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# A theoretically based computer-assisted instruction program expressing anatomical, physiological, and kinesiological aspects of the human knee

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# A Theoretically Based Computer-Assisted Instruction Program Expressing Anatomical, Physiological, and Kinesiological Aspect_ of the Human Knee

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A Theoretically Based Computer-Assisted Instruction Program Expressing Anatomical, Physiological, and Kinesiological Aspects of the Human Knee

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ABSTRACT

A Theoretically Based Computer-Assisted Instruction Program Expressing Anatomical, Physiological, and Kinesiological Aspects of the Human Knee

Randall Edward Deere

The purpose of this study was to develop a computer-assisted instruction program to aid future allied health professionals in learning about the anatomical, physiological, and kinesiological aspects of the human knee. The project provides a review of related literature on computer-assisted instruction (CAI), describes various learning theories used for instructional development, and applies the instructional model used for the construction of the CAI program.

Chapter 1 surveys traditional versus non-traditional methods of instruction. The introduction briefly scans the development of CAI in education and more specifically the areas of sports sciences and medical education. The discussion proceeds with a statement of the problem, limitations of the study, and an explanation of CAI terms.

Chapter 2 considers the theoretical frameworks used to formulate an instructional design utilized for the development of computer-assisted instruction (CAI) programs. Relevant related literature was reviewed. This chapter contains two major headings: (1) a review of the learning

theories of Thorndike, B. F. Skinner, Piaget, Bruner, Gagne, Bransford, and Steinberg and (2) an overview of the utilization of CAI in higher education.

Chapter 3 includes the instructional design used for the development of this computer-assisted instruction program which is based upon the various concepts of learning as presented in Chapter 2. This chapter also presents the computer-programming techniques used in the development of this computer-assisted instruction program.

Chapter 4 provides an outline of the computer-assisted instruction program. It is recommended that the reader utilize the computer program in order to obtain a complete understanding of the program contents.

Chapter 5 presents a summary and conclusions with specific recommendations listed. Those recommendations include:

1. There seems to be a need for the adoption of a uniform instructional paradigm for sequencing CAI programs.

2. Agreement concerning evaluative instruments seems essential when attempting to compare and evaluate CAI programs.

3. Selection of a computer programmer whose knowledge encompasses the multiple aspects of CAI programs is critical.

4. CAI programs can address individual needs in ways that classroom instruction cannot (i.e., high degree of

feedback and interaction involved); however, it is more expensive, takes longer to prepare, and is more complex to administer.

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# DEDICATION

This dissertation is dedicated to my wife Kathy and my children, Laura, Lyndsey, and Andrew. Without their love and support, this project could not have been completed.

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CHAPTER 1

# Introduction

Education entails acquiring information about a subject and, from this, a comprehension of relationships between concepts and facts (Prentice & Kenny, 1986). Empirical studies on various teaching methodologies have shown distinct advantages and disadvantages for each.

Collins (1991) indicated that education holds two prominent views on teaching methodology. A didactic approach contains the idea that teachers should be the authority of a particular domain and should disseminate information to students through lectures and group interaction. A constructivist approach holds that teachers should facilitate learning by helping students form their own understandings and capabilities in carrying out a particular task "through various instructional methods rather than solely relying on the traditional lecture technique" (Collins, 1991, p. 29). One example of the constructivist approach has been the innovative growth of the computer in the classroom. Over the past decade, the use of computers in the classroom has been an ever-increasing development. Computer usage has provided an experiential form of learning for students which supplements traditional lecture methodology. Alternative teaching methods, such as computer-assisted instruction (CAI), have great potential for the future as an educational tool to disseminate information to the student. Computer-assisted instruction has been widely tested and accepted as an effective method of learning (Garrett & Ashford, 1986; Niemiec, Samson, Weinstein, & Walberg, 1987; Pazdernik & Walaszek, 1983).

According to Baker (1990), education has been slow in responding to the challenge of educating the population about this new technology. Due to the pressures of accountability placed on educators today, alternative teaching methods, such as CAI, could be employed as a means of disseminating information to the student.

There are situational advantages to using computer-assisted instruction over traditional teaching methodologies. According to Mecaskey et al. (1989), CAI provides interaction and is capable of providing immediate feedback to the student. Miller (1987) stated that "simulations parallel reality and as such provide a means for 'practice of life' situations that should be a part of the educational experience . . ." (p. 35). J. B. Skinner, Knowles, Armstrong, and Ingram (1983) indicated that medical students are safely allowed to make mistakes regarding patient diagnosis and management through the use of computer-assisted instruction programs.

Among the numerous academic areas utilizing computer-assisted instruction are medical schools which have provided numerous studies on the utilization of computer-assisted instruction and programming (Hmelo, 1990). The field of physical education also provides for a diversity of class structures (class lecture/demonstration, activities, etc.) which could utilize CAI techniques for instruction (Adams, Kandt, Throgmartin, & Waldrop, 1991).

The field of physical education currently provides some computer-assisted instruction programs used to supplement instructional texts. However, there are limited numbers of quality CAI programs available in this discipline (Kelly, 1987).

## Statement of the Problem

From a review of related literature there appears to be a significant need to develop computer-assisted instruction programs in the field of sports science that will articulate the various anatomical, physiological, and kinesiological aspects of the knee. The program designed in this endeavor will be theoretically based upon the most recent information available and will utilize an eclectic approach.

## Justification of the Study

As of June 1993, there will no longer be a National Athletic Trainers' Association (NATA) approval process for entry-level athletic training educational programs. Existing NATA-approved programs will maintain approval status until their five-year review. At that time, the Committee on Health Education Accreditation (CAHEA) will treat those programs as initial applicants for the accreditation process. In the Essentials and Guidelines manual provided by CAHEA, explicit program requirements are provided to aid the accreditation process. Under the area titled "Learning Resources," CAHEA states that "adequate audio-visual and other appropriate instructional aids must be available for use by athletic training education program personnel" (Essentials and Guidelines, 1991, p. 4).

In the recognition and evaluation area and the rehabilitation area of the competencies required by CAHEA, one competency within the psychomotor domain is constant, which is: "use of manual muscle testing techniques including application of the principles of muscle/muscle groups isolation, segmented stabilization, resistance/pressure, grading, etc." (National Athletic Trainers' Association, 1992, p. 6). Another competency within the psychomotor domain of the recognition and evaluation area states that: "location and palpation of 'key' anatomical structures commonly involved in injury pathology, including bony landmarks, ligamentous/capsular tissues, musculotendinous structures, and abdominal regions" (NATA, 1992, p. 6). These are just 2 of the 191 competencies identified by the NATA and CAHEA. Entry-level athletic trainers must be able to demonstrate these competencies in order to obtain certification as an athletic trainer.

## Assumptions

The information acquired and utilized in this study to develop a computer-assisted instruction program about the knee will be based upon appropriate theoretical designs and reliable research methods assumed to be valid and reliable.

## Limitations of the Study

The examination of related literature was, for the most part, of sources that are subsequent to 1980. Exceptions to this are certain classical contributions by Athey and Rubadeau (1970), Bransford (1979), Bruner (1960, 1971), Bugelski (1971), Craig (1966), Gagne (1977), Gerber (1977), Hill (1977), Lundin (1979), Mikulas (1974), Mouly (1973), Piaget and Inhelder (1966/1969), B. F. Skinner (1968), Stallings (1973), and Thorndike (1931).

This CAI program was confined to the bodily area and physiological makeup of the human knee. This program is limited to IBM or IBM-compatible computers.

## Definition of Terms

Computer-assisted instruction--computer-presented instruction that is individualized, interactive, and guided.

Eclectic--Selecting of what seems best of varied sources.

Feedback--a message that is presented to a learner after the learner gives a response.

Fidelity--the relationship between content of material and authentic situations.

Formative evaluation--evaluation following specific CAI lessons.

Instructional design--the method of presentation for the content of material.

Interaction--mechanics or communication with the computer; relates to the acquisition of knowledge and skills; in computer-assisted instruction, interaction consists of question, response, and feedback.

Interference--increases difficulty in learning a set of items as more items become involved.

Learner control--a psychological factor relating to cognition and control of instruction; relating to choice of instructional material.

Menu--provides a choice; selection of material.

Program design--foundation for which instructional material is presented.

Sequencing--progression of material; order of presentation.

Simulation--to create the effect or appearance of.

Spaced practice--allows the learner to keep track of the items that a particular learner was working on during the last session.

Summative evaluation--evaluation following completion of CAI program.

## CHAPTER 2

## Review of Literature

This chapter considers theoretical frameworks used to formulate an instructional design utilized for the development of computer-assisted instruction programs. Relevant related literature was reviewed. This chapter will contain two major headings: (1) a review of the learning theories of Thorndike, B. F. Skinner, Piaget, Bruner, Gagne, Bransford, and Steinberg, and (2) an overview of the utilization of CAI in higher education.

### Review of Related Literature

There is no one instructional method that is optimal for all learners; "therefore learning characteristics should be focused upon when developing computer assisted instruction" (Paulanka, 1986, p. 247). CAI is a relatively new type of instructional method (Mecaskey et al., 1989). There are both similarities and differences between traditional methods of instruction and CAI. Because CAI is different in some important ways from other methods of instruction, a foundation or framework should be established, based upon educational theory prior to developing a CAI program (Steinberg, 1991).

### Review of Selected Educational Learning Theories

Contemporary theories of learning can be classified into two broad categories: (1) associative, connectionist, and behaviorist or stimulus-response theories and (2) cognitive or field theories (Hill, 1977; Mikulas, 1974; Mouly, 1973; Stallings, 1973). Stallings (1973) indicates that the differences which exist between the two types of theories in defining learning are: (1) "associative, connectionist and behaviorist theories consider the environment the principal source for . . . explaining, estimating, and governing behavior," and (2) "cognitive theorists maintain the individuals' interpretation of the environmental situation as the critical factor . . . involved in learning" (p. 14). Good and Brophy (1990) propose that a behaviorist believes that behavior is determined by the strengthening of a stimulus-response bond and reinforcements that accompany such behavior.

Much has been written about the association between reinforcement and learning. Thorndike and B. F. Skinner are two associative theorists who emphasize how reinforcement affects learning.

Thorndike

Bugelski (1971) notes that Thorndike's research on animals led him to the development of three laws of learning: (1) "law of effect," (2) "law of exercise," and (3) "law of readiness" (p. 57). Hill (1977) cites that Thorndike's primary law of learning was the law of effect. The law of effect simply refers to the stamping in of stimulus-response connections and the effects which follow the response (Gagne, 1985; Good & Brophy, 1990; Stallings, 1973). Thorndike (1931) concluded that "connections grow stronger if they issue satisfying states of affairs" (p. 101).

B. F. Skinner

B. F. Skinner, like Thorndike, based much of his research on the application of reinforcement to strengthen learning. While Thorndike emphasized reinforcement of the total stimulus-response situation, B. F. Skinner's theory, referred to as operant conditioning, is concerned with reinforcement of the response (Stallings, 1973). B. F. Skinner (1968) demonstrated that he could increase the frequency of any particular operant behavior by rewarding the individual for performing that behavior and that reinforcement was dependent upon the performance of such behavior. He also stated that reinforcements continue to be important long after the individual has learned how to do something.

One of the unique features of B. F. Skinner's research was what he called schedules of reinforcement (Hill, 1977; B. F. Skinner, 1968; Stallings, 1973). This particular term refers to the pattern in which reinforcers follow responses. Hill (1977) refers to schedules of reinforcement as either continuous or intermittent. Continuous reinforcement was identified as a reinforcer given for every response during a sequence of learning events. Intermittent reinforcement is used after the response is learned and only periodically.

Lundin (1979) and Good and Brophy (1990) identified B. F. Skinner's schedule of reinforcement as either being fixed or variable and made up of four schedules: fixed interval, variable interval, fixed ratio, and variable ratio. In the fixed interval schedule, the reinforcement comes after a designated time, regardless of what the individual was doing in-between. Variable interval schedules are defined as reinforcements scheduled intermittently according to time. A fixed ratio schedule is the occurrence of reinforcements after a given number of responses. The final schedule of reinforcement, as defined by Lundin (1979) and Good and Brophy (1990) is the variable ratio schedule. This schedule follows the average number of responses made as opposed to the time element.

B. F. Skinner (1968) insists that operant conditioning principles can be and should be used in schools today. Various technological methods of instruction have been developed, such as teaching machines, programmed instruction, and CAI, because of the work and ideas produced by B. F. Skinner.

Piaget

Piaget's theory is a cognitive theory of learning. A cognitive theory, according to Phillips (1981), is concerned with the human intellectual process in which the individual acts upon rather than reacts to the learning environment. In reviewing the voluminous contributions by various authors on Piaget's theory, there are several concepts which are central for the understanding of this theory.

A schema, according to Athey and Rubadeau (1970), is a term Piaget uses to illustrate ways individuals perceive, understand, and think about the environment. Hill (1977) notes that children have schemata that are relevant to many topics and this number becomes even greater as one approaches adulthood. Gerber (1977) uses the term structures as opposed to schemas to explain how the individual constructs cognitive relations. To Gerber, cognition evolves from structures that are constructed through sequential steps.

Schemas provide thoughts (cognition) which develop between the growing individual and environment. Athey and Rubadeau (1970) indicate that Piaget attributes mental change and growth in life to a biological adaptation termed "assimilation and accommodation" (p. 2). Hill (1977) defines accommodation as the process of change. Hill also states that when an experience conflicts with a schema there will be an inclination for the schema to change to accommodate this new input.

Athey and Rubadeau (1979) state that assimilation occurs when existing schema are used as "rules of action" (p. 2) toward a particular occurrence. Hill (1977) refers to assimilation "as the process by which schemata influence the interpretation of experiences" (p. 213). Gerber (1977) notes that behavior evolves from existing structures which involves assimilation and if accommodation does not occur then learning will be static.

Assimilation and accommodation have been referred to as functional invariants because they are characteristic of all biological systems and because each individual response is somewhat different (Good & Brophy, 1990; Phillips, 1981). Mouly (1973) notes that cognitive development occurs as a consequence of experiences which contrast assimilation and accommodation and cause the individual's cognitive structure to act or reorganize the schema.

Piaget and Inhelder (1966/1969) state that equilibration is a process of attaining equilibrium between the environment and the activities of the individual. For Piaget, the most fundamental factor for influencing cognitive growth was equilibration. Equilibration represents a point at which the process of assimilation and accommodation achieve a balance in order for the cognitive structures to develop (Gerber, 1977; Hill, 1977; Mouly, 1973). Gerber also states that equilibration is attained with greater or lesser difficulty, depending on the level of development (maturation) reached and the type of problems encountered.

Through a review of related literature, four primary concepts have been identified with Piaget's theory of learning which are: (1) schemas, (2) assimilation, (3) accommodation, and (4) equilibration. According to Good and Brophy (1990), the sequence of schema acquisition is global, but the rate of schema development depends on the "maturational differences, environmental experiences and social transmission" (p. 61).

From this construct, Piaget identifies four distinct stages of child development. Piaget and Inhelder (1966/1969) provide a thorough description of four stages of development which are the sensory-motor, preoperational, concrete operations, and formal operations. The first stage of development which Piaget describes as the sensory-motor is from 0-2 years of age. It is during this stage that the child develops conceptions about the nature of the material world. Piaget further divides the sensory-motor stage into six segments:

1. Stage 1 is regarded as the reflex stage.

2. Stage 2 is the period of first habits.

3. Stage 3 is when coordination and manipulation occur.

4. Stage 4 is when the subject sets out to obtain certain results.

5. Stage 5 is the period when there is a "search for new means by differentiation of schemes already known" (Piaget & Inhelder, 1966/1969, p. 11).

6. Stage 6 marks the end of the sensory-motor period when the child develops the capabilities to combine and accommodate certain schemes.

Piaget and Inhelder (1966/1969) identify the next stage of development as "preoperatory" when "semiotic" (p. 51) or symbolic functioning occurs. Others refer to this stage of development as the preoperational stage which signifies ages 2-7 years (Athey & Rubadeau, 1970; Good & Brophy, 1990; Hill, 1977; Phillips, 1981). Piaget and Inhelder (1966/1969) suggest that in this stage events, such as "deferred imitation, symbolic play, drawing, mental images and image-memory or language . . . occur with an unlimited field of application in contrast to the restricted boundaries of the sensory-motor stage" (p. 41). According to Hill (1977), the child has internalized representations which allow the individual to deal effectively with the surrounding environment.

The third stage of development is that of concrete operations which signifies ages 7-11 years (Athey & Rubadeau, 1970; Good & Brophy, 1990; Hill, 1977; Phillips, 1981; Piaget & Inhelder, 1966/1969). Piaget and Inhelder (1966/1969) propose that in this stage of development the individual becomes capable of reasoning about problems which arise, capable of drawing certain conclusions from truths, and begins to perform "hypothetico-declarative or formal thought" (p. 132). Others have identified this stage as one of reversibility. Athey and Rubadeau (1970) state that mathematical operations which require combinations, associations, identity, and reversibility are developed during this stage.

The fourth and final stage of development is that of formal operations and begins around age 12 years (Piaget & Inhelder, 1966/1969). During this stage of development, the individual explores ways of formulating a problem and experiences the consequences of action. The individual is ready to think in abstract propositions with that which is observed in the environment (Hill, 1977).

Piaget and Inhelder (1966/1969) suggested that each stage of development leads to the subsequent stage which makes it possible to divide child development which is characterized by the following:

1. The order of succession is constant, although the age in which succession occurs may vary.

2. "Each stage is characterized by an overall structure in terms of which the main behavior patterns can be explained" (Piaget & Inhelder, 1966/1969, p. 153).

3. The overall structures are integrative, with each resulting from the preceding one and preparing for the subsequent one.

Bruner

J. S. Bruner (1960, 1971) proposed ideas on how children learn similar to those of Piaget. However, Bruner provided suggestions on how teachers can stimulate student learning by directing students to discover principles and relationships for themselves. Learning through discovery, as advocated by Bruner (1960), states that the most meaningful learning is the result of discoveries that occur through exploration and curiosity. Bruner (1971) also states that discovery learning emphasizes three stages of cognitive growth:

1. The enactive stage is knowledge about how to manipulate the environment. Images, words, diagrams, and other cognitive processes are limited.

2. In the iconic stage, individuals begin to form a mental image or perceptions of the ways in which things function.

3. In the final stage of cognitive growth which is the symbolic stage, students are beginning to understand and manage abstract concepts.

Bruner (1960) reports that teaching general (fundamental) knowledge about a subject through simple skills will allow the learner to learn complex skills through discovery and experience. "The attitude that things are connected and not isolated is a case in point" (Bruner, 1971, p. 27). Bruner (1960) provides four general claims about teaching fundamental knowledge: (1) understanding fundamentals allows for a more comprehensible understanding of the subject; (2) detailed or specific material must accompany fundamental knowledge for learning to occur; (3) the understanding of fundamental principles leads to adequate transfer of knowledge; and (4) the transition of material learned throughout elementary, secondary, and college levels is sometimes out-of-date or lagging because of new developments in the field. Bruner (1960) states that the gap of information can be reduced by teaching the fundamental principle.

Mouly (1973) critiques the discovery method based on four pertinent issues:

1. Research on the enhancement of long-term cognition has not been addressed.

2. Independent discovery learning projects could be assigned to students "without jeopardizing the acquisition of a coherent body of content" (Mouly, 1973, p. 316).

3. Discovery learning is far too time-consuming to be the primary approach to teaching.

4. A background of information must be present for discovery learning to occur, and it calls for a magnitude of involvement and intellect on the part of the learner.

Gagne

Gagne (1977, 1985) believes learning consists of skill categories and capabilities which are affected by the conditions under which they are learned. Gagne (1977) indicates that previously learned capabilities necessary for learning to occur are termed "internal conditions" (p. 21). These internal conditions are those transformed or adapted to meet "external conditions" (p. 21) which are events that occur through interaction with the environment. Steinberg (1991) states that Gagne's theory proposes two important concepts which affect learning: (1) the attribute of the learner and the environmental events which contribute to learning and (2) each type of learning outcome has its own internal and external conditions.

Gagne (1985) states that an emphasis should be placed on what is learned, rather than the conditions which exist when learning occurs "because learning conditions are not the same for different varieties of what is learned" (p. 47). Therefore, Gagne suggests that it is necessary to distinguish the various types of learning outcomes which he classified as: (1) intellectual skills, (2) cognitive strategies, (3) verbal information, (4) motor skills, and (5) attitude.

Intellectual skills accentuate the use of rules and concepts and are used for problem-solving. Gagne (1985) states that rule learning is simply a matter of combining simple skills into a new pattern, whereas complex rules are made up of other known simpler rules.

Gagne (1985) identifies concepts, discriminations, higher-order rules, and procedures as subcategories of intellectual skills. Higher-order rules are the most complex level of intellectual skills which are combinations of other prerequisite rules. According to Steinberg (1991), a rule is a relationship of two or more concepts, and concepts can be broken down into discriminations which are component skills that "determine whether an item is a member of a conceptual category . . ." (p. 24). Therefore, the internal conditions for learning an intellectual skill depend on prior knowledge of simpler skills (Gagne, 1977, 1985; Gagne, Briggs, & Wager, 1988; Steinberg, 1991). The external conditions for learning intellectual skills are the events that help the learner interrelate simple skills into more complex skills (Gagne, 1977, 1985).

The second kind of capability learned by individuals is cognitive strategies. Gagne (1977) identifies cognitive strategies "as the capabilities which govern the individual's own learning, remembering and thinking behavior" (p. 25). Other than being oriented to specific kinds of content, Gagne (1985) indicates that cognitive strategies generally apply to all types of content. The internal conditions for cognitive strategies depend upon facts in familiar categories. An example of cognitive strategies used for this dissertation was that the researcher had a conceptual understanding of computer-assisted instruction, although to develop a new computer program, all content-specific information regarding program design had to be pursued and compiled. Steinberg (1991) states that external conditions that influence cognitive strategies are usually indirect, as opposed to direct because cognitive strategies are acquired over a period of time and strengthened through opportunities to practice them.

The third category of learned capability is verbal information (Gagne, 1977, 1985). Gagne (1977) indicates that verbal information is the individual's capacity for presenting information through verbalization or stating information through writing. Gagne (1985) states that the internal condition for learning verbal information is the availability of previously learned information (intellectual skills) which interrelate or transfer to the specific task. The external condition for learning verbal information is made by an association of ideas presented to the individual which allows the individual to use certain classes of information (Gagne et al., 1988).

The fourth kind of capability which is distinguishable in human performance is motor skills (Gagne, 1977, 1985; Gagne et al., 1988). Gagne (1977) describes motor skills as prescribed organized movements "that are smooth, regular, and precisely timed" (p. 4). Gagne et al. (1988) indicate that motor skills are performed not only through physical human performance, but through intrinsic activities, such as writing and typing.

Gagne (1977, 1985) states that the internal condition of motor skills is an understanding of the sequence of acts which comprise the skill. The external condition of motor skill learning is provided by repetition of practice. Through practice, feedback and knowledge of results provide the individual with the necessary information needed to perform the activity.

The fifth and final category of learned capability is attitude (Gagne, 1977, 1985; Gagne et al., 1988). Gagne (1977) defines attitude as an internal state which allows for choices of personal actions made by individuals. Gagne (1985) notes that attitudes are influenced by both intellectual and emotional aspects and that outcomes of human performance provide a reference point for this behavior. The internal condition which affects attitude is that of imitation or human modeling. According to Gagne (1977, 1985), the learner will have respect or admiration for the individual or person whose behavior is being imitated. The external conditions which affect attitude are identified by an emotional behavior which provides circumstances that are measured by success or failure.

Gagne et al. (1988) suggest that "instruction consists of a set of events external to the learner designed to support the internal process of learning" (p. 181). In order to make learning more effective, Gagne et al. (1988) suggest nine instructional events which can be employed by the teacher:

1. Gain the learners' attention by introducing a stimulus that is appealing to the students.

2. Inform the learners of the objectives or key points to be learned.

3. Help the students recall material that was previously learned in order to provide a basis for new material.

4. Present the material to be learned (body of knowledge).

5. Provide cues to aid the students in sequencing new material.

6. Elicit student response about body of knowledge.

7. Confirm correctness or degree of correctness of rules and application (establishing reinforcement).

8. Assess the students' application of concepts.

9. Enhance retention and transfer by performing space reviews.

Bransford

Bransford (1979) explored the process of learning, understanding, and remembering by presenting a framework of four components: (1) nature of materials to be learned, (2) characteristics of the learner, (3) learning activities, and (4) critical task. Bransford believed that understanding the relationships among these components is critical when evaluating questions about learning, understanding, and remembering.

According to Bransford (1979), the nature of materials to be learned is extremely diverse. The materials may be "written or oral, visual or verbal, difficult or complex, hierarchial in nature or not" (Steinberg, 1991, p. 26). An example of diversity of the nature of materials to be learned could be the difference in a student reading a book about a certain town or country and actually experiencing that town or country by visitation.

