Training manual for mid-level therapists

Part 1
Theory and basic anatomy

Arthrology

Edition 1996
ARTHROLOGY is the study of joints.

OBJECTIVES

At the time of the exam and with 80% proficiency, the students will be able to correctly:

1. describe the main supporting structures of a joint (ligament, tendon, capsule, cartilage).

2. identify major joints of the body and the movements available at each joint.

3. state the amount of degrees for different angle measurements.

4. when shown a joint in a specific position, state the approximate (+/- 10°) angle the joint is in.

5. given a patient problem, evaluate range of motion (ROM), identify the limitation, and give the approximate measurement of the joint (+/- 10°).

6. given a patient problem, identify the area(s) of compensation for different movements.

CHAPTER CONTENTS

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C. STABLE JOINTS AND MOBILE JOINTS
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E. DIRECTIONS OF JOINT MOVEMENT
F. AMOUNT OF JOINT MOVEMENT (RANGE OF MOTION)
G. SPECIFIC JOINTS OF THE BODY
H. CHAPTER SUMMARY
A. INTRODUCTION

ARTHROLOGY is the study of joints. A joint is the place where two or more bones come together. There are many joints in the body.

B. FUNCTION OF JOINTS

Joints have two functions:

1) to hold the bony skeleton together

2) to permit movement of the bones in specific directions.

C. STABLE JOINTS AND MOBILE JOINTS

In OSTEOLOGY chapter we learned that there are many different shapes of bones.

In the same way, there are also many different shapes of joints.

The SHAPE of the joint is what most often decides how much and what kind of movement is available there.

Some joints of the body have a shape that does not allow much movement between the bones; they fit together very tightly.

These joints are for STABILITY. For example, the joints between the bones of the skull are very stable.

They do not have much movement; their shape holds the bones together well.
In other joints, the bones can move very well in many directions.

More movement means more mobility.

An example of a joint that is very mobile is the shoulder. The bones of the shoulder are shaped in such a way that their ends do not attach together closely and so can move more freely.

Not many joints have complete stability or complete mobility in them -- most joints have a little of both.

The bones of the joint will help decide how much stability or mobility there is.

Of most importance to the PTA are those joints that have a lot of movement (are the most mobile).

This is for two reasons.

1) the more movable joints are the ones that we most often use in our common daily activities

2) the more mobile joints are the joints most often injured.
Activity:

In the picture given below, please (a) draw all the bones that you know and (b) name all of the body parts and bones that you see in the picture.
Activity: The shoulder, elbow, wrist, hip, knee and ankle are all joints that have some mobility. Please name the bones that help to make each of these joints.

SHOULDER ____________________________________________________________

HIP _________________________________________________________________

ELBOW ______________________________________________________________

KNEE ________________________________________________________________

WRIST ______________________________________________________________

ANKLE ______________________________________________________________

Because the bones are not tightly attached to each other, the more mobile joints have other parts that help to keep the bones together.

D. DIFFERENT PARTS OF A MOBILE JOINT

We have said that bones are alive. The other parts of a joint are also alive! They need food, can become sick or damaged, and will grow and change with time and activity.

There are many different parts that help to keep the bones together. The parts that the PTA should know are:

1. ligament 2. tendon
3. cartilage 4. capsule
1. LIGAMENT

The ligament directly connects bone to bone.

The main function is to limit joint movement. It is very strong and is like the plastic (rope) that is used to hold packages together.

It helps to give the joint more stability.

Activity: Draw a picture of the right femur, tibia and fibula in anatomical position.

Draw a ligament attaching the external side of the femur with the external side of the fibula.

Draw a ligament attaching the internal side of the femur with the internal side of the tibia.

What are the functions of these ligaments?

What direction of movement do they limit?
2. TENDON

The tendon connects muscle to bone.

(Muscle is a very elastic part of the body that helps to make the bones move -- it will be discussed in the next chapter.)

A tendon is strong like a ligament and also gives stability to the joint.

Question: What area of the body do you find the patellar tendon (upper limb or lower limb)?

3. CARTILAGE

Cartilage is like very hard rubber; it covers the ends of bones to make movement easier.

It makes the surfaces smoother so the bones can move against each other without trouble.
Activity:
Cartilage is alive. Normally there is a special fluid that surrounds the cartilage that gives it food and keeps it wet.

Explain the problem at a joint is this fluid did not exist.

The disc in the vertebral column is also made of cartilage.

As we said earlier, it helps for more movement in the vertebral column.

It also works to prevent damage to our vertebral bones as we walk, run or jump.

It does this by acting as a cushion placed between each of the hard bones.

This cushion decreases the hitting of hard bones together and so protects them from damaging each other.
4. CAPSULE

The capsule is like a plastic sac that surrounds the joint.

Inside of this sac is a water-like fluid that helps the bones to move on each other more easily.

