AN ABSTRACT OF THE THESIS OF

Gary Gower Kennedy for the degree of Doctor of Philosophy

in Science Education presented on February 14, 1979

Title: THE EFFECTS OF COMMUNITY COLLEGE LABORATORY INSTRUCTION AND VIDEO-TAPED PRESENTATIONS INVOLVING THE SKELETAL SYSTEM ON COGNITIVE ACHIEVEMENT AND RETENTION

Abstract approved Redacted for privacy

Dr. Thomas P. Evans

The purpose of this study was to determine if a significant difference in cognitive achievement and retention occurred when skeletal system anatomy and terminology were presented utilizing either video-taped presentations or a traditional laboratory procedure.

Fifty-three first semester nursing students enrolled in biology (Bio. 160 - anatomy and physiology) at Lethbridge Community College, Lethbridge, Alberta, Canada participated in the study. The subjects were enrolled in biology during one of the three semesters of 1977-78. The subjects were randomly assigned to either a control group, a video-tape group or a traditional laboratory group.

A pretest for previous knowledge of the skeletal system was administered to all groups during the first scheduled meeting of the class. Three cognitive achievement post-tests were administered at the termination of the first, second and third weeks of the experiment. A cumulative post-test was then administered to measure total gain scores

and 53 days later it was readministered to determine retention of skeletal terminology and anatomy.

The analysis of variance design used for this study was a one-way randomized block design having as levels of treatment video-tape, traditional and control groups. A paired t-test and the F statistic were used to assess means ($\overline{X}$) for the presence of significant differences between groups.

Within the limitations of this study, the following major conclusions were drawn:

1. The cognitive achievement of prenurse students at L.C.C. who are taught skeletal anatomy and terminology by video-taped presentations is not significantly different from that of similar students who are taught by a traditional laboratory approach;
2. Retention of cognitive material by prenurse students at L.C.C. who are taught skeletal anatomy and terminology by video-taped presentations is not significantly different from that of similar students who are taught by a traditional laboratory approach; and
3. The cognitive achievement and retention of prenurse students at L.C.C. who are taught skeletal anatomy and terminology by video-taped presentations or by a traditional laboratory approach are significantly different from that of similar students who do not receive formal skeletal instruction.

THE EFFECTS OF COMMUNITY COLLEGE LABORATORY INSTRUCTION AND VIDEO-TAPED PRESENTATIONS INVOLVING THE SKELETAL SYSTEM ON COGNITIVE ACHIEVEMENT AND RETENTION

by

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A THESIS

submitted to

Oregon State University

in partial fulfillment of
the requirements for the
degree of

Doctor of Philosophy

June 1979

APPROVED:

Redacted for privacy

Professor of Science Education in charge of major

Redacted for privacy

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Date thesis is presented February 14, 1979

Typed by Audrey Johnson for Gary Gower Kennedy

ACKNOWLEDGEMENTS

The cooperation and assistance of many individuals made the completion of this research project possible.

I would like to extend thanks to the faculty members at Oregon State University who comprised my doctoral committee. Dr. Jake Nice, Dr. John Fryer, Dr. Brookes Spencer, Dr. Larry Dale and Dr. Donald Amort willingly contributed their valuable time to the various meetings and discussions that I required during the past several years. Also, a sincere thankyou is extended to Dr. Thomas Evans, chairman of the committee, for his technical advice and personal interest in my work.

I am especially grateful to Mr. Neil Poulsen for all the statistical interpretations and assistance that he unselfishly provided.

Also, I would like to thank various members of the Lethbridge Community College: Mr. Fiori D'Andrea and Jeff Calvert for their technical assistance and advice on the preparation of the video-tapes, Joyce D'Andrea, Ron Beck, Shane Porter, Joanne Scholdra and Harvey Johnson for their evaluation of the video-tapes, Denise Witbeck for helping prepare the cognitive achievement tests and Gardner Schurman for his unfailing good humor.

I would like to extend thanks to Mrs. Audrey Johnson for her capable and conscientious efforts in typing this thesis.

In conclusion, I wish to acknowledge the important role my family played. First to my parents, a special thanks for their continued interest in my education even after they were informed that it would take a small miracle to get me through ninth grade. Secondly for my wife Bonnie, this project provided hours of enjoyable typing and a

chance to brush up on English composition. Finally my sons, Jay and Bret, benefited from the study by learning to play quietly for hours while the investigator investigated. A sincere thankyou to all of you.

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I. INTRODUCTION

Background to the Problem

Since the Sputnik catalyst of the late fifties, science education has become steeped in the philosophy of the new science curricula. Science teachers generally tend to be operating, or at least profess to be operating, under the "hands on" discovery paradigm that has its roots in the philosophy advocated by Dewey (1968, p. 153):

> Even the kindergarten and Montessori techniques are so anxious to get at intellectual distinctions, without 'waste of time', that they tend to ignore or reduce the immediate crude handling of familiar material of experience, and to introduce pupils at once to material which expresses the intellectual distinctions which adults have made. But the first stage of contact with any new material, at whatever age of maturity, must inevitably be of the trial and error sort.

In teacher education courses, the student is somewhat indoctrinated in the importance of discovery learning. The "hands on" discovery paradigm is further reinforced when the prospective teacher examines curricula such as Science Curriculum Improvement Study (SCIS), Elementary Science Study (ESS), and Biological Science Curriculum Study (BSCS). The mainstream of philosophy behind these curricula is reflected in Whitehead's (1959, p. 3) statement that, "From the very beginning of his education, the child should experience the joy of discovery." Many of the teachers educated under this philosophic trend, undoubtedly, are of the opinion that the "hands on" discovery approach

is the best, if not the only, method for science teaching. Unfortunately, many of these same teachers are also of the opinion that as long as the students have material at hand, then the learning experience will be complete.

Although discovery learning appears to be a prime instructional approach to science education, its importance for actual learning should probably be questioned. Evans (1969) notes that before agreement can be reached pertaining to the importance of discovery as an aspect of learning, a great deal of clarification and research will be required. Clarification, therefore may be one of the key factors that should be examined when considering discovery learning. Is discovery learning restricted to information that the student learns while manipulating and handling materials relative to a particular laboratory experience? Or is Bruner (1973, p. 402) on the right track when he states that:

> ... I do not restrict discovery to the act of finding out something that before was unknown to mankind, but rather include all forms of obtainable knowledge for oneself by the use of one's own mind... . For whether one speaks to mathematicians or physicists or historians, one encounters repeatedly an expression of faith in the powerful effects that come from permitting the student to put things together for himself, to be his own discoverer.

If discovery learning can arise from all forms of obtainable knowledge, a number of various instructional techniques may prove to be as effective for learning as one of the present science education discovery paradigms.

Dewey (1968, p. 155) suggests that the school environment is remote from real situations of experience:

> No amount of improvement in the personal technique of the instructor will wholly remedy this state of things. There must be more actual material, more stuff, more appliances, and more opportunities for doing things, before the gap can be overcome.

Since Dewey made this statement, the personal techniques of the teacher have been supplemented by a wide array of instructional media ranging from overhead projectors to video-taping equipment. Smith (1972, p. 10) may be correct in stating that, "... we learn best, though not as efficiently by experience - by seeing an object, listening to it, smelling it, tasting it, and touching it. While experience may be the best teacher, it is often a hard taskmaster ..." Perhaps the task can be simplified by utilizing modern instructional media as an alternative for learning material traditionally associated with the science laboratory. As Stotler (1967) points out, education of the student rather than instruction of the student is the goal of science teaching:

> The teacher expects himself to teach (whether that means 'lecturing', 'leading', or 'loving') in a way that satisfies his own needs and those of his students... those needs don't always coincide, nor are they always satisfied when they do (Hernan 1972, p. 24).

If instructional media can be as viable as traditional laboratory experiences, it can be used as an alternative for learning and meeting the needs of student and teacher alike. As Postlethwait (1966, p. 49) notes:

> Individuals differ in their responsiveness to different kinds of communication devices. Some people learn well through reading, some can learn best by auditory communication, and others by literally handling specimens and doing experimentation.

Statement of the Problem

The purpose of this study is to:

1. Determine if there is a significant difference in cognitive achievement by prenurse students when skeletal system anatomy and terminology are presented utilizing video-taped presentations or a traditional laboratory procedure.
2. Investigate the extent that prenurse students retain cognitive material when taught by either video-taped presentations or a traditional laboratory procedure.

Origin and Need for the Study

The present study grew partly from the investigator's initial review of the available literature on audio-tutorial instruction as it relates to biology. The investigator became interested in this approach to teaching biology when the Lethbridge Community College, hereafter referred to as the L.C.C., promoted the concept of modular instruction and continuous student intake.

The available literature tended to indicate that audio-tutorial instruction could be as good as conventional methods for teaching biology, but implementation of an effective audio-tutorial approach to learning at the L.C.C. seemed to be limited by prohibitive cost factors. Because of this, the idea of video-taped modules for specific biology areas developed. The investigator suspected that certain video-taped laboratory experiences could be presented as effectively as a "hands on" approach to learning. Should this suspicion be validated by the study, then the educational implications for curricular activities in nursing biology (anatomy and physiology) would be considerable. The approach

would provide an alternative in laboratory instructional strategy not only in the two year nursing program, but in the allied health fields as well.

As in many regions in North America, the registered nursing programs in Alberta are rapidly shifting from the traditional three year hospital experience and university based training to a two year community college program. "More registered nurses are now being prepared in community college programs than in either of the other two types of basic nursing programs" (Bullough and Sparks 1975, p. 688).

In general, community colleges are moving into the area of training the allied health professionals and this has led to proliferation of courses, specification of work tasks, and often a complex hierarchy. As a consequence, the general education function of the community college is gradually giving way to the diploma school approach where students in a given allied health profession have little, if any, academic contact with the general student population. A need for a core curricula thus appears to be arising. "A core curriculum presumes that within the allied health occupations there is a base of information and skills which is relevant to all students" (Meek 1972, p. 32).

Video-taped presentations may provide one avenue for approaching the development of a core curriculum in the allied health fields as laboratory experiences are often common to programs such as nursing, nursing aid, and mortuary science. In some learning situations, video-taped presentations may have several advantages over traditional methods of laboratory instruction. "Experts in learning techniques have come to the conclusion ... that if instructors devoted less time disseminating

information which can be transmitted more efficiently in other ways, they would increase efficiency and gain time and energy for discourse and for student questions" (Hinton 1970, p. 2). Video-taping selected laboratory experiences for allied core curricula could prove advantageous where the number of students per laboratory section is excessive. The same technique can reduce the repetitive work load of the instructor when there are multiple laboratory sections. This problem is one that basically parallels the difficulty of multiple section, live lectures. "In colleges the practice of repeating multiple section, live lectures intended primarily for conveying factual information is a common example of the misuse of instructor time" (Hinton 1970, p. 2). The use of video-taped presentations could free the instructor so that his time could be utilized more effectively. Rather than repeating the information, the instructor could conduct a common discussion period for questions that develop from the taped presentations.

Whitehead (1959, p. 17) states that, "The best education is to be found in gaining the utmost information from the simplest apparatus." Although video-taped television is not a simple apparatus in the mechanical sense, it may provide excellent educational opportunities in many areas. Gagne (1965) pointed this out in suggesting that the advantage of moving pictures is that they enormously extend the range of stimulus situations that can be brought into the classroom. It should be pointed out, however, that the assimilation of this stimuli is not an automatic task on the part of the student.

> A fundamental characteristic of television, according to Marshall McLuhan, is that it demands a great deal of participation by the viewer. A person watching television is not, and cannot, remain passive, for all his senses are actively involved in collating the different sense-stimuli, the sound, the picture, the tactility of the image, into a coherent and meaningful piece of information. The viewer does not receive unified pieces of information from the television set; he assembles them from the data received from several sources. Viewing television is a creative act (Rosen 1967, p. 7).

In other words, video-taped television may be an effective teaching device in many curricular areas, but it is probably far from being an educational panacea in itself. Research relative to the application of video-taped television will provide information concerning effective use of this method of instruction.

Null Hypotheses

The null hypotheses are as follows:

1. The cognitive achievement of students who are taught skeletal anatomy and terminology by video-taped presentations will not be significantly different from that of students who are taught by a traditional laboratory approach.
2. Retention of cognitive material by students who are taught skeletal anatomy and terminology by video-taped presentations will not be significantly different from that of students who are taught by a traditional laboratory approach.

Assumptions

1. Knowledge of skeletal system anatomy and terminology can be measured validly and reliably by the cognitive achievement tests utilized in the study.

Limitations of the Study

1. Measurement of knowledge of skeletal system terminology and anatomical structures is limited to cognitive achievement tests developed by the investigator.
2. The laboratory manual and the video-tapes used in the study have been prepared by the investigator.

Delimitations of the Study

1. The study is delimited to community college students enrolled in the first semester of nursing, during 1977-78, at the L.C.C.
2. One hundred and eighty-one skeletal terms have been selected as material to be presented in the study.

Definition of Terms

For the purpose of this study, the following definitions are employed:

Video-tape recording unit — "A video-tape recording unit consists basically of three parts: Recorder, television camera, and television monitor" (Bittner 1971, p. 173). The video-tape recording unit to be used in this study is composed of the following:

a. a Sony Trinicon DXC 1600 color camera
b. a Sony U-Matic V02850 3/4 inch video-cassette recorder
c. a 19 inch Sony color television monitor

Video-tape presentation — Video-taped presentations consist of discussion of the skeletal system and close-up examination of the various skeletal parts and processes. The presentation is recorded with a video-tape recording unit.

"Hands on" discovery learning	"Hands on" discovery learning refers to student manipulation and experimentation with laboratory materials.
Traditional laboratory methods	The traditional laboratory approach is the laboratory method that is used at L.C.C. for teaching knowledge of the skeletal system. This method utilizes a laboratory manual prepared by the investigator and plastic or actual bone skeletons. The laboratory instructor acts as a resource individual, answering questions pertaining to anatomical locations of skeletal parts.

Instructional media	Traditionally, the media field was labeled with the misnomer 'audio-visual materials of instruction'. Since it appeared that over 80 percent of learning involved the senses of sight and sound, such a label seemed appropriate. Today we know that human learning includes much more than simple eye and ear stimuli. It involves the total organism along with readiness, experience, and feeling to name a few. Thus the term 'instructional materials' or 'instructional media' considers the tools and techniques of instruction and the sensory apparatus in a much broader context than 'audio-visual' materials (Smith 1972, p. 10).
Knowledge	Knowledge refers to the first major category in the cognitive domain (Bloom 1956).
Cognitive achievement test	Cognitive achievement test refers to labeling specific skeletal parts with numbers and letters. At each test station, a maximum of two skeletal parts are numbered, lettered and accompanied by a corresponding identification question. The student is required to identify the specific labeled part(s) at each station and record the answer(s) on a blank answer sheet within a one minute time period.

Skeletal system terminology	The skeletal system terminology is composed of the 181 anatomical terms outlined in the laboratory manual prepared by the investigator.
Identification of skeletal anatomy	Identification of skeletal anatomy is to be measured by written identification of skeletal parts selected for the cognitive achievement test.

Organization of the Study

In order to set the theoretical base for this research, Chapter II will include a review of the related literature. The methodology will be presented in Chapter III and the analysis of data and summary of findings will be included in Chapters IV and V respectively.

The study will use subjects enrolled in first year nursing. These subjects will be randomly divided into three groups - two experimental groups and one control group. Basically, the design of the study will be a pretest - post-test control group design as outlined by Campbell and Stanley (1967). One of the experimental groups will learn skeletal anatomy and terminology using prepared video-tapes of the material while the other experimental group will learn the same material presented to them through a traditional laboratory approach.

Statistically, the data will be analyzed using analysis of variance. The applicable statistical design will be a one-way (one-factor) randomized block design having as levels of treatment, video-tape, traditional and control, with the particular blocks being semester one, semester two and semester three students.

II. LITERATURE REVIEW

The Advent of Instructional Television

Although instructional television had its beginning in 1950-51, its roots go back into the decade of the 1930's. At that time, the State University of Iowa was involved in technical experiments with visual broadcasting including topics and materials from a variety of different university departments. As Mary Smith (1961, p. 6) elaborates on these early investigations:

> The comments of Dr. E. B. Kurz, who directed these experiments, are both interesting and prophetic:
>
> 'An illustrated lecture put on over a sound-sight broadcast will give you the personal touch which none of these other instrumentalities can provide. I have witnessed sound-sight broadcasts sitting at home, and I have felt just as though I were sitting in a classroom with the professor facing the class, stepping aside to write something on the board, turning again and speaking in a natural tone. I could not but feel that he was talking to me. I know of no other medium which can duplicate that seeming close relationship.'

Ramey (1964) noted that the first closed-circuit telecast of a surgical operation, originated in 1947 from The Johns Hopkins University. The age of medical television proceeded rapidly and by 1949 the Smith Kline and French-Columbia Broadcasting System caravan developed color surgery demonstrations. During that same period, the University of Kansas Medical School had initiated television for teaching. Smith (1961) stated that in 1952 a major advance was made in instructional television. At that time, due to the urging of the Joint Council on Educational Television, the Federal Communications Commission reserved approximately 250 channels for educational use. By 1961 fifty educational stations were broadcasting to schools and colleges in

twenty-five states and in Puerto Rico.

According to Asheim (1965), the Educational Media Study Panel was established in 1960 to act as an official advisory group to the Commissioner and the United States Office of Education. The Educational Media Study Panel stated at that time that educational television had a significant role to play in the extension and improvement of educational and cultural environments if national interests were to be fulfilled. As Gordon (1971) inferred, the recent expansion of this role is obvious when one considers that approximately one thousand universities and colleges, and some two thousand elementary and secondary school systems use some form of open or closed-circuit television. Ramey (1964), however, indicated that the impression of widespread and varied uses of television in medical education was generated by numerous journal articles on the subject. A 1961 survey of medical school use of television disclosed that many of the reported uses of television were merely isolated experimental studies. Apparently, medical use of television was not as comprehensive as the literature tended to indicate.

Resistance to Instructional Television

While it is generally accepted that television has an important role to play in education, its integration has at times met a certain amount of resistance. Koch (1975, p. 31) suggested that integration of a technology such as video-tape television into our school systems has at times proved to be a problem because many school administrators believed that audio-visual devices should and would save money when in practice this was often not the case. He reiterated by stating, "... a true technology - one that will improve learning and provide the highest

quality of education - costs money". Although the cost factor is definitely an administrative concern, video-tape integration could, in many situations, be considered economical when regarding the educational advantages it presents. As Mondfrans et al. (1972) suggested, one of the advantages of video-tape television is evident when the relative cost of educational film is considered. Industry also provides some insight into the cost of video-tape television. Gene McWhorter (1973) reported that Texas Instruments Incorporated relies extensively on video-tape for training personnel. Economy was their major reason for using video-tape. They found that video-tape television had the ability to train more people, at more locations, at more times, and at lower cost than other methods of instruction used by them.

