

# Introduction

This laboratory manual serves as an ancillary to the text *Kinesiology (10th ed. )* by Hamilton and Luttgens. Most of the material contained herein is taken directly from that text. The purpose of this lab manual is to take many of the Laboratory Experiences presented in the textbook and present them in such a way as to guide the student through the process of using an experiential approach to further understanding of the concepts presented in the text. Each of the labs in this manual requires the student to apply the concepts learned in some way, whether through experimentation, problem solving, observation, or analysis. Throughout the manual the student is asked to gather data in some manner and to explain what these data mean in terms of the problem at hand. This step from data gathering to an understanding of the application of concepts is one of the most critical steps in the learning process. This laboratory manual is structured to help the student take that step.

The format of the laboratory manual is intended to move the student easily from lecture presentation and reading of the material in the textbook to the laboratory experience. Each lab is introduced with a set of objectives. These closely follow the objectives stated at the beginning of each chapter in the text. By noting the objectives for each lab the student will quickly be able to determine the manner in which the lab relates to the text. Background information for each lab experience again is drawn from the text in many cases and should refresh the student's memory of the material which will be illustrated through the lab experience. Any part of the background information that is not familiar to the student at the beginning of that lab period should be reviewed immediately in the text before proceeding. Laboratory experiences will be difficult and less productive for the student who is ill prepared.

The procedures for each lab experience differ from lab to lab. The student would be well advised to read through these procedures in advance of the lab period and be prepared with any procedural questions they might have. Once the lab experiences have been initiated, procedures should be followed as closely as possible. The student should not hesitate to ask assistance from the lab instructor if the procedure to be followed is not clearly understood. In many cases the procedures call for work in small groups, usually two to three people. In these instances each person in the group should clearly understand the role that they are to play in the lab experience.

It is critical for the student to understand that, while the collection of the relevant data according to the procedures outlined is important, the purpose of the laboratory experience is to help the student to understand the explanation for the data collected. In any scientific study data of some sort is collected and used to illustrate a concept. Data can take many forms, from numerical data to observational data to lists of muscles. The purpose for collecting this data is to learn something about the thing being studied. In these laboratory experiences the student will be asked to collect many kinds of data or to solve quantitative problems. The most vital step in this process is to be able to examine the data collected or calculated and determine the reason behind the observed result. In other words, now that you have this result (data), what does it mean in terms of the problem at hand? In this laboratory manual the student is often asked to explain the results of an experiment or experience. This is, in fact, the part of each lab experience that contains the most meaning for the student. It is at this point that the student must examine the results, reflect on how the concepts learned apply to those results, and formulate a clear and concise explanation based on those concepts.

Composing and writing a clear and concise explanation of an observed phenomena is a skill which must be developed. Once the resultant data have been gathered the student should carefully examine them. Using the information presented in lecture, in the text, and as background the student should next attempt to clearly establish in their own thinking the link between the concepts learned and the result observed. Once the student feels a clear understanding of the concepts and applications of concepts involved, the explanation may be constructed. This explanation should contain a clearly written description of *how* the kinesiological concept involved produced the observed result. It is not sufficient to simply state the concept. The goal of the exercise is to produce a statement which describes the way in which a given concept applies in the particular instance of the lab experience at hand. The

student of kinesiology must be able to take what has been learned and apply it to practical situations. They must be able to explain what is occurring in a manner which will be understood not only by other kinesiologist but by those not trained in the discipline -- students, clients or others. All of the learning of kinesiological theory has little value if it can not be applied in practice. It is the move from theory to practice that is the final result of each laboratory experience and the ultimate goal of this lab manual.

# LABORATORY 1

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## Introduction to Kinesiological Analysis

### Objectives (Chapter 1)

1. Describe the major components of a kinesiological analysis.
2. Prepare a description of a selected motor skill, breaking the skill down into component phases and identifying starting and ending points.
3. Determine the simultaneous - sequential nature of a variety of movements skills.
4. Classify motor skills using the classification system presented.
5. State the mechanical purpose of a variety of movement skills.
6. Utilize methods of observation and palpation to identify the joints and basic muscle groups active in a movement skill.

### Background

A kinesiological analysis is the application of this information to assessing the effectiveness of a given motor performance. It consists of

1. describing a skill in a logical and systematic fashion by breaking it down into its constituent elements
2. evaluating the performance of the skill by determining whether and how the related anatomical and mechanical principles have been violated
3. prescribing corrections based on an appropriate identification of the cause or causes.

The first step in the description phase of the analysis is to identify the primary purpose of the movement. Without a clear understanding of why the movement is being performed, it is virtually impossible to evaluate its effectiveness. In this statement of purpose, applicable references to speed, accuracy, form, and distance should be included.

Motor skills take many forms and are used for many purposes. A classification scheme is important because it permits the variety of potential movement skills to be organized into a manageable grouping. This manner of organization facilitates the recognition of commonalities across movements. It also fosters increased understanding by enabling one to focus upon either differences or similarities in movement patterns, as the situation demands. Classification of movement patterns and skills provides further clues as to the nature of both the anatomical and mechanical requirements of a particular group of skills.

A system for the classification of movements is presented on pages 6-7 of Hamilton and Luttgens' *Kinesiology, 10th ed.* To simplify the complexities of such the wide range of possibilities presented, it is important to understand that when motions are combined, bodily movements may be classified as occurring on a continuum ranging from the *simultaneous* to the *sequential* use of the body segments. The simultaneous use of the body segments, where the various segments move as one, is exemplified by motions such as pushing, pulling, or lifting objects. In a simultaneous movement pattern, all of the movement is directed along a straight line. Simultaneous use of body segments is the only way it is anatomically possible to move the hand or foot in a straight line. This straight-line application of force by the hand or foot is the most advantageous method to use when overcoming heavy or large objects or external forces such as those encountered in pushing file cabinets and lifting weights.

When it is important to have maximum speed at impact or release, a sequential use of the body segments is appropriate. The use of the segments in an orderly sequence so that subsequent segments are accelerated at the appropriate time to create the highest possible speed is critical in activities exemplified by throwing, striking

movements such as batting or the golf drive, and kicking. Sequential movements produce forces applied so that the final segment moves along a curved path. The farther this curved path is from the center of the motion, the greater will be the speed of the throwing, striking, or kicking segment.

Motions may occur anywhere along this simultaneous-sequential continuum or may combine the two basic forms.

The anatomical analysis of a movement should include an examination of the skeletal joint action, a description of segment motion, and an account of the muscle participation.

## Laboratory Report - Kinesiological Analysis

Name \_\_\_\_\_ Section \_\_\_\_\_

Date \_\_\_\_\_

1. Select three motor skills, using movements which appear to be quite different in nature.

Skills selected:

- a.
- b.
- c.

Identify the underlying mechanics objective for each of these skills using the system on page 13 in the text.

- a.
- b.
- c.

Classify each skill according to the outline for classification of motor skills (pg 6 & 7).

- a.
- b.
- c.

2. Using a simple skill of the student's choosing, prepare a qualitative description of a motor skill. Follow the outline provided:

Purpose of the motion

Simultaneous-sequential nature of the motion (give a rationale for your answer).

Provide a brief, simple description of the motion. Use language that would be appropriate for explaining this motion to a young student, not a kinesiologist.

Describe the phases which you will break this motion into. Each phase description should include a clear and concise description of the starting and ending actions which define the phase.

3. Using the skill from #2, utilize methods of observation and palpation to identify the joints and basic muscle groups involved in the motion.

Phase \_\_\_\_\_

	Joint	Muscle Groups
a.		
b.		
c.		
d.		
e.		
f.		
g.		
h.		

Phase \_\_\_\_\_

	Joint	Muscle Groups
a.		
b.		
c.		
d.		
e.		
f.		
g.		
h.		

Phase \_\_\_\_\_

Joint

Muscle Groups

- a.
- b.
- c.
- d.
- e.
- f.
- g.
- h.

## LABORATORY 2

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### Range Of Motion\*

#### Objectives (Chapter 2)

1. Name the factors that contribute to joint range of motion and stability, and explain the relationship that exists between range of motion and stability.
2. Assess a joint's range of motion, evaluate the range, and describe desirable procedures for changing it when indicated.

#### Background

The mobility of joints is dependent upon several factors. The bony structure of the joint is the primary determinant of the type of motion allowed. The range of motion refers to the actual degree to which joint motion is able to occur.

Active range of motion is that arc of excursion or the degree of motion possible through voluntary muscle action. Passive range of motion is that range of motion possible without injury or discomfort through the action of an outside force.

Some range of motion “averages”:

Joint	Flexion (degrees)	Hyperextension (degrees)
Elbow	140-145	0-10
Wrist	50-70	60-90
Hip	100-125	10-30
Knee	120-150	0
Ankle	(plantar) 20- 50	(dorsi) 15-30

#### Procedures

1. Locate the following bony landmarks and mark lightly with a pen or chalk.
  - a. greater tubercle of humerus
  - b. head of radius
  - c. styloid process of ulna
  - d. head of fifth metacarpal
  - e. greater trochanter (femur)
  - f. lateral condyle of femur
  - g. lateral malleolus
  - h. proximal end, fifth metatarsal
2. Have the subject assume the base starting position for each joint measurement as follows:
  - a. Elbow flexion - From the anatomical position, shoulder abduction to 90° with the elbow fully extended and the hand in supination.