Characteristics of the learner is the second component identified by Bransford (1979). Learner characteristics are attributes individuals possess that include previously acquired skills and knowledge, beliefs and expectations, developmental maturity, and experience (Bransford, 1979; Steinberg, 1991). Bransford states that our knowledge is organized into certain categorical structures and the recall mechanism of prerequisite knowledge depends on the organizational structure of that knowledge previously acquired.

Learning activities is the third component identified by Bransford (1979). Bransford identifies two factors which are important to active learning. The first factor is that material must be actively rehearsed (practiced) or it will be forgotten. The second factor deals with attention which

Bransford identifies as selective and limited. Steinberg (1991) states that learning activities vary according to the nature of materials to be learned and the characteristics of the learner. Steinberg (1991) refers to the "chunking of information" (p. 26) (dividing the information into smaller groups) as one activity mature learners use when dealing with multiple numbers.

The fourth component is critical task (Bransford, 1979). Bransford's critical task involves the recognition and recall of information, the transferring of information, and the act of problem-solving. Bransford notes that it is not sufficient to simply store information because, if not used, the information stored will be of little importance. Steinberg (1991) identifies critical task as methods used to test outcomes through memorization, acquisition of concepts, and problem-solving. Steinberg (1991) also states that for effective learning to occur "different activities are needed for different critical tasks" (p. 26).

Steinberg

Steinberg (1991) provides four components for a computer-assisted instruction framework which are based upon the contributions of Gagne (1985) and Bransford (1979). The components are: target populations, goals, tasks, and instruction.

Steinberg (1991) identifies "target population" (p. 27) as the first component that is central to learning. Target population refers to the diverse characteristics of the learners involved. Development limitations, prerequisite knowledge and skills, prior knowledge, structure of knowledge, and metacognition are specifically identified by Steinberg (1991) as subcomponents of the target population.

Developmental limitations are identified as learning expectations of an individual or a particular group. It would be unreasonable to expect a child to ride a motorcycle if that child is unable to ride a bicycle. Prerequisite knowledge and skills refer to assumptions which instructors make that learners have the knowledge and skills to complete the task required. Prior knowledge is more generalized or conceptual and not task-specific. This type of knowledge allows the individual to make inferences and solve problems. Structure of knowledge "is the process by which information is received, stored, and retrieved" (Steinberg, 1991, p. 31). Steinberg also notes that students' backgrounds strongly influence structure of knowledge. The last subcomponent of target population is metacognition. Steinberg (1991) states that metacognition is knowing about your own knowledge and cognitive processes.

Gagne (1985) refers to the first component (target population) as internal conditions which rely on previously learned intellectual skills which must be present to perform a particular task. Bransford (1979) refers to this component (target population) as learner characteristics which incorporate skills and prerequisite knowledge, attitudes, and metacognition.

The second component central to learning is described as goals (Steinberg, 1991). Steinberg indicates that goals are the expected outcomes of instruction and that goals are also very important when designing instructional material because goals reflect on intended behavior or outcomes. Gagne (1985) refers to goals as outcomes that are categorized as intellectual skills, verbal skills, cognitive strategies, motor skills, and attitudes. Bransford (1979) refers to goals as critical tasks which involve the psychological processes of attention, memory, and practice.

The third component central to learning is identified as tasks (Steinberg, 1991). Steinberg (1991) refers to tasks as the skills and processes used to accomplish goals and that tasks may "vary according to the subject matter, and nature of materials" (p. 35). Bransford (1979) refers to tasks as the nature of materials to be learned. Bransford states that there is a diversity among the nature of materials to be learned because they may be written, visual, or verbal. Gagne (1985) describes tasks as the internal processes the individual exercises to pursue the intended goal.

The fourth and final component central to learning is instruction (Steinberg, 1991). Bransford (1979) refers to instruction as learning activities. These are the various activities employed by the student and instructor in reaching the ultimate outcome termed learning. Gagne (1985) refers to instruction as external events that facilitate student learning.

## Computer-Assisted Instruction

The act of teaching and learning has been studied for many years. There is a wealth of information available which provides individuals with the questions and answers of how to and why regarding teaching and learning. Alternative teaching methods, such as computer-assisted instruction (CAI), have great potential for the future as an educational tool to disseminate information to the student. Computer-assisted instruction has been widely tested and accepted as an effective method used to enhance learning (Garrett & Ashford, 1986; Niemiec et al., 1987; Pazdernik & Walaszek, 1983).

Niemiec et al. (1987) provided a taxonomy for the uses of computers in education. Computer-managed instruction (CMI) assesses the students' progress toward instructional goals and also provides an indication of additional needed instruction. Computer-assisted instruction provides direct interaction with the computer through four various forms of instruction:

1. Drill and practice--the computer provides recall of content-specific material. It is used to supplement classroom instruction.

2. Tutorial--the tutorial provides concepts to students. This is different from drill and practice because it reinforces correct response and provides assistance in correcting mistakes.

3. Problem-solving--the computer can be used as a tool to obtain information needed in the solution of a problem.

4. Simulation--the computer can be used to approximate certain conditions in which the student is asked to respond and is provided feedback for the response. According to Niemiec et al. (1987), "simulation is used when actual laboratory training conditions are difficult to implement" (p. 86).

Charron, Evans, and Korpela (1990) presented a variety of reasons for using CAI as an alternative to other learning activities:

1. Computer-assisted instruction can reduce learning time one-third to one-half, compared to traditional teaching methods.

2. Class time can be spent applying various concepts learned from CAI, and this will allow the instructor to observe, detect, and correct problem areas.

3. Computer-assisted instruction guarantees more student involvement than the traditional classroom lecture.

4. Computer-assisted instruction can provide faculty members an opportunity to attend to other job-related issues. Computer-assisted instruction also provides

students who have limited computer knowledge and experience the opportunity to encounter the various functions of a modern computer (Mecaskey et al., 1989).

Various studies have observed the attitudes of students and faculty members using CAI in higher education. Other studies have investigated student achievement using a variety of CAI techniques. Garrett and Ashford (1986) studied pre-test and post-test scores of 14 medical students using a CAI simulation (lung cancer patient management) program. Twelve students increased their post-test scores, while one decreased the post-test score, and one score remained the same.

Whiteside, Lang, and Whiteside (1989) investigated 102 junior medical students' knowledge about the willingness to use, as well as attitudes toward the use of, computers as instructional tools. The results showed that 74 percent of the students believed that computers could improve medical education, while 83 percent indicated that students could learn from using computers, and 76 percent agreed that patient diagnoses or management simulations are an effective way to learn certain types of information. The results of this study indicate that medical students are willing to move from the traditional (didactic) method of instruction to a more progressive method, such as computer-assisted instruction.

Nyamathi, Chang, Sherman, and Grech (1989) compared the effects to which learning styles influence cognition and retention on nursing students. The researchers chose 23 nursing students, 14 of whom were chosen for the experimental group (CAI), while 9 were chosen for the control group (lecture method). The lessons for both groups consisted of a general review of the maintenance of mobility (range of motion) for hospitalized patients and the nurse's role in patient assessment. The results showed no statistical difference on post-test scores between the students receiving instructions via CAI and students receiving instruction via the lecture method and that the experimental (CAI) group learned the material in approximately half the time of the lecture group.

Koch, Rankin, and Stewart (1990) studied the attitudes of 110 second-year nursing students on individual and group usage of a computer-assisted instruction program. The results showed that a majority of students (52.7 percent) preferred using the CAI with supervision, while 26.4 percent preferred no supervision at all. The other 20.9 percent showed no preference or failed to respond to the questionnaire.

Computer-assisted instruction has also been used in the educational process of dental students. Levine, Jones, and Morgan (1987) performed a cross-over study of 60 dental students who were divided into two groups to compare the learning of "dental carries" and "periodontitis" (p. 305) by using two methods of instruction. The first group received instruction in dental carries using CAI, and the second group received instruction in dental carries using traditional techniques (lecture method) of instruction. Subsequently, the first group received instruction in periodontitis through the traditional method, while the second group received instruction in periodontitis using CAI. There was no significant difference, as demonstrated in the results gained after instruction by the two methods.

A meta-analysis on the effectiveness of CAI in basic medical science education was performed by Marion, Niebuhr, Petrusa, and Weinholtz (1982). The measures of the effectiveness of CAI were provided through the analysis of three variables: (1) achievement test performance, (2) learner attitudes toward CAI, and (3) the amount of study time. The results of this study indicated that examination performances did not vary for students who received instruction through the computer and for students who did not. Several studies indicated that students believed that computer-assisted instruction enhanced their learning, and other studies indicated that CAI reduced the amount of study time required for certain basic science courses.

## Summary

It has been the researcher's intent to provide a thorough review of selected learning theories and also a review of selected studies on the utilization of computer-assisted instruction in higher education. The next chapter includes the instructional design used for the development of this computer-assisted instruction program which is based upon the various concepts of learning as presented in this chapter. Chapter 3 also presents the computer-programming techniques used in the development of this computer-assisted instruction program.

# CHAPTER 3

## Methods and Procedures

In this chapter, the researcher presents the instructional model utilized as a basis for the computer-assisted instruction (CAI) design and the sequence of the computer programming design covering the anatomical structure of the knee joint. It is clear from the work of Thorndike, B. F. Skinner, Piaget, Bruner, Gagne, Bransford, and Steinberg there are certain components that are central to learning, regardless of the theoretical position or terms which identify them. The researcher adopted four components identified by Steinberg (1991) which served as the primary basis for the CAI framework. The components are: (1) target population, (2) goals, (3) tasks, and (4) instruction. The researcher is fully aware that these four concepts were built upon the work of those individuals mentioned earlier in this paragraph.

### Target Population

Individuals are different; therefore, the characteristics of learning among individuals are also different (Steinberg, 1991). The important aspect of defining the target population is to provide instruction which approximates the learning characteristics of the students involved (see Appendix A).

This computer-assisted instruction program was designed specifically for a junior-level baccalaureate- degree-seeking individual majoring in physical education or athletic training. The sequential nature of the computer program allowed for diversity of learning characteristics of the students involved.

## Goals

Steinberg (1991) indicated that goals are most often thought of in terms of performance or behavior that is demonstrated by completing a test. She also indicated that in CAI goals may be in other forms, such as performance or behavior to be demonstrated, experience or processes in which the learner is expected to engage, learning how to learn a particular task, influencing the effective domain or attitudes about an issue, and allowing the learner to choose various topics to review (see Appendix A).

In this computer-assisted instruction program, the goals of each lesson were stated in behavioral terms, specifying the intended results or learning outcomes each student should receive. The goals or objectives provided an overview of the section to be covered.

## Tasks

Steinberg (1991) indicated that tasks refer to the activities required to complete the goals. According to Steinberg (1991), the ability to read a textbook is a skill which is needed to understand both chemistry and history.

Reading a chemistry book requires the ability to interpret formulas and equations, while reading a book about American history does not (see Appendix A).

The tasks involved to complete this computer-assisted instruction program resulted from interaction between the student and computer, involving such skills as reading, writing (pencil and paper), and usage of a computer keyboard.

## Instruction

Steinberg (1991) defined instruction as a set of "activities arranged by the instructional designer to facilitate learning" (p. 35). She also stated that computers are excellent vehicles for implementing established models of instruction (see Appendix A).

In the development of a computer-assisted instruction program, one needs a model of instruction to act as a guide for sequencing the activities involved. Gagne (1985) and Gagne et al. (1988) recommended nine instructional events which comprise a specific lesson. They are:

1. Gaining the learner's attention;
2. Informing the learner of the lesson objective or goals;
3. Incorporating recall of prior information which will activate and stimulate prior learning;
4. Presenting the stimulus through distinctive features;

5. Providing learner guidance by associating subsequent material;

6. Eliciting performance by requesting the student to recall information learned;

7. Providing feedback about correct and incorrect responses;

8. Assessing performance by requesting information recall using various methods; and

9. Enhancing retention and transfer by spacing the materials to be learned and the recall of those materials.

The researcher incorporated the nine preceding instructional events as a guide for the instructional design of this computer-assisted instruction program. Each of the nine areas were further discussed and supported under the following heading called Procedures for Instructional Design.

## Procedures for Instructional Design

In this section of Chapter 3, the researcher explains the events of instruction that were incorporated into designing the computer-assisted instruction program. The events of instruction that were used in the design process are those identified by Gagne (1985), Gagne et al. (1988), and Gagne and Driscoll (1988).

### Gaining the Learner's Attention

This computer-assisted instruction (CAI) program presented initial operating instructions by using action words, such as look, watch, identify, and press. This program included a learner-controlled menu, along with color graphics which enhance the student's interaction with the computer and disallow subsequent movement until responses are made. The menu design was based on the work of Gray (1988), Schuerman and Peck (1991), and Steinberg (1989) (see Appendix B).

Informing the Learner of the Objective

This computer-assisted instruction program provided objectives stated in behavioral terms and presented to the student at the beginning of each lesson within the CAI program (see Appendix C).

Stimulating Recall of Prior Learning

It was the investigator's intent for this computer-assisted instruction program to be used as a supplemental instructional activity subsequent to traditional classroom instruction. This CAI program may also be utilized as an instructional method without prerequisite classroom knowledge.

Presenting Stimuli

This computer-assisted instruction program provided instructional stimuli by using various methods of presentation. Printed prose in the form of a chapter in a textbook and visual static graphics in the form of pictures were the primary means of presenting the content-specific stimulus (see Appendix D).

Providing Learning Guidance

This computer-assisted instruction program provided for learning guidance through the sequencing of the content-specific materials to be learned. Instructional cues were provided which enabled the learner to recover what has been previously learned (see Appendix E). The primary instructional cues used in this CAI program were provided by referring the student to the various pictures which correlate the lesson objectives (see Appendix E).

Eliciting Performance

This section confirmed to the student what learning has taken place. This section of the computer program required the students to answer questions written in multiple-choice form and based upon Gagne's (1985) statement of eliciting performance (see Appendix F). The spacing or sequencing of questions was based upon what Steinberg (1991) identified as "questions after learning" (see Appendix F).

Providing Feedback

This computer-assisted instruction program provided immediate feedback to questions presented which were response-contingent upon the answers chosen. This was done by using two types of response-contingent feedback. The first method used was to tell the student why his or her response was wrong, and the second method was to tell the student the correct response and why it was correct (see Appendix G). The feedback design was based upon the studies of Terrell (1990) and Clariana (1990) which indicated that knowledge of correct response (KCR) provided better comprehension (as shown on post-test scores of students using CAI) than answer until correct responses (AUC).

Assessing Performance

In this computer-assisted instruction program, there is a test at the end of the program that evaluates what learning has occurred. The test assesses the student's knowledge of specific issues that are covered throughout (summative evaluation) the CAI program (see Appendix H).

Enhancing Retention and Transfer

This computer-assisted instruction program is learner-controlled. This affords the learner the opportunity to begin or review a section of the program without starting at the beginning and continuing in a linear fashion until the learner reaches the section he or she wishes to review (see Appendix I).

In addition, this program provides for the transfer of new knowledge through selected computer simulation activities. These activities provide situations that examine the application of what has been learned (see Appendix I).

## Computer Program Design

In this section of Chapter 3, a description of the procedures used in the design process for this computer-assisted instruction program is addressed. Also, a brief description of the computer software utilized to develop this CAI program is presented.

### Phase 1

The first phase in the development of this CAI program was to identify the various graphics (pictures) that would be integrated into the program. The researcher obtained permission from the American Academy of Orthopedic Surgeons (AAOS), Mosby Year Book, and the American Journal of Sports Medicine to duplicate various pictures used in this program (see Appendix J). Once permission was granted from these publishers to utilize the selected pictures, the researcher then commissioned Mr. William Swenson of Maryville, Tennessee, and Dr. Chuck Crume of Louisville, Kentucky, to reproduce the pictures using colored pencils.

After the drawings were completed, the researcher scanned the pictures using an Epson 3000 color scanner and a Zenith 386/25 Mhtz 40-megabyte-drive computer and a VGA monitor. The scanner converted the drawings to computer-format graphics by using the Picture Publisher for Windows program through the Microsoft Windows 3.0 application program. Microsoft Windows served as the application program from which Picture Publisher and P C Paintbrush were run. The researcher then edited and labeled the computer graphics using the Picture Publisher and P C Paintbrush programs.

The color graphics were edited and labeled through the P C Paintbrush program, using a Zenith 286/12 Mhtz with 40-megabyte drive. The black and white graphics were edited and labeled through the Picture Publisher program, using the same computer as utilized for the color graphics.

Phase 2

The next step in developing this CAI program was to create the instructional text, test questions, and graphics. A panel of experts was used to verify these components. The panel consisted of two orthopedic surgeons (Dr. Robert Goodwin and Dr. Craig Beard); one physical therapist (Mr. Paul Gray); and three athletic trainers (Dr. Ken Wright, Mr. Bill Edwards, and Mr. Larry Gurchiek).

The WordPerfect 5.1 program was then used for the creation of text files, the program source code (program listing), and the user's manual. After the initial files were created, the programmer chose the Turbo Pascal 6.0 program as the authoring language used to translate the files into a sequential order.

The following chapter provides an outline of the CAI program contents. This outline will allow the reader to peruse the contents without running the program. It is recommended that the reader utilize the computer program in order to comprehend the nature of the contents.

CHAPTER 4

Computer-Assisted Instruction Program Outline

In this chapter, the outline for the computer-assisted instruction (CAI) program concerning anatomy, mechanisms of injuries, and joint stability evaluations of the human knee is presented. The program reflects the compilation of material as presented in Chapters 1, 2, and 3 of this manuscript. It is recommended that the reader utilize the computer program in order to obtain a complete understanding of the program contents.

This CAI program on the human knee consists of three separate instructional units: (1) anatomical structures of the human knee joint, (2) mechanisms of selected knee-joint injuries, and (3) knee-joint stability tests. At the conclusion of each instructional unit, the student will be able to evaluate their knowledge by completing a multiple-choice test. If the student does not answer correctly the number of questions identified at the beginning of the test, equivalent to 80 percent success, then it is recommended they review the unit in question again. A fourth unit contains test questions covering the three previous units. For satisfactory performance, the student must correctly answer 24 (80 percent) of the 30 questions.

## Unit 1: Anatomical Structures of the Human Knee Joint

The first unit presents various anatomical structures of the human knee. This includes bones, ligaments, muscles, tendons, menisci, and joint classification and movement. Included in this unit are 65 individual frames. The author believes the student should first have a thorough understanding of the anatomical structures before proceeding to the mechanisms of injuries and joint stability tests.

1. Bones of the knee joint (structure and function)
    a. Femur
    b. Patella
    c. Tibia
    d. Fibula
2. Joint classification
    a. Patellofemoral joint
    b. Tibiofemoral joint
3. Joint movement
    a. Primary movement
        (1) Flexion
        (2) Extension
    b. Secondary movement
        (1) Internal rotation
        (2) External rotation
4. Ligaments (structure and function)
    a. Cruciate ligaments

(1) Anterior cruciate ligament (ACL)

(2) Posterior cruciate ligament (PCL)

b. Collateral ligaments

(1) Medial collateral ligaments (MCL)

(a) Superficial medial collateral ligament (tibial collateral ligament)

(b) Deep medial collateral ligament (capsular ligament)

(2) Lateral collateral ligament

5. Knee musculature (structure and function)

a. Knee flexion

(1) Semitendinosus

(2) Semimembranosus

(3) Biceps femoris

(4) Gastrocnemius

(5) Popliteus

b. Knee extension

(1) Vastus medialis

(2) Vastus lateralis

(3) Vastus intermedius

(4) Rectus femoris

6. Tendons (structure and function)

a. Patella tendon

b. Retinacula of patella

c. Pes anserinus tendons

d. Biceps femoris tendon

7. Menisci (structure and function)
    a. Medial meniscus
    b. Lateral meniscus
    c. Discoid meniscus
8. Ten-item multiple choice test covering Unit 1

## Unit 2: Mechanisms of Selected Knee-Joint Injuries

The second unit of this program defines the forces that produce knee injuries and presents the various mechanisms which cause knee injuries. Included in this unit are 30 individual frames. The student should understand the forces which produce and the mechanisms which cause knee injuries before learning the various joint stability tests.

1. Introduction
2. Definition of forces
    a. Compression force
    b. Tension force
    c. Shearing force
    d. Torsion force
    e. Valgus
    f. Varus
3. Mechanisms of injuries (forces that produce injury)
    a. Valgus (straight)
    b. Valgus/external rotation
    c. Varus (straight)
    d. Varus/internal rotation

e. Hyperextension

4. Five-item multiple-choice test covering Unit 2

## Unit 3: Knee-Joint Stability Tests

The third unit of this CAI program presents nine types of knee evaluation tests. The tests are designed to identify the various anatomical structures that have been injured as a result of sports participation. This unit provides a definition and description for the Abduction Stress Test, Adduction Stress Test, Anterior/Posterior Drawer Test, Lachman's Test, Lateral Pivot Shift Test, External Rotational Recurvatum Test, Apprehension Test, McMurray Test, and Apley's Compression Test. Included in this unit are 55 individual frames.

1. Introduction
2. Examination techniques
3. Joint Stability Test
   a. Abduction Stress Test
   b. Adduction Stress Test
   c. Anterior/Posterior Drawer Test
   d. Lachman's Test
   e. Lateral Pivot Shift Test
   f. External Rotational Recurvatum Test
   g. Apprehension Test
   h. McMurray Test
   i. Apley's Compression Test
4. Ten-item multiple choice test covering Unit 3

Unit 4: Comprehensive Evaluation

The fourth and final unit of this CAI program provides the student an opportunity to evaluate learning through questions presented by the computer and answered in the workbook. The goal for this unit is for the student to answer a minimum of 24 (80 percent) of 30 questions correctly. When the student successfully completes this comprehensive evaluation, they have completed the three instructional units:

(1) anatomical structures of the human knee joint,

(2) mechanisms of selected knee-joint injuries, and

(3) knee-joint stability tests.

This concludes the outline of this computer-assisted instruction program of the knee joint. The following chapter will provide a summary and conclusions of this dissertation project.

# CHAPTER 5

## Summary and Conclusions

Developing appropriate computer-assisted instruction (CAI) programs involves a number of very important variables. The amount of time required to develop CAI programs is dependent on the nature of the program, the expertise of the author, and the availability of mechanical and human resources. The time frame for this computer-assisted instruction program took approximately 18 months.

Over the past decade, the use of computers in the classroom has been an ever-increasing development. Computer usage has provided an experiential form of learning for students which supplements traditional teaching methodology. Alternative teaching methods, such as computer-assisted instruction (CAI), have great potential for use in the future as an educational tool to disseminate information to the student. Computer-assisted instruction has been widely tested and accepted as an effective method of learning (Garrett & Ashford, 1986; Niemiec, Samson, Weinstein, & Walberg, 1987; Pazdernik & Walaszek, 1983).

The field of physical education currently provides some computer-assisted instruction programs used to supplement instructional texts. However, there are limited numbers of quality CAI programs available in this discipline (Kelly, 1987).

This computer-assisted instruction (CAI) program was developed because of a need for instructional programs identified by the National Athletic Trainers Association (NATA) and the Committee on Health Education Accreditation (CAHEA) of the American Medical Association (AMA) and addresses two competencies from the psychomotor domain area. They are: (1) "location and palpation of key anatomical structures commonly involved in injury pathology including bony landmarks, ligamentous/capsular tissue, musculotendinous structures, abdominal region, etc." and (2) "use of manual muscle testing techniques, including application of the principles of the muscles/muscle group isolation, segmental stabilization, resistance/pressure, grading, etc." (NATA, 1992, p. 6). It was the authors' intent for this CAI program to reflect these competencies by articulating the various anatomical, physiological, and kinesiological aspects of the human knee.

One important feature of the CAI program was in the development of the instructional design. The learning program designed in this endeavor was based theoretically upon the most recent information available and utilized an eclectic approach.

Following the development of the program rationale and instructional design, the author identified the program contents which consisted of written text, tests, static graphics, and workbook. The CAI program requires the student's interaction with the computer and workbook, providing feedback and reinforcement to the instruction. After the author compiled the various components needed to complete the CAI, a panel of experts was used for validation purposes. The author plans to subject this CAI program to reliability and validity confirmation at selected universities during the summer of 1993.

## Suggestions and Recommendations

There are several suggestions and recommendations the author would like to make regarding the development of computer-assisted instruction programs:

1. There seems to be a need for the adoption of a uniform instructional paradigm to be used in sequencing CAI programs.

2. Agreement concerning evaluative instruments seems essential when attempting to compare and evaluate CAI programs.

3. Selection of a computer programmer whose knowledge encompasses the multiple aspects of CAI programs is critical.

4. CAI programs can address individual needs in ways that classroom instruction cannot (i.e., high degree of feedback and interaction involved); however, it is more expensive, takes longer to prepare, and is more complex to administer.