Gordon (1971) proposed that teachers resist the use of television for instructional purposes out of a fear of being replaced by technology. He further indicated that the problem was compounded as teachers are generally convinced that human interaction between student and teacher is more valuable than an impersonal "master teacher" on the television tube. Trotter (1970) also felt that television for instruction was controversial. He stated that many university teachers were indifferent to it because it took time and trouble. While some instructors apparently feel that they cannot use the medium effectively, others are actively hostile towards it because, in their opinion, it threatens the individual teacher's autonomy and the teacher's right to privacy in a professional teaching relationship with students. Trotter (1970, p. 16) expanded by saying, "Television in all but its simplest applications (eg. self-contained single camera demonstrations in a classroom or

laboratory) involves 'outsiders'. As soon as a lecture is transmitted outside of the classroom it passes through master control; it is seen by non-students. If it is recorded for later playback, it is even more exposed".

Metzner and Bittker (1973) contended that well intentioned educators may attempt to produce their own video-tapes only to become discouraged by a variety of unexpected problems. These problems generally occur because video-tape productions force the educator to confront a range of practical issues outside his usual area of expertise. While they found this to be a definite problem with medical educators, Friedman and Judge (1976) reported that media teams composed soley of medical students and media producers were able to make successful video-tapes on physical diagnosis. In this situation, faculty physicians served only as advisors and final judges as to the accuracy and effectiveness of the presentation. Wischner and Scheier (1955, p. 613) noted that, "The experience of researchers in the TV area indicates that training instructors for TV is not necessarily a prohibitive consideration. For certain types of subject matter at least, and with certain production arrangements, instructors can be trained in a relatively short time". The problem, therefore, is not necessarily as complex as it first seems. Perhaps Metzner and Bittker (1973) were at the crux of the matter when they concluded that understanding and preparation in these areas of communication can only occur through practical experience with video-tape productions.

Video-tape Television

Apart from all of its inherent problems, educational television is now firmly entrenched in our educational system. As Harris (1969) pointed out, people who have worked with closed-circuit television at all levels of the educational system generally feel that this medium is the most significant teaching aid that has ever been developed. Its vast potential and wide range of applications is only beginning to be realized.

Gordon (1971) inferred that while broadcast instructional television faces a dubious future, increasing use of video-tape and inexpensively produced local television lessons will become ubiquitous and indispensable teaching tools during the next quarter century.

> If in the future, broadcast television will be of marginal importance as a university instructional medium per se it is because two other delivery systems are rapidly being developed both of which are decidedly relevant to the student interested in home study and the campus-centered institutions alike. These systems are (a) cable television and (b) low-cost video-tape playback and/or recording through a conventional home television viewing set (Trotter 1970, p. 23).

As Roth (1971) commented, the advent of video-tape recorders has revolutionized the entire field of television and consequently has significant and substantial import for instructional use. The video-tape recording enables instructional programs to be retained and presented repeatedly with minimum error factor due to electronic editing processes. For this reason, Warwick and Ravin (1975) suggested that video-taped instruction can be responsive to individual educational needs because evaluation, testing and revisal of a lesson can occur before it is used in the classroom. The prediction that video-tape

rather than film is the medium of the future and the indication that nurse educators have begun to use more and different kinds of audio-visuals in recent years, were corroborated in a study conducted by Nursing Outlook (Nursing Outlook 1975). Shaffer and Pfeiffer (1976) expanded by saying that due to increased numbers of students entering nursing as a profession, nurse educators have been forced to realize the need of sophisticated technology for instructional purposes. It was their contention that video-tape is an important form of technology that can provide increased learning experiences and promote improved student learning. Their opinion was similar to that of Roth (1971), and Warwick and Ravin (1975) in that they all noted the medium's additional advantages of instant playback repetition and erasibility.

The Use of Video-tape for Continuing Medical Education

According to Metzner and Bittker (1973), medical educators have become increasingly aware of the convenience and effectiveness of television for facilitating instruction. This has become evident as growing numbers of medical schools have acquired the facilities for television instruction. Metzner and Bittker (1973) contend that video-tape equipment is the core of an optimally utilized television system which can be efficiently employed for undergraduate training, residency training and for the increasing importance of continuing education of health professionals.

> One result of the rapid expansion of medical knowledge and technology has been increased pressure for medical professionals to avail themselves of Continuing Medical Education (CME) programs. Not only has CME become mandatory for physicians in some areas but nurses have also found themselves embroiled in legislative polemics regarding CME. ...the Board of Commissioners of the Joint Commission of Accreditation of Hospitals now requires that medical staff provide a continuing program of professional education ... (Sanborn et al 1975, p. 35).

Fry, Baer and Cornett (1976) also expressed interest in Continuing Medical Education for members of the nursing profession, especially for those individuals who for one reason or another are not able to come to the conventional classroom. They noted that video-taped television distributed to nurses in outlying geographic areas provides a solution to this problem, but concurred with Herminghaus (1957) that a major disadvantage lies in the absence of feedback between the instructor and student. To alleviate this problem, a two-way communication capability was built into a television system at The Ohio State University School of Nursing. Although this medical microwave system is a viable, appropriate instructional medium for providing continuing education for nurses, it would tend to be cost prohibitive for most educational institutions. Sanborn et al. (1973) also indicated that the lack of opportunity for those involved in education via television to raise questions and discuss the topics at hand possibly reduces the effectiveness of the method. Therefore, a pilot study was designed to determine if a two-way, closed-circuit television system would be acceptable as a medium for continuing education of nurses. The results of the evaluation indicated a relatively strong acceptance of two-way, closed-circuit television by nurses in continuing education. A direct

comparison, however, with video-taped presentations was not made.

Review of Related Studies in Instructional Television

In a study by Mondfrans, Sorenson and Reed (1972), the effectiveness of teaching nursing procedures by video-tapes as compared to live lecture-demonstrations was evaluated. Students in a beginning nursing course were randomly assigned to two groups. One group with 52 students was taught by the video-tape method and the other group of 35 students received conventional lectures. The same individual lectured and presented the material on the video-tapes. Student learning was evaluated by a series of quizzes, and students in the video-tape performed significantly better than the lecture group. The level of significance, however, was not indicated in the report. It was concluded that for teaching situations requiring the use of demonstrations and for presenting uniform content to large numbers of students, video-tapes were superior to live lectures.

Moser and Kondracki (1977) compared the cognitive achievement of nursing students exposed to three methods of instruction (lecture, black and white televised instruction, and color television via a Dial Access Information and Retrieval System - DAIRS). One hundred twenty-nine freshmen students from the College of Nursing at the University of Delaware were randomly assigned to five groups of unequal sizes. The five groups were then randomly assigned to the three methods of teaching which were taught by two instructors. A precognitive test was administered prior to the actual experiment and postcognitive tests were given immediately after exposure to the instructional strategy and again after three weeks.

With respect to the variables, instructional methods and instructors, the groups were compared using a two variable analysis of variance. In this analysis, a lecture section and a DAIRS section from each instructor were compared. It should be noted that only one instructor used the black and white television method and thus a one variable analysis of variance was used to include all three methods taught by the same instructor. At the .05 level of confidence, no significant differences in cognitive achievement were indicated among the three methods of instruction. The results of the experiment also led to the conclusion that the effectiveness of a particular method of instruction did not depend on which one of the instructors taught that method.

Warwick and Ravin (1975) prepared three video-tapes as well as supplementary reading material for the instruction of medical students in the techniques of regional anesthesia (spinal, caudal, epidural). To evaluate retention of the cognitive material presented in both the reading material and video-tapes, 11 second-year medical students were chosen and evaluated on the basis of a 100 point objective test. A t-test comparison of pretest and post-test scores related to information presented by the video-tapes indicated a significant increase in knowledge, about regional anesthetics, at the .01 level. It was also noted that students who scored lowest on the pretest had the greatest increase in knowledge as measured by the post-test.

McVay (1969) compared the effectiveness of video-taped segments with that of conventional teaching methods. The Mann-Whitney Test for unequal N as well as t-tests were used to determine statistical

differences in test performance between experimental and control groups. At the .01 level of confidence, nursing, chemistry and business students exposed to video-taped instruction performed significantly better than those receiving conventional instruction. However, electronics and engineering groups had little variation between their respective control and experimental groups. McVay concluded that video-taped instruction would be beneficial for teaching special skills particularly in the cognitive-subjective areas.

Floyd and Willson (1970, p. 82) prepared video-taped lectures for teaching the skeletal system. They apparently did not set up an experiment per se but indicated that their "... experiences with the video-tape method of instruction for this subject have been extremely satisfying and rewarding. There is no question that the comprehension of pertinent material by the students is greatly enhanced through the utilization of video-tape lectures".

Opacinch et al. (1974) compared traditional lecture, audio-tutorial and educational television instructional methods. Ability in or prior knowledge of biology was measured by the Fundamentals of Biology test. A one-way analysis of variance was computed on post-test scores. At the .05 level of confidence, no significant difference was found between the three methods of instruction. Opacinch (1974, p. 9) concluded:

> ... that offering various methods of instruction is a viable alternative to the more traditional approach where one method is deemed 'best' and utilized by all. This study has also demonstrated that many students prefer characteristics of both the audio-tutorial and lecture teaching methods which suggest that purity of method might be sacrificed for preference - notably in terms of specifying course objectives.

Elwell (1967) supported the contention of Jacobs and Bollenbacher (1960) that biological science is particularly fruitful for television instruction due to its dependency on visual stimuli. In the study by Jacobs and Bollenbacher, four classes within each of four schools were selected. Two of the four classes were randomly assigned to receive television instruction in ninth-grade biology, and the remaining two classes received conventional instruction. One teacher was assigned to all four groups in each school and the course of study for all groups was the same. To determine achievement in biology, the Cooperative Biology Test was administered as a pretest at the beginning of the study and a second form of it was administered as a post-test. The results of the experiment were analyzed using covariance techniques. At the .05 level of confidence, the television method proved to be significantly more effective than the conventional method. It was also noted that for varying levels of pupil activity, the televison method was superior to conventional instruction.

Herminghaus (1957), reported on an experiment which involved large group instruction by television. The experimental groups were selected from two St. Louis high schools and were composed respectively of 145 and 122 students in general science and 146 and 122 students in English composition. A similar number of control students were selected from three high schools considered to be comparable to the other two. The experimental and control groups were compared on the basis of intelligence quotient, age and father's occupation.

As measured by several testing instruments such as the Greene-Stapp Language Abilities test and the Iowa Tests of Educational Development

(Test 8 -General Vocabulary and Test 6 -Ability to Interpret Reading Materials in the Natural Sciences), the large group television classes showed a level of achievement at least equal to that of students in the control classes where conventional instruction was used. Herminghaus concluded that although the experimental groups had a satisfactory degree of achievement, much experimentation and research is still required in this area of education.

A desire to promote a better utilization of the potential of television for instructional purposes was a major concern in much of the literature. Asheim (1965) regarded this as an area of particular significance. He indicated that the basic question is not simply how to use television, but rather how to combine it in an efficient manner with other learning experiences and resources. As Trotter (1970, p. 2) states, "It is not profitable to look at any single teaching/learning resource in isolation from others in use or in prospect. We must aim at nothing less than fundamental review of the instructional process".

Maclean (1971) discussed the fact that the universities of Glasgow and Strathclyde have tackled television lecture in three significantly different ways. Firstly, television has been used in the "overflow" lecture situation where student population was too large to be completely accommodated in the live lecture theatre. In this situation the proceedings were relayed live to a second lecture room. Student reactions to this method varied markedly from one department to another depending on the nature of the subject matter. The second and least successful method of television instruction originated in a television

studio and was transmitted to large lecture theatres. The absence of staff supervision in the lecture rooms apparently contributed to a considerable amount of student resentment. The third method committed the conventional lecture to video-tape with a minimum of television polish. The recordings were played to students who would normally be in groups of a hundred at a time. According to Maclean, this method's greater success was apparently due to its integration with handout notes and weekly small group tutorial meetings. Maclean indicated that television is not only used for lectures at Glasgow and Strathclyde but are regarded as a supplement rather than a substitute for other training methods.

According to Harris and Schaffer (1969), Maclean (1971) and Coltman (1971), another distinct advantage to using video-tape television in a biology laboratory is its ability to magnify structures that otherwise would be difficult to show an entire class. This advantage becomes apparent when anatomical demonstrations are presented to more than five or six students. Richter (1964) commented on an experimental design by Diamond (1962) where 128 students in a human anatomy course at San Jose State College were divided into two laboratory groups. One group used the experimental television method and the other group utilized the conventional demonstration method of instruction. In reviewing the effects of television as a simple magnification device within the laboratory, Richter indicated that not only did this method reduce the time for demonstrations, but on the basis of a t-test comparison with regard to their ability to identify anatomical structures of the skeletal system, low ability students performed better than their

counterparts in the conventional laboratory section. The study also showed that high ability students had comparable achievement in either laboratory situation.

To determine which teaching method was more effective, Woodward (1964) compared achievement between 126 students in direct class lectures and 543 students in television lectures. Achievement was evaluated by comparisons of scores on a midterm examination and a final examination. A t-ratio analysis at the .001 level indicated a significant difference in mean score between the two groups with the lecture method being superior to the television instruction. On this basis, biology classes offered during the following term were taught by direct lecture while television was reserved for special demonstrations.

Video-tape Retention Studies

Although the majority of retention studies have been conducted in areas other than biological science, some of the implications regarding student retention may be applicable to biology. A variety of variables such as the time period over which retention is measured, subject matter and level of student education, however, makes the transition somewhat difficult. Whittaker (1976, p. 304) suggests that the problem is further compounded in that:

> ... there are many different ways of defining memory. We can define it in terms of the number of items recognized, amount recalled, or time required for reconstruction. Furthermore, the course of forgetting is different for each of the definitions. If we define memory in terms of recognition, for example, we see a relatively slight decrement as a function of time. On the other hand, if memory is defined in terms of relearning or recall, the decrement is much greater.

Vernon (1976) expressed that retention and forgetting are actually the

same measure, one being the reciprocal of the other. This implies that if you have forgotten 70 percent of what you originally acquired, your retention score would then be 30 percent. He noted that retention experiments involved the passage of time where the subject either learned the material to a 100 percent criterion or where 100 percent indicated the totality of the acquisition level achieved. A given interval is then allowed to pass and the subject is again tested. This percentage score is then used as an indication of retention rather than acquisition.

In general, video-tape retention studies exhibit a similar range of results to those found with video-tape acquisition studies. Entorf (1967), for example, conducted an investigation to compare the effectiveness of video-taped, closed-circuit television with the conventional lecture method for teaching technical information in woodworking. He concluded that students taught by video-tapes scored higher on achievement tests measuring initial learning and retention. Taylor (1968) investigated the effectiveness of video-taping classroom interactions for presentations to other classes as a means of maximizing the recall of course content from instructional television. It was concluded that students of low ability achieved maximum recall of the course content when a period of live instruction with the video-taped teacher was included as part of their total instruction. Taylor reported no significant differences in achievement observed among treatments for students of high ability. These results were basically supported in a study by Benschoter and Charles (1957). Their study of long term retention was based on a previous study. Three year retention of psychology subject

matter taught by television and traditional methods was analyzed and a comparison of the mean differences in retention indicated that there was no significant difference in the amount retained by the groups. It was also noted that individuals with the lowest original scores lost less than those with higher scores.

Summary

Although video-tape playback (VTP) has been utilized in science instruction and numerous other subject areas, the bulk of the reported uses of VTP can be categorized in one of the following areas:

1. Psychomotor training
2. Counselling and psychotherapy
3. Counsellor and teacher education

Ronchi (1972), p. 1) further suggested that:

> Most of the studies have been conducted since 1960 and, with few exceptions, have been anecdotal and impressionistic accounts of the authors' experience with VTP. In many cases, control groups were inadequate or nonexistent.

Smith (1961) commented that the literature generally supports the conclusion that students taught by television learned content as well or better than those taught without it. Evans (1955), Gordon (1971) and many other authors supported this conclusion. Gordon (1971, p. 201) declared that, "The kind of research that characterizes most of the documents purporting to examine ITV ... show No Significant Difference between courses taught over television and equivalent courses given to live matched groups". Trotter (1970, p. 18) noted that, "Fifteen years of evaluation have demonstrated that televised instruction (whether the production is simple or elaborate) is usually as effective as

conventional methods of instruction". However, if this is the only claim that can be made for instructional television, then its major advantage would simply be preventing duplication of teacher effort in multiple sections of the same courses.

Schramm (Ashiem 1965) summarized the results of 393 comparisons between televised and classroom teaching in schools and colleges. He reported that approximately 65 percent of the comparisons showed no significant difference in student achievement between the two methods, 14 percent showed that students learned significantly less from television, and 21 percent showed, as did studies such as the ones by Mondfrans et al. (1972), Macomber et al. (1967) and Jacobs and Bollenbacher (1960), that students learned significantly more from television.

A study conducted by Stickell (1963) advanced the hypothesis that the apparently inconsistent results with regard to television and traditional instruction were due to inadequate experimental controls. A set of standards was defined for judging the experimental designs utilized in television and traditional instruction comparisons. Two hundred and fifty studies were then classified according to the extent to which they met these requirements. Of the 250 comparisons, 217 were classified as "unintrepretable", 23 were classified as "partially interpretable" and the remaining ten were considered "interpretable". The ten "interpretable" comparisons demonstrated no significant difference. On the basis of the "interpretable" results, it was concluded that neither television nor traditional instruction was superior.

The overall results of the research were adeptly summarized by Wischner and Scheier (1955, p. 613):

> What have we learned? A major conclusion warranted by all of the research findings is: TV can teach. Within the range of subject matters and student groups investigated, TV groups generally learn as well as regular instruction groups. In some instances TV groups achieve significantly better than their controls. With respect to retention measures, TV groups do as well as regularly instructed groups.

Perhaps the apparently inconsistent results with regard to comparison studies of television and traditional instruction are inherent in the variety and range of subject areas studies. However, as Greenhill (1964, p. 21) stated:

> Several things are clear: research on instructional television will be with us for some time to come, and it is becoming more sophisticated and more complex. Television and videotape recordings in particular, provide a marvelous vehicle with excellent control over the stimulus materials to make research feasible and productive.

III. METHODOLOGY

Introduction

The methodology followed in this study is described under the following headings: (1) Selection of the Sample, (2) Materials Used, (3) Procedure, (4) The Instrument, (5) Collection of the Data and (6) Statistical Analysis of the Data.

Selection of the Sample

The Lethbridge Community College serves a student population from southern Alberta, eastern British Columbia and western Saskatchewan. The two year nursing diploma program at the Lethbridge Community College has a triple entry date (September 7, November 29, and February 28) enrolling students in each of the three semesters.