- b. Wrist hyperextension - same as above.
  - c. Hip flexion - Lie on a firm, flat surface in a supine position. With the knees bent, fully flex *both* hips.
  - d. Hip hyperextension - Lie prone on a firm, flat surface. Keeping *both sides* of the crest of the ilium in contact with the surface and the knee fully extended, hyperextend the right hip.
  - e. Knee - Assume a supine lying position with the knee fully extended and the hip at approximately 45° - 50°. Use caution when performing passive knee hyperextension in this position.
  - f. Ankle - In a sitting position with the knee and ankle at 90°. The foot should be well clear of the floor. The goniometer axis must be below the malleolus.
3. Place the goniometer on the subject so that the fixed arm of the goniometer is along the mechanical axis of the proximal, or fixed, segment of the active joint.
- The axis or 0° mark of the goniometer should be at the joint axis for the joint to be measured. Make sure that the protractor part of the goniometer is toward the direction of motion.
- Place the moveable arm of the goniometer along the mechanical axis of the segment moved after the final range of motion position has been reached. Do not try to keep the goniometer on the moving segment during the motion.
- All measurements should be done on the same side of the body.
4. Record your results for maximum active and passive range of motion in both flexion and hyperextension of the Lab Report. Answer all discussion questions.
  5. Graph your results on graph paper.

## Lab Report - Range of Motion

Name \_\_\_\_\_ Section \_\_\_\_\_

Date \_\_\_\_\_

### Ranges of Motion in Degrees

*Flexion*

*Hyperextension*

	Active	Passive	Active	Passive
Elbow				
Wrist				
Hip				
Knee				
Ankle				

- Where did your *active* range of motion measurements fall outside the limits of those presented as average? **(Be specific as to joint name and amount of difference found.)**

#### ROM Differences (+ or -)

Joint	Flex.	Hyper.

- Speculate on specific reasons for you as an individual that might account for any for the differences you found in each joint:

3. Compare your active range of motion to your passive range of motion. In general, which of the two was greater?

How would you explain this difference?

4. What anatomical or structural factors either enhance or limit range of motion in each joint tested?

## LABORATORY 3

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### Reflexes

#### Objectives

1. Explain how the various receptors function, and describe the effect each has on musculoskeletal movement.
2. Describe reflex action, and enumerate and differentiate among the reflexes that affect musculoskeletal action.
3. Perform an analysis of the neuromuscular factors influencing the performance of a variety of motor skills.

#### Background

Reflexes are integrated at various levels of the nervous system. A reflex movement is a specific pattern of response that occurs without volition and without the need of direction from the cerebrum. The anatomical basis for a reflex act is the reflex arc. This consists of an afferent neuron that comes from a receptor organ, enters the spinal cord, and there makes a synaptic connection either directly with the dendrites and the cell body of an efferent neuron, or indirectly through one or more connector neurons. The axon of the efferent neuron extends from the cord to the muscle where its distal branches terminate in muscle fibers. The point of contact between an axon and a muscle fiber is known as a myoneural junction, or motor end-plate. The number of reflex arcs and the number of motor units involved depend both upon the nature of the reflex and upon the extent of muscular activity needed. Automatic reflex motions accompany all normal voluntary motion. Indeed, very few muscles in most movement patterns are under conscious control.

Although there is some overlap, there are two main classes of reflexes related to skeletal movements--namely, exteroceptive and proprioceptive. Many of the exteroceptor reflexes exhibited by animals and human beings are familiar to us. A horse will twitch its skin when flies alight on it; a dog will scratch when its skin is irritated by a flea, or perhaps tickled by a person. A human jumps upon hearing a sudden loud noise. A person also blinks when a foreign body strikes the eyeball, or even threatens to strike it. Three exteroceptive reflexes that may be of special interest are the extensor thrust, flexor, and crossed extensor reflexes.

Proprioceptive reflexes are generally described as those reflexes that occur in response to stimulation of receptors located in the skeletal muscles, tendons, joints, and labyrinths of the inner ear. According to this interpretation the proprioceptive reflexes are those interoceptors related to motions and positions of the body. The stretch or myotatic reflex is always included among these. Some classifications also include the extensor thrust, the labyrinth and neck, and the tendon organ reflex.

The muscle-response patterns of well-learned motor skills involve the integrated action of many reflexes and the inhibition of others. Reflexes may act to facilitate or inhibit desired actions. It is possible to use reflexes to enhance performance or to reduce injury. At times reflexes may be overridden while at other times they are completely involuntary.

#### Procedure

Work in groups of three. For each of the activities described have the required number of people in your group (usually 1) perform the activity as the others observe. Following the performance and observation, record what was seen. Make sure that you understand the activity prior to performance. The observers should choose their positions carefully with reference to the planes of motion.

## Laboratory Report - Reflexes

Name \_\_\_\_\_ Section \_\_\_\_\_

Date \_\_\_\_\_

1. Long Jump - perform 2 trials of each of these jumps in turn. Record the relative length of each jump (which jumps are longer than others).

Assign a rank order by distance:

- \_\_\_\_\_ a. Use a bobbing motion with the knees and arms.
- \_\_\_\_\_ b. Start the jump from a position of deep knee flexion, with no knee motion prior to the start of the jump.
- \_\_\_\_\_ c. Start the jump with the knees fully extended, using no knee motion.

Explain the reflex involvement primarily responsible for these results:

- a. identify the reflex
- b. describe the reflex in terms of stimulus, receptor, & response
- c. explain how the reflex applies in this experiment

2. Stand in a doorway. With the arms at the side and the elbows extended press the backs of the hands against the door frame with maximal force for 30 seconds. When the time limit has been reached, *immediately* step forward out of the doorway. Do not let the arms relax to the sides before stepping forward.

What happens? \_\_\_\_\_

Explain the reflex involvement which produced these results:

3. Repeat this experiment, but as the subject steps out of the doorway have a member of your group call out a direction, left or right. As the subject steps away from the door the head should be turned to that side as far as it will go. The eyes remain closed.

What happens?

Explain the reflex involvement which produced these results:

4. In a seated position, do a biceps curl using the heaviest weight that can be lifted.

What happens in the head and neck?

Explain the reflex involvement which produced these results:

5. Have the subject stand with the eyes closed and the feet parallel and close together. Have one partner push the subject between the shoulder blades with enough force to cause a loss of balance.

What occurs in the subjects head and neck? What do the arms and legs do?

Explain the reflex involvement which produced these results:

6. Have two partners sit facing each other across a desk. The two will arm wrestle until one partner loses. Observe the reaction of the loser's arm carefully.

What happens to the loser's arm when they lose?

Explain the proprioceptive involvement which produced these results:

7. Have the subject close their eyes. Spin the subject around 5 times, quickly. Immediately ask the subject to open the eyes and attempt to walk a straight line.

What happens?

Explain the reflex involvement which produced these results:

## LABORATORY 4

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### Analysis of the Shoulder Region

#### Objectives

1. Name and demonstrate the movements possible in the joints of the shoulder region regardless of starting position.
2. Name and locate the muscles and muscle groups of the shoulder region, and name their primary actions.
3. Analyze the fundamental movements of the arm and trunk with respect to joint and muscle actions.
4. Perform an anatomical analysis of the shoulder region in a motor skill.

#### Background

Anatomical cooperation is beautifully illustrated in the movements of the arms on the trunk. The arm travels through a wide range of movements, and in each of these the scapula cooperates by placing the glenoid fossa in the most favorable position for the head of the humerus. This is known as scapulohumeral rhythm. When the arm is elevated sideward (abducted), for instance, the scapula rotates upward; when it is elevated forward (flexed), the scapula not only rotates upward but it tends to slide partially around the rib cage (abducted). While occasionally movement of the scapula is deliberately repressed (as in some stylized dance movements, and in some posture exercises), in all natural movements, the scapula shares with the humerus in the movements of the arm on the trunk. In abduction of the arm, for instance, the movements of the scapula and humerus are continuous throughout the movement, with the humeral movement accounting for approximately two-thirds of the total movement and the scapular movement for one-third. It is important to remember, however, that this cooperative scapulohumeral rhythm is not a linear relationship. It varies with individuals and with the phase of the movement.

The upper extremity is suspended from the axial skeleton (head and trunk) by means of the shoulder girdle. The latter consists of the sternum and two clavicles in front, and two scapulae in back. The sternoclavicular joints connect the sternum and each clavicle and the acromioclavicular joints connect the acromion process of each scapula with the corresponding clavicle. Since there is no union between the two scapulae in back, this is an incomplete girdle. The upper extremity's connection with the shoulder girdle is made through the glenohumeral joint, the joint between the head of the humerus and the glenoid fossa of the scapula, better known as the shoulder joint.

The sternoclavicular joint is an exceedingly small one, about the size of the joint between the great toe and the first metatarsal bone, yet it is the sole skeletal connection between the upper extremity and the trunk. This anatomical arrangement accounts for the extensive freedom of motion enjoyed by the upper extremity and is a vital factor in the superb cooperation that exists between the shoulder joint and the shoulder girdle. The upper arm has a remarkably wide range of motion owing largely to its ball and shallow socket construction. Its movements are further amplified by the cooperative actions of the shoulder girdle, as described above.