# APPENDICES

# APPENDIX A

# CAI FRAMEWORK COMPONENTS

# APPENDIX A

# CAI FRAMEWORK COMPONENTS

## Target Population

B. F. Skinner (1968) indicates that alternative methods of instruction, such as the use of teaching machines, will not affect how students are grouped according to ability because it is possible for each student to proceed through a lesson at his or her own pace. Also, through the use of teaching machines, a student will master a unit before proceeding to the next level of instruction.

Bruner (1960) indicates that teaching which emphasizes structure of a subject is probably more valuable for the less-gifted student than for the gifted student because the less-gifted students tend to struggle more with instruction that is not structured. Therefore, properly written computer-assisted instruction (CAI) programs that are structured or sequenced can be utilized as a method of instruction for an intellectually diverse group of students.

Gagne, Briggs, and Wager (1988) proposed that instructional designers should: (1) reduce the diversity of learning characteristics among class members by identifying learning characteristics that are common to all and (2) once the common learning characteristics have been identified, provide an instructional design that is appropriate to these variations.

## Goals

Instructional lessons are designed to help the learner achieve a prescribed set of outcomes (Steinberg, 1991). Craig (1966) stated that motivation is an internal state which directs individuals toward related goals. "Although motives reside within the learner, they can be influenced from without" (Craig, 1966, p. 8). Motivational activities can be provided by the teacher through controlling the various learning opportunities and offering incentives for learning (Craig, 1966).

B. F. Skinner (1968) believed that behavior is shaped by a process where the instructor or teacher selects the desired outcomes (goals) and approximates the conditions of the lesson so reinforcement can occur. B. F. Skinner also believed that in order to receive a reward (which will strengthen learning) the individual must do something or operate on the environment. He uses the term operant conditioning to refer to this behavior (see Chapter 2).

Gagne and Driscoll (1988) concur with Craig (1966) by indicating that in order for goals to be achieved, learners need to be motivated. They also indicated that on some occasions, learners may not be motivated toward achieving a goal. Therefore, motivation may be established by communicating to the learners what they can expect to happen as a result of their learning activity.

## Tasks

Bruner (1971) states that "any body of knowledge can be presented in a manner that . . . any particular learner can understand" (p. 44). Bruner (1971) presents three ways in which he believes any domain of knowledge can be represented. The first is through action and is called enactive representation. This is when experience is used to conduct the required task. The second way knowledge is presented is called iconic representation which refers to a set of images or graphics that represents a certain concept. The third and final way a body of knowledge can be represented is through symbolic representation. A symbolic system or task requires a transformation of propositions which are governed by rules or laws (see Chapter 2).

Hill (1977), reporting on the works of Thorndike, states that Thorndike's law of effect (which simply refers to meaningful reinforcement of the stimulus-response bond) reflects the way instructional goals and tasks are designed. In other terms, to achieve satisfying consequences through stimulus-response bonding, the teacher must design instruction that will elicit this type of behavior.

Bransford (1979) indicates that tasks should be dependent upon the nature of materials to be learned. Bransford (1979) states that some instructors identify certain tasks by predicting the "readability of various materials so they can be geared to the current level of knowledge and skills of the learner . . ." (p. 87), while others try to identify students' abilities by assessing performance on certain types of materials.

Gagne (1985) agrees with Bransford (1979) regarding task identification by stating that tasks must be categorized according to projected learning outcomes. Gagne identifies these learning outcomes as intellectual skills, cognitive strategies, verbal information, motor skills, and attitudes (see Chapter 2).

## Instruction

Athey and Rubadeau (1970) report that Piaget's concepts of intelligence are derived from experiences of interaction upon the environment. Piaget believes that mental structures are developed from birth and altered through the process of assimilation and accommodation (see Chapter 2). The twin processes of assimilation and accommodation are of particular importance when designing an instructional lesson because knowledge always involves a mental operation which permits one to transform the instructional material presented into a context of what one already knows.

B. F. Skinner (1968) indicates that the application of operant conditioning to education is a simple process. Instruction in this context is the "arrangement of special contingencies which would otherwise be acquired slowly or making sure of the appearance of behavior which might otherwise never occur" (p. 65). He also states that teaching machines which employ programmed instruction can provide for contingencies of reinforcement.

Steinberg (1991) defines instruction as a set of "activities arranged by the instructional designer to facilitate learning" (p. 35). She also states that computers are excellent vehicles for implementing established models of instruction.

Bruner (1971) states that instruction "must facilitate the exploration of alternatives . . ." (p. 43) (discovery learning) because learning and problem-solving depend upon alternative choices. Gagne and Driscoll (1988) indicate that instructional designers must keep in mind the external events of instruction that influence the learning processes when planning for instruction.

APPENDIX B

GAINING LEARNERS’ ATTENTION

# APPENDIX B

## GAINING LEARNERS' ATTENTION

Gray (1988) studied the effects of two different types of computer-assisted instruction (CAI) sequence control menus on 96 sociology students at a New York university. The dependent variables were based on comprehension, retention, and attitudes toward the two types of menus. The "broad menus" (Gray, 1988, p. 58) presented students with instructional sequencing options on one menu, while the "deep menus" (p. 58) broke the decision selection procedure down into three narrower menu screens. The results of this study showed that the breadth and depth of menus to select from did not affect the attitudes or comprehension toward the CAI. The breadth and depth of menu selection did, however, affect the retention of instructional content. Gray concluded by stating that "significant attention should be directed to the semantic categories used in the construction of CAI menus" (p. 59).

Steinberg (1989) performed a meta-analysis of cognition and learner control by reviewing related studies from 1977 to 1988. Steinberg identified learner control as the student's ability to select the desired learning activities as programmed through the CAI lesson. Computer-controlled instruction was identified as instruction being controlled or sequenced by the computer, thus not allowing the student instructional leniency.

Steinberg (1989) states that learner control can "alleviate boredom, frustration, and anxiety . . . because it allows the students to skip materials they have previously learned or avoid materials they choose not to study" (p. 117). Steinberg concluded by stating that instructional control within a lesson should shift from computer control to learner control and vice versa because of the diverse learning abilities between students.

Schuerman and Peck (1991) investigated the effects pull down menus (PDM) versus static menus (return to main menu design or RMM and return to sub-menu design or RSM) had on students in choosing the sequential order of learning activities using CAI. The subjects investigated were 75 undergraduate students studying a lesson on Bloom's Taxonomy of Educational Objectives. The pull-down menu was a semipermanent display across (horizontal) the top of the screen called a <u>menu-bar</u>. The static menus consisted of a full screen selection with the major headings (RMM and RSM) listed in a vertical fashion which provided sub-menus when a major heading was chosen. There were 25 students assigned to one of the three conditions, consisting of PDM, RMM, and RSM.

The students assigned to the PDM were able to choose at any time the sequence of material to be reviewed. The students in the RMM were able to do the same as the PDM, although they were returned to the main menu. The students placed in the RSM were also able to choose, at any time, a new lesson to review, although they were returned to the sub-menu.

The results of this study indicated that all three menus were browsed in a random fashion, but the students in the PDM group had a tendency to look at specific lessons without performing the instructional activity. The students in the RMM and PDM lessons were only faced with one decision about which activity to select, while the RSM group was faced with two decisions because they were returned to the sub-directory of the main menu. The RSM condition promoted significantly stronger sequencing of the instructional material which the authors attribute to location of the lesson in relationship to the return-to-menu option.

In conclusion, Schuerman and Peck (1991) indicated that instructional designers should place or sequence material that is closely related or material that is prerequisite to the next in the same sub-menu, regardless of the type of menu chosen.

# APPENDIX C

# LEARNING OBJECTIVES

# APPENDIX C

## LEARNING OBJECTIVES

Gagne (1985) states that when learners comprehend the objective of instruction, "they will acquire an expectancy that normally persists throughout the time learning is taking place which will be confirmed by the feedback given when learning is complete" (p. 246). Gagne, Briggs, and Wager (1988) indicate the objective should state in simple terms what the students will have accomplished once they have completed the lesson or what they will be able to do when learning has been completed.

Gagne and Driscoll (1988) stated that if students have a knowledge of what they will be able to do once the lesson is completed, they (students) can develop an expectancy of new information that will enable the learner to accommodate what is being presented.

# APPENDIX D

# INSTRUCTIONAL STIMULI

# APPENDIX D

## INSTRUCTIONAL STIMULI

The stimulus presented as a lesson of events is dependent upon what is to be learned (Gagne & Driscoll, 1988). Gagne (1985) states that the content material must be specific to the objective, regardless of the task required for the activity. Gagne also states that "when the text in prose form is the stimulus, techniques of making features distinctive include underlining or using bold print and topic headings" (p. 252). Gagne and Driscoll (1988) indicate that when identification of an object is required, the parts of the object may be separately outlined and labeled in a diagram to which students may refer while making observations. This is provided to the student in this CAI program by presenting the picture with the textual material surrounding the picture.

Jones (1989) stated that graphics can greatly enhance a CAI program if used correctly. "One screen of graphics can meet the need for many screens of text" (Jones, 1989, p. 66). Jones also stated that if the computer screen displays only text the student might as well read a textbook. "The use of attractive screens in CAI programs increases interaction . . . and stimulates and maintains interest" (p. 67).

Aspillaga (1991) investigated the effects computer screen design has on learning, using 60 undergraduate students taking an entry-level Spanish class using a computer-assisted instruction program. The study consisted of two purposes: (1) whether displaying text information overlapping onto relevant parts of graphics enhances learning and (2) whether displaying information at consistent locations on the computer screen enhances learning.

The results of this study showed that information which is overlapping a relevant aspect of the graphics does facilitate learning, as compared to information placed in a random location. The results also showed that information placed in a consistent location within the monitor screen facilitated the transfer of learning.

# APPENDIX E

# LEARNING GUIDANCE

# APPENDIX E

## LEARNING GUIDANCE

Gagne (1985) indicates that the guidance of learning may consist of either "verbal communication . . . or through pictures, graphics or tables" (p. 311). Gagne (1985) also states that if verbal directions (communication) are used, their function is not necessarily instruction, but used in a sense of telling the learner what to do at any given time. "Pictures and diagrams may be used in instruction to provide concrete visual images to serve an encoding function" (p. 311). The use of pictures in instruction serves the important function for supporting the student's ability to recall information.

Gagne, Briggs, and Wager (1988) state that instructional cues do not tell the learners the answers being sought, but they "rather suggest the line of thought which will presumably lead to the desired combining of subordinate concepts and rules to form the new to be learned rule" (p. 187). The main point on learning guidance is whatever form of guidance is presented, its main purpose is to assure a form of "encoding" (Gagne & Driscoll, 1988, p. 123) that will enable the learner to later recover what has been learned and display that learning into some kind of performance.

# APPENDIX F

# ELICITING PERFORMANCE

# APPENDIX F

## ELICITING PERFORMANCE

Gagne (1985) states that "eliciting performance" (p. 254) in a lesson is the section in which the learner is required to demonstrate the newly acquired knowledge. Gagne also indicates that eliciting performance should reflect the type of lesson objective stated. If the lesson required verbal information, then the student is asked to "tell it" (p. 255). If the lesson requires a cognitive strategy (problem-solving), then the student may be required to use a strategy to provide a solution. If the lesson requires a motor skill, then the student will be required to exhibit performance. Gagne and Driscoll (1988) noted that asking the student to exhibit what has been learned is an external event that requires internal processing on the student's part to accomplish the task.

Steinberg (1991) reports that "questions may be presented before instruction begins, during instruction and after instruction has been completed" (p. 103). Questions asked before learning can serve as a placement device so the students can evaluate whether they need to cover that section. Questions asked during learning can be used to gain and maintain students' attention, to provide a formative evaluation, and to encourage remembering (Steinberg, 1991).

Steinberg (1991) also notes that questions presented after instruction provide three uses: (1) "they assess each learner's knowledge and skills"; (2) "they provide information about the performance of an entire group"; and (3) "they assess the effectiveness of the lesson" (p. 105). The frequency of questions should vary according to the difficulty of the instructional material presented. Steinberg states that "if students need a considerable amount of structure and guidance, then a question should be asked on every display" (p. 109). Steinberg also notes that questions asked after two or three displays might be appropriate for college students.

APPENDIX G

FEEDBACK

# APPENDIX G

## FEEDBACK

Gagne (1985) reports that "following the performance which shows that learning has occurred" (p. 254) there has to be some type of communication provided to the learner about the correctness of the performance. Gagne and Driscoll (1988) refer to this as informative feedback and state that informative feedback must occur in order for reinforcement to exist.

Gagne, Briggs, and Wager (1988) note that many times feedback is automatically provided, such as seeing the placement of a dart on a dart-board. They also state that "there are no standard ways of phrasing or delivering feedback . . . but the important characteristic of the communication is not its content but its function" (Gagne, Briggs, & Wager, p. 189).

Steinberg (1991) disagrees somewhat with Gagne, Briggs, and Wager (1988) because she identifies inappropriate feedback as "insulting verbal messages, flashing graphic displays, and unpleasant sounds" (p. 127). Steinberg (1991) also indicates that "negative reinforcement and information that a response is incorrect may decrease the probability that a learner will repeat an incorrect response, but it does not necessarily help him learn the correct one"

(p. 37). Steinberg concludes by stating that feedback should be presented to the student in an explicit manner. A vague response sometimes leaves the students wondering if the answer they gave was right or wrong.

Several studies have shown effective methods to present feedback in computer-assisted instruction programs. Clariana (1990) compared the effectiveness of answer until correct responses (AUC) and knowledge of correct responses (KRC) (which are types of feedback used in the CAI programs) using a social studies CAI program. The subjects evaluated were 32 eleventh-grade students enrolled in a summer ACT preparation course with previous ACT scores no higher than 15 and no lower than 10. The author described these students as "academically low-ability" (p. 126) based upon their test scores.

The KCR feedback required the students to make one response to each question with the correct answer given after the initial response. The AUC feedback required the students to respond for a second time if the incorrect response was given the first time. After the second attempt to answer the question, regardless of the student's response, the computer displayed the correct answer to the question.

The results of this study showed that KCR mean post-test scores were higher than the AUC mean post-test scores. Clariana (1990) concluded by stating that knowledge of correct response (KCR) feedback is more effective for low-ability students than the answer until correct (AUC) feedback.

Terrell (1990) also investigated the effects feedback has on student cognition, using 41 Army aviation students taking a course in aerial navigation. The experimental group was divided into two groups (14 subjects per group) who received supplemental CAI training in addition to regular navigation training. One group (computer-remediation) received feedback that presented the correct answer and a brief explanation following an incorrect response. The other group (student-remediation) was required to work the navigational problem again, following an incorrect response. The control group consisted of 13 subjects who only received standard navigational training.

The result of this study showed that both experimental groups (computer-remediation and student-remediation) scored higher on the post-test than the control group. The results also showed that of the errors made on the post-test, the student remediation group spent more time in correcting the mistakes than those in the computer remediation or control groups.

In conclusion, Terrell (1990) makes two recommendations that are relevant to the results of this study. The first was that the results suggest that feedback in CAI "should be designed to remediate errors made by presenting correct answers and explanations of how correct answers can be derived" (p. 95). The second suggestion made by Terrell was that CAI errors could be followed by corrective feedback that provides hints, but not complete answers, and then provide an opportunity for the students to work the problem again.

# APPENDIX H

# ASSESSING PERFORMANCE

# APPENDIX H

## ASSESSING PERFORMANCE

Performance that accompanies new learning is simply a verification that learning has occurred (Gagne, 1985). Gagne (1985) suggests that in order to be sure that learning has occurred and is indeed present, "it is necessary to require additional instances of the performance" (p. 255). Giving a test is certainly one way of assessing performance. Gagne (1985) states that tests have two primary functions: (1) "establish that the newly learned capability has reasonable stability" and (2) "provide additional practice that serves to consolidate what has been learned" (p. 255).

Gagne and Driscoll (1988) note that a single performance reflecting new learning is not adequate to measure the "dependability" (p. 125) of learning. Therefore, to measure the application of new learning, these authors suggest that students need to demonstrate a performance a number of times.

## APPENDIX I

## RETENTION AND TRANSFER

# APPENDIX I

## RETENTION AND TRANSFER

Gagne and Driscoll (1988) state that provisions for enhancing retention and retrieval of new learning should be in the form of "spaced reviews" (p. 125). Gagne and Driscoll (1988) and Gagne, Briggs, and Wager (1988) indicate that the recall of new learning is greatly enhanced when multiple examples are spaced in time following the initial learning.

Gagne, Briggs, and Wager (1988) state that transfer of learning can be accomplished by designing a variety of new tasks for the learner: "These tasks should require the application of what has been learned in situations that differ substantially from those used for the learning itself" (p. 190).

Salisbury (1990) notes that spaced practice and spaced reviews seem to be a very important factor in enhancing the retention of learned materials. On the issue of spaced practice, Salisbury notes that spaced practice is considerably more effective than massed practice because the "learning context on each occasion is somewhat different" (p. 25) which causes the information to be coded differently each time. Salisbury states that CAI programs should allow the learner to stop and resume practice sessions without having to go back to the beginning of the drill.

Computer simulation has been used in numerous academic domains (Verbeek, 1987). Medical education has provided numerous studies on the utilization of computer-assisted instruction and programming (Hmelo, 1990). Norman, Tugwell, and Feightner (1982) investigated the validity of using computer-simulated patients versus real patients to train medical students. The subjects consisted of 10 medical resident students. The simulated patients were created from four actual patients with chronic conditions and stable findings. The simulated patients were created from the findings of the real patients. The residents were then instructed to interview and examine all eight (four real and four simulated) patients. A comparison was made between the real and simulated patients, looking specifically at four areas: (1) data-gathering, (2) critical data elicited from the patient, (3) diagnosis, and (4) the use of investigations.

The results of this investigation showed that there was no difference between the simulated patients and the real patients in the amount of data-gathering activity, in the diagnostic procedures, and in the planned investigations. The residents were then asked to identify by name which patients were real and which were simulated. The results showed that the residents correctly identified 67 percent of the patients as real or simulated, and several of the residents stated that the only basis for identification was a direct comparison of the presentation.

Norman, Tugwell, and Feightner (1982) concluded by stating that the residents' performance with simulated patients "is a valid approximation of cognitive performance with actual patients" (p. 715).

Verbeek (1987) wrote about the utilization and development of a CAI simulation program used for self-instruction by medical students at the University Hospital in Leiden, Netherlands. Verbeek stated that the rationale for the development and utilization of the simulation program stemmed from changes in medical education. At one time, medical education was primarily disease-oriented and has moved since to problem-oriented education. Verbeek stated that this posed problems because problem-based education requires interaction among students, and this was impossible to accomplish in lecture halls which housed large audiences. From this, various CAI programs were developed for individual usage by the medical students.

The type of program Verbeek explained was a program developed to train students in clinical problem-solving. The program simulates some of the steps doctors take in their decision-making processes. Verbeek's (1987) program consisted of three major areas: (1) "collection of data which includes patients' history, physical examinations, lab tests, x-rays, CT scans, etc."; and (2) "diagnosis based on the collected data"; and (3) "choice of treatment" (p. 11).

Verbeek (1987) also reported on five issues that he feels are important for medical educators who have an interest in developing CAI programs that include simulation.

1. A teacher must be able to write a clinical case in several hours.

2. The author should not be concerned with the computer language.

3. When a new case or patient file is created, it should be a very simple process to modify the content.

4. If the teachers are not happy with the program, the program should be flexible so changes can be made.

5. The program should be user-friendly and easy to access on personal computers.

Verbeek (1987) concluded by stating that "computer assisted instruction will never be able to replace bedside teaching; however, it may be an excellent adjunct in clinical teaching" (p. 10).

APPENDIX J

LETTERS OF APPROVAL

# APPENDIX J

## LETTERS OF APPROVAL

January 19, 1992

American Academy of Orthopaedic Surgeons
C/O Monica Trocker
Publications Office
222 South Prospect
Park Ridge, IL 60668

Dear Ms. Trocker

My name is Randy Deere. I am currently a doctoral student in the Department of Health, Physical Education and Recreation, at Middle Tennessee State University in Murfreesboro, TN.

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| | 21.5 on p. 320 | | 21.29 on p. 346 |
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213 April Way
Bowling Green, Ky. 42104

I look forward to receiving your reply.

Sincerely,

Randy Deere

Randy Deere

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M. L. Fox / mmt
Marilyn L. Fox, PhD
Assistant Director, Publications

National Athletic Trainers Association, Inc.
PROFESSIONAL EDUCATION COMMITTEE
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Indiana State University
Terre Haute, Indiana 47809
(812) 237-3026

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Best wishes with your dissertation.

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Robert S. Behnke, H.S.D., A.T.,C.
Chair, NAJA Professional Education Committee

RB/lb

cc: A. Culbertson

N A T A

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Amanda W. Culbertson
Acting Executive Director

cc: Robert S. Behnke, HSD, ATC

August 18, 1992

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Dear Publisher,

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Sincerely,

Randy Deere

Randy Deere

American Academy of Orthopaedic Surgeons
222 South Prospect Avenue, Park Ridge, Illinois 60068-4058
Phone 708 823-7186 • 800 346-AAOS • Fax 708 823-8125

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Sincerely,

Monica M. Trocker

Monica M. Trocker, Production Editor
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Aug. 25, 1992

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Anastasia Broderick, Manager
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ab
Attachment

August 29, 1992

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American Orthopaedic Society for Sports Medicine
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Attn: Permissions Department

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I am in the process of proposing my dissertation topic for the Doctor of Arts Degree in Physical Education. The dissertation involves the writing of a computer assisted instructional program. To complete the dissertation, I am requesting your permission to duplicate an illustration from the following text:

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I look forward to receiving your reply.

Sincerely,

Randy Deere

Randy Deere
PERMISSION IS GRANTED FOR USE BY:

Robert Leach MD — 9/6/92

ROBERT E. LEACH, M.D., EDITOR, AJSM — DATE

September 2, 1992

Randy Deere
Physical Education
Smith Stadium
Western Kentucky University
Bowling Green, Kentucky 42101

Dear Randy,

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After Arnheim, 1991

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APPENDIX K

CAI WORKBOOK

ANATOMY, MECHANISMS OF INJURIES, AND JOINT-STABILITY EVALUATIONS OF THE HUMAN KNEE

# PREFACE

This dissertation is a nontraditional type designed to fulfill requirements for the Doctor of Arts Program at Middle Tennessee State University. The study has resulted in the development of a theoretically based computer-assisted instruction program. Due to the nature of its contents, the following manual does not adhere to a standard dissertation format.

TABLE OF CONTENTS

# GETTING STARTED

## Computer Requirements

This program can be installed and executed on an IBM-AT-compatible computer. It is recommended that a computer have no less than 16MHz clockspeed. It is possible to run the program on a slower computer, but the lapse time between screens would be considerably longer. A hard drive with a minimum of three megabytes of memory and a VGA-compatible monitor are required. A printer is recommended to print the lessons displayed throughout the program.

## Installation Instructions

### Steps to Install and Execute the Program

Insert disk 1 in drive A and type A: now press ENTER. When the DOS prompt indicates the computer is reading drive A, type INSTALL, and press ENTER. The installation program will instruct you to replace the disk if necessary. Once installation has been completed, the message Installation Completed will be displayed.

To initiate the computer program, change the directory to the DOS prompt which reads the hard drive. Type the name of the program by completing the following instructions:

Type CD\KNEE and press ENTER,

Type KNEE and press ENTER.

Files Included

Included with this manual are 5.25-inch and 3.5-inch disks. These disks contain the executable program together with the graphics and lesson files. KNEE EXE is the program you need to run to start the lessons. Programs with the extension PCX or TIF are graphic files. They each contain a picture that will be used by the executable program during a session. TXT extension files contain the text to be used.

# RUNNING THE PROGRAM

## Introduction

The first screen is the introductory screen. The name of the program and purposes are provided. After the first screen, the Main Menu will appear.

## Using the Menu

Use the arrow keys to move to the different options identified on the menu. When the option you want is highlighted, press the ENTER key to select it. All the lessons can be run through the menu. Use the Exit program option to terminate program execution.

## Executing Lessons

Choose the option All lessons to execute all the lessons available. Choose Start at lesson . . . to start at a specific part of the program. Once this option is selected, you will be asked the lesson number you want to execute.

## User Evaluation

A test cannot be executed unless a lesson has been reviewed by the student first. The evaluation questions are all in multiple-choice form. The student will be allowed two opportunities to respond correctly. If the student is correct, the program will notify the student.

At the end of each test, a message will be displayed, showing a percentage of the score. If the score is not acceptable, a suggestion will be made to repeat the current lesson. Regardless of the test outcome, the student will have the opportunity to return to the previous lesson or continue to the next lesson.

## Glossary

A glossary is available during the execution of a lesson. To call the glossary, press the F3 key. To search for a term while in the glossary, press the F4 key. A new window appears, and the student will enter the string of characters to match. When a match is found, the text with the string will appear. An appropriate message will be displayed if the string is not found. To exit the glossary window, press the F10 key.