This fluid keeps the cartilage healthy, wet and smooth.

The functions of the capsule are to keep this fluid in the joint and also provide some joint stability.

In summary, the five main parts of a movable joints are:

BONE, LIGAMENT, TENDON, CARTILAGE and CAPSULE.
Questions:

What **three** parts help to make a joint more stable? (Do not include bone).

What **two** things help to make the bones move more easily on one another? (Do not include bone.)

---

E. DIRECTIONS OF JOINT MOVEMENT

Bone shape can limit what direction a joint can move.

A tight muscle/tendon, tight ligament, or tight capsule could also decrease joint mobility.

Normally, each joint of the body has specific movements that it can do.

It is important for the PTA to know in **what direction** most normal joints move.

**NOTE**  To be very clear, it must be well understood that you can say the **direction** that you **move** the limb **AND** the **position** the limb is in when it **stops moving**.
For example:

Start with your right shoulder in complete flexion (arm next to your head).

Next, slowly lower your arm until it is straight out in front of you.

You have started in a position of flexion (A)
You have moved in a direction of extension (B)
You have stopped in a position of flexion (C)

Anatomical position (BODY PARTS AND MEDICAL VOCABULARY CHAPTER) is the neutral position for all joints. *

This means that in anatomical position the joint has 0° flexion, 0° extension, 0° IR, 0° ER, 0° adduction, and 0° abduction.

* The area that is not in neutral position is the forearm which is in complete supination.

Naming joint positions and directions of movement is in reference to anatomical position.
Activity:
For each of the joints shown below, please write the name of the Starting Position (SP), Direction of Movement (DOM), and Ending Position (EP).

HIP:

SP _______ DOM _______ EP _______

ELBOW:

SP _______ DOM _______ EP _______

Questions:
In anatomical position, the forearm is in supination; why?

__________________________________________________________

__________________________________________________________

With the elbow extended and the forearm in neutral position, would the thumb be external, anterior, or posterior to the hand?

__________________________________________________________
In Chapter 2 (pages 15 - 20) we discussed directions of movement. Review the different directions of movement and then apply them in the following activity.

<table>
<thead>
<tr>
<th>Activity: For the joints listed below, write the types (directions) of movement that you can do at each joint.</th>
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<tbody>
<tr>
<td>SHOULDER</td>
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<td>ELBOW</td>
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<td>ANKLE</td>
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<tr>
<td>Foot *</td>
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<tr>
<td>TOES</td>
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</table>

* Please note that the forearm and foot are NOT joints. They are areas where a movement can be seen most simply.
Question:
You can see that the types of movements you can do at different joints is not the same. Why?

F. AMOUNT OF JOINT MOVEMENT

The amount of movement at each joint is called the RANGE OF MOTION (ROM) of that joint.

Normally, each joint of the body has a specific amount of movement that it can do.

Bone shape can limit the amount of movement of a joint.

A tight muscle/tendon, tight ligament, or tight capsule could also decrease joint mobility.

If the amount of movement is not normal, then we must be able to write or say clearly how much movement there is at a joint.

To draw a picture of the joint position is one way to show how much a joint moves.

Another way to describe joint range of motion (ROM) is by using numbers.

Because numbers are the common method used in hospitals, it will be the method discussed in this manual.

To understand measurement of joint movement, we must first understand some basic mathematical words.

The words that are important to understand are angle, degree, perpendicular, and parallel.
ANGLE:

The picture shows two lines that join together. The space that is between the two lines is called an angle.

An ANGLE is the amount of space that is between two lines that are joined together.

The word used to describe how much space is between the two joined lines (angle) is degree.

Normally, the word "degree" is represented by a small circle (°).

For example: 10 degrees is written as $10^\circ$
73 degrees is written as $73^\circ$
24° means 24 degrees.

A DEGREE is a word used to describe how much space there is in an angle.

Activity:

Below are pictures of three angles.

1. What picture has the most space between the two joined lines?

2. What picture has the biggest angle?

3. What picture has the smallest angle?
Activity: (continued)

4. $40^\circ$ is the measure of what?

5. What is the number of degrees of the angle in picture (C)?

The PTA should be able to say approximately how big an angle is just by looking at it with her eyes.

Three angles that are very easy to see are $360^\circ$, $180^\circ$, and $90^\circ$.

These are very important angles to remember; you can more easily identify other angles if you use these angles as your reference.

$360^\circ$: If a line joins another line and is going in exactly the same direction, the space between them is $360^\circ$.

(Note that at the end point there is also no space between the two joined lines, so this angle can also be $0^\circ$.)
180°: If two lines join together in exactly opposite directions, then the space between them is 180°.

90°: If two lines join together and the space between them is 90°, (exactly one half of 180°), then the lines are PERPENDICULAR.

Activity: 90° angles are very common when building houses, chairs, and equipment. Give three examples of PERPENDICULAR lines (90° angles) that you can see in your classroom.