The subjects in the study represented the entire population of first semester nursing students enrolled in Biology 160 (anatomy-physiology) at the Lethbridge Community College during the 1977-78 school year. Fifty-one of the subjects were female and two were males. Their ages ranged from eighteen years to forty-five years with thirty-seven of the subjects being between eighteen and twenty-three years of age, six of the subjects being between twenty-three and twenty-eight years of age, three of the subjects being between twenty-eight and thirty-three years of age, four of the subjects being between thirty-three and thirty-eight years of age, and the remaining three subjects being between thirty-eight and forty-five years of age.

Materials Used

The materials used in this study were as follows:

1. Seven articulated Denoyer-Geppert plastic model skeletons and four disarticulated human bone skeletons;
2. A general anatomy and physiology laboratory manual prepared by the investigator; and
3. Three video-taped presentations on the skeletal system.

The video-taped presentations were prepared by the investigator and an audio-visual coordinator using a Sony Trinicon DXC 1600 color camera and a Sony U-Matic VO2850 3/4 inch video-cassette recorder. Each of the three presentations was approximately fifty minutes in length and consisted of a discussion of the skeletal system, and a close up examination of the various skeletal parts and processes. Video-taped presentations I, II and III presented skeletal anatomy and terminology of the head, torso and limbs. The material covered by tapes I, II and III corresponds directly with laboratory exercises number I (pages 1-10), number II (pages 11-18) and number III (pages 19-20), of the investigator's laboratory manual.[1]

A group of evaluators composed of three biology instructors, one nursing director, one nursing instructor and two media coordinators viewed the three video-taped presentations of the skeletal system and evaluated them on the basis of the following five criteria suggested by Martin (1973):

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[1] Pages 1-26 of the investigator's laboratory manual are included in Appendix F.

1. The material must be technically correct;
2. The material must be appropriate for the need it serves;
3. The material must be well organized;
4. The presentation must be well delivered;
5. On the whole, the presentation should be of professional quality.

Martin (1973, p. 42) expanded on the fifth point when he stated:

> Through our exposure to commercial television, we are all conditioned to expect a certain 'smoothness' of presentation, picture and sound. Poor lighting, fluffs of lines, extended pauses, etc. may be distracting. However, since the purpose of these tapes is to teach and not to entertain, this point is the least important...

As he went on to point out, evaluation of a module by these criteria is not an automatic procedure as four of the five call for value judgements on the part of the evaluator. They do, however, guide the evaluator in what to look for.

The seven evaluators were asked to rate each of the five criteria on a scale from one to ten with one being the lowest rating and ten being the highest rating the criteria could receive. The five criteria were evaluated favorably by all of the evaluators (see Table 1). This evaluation gave support to the content validity of the video-tapes. In other words, the video-tapes covered the content they were designed to cover. It should be noted that one of the media coordinators did not comment on whether the material was technically correct. This individual did not have the background experience to make that particular evaluation.

Two of the biology instructors evaluated the investigator's laboratory manual as well as the pretest and the post-tests. Their

evaluation concluded that the laboratory manual, pretest and post-tests were appropriate and valid for the purpose of this study.

Procedure

For each of the three consecutive semesters of 1977-78, the students enrolled in Biology 160 (Bio 160) during each of the specific semesters were randomly assigned to a control group and two treatment groups by drawing numbered slips of paper from a hat. A pretest for previous knowledge of the skeletal system was administered to all the groups during the first scheduled meeting of the class.[2]

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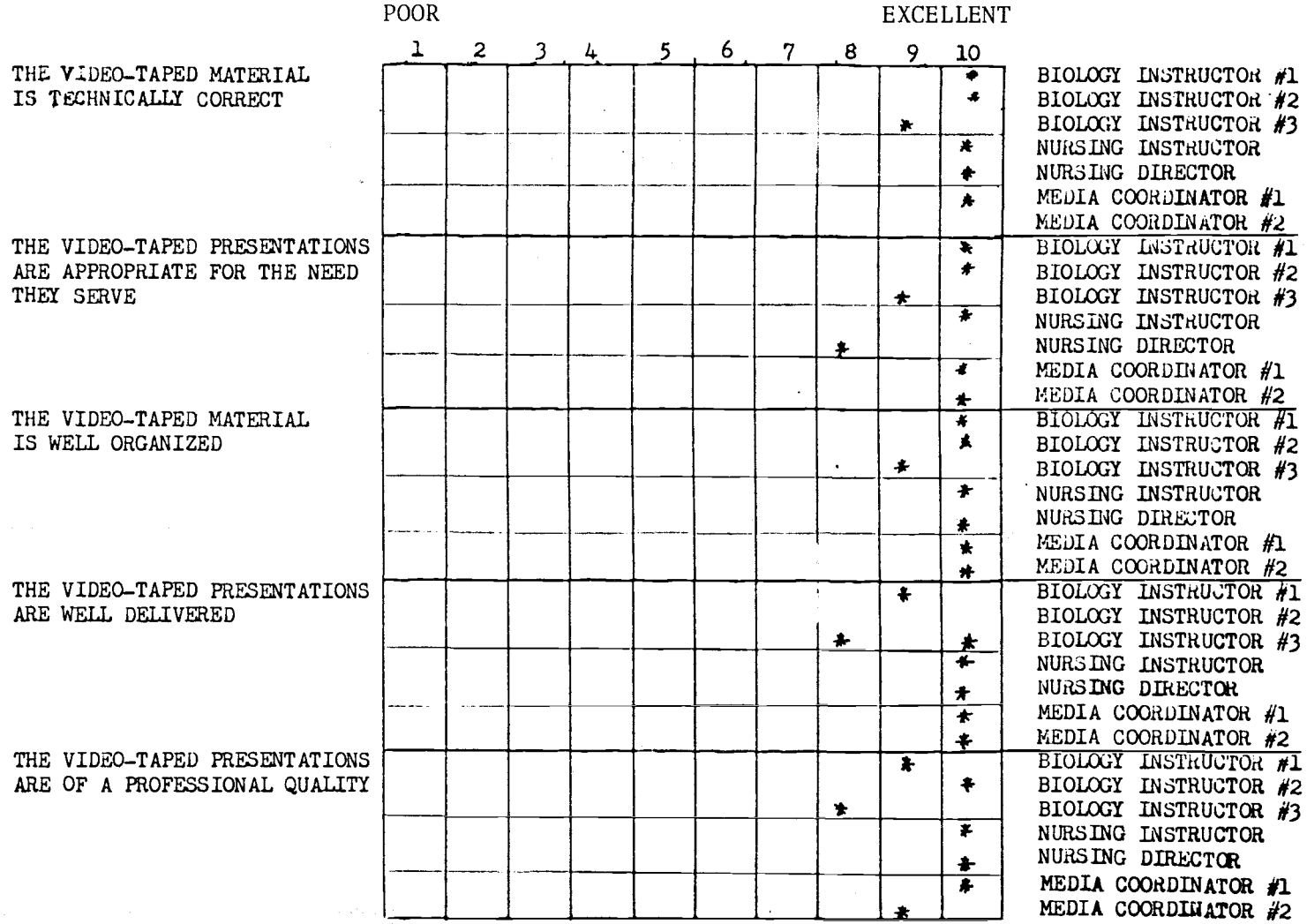
[2] The pretest, answer sheet and key are included in Appendix A.

Table 1

VIDEO-TAPE EVALUATION FORM



The three groups were exposed to different instructional techniques:

1. The traditional group was exposed to the conventional laboratory approach to learning the skeletal system. In this group, the student was provided with skeletal material (one articulated skeleton per every two students and one disarticulated skeleton per every four students), and an illustrated laboratory manual prepared by the investigator. The laboratory instructor (investigator) was available as a resource individual to answer questions with regard to pronunciation and location of specific skeletal parts or processes.
2. The video-tape group was exposed to the three video-taped presentations of the skeletal system. The student was provided with the same laboratory manual that was used by the traditional treatment group and the laboratory instructor (investigator) was present only to operate the video-taping equipment.
3. The control group was required to learn the skeletal material on their own. This group did not have access to the laboratory, the video-tapes or the plastic or actual bone skeletons. The group was informed that written materials such as anatomy-physiology laboratory manuals and text books were available in the Lethbridge Community College and University of Lethbridge libraries.

This study of the skeletal system was divided into the three major parts outlined in the investigator's laboratory manual (pp. 1-10, 11-18, 19-26). Part one included skeletal anatomy and terminology of the skull

and vertebral column, part two included the torso and humerus and part three included the limbs and pelvis. During the first three weeks of the semester, the traditional and video-tape groups were required to complete these three sections. Both groups were given two hours of exposure (one hour per day) per week for the three week period.

In each of the three semesters, the traditional and video-tape groups met at identical times on the same days (eight a.m. Thursday and eight a.m. Friday) in adjacent laboratory rooms of comparable design. All three groups were in the same lecture section. The skeletal system was not covered in the lectures by the investigator.

To determine student knowledge of the skeletal system, a post-test was administered simultaneously to all three groups at the end of the first, second and third weeks of each semester (post-test one, two, three).[3] The students were not informed of their results on these post-tests until after the cumulative post-test was given.

The cumulative post-test for measuring knowledge of skeletal terminology and identification of skeletal anatomy was administered simultaneously to all three groups during the first day of the fourth week of each semester.[4] Without being forewarned, the three groups concurrently rewrote the cumulative cognitive achievement test after fifty-three days. This was done to determine student retention of skeletal system knowledge

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[3] Post-tests one, two and three and their respective keys are included in Appendices B, C and D.

[4] The cumulative post-test and key is included in Appendix E.

at the end of the semester. Three semester one subjects withdrew from the nursing program during the last month of the semester and were unavailable to write this final cognitive achievement test. One of the subjects was in the traditional group while the other two were in the self study group.

The pretest was used to compute pretest post-test gain scores for both the experimental and control groups. Gain scores were calculated for post-test one, two, three and the cumulative post-test.

Table 2 summarizes the procedural design of the study. As Table 2 shows, semester one, two, and three are an exact repetition of the same procedure. The table indicates the tests and treatments given to the traditional, video-tape and control groups during the first, second, third and fourth weeks of the experiment.

The Instrument

The instrument for measuring cognitive achievement and retention of skeletal anatomy and terminology was developed by the investigator. Of the 181 bones and processes outlined in the investigator's laboratory manual, sixty-five were randomly selected by drawing numbered slips of paper from a hat and incorporated into the pretest.[5] Twenty-three, twenty and twenty-two of the items came from the first, second and third laboratory exercise respectively. Thirty, thirty, thirty-four and sixty bones and processes were randomly selected by the same method and respectively incorporated into post-test one, two, three and the cumulative

[5] The pretest and answer key are included in Appendix A.

Table 2

THE PROCEDURAL DESIGN

			FIRST WEEK		SECOND WEEK		THIRD WEEK		FOURTH WEEK
			Completion of lab. 1 (pg. 1-10, laboratory manual)		Completion of lab. 2 (pg. 11-18 laboratory manual)		Completion of lab. 3 (pg. 19-26, laboratory manual)		Cumulative Cognitive Achievement Test
Semester one	Traditional gr.	Pretest All 3 Groups Previous to the First Week	-traditional laboratory experience for one hour on day X -traditional laboratory experience for one hour on day Y	Post-test All 3 Groups at the End of Week One	-traditional laboratory experience for one hour on day X -traditional laboratory experience for one hour on day Y	Post-test All 3 Groups at the end of Week Two	-traditional laboratory experience for one hour on day X -traditional laboratory experience for one hour on day Y	Post-test All 3 Groups at the End of Week Three	Evaluation (Post-test)
	Video-Tape gr.		-video-taped presentation for one hour on day X -video-taped presentation repeated on day Y		-video-taped presentation for one hour on day X -video-taped presentation repeated on day Y		-video-taped presentation for one hour on day X video-taped presentation repeated on day Y		Evaluation (Post-test)
	Control gr.		Self Study		Self Study		Self Study		Evaluation (Post-test)
Semester two	Traditional gr.	Pretest All 3 Groups Previous to the First Week	-traditional laboratory experience for one hour on day X -traditional laboratory experience for one hour on day Y	Post-test All 3 Groups at the End of Week One	-traditional laboratory experience for one hour on day X -traditional laboratory experience for one hour on day Y	Post-test All 3 Groups at the End of Week Two	-traditional laboratory experience for one hour on day X -traditional laboratory experience for one hour on day Y	Post-test All 3 Groups at the End of Week Three	Evaluation (Post-test)
	Video-Tape gr.		-video-taped presentation for one hour on day X -video-taped presentation repeated on day Y		-video-taped presentation for one hour on day X -video-taped presentation repeated on day Y		-video-taped presentation for one hour on day one -video-taped presentation repeated on day Y		Evaluation (Post-test)
	Control gr.		Self Study		Self Study		Self Study		Evaluation (Post-test)

Table 2 (continued)

THE PROCEDURAL DESIGN

Semester three Traditional gr	Pretest All 3 Groups Previous to the First Week	-traditional laboratory experience for one hour on day X -traditional laboratory experience for one hour on day Y	Post-test All 3 Groups at the End of Week One	-traditional laboratory experience for one hour on day X -traditional laboratory experience for one hour on day Y	Post-test All 3 Groups at the End of Week Two	-traditional laboratory experience for one hour on day X -traditional laboratory experience for one hour on day Y	Post-test All 3 Groups at the End of Week Three	Evaluation (Post-test)
Video-Tape gr.		-video-taped presentation for one hour on day X -video-taped presentation repeated on day Y		-video-taped presentation for one hour on day X -video-taped presentation repeated on day Y		-video-taped presentation for one hour on day one -video-taped presentation repeated on day Y		Evaluation (Post-test)
Control gr.		Self Study		Self Study		Self Study		Evaluation (Post-test)

post-test.[6]

The pretest was a written examination incorporating the diagrams used in the laboratory manual. The post-tests incorporated the randomly selected bones and processes into a cognitive achievement test, utilizing human skeletons and plastic skeleton models.

At the end of the three weeks the cumulative post-test was administered. Fifty-three days later it was again administered for evaluation of student retention.

The pretest and post-test examinations were composed of 65 and 60 randomly selected bones and processes. It should be noted that for each examination, these items represented at least 30 percent of the total 181 skeletal terms and processes used in the study. In addition, the 30, 30 and 34 terms and processes that were randomly selected and incorporated into post-tests one, two and three represent at least 30 percent of the bones and processes listed in part one, two and three of the laboratory manual. The random selection of the test items and the incorporation of 30 percent of the bones and processes into each examination contributed to the content validity of the pretest and the post-tests.

The reliability of the results from semester one to semester two and three was strengthened by utilizing identical examinations during each of the three semesters. In addition, these objective examinations required one or two word answers which were marked using predetermined answer keys.

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[6] Post-tests one, two, three and the cumulative post-test are included in Appendices B, C, D and E respectively.

Collection of the Data

The subjects of the study recorded their responses to the pretest, post-tests one, two, three and the cumulative post-test on answer sheets provided by the invigilator of each specific examination. During each of the three semesters, student responses to each of the five examinations were evaluated by using predetermined answer keys for each of the five examinations. From the raw student score, a percentage grade was calculated for each student on each of the five examinations and a pretest post-test gain score was computed for both the experimental groups and the control group.

Data concerning the ages of the subjects were obtained through Student Services at the Lethbridge Community College.

Statistical Analysis of the Data

After the data were collected and the responses key punched on IBM cards, the card deck was inspected and checked for accuracy. A computer program was written to tabulate the results for each variable and processed through the computing services at Oregon State University.

The analysis of variance design used was a one-way (one-factor) randomized block design having as the levels of treatment, video-tape, traditional and control groups. The particular blocks were semester one, semester two and semester three. A paired t-test and the F statistic, a test designed for assessing means to determine the presence of significant differences, were used in analyzing the data.

IV. ANALYSIS AND PRESENTATION OF THE FINDINGS

The treatment, analysis and interpretation of data collected for this study are presented in Chapter IV under the following headings: (1) General Experimental Data, (2) Analysis of Differences Among Methods, (3) Analysis of Differences Between Methods, (4) Analysis of Retention Differences, (5) Findings Not Related to the Hypotheses and (6) Results of Hypotheses Tested.

The findings are based on the data obtained from a pretest (Appendix A) and four post-tests (Appendices B, C, D and E) administered to first semester nursing students enrolled in anatomy and physiology (Bio 160).

The analysis of variance design used was a one-way (one-factor) randomized block design having video-tape, traditional and control groups as the levels of treatment. The particular blocks were semester one, semester two and semester three. A paired t-test and the F statistic, a test designed for assessing means to determine the presence of significant differences, were used in analyzing the data.

General Experimental Data

Table 3 gives a general overview of the experimental data of the study. The following outline provides a brief interpretation of that table:

Column A	Column A indicates the specific method by which skeletal anatomy and terminology were presented to the student. Number one refers to video-tape presentations, number two refers to a traditional laboratory approach and three indicates the control group method.
Column B	Column B denotes the specific semester during which the student was enrolled in anatomy and physiology. The first semester is denoted by number one while semester two and three are denoted by numbers two and three respectively.
Column C	Each student was assigned a student number during the study. These numbers are represented in Column C.
Column D	Column D represents the pretest scores (percent).
Columns E and F	The pretest scores (percent) for the initial laboratory section (the skull and vertebral column) are represented in Column E whereas the post-test scores (percent) for this section are in Column F.

Columns G and H	The pretest scores (percent) for the second laboratory section (torso and humerus) are represented in Column G whereas the post-test scores (percent) for this section are in Column H.
Columns I and J	The pretest scores (percent) for the third laboratory section (limbs and pelvis) are represented in Column I whereas the post-test scores (percent) for this section are in Column J.
Column K	The cumulative post-test scores (percent) are recorded in Column K.
Column L	The figures in Column L represent the scores (percent) obtained on the cumulative post-test (postpost-test) when it was readministered 53 days after it was first written by the student.
Column M	The total gain scores (cumulative post-test score minus pretest score) are recorded in Column M.
Column N	Column N represents the gain score from pretest one to post-test one.

Column O	Column O represents the gain score from pretest two to post-test two.
Column P	Column P represents the gain score from pretest three to post-test three.
Column Q	Retention scores (the difference between post-test and postpost-test scores) are recorded in Column Q.

Because of the unequal observations, a linear model approach (least squares) was required to obtain the F statistics needed to make the appropriate comparisons. In other words, differing numbers of students for each semester and or method determined the use of the model in order to statistically test differences in gains among methods. For this reason, it was necessary to utilize an X matrix (see Table 4) in order to obtain the analysis dealing with the unequal number of students within cells. Basically, an analysis of variance can be performed as a multiple regression. The matrix approach to this analysis is useful since it permits large arrays of data to be denoted compactly. The columns in the X matrix represent the independent variables utilized in this particular regression. Specifically, Column R represents the grand mean of the X matrix cells and columns M_1 and M_2 represent the variables used to allow for differences between methods. Columns S_1 and S_2 denote the variables used to allow for differences between semesters.