## Keyboard Definition

There are special purpose keys that are defined throughout the program. Most of these keys will be available at all times. Key definitions follow:

| Key | Description |
|---|---|
| F1 | Help key--contains keyboard definition descriptions. |
| F2 | Alternate graphic switch. Whenever there is more than one graphic available for the text displayed, a label will appear at the bottom of the screen showing the key name and the abbreviation of its function. When the F2 key is pressed, the graphics will be switched. |

| Key | Description |
| --- | --- |
| F3 | <u>Glossary</u>. A glossary of terms is available when the student is studying a lesson. A new window is displayed on the screen with the terms. While in this window, the student is able to press the F4 key which allows the search of a specific string pattern. The F10 key exits the glossary. |
| F4 | Open the <u>lookup window</u> during the glossary. The user is allowed to enter a string of characters to match a glossary term. |
| F10 | <u>Exit key</u>. Use this key to exit the current task and return to the previous screen (i.e., exit the glossary window). |
| PgUp | <u>Page up</u>--displays previous screen (used during a lesson). |
| PgDn | <u>Page down</u>--displays next screen (used during a lesson). |
| Down arrow | <u>Down arrow</u>--moves the highlighter one option down (used with the menu). |
| Up arrow | <u>Up arrow</u>--moves the highlighter one option up (used with the menu). |
| Enter | <u>Select option</u> from the menu. |

# OUTLINE OF CAI ACTIVITIES

I. Unit 1--Anatomical Structures of the Human Knee Joint

A. Bones of the Knee Joint (structure and function)

1. Femur
2. Patella
3. Tibia
4. Fibula

B. Joint Classification

1. Patellofemoral Joint
2. Tibiofemoral Joint

C. Joint Movement

1. Flexion
2. Extension
3. Internal Rotation
4. External Rotation

D. Ligaments (structure and function)

1. Anterior Cruciate Ligament (ACL)
2. Posterior Cruciate Ligament (PCL)
3. Superficial Medial Collateral Ligament (Tibial Collateral Ligament)
4. Deep Medial Collateral Ligament (Capsular Ligament)
5. Lateral Collateral Ligament

E. Knee Musculature (structure and function) Flexion

1. Semitendinosus
2. Semimembranosus
3. Biceps Femoris
4. Gastrocnemius
5. Popliteus

F. Knee Musculature (structure and function) Extension

1. Vastus Medialis
2. Vastus Lateralis
3. Vastus Intermedius
4. Rectus Femoris

G. Tendons (structure and function)

1. Patella Tendon
2. Retinacula of Patella
3. Pes Anserinus Tendons
4. Biceps Femoris Tendon

H. Menisci (structure and function)

1. Medial Meniscus
2. Lateral Meniscus
3. Discoid Meniscus

II. Unit 2--Mechanisms of Selected Knee-Joint Injuries

A. Definition of Forces that Produce Knee-Joint Injuries

1. Compression Force

2. Tension Force
3. Shearing Force
4. Torsion Force
5. Valgus
6. Varus

B. Mechanisms of Injuries

1. Valgus (straight)
2. Valgus/External Rotation
3. Varus (straight)
4. Varus/Internal Rotation
5. Hyperextension

III. Unit 3--Knee-Joint Stability Tests

A. Examination Techniques

B. Joint Stability Tests

1. Abduction Stress Test
2. Adduction Stress Test
3. Anterior and Posterior Drawer Test
4. Lachman's Test
5. Lateral Pivot Shift Test
6. External Rotational Recurvatum Test
7. Apprehension Test
8. McMurray Test
9. Apley's Compression Test

IV. Unit 4--Comprehensive Evaluation

A. Bones and Joint Classification and Movement (10 questions)

B. Ligaments, Tendons, Muscles, and Meniscus
(13 questions)

C. Mechanisms of Injuries and Joint-Stability Tests
(7 questions)

# UNIT 1

# ANATOMICAL STRUCTURES OF THE HUMAN KNEE JOINT

BONES OF THE KNEE JOINT

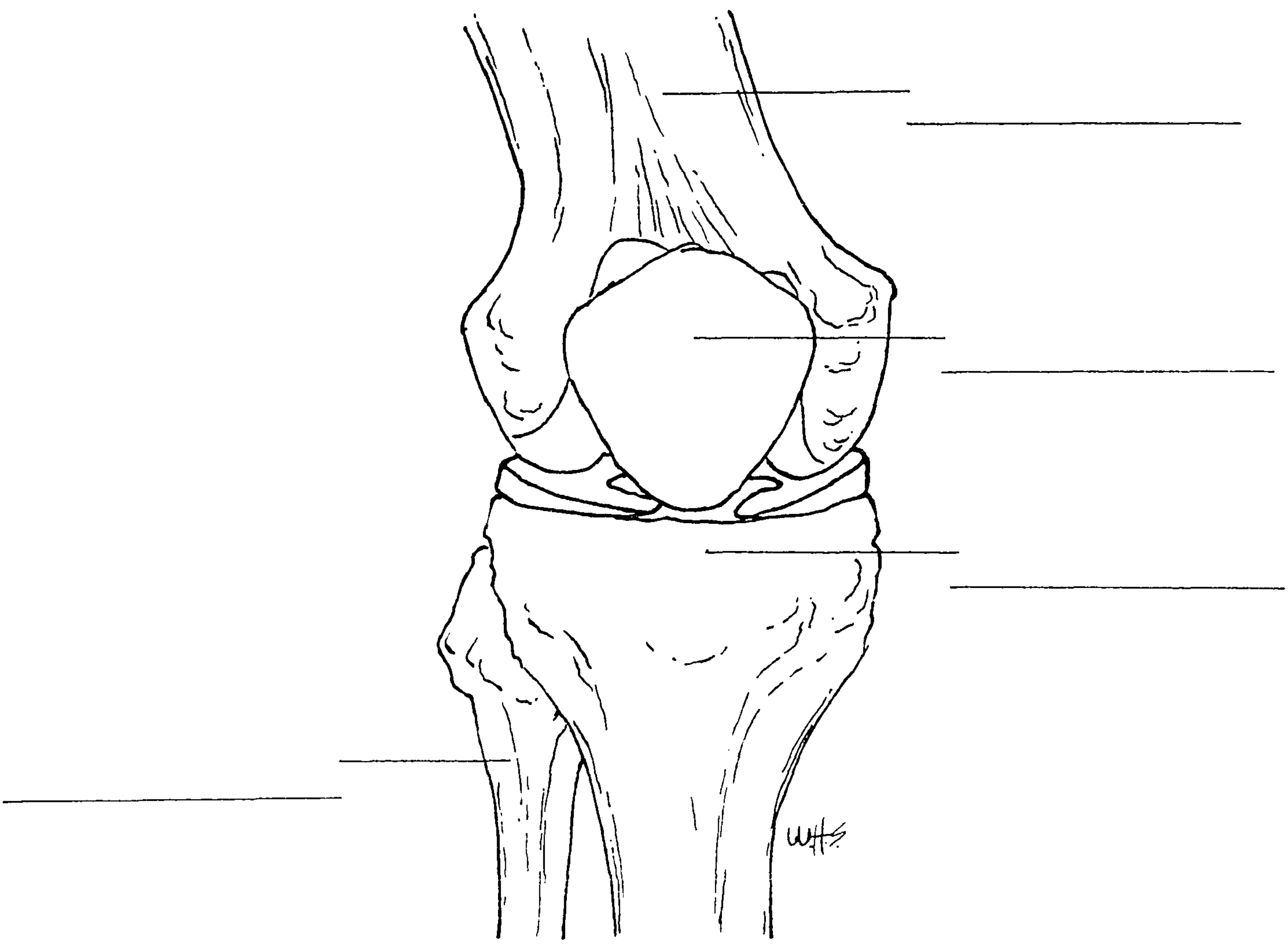



FIGURE 1.1

JOINT CLASSIFICATION

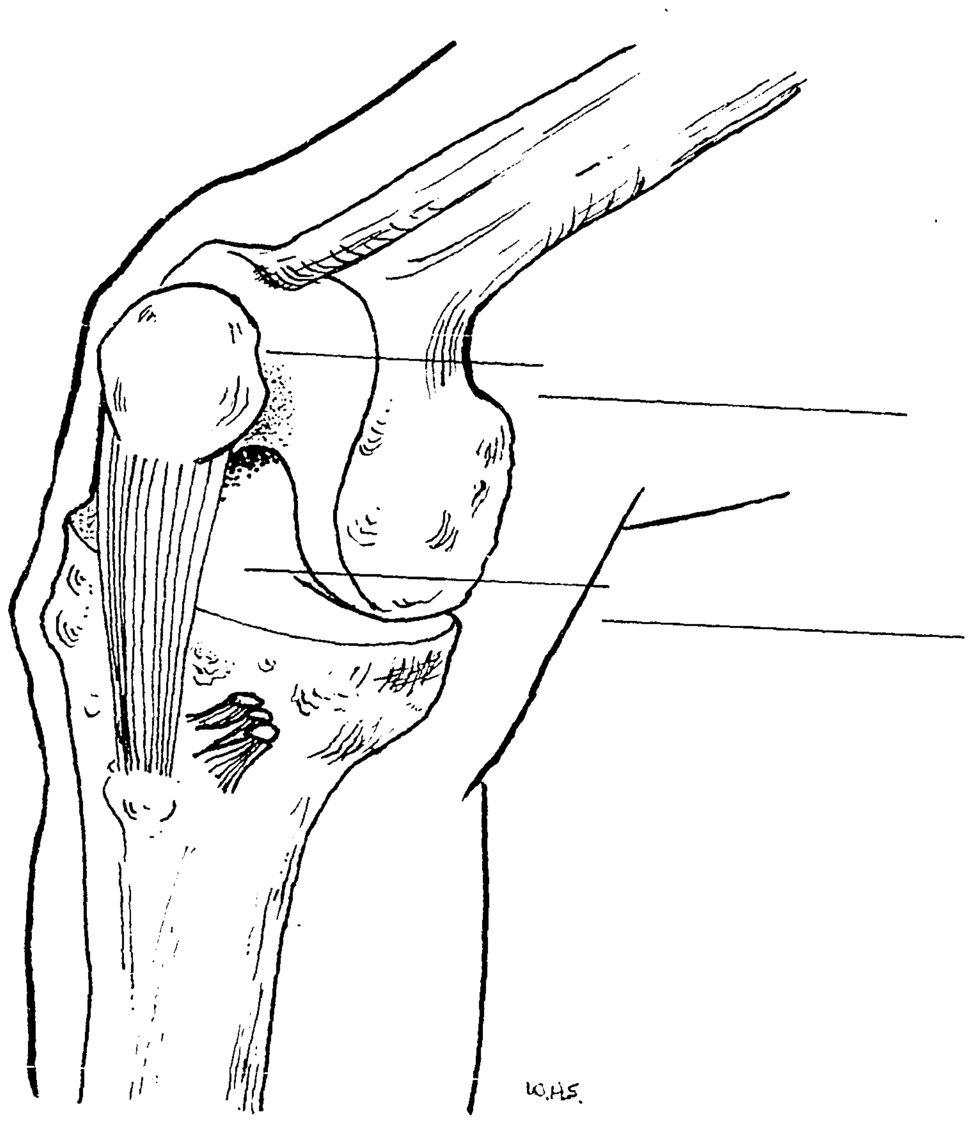



FIGURE 1.2

JOINT MOVEMENT (PRIMARY)

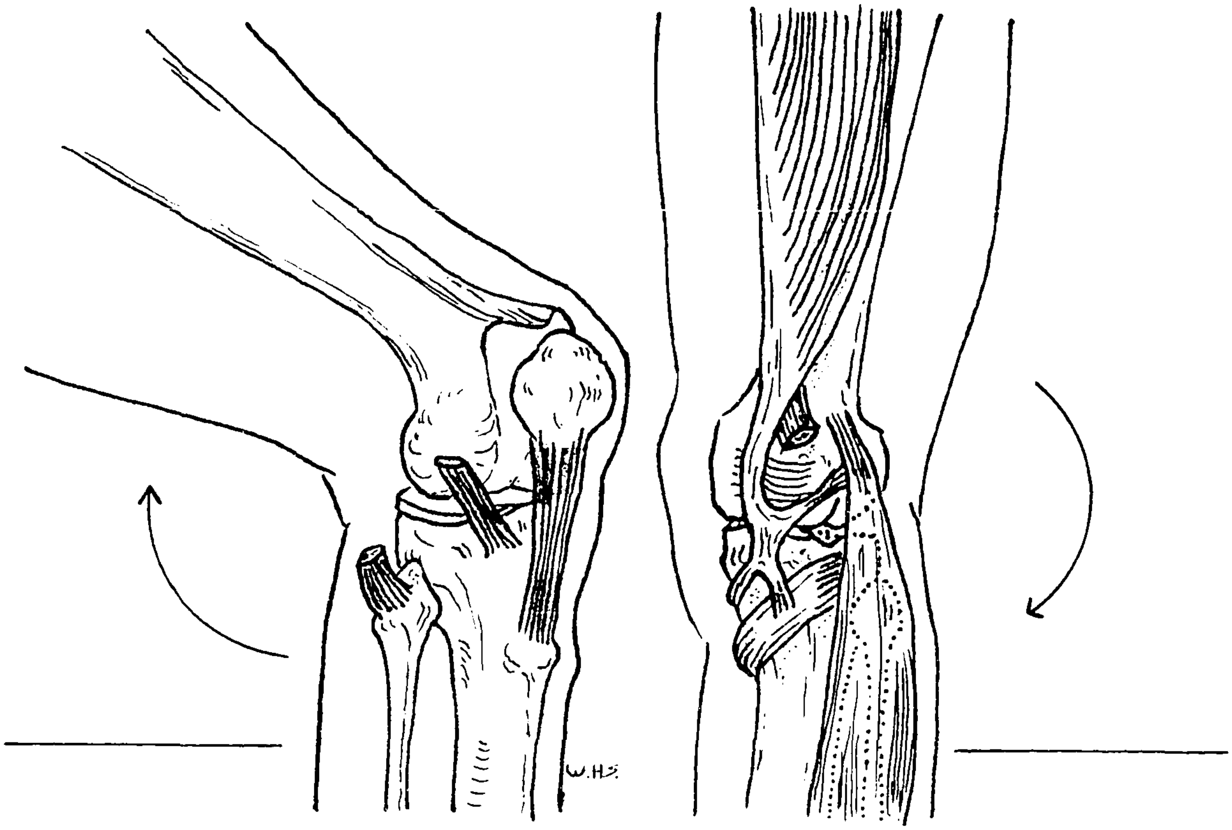



FIGURE 1.3

JOINT MOVEMENT (SECONDARY)

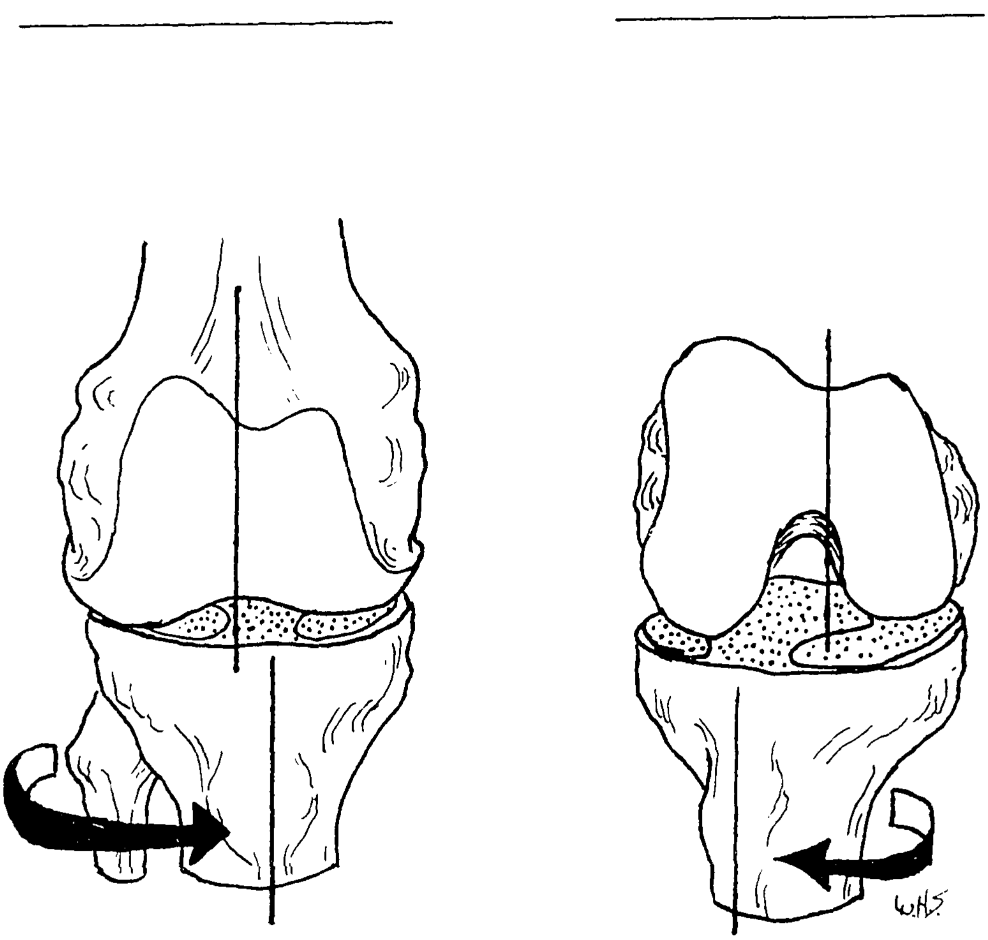



FIGURE 1.4

CRUCIATE LIGAMENTS

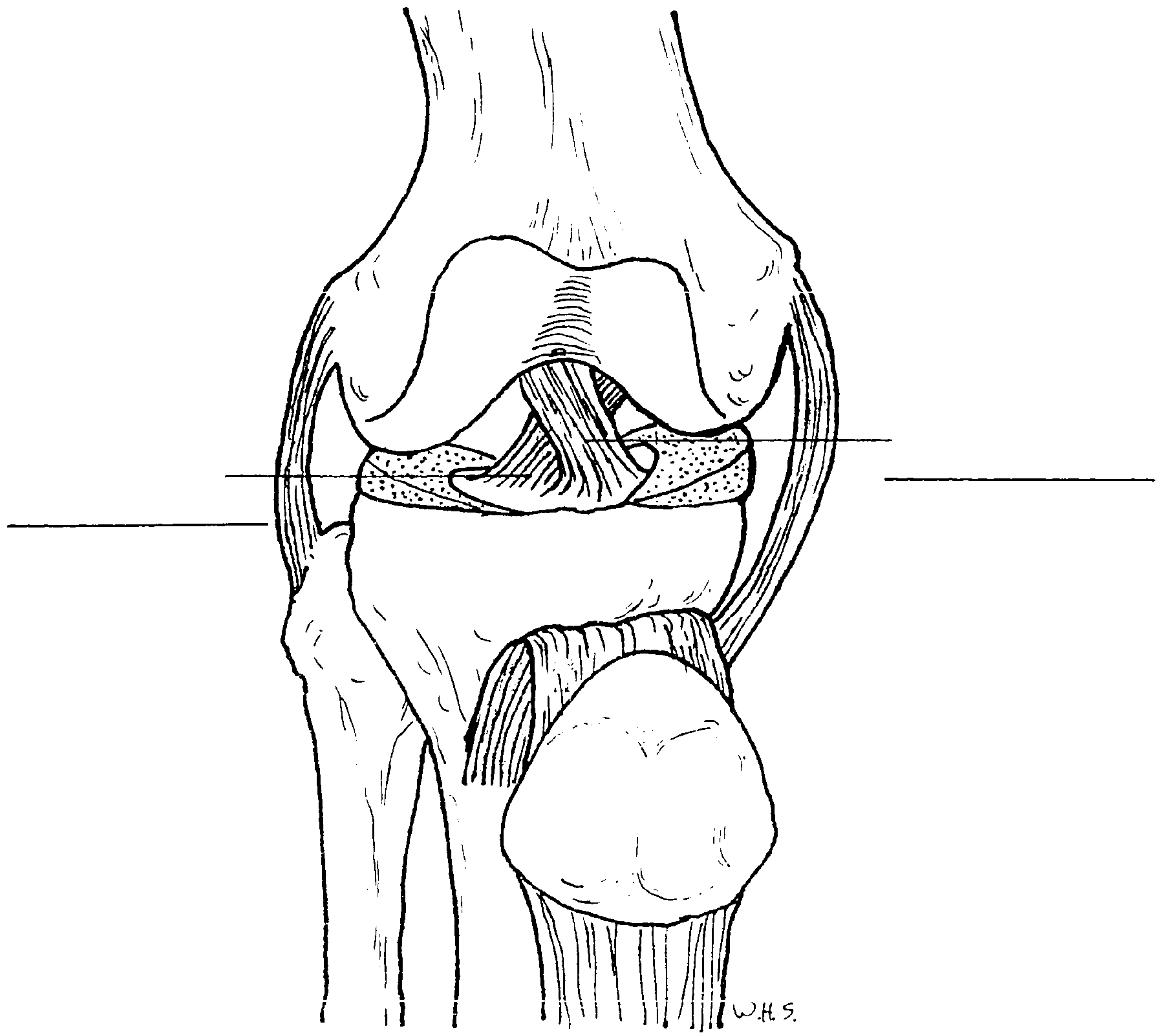



FIGURE 1.5

MEDIAL COLLATERAL LIGAMENTS (MEDIAL VIEW)

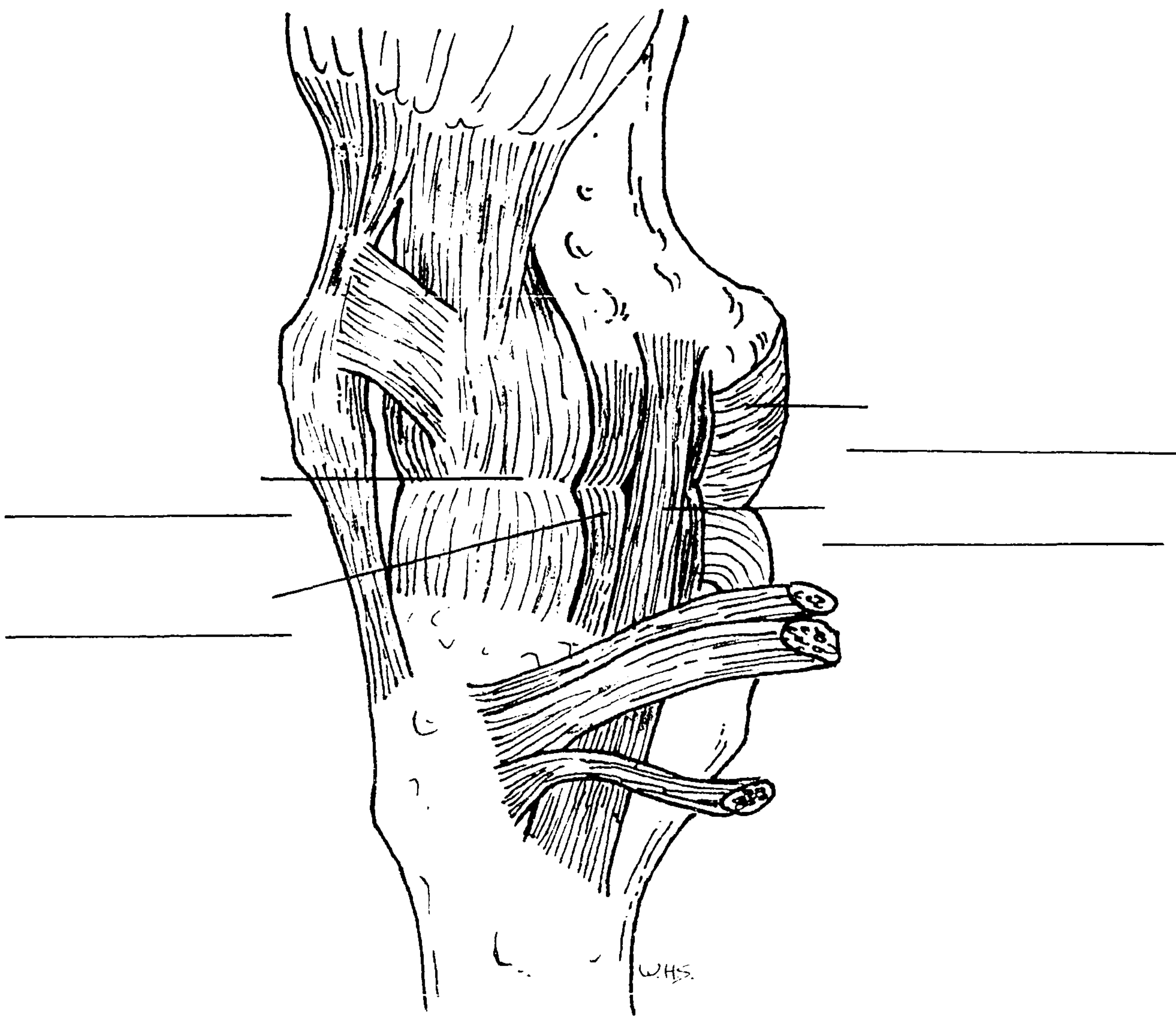



FIGURE 1.6

LATERAL COLLATERAL LIGAMENT (LATERAL VIEW)