1. 
2. 
3. 

In summary, three angles that are easy to see are 360°, 180°, and 90°.

The last general word to know is PARALLEL.

Parallel lines do not join together.

For example:

With one line "A", there can be many, many lines that are parallel to "A".

These lines can be above "A", below "A", beside "A", on top of "A", close to "A", far from "A"
The one rule they must all follow is that to be parallel to "A", they must be placed in exactly the same direction as "A".

If you have two lines that are parallel, their ends will never meet (never join together)

**Question:** What does parallel bars mean?

**Activity:** On many maps you need to have the directions of North, South, East and West so you can find your way. Most often the directions look like the picture on the left.

1. How many degrees are between North and East? 

2. What direction(s) is (are) perpendicular to West?

3. How many degrees between North and South?
Activity: Match the picture with the number of degrees it describes correctly.

1. 45°  __________  1.  
2. 100°  __________  2.  
3. 300°  __________  3.  
4. 90°  __________  4.  
5. 160°  __________  5.  
6. 20°  __________  6.  

Draw an angle of 75°  

Draw an angle of 90°  

Draw an angle of 10°  

Draw an angle of 270°  

Activity: This is a picture of a head. Choose the correct head position (between A, B, C, D) to answer the following questions.

1. If head (x) turns 180°, what will be the end position(s)?  
2. If head (x) turns 90°, what will be the end position(s)?  
3. If head (x) turns 360°, what will be the end position(s)?
Activity: Below are pictures of five clocks. Please give the number of degrees (the amount of space) that is between the two hands on each clock.

A. _____ B. _____ C. _____ D. _____ E. _____

Now that you are familiar with angles and measurements, we will apply them to the human joints.

We had said that each joint of the body can move in specific directions.

The PTA should know that for every direction, the joint only moves in a specific space (number of degrees).

This amount of movement is called range of motion (ROM).

The Range of Motion (amount of movement) at each joint can be measured.

It is important to know if the range of motion is normal, or if the movement is limited (amount of movement is less than normal).

The guidelines, hand positions, and movements made to evaluate range of motion will be presented at the end of this chapter.
G. SPECIFIC JOINTS OF THE BODY

In the following joints, more complete anatomy, specific movements and range of motion will be discussed.

I. Shoulder *
II. Elbow
III. Forearm *
IV. Wrist *
V. Hand/Fingers *
VI. Hip
VII. Knee
VIII. Ankle
IX. Foot/Toes *
X. Vertebral column *

** Note that these areas may be a combination of many joints (hand, foot, shoulder, vertebral column); or may be an area and not a joint (forearm).

For each of the areas shown above, the following information will be given.

a. bones
b. function
c. other structures
d. movement
e. range of motion
I. THE SHOULDER

There is more than one joint in the shoulder area, but the joint most commonly identified as the "shoulder joint" is the one made by the joining of the HUMERUS with the SCAPULA.

The humerus is like a stick with a ball on its proximal end. The part of the scapula where the humerus attaches is shaped like a shallow half-circle.

Activity: With your left hand, flex the fingers tightly so the hand is in a fist. Flex the wrist slightly. Keep it in this position. With the right hand, adduct all fingers so that they are touching together. Now bend the palm and the fingers a small amount. Keep it in this position. Now put the left hand in the palm of your right hand. Your left hand is the head of the humerus and your right palm is a part of the scapula where the head of the humerus attaches.
b) Function of the shoulder

The function of the shoulder is to attach the upper limb to the trunk.

Because it is a very mobile joint, it allows the hand to be functional in many different positions around the body.

c) Other Structures of the shoulder

Because of the shape of the bones, the shoulder is not a very stable joint.

The capsule, muscles, and tendons provide the stability for this joint.

Observe that the cartilage helps to make the cup shape on the scapula a bit more deep.

d) Movement of the shoulder

It is important to know that to move the upper limb, the scapula and clavicle will move also.

**Question:** If the scapula could not move, would you expect the Range of Motion (ROM) at the shoulder to be increased or decreased?

____________________________________________________________________________________

Why? ____________________________________________________________________________

____________________________________________________________________________________

____________________________________________________________________________________
Activity: For the pictures given below, please write the name of the position and the number of degrees between starting and ending positions. The amount of space between them is a darker area.

Position: __________  Position: __________
Degrees: ________  Degrees: ________

Position: __________  Position: __________
Degrees: ________  Degrees: ________

Position: __________  Position: neutral
Degrees: 0°

Position: __________  Position: __________
Degrees: ________
II. THE ELBOW

a) Bones of the elbow

The elbow is the attachment of the distal part of the HUMERUS with the proximal parts of the RADIUS and ULNA.

Note that the ulna has the most contact with the humerus and has a very special shape.