To understand and appreciate the great variety of movements of the arm on the trunk, it is essential that one be thoroughly familiar with the structure and function of each joint involved and be able to distinguish between the contributions of each in any given movement.

## Laboratory Report - Shoulder Region

Name \_\_\_\_\_ Section \_\_\_\_\_

Date \_\_\_\_\_

Work in groups of three, with one person serving as the subject, the second as an assistant helping to support or steady the stationary part of the body and giving resistance to the moving part, and the third palpating the muscles and recording the results.

1. *Abduction of the Arm.*

Shoulder joint: abduction and possibly outward rotation; shoulder girdle: upward rotation.

*Subject:* In erect position, abduct the arm to shoulder level, keeping the forearm extended.

*Assistant:* Resist movement by exerting pressure downward on subject's elbow. See to it that subject does not elevate shoulder.

*Observer:* Palpate the three portions of the deltoid and tell which portions contract. Palpate the four parts of the trapezius.

Which parts contract?

Does the pectoralis major contract during any part of the movement? If so, which portion and when in the motion?

2. *Adduction of the Arm*

Shoulder joint: adduction and possibly reduction of outward rotation; shoulder girdle: downward rotation.

*Subject:* In erect position with arm abducted to shoulder level, lower arm until 45 degrees from side.

*Assistant:* Place hand under subject's elbow and resist movement. (If no resistance is given, the muscle action will be the same as in abduction, except that the contraction will be eccentric instead of concentric.)

*Observer:* Palpate the latissimus dorsi, teres major, pectoralis major, and posterior deltoid.

Do each of the four muscles contract?

If so, during which part of the movement does each contraction occur?

3. *Flexion of the Arm*

Shoulder joint: flexion; shoulder girdle: upward rotation and probably abduction.

*Subject:* In erect position, flex arm to shoulder level, keeping elbow extended.

*Assistant:* Resist movement by exerting pressure downward on the subject's elbow. See that subject does not elevate shoulder.

*Observer:* Palpate the anterior deltoid and the pectoralis major.

Do both the sternal and clavicular portions of the latter muscle contract?

Was this what you expected? \_\_\_\_\_ Why or Why not?

4. *Extension of the Arm*

Shoulder joint: extension; shoulder girdle: downward rotation and probably adduction.

*Subject:* In erect position with arm flexed to shoulder level, lower it until 45 degrees from side.

*Assistant:* Resist movement at underside of elbow.

*Observer:* Palpate the latissimus dorsi and the pectoralis major.

Do these two muscles contract with equal force throughout the movement? Explain your answer.

5. *Horizontal adduction of the Arm*

Shoulder joint: horizontal adduction and slight inward rotation; shoulder girdle: abduction and lateral tilt.

a. *Subject:* In erect position with arm abducted to shoulder level, palm down, horizontally adduct the arms.

*Assistant:* Stand behind subject's arm and resist movement by holding elbow.

Observer: Palpate pectoralis major and anterior deltoid.

How do the actions of these muscles compare to the findings when performing shoulder flexion?

6. *Adduction of Shoulder Girdle*

*Subject:* In erect position with arms abducted, elbows flexed, and fingers resting on shoulders, push elbows backward (horizontally extend at the shoulder joint) keeping the elbows at shoulder level.

*Assistant:* Stand facing subject and resist movement by pulling elbows forward (horizontally flex at the shoulder joints).

*Observer:* Palpate middle and lower trapezius (Parts III and IV).

Explain the actions of the trapezius?

What other muscles contribute to scapular adduction?

7. *Abduction of Shoulder Girdle*

*Subject:* In erect position with arm abducted, elbows flexed, and fingers resting on shoulders, horizontally flex at the shoulder joints, attempting to touch the elbows in front of chest.

*Assistant:* Stand behind subject and resist movement by pulling elbows back (horizontally extend at the shoulder joint).

*Observer:* Palpate serratus anterior.

Explain the action of this muscle.

## **Scapulohumeral Rhythm**

Using the following procedures determine the range of motion in the shoulder for the movements listed, first with the scapula fixed and then with the scapula unrestricted.

For a fixed scapula place one hand across the shoulder of the subject in such a way that the little finger is in contact with both the acromion process and the heel of the hand is on the scapular spine. Allow no scapular motion. When the scapula does begin to move instruct the subject to stop shoulder joint motion and hold the position for measurement.

For the free scapula apply no restriction.

To measure the range of motion for shoulder flexion and hyperextension place the axis of the goniometer over the greater tubercle of the humerus on the lateral aspect of the shoulder joint. Hold the fixed arm of the goniometer in a position parallel to the midline of the trunk. The free arm of the goniometer should be aligned with the lateral epicondyle of the humerus for measurement.

To measure shoulder abduction place the axis of the goniometer at a point which approximates joint center on the posterior aspect of the shoulder. Hold the fixed arm of the goniometer in a position parallel to the midline of the trunk. The free arm of the goniometer should be aligned with the lateral epicondyle of the humerus for measurement.

8. Shoulder Motion ROM: Record the total degrees of motion measured under each condition:

	<i>Fixed Scapula</i>	<i>Free Scapula</i>
Flexion	_____	_____
Hyperextension	_____	_____
Abduction	_____	_____

How much difference is there between the two conditions for flexion ? \_\_\_\_\_ hyperextension? \_\_\_\_\_  
abduction? \_\_\_\_\_

Explain why (anatomically) such differences exist.

9. For each of the following actions determine what the motion will be in the shoulder girdle and the shoulder joint during the *power* phase of the motion:

<i>Motion</i>	<i>Shoulder Girdle</i>	<i>Shoulder Joint</i>
Rowing stroke	_____	_____
Military press	_____ _____	_____
Push-up	_____ _____	_____
Volleyball serve	_____ _____	_____

## LABORATORY 5

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### Analysis Of The Elbow, Wrist And Hand

#### Objectives

1. Name and demonstrate the movements possible in the joints of the elbow, forearm, wrist, and hand regardless of the starting position.
2. Name and locate the muscles and muscle groups of the elbow, forearm, wrist, and hand, and name their primary actions as agonists, stabilizers, neutralizers, or antagonists.
3. Analyze the fundamental movements of the forearm, hand, and fingers with respect to joint and muscle actions.
4. Perform an anatomical analysis of the elbow, forearm, wrist, and hand in a motor skill.

#### Background

In much the same way that the shoulder girdle's cooperation with the shoulder joint contributes to the wide range of motion available to the hand, the cooperative movements of the elbow, radioulnar, and wrist joints contribute to the versatility and precision of its movements. Although the hand is intrinsically skillful, its usefulness is greatly impaired when anything interferes with the motions of the forearm or wrist. Injury to any one of the joints involved makes this painfully obvious to the sufferer.

The elbow is far more complex than the simple hinge joint that it appears to be. The two bones of the forearm attach to the humerus in totally different ways. The humeroulnar joint is indeed a true hinge joint, but the humeroradial joint is far from it. It has been classified as an arthrodial or gliding type of joint, but it is more accurately described as a restricted ball-and-socket joint. The distal end of the humerus presents a spool-like process (trochlea) on the medial side and a spherical knob (capitulum) on the lateral side. The ulna articulates with the humerus by means of a semicircular structure that is cupped around the back and underside of the trochlea. The inner surface of this is known as the semilunar notch. It terminates below and in front in the small coronoid process, and above and in back in the broad olecranon process.

The radius articulates with the humerus by means of a slightly concave, saucerlike disk, which is directly beneath the capitulum when the arm is hanging straight down. In spite of the joint's ball-and-socket structure the radius is unable to abduct or adduct because of the annular ligament that encircles the radial head and binds it to the radial notch of the ulna. Furthermore, because of this and other ligamentous connections with the ulna, the radius is unable to rotate independently. Hence, the only movements it is free to engage in at the elbow are flexion and extension. For this reason, one is justified in classifying the elbow joint as a hinge joint.

The hand and wrist owe their mobility to their generous supply of joints. The most proximal of these is the radiocarpal or wrist joint. Just beyond this are the two rows of carpal bones, each row consisting of four bones. The carpal joints include the articulations within each of these rows, as well as the articulations between the two rows. The carpometacarpal joints are located at the base of the hand. Closely associated with them are the intermetacarpal joints, those points of contact between the bases of the metacarpal bones of the four fingers. The fingers unite with the hand at the metacarpophalangeal joints. Within the fingers themselves there are two sets of interphalangeal joints, the first between the proximal and middle rows of phalanges and the second between the middle and distal rows. The thumb differs from the four fingers in having a more freely movable metacarpal bone and in having only two phalanges instead of three. The metacarpal bone of the thumb is so similar to a phalanx that it might well be described as a cross between a phalanx and a metacarpal. The wrist joint is capable of producing flexion and

extension as well as ulnar and radial flexion. The fingers flex, extend, abduct, and adduct. In addition, the thumb is capable of opposition in relation to each of the fingers.

In this laboratory experience the students will examine each of the possible motions of the elbow, wrist and hand, being made particularly aware of the muscular involvement in each of these motions. In addition, the student will analyze motions as they relate to applied situations.