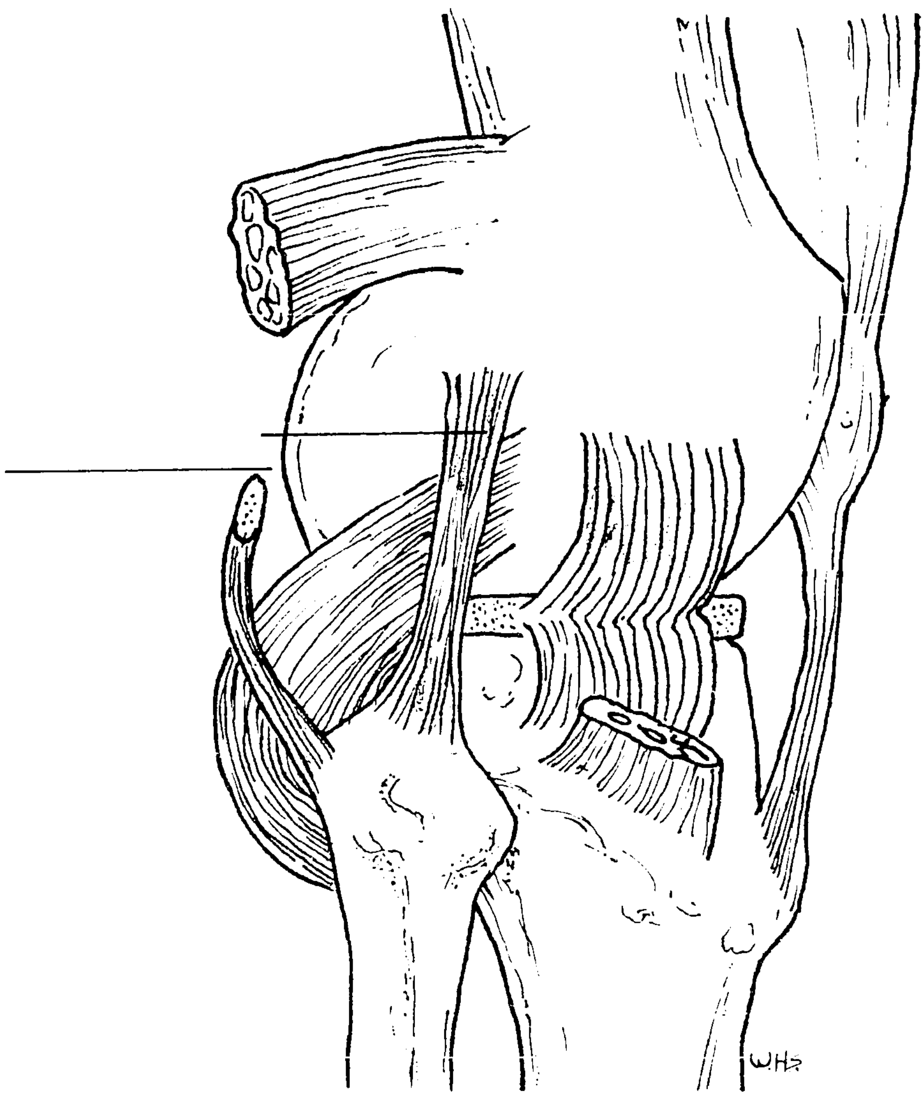



FIGURE 1.7

KNEE MUSCULATURE (POSTERIOR VIEW)

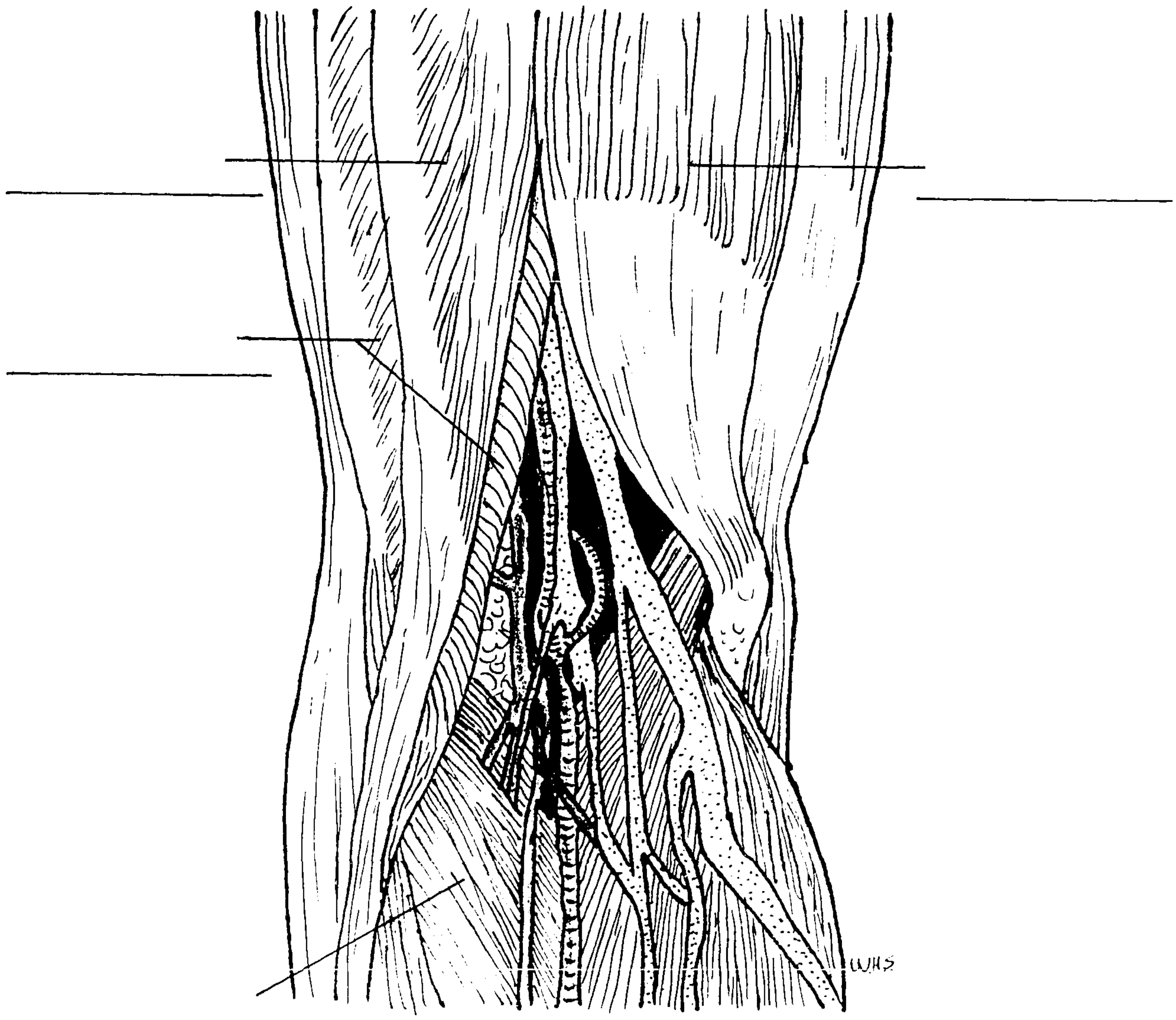



FIGURE 1.8

KNEE MUSCULATURE (POSTERIOR VIEW)

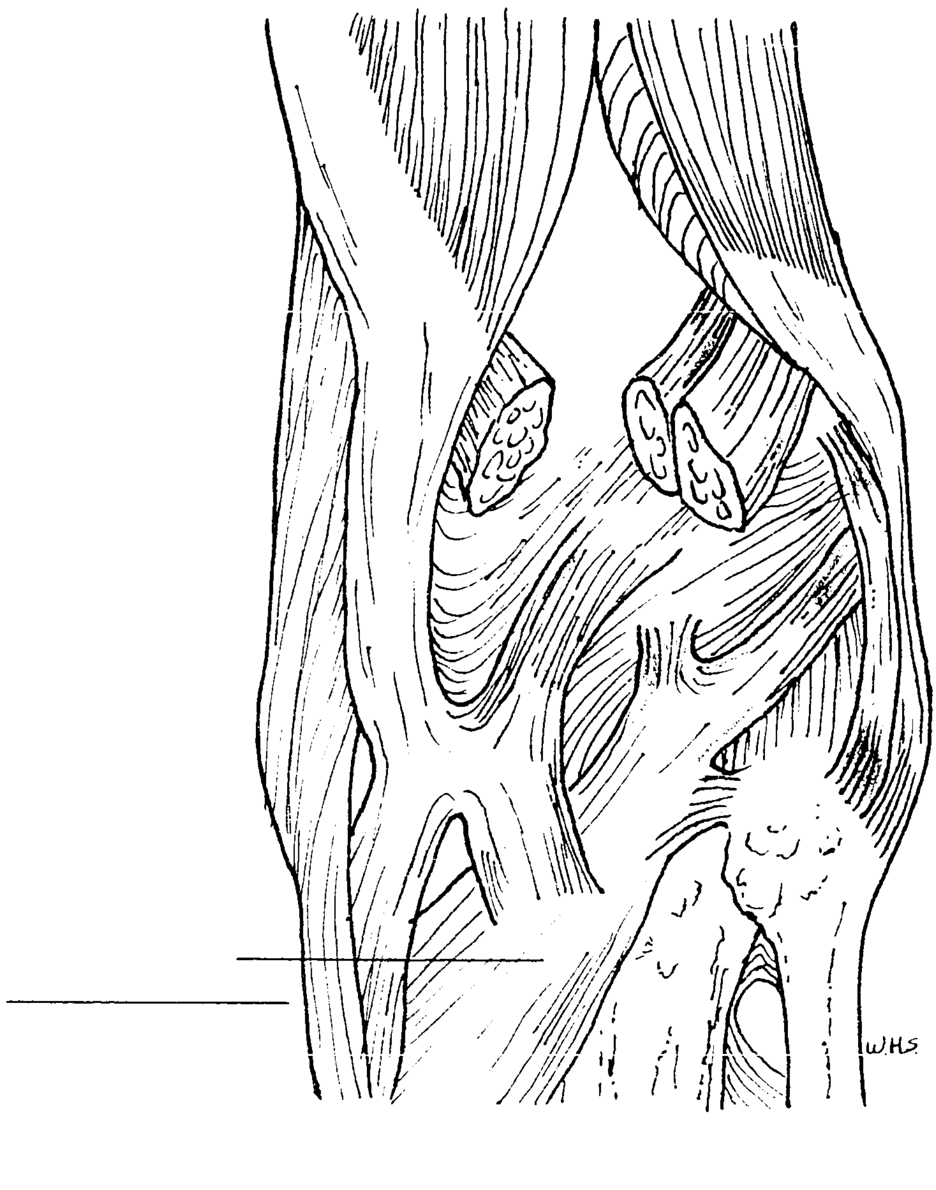



FIGURE 1.9

KNEE MUSCULATURE (ANTERIOR VIEW)

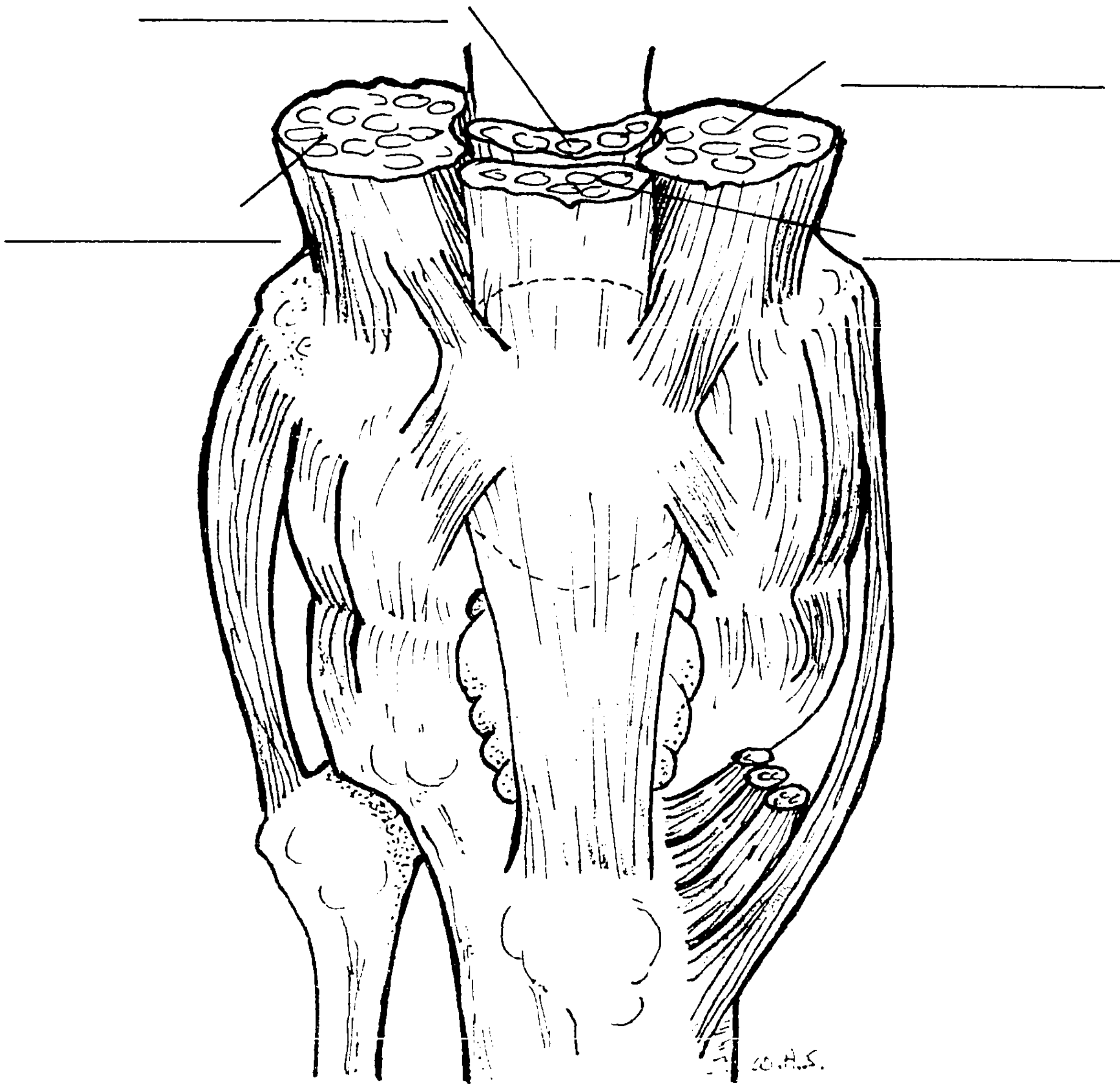


FIGURE 1.10

KNEE TENDONS (ANTERIOR VIEW)

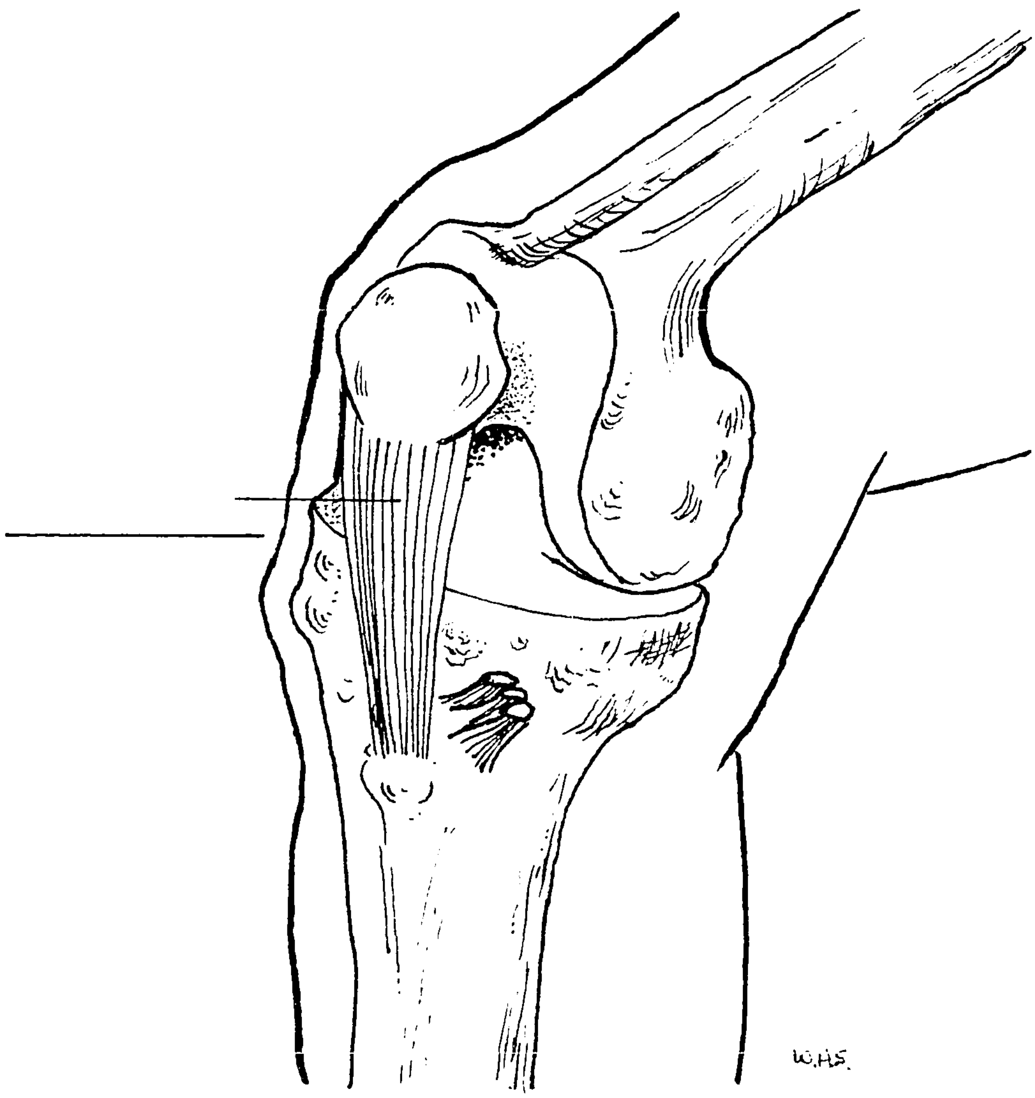



FIGURE 1.11

KNEE MUSCULATURE (ANTERIOR VIEW)

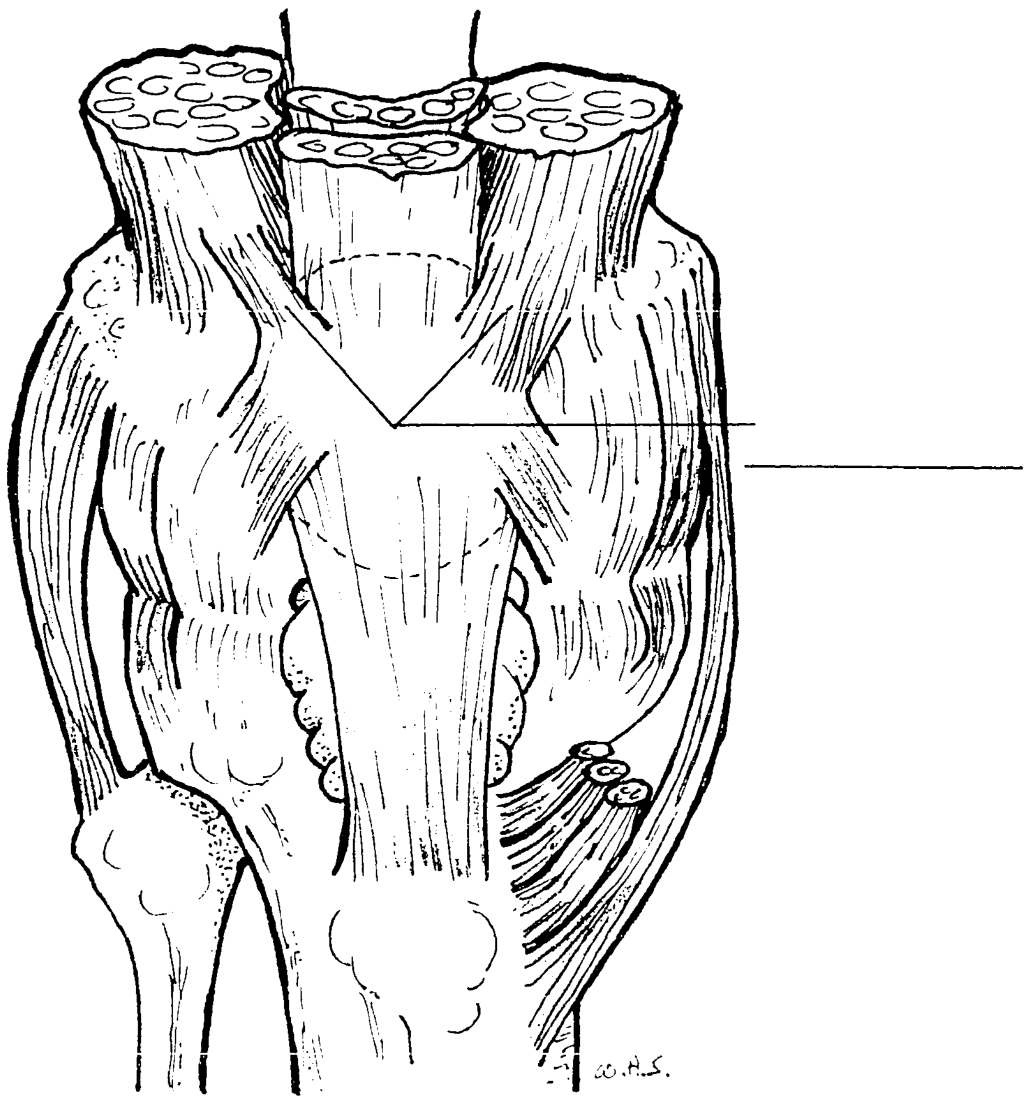



FIGURE 1.12

KNEE TENDONS (MEDIAL VIEW)

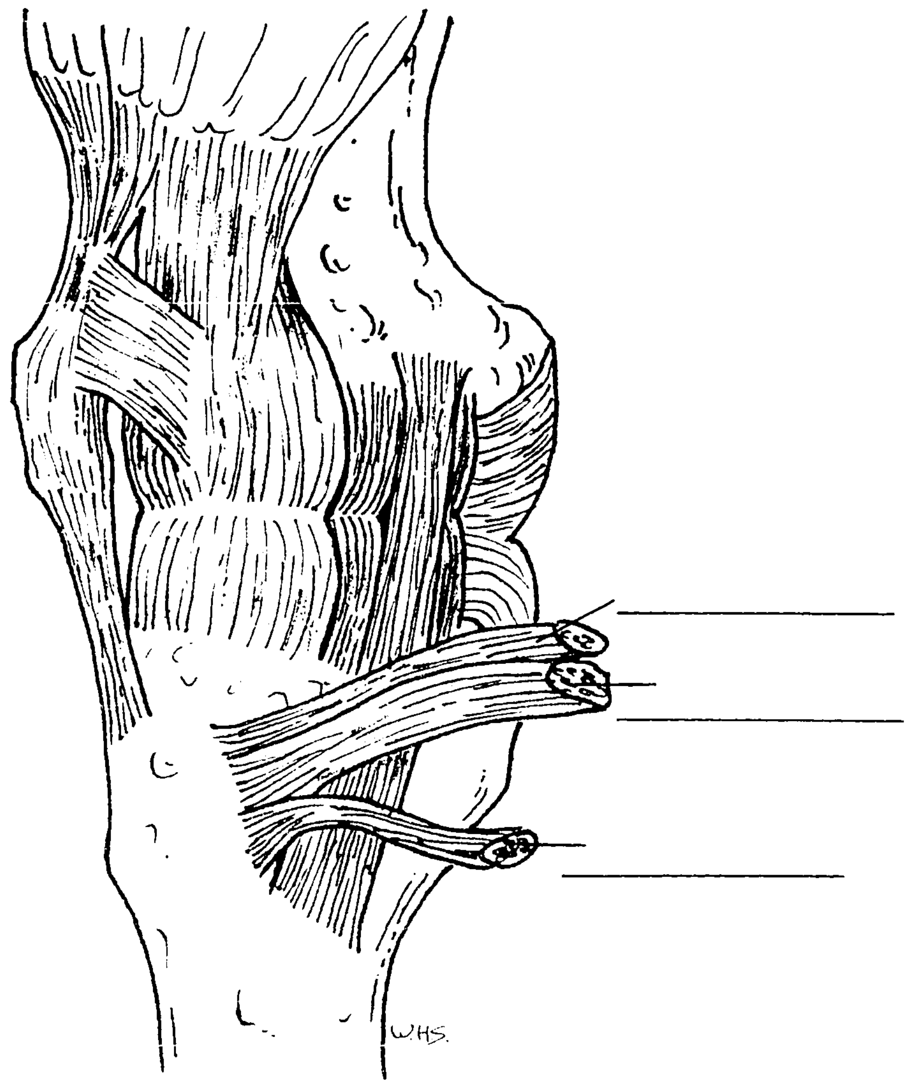


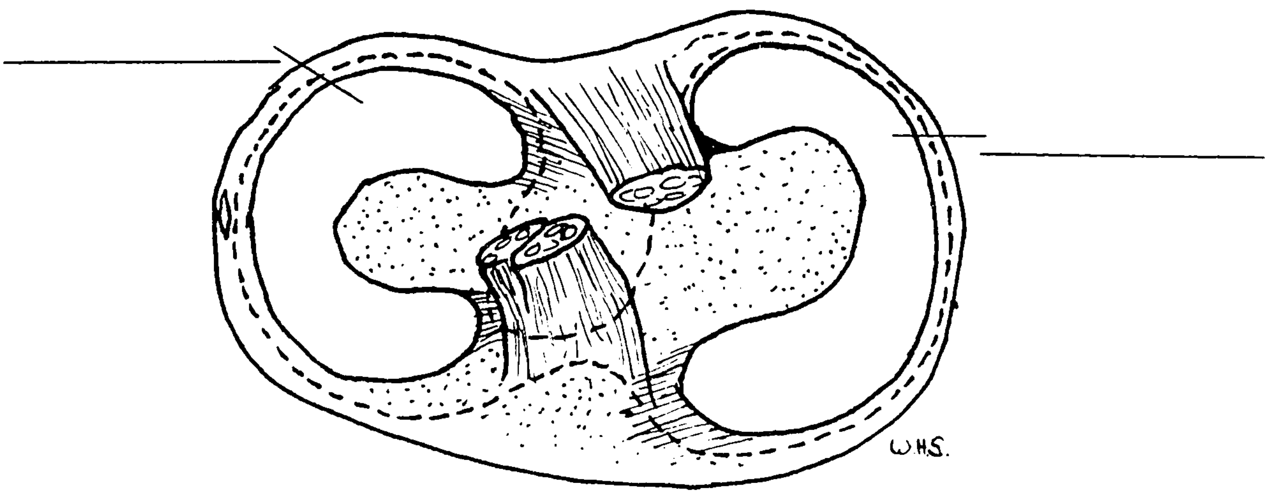

FIGURE 1.13

KNEE MUSCULATURE (MEDIAL VIEW)