The proximal part of the ulna is shaped like the letter "c" and the distal humerus is shaped like the letter "o".
Activity: Feel the posterior elbow area; the bone that makes the point of the elbow is the proximal part of the ulna. This part is called the OLECRANON.

ULNA.

b) Function of the elbow

Activity: Normally you have three bones between the shoulder and the wrist. Your body has changed and now you have only one long bone in the upper limb; the length of your upper limb remains the same.

With this new upper limb, try to scratch the top of your head. Try to put something in your mouth. Try to write words in your book.

Describe what happened with these activities:

_____________________________________________________________________________________

Did you have difficulty?

_____________________________________________________________________________________

If yes, what?

_____________________________________________________________________________________

In your own words, write the function of the elbow joint:

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________

_____________________________________________________________________________________
c) Other Structures of the elbow

Because the ulna fits closely with the humerus, the elbow is a very secure joint.

There are, however, many ligaments that connect the radius to the ulna, and the ulna and radius to the humerus.

The joint capsule surrounds the distal end of the humerus and the proximal parts of the radius and ulna.

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d) Movement of the elbow

Observe that with elbow movement, the "c" (ulna) moves on the "o" (humerus).

The movement of extension stops when the top of the "c" contacts the humerus.

In flexion, it is more the skin and muscles that will stop the movement.
Activity: You are measuring the elbow ROM on two patients. One is a huge obese woman and the other is a very malnourished man.

Will elbow flexion be the same for these two patients? ______________________

Why or why not? ____________________________________________

__________________________________________________________

If not the same, who will have more ROM for elbow flexion (the woman or the man)? ______________________

* Note that the joints of each patient are normal.

Range of Motion of the elbow

Activity: For the pictures given below, please write the name of the position and the number of degrees between starting and ending positions. The amount of space between them is a darker area.

Position: __________  
Degrees: __0°__________  

Position: __________  
Degrees: __________
III. THE FOREARM  (Note that this is an area and not a joint.)

a) Bones of the forearm

The bones of the forearm are the RADIUS and the ULNA.

b) Function of the forearm

The function of this area is to make the hand more functional in allowing pronation and supination.

Activity: Please list four activities that you could not do if you were unable to pronate and supinate the forearm.

1. 

2. 

3. 

4. 
c) Other Structures of the forearm

There are ligaments at the proximal and distal ends of these bones to help to provide stability.

There is also a strong membrane that helps to attach the two bones along the middle.

\[\text{Diagram: anterior view, posterior view}\]

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d) Movement of the forearm

In supination, the radius and ulna are parallel to each other (A).

In pronation the radius crosses over the ulna (B).

\[\text{Diagram: anterior view left forearm and hand}\]

The actual crossing of bones occurs in the forearm; thus we have decided to describe supination and pronation as happening in the forearm.
e) Range of Motion of the forearm

**Activity:** For the pictures given below, please write the **name of the position** and the **number of degrees** between starting and ending positions. The amount of space between them is a darker area.

- **Position:** __________
  **Degrees:** _________

- **Position:** neutral
  **Degrees:** 0°

- **Position:** __________
  **Degrees:** _________

---

**IV. THE WRIST**
a) Bones of the wrist

The wrist is made of the joining of the distal RADIUS/ULNA and the CARPAL BONES.

b) Function of the wrist

Like the other joints in the upper limb, the wrist joint helps to make the hand more mobile and functional in everyday activities.

c) Other Structures of the wrist

There are many small ligaments that attach the bones of the forearm and the carpal bones together.

d) Movement of the wrist

Note that in the elbow, the proximal part of the ulna has the most contact and importance in movement. (A)

In the wrist, it is the distal part of the radius that plays the major role in contact and movement. (B)
e) Range of Motion

Activity: For the pictures given below, please write the name of the position and the number of degrees between starting and ending positions. The amount of space between then is a darker area.

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V. THE HAND/FINGERS

a) Bones of the hand/fingers

**Question:** There are many bones and many joints in the hand. What are the names of the bones in the hand?

________________  ___________________  __________________

**Activity:** Look at the fingers and thumb; how many joints (total) are in these parts?

Fingers:  __________  Thumb:  __________
b) Function of the hand/fingers

**Activity:** Think about all the times you use your hands in one day. Please list five activities that you do with your hands.

1. 
2. 
3. 
4. 
5. 

Your hands are the tools that you have to grab and move all things (light, heavy, big, or small) in any way that you wish.
c) Other Structures of the hand/fingers

In the hand and fingers there are many, many ligaments that hold all of these small bones together.

Look at the shape of the palm; you can see that it is not flat, but looks more like the shape of a spoon.  

This helps to make objects easier to hold. It is made by bone shape, ligaments, and small muscles of the hand.

There are also many tendons that attach to different bones in the hand.