## Lab Report - Elbow, Wrist And Hand

Name \_\_\_\_\_ Section \_\_\_\_\_

Date \_\_\_\_\_

Work in groups of three, with one person serving as the subject, the second as an assistant helping to support or steady the stationary part of the body and giving resistance to the moving part, and the third palpating the muscles and recording the results.

### 1. *Elbow Flexion*

*Subject:* Sit with the entire arm resting on a table. Flex the forearm in each of the following positions:

- a. with palm up (forearm supinated)
- b. with thumb up (forearm in neutral position)
- c. with palm down (forearm pronated)

*Assistant:* Resist the movement by holding the wrist. Steady the upper arm if necessary.

*Observer:* Palpate as many of the forearm flexors as possible.

What differences do you notice between the muscular actions in a, b, and c?

How do explain these differences?

### 2. *Elbow Extension*

a *Subject:* Lie face down on a table with one arm raised to shoulder level with the upper arm resting on the table, the forearm hanging down. Extend the forearm without moving the upper arm.

*Assistant:* Steady the upper arm and resist the forearm at the wrist.

*Observer:* Palpate the triceps and anconeus.

b. *Subject:* On hands and knees, flex and extend the arms at the elbows in a push-up exercise.

*Observer:* Palpate the triceps.

Explain the muscular actions of this muscle.

### 3. *Forearm Supination*

*Subject:* Assume a handshaking position with the assistant and supinate the forearm.

*Assistant:* Assume the same position with the subject and resist the movement.

*Observer:* Palpate the muscles which contract.

Identify these muscles and explain their action.

4. *Forearm Pronation*

*Subject:* Assume a handshaking position with the assistant and pronate the forearm.

*Assistant:* Assume the same position with the subject and resist the movement.

*Observer:* Palpate and identify the muscles which contract.

What is their function?

Can you palpate the principal movers? Why or why not?

5. *Analysis*

Working with a partner execute a knee push-up, i.e., a push-up from the front lying position, onto the knees instead of the toes, until the elbows are fully extended. Keep the body straight from the knees to the top of the head. Return to the starting position slowly and in good form.

a. Analyze the joint and muscular action of the elbows in the pushup.

b. Do the same for the return movement.

What force is responsible for the movement in a?

What force is responsible for the movement in b?

What is the chief difference in the *type* of muscular action used in the pushup and in the letdown (return movement)?

*Wrist and Hand: Joint Structure and Function*

6. With a protractor or goniometer measure the amount of hyperextension possible at the wrist:

a. with the fingers flexed,

b. with fingers extended.

In which case was the greatest hyperextension possible?

Explain these results.

Now measure the amount of flexion possible at the wrist:

- a. with the fingers flexed,
- b. with fingers extended.

In which case was the greatest flexion possible?

Explain these results.

7. *Flexion at Wrist*

*Subject:* Sit with forearm resting on a table with palm up. Flex hand at wrist.

*Assistant:* Resist movement by holding palm.

*Observer:* Palpate and identify the action of as many muscles as possible.

Explain the actions of these muscles.

8. *Extension and Hyperextension at Wrist*

*Subject:* Sit with forearm resting on a table with palm down. Extend hand at wrist.

*Assistant:* Resist movement by holding back of hand.

*Observer:* Palpate and identify the action of as many muscles as possible.

Explain the actions of these muscles

9. *Radial Flexion at Wrist*

*Subject:* Sit with forearm resting on a table, ulnar side (little finger side of hand) down. Keeping thumb against hand, raise hand from table without moving forearm.

*Assistant:* May give slight resistance to hand.

*Observer:* Palpate and identify the muscles responsible for radial flexion.

Explain the actions of these muscles

10. *Ulnar Flexion at Wrist*  
*Subject:* Lie face down or bend forward in such a way that radial side of hand (thumb side) is on supporting surface, with forearm supported and wrist neither flexed nor hyperextended. Keeping little finger against hand, raise hand without moving forearm.  
*Assistant:* May give slight resistance to hand.  
*Observer:* Palpate and identify the muscles responsible for ulnar flexion.

Explain the actions of these muscles

11. *Finger Flexion*  
*Subject:* Sit with forearm resting on a table with palm up. Flex fingers without flexing wrist.  
*Assistant:* Resist movement by hooking own fingers over those of subject.  
*Observer:* Palpate and identify the action of as many muscles as possible.

Explain the actions of these muscles.

12. *Finger Extension*  
*Subject:* Sit with forearm resting on a table with palm down, fingers curled over edge of table. Extend fingers.  
*Assistant:* Resist movement by holding hand over subject's fingers.  
*Observer:* Palpate and identify the action of as many muscles as possible.

Explain the actions of these muscles.

13. *Abduction of Thumb*  
*Subject:* Place the hand on a table with the palm up and the thumb slightly separated from the index finger. Abduct the thumb at the carpometacarpal joint by raising it vertically upward.  
*Assistant:* Give slight resistance to the thumb at the proximal phalanx.  
*Observer:* Palpate the abductor pollicis brevis in the thenar eminence.

Explain the action of this muscles.

14. *Hyperflexion of Thumb in Position of Slight Abduction*  
*Subject:* Place the hand on a table with the palm up and the thumb slightly raised from the table. Hyperflex the thumb at the carpometacarpal joint.  
*Assistant:* Give slight resistance to the proximal phalanx of the thumb.  
*Observer:* Palpate the flexor pollicis brevis in the thenar eminence.

Explain the action of this muscles.

15. *Extension of Thumb*  
*Subject:* Rest the fully extended hand on its ulnar border with the thumb uppermost. Extend the thumb as far as possible.  
*Observer:* Identify the tendons of the abductor pollicis longus, extensor pollicis longus, and extensor pollicis brevis.

Explain the actions of these muscles.

16. *Opposition of Thumb*  
*Subject:* Press the thumb hard against the tip of the middle finger.  
*Observer:* Palpate and identify the opponens pollicis and adductor pollicis.

Explain the actions of these muscles.

#### *Hands: Application*

17. Demonstrate the various styles of grasping objects and analyze a few of these.

Identify the joint position of the wrist, fingers, and thumb in each grasp.

Determine the chief muscular involvement.

## LABORATORY 6

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### Analysis of the Pelvic Girdle and Hip

#### Objectives

1. Name and demonstrate the movements possible in the pelvic girdle and hip joint, regardless of starting position.
2. Name and locate the muscles and muscle groups of the pelvis and hip, and name their primary actions.
3. Analyze the fundamental movements of the pelvis and thigh with respect to joint and muscle actions.
4. Perform an anatomical analysis of the hip region in a motor skill.

#### Background

The relationship between the pelvic girdle and hip is somewhat similar to that between the shoulder girdle and shoulder joint. Just as the scapula tilts or rotates to put the glenoid fossa in a favorable position for the movements of the humerus, so does the pelvic girdle tilt and rotate to put the acetabulum in a favorable position for the movements of the femur. There are these differences, however. Whereas the left and right sides of the shoulder girdle can move independently, the pelvic girdle can move only as a unit. The difference in depth of socket also limits the movement at the hip joint but is vital to accommodate the weight-bearing function of this joint. Furthermore, whereas the movements of the shoulder girdle take place in its own joints (sternoclavicular and acromioclavicular), the pelvic girdle is dependent for its movements upon the lumbosacral and other lumbar joints, and the hip joints. Hence, an analysis of the movements of the pelvic girdle must always be stated in terms of spinal and hip action.

The hip joint, a typical ball-and-socket joint, is formed by the articulation of the spherical head of the femur with the deep cup-shaped acetabulum. The latter, formed by the junction of the three pelvic bones (ilium, ischium, and pubis), is also described as horseshoe-shaped since there is a gap (the acetabular notch) at the lower part of the "cup."

The movements of the femur are similar to those of the humerus but are not quite so free as the latter because of the deeper socket. In studying the movements of the femur, the student should first be aware of the position of the femur in the fundamental standing position. If viewed from the front, it is seen that the shaft is not vertical but slants somewhat medialward. This serves to place the center of the knee joint more nearly under the center of motion of the hip joint. Hence, the mechanical axis of the femur--a line connecting the center of the femoral head with the center of the knee joint--is almost vertical (Figure 2.2). The degree of slant of the femoral shaft is related both to the size of the angle between the neck and shaft (angle of inclination) and the width of the pelvis. The angle of inclination decreases with age and the inner spongy or trabecular bone becomes thinner, which makes the femur more susceptible to fracture.

As seen from the side, the shaft bows forward. This characteristic, along with the obtuse neck-shaft angle, provides resistance for the strains and stresses sustained in walking, running, and jumping, and for assuring the proper transmission of weight through the femur to the knee joint. The femur is the longest yet strongest bone of the skeletal system.

## Laboratory Report - Hip and Pelvic Girdle

Name \_\_\_\_\_ Section \_\_\_\_\_

Date \_\_\_\_\_

Work in groups of three, with one person serving as the subject, the second as an assistant helping to support or steady the stationary part of the body and giving resistance to the moving part, and the third palpating the muscles and recording the results.

### 1. *Hip Flexion*

*Subject:* Sit on a table with legs hanging over edge. Flex the thigh at the hip joint.

*Assistant:* Resist movement slightly by pressing down on knee.

*Observer:* Palpate pectineus, tensor fasciae latae, sartorius, rectus femoris, and adductor longus.

Explain the actions of these muscles.