FIGURE 1.14

KNEE MENISCI (TRANSVERSE VIEW)

Posterior Cruciate




Anterior Cruciate

FIGURE 1.15

KNEE MENISCI (TRANSVERSE VIEW)

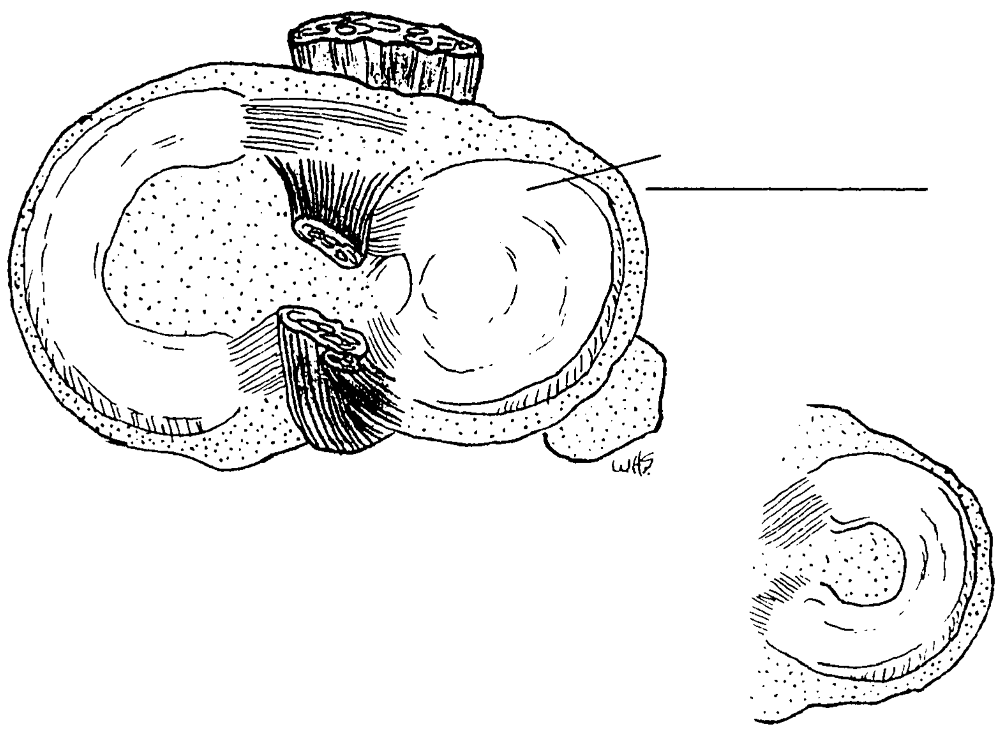


FIGURE 1.16

# UNIT 2

# MECHANISMS OF SELECTED KNEE JOINT INJURIES

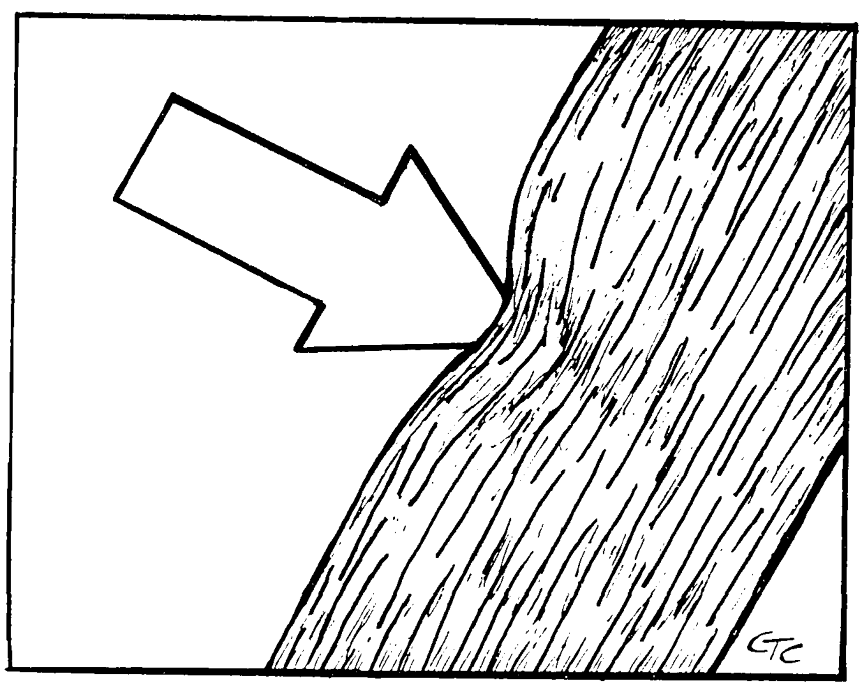



FIGURE 2.1

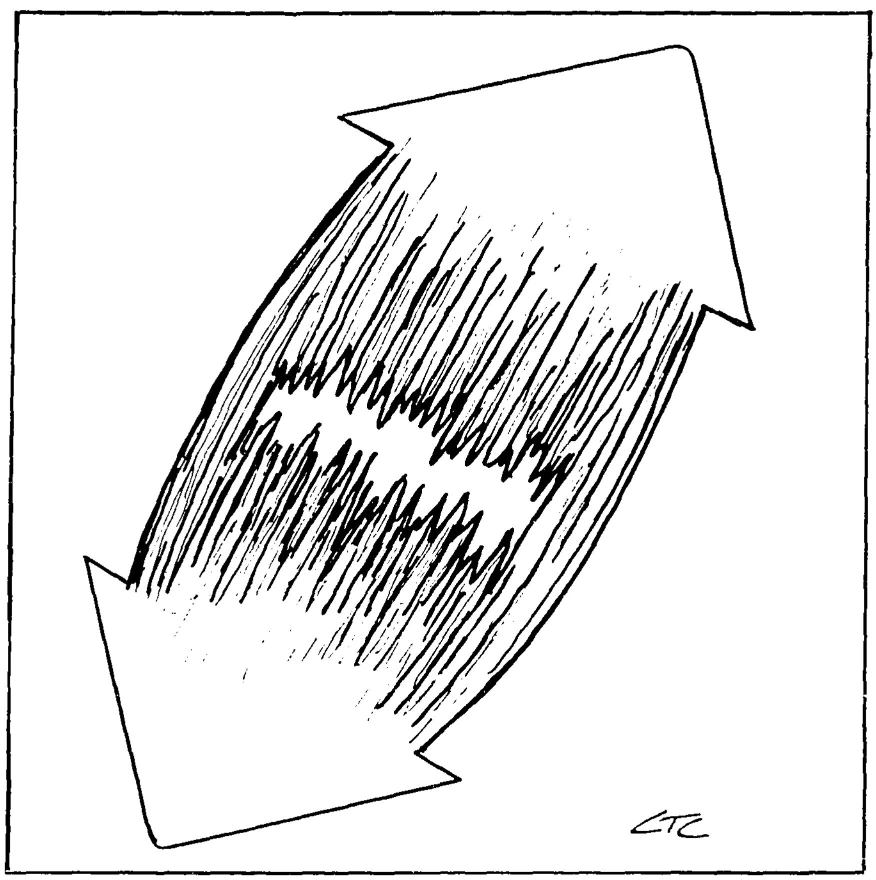



FIGURE 2.2

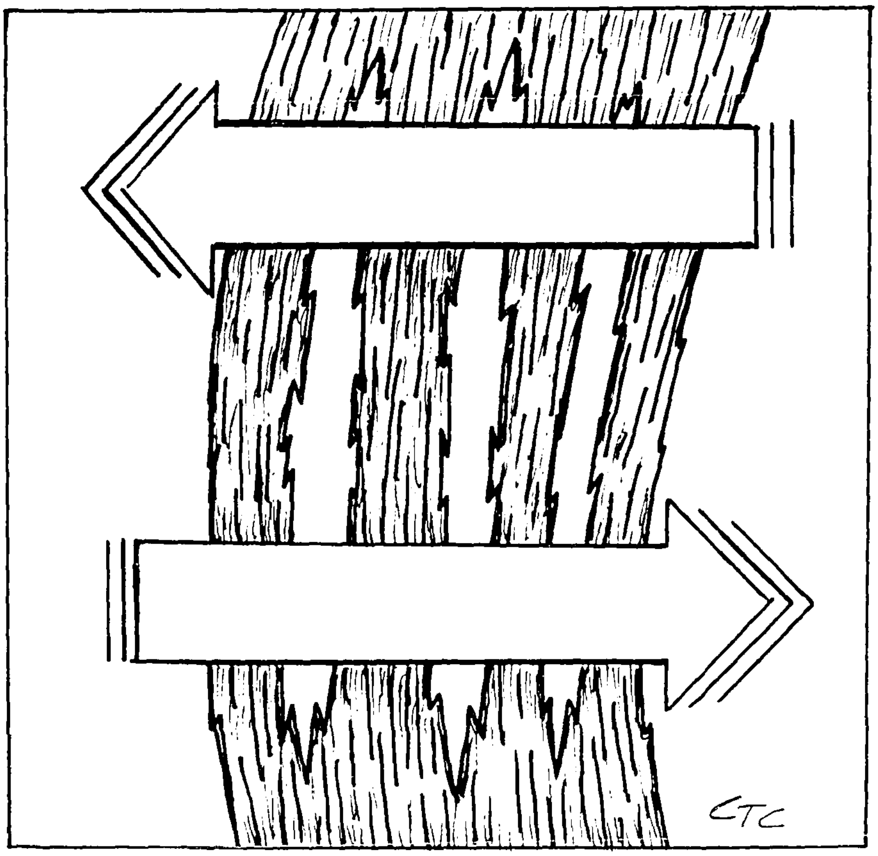



FIGURE 2.3

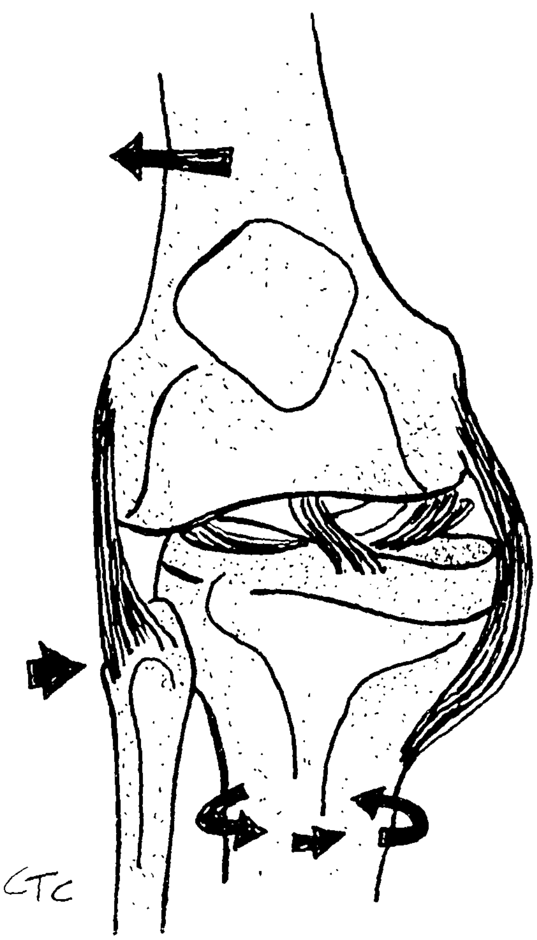



FIGURE 2.4

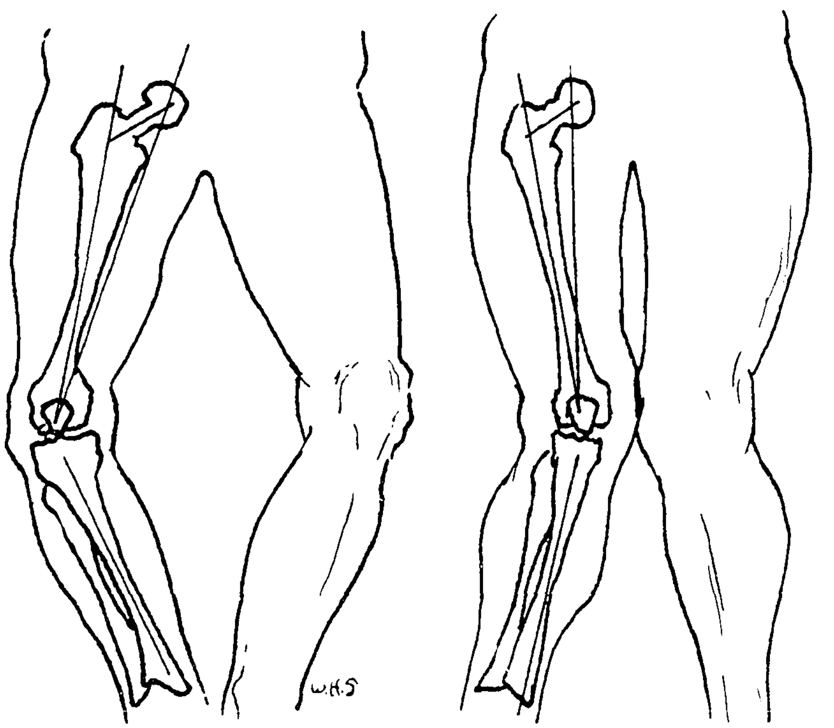



FIGURE 2.5

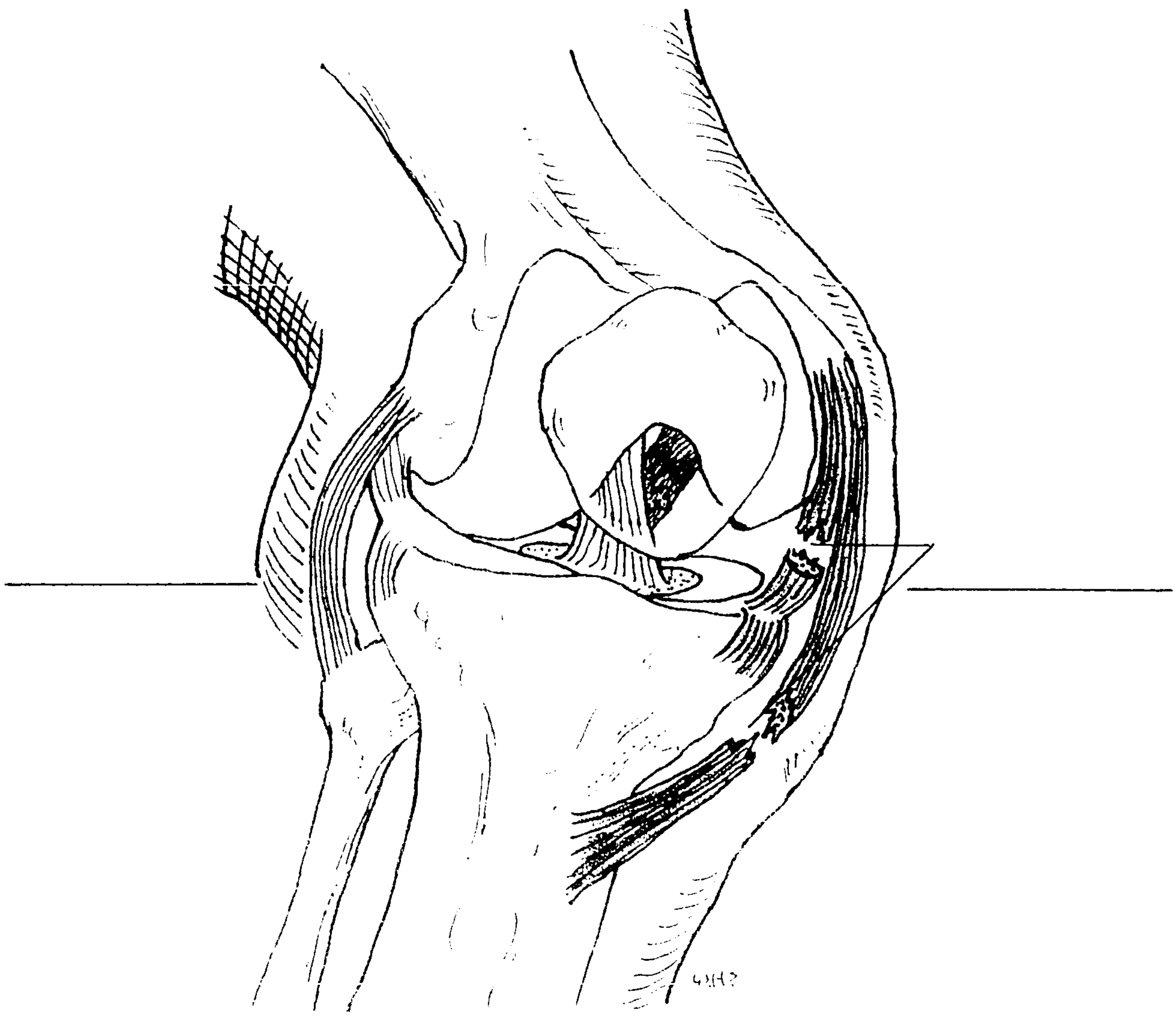


FIGURE 2.6

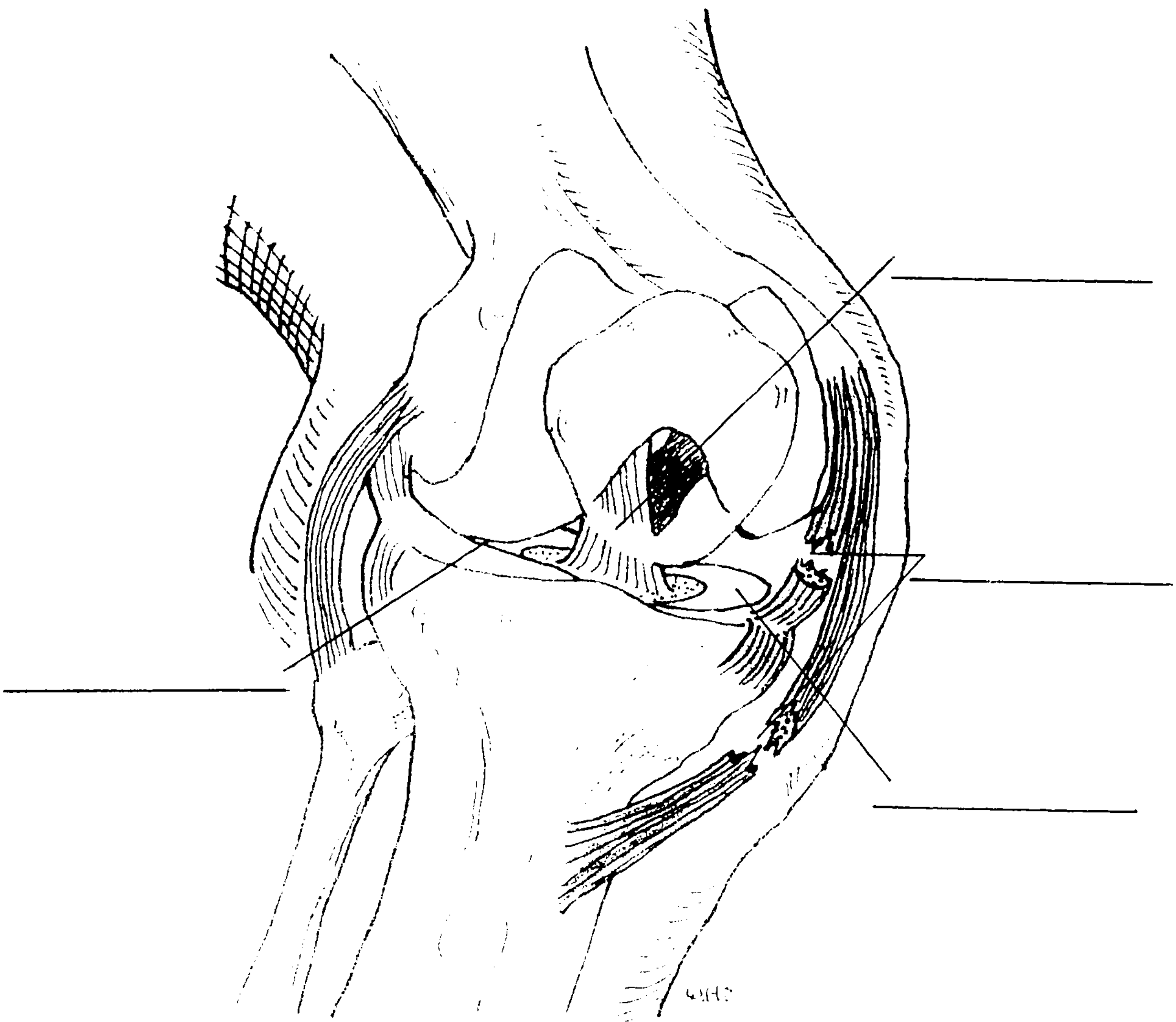


FIGURE 2.7

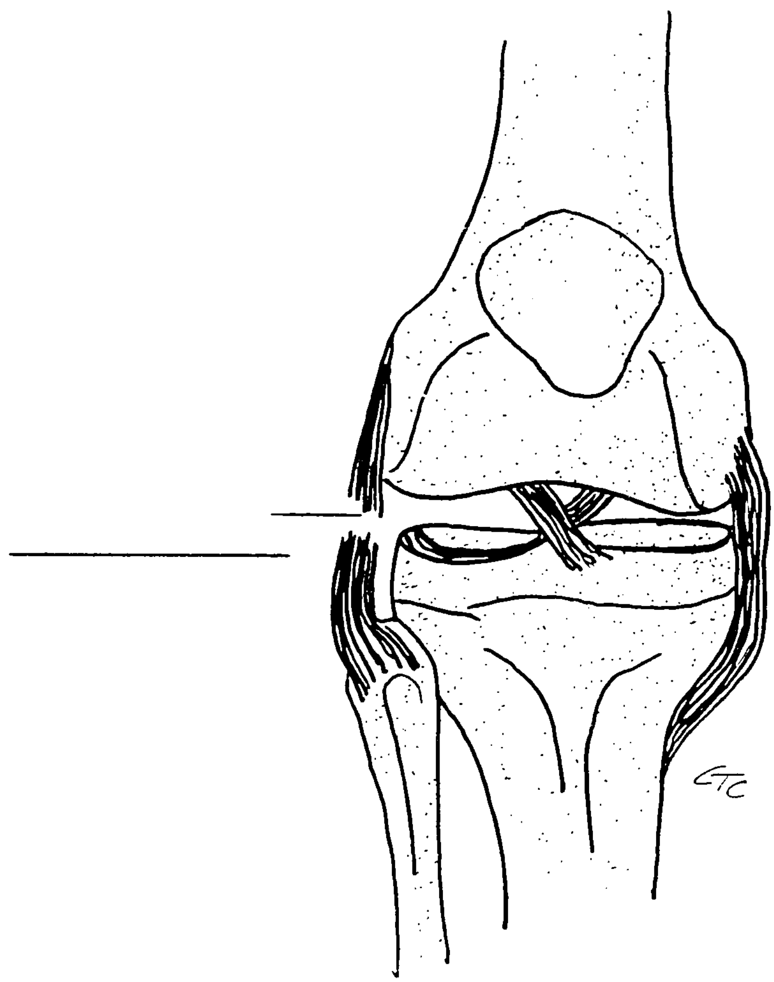



FIGURE 2.8

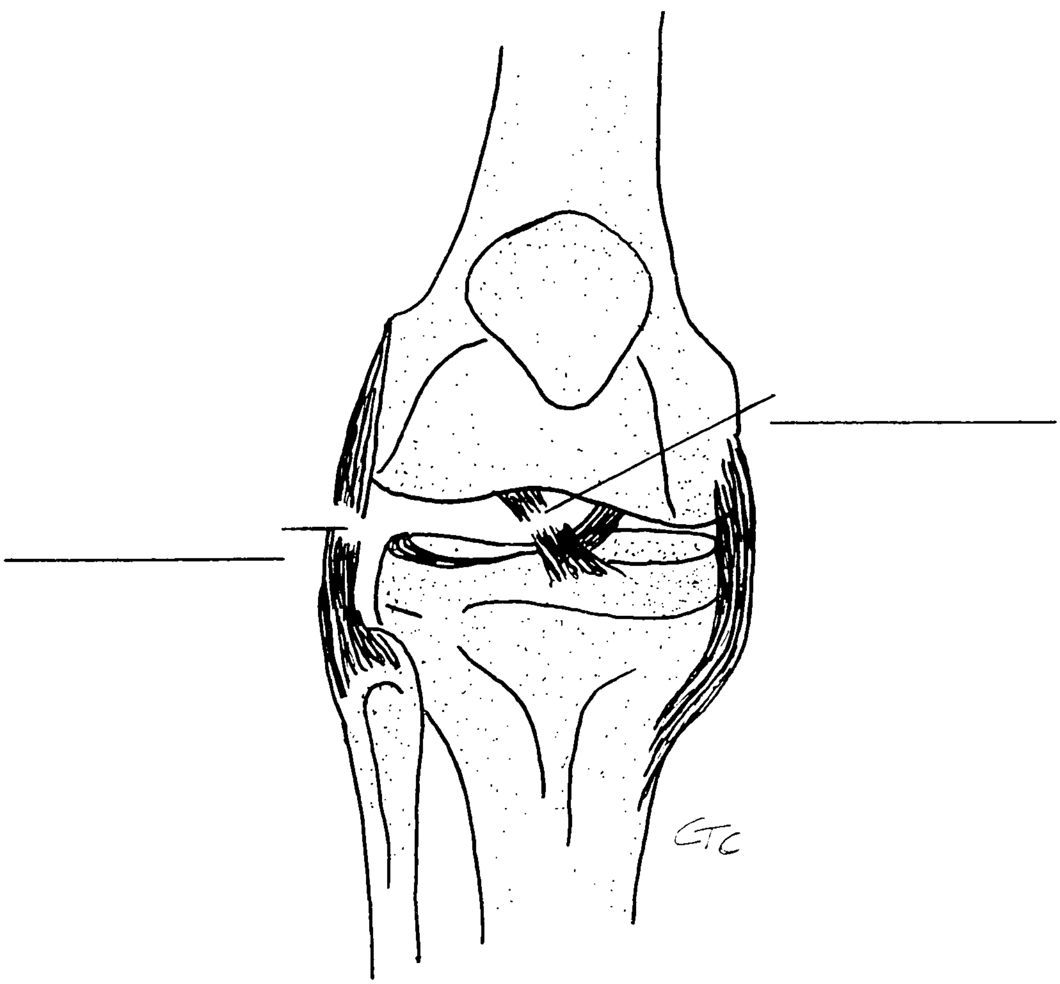



FIGURE 2.9

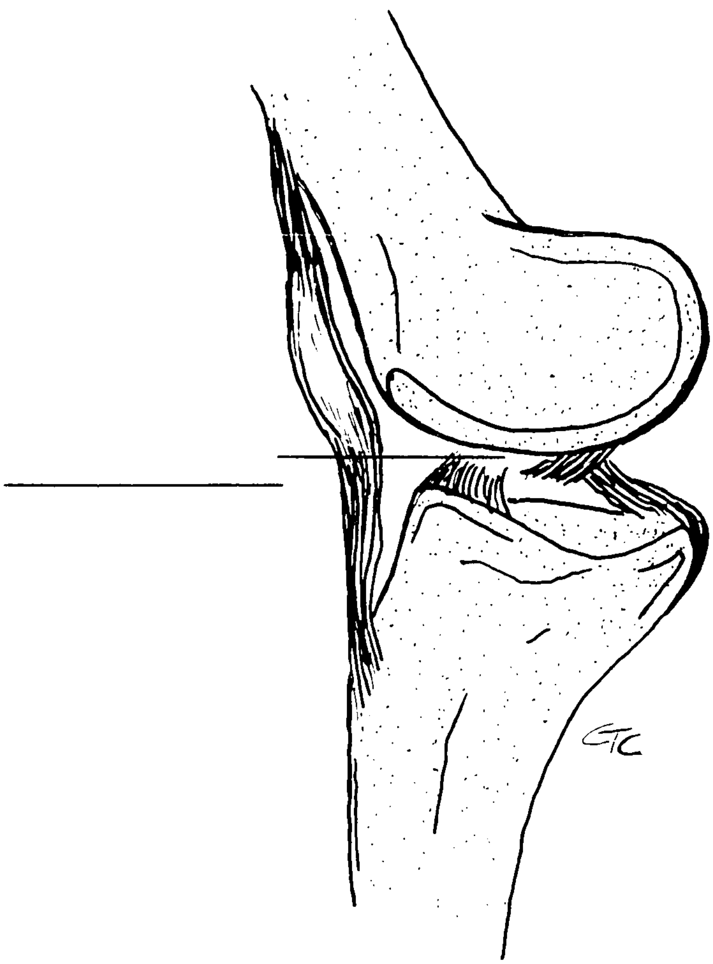



FIGURE 2.10

# UNIT 3

# KNEE-JOINT STABILITY TESTS

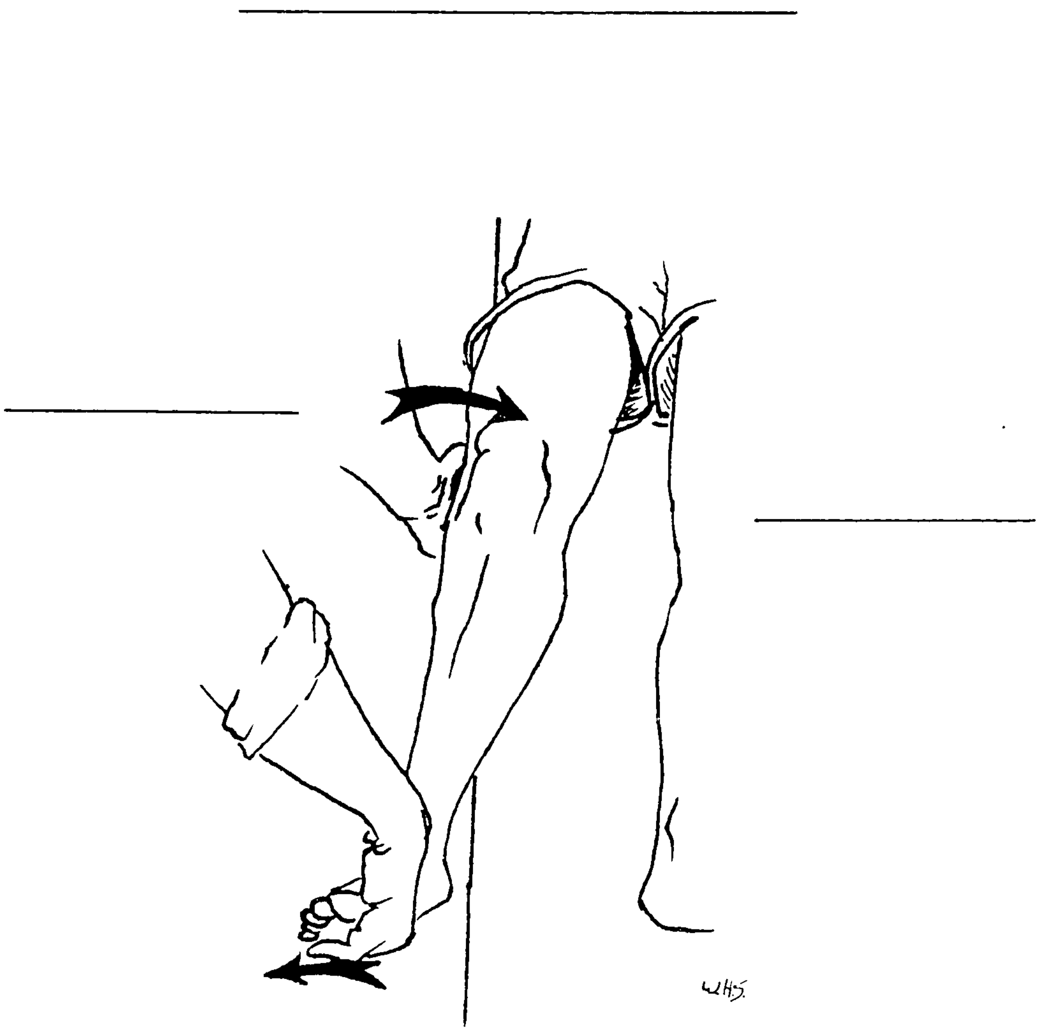


FIGURE 3.1

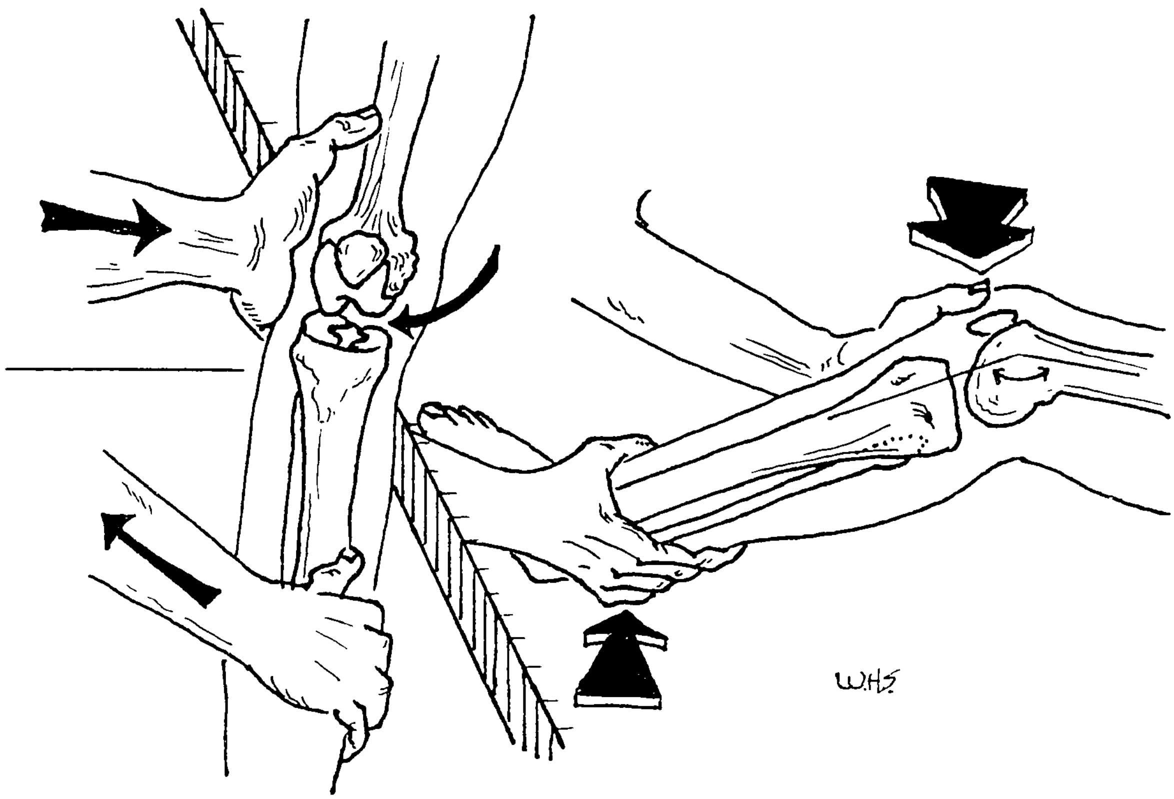



FIGURE 3.2

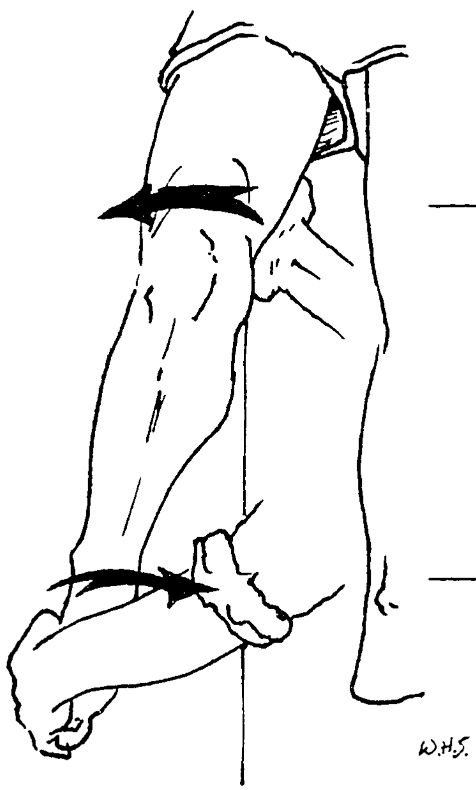



FIGURE 3.3

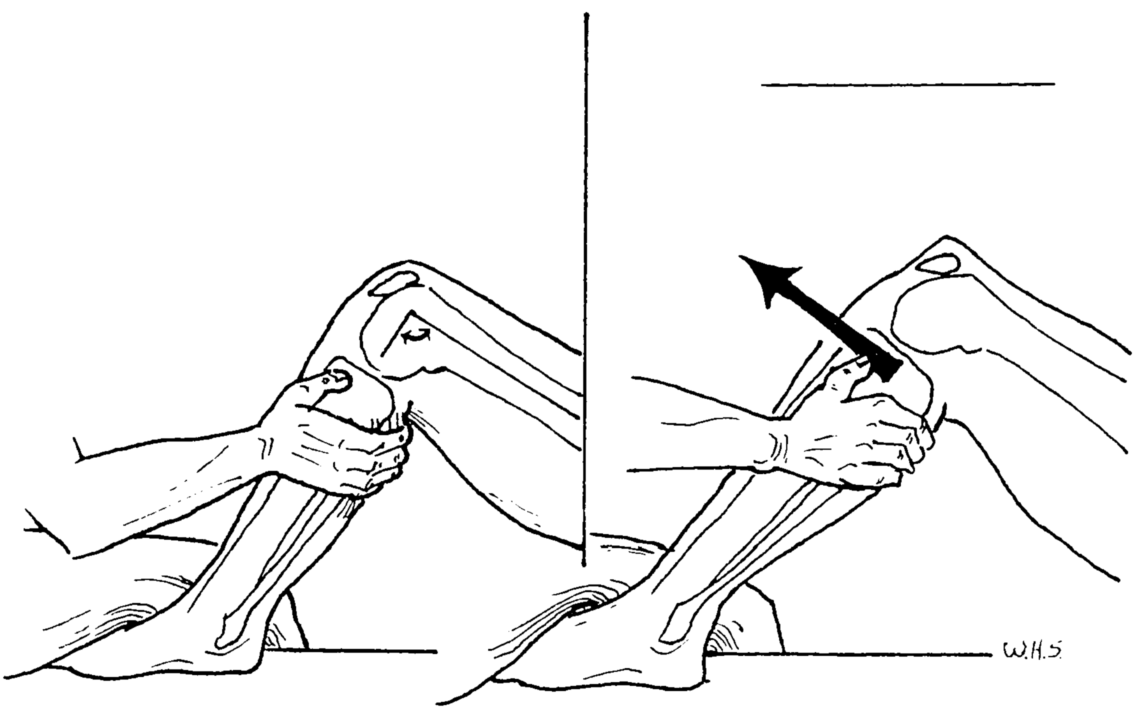



FIGURE 3.4

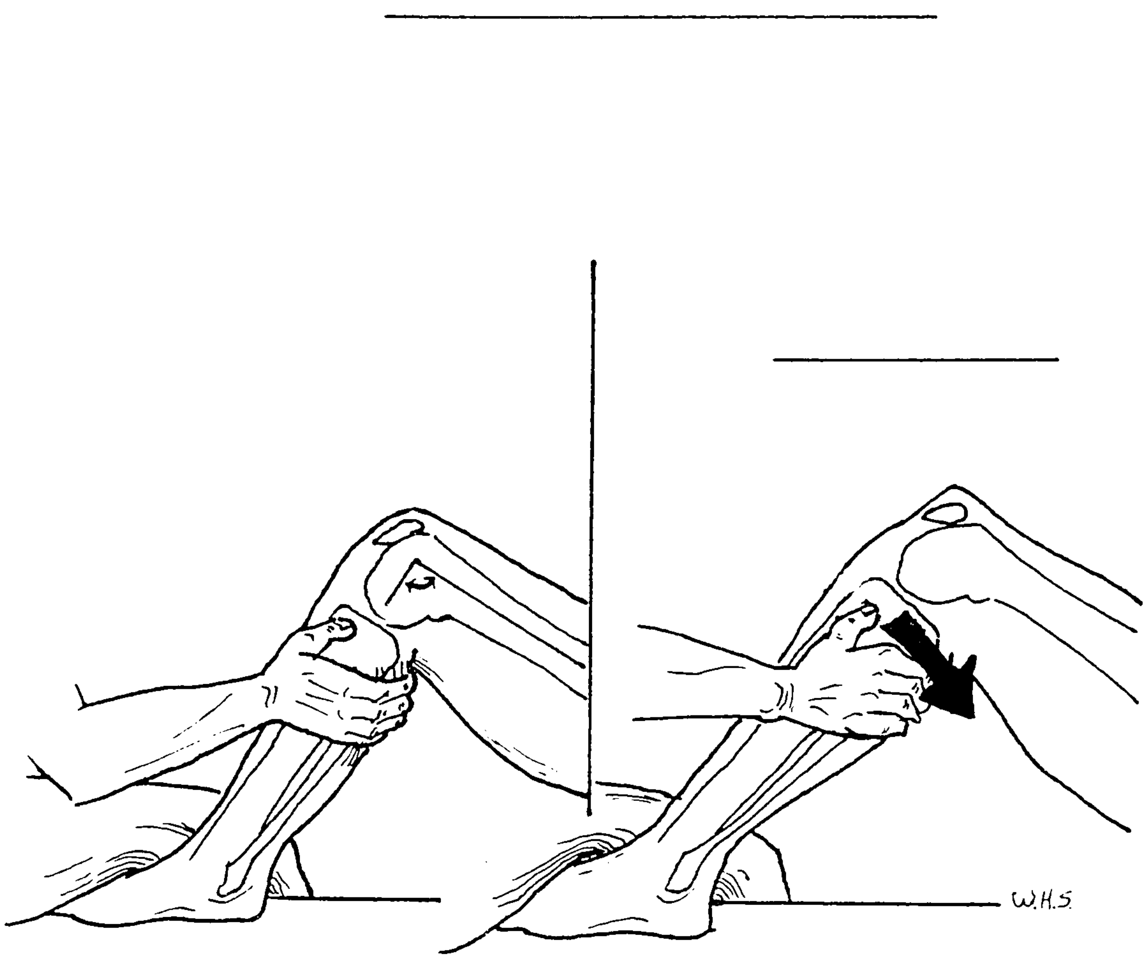



FIGURE 3.5

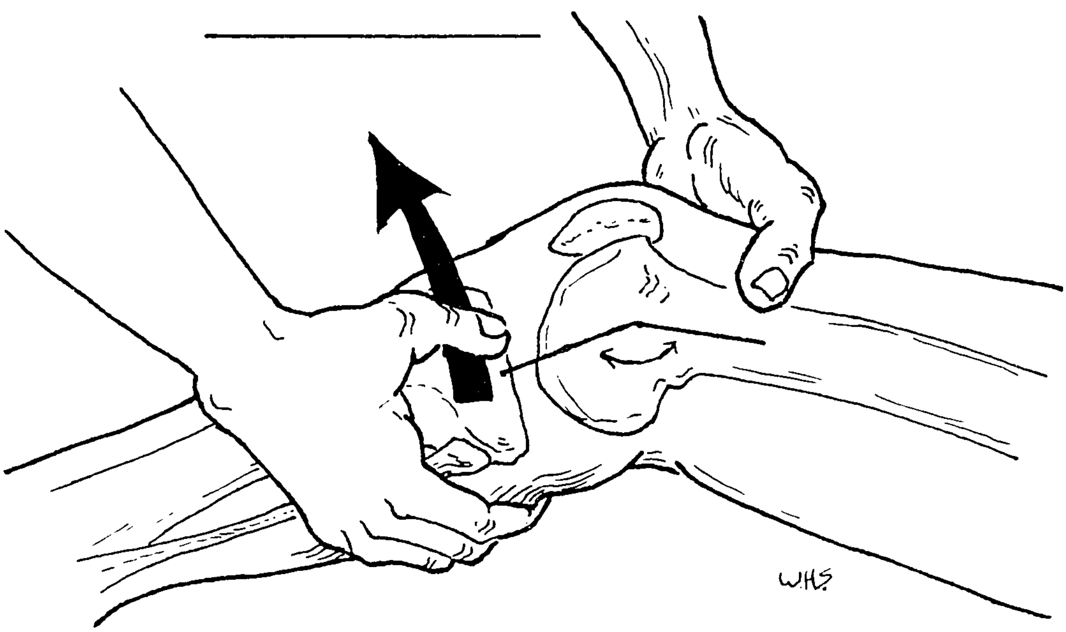



FIGURE 3.6

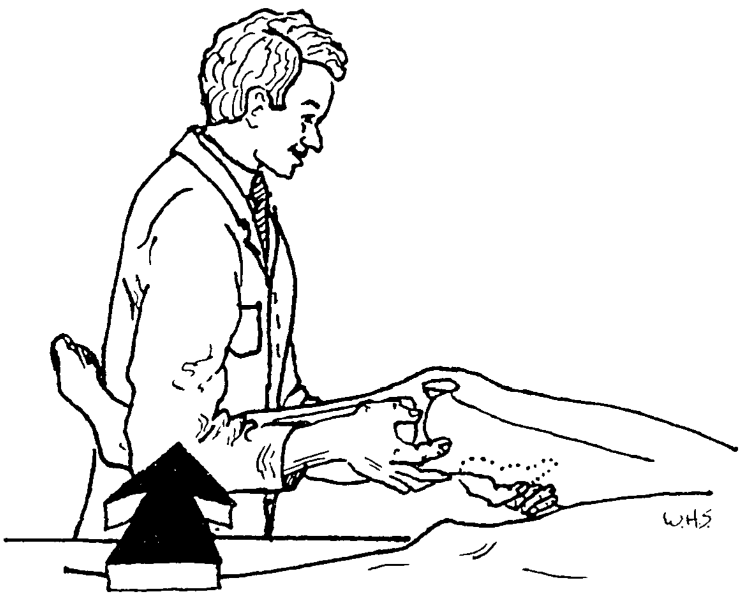



FIGURE 3.7

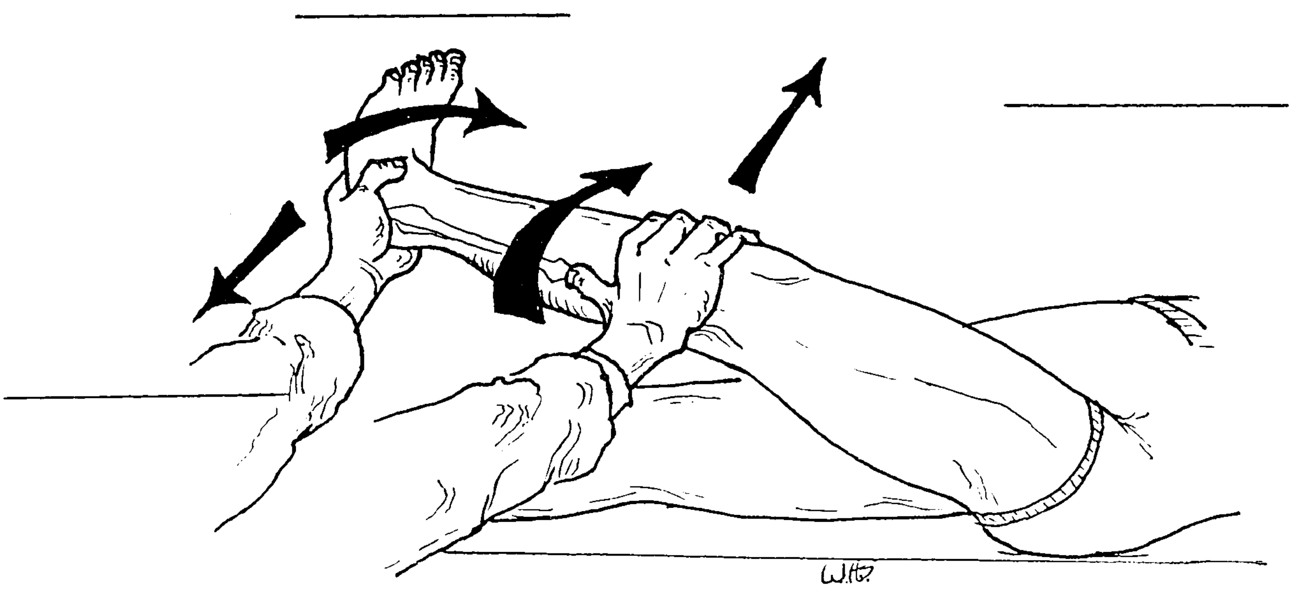


FIGURE 3.8

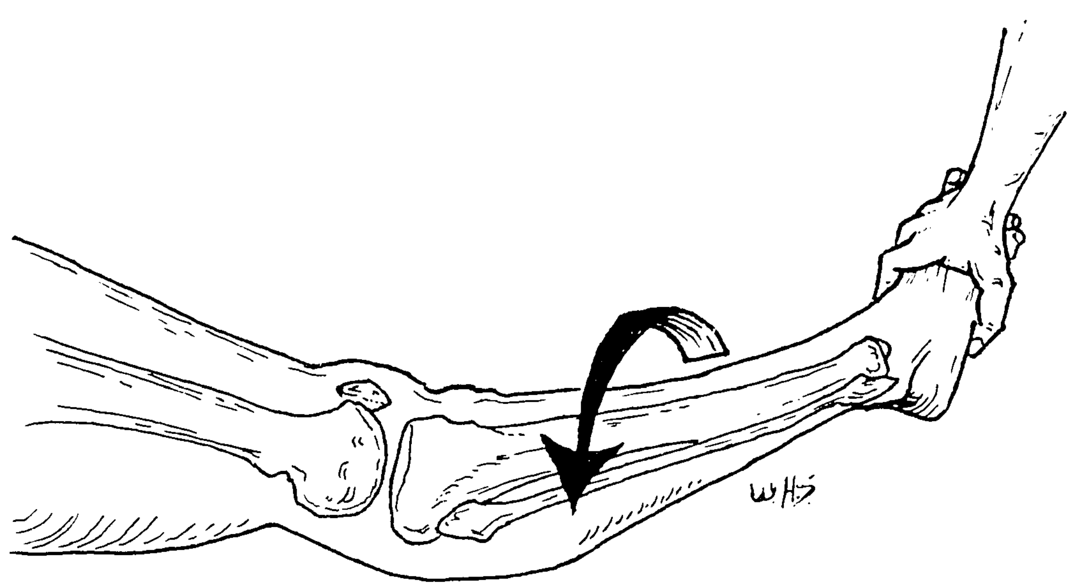


FIGURE 3.9

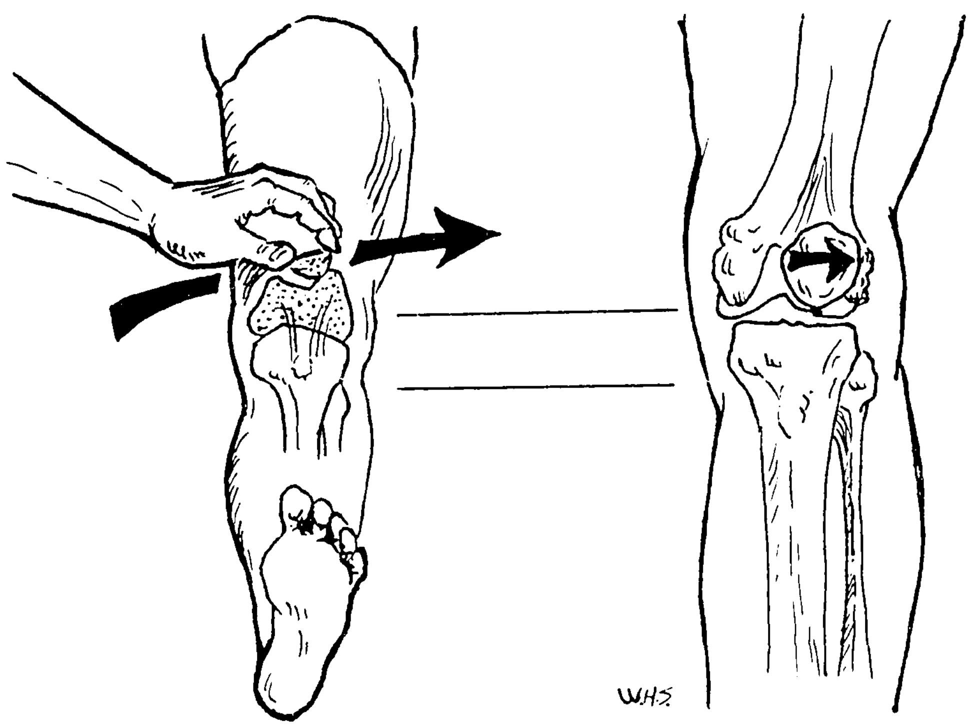



FIGURE 3.10

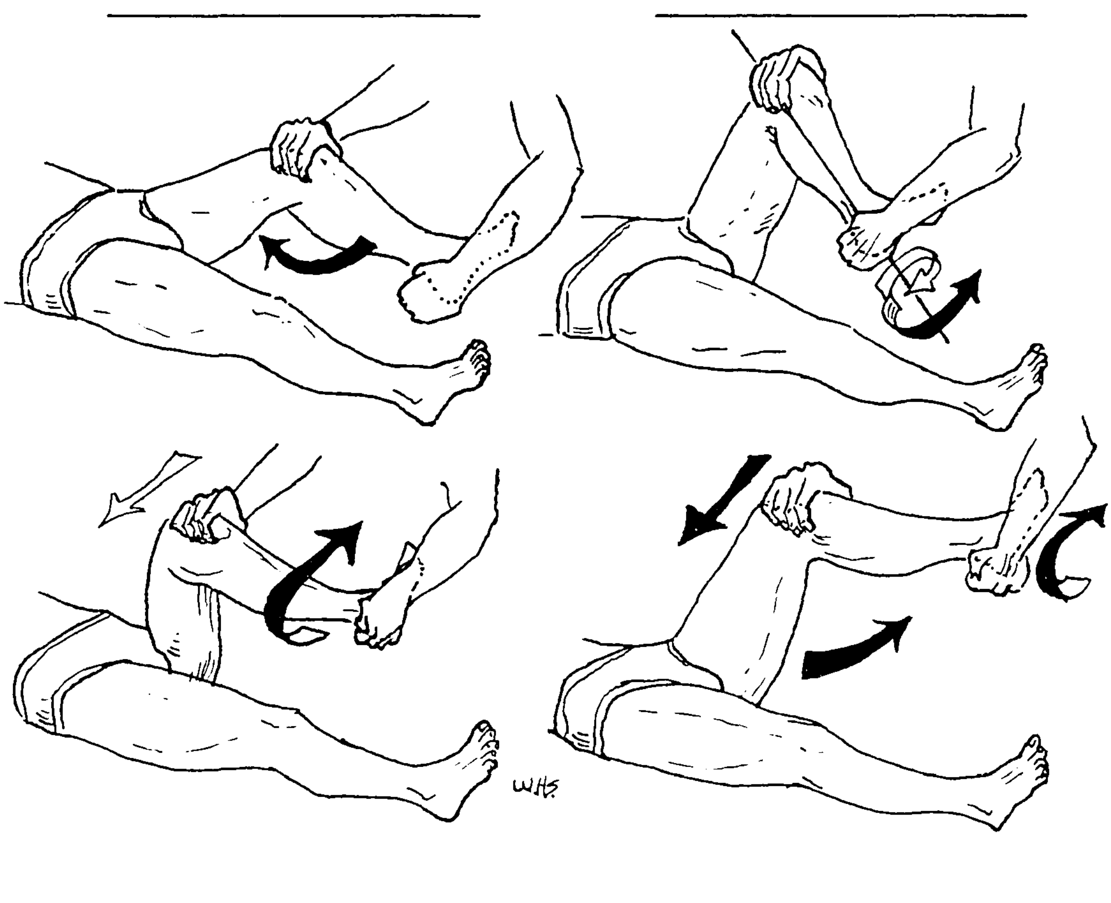



FIGURE 3.11

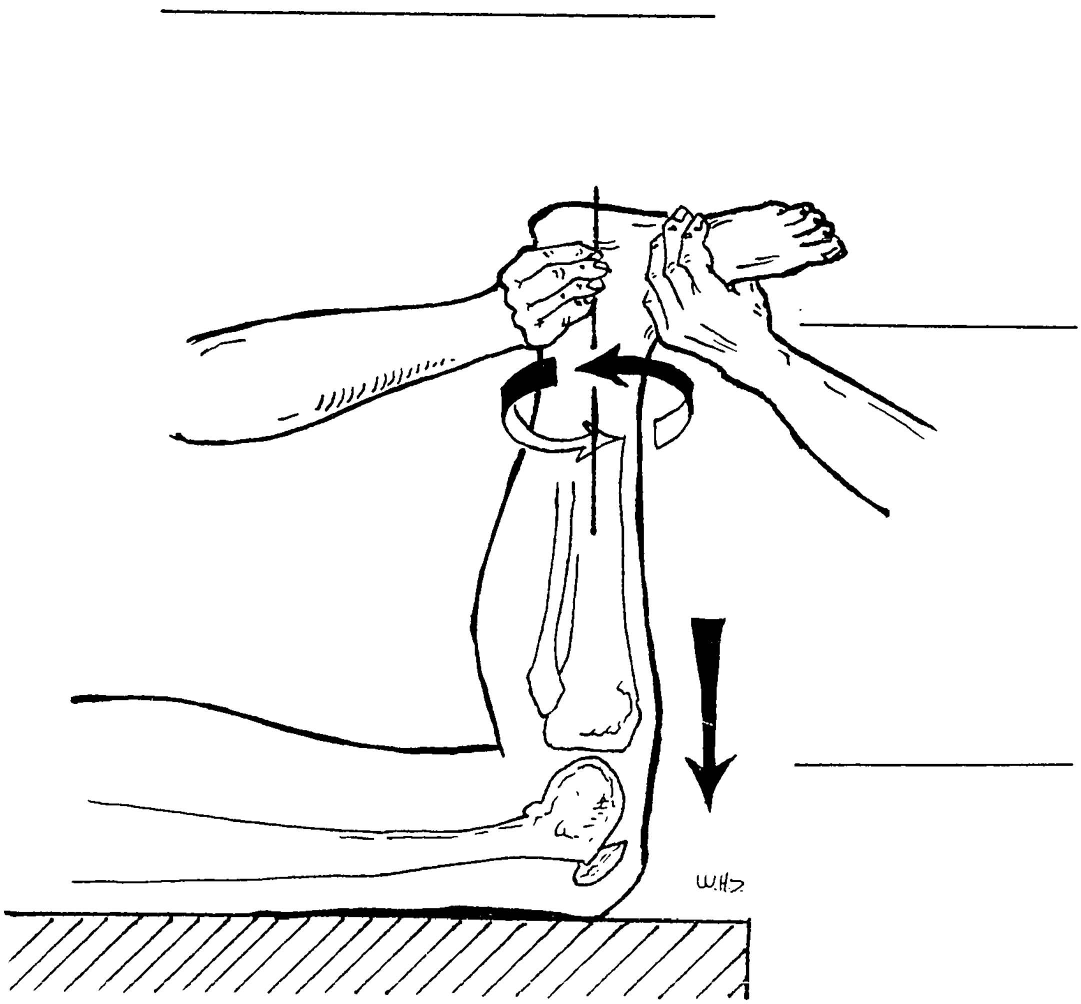



FIGURE 3.12

# UNIT 4

# COMPREHENSIVE EVALUATION

COMPREHENSIVE EVALUATION

Questions 1-10: Bones and Joint Classification and Movement

1. This bone is the primary weight-supporting bone in the lower leg.

    ____________________________

2. This bone is the largest bone in the body and is often referred to as the thigh bone.

    ____________________________

3. This bone is commonly referred to as the kneecap.

    ____________________________

4. This is the nonweight-bearing bone in the lower leg which is located on the lateral side of the leg.

    ____________________________

5. This joint is formed between the patella and femur.

    ____________________________

6. This joint is formed between the tibia and femur.

    ____________________________

7. Name the primary movements of the knee joint.

    ____________________________ and ____________________________

8. Name the secondary movements of the knee joint.

    ____________________________ and ____________________________

9. This movement occurs when the lower leg is moving toward the hip (bending).

    ____________________________

10. This type of knee movement occurs when the foot is rotated outward.

______________________________

<u>Questions 11-23: Ligaments, Tendons, Muscles, and Meniscus</u>

11. This ligament prevents the tibia from shifting forward away from the femur.

______________________________

12. This ligament's primary function is to prevent valgus stress.

______________________________

13. This ligament's primary function is to prevent varus stress.

______________________________

14. This ligament prevents the tibia from shifting backward away from the femur.

______________________________

15. This medial collateral ligament is divided into two portions: the superficial portion and the deep portion. What are the other terms often used to describe these ligaments?

______________________________ ______________________________

16. The muscles which execute knee flexion are located on what side of the leg?

______________________________

17. What muscles make up the quadriceps?

_________________________ _________________________

_________________________ _________________________

18. This muscle is often referred to as the calf muscle.

_________________________

19. What three muscles are commonly referred to as the hamstring muscles?

_________________________ _________________________

_________________________

20. This tendon extends from the inferior pole of the patella to the tibial tubercle.

_________________________

21. These are a group of tendons which insert onto the upper medial aspect of the tibia which helps protect the knee from rotary and valgus stress.

_________________________

22. This meniscus is attached to the tibial collateral ligament.

_________________________

23. This meniscus is a congenital variation of the normal semilunar meniscus.

_________________________

Questions 24-30: Mechanisms of Injuries and Joint-Stability Tests

24. This type of force has the potential to crush tissues.

_________________________

25. This type of force causes a twisting or rotational-type motion.

_________________________

26. This term is used to describe angulation of the lower leg. This term is sometimes referred to as "knock-knees."

_________________________

27. These joint-stability tests are used to determine the integrity of the anterior cruciate ligament.

_________________________ _________________________

_________________________

28. These joint-stability tests are used to determine the integrity of the menisci.

_________________________

29. This test is used to determine the integrity of the medial collateral ligament.

_________________________

30. This test is used to determine the integrity of the lateral collateral ligament.

_________________________

# GLOSSARY OF TERMS

# GLOSSARY OF TERMS

## KNEE JOINT

Anterior cruciate ligament--ligament that passes from the lateral intercondylar notch of the femur to attach anteriorly on the articular surface of the tibia.

Anterolateral rotatory instability--anterior internal rotational subluxation of the lateral tibial condyle on the femur, reflecting damage to the anterior cruciate ligament and lateral structures.