These tendons are from muscles that work to extend or flex the hand; they can be seen on the dorsal and palmar side of the hand or wrist.
Activity:

Supinate your forearm and put your thumb and last finger together. Slightly flex your wrist. When you look at your wrist you should see one long tendon that comes from your forearm and passes your wrist.

Pronate your forearm. Flex all of your fingers together making a fist. In this position, gently move your index finger in abduction and adduction. You can see the tendon moving across the knuckle.

d) Movement of the hand/fingers

Because the hand has many small bones, it can easily change its shape to fit many different sizes and shapes of objects.

A special movement found only in humans in the movement made by the thumb.

This movement is called opposition. Opposition is the thumb’s ability to touch the other fingers in the hand.

We use opposition every time we write (holding a pen between fingers and thumb), eat (holding a spoon or food between the fingers and thumb), in dressing, and many other activities during the day.

Opposition is very important!

e) Range of Motion of the hands/fingers

Because the movements of the hand are difficult to measure, sometimes it is better to describe the position of the fingers and thumb and say what they can do functionally.
Activity:
For each of the pictures below, write the name of the position only.

name of position of proximal finger joint:

name of position of the thumb:

name of position of distal finger joint:

name of position:
VI. THE HIP

(a) Bones of the hip

The hip is the joining of the FEMUR with the ILIAC BONE.

The way the two bones come together is similar to the shape of the place where the humerus and scapula meet in the shoulder.

Activity:

In your own words, describe the shape of the hip joint where the surfaces of the femur and iliac bone come together.

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-----------------
Although the hip joint and the shoulder joint are similar in their shape, there are some differences between the two joints:

* The place on the iliac bone where the femur attaches is deeper than the place where the humerus attaches to the scapula.

* Ligaments and tendons in the shoulder are very important for stability.

* The ligaments and tendons in the hip are not as important because the bone shape helps to make the hip joint more stable.

* The hip is a bigger and stronger joint made for weight bearing; the shoulder is not.

b) Function of the hip

The function of the hip is weight bearing and mobility. It allows the leg and foot to be placed in many different positions; it also holds the weight of the upper body during standing and walking activities.

Activity:

Normally your hip joint can move in many directions. Imagine this has changed. Your hip joint is now fused and no movement can happen here. Your lower limbs are in a straight position only, and cannot move.

Describe how you put your pants on in the morning.
Activity: (continued)

Describe how you walk.

Describe how you sit.

There are many strong ligaments that help support the hip on all sides.
d) Movement of the hip

It is important to know that the hip joint is indirectly attached to the sacrum (i.e. the femur attaches to the iliac bone and the iliac bone attaches to the sacrum).

This means that movement at the hip can affect the vertebral column.

This is because of the many ligaments and tendons that are in these areas.

---

**Activity:**

Put your body in supine position with the lower limbs straight. Feel the lumbar area of your vertebral column.

In supine position, flex your hips and knees, and put your feet flat on the floor. Again feel the lumbar area of your spine.

In what position do you feel more lumbar lordosis?

_________________________________________________________________________

_________________________________________________________________________

What position decreases lumbar lordosis?

_________________________________________________________________________

_________________________________________________________________________
e) Range of Motion of the Hip

Activity:

For the pictures given below, please write the name of the position and the number of degrees between starting and ending positions. The amount of space between them is a darker area.

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VII. THE KNEE

a) Bones of the knee

The bones that make the knee joint are the distal part of FEMUR, proximal part of TIBIA, and the PATELLA.

Although the fibula is near the joint, it is not a part of the knee joint.

b) Function of the knee

The knee helps to support the weight of the body in standing and walking and helps in mobility (walking, sitting and squatting activities).

Knee flexion and extension also provide a functional shortening and lengthening of the lower limb.
c) Other Structures of the Knee

The bones of the knee do not give it much stability; but the many strong ligaments that connect the bones, and the tendons that cross the joint help to make it a stable joint.

It is more stable in extension than in flexion because the ligaments are more tight in extension.

There is also special cartilage (called MENISCUS) that is between the femur and the tibia. Its function is for increased stability and to decrease hitting of the femur and tibia together.

The knee joint is one of the most complex because of the many tendons and many ligaments that attach in this area.

The joint capsule is also very big and is important in holding the fluid that helps the three bones easily move upon one another.

d) Movement of the Knee

The patella changes its position with knee flexion and extension. In flexion it moves down, in extension it moves up.

A small amount of internal and external rotation can happen at the knee. These movements happen only when the knee is flexed at 90°.

It is not important for the PTA to measure this movement; just know that some rotation of the knee can occur when the knee is in a flexed position.
e) Range of Motion of the knee

Activity:
For the pictures given below, please write the name of the position and the number of degrees between starting and ending positions. The amount of space between them is a darker area.

position: ______________________
degrees: ______

position: ______________________
degrees: ______

VIII. THE ANKLE

(internal view; talus and calcaneus)
(posterior view; ankle)
(external view of the ankle)
a) Bones of the ankle

Many people will call the area where the foot and the leg meet the "ankle"; generally, this is true.