Table 3

GENERAL EXPERIMENTAL DATA RELATIVE TO

PRETEST AND POST-TEST GAIN SCORES

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
1	1	1	0	0	55	0	75	0	74	79	34	79	55	75	74	-45
1	1	2	0	0	68	0	60	0	31	75	11	75	68	60	31	-64
1	1	3	2	0	83	0	30	5	54	69	41	67	83	30	49	-28
1	1	4	5	0	83	10	97	5	99	92	62	87	83	87	94	-30
1	1	5	3	4	93	5	95	0	94	97	66	94	89	90	94	-31
1	1	6	13	20	77	8	63	11	76	88	55	75	57	55	65	-33
1	1	7	2	4	67	0	72	0	79	69	22	67	63	72	79	-47
1	1	8	0	0	87	0	68	0	78	82	21	82	87	68	78	-61
1	1	9	0	0	75	0	75	0	31	83	25	83	75	75	31	-58
1	1	10	12	17	93	10	88	7	66	87	52	75	76	78	59	-35
1	1	11	0	0	73	0	80	0	85	82	61	82	73	80	85	-21
1	2	12	3	4	85	0	83	5	87	92	50	89	81	83	82	-42
1	2	13	0	0	77	0	98	0	88	90	74	90	77	98	88	-16
1	2	14	6	4	47	5	88	9	87	91	69	85	43	83	78	-22
1	3	15	15	15	97	9	93	20	97	96	65	81	82	84	77	-31
1	3	16	2	0	90	5	87	0	99	88	35	86	90	82	99	-53
1	3	17	2	0	93	5	92	0	94	94	67	92	93	87	94	-27
2	1	31	12	9	87	10	97	18	91	92	52	80	78	87	73	-40
2	1	32	0	0	85	0	90	0	79	65	0	65	85	90	79	-65
2	1	33	0	0	87	0	93	0	85	87	36	87	87	93	85	-51
2	1	34	0	0	92	0	95	0	97	91	56	91	92	95	97	-35
2	1	35	0	0	33	0	80	0	49	79	25	79	33	80	49	-54
2	1	36	0	0	70	0	98	0	93	66	29	66	70	98	93	-37
2	1	37	2	4	73	0	90	0	76	75	38	73	69	90	76	-37
2	1	38	1	0	75	0	95	2	78	67	35	66	75	95	76	-32
2	1	39	6	4	72	5	72	9	69	64	25	58	68	67	60	-39
2	1	40	0	0	60	0	53	0	25	87	43	87	60	53	25	-44
2	1	41	0	0	65	0	77	0	79	84	52	84	65	77	79	-32

The following is a brief description of columns A through Q:

A - Method of instruction (1 - video-tape presentations; 2 - traditional approach; 3 - control group method)

B - Semester during which the experiment was conducted (1 - first semester; 2 - second semester; 3 - third semester)

C - Student number (each student was assigned a student number during the study)

D - Percent values of the pretest (appendix A) scores

E - Percent values of pretest scores pertaining to laboratory one (appendix F)

F - Percent values of post-test scores pertaining to laboratory one (appendix F)

G - Percent values of pretest scores pertaining to laboratory two (appendix F)

H - Percent values of post-test scores pertaining to laboratory two (appendix F)

I - Percent values of pretest scores pertaining to laboratory three (appendix F)

J - Percent values of post-test scores pertaining to laboratory three (appendix F)

K - Percent values of the cumulative post-test (appendix E) scores

L - Percent values of the postpost-test (cumulative post-test readministered 53 days after it was first written by the student) scores

M - Percent value of the total gain scores (cumulative post-test score minus pretest score)

N - Percent value of gain score from pretest 1 to post-test 1

O - Percent value of the gain score from pretest 2 to post-test 2

P - Percent value of the gain score from pretest 3 to post-test 3

Q - Percent value of the retention score (the difference between post-test and postpost-test scores)

Table 3 (continued)

GENERAL EXPERIMENTAL DATA RELATIVE TO

PRETEST AND POST-TEST GAIN SCORES

A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q
2	1	42	0	0	93	0	98	0	91	88	44	88	93	98	91	-44
2	2	43	10	11	90	10	97	9	99	82	40	72	79	87	90	-42
2	2	44	0	0	37	0	75	0	44	62	22	62	37	75	44	-40
2	2	45	6	4	52	0	97	14	85	84	40	78	48	97	71	-44
2	3	46	2	4	78	0	70	0	57	80	67	78	74	70	57	-13
2	3	47	3	9	52	0	70	0	26	80	34	77	43	70	26	-46
2	3	48	15	20	88	18	85	5	34	72	35	57	68	67	29	-37
3	1	61	0	0	38	0	55	0	46	35	0	35	38	55	46	-35
3	1	62	0	0	72	0	83	0	87	74	25	74	72	83	87	-49
3	1	63	7	0	48	3	62	2	54	47	28	40	48	59	52	-19
3	1	64	5	4	77	5	57	5	87	83	0	78	73	52	82	-83
3	1	65	2	0	42	5	53	0	53	44	28	42	42	48	53	-16
3	1	66	0	0	77	0	88	0	65	72	32	72	77	88	65	-40
3	1	67	0	0	35	0	87	0	72	46	12	46	35	87	72	-34
3	1	68	12	26	43	0	83	9	81	82	72	70	17	83	72	-10
3	1	69	2	7	70	0	77	0	51	72	38	70	63	77	51	-34
3	1	70	0	0	33	0	57	0	34	32	15	32	33	57	34	-17
3	1	71	5	13	28	0	43	0	10	31	6	26	15	43	10	-25
3	2	72	0	0	45	0	68	0	66	63	17	63	45	68	66	-46
3	2	73	3	9	40	0	68	0	51	69	34	66	31	68	51	-35
3	2	74	1	2	27	0	53	0	72	52	25	51	25	53	72	-27
3	3	75	28	20	93	14	90	55	93	97	86	69	73	76	38	-11
3	3	76	2	4	65	0	43	0	31	57	18	55	61	43	31	-39
3	3	77	3	4	80	5	82	0	82	83	47	80	76	77	82	-36
3	3	78	0	0	67	0	47	0	24	41	18	41	67	47	24	-23

The following is a brief description of columns A through Q:

A - Method of instruction (1 - video-tape presentations; 2 - traditional approach; 3 - control group method)

B - Semester during which the experiment was conducted (1 - first semester; 2 - second semester; 3 - third semester)

C - Student number (each student was assigned a student number during the study)

D - Percent values of the pretest (appendix A) scores

E - Percent values of pretest scores pertaining to laboratory one (appendix F)

F - Percent values of post-test scores pertaining to laboratory one (appendix F)

G - Percent values of pretest scores pertaining to laboratory two (appendix F)

H - Percent values of post-test scores pertaining to laboratory two (appendix F)

I - Percent values of pretest scores pertaining to laboratory three (appendix F)

J - Percent values of post-test scores pertaining to laboratory three (appendix F)

K - Percent values of the cumulative post-test (appendix E) scores

L - Percent values of the postpost-test (cumulative post-test readministered 53 days after it was first written by the student) scores

M - Percent value of the total gain scores (cumulative post-test score minus pretest score)

N - Percent value of gain score from pretest 1 to post-test 1

O - Percent value of the gain score from pretest 2 to post-test 2

P - Percent value of the gain score from pretest 3 to post-test 3

Q - Percent value of the retention score (the difference between post-test and postpost-test scores)

Table 4

PRETEST POST-TEST EXPERIMENTAL DATA AND THE X MATRIX

A	B	C	M	N	O	P	Q	X MATRIX R	M_1	M_2	S_1	S_2
1	1	1	79	55	75	74	-45	1	1	0	1	0
1	1	2	75	68	60	31	-64	1	1	0	1	0
1	1	3	67	83	30	49	-28	1	1	0	1	0
1	1	4	87	83	87	94	-30	1	1	0	1	0
1	1	5	94	89	90	94	-31	1	1	0	1	0
1	1	6	75	57	55	65	-33	1	1	0	1	0
1	1	7	67	63	72	79	-47	1	1	0	1	0
1	1	8	82	87	68	78	-61	1	1	0	1	0
1	1	9	83	75	75	31	-58	1	1	0	1	0
1	1	10	75	76	78	59	-35	1	1	0	1	0
1	1	11	82	73	80	85	-21	1	1	0	1	0
1	2	12	89	81	83	82	-42	1	1	0	0	1
1	2	13	90	77	98	88	-16	1	1	0	0	1
1	2	14	85	43	83	78	-22	1	1	0	0	1
1	3	15	81	82	84	77	-31	1	1	0	-1	-1
1	3	16	86	90	82	99	-53	1	1	0	-1	-1
1	3	17	92	93	87	94	-27	1	1	0	-1	-1
2	1	31	80	78	87	73	-40	1	0	1	1	0
2	1	32	65	85	90	79	-65	1	0	1	1	0
2	1	33	87	87	93	85	-51	1	0	1	1	0
2	1	34	91	92	95	97	-35	1	0	1	1	0
2	1	35	79	33	80	49	-54	1	0	1	1	0
2	1	36	66	70	98	93	-37	1	0	1	1	0
2	1	37	73	69	90	76	-37	1	0	1	1	0
2	1	38	66	75	95	76	-32	1	0	1	1	0
2	1	39	58	68	67	60	-39	1	0	1	1	0
2	1	40	87	60	53	25	-44	1	0	1	1	0
2	1	41	84	65	77	79	-32	1	0	1	1	0

Columns A through Q represent the general experimental data as listed in Table 3. The following is a brief description of columns R, M_1, M_2, S_1 and S_2 of the X matrix:

R - Grand mean of the X matrix cells

M_1- Variables used to allow for the differences between methods (1 - Videotape presentations; 2 - traditional approach; -1 - control group)

M_2- Variables used to allow for the differences between methods (0 - Videotape presentations; 1 - traditional approach; -1 - control group)

S_1- Variables used to allow for differences between semesters (1 - first semester; 0 - second semester; -1 - third semester)

S_2- Variables used to allow for differences between semesters (0 - first semester; 1 - second semester; -1 - third semester)

Table 4 (continued)

PRETEST POST-TEST EXPERIMENTAL DATA AND THE X MATRIX

A	B	C	M	N	O	P	Q	X MATRIX R	M_1	M_2	S_1	S_2
2	1	42	88	93	98	91	-44	1	0	1	1	0
2	2	43	72	79	87	90	-42	1	0	1	0	1
2	2	44	62	37	75	44	-40	1	0	1	0	1
2	2	45	78	48	97	71	-44	1	0	1	0	1
2	3	46	78	74	70	57	-13	1	0	1	-1	-1
2	3	47	77	43	70	26	-46	1	0	1	-1	-1
2	3	48	57	68	67	29	-37	1	0	1	-1	-1
3	1	61	35	38	55	46	-35	1	-1	-1	1	0
3	1	62	74	72	83	87	-49	1	-1	-1	1	0
3	1	63	40	48	59	52	-19	1	-1	-1	1	0
3	1	64	78	73	52	82	-83	1	-1	-1	1	0
3	1	65	42	42	48	53	-16	1	-1	-1	1	0
3	1	66	72	77	88	65	-40	1	-1	-1	1	0
3	1	67	46	35	87	72	-34	1	-1	-1	1	0
3	1	68	70	17	83	72	-10	1	-1	-1	1	0
3	1	69	70	63	77	51	-34	1	-1	-1	1	0
3	1	70	32	33	57	34	-17	1	-1	-1	1	0
3	1	71	26	15	43	10	-25	1	-1	-1	1	0
3	2	72	63	45	68	66	-46	1	-1	-1	0	1
3	2	73	66	31	68	51	-35	1	-1	-1	0	1
3	2	74	51	25	53	72	-27	1	-1	-1	0	1
3	3	75	69	73	76	38	-11	1	-1	-1	-1	-1
3	3	76	55	61	43	31	-39	1	-1	-1	-1	-1
3	3	77	80	76	77	82	-36	1	-1	-1	-1	-1
3	3	78	41	67	47	24	-23	1	-1	-1	-1	-1

Columns A through Q represent the general experimental data as listed in Table 3. The following is a brief description of columns R, M_1, M_2, S_1 and S_2 of the X matrix:

R - Grand mean of the X matrix cells

M_1- Variables used to allow for the differences between methods (1 - Videotape presentations; 2 - traditional approach; -1 - control group)

M_2- Variables used to allow for the differences between methods (0 - Videotape presentations; 1 - traditional approach; -1 - control group)

S_1- Variables used to allow for differences between semesters (1 - first semester; 0 - second semester; -1 - third semester)

S_2- Variables used to allow for differences between semesters (0 - first semester; 1 - second semester; -1 - third semester)

Analysis of Differences Among Methods

Hypothesis one stated that the cognitive achievement of students who are taught skeletal anatomy and terminology by video-taped presentations will not be significantly different from that of students who are taught by a traditional laboratory approach. An initial analysis of variance was performed to determine whether differences existed between the video-tape, traditional and control groups. This particular analysis was not utilized to specify where the differences existed, but merely indicated whether the instructional methods varied with regard to total gain, gain one, gain two, and gain three. It should be noted that total gain is the difference between the cumulative post-test (Appendix E) score and the pretest (Appendix A) score whereas gain one, gain two and gain three represent the corresponding difference between pretests one, two, three (Appendix A) and their respective post-tests (Appendices B, C and D).

The F values associated with the analysis of differences among methods are listed in Table 5. This table indicates the computed F value from analysis of variance, the F table values and the degrees of freedom for total gain, gain one, gain two and gain three.

Table 5

F VALUES - ANALYSIS OF DIFFERENCES AMONG INSTRUCTIONAL METHODS

	F (degrees of freedom)	Computed F Value From Analysis of Variance	F Table Values
Total Gain	**F 2,48**	19.0960	.05 = 3.1907 .01 = 5.0767
Gain 1	**F 2,48**	11.2339	.05 = 3.1907 .01 = 5.0767
Gain 2	**F 2,48**	6.4003	.05 = 3.1907 .01 = 5.0767
Gain 3	**F 2,48**	3.1725	.05 = 3.1907 .01 = 5.0767
Retention	**F 2,45**	3.2232	.05 = 3.2043 .01 = 5.1103

Total Gain: Total gain is the difference between the cumulative post-test (appendix E) score and the pretest (appendix A) score.

Gain 1,2,3: Gain 1, 2 and 3 represent the corresponding differences between pretests 1,2,3 (appendix A) and their respective post-tests (appendices B, C and D).

Retention: Retention represents the difference between the post-test score and the postpost-test (post-test readministered in 53 days) score.

Total Gain:

An analysis of variance was performed to determine whether there were differences in total gain (the difference between the cumulative post-test score and the pretest score) when comparing video-tape, traditional and control methods of instruction. The total gain for each instructional method, semester and semester-method combination are represented in Tables 6, 7 and 8. The total gain for each instructional method is represented in Table 6. The video-tape, traditional and control groups are compared with regard to the number of experimental subjects (frequency), the mean of the total gain scores and the standard deviation. The total gain for each semester is depicted in Table 7. In this particular table, semester one, two and three are contrasted with regard to frequency, mean of total gain scores and standard deviations. The frequency, mean of the total gain scores and standard deviation for each of the nine semester-method combinations are listed in Table 8.

The F statistic (see Table 5) from the analysis of variance of this randomized block design indicates that for total gain, differences exist among the three methods at the .01 significance level.

Gain One:

An analysis of variance was utilized to determine whether there were differences in gain one (post-test one minus pretest one - the skull and vertebral column) when comparing video-tape, traditional and control methods. Gain one for each method, semester and semester-method combination are represented in Tables 9, 10 and 11. Gain one for each instructional method is represented in Table 9. The video-tape, traditional and control groups are compared with regard to the number of experimental

Table 6

TOTAL GAIN (POST-TEST SCORE MINUS PRETEST SCORE) FOR EACH INSTRUCTIONAL METHOD

METHOD	FREQUENCY	MEAN OF TOTAL GAIN	STANDARD DEVIATION
1. video-tape	17	81.706	7.9590
2. traditional	18	74.889	10.610
3. control	18	56.111	17.269

Table 7

TOTAL GAIN (POST-TEST SCORE MINUS PRETEST SCORE) FOR EACH SEMESTER

SEMESTER	FREQUENCY	MEAN OF TOTAL GAIN	STANDARD DEVIATION
1. semester 1	34	69.853	17.731
2. semester 2	9	72.889	13.550
3. semester 3	10	71.600	15.932

Table 8

TOTAL GAIN (POST-TEST SCORE MINUS PRETEST SCORE) FOR EACH SEMESTER-METHOD COMBINATION

SEMESTER-METHOD	FREQUENCY	MEAN OF TOTAL GAIN	STANDARD DEVIATION
1. semester 1 - video-tape	11	78.727	8.1128
2. semester 2 - video-tape	3	88.000	2.6458
3. semester 3 - video-tape	3	86.333	5.5076
4. semester 1 - traditional	12	77.000	11.045
5. semester 2 - traditional	3	70.667	8.0829
6. semester 3 - traditional	3	70.667	11.846
7. semester 1 - control	11	53.182	19.590
8. semester 2 - control	3	60.000	7.9373
9. semester 3 - control	4	61.250	16.939

Table 9

GAIN ONE (POST-TEST ONE SCORE MINUS PRETEST ONE SCORE) FOR EACH INSTRUCTIONAL METHOD

METHOD	FREQUENCY	MEAN OF TOTAL GAIN	STANDARD DEVIATION
1. video-tape	17	75.000	13.811
2. traditional	18	68.000	17.898
3. control	18	49.500	21.105

Table 10

GAIN ONE (POST-TEST ONE SCORE MINUS PRETEST ONE SCORE) FOR EACH SEMESTER

SEMESTER	FREQUENCY	MEAN OF TOTAL GAIN	STANDARD DEVIATION
1. semester 1	34	64.618	20.937
2. semester 2	9	51.778	21.609
3. semester 3	10	72.700	14.469

Table 11

GAIN ONE (POST-TEST ONE SCORE MINUS PRETEST ONE SCORE) FOR EACH SEMESTER-METHOD COMBINATION

SEMESTER-METHOD	FREQUENCY	MEAN OF TOTAL GAIN	STANDARD DEVIATION
1. semester 1 - video-tape	11	73.5454	11.6907
2. semester 2 - video-tape	3	67.0000	20.8806
3. semester 3 - video-tape	3	88.3333	5.6862
4. semester 1 - traditional	12	72.9166	16.5499
5. semester 2 - traditional	3	54.6666	21.7791
6. semester 3 - traditional	3	61.6666	16.4418
7. semester 1 - control	11	46.6363	21.9694
8. semester 2 - control	3	33.6666	10.2632
9. semester 3 - control	4	69.2500	6.6520

subjects (frequency), the mean of the total gain one scores and the standard deviation. The gain one scores for each semester are compared in Table 10. That is, semester one, two and three are outlined with regard to frequency, mean of total gain one scores and standard deviations. These same comparisons are made in Table 11 with regard to the nine semester-method combinations.