Anteromedial rotatory instability--when the medial plateau of the tibia rotates anteriorly and medial joint opening occurs, indicating disruption of the superficial tibia collateral ligament, medial and posteromedial capsular structures, and anterior cruciate ligament.

Anteroposterior drawer test--test for anterior and posterior laxity in which the examiner holds the knee in 30 degrees of flexion, stabilizes the thigh, and carries out an anteroposterior drawer motion with the proximal tibia; the test is positive if changes in anteroposterior displacement of the tibia are noted.

Chondromalacia--pathologic condition involving softening of the patella and/or articular femoral cartilage.

Connective tissue--tissue which connects and supports the structures of the body.

Deep medial collateral ligament--see medial capsular ligament.

Discoid meniscus--congenital variation of the normal semilunar meniscus, in which the meniscus is discoid in shape.

Eversion--turning outward.

Femoral condyles--two surfaces at the distal end of the femur that articulate with the superior surfaces of the tibia.

Femur--the thigh bone; extends from the pelvis to the knee and is the longest and largest bone in the body.

Fibula--outer and smaller of the two bones of the leg, extending from just below the knee to form the lateral portion of the ankle joint.

Fibular collateral ligament--ligament that inserts from the femoral condyle to the fibular head.

Flexion-rotation drawer test--a modification of the pivot shift test and the Lachman test; the test is positive if anterolateral subluxation of the lateral femorotibial articulation occurs; test for anterolateral rotatory instability of the knee in which the leg is held in neutral rotation at 20 degrees of knee flexion.

Genu recurvatum--tendency of the knee to hyperextend.

Gravity drawer test--test for posterior laxity of the knee in which the athlete lies supine and the hip and knee are flexed to 90 degrees.

Gravity external rotation test--test for determining posterolateral rotatory instability; the knee, as well as the hip joint, is flexed to 90 degrees; the examiner rotates the tibia and foot externally and notes the excursion of the fibular head and tibial tubercle.

Hamstring--one of the large muscle groups at the back of the thigh that flex the knee.

Hughston jerk test--a test for anterolateral rotatory instability of the knee in which the athlete lies supine, with the knee flexed approximately to a right angle and the hip at about 45 degrees of flexion; while the knee is extended, an internal rotational force is placed on the tibia, and a valgus stress applied; a positive test produces a snap and a pop.

Iliotibial band--thickening of the iliotibial tract that inserts directly into the lateral tubercle of the tibia.

Intercondylar notch--bony notch that separates posteriorly the condyles of the femur.

Ischium--one of the three bones (ilium, ischium, and pubis) that fuse to form the pelvic bones.

Joint--articulation, place of union, or junction between two or more bones of the skeleton.

Jumper's knee--overuse injury of the extensor mechanism; occurs when the proximal pole of the patella is injured by repetitive traction of the insertion of the quadriceps mechanism.

Lachman test--test for instability of anterior cruciate ligament of the knee in which the examiner stabilized the thigh while performing an anteroposterior drawer motion, with the hand holding the proximal tibia to direct tibial displacement.

Lateral--lying away from the midline.

Lateral condyle--forms the lateral border of the upper surface of a joint.

Lateral meniscus--the lateral C-shaped fibrocartilaginous structure of the knee; see meniscus.

Lateral patellar retinacula--expansion on both sides of patella; made up of extensions of the vastus lateralis that help extend the knee joint.

Lateral pivot shift test--test for anterolateral rotatory instability of the knee in which the tibia is internally rotated on the femur and pushed anteriorly to note subluxation of the lateral tibial plateau.

Ligament--band of the fibrous tissue that connects bones to bones and supports and strengthens joints.

McMurray test--meniscal test used to detect a posterior horn tear; the examiner, with the athlete's knee in full flexion, externally rotates the leg and extends the knee; a click indicates a medial meniscal tear. To test for a lateral meniscal tear, the leg is internally rotated.

Medial--lying toward the midlines.

Medial capsular ligament--mid-third of the true capsule of the knee joint; ligament extending from the femur to the mid-portion of the meniscus and then to the tibia.

Medial collateral ligament--ligament on the medial aspect of the knee, consisting of anterior, posterior, and oblique components and extending from the femur to the tibia.

Medial condyle--forms the medial border of the upper surface of a joint.

Medial meniscus--the medial C-shaped fibrocartilaginous structure of the knee; see meniscus.

Medial patellar retinacula--extension of the vastus medialis that helps extend the knee joint.

Medial retinaculum--structure composed of the aponeurosis of the vastus medial muscle itself; attaching along the medial border of the patella, its primary function is to hold the patella medially.

Meniscus--cushion of cartilage that fills up a space between bones and aids in the gliding motion and stability of the joint.

Muscles--tissue composed of bundles of specialized cells that have the ability to contract and relax, thus producing movement or force.