More specifically, the ankle joint is the connection between the TALUS, the distal part of TIBIA, and the distal part of FIBULA.

b) Function of the ankle

The ankle attaches the foot to the leg.

It works closely with the foot to support the body in standing, helps in contacting and leaving the ground when walking, can help make you taller in reaching high places, and allow you to tap your feet to music.

c) Other Structures of the ankle

Again, as in all of the joints, there are ligaments to help keep the bones together. The ligaments of the ankle joint help to give stability to the area.

Question:

Sometimes when you walk or run you turn your ankle and fall on the external side of the joint. The area below the distal fibula may have pain and swelling. What could be damaged?
e) Range of Motion of the ankle

Activity:

For the pictures given below, please write the name of the position and the number of degrees between starting and ending positions. The amount of space between them is a darker area.

position: __________

degrees: __________

position: NEUTRAL

degrees: __________

position: __________

degrees: __________
IX. THE FOOT/TOES

a) Bones of the foot/toes

Activity:
As in the hand, there are many bones and joints in the foot and toes. Please write all of the bones that you know in the foot.

_________________  __________________  __________________
_________________  __________________

b) Function of the foot/toes

The foot functions as our only contact with the ground when walking.
It carries all of the weight of our body and adapts its shape to adjust to the surfaces we walk on.

Think about this as you walk on rocks, over uneven surfaces, and up and down hills.
The foot will always try to have complete contact with the surface it is walking on.

**Question:**

One boy (A) walks with very hard bottoms (soles) on his shoes; they cannot bend much. One boy (B) walks with thin rubber on the bottom of his shoes. On uneven surfaces, which boy will have the most movement between the bones in his feet?

**Why?**

---

c) **Other Structures of the foot/toes**

As in the hand, there are many small ligaments that attach the bones together.

Just as the hand has a special shape, so does the sole (bottom of the foot).

The rounded part is called an arch. The arches help the foot adjust to the different surfaces that it moves on.
There are also many tendons that attach to the bones of the foot and toes.

These tendons are from muscles that will dorsiflex or plantarflex the foot.

Activity:

You can see many tendons on the dorsal side of the foot if you extend the toes.

Posteriorly, you can see and feel a big tendon just superior to the calcaneus.

There are also many small muscles located in the foot/toe area.

d) Movement of the foot/toes

Inversion and eversion are important movements that happen in the foot.

They are combinations of many movements.

Generally the result of these movements is:

Inversion  -- when the bottom of the foot turns to the inside.

Eversion  -- when the bottom of the foot turns to the outside.
Movement of the toes are flexion/extension and a little abduction and adduction.

e) Range of Motion of the foot/toes

Activity:
Because movement of the foot and toes is difficult to measure, sometimes it is better to describe the position of the foot and toes and what they can do functionally.

For each of the pictures below, write the name of the position only.

position: neutral

position: ____________________________  position: ____________________________
X. THE VERTEBRAL COLUMN

a) Bones of the vertebral column

Activity:

From your study in Osteology, please give the names of the areas of the vertebral column and the number of vertebrae in each area.

<table>
<thead>
<tr>
<th>Area</th>
<th>Number of vertebrae</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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</tr>
</tbody>
</table>

Posterior view

Lateral view
Generally, each vertebra joins together in two places.

One place is between the bodies of the vertebrae (with the discs between each one), and one place is posterior between the small parts of the vertebrae called articulating processes or facets.

b) Function of the vertebral column

**Activity:**

Again from your study in Osteology, what are the functions of the vertebral column?

1. 

2. 

3. 

c) Other Structures of the vertebral column

The disc, ligaments and muscles help control each vertebral joint.

We have said that the disc helps the vertebral bones to move on each other for bending actions.
The outer part of the disc is strong and firmly attached to the vertebral bodies.

The inner part is like a thick liquid that moves as the vertebrae bend on each other.

**Ligaments** are found anterior to the vertebral body, posterior to the vertebral body, between spinous processes, and between transverse processes.

Each ligament gives the vertebral column more stability by limiting movement in specific directions.
Activity:

For the pictures below, please write what direction of movement each ligament (A,B,C,D,E,F) will limit.

(lateral view of vertebral column)

Ligament A limits __________________

Ligament B limits __________________

Ligament C limits __________________

Ligament D limits __________________

Ligament E limits __________________

Ligament F limits __________________

What movement is most limited by ligaments?
Vertebral bone shape does not limit flexion movements. Extension movements are limited by the shape of the vertebral bones (think of spinous processes).

This is the main reason why there are many ligaments that help to limit flexion, and few ligaments that limit extension.

There are also ligaments that help attach the sacrum to the iliac bone.