Does the gracilis contract? Speculate on the reasons for this.

### 2. *Hip Extension*

a. *Subject:* Stand facing table with trunk flexed forward until it rests on table. Grasp sides of table. Extend at one thigh by raising one leg, keeping the knee extended.

*Assistant:* Resist movement by pushing down on thigh close to knee. Second time, give resistance at heel.

*Observer:* Palpate gluteus maximus, adductor magnus, and hamstrings.

Explain the differences in the actions of these muscles between the first and second trials.

b. *Subject:* Lie facedown on table and extend lower extremity at the hip joint keeping the knee extended.

*Assistant:* Resist movement by pushing down on knee.

*Observer:* Palpate same muscles as in a.

Were there any differences in the contractions between a and b? Speculate on the anatomical reason for any differences you felt.

3. *Hip Abduction*

*Subject:* Lie on one side and abduct the top lower extremity at the hip joint.

*Assistant:* Resist movement by pushing down on knee.

*Observer:* Palpate gluteus maximus, gluteus medius, and tensor fasciae latae.

Explain the actions of these muscles.

4. *Hip Adduction*

*Subject:* Lie on one side with the top lower extremity abducted; then adduct it.

*Assistant:* Resist movement by pressing up against knee.

*Note:* Unless resistance is applied, the action will be performed by means of the eccentric contraction of the abductors.

*Observer:* Palpate three adductors.

Name the adductors.

Explain the actions of these muscles.

5. *Outward Rotation of Thigh*

*Subject:* Stand on one foot with the other leg flexed at the knee so that the lower leg extends horizontally backward. Rotate the free thigh outward by swinging the foot medially.

*Assistant:* Steady subject's knee and resist movement of leg at ankle.

*Observer:* Palpate gluteus maximus.

Explain the actions of this muscle.

Is this muscle the primary agonist in this joint action? Explain your answer and provide the names of any other muscles which are likely to be more active.

6. *Inward Rotation of Thigh*

*Subject:* Stand on one foot with other leg flexed at the knee so that the lower leg extends horizontally backward. Rotate the free thigh inward by swinging the foot laterally.

*Assistant:* Steady subject's knee and resist movement of leg at ankle.

*Observer:* Palpate gluteus medius, tensor fasciae latae, and lower adductor magnus.

Explain the actions of these muscles.

Are these muscles the only prime movers in this joint action? Explain your answer and provide the names of any other muscles which are likely to be active.

*Hip and Pelvic Girdle Cooperation in Hip Abduction*

7. Have the subject lie in a supine position. Place the axis of the goniometer at joint center, where the groin fold occurs. Place the fixed arm parallel to a line drawn between the two anterior superior iliac spines. The free arm of the goniometer is placed parallel to the long axis of the femur. Place a hand on each iliac crest, remembering not to interfere with the goniometer. As the subject begins abduction try to feel any motion of the pelvis. At the point when pelvic motion does occur instruct the subject to stop hip joint motion and hold that position for measurement. Repeat the action without restriction in the pelvic movements. Record the total degrees of motion measured.

Fixed Pelvis

Free Pelvis

\_\_\_\_\_

\_\_\_\_\_

Is there any difference between the two conditions? \_\_\_\_\_ How much? \_\_\_\_\_

Explain why such a difference exists.

8. For each of the following actions determine what the motion of the indicated girdle and extremity will be during the *power* phase of the motion:

<i>Motion</i>	<i>Pelvic Girdle</i>	<i>Right Hip</i>	<i>Left Hip</i>
Baseball swing	_____	_____ _____ _____	_____ _____ _____
Sprint run	_____ _____	_____ _____ _____	_____ _____ _____
Vertical jump	_____	_____	_____
Football punt	_____ _____	_____ _____	_____ _____

Remember that both the hip joint and the pelvic girdle are capable of motion in all three planes.

## LABORATORY 7

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### Analysis of the Knee and Ankle

#### Objectives

1. Name and demonstrate the movements possible in the joints of the knee and ankle regardless of starting position.
2. Name and locate the muscles and muscle groups of the knee and ankle and name their primary actions.
3. Analyze the fundamental movements of the lower leg and foot with respect to joint and muscle actions.
4. Perform an anatomical analysis of the lower extremity in a motor skill.

#### Background

The knee joint is the largest and most complex joint in the human body. It is a masterpiece of anatomical engineering. Placed midway down each supporting column of the body, it is subject to severe stresses and strains in its combined functions of weight bearing and locomotion. To take care of the weight-bearing stresses, it has massive condyles; to facilitate locomotion it has a wide range of motion; to resist the lateral stresses due to the tremendous lever effect of the long femur and tibia, it is reinforced at the sides by strong ligaments; to combat the downward pull of gravity and to meet the demands of such violent locomotor activities as running and jumping, it is provided with powerful musculature. It would be difficult, indeed, to find a mechanism better adapted for meeting the combined requirements of stability and mobility than the knee joint.

The movements that occur at the knee joint are primarily flexion and extension. A slight amount of rotation can take place when the knee is in the flexed position and the foot is not supporting the weight or during the initial stages of flexion and the final stages of extension.

The ankle joint acts to unite the foot with the leg. The movements of the ankle joint occur about an axis that is usually described as frontal-horizontal but is actually slightly oblique, as evidenced by the slightly posterior position of the lateral malleolus relative to the medial. This is of minor significance, but it explains the tendency of the foot to turn out when it is fully dorsiflexed and to turn in when fully plantar-flexed.

## Laboratory Report - Knee and Ankle

Name \_\_\_\_\_ Section \_\_\_\_\_

Date \_\_\_\_\_

Work in groups of three, with one person serving as the subject, the second as an assistant helping to support or steady the stationary part of the body and giving resistance to the moving part, and the third palpating the muscles and recording the results.

### Knee

1. *Flexion at Knee*

*Subject:* Lie facedown and flex leg at knee by raising foot.

*Assistant:* Steady subject's thigh and resist movement by pushing down on ankle.

*Observer:* Palpate biceps femoris, semitendinosus, gracilis, sartorius, and gastrocnemius.

Explain the action of these muscles.

2. *Extension at Knee*

a. *Subject:* Rise from a squat position.

*Observer:* Palpate quadriceps femoris.

b. *Subject:* Sit on table with legs hanging over edge. Extend leg.

*Assistant:* Steady subject's thigh and resist movement by holding ankle down.

*Observer:* Palpate quadriceps femoris.

Compare the action of this muscle under these two conditions.

### Ankle and Foot

3. *Plantar Flexion*

*Subject:* Perform each of the following actions:

a. Stand and rise on the toes.

b. Hold one foot off the floor and extend it vigorously.

Compare the muscular action of the leg in a and b.

4. *Dorsiflexion*  
*Subject:* Sit on a table with the legs straight and with the feet over the edge. Dorsiflex one foot as far as possible.  
*Assistant:* Resist the movement by holding the foot.

Identify the tibialis anterior, peroneus tertius, extensor digitorum longus, and extensor hallucis longus.

Explain the action of these muscles.

5. *Pronation (Eversion and Abduction)*  
*Subject:* In same starting position as in number 10, pronate one foot without extending it.  
*Assistant:* Steady the leg at the ankle and resist the movement by holding one foot.

Identify the muscles that contract.

Explain the action of these muscles.

6. *Supination (Inversion and Adduction)*  
*Subject:* In same position as above, supinate one foot as far as possible.  
*Assistant:* Steady the leg at the ankle and resist the movement by holding the foot.

Identify the muscles that contract.

Explain the action of these muscles.

## **Kinesiological Analysis**

7. Choose a simple motor skill.. Do a complete anatomical analysis of the lower extremity following the analysis outline from Chapter 1 of Hamilton and Luttgens *Kinesiology* (10th ed.).

## LABORATORY 8

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### Analysis of the Spine

#### Objectives

1. Name, locate, and describe the structures and the articulations of the spinal column and thorax.
2. Name and demonstrate the movements possible in joints of the spinal column and thorax, regardless of starting position.
3. Name and locate the muscles and muscle groups of the spinal column and thorax and name their primary actions.
4. Analyze the fundamental movements of the spinal column and thorax with respect to joint and muscle actions.
5. Perform an anatomical analysis of the movements of the spinal column in a motor skill.

#### Background

If you were faced with the problem of devising a single mechanism that would simultaneously (1) give stability to a collapsible cylinder, (2) permit movement in all directions and yet always return to the fundamental starting position, (3) support three structures of considerable weight (a globe, a yoke, and a cage), (4) provide attachment for numerous flexible bands and elastic cords, (5) transmit a gradually increasing weight to a rigid basinlike foundation, (6) act as a shock absorber for cushioning jolts and jars, and (7) encase and protect a cord of extreme delicacy, you would be staggered by the immensity of the task. Yet the spinal column fulfills all these requirements with amazing efficiency. It is at the same time an organ of stability and mobility, of support and protection, and of resistance and adaptation. It is an instrument of great precision, yet of robust structure. Its architecture and the manner in which it performs its many functions are worthy of careful study. From the kinesiological point of view, we are interested in the spine chiefly as a mechanism for maintaining erect posture and for permitting movement of the head, neck, and trunk.