The F statistic (see Table 5), from the analysis of variance of this randomized block design, indicates that there are differences among the three methods for the variable gain one at the .01 significance level.

Gain Two:

An analysis of variance was performed to determine whether there were differences in gain two (post-test two minus pretest two - the torso and humerus) when comparing video-tape, traditional and control methods. Gain two for each method, semester and semester-method combination are represented in Tables 12, 13 and 14. Gain two scores for each instructional method are represented in Table 12. The video-tape, traditional and control groups are compared with regard to the number of experimental subjects (frequency), the mean of the total gain two scores and the standard deviation. The gain two scores for each semester are compared in Table 13. Specifically, semester one, two and three are outlined with regard to frequency, mean of total gain two scores and standard deviation. The frequency, mean of the total gain two scores and standard deviation for each of the semester-method combinations are listed in Table 14.

Table 12

GAIN TWO (POST-TEST TWO SCORE MINUS PRETEST TWO SCORE) FOR EACH INSTRUCTIONAL METHOD

METHOD	FREQUENCY	MEAN OF TOTAL GAIN	STANDARD DEVIATION
1. video-tape	17	75.706	15.878
2. traditional	18	82.722	13.332
3. control	18	64.667	15.681

Table 13

GAIN TWO (POST-TEST TWO SCORE MINUS PRETEST TWO SCORE) FOR EACH SEMESTER

SEMESTER	FREQUENCY	MEAN OF TOTAL GAIN	STANDARD DEVIATION
1. semester 1	34	74.265	17.540
2. semester 2	9	79.111	14.641
3. semester 3	10	70.300	14.833

Table 14

GAIN TWO (POST-TEST TWO SCORE MINUS PRETEST TWO SCORE) FOR EACH SEMESTER-METHOD COMBINATION

SEMESTER-METHOD	FREQUENCY	MEAN OF TOTAL GAIN	STANDARD DEVIATION
1. semester 1 - video-tape	11	70.000	16.840
2. semester 2 - video-tape	3	88.000	8.6603
3. semester 3 - video-tape	1	84.333	2.5166
4. semester 1 - traditional	12	85.250	13.791
5. semester 2 - traditional	3	86.333	11.015
6. semester 3 - traditional	3	69.000	1.7321
7. semester 1 - control	11	66.545	17.090
8. semester 2 - control	3	63.000	8.6603
9. semester 3 - control	4	60.750	18.264

The F statistic (see Table 5) from the analysis of variance of this randomized block design, indicates that there are differences among the three methods for the variable gain two at the .01 significance level.

Gain Three:

An analysis of variance was conducted to determine whether there were differences in gain three (post-test three minus pretest three - the limbs and pelvis) when comparing video-tape, traiditional and control methods. Gain three for each method, semester and semester-method combination are represented in Tables 15, 16 and 17. The gain three scores for each instructional method are represented in Table 15. The video-tape, traditional and control groups are compared with regard to the number of experimental subjects (frequency), the mean of the total gain three scores and the standard deviation. The gain three scores for each semester are compared in Table 16. That is, semester one, two and three are outlined with regard to frequency, mean of total gain three scores and standard deviation. These same comparisons are made in Table 17 with regard to the nine semester-method combinations.

The F statistic from the analysis of variance of this randomized block design indicates that there is not a significant difference among the three methods for the variable gain three at either the .01 or the .05 levels of significance. As can be noted in Table 5, the level of rejection was extremely narrow at the .05 level of significance.

Retention:

Hypothesis two stated that retention of cognitive material by students who are taught skeletal anatomy and terminology by video-taped presentations will not be significantly different from that of students

Table 15

GAIN THREE (POST-TEST THREE SCORE MINUS PRETEST THREE SCORE) FOR EACH INSTRUCTIONAL METHOD

METHOD	FREQUENCY	MEAN OF TOTAL GAIN	STANDARD DEVIATION
1. video-tape	17	73.941	20.768
2. traditional	18	66.667	23.510
3. control	18	54.889	21.676

Table 16

GAIN THREE (POST-TEST THREE SCORE MINUS PRETEST THREE SCORE) FOR EACH SEMESTER

SEMESTER	FREQUENCY	MEAN OF TOTAL GAIN	STANDARD DEVIATION
1. semester 1	34	66.059	22.214
2. semester 2	9	71.333	15.708
3. semester 3	10	55.700	29.837

Table 17

GAIN THREE (POST-TEST THREE SCORE MINUS PRETEST THREE SCORE) FOR EACH SEMESTER-METHOD COMBINATION

SEMESTER-METHOD	FREQUENCY	MEAN OF TOTAL GAIN	STANDARD DEVIATION
1. semester 1 - video-tape	11	67.182	22.538
2. semester 2 - video-tape	3	82.667	5.0332
3. semester 3 - video-tape	3	90.000	11.533
4. semester 1 - traditional	12	73.583	20.403
5. semester 2 - traditional	3	68.333	23.116
6. semester 3 - traditional	3	37.333	17.098
7. semester 1 - control	11	56.727	22.303
8. semester 2 - control	3	63.000	10.817
9. semester 3 - control	4	43.750	26.133

who are taught by a traditional laboratory approach. An analysis of variance was performed to determine whether there were differences in student retention (postpost-test minus post-test) when comparing video-tape, traditional and control methods of instruction. Retention for each method, semester and semester-method combination are represented in Tables 18, 19 and 20. The retention gain scores for the video-tape, traditional and control groups are represented in Table 18. The three groups are contrasted with regard to the number of experimental subjects (frequency), the means of the total retention gain scores and the standard deviation. The retention gain scores for each semester are depicted in Table 19. In this particular table, semester one, two and three are compared with regard to frequency, mean of the total retention gain scores and standard deviation. The frequency, mean of the total gain retention scores and standard deviation for each of the nine semester-method combinations are listed in Table 20.

The F statistic (see Table 5) from the analysis of variance of this randomized block design indicates that there is a difference among the three methods for the retention variable at the .05 level of significance. The data, however, does not allow one to conclude that differences exist from method to method at the .01 significance level.

In summary, the analysis of differences among methods indicates that a significant difference exists among the video-tape, traditional and control groups when they are compared with regard to total gain, gain one, gain two and retention. It should be noted that although gain three did not appear to differ among groups, its level of statistical rejection was extremely narrow.

Table 18

RETENTION GAIN (POSTPOST-TEST SCORE MINUS POST-TEST SCORE) FOR EACH INSTRUCTIONAL METHOD

METHOD	FREQUENCY	MEAN OF TOTAL GAIN	STANDARD DEVIATION
1. video-tape	17	-37.882	14.624
2. traditional	17	-39.235	9.0314
3. control	16	-28.813	12.106

Table 19

RETENTION (POSTPOST-TEST SCORE MINUS POST-TEST SCORE) FOR EACH SEMESTER

SEMESTER	FREQUENCY	MEAN OF TOTAL GAIN	STANDARD DEVIATION
1. semester 1	31	-36.839	13.179
2. semester 2	9	-34.889	10.717
3. semester 3	10	-31.600	13.476

Table 20

RETENTION (POSTPOST-TEST SCORE MINUS POST-TEST SCORE) FOR EACH SEMESTER-METHOD COMBINATION

SEMESTER-METHOD	FREQUENCY	MEAN OF TOTAL GAIN	STANDARD DEVIATION
1. semester 1 - video-tape	11	-41.182	14.696
2. semester 2 - video-tape	3	-26.667	13.614
3. semester 3 - video-tape	3	-37.000	14.000
4. semester 1 - traditional	11	-40.455	7.2023
5. semester 2 - traditional	3	-42.000	2.0000
6. semester 3 - traditional	3	-32.000	17.059
7. semester 1 - control	9	-27.111	12.888
8. semester 2 - control	3	-36.000	9.5394
9. semester 3 - control	4	-27.250	12.868

The statistical analysis that follows, attempts to determine where the difference among the video-tape, traditional and control groups actually occurs. For example, knowing that there is a difference among groups, it can then be determined whether the video-tape group differs from the control group or the traditional instructional group. This analysis was performed with regard to total gain, gain one, gain two and retention scores. Although gain three did not appear to differ among the groups, due to the extremely narrow level of rejection, gain three scores were also subjected to this statistical analysis.

As a point of clarification, total gain is the difference between the cumulative post-test (Appendix E) score and the pretest (Appendix A) score whereas gain one, two and three represent the corresponding differences between pretests one, two, three (Appendix A) and their respective post-tests (Appendices B, C and D).

Analysis of Differences Between Methods

Hypothesis one stated that the cognitive achievement of students who are taught skeletal anatomy and terminology by video-taped presentations will not be significantly different from that of students who are taught by a traditional laboratory approach. To determine where the differences between methods occurred, an analysis of variance was conducted with regard to total gain, gain one, gain two and gain three. Total gain represents the difference between the cumulative post-test (Appendix E) score and the pretest (Appendix A) score whereas gain one, gain two and gain three represent the corresponding difference in scores between pretests one, two, three (Appendix A) and their respective

post-tests (Appendices B, C and D) scores.

The computed F values from analysis of variance of this design and their respective table values are listed in Table 21. This particular table compares the combination of the video-tape and traditional instructional methods with the control group for total gain, gain one, gain two and gain three. In addition, these same comparisons are made with regard to the video-tape and traditional instructional methods.

Total Gain:

The combination of the video-tape method and the traditional method were compared with the control group. The computed F value from analysis of variance (see Table 21) of this design indicates that at the .01 level of significance, total gain does vary between the two experimental groups and the control group.

Using the same statistical analysis, the video-tape method was then compared with the traditional method. Based on the F statistic for total gain (see Table 21), it cannot be concluded that students taught by video-tape are different from students taught by the traditional method at either the .01 or the .05 levels of significance.

Gain One (skull and vertebral column):

The initial analysis for gain one, which is the difference between pretest one (Appendix A) and post-test one (Appendix B) scores, compared the combination of the video-tape and the traditional methods with the control group. The F statistic (see Table 21) from the analysis of variance of this design indicates that at the .01 level of significance, gain one does vary between the two experimental groups and the control group.

Table 21

F VALUES - ANALYSIS OF DIFFERENCES BETWEEN INSTRUCTIONAL METHODS

Specific Gain	Groups Compared	$F_{1,48}$ Computed F Value from Analysis of Variance	$F_{1,48}$ (table values)
Total Gain	video-tape and traditional instructional methods compared with the control group	35.385	.05= 4.0427
	video-tape method compared with the traditional instructional method	2.4790	.01= 7.1942
Gain 1	video-tape and traditional instructional methods compared with the control group	20.0010	.05= 4.0427
	video-tape method compared with the traditional instructional method	1.5030	.01= 7.1942
Gain 2	video-tape and traditional instructional methods compared with the control group	11.1970	.05= 4.0427
	video-tape method compared with the traditional instructional method	1.8900	.01= 7.1942
Gain 3	video-tape and traditional instructional methods compared with the control group	5.7650	.05= 4.0427
	video-tape method compared with the traditional instructional method	.9570	.01= 7.1942

Total Gain: Total gain is the difference between the cumulative post-test (Appendix E) score and the pretest (Appendix A) score.

Gain 1,2,3: Gain 1,2 and 3 represent the corresponding differences between pretests 1,2, 3 (Appendix A) and their respective post-tests (appendices B,C and D).

The video-tape method was then compared with the traditional method of instruction. Based on the F statistic (see Table 21) from the analysis of variance for gain one, it could not be concluded at either the .01 or .05 significance levels that students in the video-tape group varied from those in the traditional group.

Gain Two (torso and humerus):

The initial analysis for gain two, which is the difference between pretest two (Appendix A) and post-test two (Appendix C) scores, compared the combination of the video-tape method and the traditional method with the control group. The F statistic (see Table 21), from the analysis of variance of this design indicates that at the .01 level of significance, gain two does vary significantly between the two experimental groups and the control group.

Using the same statistical analysis, the video-tape method was compared with the traditional method. Based on the F statistic (see Table 21) from the analysis of variance for gain two, it cannot be concluded that video-tape students are different from traditional students at either the .01 or .05 levels of significance.

Gain three (limbs and pelvis):

The initial analysis for gain three, which is the difference between pretest three (Appendix A) and post-test three (Appendix D) scores, compared the combination of the video-tape method and the traditional method with the control group. The F statistic (see Table 21) from the analysis of variance indicates that gain three does vary among the two experimental groups and the control group. The level of significance, however, was .05. The result of this statistical analysis appears contrary to the

previous analysis of differences among methods. However, the differing degrees of freedom used in this analysis makes this F statistic acceptable.

Using the same analytical method, the two experimental groups were compared. Based on the F statistic (see Table 21) from the analysis of variance for gain three, it cannot be concluded that video-tape students are different from traditional students at either the .01 or the .05 levels of significance.

In summary, the analysis of differences between methods indicated a significant difference between the control group and the other two instructional methods for total gain, gain one, gain two and gain three. This analysis, however, did not indicate a significant difference between the video-tape method and the traditional instructional method with regard to total gain, gain one, gain two and gain three scores.

Analysis of Retention Differences Between Methods

Hypothesis two stated that retention of cognitive material by students who are taught skeletal anatomy and terminology by video-taped presentations will not be significantly different from that of students who are taught by a traditional laboratory approach. In the initial analysis, a paired t-test was used to determine if there were differences between post-test scores and postpost-test (the post-test readministered in 53 days) scores for the video-tape, the traditional instructional group, the control group and for all students combined.

The experiment was conducted over three semesters. During each of the three semesters, statistical data was collected on subjects enrolled

in anatomy and physiology (Bio 160). In other words, each semester of the experiment utilized a completely different group of experimental subjects. Statistically, it was advantageous to use a paired t-test to correct for the different subjects in each of the three semesters.

For All Students:

The difference between post-test scores and postpost-test scores for all students is represented in Table 22. Among other data, the table lists the sample size, means and the t-values for all the experimental subjects combined.

The paired t-test was used to determine if, for all students, there was a difference between the post-test (Appendix E) scores and the postpost-test (post-test readministered in 53 days) scores. In this analysis, the t-value was 19.644 (see Table 22). From this t-value, it may be concluded that there is a difference between the post-test and the postpost-test at the .01 significance level.

Video-tape Students:

Table 23 refers to the analysis to determine if there is a significant difference between the post-test (Appendix E) scores and the postpost-test scores for subjects in the video-tape group. The table lists the sample size, the means of the post-test and postpost-test scores, mean difference and t-values. As the t-value is 10.680, it can be concluded that at the .01 significance level there is a difference between the post-test and the postpost-test scores for those students in the video-tape method.

Table 22

DIFFERENCE BETWEEN POST-TEST SCORES AND POSTPOST-TEST SCORES FOR ALL STUDENTS

1. sample size	50
2. mean of post-test	75.120000
3. mean of postpost-test	39.680000
4. number of missing pairs	3
5. mean difference	35.440000
6. standard error of difference	1.804113
7. t-value	19.644000
8. degrees of freedom	49
9. t-table value at (.95)	2.014000
(.99)	2.690000

Table 23

DIFFERENCE BETWEEN POST-TEST SCORES AND POSTPOST-TEST SCORES FOR VIDEO-TAPE STUDENTS

1. sample size	17
2. mean of post-test	85.529412
3. mean of postpost-test	47.647059
4. mean difference	37.882353
5. standard error of difference	3.546832
6. t-value	10.680617
7. degrees of freedom	16
8. t-table value at (.95)	2.120000
(.99)	2.690000

Traditional Students:

Table 24 refers to the analysis to determine if there is a significant difference between the post-test (Appendix E) scores and the postpost-test (post-test readministered in 53 days) scores for the subjects in the traditional laboratory group. In general, this particular table includes sample size, means of the post-test and postpost-test scores, mean difference and t-values. As the t-value is 17.912, it can be concluded that at the .01 significance level, there is a difference between the post-test and the postpost-test scores for those students using the traditional approach.

Control Students:

Table 25 refers to the analysis to determine if there is a significant difference between the post-test (Appendix E) scores and the postpost-test (post-test readministered in 53 days) scores for the subjects in the control group. The sample size, the means of the post-test and postpost-test scores, mean difference and t-values are listed in Table 25. As the t-value is 9.519, it can be concluded that at the .01 significance level, there is a difference between the post-test and the postpost-test scores for the control students.

On the basis of the paired t-test, it may be concluded that there is a significant difference between the post-test (Appendix E) scores and the postpost-test (post-test readministered in 53 days) scores for the video-tape students, the traditional students, the control students and all students combined. This analysis, however, does not indicate differences among the methods. To determine where the differences among the methods occurred, an analysis of variance was conducted with regard to

Table 24

DIFFERENCE BETWEEN POST-TEST SCORES AND POSTPOST-TEST SCORES FOR TRADITIONAL STUDENTS

1. sample size	17
2. mean of post-test	78.823529
3. mean of postpost-test	39.588235
4. mean difference	39.235294
5. standard error of difference	2.190436
6. t-value	17.912092
7. degrees of freedom	16
8. t-table value at (.95)	2.120000
(.99)	2.921000

Table 25

DIFFERENCE BETWEEN POST-TEST SCORES AND POSTPOST-TEST SCORES FOR CONTROL STUDENTS

1. sample size	16
2. mean of post-test	60.125000
3. mean of postpost-test	31.312500
4. mean difference	28.812500
5. standard error of difference	3.026575
6. t-value	9.519837
7. degrees of freedom	15
8. t-table value at (.95)	2.131000
(.99)	2.947000

retention.

The initial analysis for retention differences between methods compared the combination of the video-tape and the traditional groups with the control group. The computed F values from analysis of variance and the F table values are represented in Table 26. The table makes a comparison between the control group, and the video-tape and traditional groups combined. In addition, the table contrasts the video-tape and the traditional instructional groups. The F statistic (see Table 26) from the analysis of variance of this design indicates that at only the .05 level of significance does retention vary between the two experimental groups and the control group.

Using the same statistical analysis, the video-tape method was compared with the traditional method for retention. Based on the F statistic (see Table 26) from the analysis of variance, it cannot be concluded at either the .01 or the .05 levels of significance that video-tape students are different from traditional students.

In summary, the analysis of retention differences indicated a significant difference between the control group and the other two instructional methods. This analysis, however, did not indicate a significant difference between the video-tape method and the traditional instructional method with regard to retention.

Table 26

F VALUES - ANALYSIS OF RETENTION DIFFERENCES

BETWEEN INSTRUCTIONAL METHODS

Groups Compared	$F_{1,45}$ Computed F Value from Analysis of Variance	$F_{1,45}$ (table values)
video-tape and traditional instructional groups compared with the control group	6.8400	.05 = 4.0566 .01 = 7.2339
video-tape group compared with the traditional instructional group	.1030	.05 = 4.0566 .01 = 7.2339

Findings Not Related to the Hypotheses

A split plot analysis was used in an attempt to determine if cognitive achievement gain scores differed among each of the three weeks of the experiment. In other words, did the student learn more during the first week of the experiment, the second week or the third week? Data from students enrolled in the first semester of the experiment were utilized for this analysis.