Muscles attach to each of the vertebrae to give them stability and help them move.

d) Movement of the vertebral column

Each vertebra does not move much by itself, but when all of the bones move together you can see a big change in the position of the vertebral column.

Activity:

One student will stand in front of the class and slowly make different movements of the trunk. The class should observe the movement of the vertebral column and discuss the following:

- The place(s) where you see the most rotation

- The places(s) where you see the most lateral bending

- The places(s) where you see the most flexion/extension

Discuss your observations with the entire class.
Remember that the ribs attach to each thoracic vertebrae.

In **inspiration** (taking air in) the ribs move **up and out**.

In **expiration** (pushing air out) the ribs move **down and in**.

e) Range of Motion of the vertebral column

As in the other areas that have many bones (hand, foot), the movements in the vertebral column are difficult to measure.

It is important that you can **identify** the different movements and positions so that you can **describe** them if they are not normal.

**Activity:**

For each of the pictures below, please write the **name of the position** only.

---

name of position

name of position
Activity: (continued)

For each of the pictures below, please write the name of the position only.

( posterior view )

name of position

( superior view )

name of position
Activity:

Below are pictures of different joints of the body.

For each picture, you must:

a) Put a **circle** around the joint.

b) **Name** the joint.

c) Write the **view** (what direction you are looking at the joint — anterior, posterior, lateral).

d) **Name** the bones that make the joint.

e) **Label** these bones on the picture.
<table>
<thead>
<tr>
<th>Activity: (continued)</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Joint 1" />  View  Bones</td>
</tr>
<tr>
<td><img src="image2" alt="Joint 2" />  View  Bones</td>
</tr>
<tr>
<td><img src="image3" alt="Joint 3" />  View  Bones</td>
</tr>
<tr>
<td><img src="image4" alt="Joint 4" />  View  Bones</td>
</tr>
</tbody>
</table>
XI. SPECIAL VOCABULARY

In the beginning of this chapter we discussed major joints of the body, their general shape and the movements they can do.

Now that you are familiar with these, it is important to present some of the problems that can occur with a joint.

There are four medical words that you should be familiar with.

These are: hypermobile, hypomobile, dislocation, and sprain.
HYPERMOBILE

The joint moves more than it normally should (more than complete ROM). An example is that in some people the elbow can bend more than 0°.

HYPOMOBILE (stiff)

The joint moves less than it normally should (less than complete ROM). An example is if a knee has not moved for 3 months, it will probably be stiff or hypomobile.

DISLOCATION

Normally two bones come together and move on each other in a specific way.

When one of these bones is pushed in a position where there is no longer normal contact between the bones, the joint is said to be dislocated.
SPRAIN

When the ligament holding the two bones together become overstretched or torn.

Posterior view of right ankle

A. Hands are feeling a NORMAL ligament that connects the fibula to the talus and calcaneus.

B. Hands are feeling the same ligament that connects the fibula to the talus and calcaneus. This picture shows a torn ligament; this is one type of ankle SPRAIN. A torn ligament results in more joint mobility and less joint stability.
RANGE OF MOTION EVALUATION GUIDELINES

To know how much movement (range of motion) a patient has at a joint, the PTA can observe the active movement, or can move the limb passively.

In this manual we will discuss methods for PASSIVE RANGE OF MOTION EVALUATION.

General guidelines for all passive range of motion evaluation techniques.

1. Put the patient in a comfortable position so that the individual joint can be easily moved through its range of motion. (Position similar to anatomical position.)

2. Instruct the patient as to what you are going to do and why (moving the limb to find the areas that may be stiff or painful).

3. For PASSIVE measurement, ask the patient to relax and the PTA will do all the work.

4. Hold the limb around the joints to support these parts and have better control of the movement.

5. Move the limb slowly through the range of motion; observe at what angle the patient has pain and at what angle you feel stiffness. *

* Note that when one area is stiff and cannot move, other parts of the body will try to help make this movement; this is called COMPENSATION.

It is important that during the evaluation, the PTA observes the patient carefully to be able to identify what movements are happening at the specific joint, and what movements are being held by other parts of the body.
Example:

When you are testing right shoulder abduction, the movement should be at the joint.

If the joint is stiff, the patient may begin to bend their body to the left so it would look like an abduction movement, but actually the joint angle would not change.

This would be compensation seen in the vertebral column.

6. The PTA should write what compensatory movement he observes in his evaluation.

7. After the PTA completes the evaluation of one joint, he should write the results down on paper in order to remember the details.

8. The PTA must always compare the two sides of the body. Often this will help the PTA identify the "normal" movement for the patient and what movement is limited.
The pictures on the following pages are to be used as general guidelines for hand positioning and patient positions.

THE SHOULDER

FLEXION

ABDUCTION
THE SHOULDER

EXTENSION *

(* May modify this position to see the patient.)