Osgood-Schlatter disease--partial avulsion of the tibial tubercle because the tubercle is subjected to traction forces by the patellar tendon insertion, causing painful swelling in the knee of the adolescent.

Patella--kneecap.

Patellar ligament--see patellar tendon.

Patellar tendon--the extension of the quadriceps mechanism from the patella to the tibia; also called patellar ligament.

Patellofemoral joint--joint between the patella and the femur.

Pes anserinus--conjoined tendon, composed of the sartorius, gracilis, and semitendinosus muscle, which inserts onto the upper medial aspect of the tibia.

Popliteus muscle--muscle deep to the popliteal artery with three proximal insertions on the tibia; its primary function is internal rotation of the tibia on the femur.

Posterior cruciate ligament--ligament extending from the intercondylar area of the posterior tibia to the lateral surface of the medial femoral condyle; functions with the anterior cruciate ligament in anteroposterior and rotatory stability of the knee; shorter, thicker, stronger, and less oblique than the internal rotation of the tibia on the femur.

Posterolateral rotatory instability--the lateral tibial plateau rotates posteriorly in relationship to the femur.

Posteromedial rotatory instability--the medial tibial plateau rotates posteriorly on the femur, with associated medial opening.

Q angle--the angle made by the rectus femoris and patellar tendon as it attaches to the tibial tuberosity.

Quadriceps--see quadriceps muscle.

Quadriceps muscle--extensor muscle situated at the front of the thigh; composed of four components: vastus medialis, vastus lateralis, vastus intermedius, and rectus femoris.

Quadriceps tendon--convergence of the rectus femoris, vastus intermedius, vastus medialis, and vastus lateralis; inserts in the superior pole of the patella.

Rectus femoris--anterior thigh muscle of the quadriceps group.

Semimembranosus muscle--muscle extending from the ischial tuberosity to the tibia which acts to flex the leg and extend the thigh; important stabilizing structure to the posterior aspect of the knee.

Semitendinosus muscle--one of the pes anserinus muscles that help protect the knee against rotatory and valgus stress (the other pes anserinus muscles are the gracilis and sartorius).

Slocum anterolateral rotatory instability test--modification of the lateral pivot shift test in which the athlete lies on his or her side with the uninvolved leg flexed at the hip; the examiner applies an internal rotation force to the proximal tibia and a valgus stress to the joint; at 20 degrees of flexion the knee visibly, palpably, and audibly reduces.

Slocum external rotation test--one of the tests for anteromedial-rotatory instability conducted with the hip flexed to approximately 45 degrees and the knee to approximately 80 degrees; a forward motion is applied to the thigh, and the degree of anterior drawer is assessed.

Soleus muscle--muscle extending from the proximal fibula to the calcaneus, that act to extend and rotate the foot.

Sprain--stretching or tearing of a ligament.

Straight anterior laxity--true anterior instability of the knee; straightforward motion of the tibia on the femur, which indicates damage to the anterior cruciate ligament.

Straight lateral laxity--abnormal motion with lateral opening of the joint, or varus laxity; demonstrating injury to the fibular collateral ligament and lateral capsular structures.

Straight medial laxity--abnormal motion with lateral opening of the joint, or valgus laxity, reflecting damage to the tibial collateral ligament.

Straight posterior laxity--the tibia can be displaced posteriorly in a neutral position, without any rotation, indicating damage to the posterior cruciate ligament.

Strain--stretching or tearing of a muscle; also, the deformation at a point in a structure under loading.

Tendon--tough, rope-like cord of fibrous tissue that attaches skeletal muscles to bone.

Tibia--shinbone; the larger of the two leg bones.

Tibial collateral ligament--one of the major ligamentous support structures of the knee; extends from the medial condyle of the femur to the medial condyle of the tibia and its shaft.

Tibial plateaus--the expanded upper ends of the tibia; form the interior surface of the knee joint and articulate with the femoral condyles.

Tibial tubercle--the bony prominence of the proximal tibia.

Tibiofemoral joint--hinge joint that bears the body's weight during locomotion; joints between each tibial and femoral condyle.

Tuberosity--prominence on a bone where tendons insert.

Valgus (knock-knees)--a term denoting position; denoting a deformity in which angulation of the distal part is away from the midline of the body.

Varus (bowlegs)--a term denoting position; denoting a deformity in which angulation of the distal part is toward the midline of the body.

Vastus intermedius--a component of the quadriceps muscle.

Vastus lateralis--a component of the quadriceps muscle.

Vastus medialis--a component of the quadriceps muscle.

Source: American Academy of Orthopaedic Surgeons. (1991). Athletic training and sports medicine (2nd ed.). Park Ridge, IL: Hunter-Griffing.

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DISCLAIMER

This computer-assisted instruction program is based on research, recommendations, and suggestions of athletic trainers, physicians, and other allied health professionals currently active in the field of sports medicine. The author disclaims responsibility for any adverse effects or consequences resulting from the misapplication or injudicious use of the information contained within this program.

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