In order to understand these functions of the spine, it is necessary to have a clear picture, first of the spinal column as a whole and second of the distinguishing characteristics of the different regions. The spinal column, consisting of seven cervical, twelve thoracic, and five lumbar vertebrae, the sacrum (five fused sacral vertebrae), and the coccyx (three to five fused vertebrae), presents four curves as seen from the side. At birth, the vertebral column is convex backward. The thoracic and sacrococcygeal curves remain convex to the rear and are considered primary curves. The cervical and lumbar curves reverse direction of the curvature during infancy and early childhood and are referred to as secondary curves. The curvature at the cervical region develops when the infant raises its head; the lumbar region develops its anterior convexity when the infant assumes an upright posture and begins to walk. The curves are a response to gravity and continue to develop through puberty.

From the first cervical to the fifth lumbar vertebra, the vertebral bodies become increasingly larger. This is an important factor in fulfilling the weight-bearing role of the spine. The vertebral bodies decrease in size from the first sacral through the coccygeal region. The sacral vertebrae complete the pelvic girdle, which transmits the weight of the head and trunk onto both femoral heads.

There are two sets of interspinal articulations, those between the vertebral *bodies* and those between the vertebral *arches*. The latter are in pairs, with one on either side of each vertebra. The articulations of the first two vertebrae are atypical and will be described separately.

There is such a close relationship between the structure of the spinal column and the movements that take place in its different regions that the student will find it well worth the effort to acquire a thorough grasp of the structure, particularly of the joints, before proceeding to the movements. If possible, both a skeleton and a strung set of vertebrae should be referred to frequently while studying spinal structure.

The articulations of the vertebral bodies are classified as synchondroses or cartilaginous joints. The bodies of the vertebrae are united by means of fibrocartilages, otherwise known as intervertebral discs. These correspond to the surfaces of the adjacent vertebral bodies, except in the cervical region, where they are smaller from side to side. They adhere to the hyaline cartilage both above and below, with no articular cavity in this type of joint. In thickness they are fairly uniform in the thoracic region, but in the cervical and lumbar regions they are thicker in front than in back. Altogether, they constitute one-fourth of the length of the spinal column. Each disc consists of two parts, an outer fibrous rim and an inner pulpy nucleus known as the nucleus pulposus. This is a ball of firmly compressed elastic material, a little like the center of a golf ball. It constitutes a center of motion and permits compression in any direction, as well as torsion. The intervertebral discs are also important as shock absorbers, resisting compressive forces.

The articulations between the facets of the vertebral arches are nonaxial diarthrodial joints. Each of these joints has an articular cavity and is enclosed within a capsule. A slight amount of gliding motion is permitted. The resultant movement of each vertebra is determined largely by the direction in which the articular facets face. The cervical spine appears to be somewhat of an exception, however. The facets in this region slant at about a 45-degree angle, lying halfway between the horizontal and the frontal planes. Such a slant would seem to favor rotation and lateral flexion and to be unfavorable to flexion and hyperextension. Yet these latter movements occur as freely as does lateral flexion, whereas rotation from the second cervical vertebra down can be rated as only moderate. In the thoracic region they lie slightly more in the frontal and less in the horizontal plane than do the cervical articulations, and they have a slight inward and outward slant. The upper facets face backward, slightly upward, and lateralward; the lower facets face forward, slightly downward, and medialward. They are adapted equally well to rotation and to lateral bending. In the lumbar region, except at the lumbosacral articulation, the articular facets lie more nearly in the sagittal plane. The upper facets face inward and slightly backward; the lower facets face outward and slightly forward. Furthermore, the upper facets present slightly concave surfaces and the lower facets convex. By this arrangement of the facets, the lumbar vertebrae are virtually locked against rotation. The slight amount of rotation that does occur is made possible by the looseness of the capsules. At the lumbosacral articulation the facets lie somewhat more in the frontal plane than is true of the other lumbar joints.

# Laboratory Report - Analysis of the Spine

Name \_\_\_\_\_ Section \_\_\_\_\_

Date \_\_\_\_\_

## Joint Structure

1. Study the bones of the spinal column. Classify the structure for each of the following joints, including the articulations of both the bodies and the arches. Explain how the structure of each joint affects its function.

- a. Atlanto-occipital

Structure

Function

- b. Atlantoaxial

Structure

Function

- c. A middle cervical joint

Structure

Function

- d. The joint between the seventh cervical and the first thoracic vertebra

Structure

Function

e. A middle thoracic joint

Structure

Function

f. The joint between the twelfth thoracic and the first lumbar vertebra

Structure

Function

g. A middle lumbar joint

Structure

Function

h. The lumbosacral joint

Structure

Function

## **Joint Action**

2. Have a subject sit cross-legged on a table and flex the spine as completely as possible. Observe the shape of the spine as seen from the side.

Compare the three regions of the spine as to forward flexibility.

3. Have a subject sit astride a bench with the hands at the neck, then rotate the trunk as far as possible, first to one side, then to the other.

Compare the regions of the spine as to rotating ability.

4. Observe flexion, hyperextension, lateral flexion, and rotation of the spine in several subjects, preferably subjects representing different body builds.

Note individual differences.

Explain differences you have found.

5. Have a subject lie face down on a table with the legs and pelvis supported on the table, the trunk extending forward beyond the table, and the hands clasped behind the neck.
  - a. Have the subject flex the spine laterally.

Compare the thoracic and lumbar regions. Note the torsion accompanying the lateral flexion.

- b. Have the subject flex the spine and then flex it laterally.

Compare the thoracic and lumbar regions as in a. What differences did you note in this trial?

- c. Have the subject hyperextend the spine (with someone helping to support the elbows) and then flex laterally.

Compare the thoracic and lumbar regions as in a & b. What differences did you note in this trial?

d. Have the subject rotate the trunk to one side as far as possible.

Compare the thoracic and lumbar regions.

Is any lateral flexion apparent in the spine?

Explain this result.

e. Have the subject flex the spine and then rotate it.

Compare the thoracic and lumbar regions as in d. What differences did you note in this trial?

f. Have the subject hyperextend the spine and then rotate it.

Compare the thoracic and lumbar regions as in d & e. What differences did you note in this trial?

## **Muscular Action**

### 6. *Flexion of the Neck*

- a. *Subject:* Lie on the back and lift the head, bringing the chin toward the chest.  
*Observer:* Palpate and identify as many of the contracting muscles as possible.
- b. *Subject:* Lie on the back and lift the head, leading with the chin.  
*Observer:* Palpate and identify as many of the contracting muscles as possible.

Compare the action of the sternocleidomastoid in b with its action in a.

7. *Extension and Hyperextension of the Neck*
- a. *Subject:* Lie face down on a table with the head over the edge. Raise the head as far as possible, hyperextending both the head and the neck.  
*Assistant:* May resist the movement if stronger muscular action is desired.  
*Observer:* Palpate and identify as many of the contracting muscles as possible.
  - b. *Subject:* Lie face down on a table with the head over the edge. Raise the head as far as possible with the chin tucked in.  
*Assistant:* Resist the retraction of the chin.  
*Observer:* Palpate and identify as many of the contracting muscles as possible.

Compare the muscular action in b with that in a.

8. *Lateral Flexion of the Head and Neck*
- Subject:* Lie on one side and raise the head toward the shoulder without turning the head or tensing the shoulder.  
*Assistant:* Give slight resistance at the temple.  
*Observer:* Palpate and identify as many muscles as possible.

Explain the actions of these muscles.

9. *Rotation of the Head and Neck*
- Subject:* Sit erect and rotate the head to the left as far as possible.  
*Assistant:* Give fairly strong resistance to the side of the jaw.  
*Observer:* Palpate the sternocleidomastoids.

Which one contracts?

Explain the action of this muscle.

10. *Flexion of the Thoracic and Lumbar Spine*
- Subject:* Lie on the back with the arms folded across the chest. Flex the head, shoulders and upper back from the table, keeping the chin in. There is no need to come to a sitting position, since this is intended as a movement of spinal, not hip, flexion.  
*Assistant:* Hold the thighs down.  
*Observer:* Palpate the rectus abdominis and the external oblique abdominal muscle.

Explain the actions of these muscles.

11. *Extension and Hyperextension of the Thoracic and Lumbar Spine*  
*Subject:* Lie face down with the hands on the hips. Hyperextend the head and trunk as far as possible.  
*Assistant:* Hold the feet down.  
*Observer:* Palpate the erector spinae and the gluteus maximus.

What is the function of the latter muscle in this movement?

12. *Lateral Flexion of the Thoracic and Lumbar Spine*  
*Subject:* Lie on one side with the under arm placed across the chest and the hand resting on the opposite shoulder, and with the hand of the top arm resting on the hip. Laterally flex the trunk.  
*Assistant:* Hold the legs down. If necessary, help the subject by pulling at the elbow.  
*Observer:* Palpate the rectus abdominis, external oblique abdominal muscle, erector spinae, and latissimus dorsi.

Explain the actions of these muscles.

13. *Rotation of the Thoracic and Lumbar Spine*  
*Subject:* Sit astride a bench with the hands placed behind the neck. Rotate to one side as far as possible without leaving the bench.  
*Assistant:* Resist the movement by grasping the subject's arms close to his shoulders and pushing (or pulling) in the opposite direction.  
*Observer:* Palpate as many of the spinal and abdominal muscles as possible. Disregard the muscles of the scapula and arm.