ADDUCTION

INTERNAL AND EXTERNAL ROTATION
ELBOW

FLEXION AND EXTENSION

WRIST

FLEXION
EXTENSION
ABDUCTION
ADDUCTION

PRONATION AND
SUPINATION

FOREARM
THE HAND

FINGER FLEXION

FINGER FLEXION AND EXTENSION

STRETCHING THE ARCH
THE HIP

FLEXION

(*) May modify this position to prevent the opposite leg from lifting.

INTERNAL AND EXTERNAL ROTATION
THE HIP

EXTENSION

ABDUCTION AND ADDUCTION *

(* May modify this position to prevent the opposite leg from moving inward.)
<table>
<thead>
<tr>
<th>JOINT / BODY AREAS</th>
<th>BONES</th>
<th>TYPES OF MOVEMENTS</th>
<th>AMOUNT OF MOVEMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHOULDER</td>
<td>humerus/ scapula</td>
<td>Flexion</td>
<td>0 – 180</td>
</tr>
<tr>
<td></td>
<td>(clavicle)</td>
<td>Extension</td>
<td>0 – 50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ABDuction</td>
<td>0 – 180</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ADDuction</td>
<td>0 – 40</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Int. Rotation</td>
<td>0 – 90</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ext. Rotation</td>
<td>0 – 90</td>
</tr>
<tr>
<td>ELBOW</td>
<td>humerus/ radius ulna</td>
<td>Flexion</td>
<td>0 – 135</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Extension</td>
<td>0</td>
</tr>
<tr>
<td>FOREARM *</td>
<td>radius/ ulna</td>
<td>Supination</td>
<td>0 – 90</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pronation</td>
<td>0 – 80</td>
</tr>
<tr>
<td>WRIST</td>
<td>radius/ulna carpal bones</td>
<td>Flexion</td>
<td>0 – 80</td>
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<tr>
<td></td>
<td></td>
<td>Extension</td>
<td>0 – 80</td>
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<td></td>
<td></td>
<td>ABDuction</td>
<td>0 – 45</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ADDuction</td>
<td>0 – 30</td>
</tr>
<tr>
<td>HAND/FINGERS *</td>
<td>carpals metacarpals phalanges</td>
<td>Flexion</td>
<td>Describe functional movement</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Extension</td>
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<tr>
<td></td>
<td></td>
<td>ABDuction</td>
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<td></td>
<td></td>
<td>ADDuction</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>Thumb Opposition</td>
<td></td>
</tr>
<tr>
<td>HIP</td>
<td>femur/ iliac bone</td>
<td>Flexion</td>
<td>0 – 135</td>
</tr>
<tr>
<td></td>
<td>(clavicle)</td>
<td>Extension</td>
<td>0 – 20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ABDuction</td>
<td>0 – 45</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ADDuction</td>
<td>0 – 20</td>
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<tr>
<td></td>
<td></td>
<td>Int. Rotation</td>
<td>0 – 30</td>
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<tr>
<td></td>
<td></td>
<td>Ext. Rotation</td>
<td>0 – 45</td>
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<tr>
<td>KNEE</td>
<td>femur patella tibia</td>
<td>Flexion</td>
<td>0 – 135</td>
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<tr>
<td></td>
<td></td>
<td>Extension</td>
<td>0</td>
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<td></td>
<td>Int. Rotation</td>
<td>very small</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ext. Rotation</td>
<td>small</td>
</tr>
<tr>
<td>JOINT / BODY AREAS</td>
<td>BONES</td>
<td>TYPES OF MOVEMENTS</td>
<td>AMOUNT OF MOVEMENT</td>
</tr>
<tr>
<td>--------------------</td>
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<td>--------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>ANKLE</td>
<td>tibia fibula talus</td>
<td>Dorsiflexion Plantar Flexion</td>
<td>0 - 10 0 - 30</td>
</tr>
<tr>
<td>FOOT/TOES *</td>
<td>tarsals metatarsals phalanges</td>
<td>Inversion Eversion Flexion Extension ABDuction ADDuction</td>
<td>Describe functional movement</td>
</tr>
<tr>
<td>VERTEBRAL COLUMN *</td>
<td>vertebal bones</td>
<td>Flexion Extension Lateral Bending Rotation</td>
<td>Describe functional movement</td>
</tr>
</tbody>
</table>

A hypermobile joint is one that moves more than it normally should.

A hypomobile (stiff) joint is one that moves less than it normally should.

Dislocation is when the bones of a joint are pushed in an abnormal position where they lose contact with the other.

Sprain is when the ligament holding the 2 bones together becomes stretched or torn.

Guidelines for evaluating ROM at each joint are given in this chapter.

Compensation is the extra movement of a part of the body in trying to help another part move.

The PTA must practice ROM techniques !!
WHAT IS IMPORTANT FOR YOU TO REMEMBER ABOUT THIS COURSE?
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