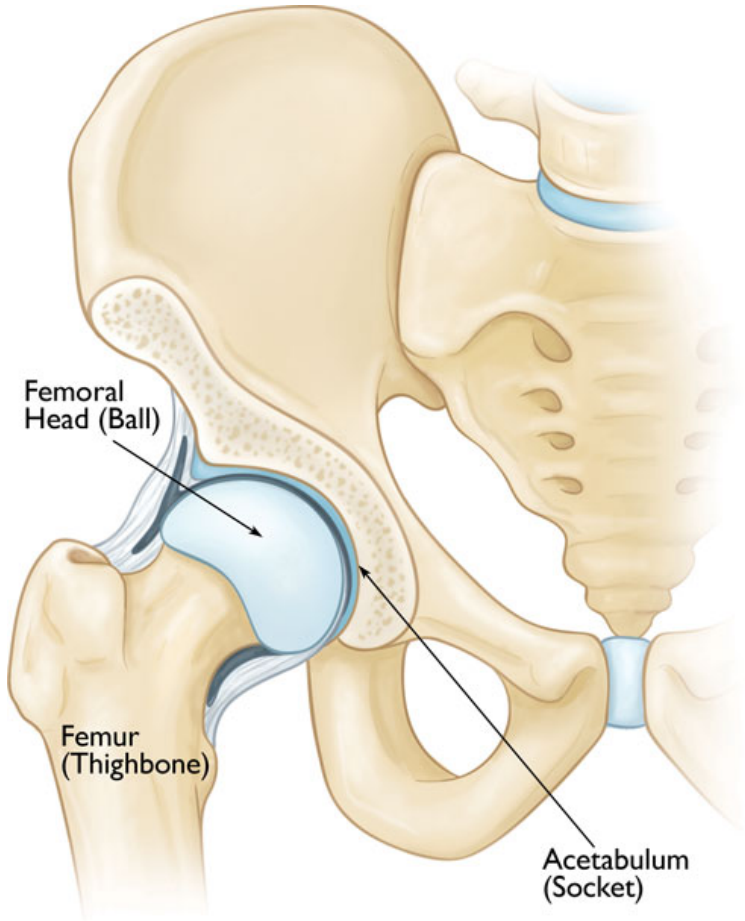

Olecranon Process
Radius
Elbow Joint
Ulna

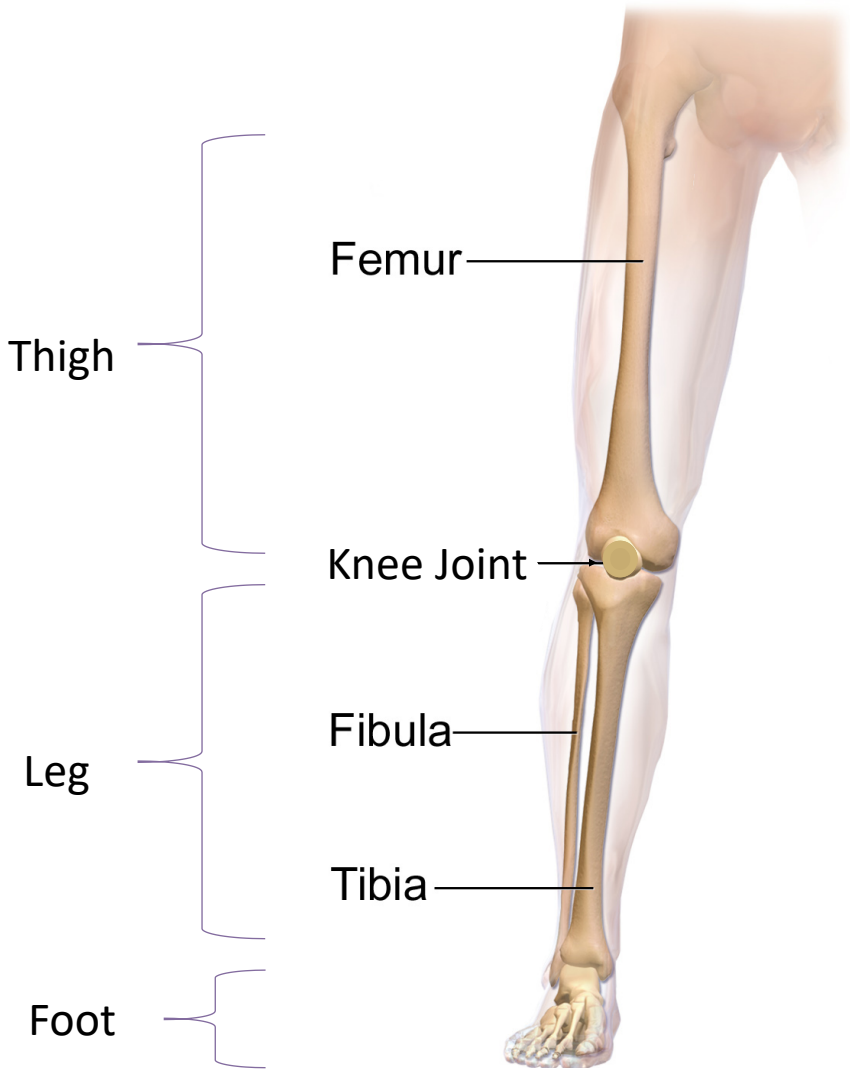

Carpals
Metacarpals
Phalanges

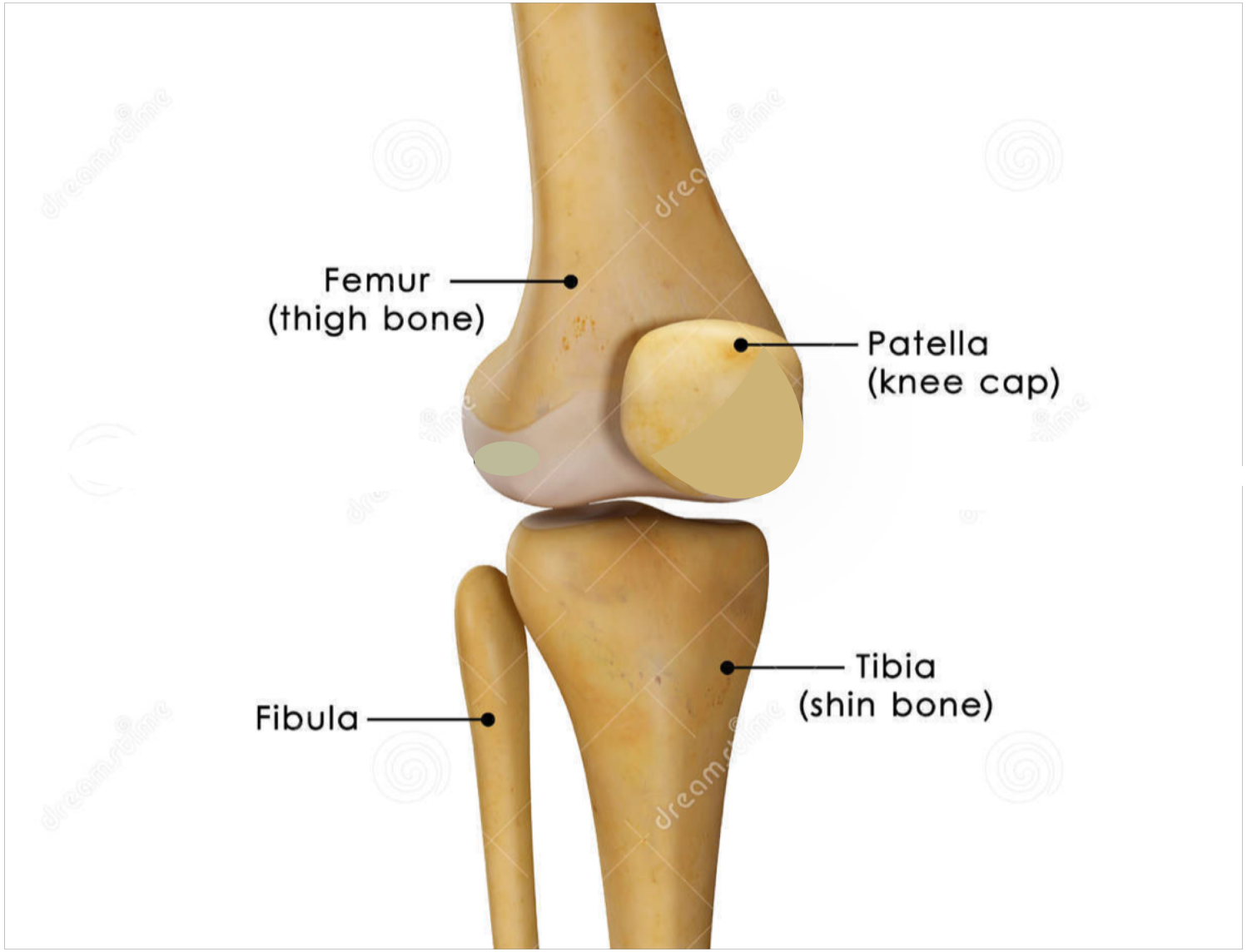
AP (Pelvis) Bilateral Hip

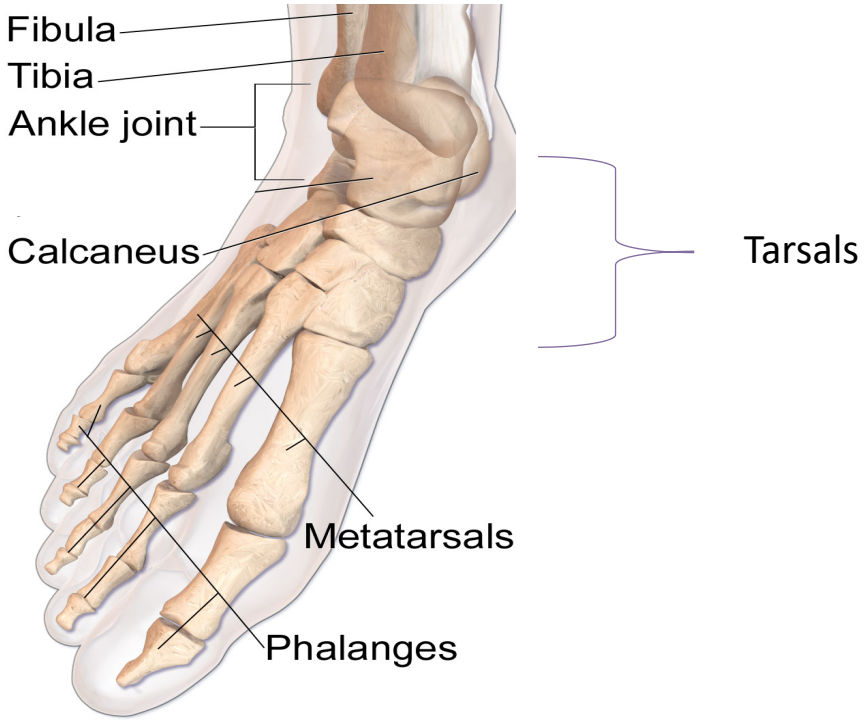





Femoral
Head (Ball)
Femur
(Thighbone)
Acetabulum
(Socket)


Thigh
Femur
Knee Joint
Leg
Fibula
Tibia
Foot


Femur
(thigh bone)
Patella
(knee cap)
Tibia
(shin bone)
Fibula


Fibula
Tibia
Ankle joint
Calcaneus
Tarsals
Metatarsals
Phalanges

FOOT

X Ray Record Keeping and File Maintenance:

Chapter 5 – Sections 5.3

Required Information in Record:

- Every patient must have their own record.
- Views
- Date
- Location
- Technologist's ID
- Techniques

X Ray Record Keeping and File Maintenance:

Chapter 5 - Section 4

Exchange of Films:

- The patient owns the information on the film, NOT THE ACTUAL FILM ITSELF.
- They are entitled to have or transfer that information on request.
- Copies can be substituted for the originals and is recommended, otherwise you should always try to retrieve the films.
- Proper releases should be obtained in advance for all transfers.
- ***Never alter films.***

X Ray Record Keeping and File Maintenance:

Chapter 1 - Sections 13.6 & 13.11
Chapter 5 - Section 2

Film Storage and Retention:

- Unexposed Film must be stored in a cool dry space and away from scatter radiation.
- Exposed Film must be stored in a cool dry space.