Identify the active muscles.

Explain the actions of these muscles.

15. *Sit-up*  
*Subject:* Lie on the back and come to a sitting position, keeping the spine as rigid as possible.  
*Assistant:* Hold the feet down.  
*Observer:* Palpate the abdominal muscles, erector spinae, and sternocleidomastoid.

Explain the function of each of these muscles in the sit-up.

16. *Trunk Flexion*  
*Subject:* Stand with the feet slightly separated. Flex forward from the hips, keeping the back flat.  
*Observer:* Palpate the erector spinae.

Explain the function of the erector spinae in this motion.

## LABORATORY 9

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### Anatomical Analysis

#### Objectives

1. Perform a complete anatomical analysis of a simple motor skill.

#### Background

In order to produce a meaningful analysis of movement it is necessary to use an organized system for analysis. The seven part analysis model developed in lecture is such a model. To further clarify analysis it is usually beneficial to break a motion down into phases. Some commonly used motion phases are preparation, execution, and recovery.

In this analysis model, the student will identify the joint, joint motion, the segment being moved by that motion, the appropriate plane and axis in which the motion occurs, the nature of the force which produces the motion, the muscle contraction type being utilized, and the muscles which act as prime movers.

Generally speaking, the segment being moved will be determined by the condition of the distal end of the extremity involved. If the distal end of that extremity is fixed (immobilized), the segment moved through motion at a joint will be the segment proximal in relation to that joint. If the distal end of the extremity is free, the segment moved will be that which is the distal segment in relation to the joint.

It is usually useful to identify the force which produces a motion before attempting to identify the prime movers or contraction type. Again, speaking generally, if the motion is horizontal or in an upward direction (and no outside force is present), muscle force is producing the motion. In this case, the muscle contraction type would be concentric. The prime movers would be those listed in Chapters 5-9 of Hamilton & Luttgens *Kinesiology*, 10th ed., for the observed joint motion. If the motion is in a downward direction, slower than what would be produced by a simple fall, gravity is the force. In this case, the contraction type would be eccentric, as the muscles are controlling the speed of the movement. The prime movers would be those listed in Chapters 5-9 as the prime movers for the motion opposite the observed motion.

#### Procedures

In this lab you will be doing an analysis of a jumping motion. You will be assigned either a standing long jump or a standing vertical jump for analysis.

Work in groups of three to four people. Have one member of your group act as a subject. The subject will perform the required motion as needed.

Working from the ankle (point of force production) to the shoulder produce a complete anatomical analysis for the two jump phases assigned to your group. Record your analysis on the form provided.

The joints which should be included in your analysis are the ankle, knee, hip, shoulder, elbow, and trunk (vertebral column). There is motion which takes place distal to the ankle, which will be ignored in this analysis. Also, it is necessary, for simplicity's sake, to deal with the trunk as a single joint. The trunk, therefore, becomes both the joint and the segment moved in that portion of the analysis.

Record your analysis on the report form provided. Be sure to specify the appropriate phase for each analysis page.

# Laboratory Report - Anatomical Analysis

Name \_\_\_\_\_ Section \_\_\_\_\_

Date \_\_\_\_\_

1. What two phases of the jump have been assigned to you?

\_\_\_\_\_ phase

\_\_\_\_\_ phase

2. Describe the motion involved in each phase. Make sure to include a description of when the phase begins and when it ends.

1.

2.

Phase

---

Joint	Joint Motion	Segment Moved	Plane & Axis	Force	Contraction Type	Prime Movers

Phase

---

Joint	Joint Motion	Segment Moved	Plane & Axis	Force	Contraction Type	Prime Movers

## LABORATORY 10

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### Vectors

#### Objectives

1. Define key biomechanical measurement terms and state how each relates to the structure of biomechanics study.
2. Convert the units of measurement employed in the study of biomechanics from the U. S. system to the metric system, and vice versa.
3. Demonstrate the use of the graphic method for the combination and resolution of two-dimensional vectors.
4. Demonstrate the use of the trigonometric method for the combination and resolution of two-dimensional vectors.
5. Identify the scalar and vector quantities represented in individual motor skills and describe the vector quantities using vector diagrams.

#### Background

The units of measurement employed in the study of biomechanics are expressed in terms of space, time, and mass. Presently in the United States, there are two systems of measurement having units for these quantities, the U.S. system and the metric system. Although the metric system is currently used in research and literature, a comparison of equivalent values is helpful.

Quantities that are used in the description of motion may be classified as either *scalar* or *vector* in nature. *Scalar* quantities are single quantities. They possess only size or amount. This size or amount is referred to as magnitude and completely describes the scalar quantity. The units of measure described in the previous section are primarily scalar quantities, described only by magnitude. Examples of scalar quantities would be such things as a speed of 8 kilometers per hour, a temperature of 70 degrees, an area of 2 square kilometers, a mass of 10 kilograms, or a height of 2 meters.

There are also double quantities that cannot be described by magnitude alone. These double quantities are called *vector* quantities. A vector quantity is described by both magnitude and direction. Examples of vector quantities would be a velocity of 8 kilometers per hour in a northwest direction, 10 newtons of force applied at a 30-degree angle, a displacement of 100 meters from the starting point. The importance of clearly designating vector quantities can be seen if the direction component of the double quantity is altered. For instance, if two people on opposite sides of a door push with equal magnitudes (amounts) of force, the door will not move. If, on the other hand, they both push on the same side of the door, thus changing the *direction* of one of the forces, the result will be very different. The nature of the movement of the door depends upon both the *amount* and *direction* of the force. Force, therefore, is a vector quantity. If the individual who ran 8 kilometers runs 8 more kilometers, the total distance run will be 16 kilometers. However, if the runner goes 8 kilometers in one direction, reverses, and runs back to the starting point, the change in position or *displacement* is zero. The runner is zero kilometers from the starting point. Displacement, then, is also a vector quantity possessing both magnitude and direction. Numerous quantities in biomechanics are vector quantities. In addition to force, displacement, and velocity already mentioned, some other examples are momentum, acceleration, friction, work, and power. Vector quantities exist whenever *direction* and *amount* are inherent characteristics of the quantities.

A vector is represented by an arrow whose length is proportional to the magnitude of the vector. The direction in which the arrow points indicates the direction of the vector quantity. Vector quantities are equal if magnitude and direction are the same for each vector. Although all the vectors below are of the same length (magnitude) only two are equal vector quantities.

Vectors may be combined by addition, subtraction, or multiplication. They are added by joining the head of one with the tail of the next while accounting for magnitude and direction. The combination results in a new vector called the *resultant*. The resultant vector is represented by the distance between the last head and the first tail.

The subtraction of vectors is done by changing the sign of one vector (multiply by -1) and then adding as before. The multiplication of a vector by a number changes its magnitude only, not its direction.

As just explained, the combination of two or more vectors results in a new vector. Conversely, any vector may be broken down or resolved into two component vectors acting at right angles to each other. Should one wish to know how much of a velocity was in a horizontal direction and how much in a vertical direction, for instance, the resultant vector ( $R$ ) must be resolved into horizontal and vertical components. The vector addition of these components once again would result in the resultant vector  $R$ .

Any vector may be resolved into horizontal and vertical components if the trigonometric relationships of a right triangle are employed. Let us use the example of the jumper whose velocity at takeoff was 9.6 meter/sec in the direction of 18 degrees with the horizontal. To find the horizontal velocity ( $V_x$ ) and vertical velocity ( $V_y$ ) at takeoff a right triangle is constructed. With the takeoff velocity ( $R$ ) as the hypotenuse of the triangle, the vertical and horizontal components of velocity become the vertical and horizontal sides of the triangle. To obtain the values of  $V_x$  and  $V_y$  the sine and cosine functions are used. The horizontal velocity of the jump  $V_x$  turns out to be a 9.1 m

The combination of vectors is also possible with the use of right triangle trigonometric relationships. If two vectors are applied at right angles to each other the solution should appear reasonably obvious since it is the reverse of the example just explained. If a baseball is thrown with a vertical velocity of 15 meter/sec and a horizontal velocity of 26 meter/sec the velocity of the throw and the angle of release may be determined by using the Pythagorean Theorem to find the magnitude of the resultant vector and using the tangent function ( $\tan^{-1}$ ) to find the appropriate angle. The resultant velocity--that is, the velocity of the throw--is 30 meter/sec and the angle of projection is 30 degrees.

If more than two vectors are involved or if they are not at right angles to each other as shown in previous examples, the resultant may be obtained by determining the  $x$  and  $y$  components for each individual vector and then summing these individual components to obtain the  $x$  and  $y$  components of the resultant. Once the  $x$  and  $y$  components are known, the magnitude and direction of  $R$  may be obtained.

As we have seen before, a knowledge of the horizontal ( $x$ ) and vertical ( $y$ ) components makes it possible to determine the resultant vector. A triangle is formed and the unknown parts are found.