The experimental data for differences between weeks are represented in Table 27. In the column labeled "method", number one refers to the video-tape method of instruction, whereas number two and number three refer to the traditional and control groups respectively. The column labeled "week" refers to the three major parts as outlined in the investigator's laboratory manual (week one refers to pp. 1-10, week two indicates pp. 11-18 and week three covers pp. 19-26). "Gain" denotes the percent gain score (post-test minus pretest score) for each of the particular weeks. Eleven individuals in each of the video-tape, traditional and control groups were compared on the basis of the gain scores. In the column labeled "individual", the numbers refer to these 11 subjects. In order to make this comparison with 11 individuals in each of the groups, it was necessary to randomly select and drop one of the twelve original subjects from the traditional instructional group.

The computed F values from the split plot analysis of variance are listed in Table 28. Appropriate F table values are also noted. This particular table compares the combination of the video-tape and traditional instructional methods with the control group for total gain, gain one, gain two and gain three. In addition, these same comparisons are

Table 27

EXPERIMENTAL DATA FOR STUDENT GAIN SCORE

DIFFERENCES BETWEEN WEEKS

method	individual	week	gain	method	individual	week	gain	method	individual	week	gain
1	1	1	55	2	1	1	78	3	1	1	38
1	1	2	75	2	1	2	87	3	1	2	55
1	1	3	74	2	1	3	73	3	1	3	46
1	2	1	68	2	2	1	85	3	2	1	72
1	2	2	60	2	2	2	90	3	2	2	83
1	2	3	31	2	2	3	79	3	2	3	87
1	3	1	83	2	3	1	87	3	3	1	48
1	3	2	30	2	3	2	93	3	3	2	59
1	3	3	49	2	3	3	85	3	3	3	52
1	4	1	83	2	4	1	92	3	4	1	73
1	4	2	87	2	4	2	95	3	4	2	52
1	4	3	94	2	4	3	97	3	4	3	82
1	5	1	89	2	5	1	33	3	5	1	42
1	5	2	90	2	5	2	80	3	5	2	48
1	5	3	94	2	5	3	49	3	5	3	53
1	6	1	57	2	6	1	69	3	6	1	77
1	6	2	55	2	6	2	90	3	6	2	88
1	6	3	65	2	6	3	76	3	6	3	65
1	7	1	63	2	7	1	75	3	7	1	35
1	7	2	72	2	7	2	95	3	7	2	87
1	7	3	79	2	7	3	76	3	7	3	72
1	8	1	87	2	8	1	68	3	8	1	17
1	8	2	68	2	8	2	67	3	8	2	83
1	8	3	78	2	8	3	60	3	8	3	72
1	9	1	75	2	9	1	60	3	9	1	63
1	9	2	75	2	9	2	53	3	9	2	77
1	9	3	31	2	9	3	25	3	9	3	51
1	10	1	76	2	10	1	65	3	10	1	33
1	10	2	78	2	10	2	77	3	10	2	57
1	10	3	59	2	10	3	79	3	10	3	34
1	11	1	73	2	11	1	93	3	11	1	15
1	11	2	80	2	11	2	98	3	11	2	43
1	11	3	85	2	11	3	91	3	11	3	10

Method:

1 - video-tape method of instruction
2 - traditional method of instruction
3 - control group

Individual:

The numbers 1-11 refer to the eleven experimental subjects in each of the three instructional groups.

Week:

1 - week one (experiment covering pp. 1-10 of the investigator's laboratory manual)
2 - week two (experiment covering pp. 11-18 of the investigator's laboratory manual)
3 - week three (experiment covering pp. 19-26 of the investigator's laboratory manual)

Gain:

Gain denotes the percent gain score (post-test minus pretest score) for each of the particular weeks.

made with regard to the video-tape and the traditional instructional methods.

The initial F statistic (see Table 28) from the split plot analysis indicated that a significant interaction was present. For this reason, it was not possible to test the variation of cognitive achievement gain scores from week to week. The interaction was eliminated by removing the control group from the split plot analysis. The F statistic for this analysis can be noted in Table 28.

Utilizing only the video-tape and traditional instructional groups, an analysis was performed to determine if gain scores varied from week one to week two to week three. The F statistic (see Table 28) from the analysis of variance of this split plot method did not indicate any significant difference among the weeks. In other words, it could not be concluded at the .05 significance level that the gain scores varied from week to week.

Table 28

F VALUES - SPLIT PLOT ANALYSIS OF VARIANCE FOR COGNITIVE ACHIEVEMENT GAIN SCORES BETWEEN INSTRUCTIONAL WEEKS

Groups Compared	Computed F Value from Analysis of Variance	(table values)
video-tape, traditional and control group split plot analysis (interaction)	$F_{4,60} = 2.5430$	$F_{4,60}$ .05 = 2.5300
video-tape and traditional group split plot analysis (interaction eliminated)	$F_{2,40} = 1.9906$	$F_{2,40}$ .05 = 3.2317
video-tape and traditional group split plot analysis of variance (gain scores)	$F_{2,40} = 2.1036$	$F_{2,40}$ .05 = 3.2317

Results of Hypotheses Tested

The central purpose of this study was to determine if cognitive achievement and retention of students who were taught skeletal anatomy and terminology by video-taped presentations would be significantly different from that of students taught by a traditional laboratory approach.

Hypothesis one stated that the cognitive achievement of students who are taught skeletal anatomy and terminology by video-taped presentations will not be significantly different from that of students who are taught by a traditional laboratory appraoch. A comparison was made between the video-tape group and the traditional laboratory group for each of the three major parts outlined in the investigator's laboratory manual (Appendix F - pp. 1-10, 11-18, 19-26). In addition, a cumulative comparison was made based on the results of the final post-test (Appendix E). The resulting F statistics (see Table 21) from the analysis of variance were not significant at either the .01 or .05 levels. Therefore, it could not be concluded that the gain scores of students in the video-tape group varied significantly from those in the traditional laboratory group. Consequently, hypothesis one failed to be rejected.

Hypothesis two stated that retention of cognitive material by students who are taught skeletal anatomy and terminology by video-taped presentations will not be significantly different from that of students who are taught by a traditional laboratory approach. A comparison was

made between the video-tape group and the traditional laboratory group based on the cumulative post-test (Appendix E) and the postpost-test. It should be pointed out that the postpost-test was a readministration of the post-test after a lapse of 53 days. Based on the F statistic (see Table 26) from analysis of variance, it could not be concluded at either the .01 or the .05 levels of significance that the gain scores of students in the video-tape group varied significantly from those in the traditional laboratory group. Consequently, hypothesis two failed to be rejected.

V. SUMMARY OF THE FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Summary of the Problem

The demand by the medical profession for trained nurses and other medical support staff is continually increasing. The need to help fill this gap between supply and demand is being met by the two year diploma programs in community colleges.

Partially because of the "open door" policy, community colleges have been forced to expand the traditional academic curricula in order to offer a variety of programs designed to meet the needs of an extremely heterogenous student population. The variation in academic background of the college student often restricts the effectiveness of so called traditional instructional techniques. It is, therefore, appropriate that the community college offer a number of alternate modes of instruction for this diverse group of individuals.

As an alternate instructional method, video-taped presentations by their nature lend themselves to fields such as those in allied health. Some learning experiences are often common to programs like nursing, nursing aid, and mortuary science. By video-taping selected laboratory experiences for an allied health core curricula, not only will the repetitive work load of the instructor be reduced, but more importantly, the learning experience will be available to the student on demand. The relative effectiveness, however, of specific video-taped laboratory experiences as compared to the traditional laboratory approach is largely conjecture. Therefore, the need to have information relative to specific learning experiences is critical. For this reason the comparison of

student gains, as a result of video-taped presentations and a traditional laboratory approach to learning human skeletal anatomy and terminology, is the basis for this study.

Purpose of the Study

1) To determine if there is a significant difference in cognitive achievement when skeletal anatomy and terminology are presented utilizing video-taped presentations or a traditional laboratory procedure.
2) To investigate the extent that cognitive material is retained when presented by either video-taped presentations or a traditional laboratory procedure.

Extent and Nature of the Study

The data collected for analysis in this investigation came from responses of 53 first semester nursing students enrolled at L.C.C. These students completed a written pretest and four cognitive achievement post-tests.

The results were key punched and processed through the computing services at Oregon State University. The analysis of variance design used was a one-way randomized block design having as levels of treatment, video-tape, traditional and control groups. A paired t-test and the F statistic were used to assess means ($\bar{X}$) for the presence of significant differences. Hypotheses were tested at the .05 and the .01 levels of significance.

Null Hypotheses Tested

The following hypotheses were tested:

1) The cognitive achievement of students who are taught skeletal anatomy and terminology by video-taped presentations will not be significantly different from that of students who are taught by a traditional laboratory approach.
2) Retention of cognitive material by students who are taught skeletal anatomy and terminology by video-taped presentations will not be significantly different from that of students who are taught by a traditional laboratory approach.

Major Findings

The following is a description of the major findings of the study.

Summary of Cognitive Achievement of Students:

An analysis of variance disclosed that the cognitive achievement of students taught by video-tape did not differ significantly from that of students taught by a traditional laboratory method. This finding was applicable to all of the following:

1) Total Gain - The difference between the pretest and the cumulative post-test scores.
2) Gain One - The difference between the pretest scores on laboratory one (the skull and vertebral column) and post-test one scores.

3) Gain Two - The difference between the pretest scores on laboratory two (torso and humerus) and post-test two scores.

4) Gain Three - The difference between the pretest scores on laboratory three (limbs and pelvis) and post-test three scores.

Summary of Student Retention:

Based on the F statistic from an analysis of variance, it could not be concluded at the .05 level of significance that retention varied between subjects taught by video-tape and those taught by a traditional laboratory method.

Summary of Differences Between Weeks:

Based on the F statistic from an analysis of variance, it could not be concluded at the .05 level of significance that cognitive achievement gain scores differed among each of the three weeks of the experiment.

Conclusions

Within the limitations of this study, the following major conclusions were reached:

1. The cognitive achievement of prenurse students at L.C.C. who are taught skeletal anatomy and terminology by video-taped presentations is not significantly different from that of similar students who are taught by a traditional laboratory approach;

2. Retention of cognitive material by prenurse students at L.C.C. who are taught skeletal anatomy and terminology by video-taped presentations is not significantly different from that of similar students who are taught by a traditional laboratory approach; and
3. The cognitive achievement and retention of prenurse students at L.C.C. who are taught skeletal anatomy and terminology by video-taped presentations or by a traditional laboratory approach are significantly different from that of similar students who do not receive formal skeletal instruction.

In other words, with regard to skeletal anatomy and terminology, instruction by video-tape does not appear to be more or less effective than a traditional laboratory approach for either cognitive achievement or retention of cognitive material.

Implications for Prenurse Training at the Community College Level

The results of this study do not show that video-taped presentations are significantly different from a traditional laboratory instructional approach. As an alternate mode of instruction, however, video-taped presentations could supplement the more traditional methods of nursing instruction at the community college level. Selected laboratory experiences could be video-taped and utilized not only as a basis for nursing core curricula but as a technique where nursing students could review important information and skills at their own desired learning pace. In addition, the allied health field has a general core of information that is relevant to all students. By video-taping selected learning experiences, the development of a general health core curricula at the

community college level could be realized.

Through an effective utilization of video-taped information and skills, the instructor could be freed from repetitive instruction. As a result, it is possible that instructional time could be used more effectively for small group discussions or other advantageous teaching techniques.

For cognitive achievement and retention of skeletal anatomy and terminology, video-taped presentations are not significantly different from a traditional laboratory approach. Thus, if all variables remain constant, either method could be used for teaching the skeletal system. However, if program costs become a consideration the video-taped presentations could be used for skeletal instruction allowing the instructor time for other teaching areas. A nursing program, on the other hand, may be more concerned with personal interaction than with program costs. If this is the case, the human element of direct teacher contact in a traditional laboratory may prove to be more desirable as an instructional method.

Recommendations

Based on this investigation and a review of the related research, the following recommendations are presented for consideration for future practice.

Recommendation No. 1 - Traditional Laboratory Approach

It is recommended that the traditional laboratory approach, for teaching skeletal anatomy and terminology be continued as part of the biology curricula at L.C.C. Although the traditional laboratory approach was not significantly different from the video-taped presentations, it

could be effectively utilized as an alternate mode of instruction. By making both methods available to the student, an individual choice could be made relative to a particular learning preference. For example, after the first week of skeletal instruction a student may decide that an alternate mode of instruction would be more suitable with regard to stimulating interest in the subject area. With more than one mode of instruction, this option would be available. It is also recommended that the traditional laboratory method should continue to use the laboratory manual prepared by the investigator. This would tend to maintain a degree of content uniformity between the two instructional methods. As a result, transition from one method to the other would be relatively simple for the student.

Recommendation No. 2 - Video-tape Presentations

The investigator recommends that the video-tape presentations, prepared for teaching skeletal anatomy and terminology, be available to the student during the traditional laboratory periods. It is further recommended that the video-tapes be available in an adjacent laboratory to the traditional section. With this particular arrangement, students could move freely from one particular mode of instruction to the other. The student would then have the opportunity to study the skeletal system entirely by the traditional method, the video-tape method or a combination of the two. Although this study did not show a significant difference between the video-tape and traditional method of instruction, some students may prefer one method over the other. If this is the case, a choice of instructional methods should be made available. This choice would be facilitated by having both methods available in adjacent rooms

during the same scheduled period. In addition, this arrangement would allow the student to cover the material more than once. This could prove to be advantageous for instructional classes exhibiting a wide range of learning rates.

Recommendation No. 3 - Implications for the Learning Resource Center

It is recommended that the Learning Resource Center at L.C.C. make available to the students, duplicate copies of the three video-tape presentations of the skeletal system. It would also be advantageous if the Learning Resource Center would purchase one plastic skeleton model to supplement the video-tape material. A skeletal model would then be available in the Learning Resource Center for study with or without the use of the video-tapes. Furthermore, it is recommended that written post-tests be prepared for each of the three video-tape presentations. These tests could then be administered in the Learning Resource Test Center to enable the student to determine his readiness with regard to writing the final skeletal cognitive achievement test. With this particular arrangement, an effective utilization of the Learning Resource Center will be achieved as students will be able to view the video-tapes, study the skeletal system and evaluate their personal progress. For a review of skeletal material, the Learning Resource Center would prove to be invaluable.

Recommendation No. 4 - Purchase of Additional Equipment

It is recommended that the biology department at L.C.C. purchase three additional skeletons so a final cognitive achievement test can be set up on a continuous basis. With the examination available to the student upon request, the learning experience relative to the skeletal

system could be self paced. In other words the student would be able to write the final cognitive achievement test when he masters the skeletal material. Without additional skeletal material, the logistics of preparing a final cognitive achievement test upon demand is prohibitive. This problem is further compounded by the fact that the present skeletal models are required for the traditional laboratory approach.

Implications for Further Study

The results of this study lend support to the conclusions of Evans (1955), Smith (1961), Trotter (1970) and Gordon (1971) that television instruction is generally as effective as conventional methods of instruction. Although the video-taped presentations were not significantly different from the traditional laboratory approach for learning skeletal anatomy and terminology, they should not be overlooked as an effective alternate mode of instruction. For this reason, additional laboratory areas in biology should be investigated to determine if video-tapes would be suitable as alternate modes of instruction. In Biology 160, for example, it is possible that video-taped presentations for learning the muscles of the human body may be as effective as the traditional laboratory approach that uses plastic models of the muscles.

Another major area that may lend itself to video-tapes is histology. At present, a black and white television camera is mounted on a microscope and histology slides are projected onto a television monitor. The images on the monitor are used to supplement and explain the prepared histology slides that the students are studying. The lack of color, however, makes identification of the various stained tissues somewhat difficult. If a color television camera could be utilized to this effect,

it is possible that useful video-tape presentations could be prepared for teaching basic histology.

The second semester of anatomy and physiology (Bio 161) at L.C.C. emphasizes the dissection of various specimens in the laboratory. As an introduction to these laboratory experiences, brief video-tape presentations involving close up views of important anatomical structures could possibly provide the student with valuable insight into the major concepts of a particular laboratory experience. As a supplementary mode of instruction, this approach would also be worth investigating.

With regard to educational research concerning video-tape presentations, a study involving character generation could prove to be useful. Basically, character generation refers to the visual presentation of words on the video-tape. Although the video-tape is accompanied by an audio discussion of the subject material, it may prove to be advantageous if specific key words were also visually projected with the presentations. In other words, a visual reinforcement of terminology may have an effect on cognitive achievement and retention. Using a video-tape character generator, a comparison could be conducted regarding the effectiveness of video-taped presentations with character generation and those without for presenting subject material.

Although this particular study did not show a significant difference between the video-tape method and the traditional instructional method, a combination of the two may prove to be more effective than either for teaching skeletal anatomy and terminology. Research could be conducted to compare the following experimental groups: a video-tape group, a traditional laboratory group and an experimental group combining the

video-tape and traditional approach.

The video-taped presentations utilized in this study were approximately 50 minutes in length. Perhaps there is an optimum length of a video-taped presentation for maximum cognitive achievement and retention. For example, the three fifty minute video-tapes could be compared with six twenty-five minute tapes, or various other lengths, to determine their effectiveness for cognitive achievement and retention.

It may prove advantageous to reproduce this study using materials with less experimenter bias. For example, each of the video-taped presentations could be produced by several biology instructors. The subjects of the study could then randomly select video-tape one, two or three from a variety of sources. In addition, the subjects in the traditional laboratory could be randomly divided into laboratory sections which would be taught by different instructors. With this particular arrangement, laboratory sections taught by video-tape presentations could be compared with laboratory sections taught by traditional methods.

In summary, video-taped presentations may prove to be an effective teaching device in many curricular areas and research relative to the application of video-taped materials will provide information concerning efficient use of this method of instruction.