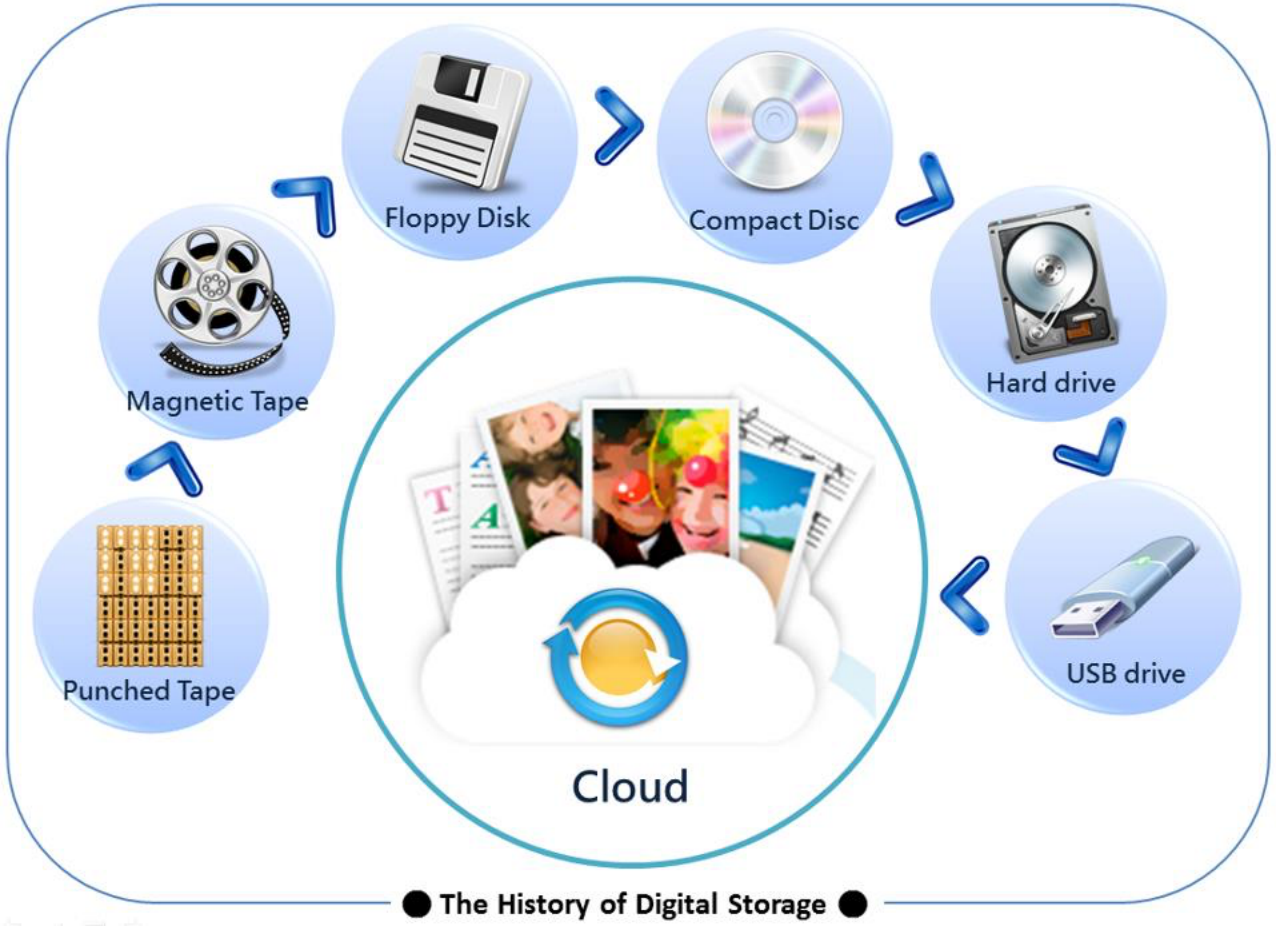
  NC - "Patient Records and Business Records shall be stored in a manner that protects them from foreseeable damage or destruction."
- Individual states have different requirements for the storage of files.
- However, good practice dictates that all records should be maintained for at least 10 years
- Recent trend is to legislate that malpractice cases can be brought up to 3 years after the patient has become aware of a possible injury.
- With the advent of digital storage there is no reason to destroy records.

  NC - "Patient or Business Records stored electronically shall have an established system of weekly back-up. Copies of the back-up records shall be delivered weekly to an off-site location, where the back-up copies will be maintained in a safe and secure manner. "
- If Digital = AUP (Acceptable Use Policy) = employee guidelines to maintain data security according to HIPAA
- If Digital = PACS (Picture Archiving and Communication Systems) = Mass storage in small spaces.