## Laboratory Report - Vectors

Name \_\_\_\_\_ Section \_\_\_\_\_

Date \_\_\_\_\_

1. Define the following key terms in your own words:

statics

dynamics

kinematics

kinetics

scalar

vector

component vector

2. Express the following units in metric terms:

a. \_\_\_\_\_ a force of 25 pounds

b. \_\_\_\_\_ a mass of 5 slugs

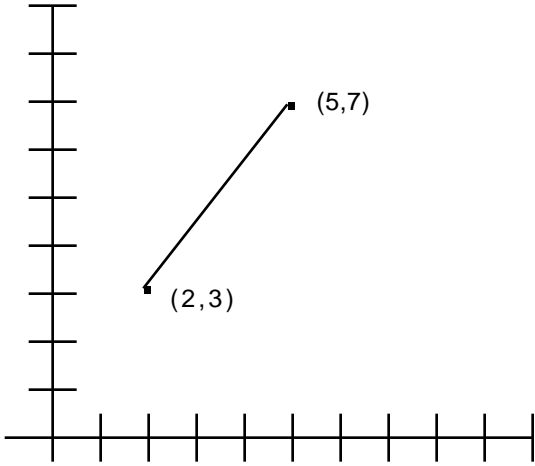
c. \_\_\_\_\_ a distance of 11 inches

d. \_\_\_\_\_ a velocity of 20 feet per second

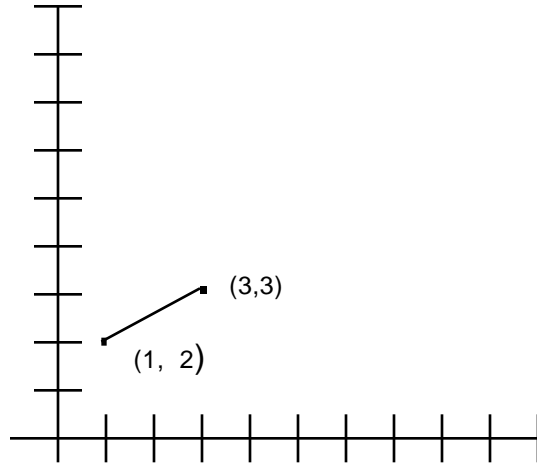
e. \_\_\_\_\_ a volume of 3 quarts

3. Determine the distance between each set of points (scale: 1 unit = 10 cm).

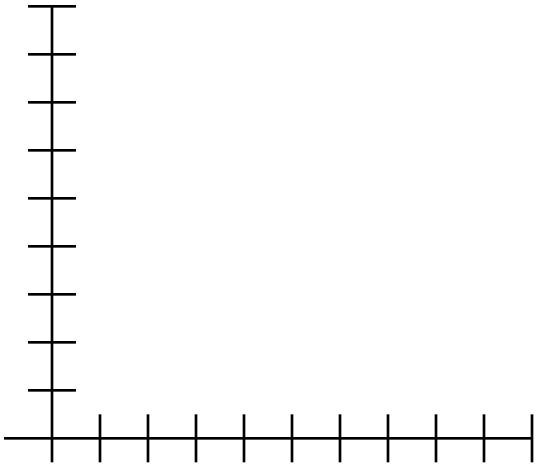
a.  $(2,3); (5,7)$



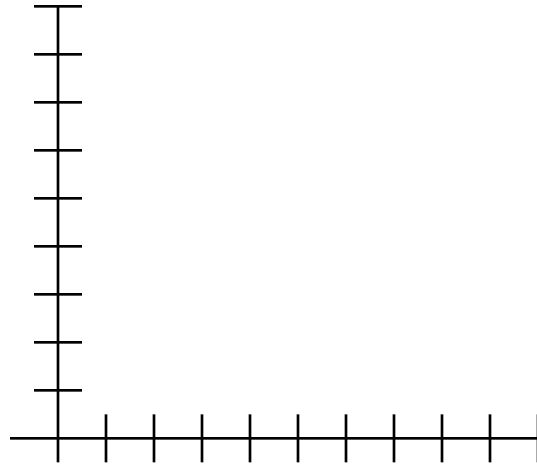
b.  $(1,2); (3,3)$



c.  $(1.5,3.0); (6,6)$



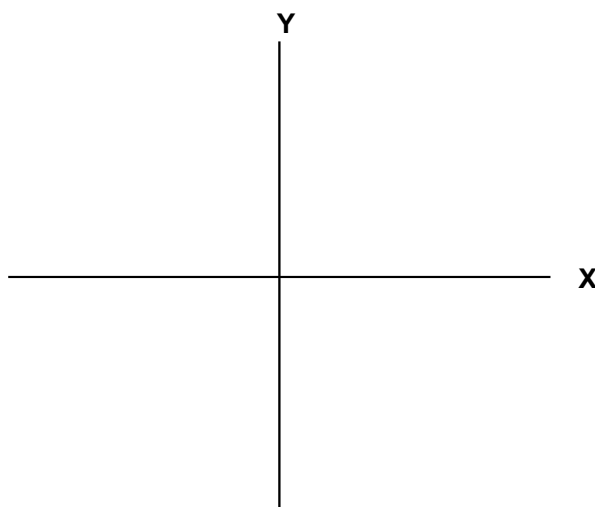
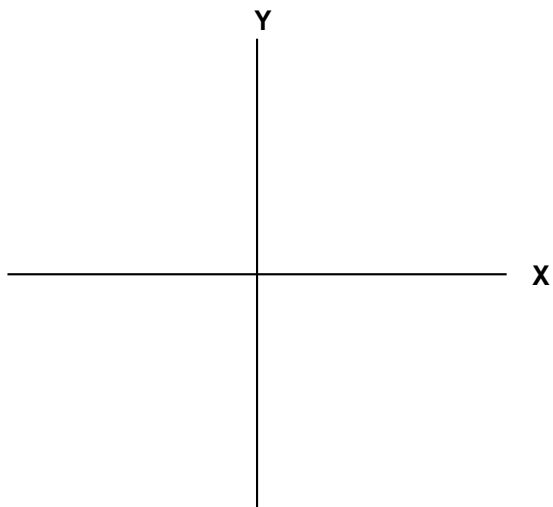
d.  $(0,0); (6.2, 3.6)$



4. Find the  $x$  and  $y$  component for each of the following vectors:

a. 45 m/sec at  $25^\circ$

b. 85 N at  $135^\circ$



c. 118 kg at  $310^\circ$

d. 25 m/sec<sup>2</sup> at  $210^\circ$

5. A basketball official runs 20 meters along the sideline in one direction, reverses, and runs 8 meters.

Draw a vector diagram.

What is the distance run? \_\_\_\_\_

What is the displacement? \_\_\_\_\_

6. The muscular force of a muscle is 650 N and the muscle is pulling on the bone at an angle of 15 degrees.

What are the vertical and horizontal components of this force?

7. At the moment of release, a baseball has a horizontal velocity component of 25 meters per second and a vertical velocity component of 14 meters per second.

At what angle was it released?

What was its initial velocity in the direction of the throw in meters/sec? \_\_\_\_\_

In feet/sec? \_\_\_\_\_

8. A child is being pulled in a sled by a person holding a rope that has an angle of 20 degrees with the horizontal. The total force being used to move the sled at a constant forward speed is 110 N.

How much of the force is horizontal? \_\_\_\_\_

Vertical? \_\_\_\_\_

9. An orienteer runs the following course: 1000 meters at  $45^\circ$ ; 1500 meters at  $120^\circ$ ; 500 meters at  $190^\circ$ .
- Draw the course to scale accurately.

b. Determine the resultant displacement graphically.

c. Determine the resultant displacement trigonometrically.

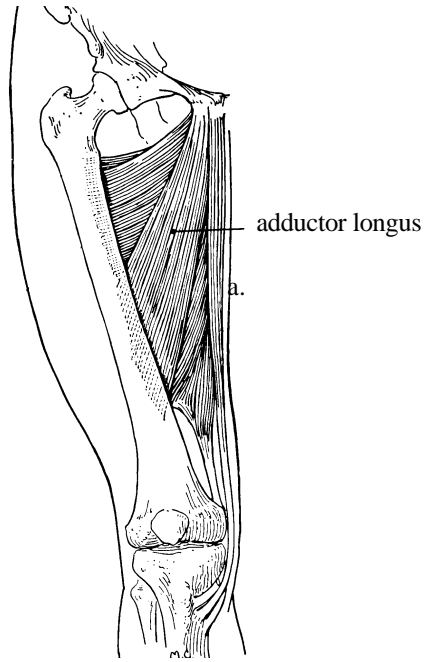
d. Explain any differences you have between your graphic and trigonometric results.

e. Express the orienteer's position at the end of the course in terms of rectangular coordinates.

Polar coordinates.

10. A football lineman charges an opponent with a force of 175 pounds in the direction of 310 degrees. The opponent charges back with a force of 185 pounds in the direction of 90 degrees. What is the resultant force and in what direction will it act?

11. Refer to the drawing of the femur and adductor longus muscle. Draw a straight line to represent the mechanical axis of the femur and another to represent the muscle's line of pull.



Using a protractor, determine the angle of pull of the muscle (angle formed by muscle's line of pull and mechanical axis of bone).

- b. Assuming a total muscle force of 900 N, calculate the force components.

12. Muscle A has a force of 450 N and is pulling on a bone at an angle of 15 degrees. Muscle B has a force of 600 N and is pulling on the same bone at the same spot but at an angle of 30 degrees. Muscle C has a force of 325 N and is pulling at the same spot with an angle of pull of 10 degrees. What is the composite effect of these muscles in terms of amount of force and direction?