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APPENDICES

APPENDIX A

Question and Answer Sheet for Skeletal System Pretest

Skeletal System Pretest

SKELETAL SYSTEM PRETEST

Pretest one (the skull and vertebral column - pp. 1-10 of the investigator's laboratory manual)

The following numbers pertain to the questions applicable to laboratory one:

- 1-16
- 51-57

Pretest two (the torso and humerus - pp. 11-18 of the investigator's laboratory manual)

The following numbers pertain the questions applicable to laboratory two:

- 17-27
- 30,31
- 48,49
- 58-62

Pretest three (the limbs and pelvis - pp. 19-26 of the investigator's laboratory manual)

The following numbers pertain to the questions applicable to laboratory three:

- 28,29
- 32-47
- 50
- 63-65

LETHBRIDGE COMMUNITY COLLEGE

BIOLOGY 160

QUESTION & ANSWER SHEET FOR SKELETAL SYSTEM PRETEST

NAME _____

The Question Numbers correspond to the numbers on the Booklet Diagrams

FIGURE #1	ANSWER COLUMN
1. Name this bone	Frontal
2. Name this bone	Parietal
3. Name this bone	Temporal
4. Name this process	Mastoid
FIGURE #2	
5. Name this suture	Lambdoid
6. Name this Projection (process)	External occipital protuberance
FIGURE #3	
7. Name this articular process	Occipital condyle
8. Name this region	Hard palate
9. Name this opening in the skull	Foramen magnum
FIGURE #4	
10. Name this region	Orbit
11. Name this bone	Maxillary
FIGURE #5 (corresponds to #14 on cover)	
12. Name the bone represented by figure #5	Mandible
13. Name the small opening in this region	Mental foramen
14. Name this region of the bone	Ramus
FIGURE #6	
15. Name this bone	Sacrum
16. Name this bone	Coccyx

FIGURE #7	ANSWER COLUMN
17. Name this general region of the bone	Body
18. Name this area	Intervertebral foramen
19. Name this process	Spine
FIGURE #8	
20. Name this region of the bone	Manubrium
21. Name this region of the bone	Body
22. Name this process	Xyphoid
FIGURE #9	
23. Name the bone represented by figure #9	Scapula
24. Name this process	Acromnion
25. Name this process	Spine
26. Name this region	Glenoid fossa
FIGURE #10	
27. Name this process	Capitulum
28. Name this bone	Radius
29. Name this process	Styloid
30. Name this bone	Humerus
31. Name this region	Epicondyle
32. Name this bone	Ulna
FIGURE #11	
33. Name this process	Olecranon
FIGURE #12	
34. What is the term used to describe the bones numbered 1 through 7	Carpal
35. Name these bones	Metacarpals
FIGURE #13	
36. Name this bone	Ilium
37. Name this bone	Ishium
38. Name this region	Pubic symphysis
39. Name this opening	Obturator foramen

FIGURE #14	ANSWER COLUMN
40. Name this process	Greater trochanter
41. Name this process	Lesser trochanter
42. Name this region	Intercondylar notch
FIGURE #15	
43. Name this bone	Fibula
44. Name this rounded region	Malleolus
45. Name this bone	Tibia
FIGURE #16	
46. What term is used to describe this heel bone	Calcaneum
47. What general term is used to describe these bones	Tarsal
USING THE FRONT COVER DIAGRAM ANSWER QUESTIONS #48, 49 & 50	
48. Name Bone #2	Clavicle
49. What type of Rib is indicated by #5	Floating
50. Name Bone #23	Patella
USING THE BACK COVER DIAGRAM ANSWER #51, 52, 53, 54	
51. Name Bone #37	Occipital
52. Name the Bones indicated by #38	Cervical
53. Name the Bones indicated by #41	Thoracic
54. Name the bones indicated by #42	Lumbar
FIGURE #17	
55. Name the depression that contains the Pituitary Gland	Sella turcica
FIGURE #18	
56. Name this bone. (located on the medial wall of "EYE SOCKET")	ethmoid
FIGURE #19	
57. Name the sinus found in this area of the skull	Maxillary

FIGURE #20	ANSWER COLUMN
58. Name this process	Superior articular process
FIGURE #21	
59. Name this process	Dens (odontoid)
FIGURE #22	
60. Name the grooved area found in this region	Intertubercular (groove)
61. Name the depression found in this region	Coronoid fossa
FIGURE #23	
62. Name the depression found in this region	Olecranon fossa
FIGURE #24	
63. Name this bone	Hamate
64. Name this bone	Trapezium
FIGURE #25	
65. Name this bone	Lateral cuneiform

BIOLOGY 160

SKELETAL SYSTEM - PRETEST

(DO NOT write in Booklet)

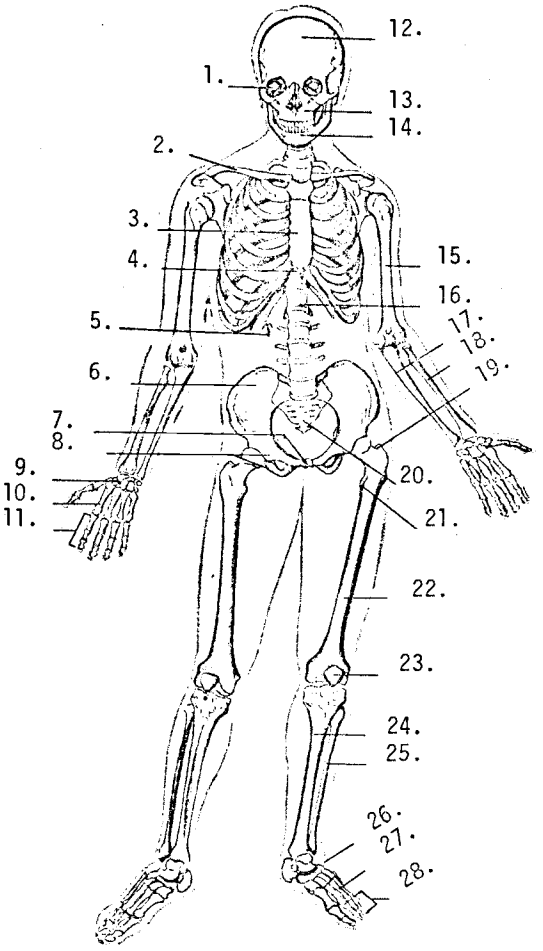


FIGURE #1

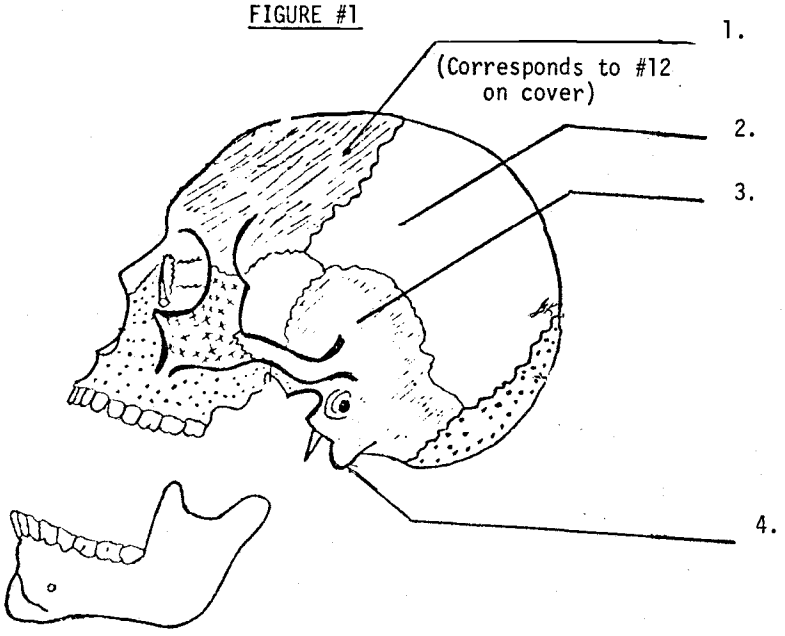


FIGURE #2

(POSTERIOR VIEW OF THE SKULL)

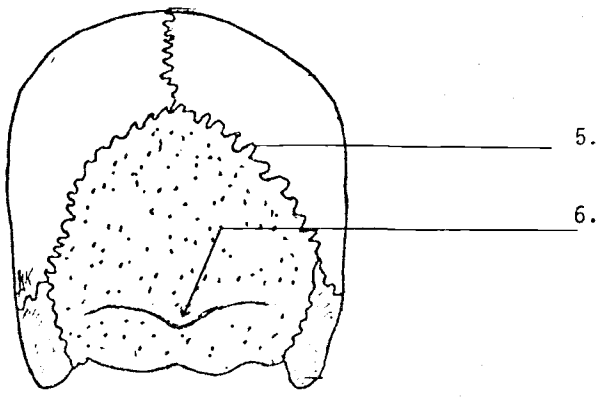


FIGURE #3

(INFERIOR VIEW OF SKULL)

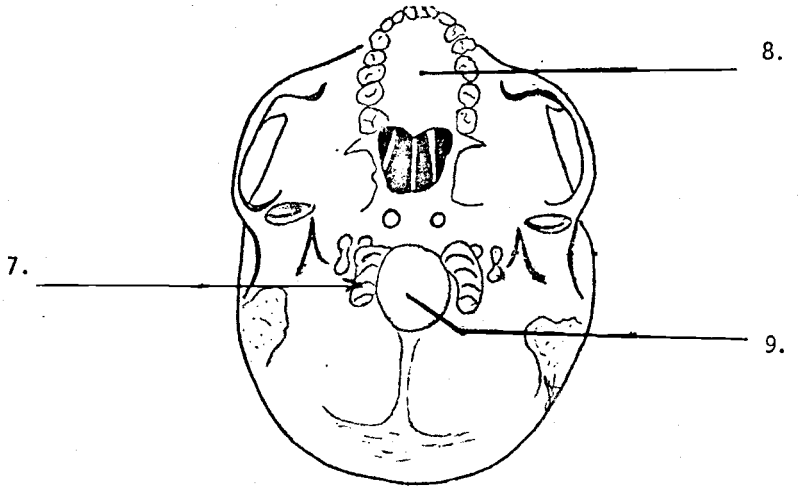
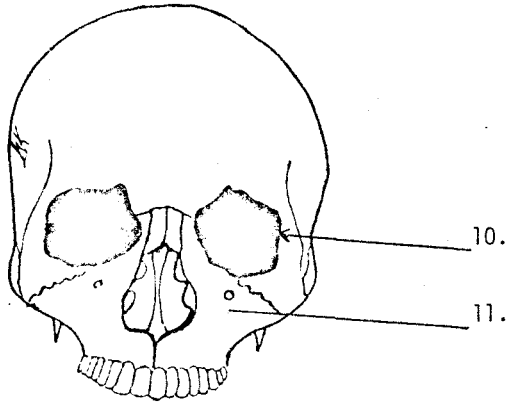


FIGURE #4



10. Corresponds to #1 on cover.
11. Corresponds to #13 on cover.

FIGURE #5

(Corresponds to #14 on cover)

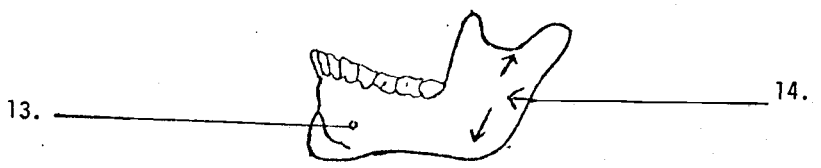


FIGURE # 6

(Corresponds to #20 and #44 Front and Back Covers)

ANTERIOR VIEW

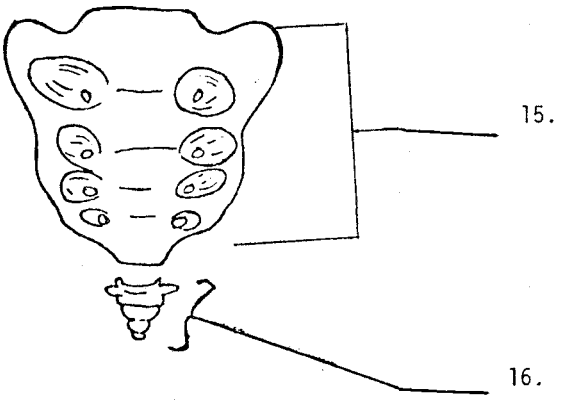


FIGURE 7

(Corresponds to Area 42 on Back Cover)

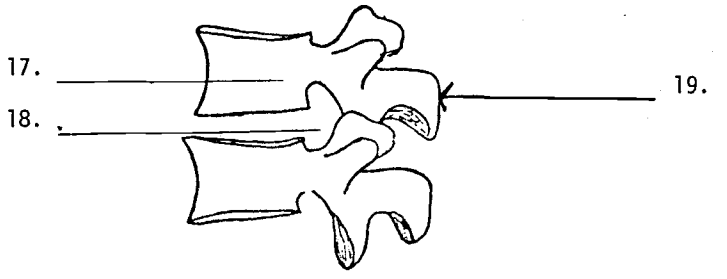


FIGURE 8

(Corresponds to #3 and 4 Front Cover)

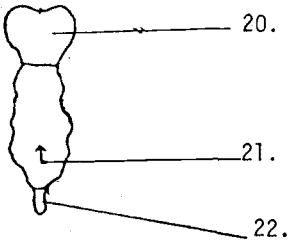


FIGURE #9 POSTERIOR VIEW

(Corresponds to Bone #40 on Back Cover)

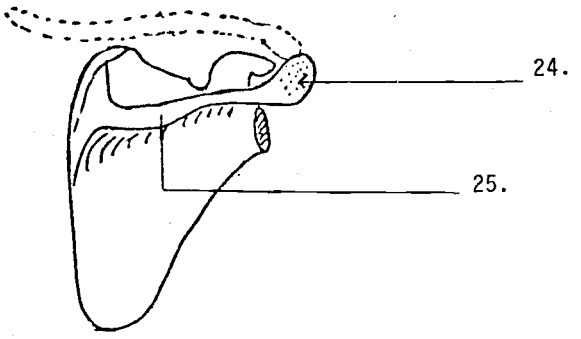


FIGURE #9 Continued LATERAL VIEW

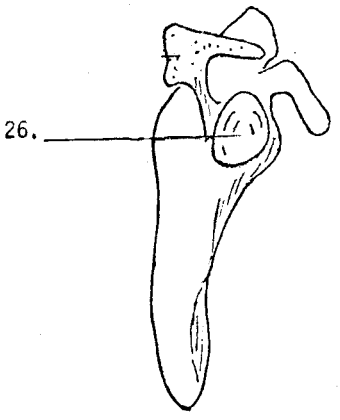


FIGURE #10

ANTERIOR VIEW (Anatomical Position)

(Corresponds to #15, 17, 18 on Front Cover)

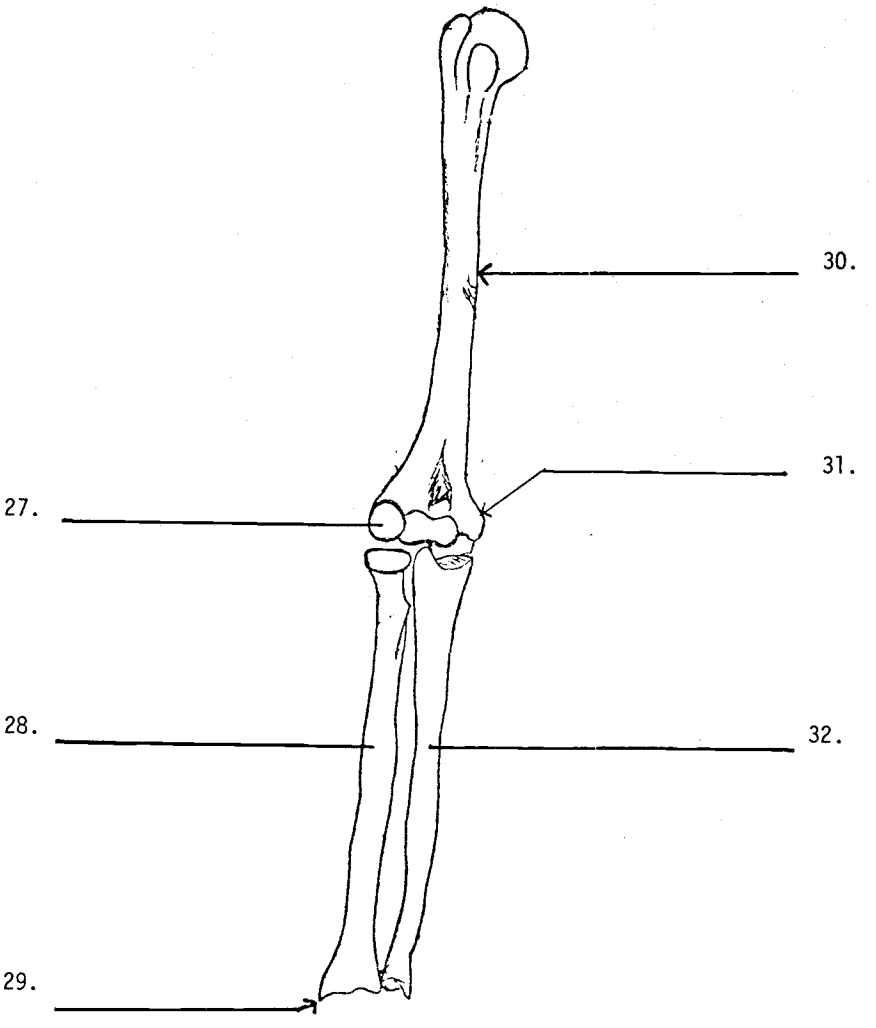


FIGURE #11

POSTERIOR VIEW

(Corresponds to Bone #33 Back Cover)

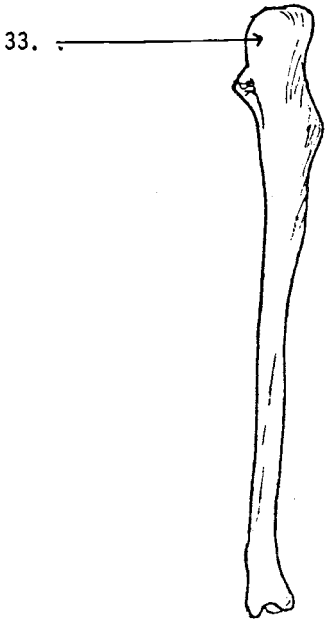


FIGURE #12

POSTERIOR VIEW (PRONATION) OF RIGHT HAND

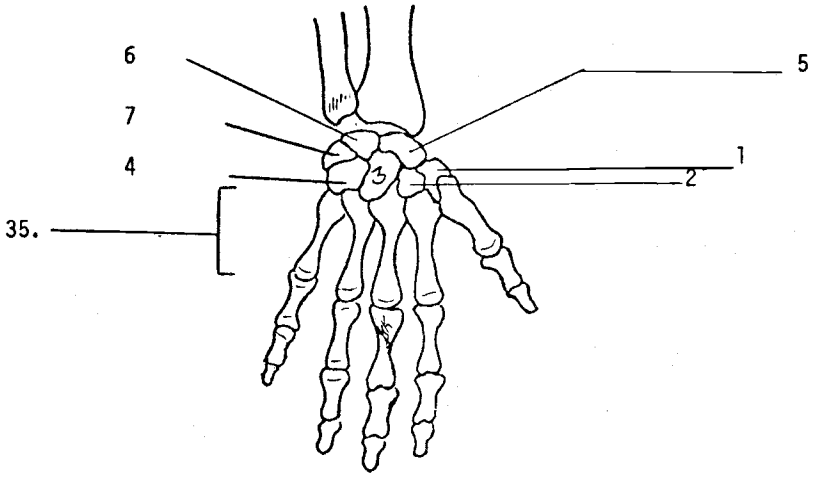


FIGURE #13

PELVIS (ANTERIOR VIEW)