X Ray Record Keeping and File Maintenance:

Chapter 1 - Section 13 (with subsections)

PACS (Picture Archiving and Communication Systems):

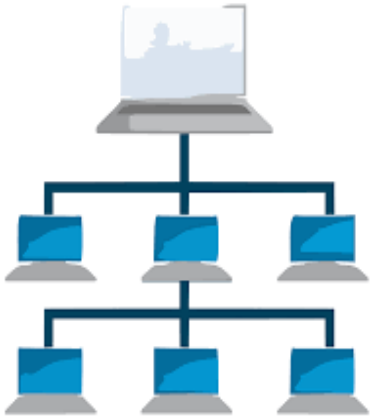


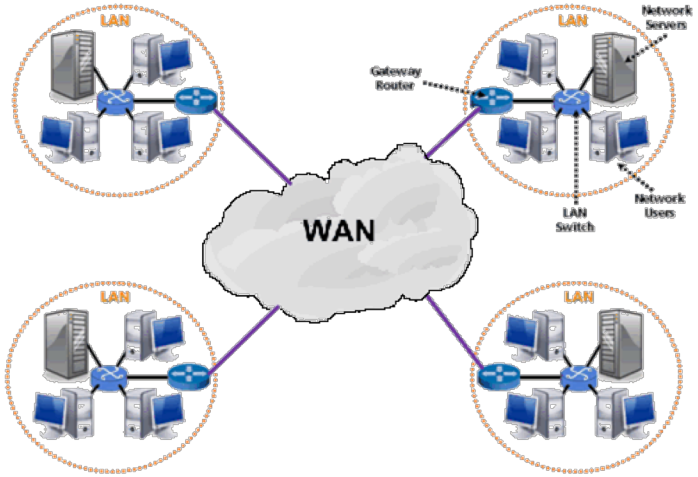
X Ray Record Keeping and File Maintenance:

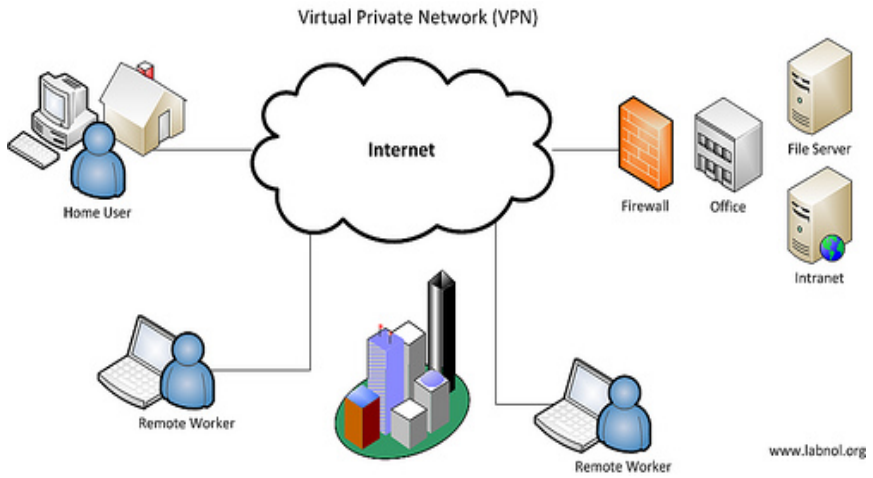
Chapter 1 - Section 13 (with subsections)

Images can be sent anywhere through the internet or other digital formats:

- LAN (Local Area Network) = Computers and devices on a single network.
- WAN (Wide Area Network) = Multiple connected networks covering a large geographical area.
- VPN (Virtual Private Networks) = Private and secure internet connections



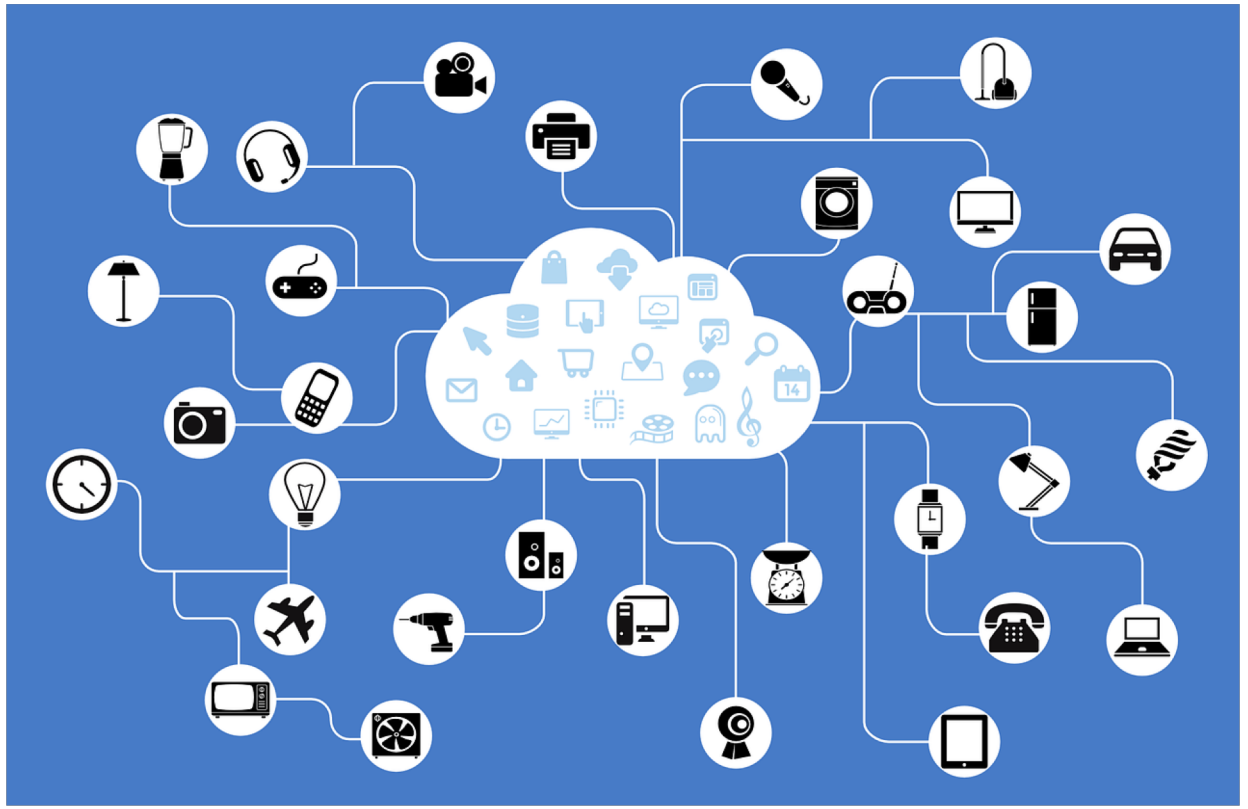




X Ray Record Keeping and File Maintenance:

Chapter 1 - Section 13 (with subsections)

Always have encryption safeguards, security, malware protection, virus protection etc. on all electronic links.



Emergency Procedures:

Disclaimer:

- This section is a general overview of Emergency Procedures. It is not intended to replace any certification program.
- This section is intended to inform you on those topics that need further instruction.
- Text reference - Chapter 9

Emergency Procedures:

Urgent Care Situations:

Procedures that require training:

1. First Aid
2. Severe Bleeding
3. Stoppage of Breathing
4. Choking
5. Stroke

Emergency Procedures:

1. First Aid: Defined as the immediate and temporary survival care given to a person in need due to accident or illness.
   - Call 911
   - Vitals-BP-Pulse-Temperature-Respiration-Comfort

Emergency Procedures:

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2. Severe Bleeding.
   - Call 911
   - Apply direct pressure to supplying artery, e.g. Brachial, Femoral using a cloth or compress of some kind
   - If possible elevate the part
   - If delay in emergency response, maintain fluids

Emergency Procedures:

3. Stoppage of Breathing.
   - Call 911
   - Check to see if there is a pulse
   - No pulse no breathing-Do they need CPR (Cardio Pulmonary Resuscitation) if needed (only if properly trained)
   - Defer to AED (Automatic External Defibrillators)
   - If pulse are they choking

Emergency Procedures:

4. Choking
   - Call 911
   - Check to see if they can talk
   - If not-perform Heimlich Maneuver

Emergency Procedures:

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5. Stroke

F.A.S.T.

"F"	face	= Ask person to smile
"A"	arms	= Ask person to raise both arms. Does one drift down?
"S"	speech	= Ask person to repeat a phrase to detect slurred speech.
"T"	time	= If any of the above call 911 immediately
"T"	**also tongue**	**= Ask person to stick out tongue. Observe if it deviates to one side.**

X-Ray Training for Chiropractic Assistants