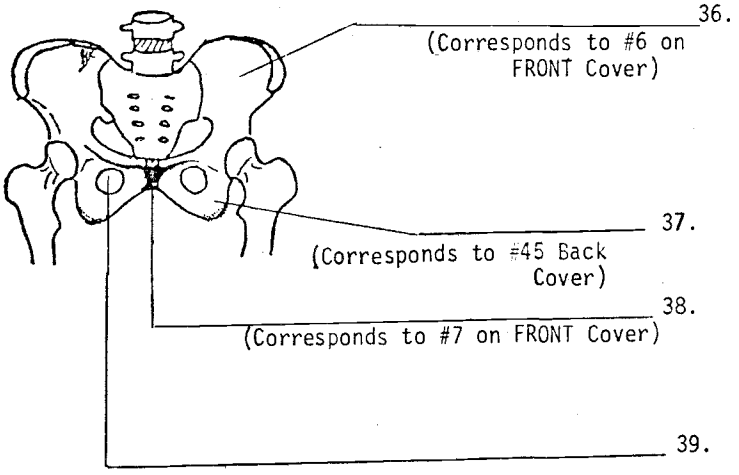


FIGURE #14

(Corresponds to Bone #22 Front Cover)

ANTERIOR VIEW POSTERIOR VIEW

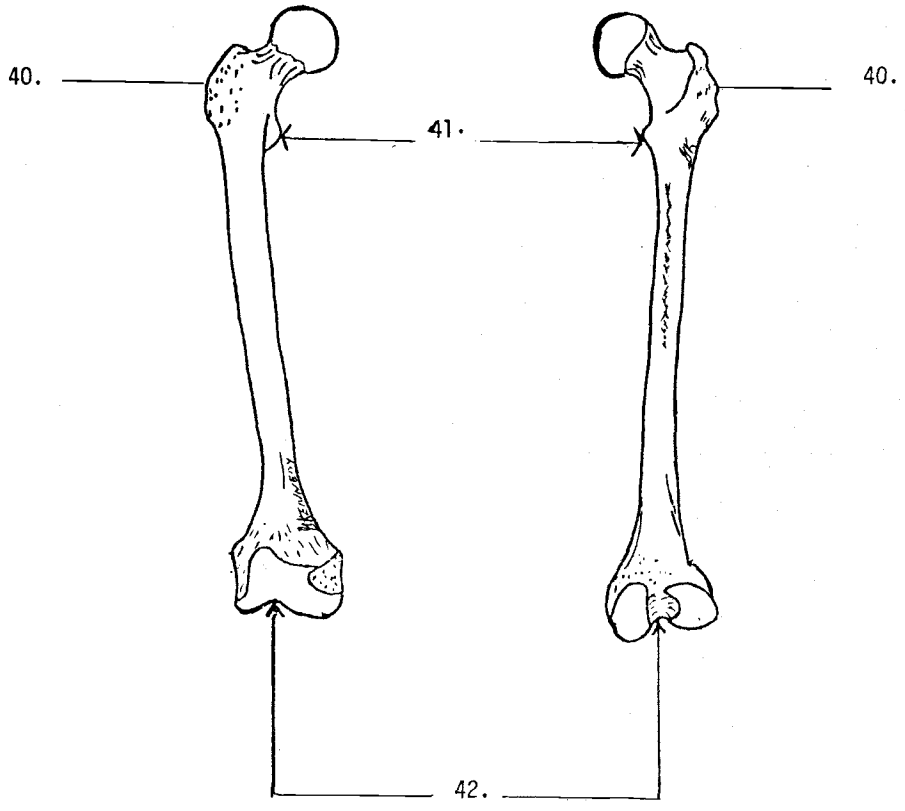


FIGURE #15

(Corresponds to #24 & 25 Front Cover)

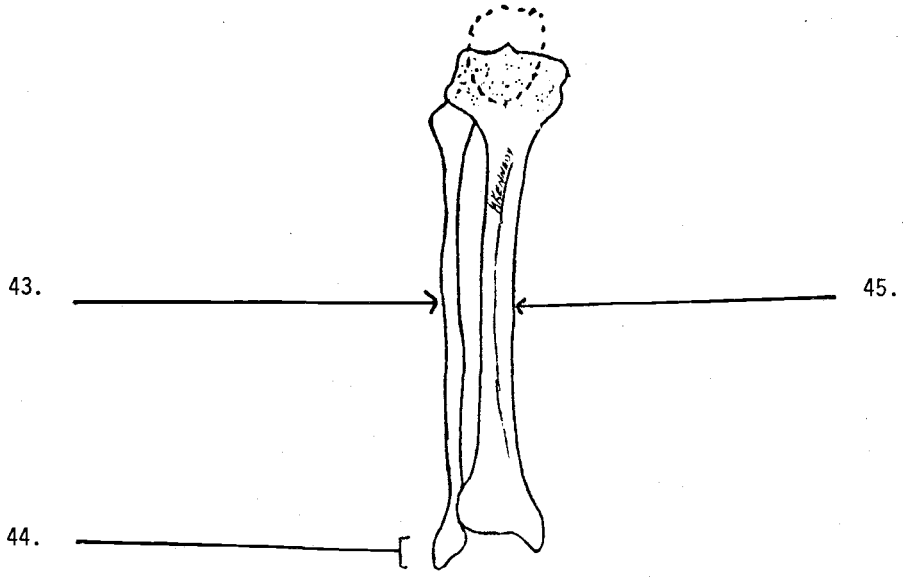


FIGURE #16 RIGHT FOOT

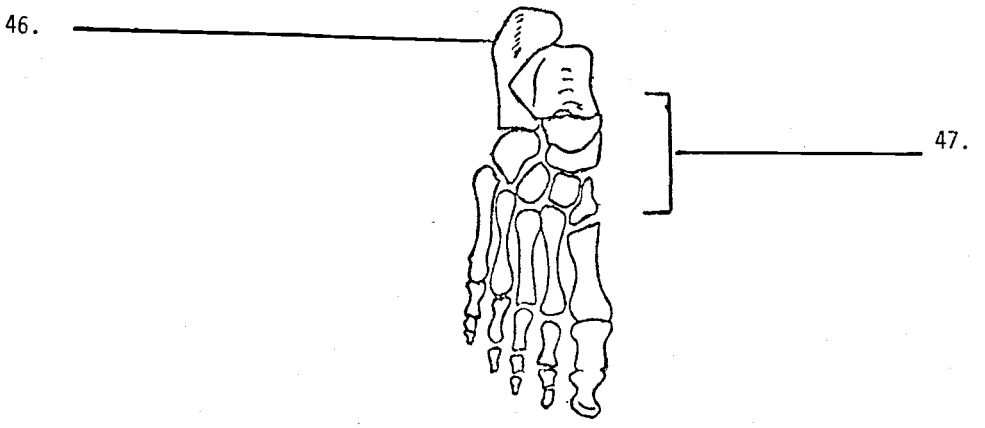


FIGURE #17 The floor of the interior of the Brain Box (The top of the skull has been removed)

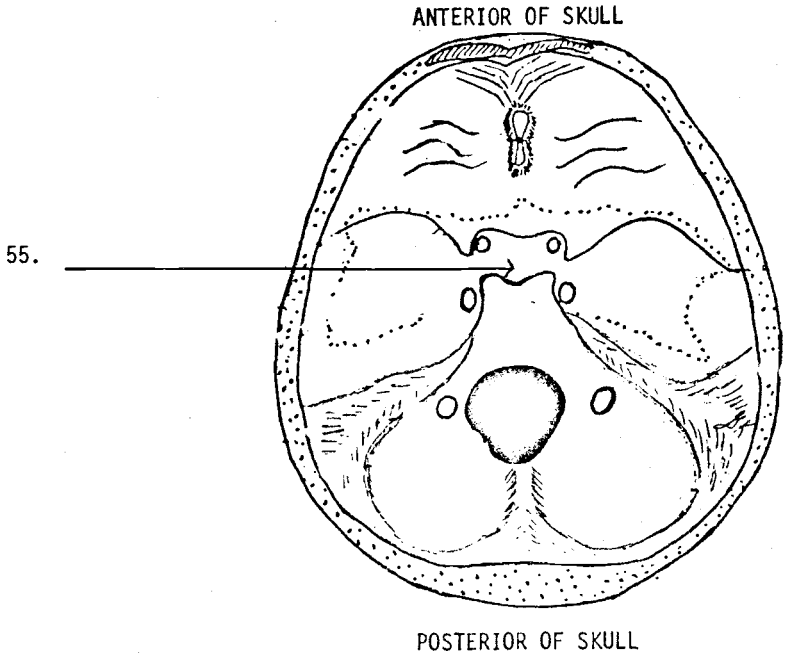


FIGURE #18

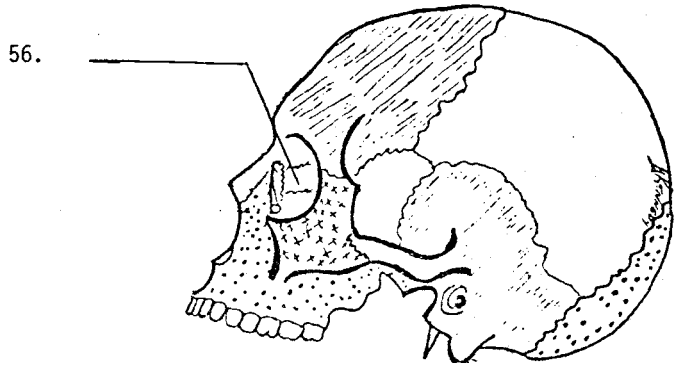


FIGURE # 19

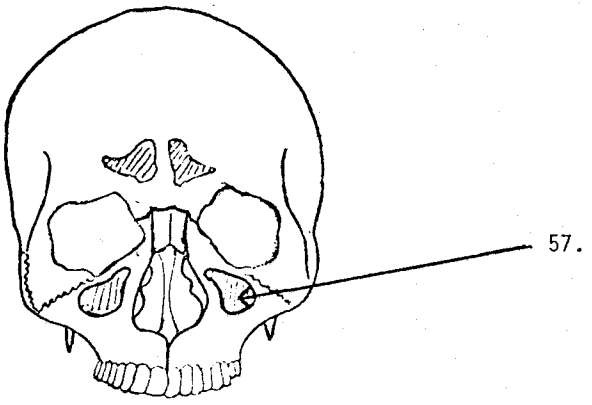


FIGURE #20

Lateral View
(Two bones from area 42 Back cover)

Posterior View
(One of the bones to the left)

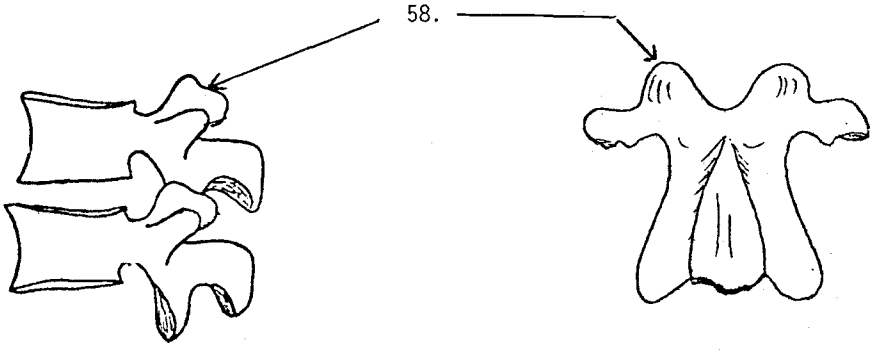


FIGURE # 21

(Corresponds to the top two bones
from area #38 - Back cover)

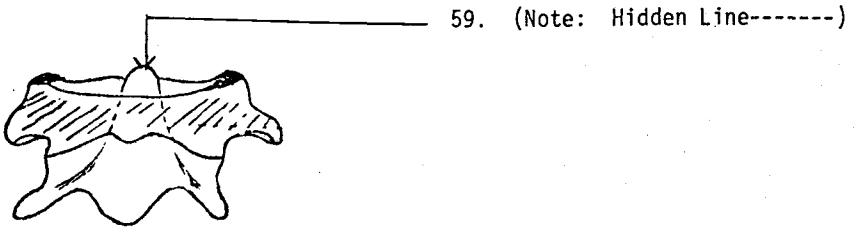


FIGURE #22

(Corresponds to #15 Front Cover)

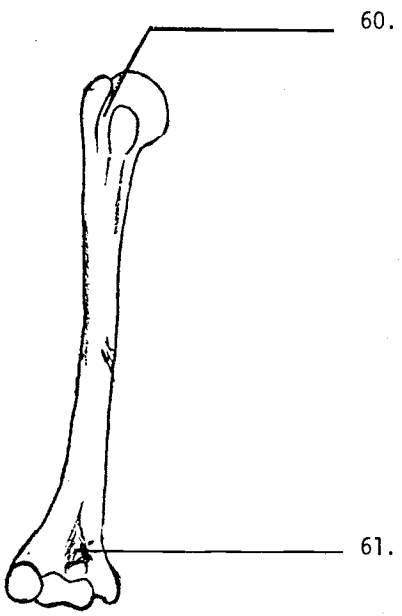


FIGURE #23

(Corresponds to Bone #30 - Back Cover)

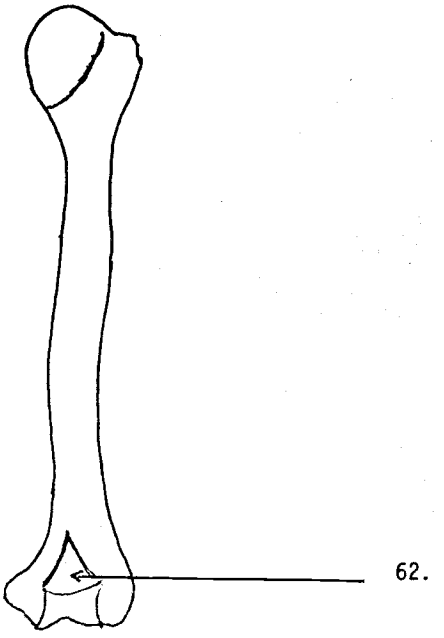


FIGURE #24

(Posterior view (Pronation) of right hand)

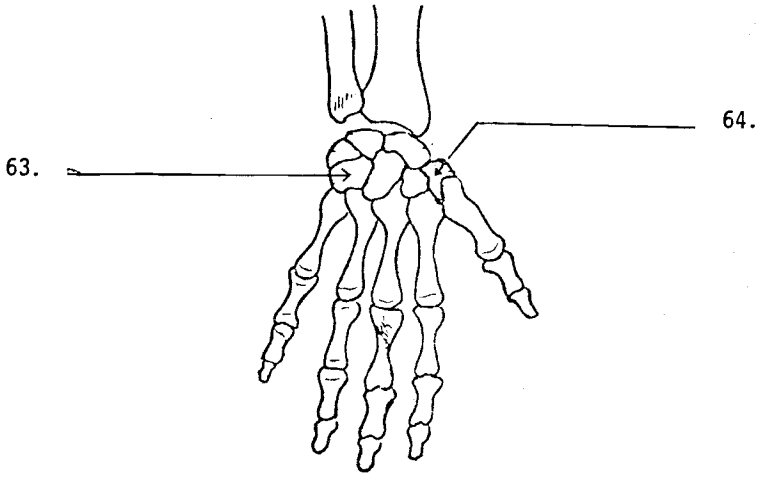
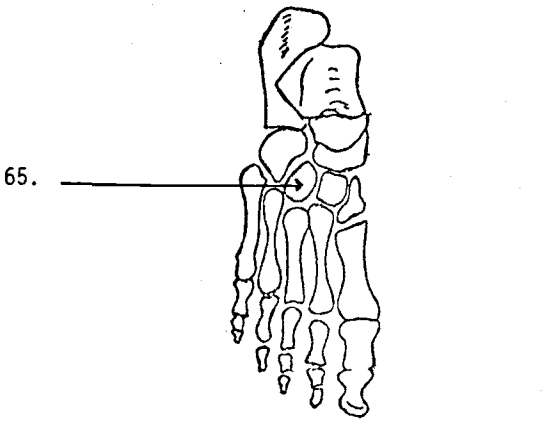
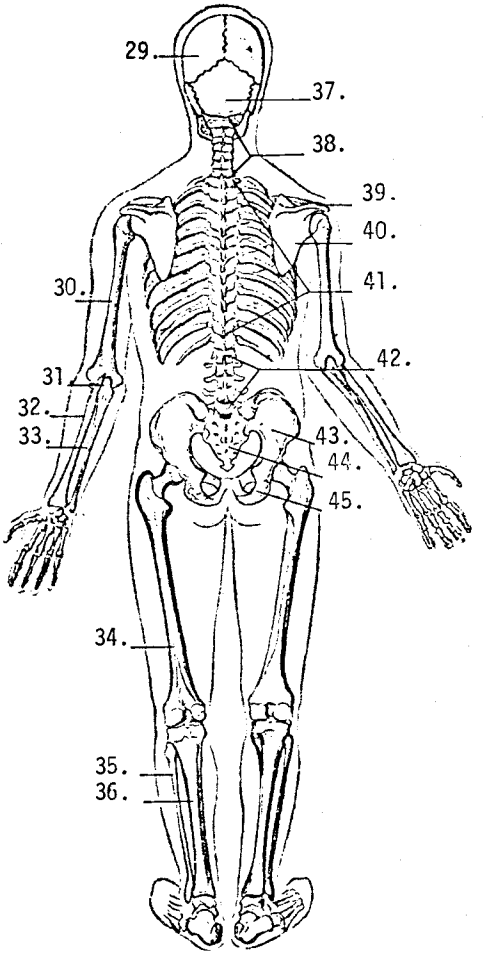


FIGURE #25

RIGHT FOOT

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APPENDIX B

Post-test One

Post-test One Answer Key

POST-TEST #1

Station Number		Station Question referring to Tagged Anatomical Structure
1.	a.	Name this finger-like process or region
	b.	Name this suture
2.	a.	Name this bone
	b.	Name this bone
3.	a.	Name this bone
	b.	Name this spine-like process
4.	a.	Name this suture
	b.	Name this bone
5.	a.	Name this process
	b.	Name this opening
6.	a.	Name these rounded processes
	b.	Name this opening
7.	a.	Name this region
	b.	Name this small projection or process
8.	a.	Name the general region marked in red ink
	b.	Name the major bone that makes up the area in part a.
9.	a.	Name this sunken region
	b.	Name the two bones marked with red ink
10.	a.	Name this bone (marked with red ink)
	b.	Name this bone (marked with green ink)
11.	a.	Name this sinus
	b.	Name this sinus
12.	a.	Name this structure
	b.	Name this depressed region (marked in green ink)
13.	a.	Name this region (marked in green ink)
	b.	Name this region
14.	a.	Name this complete bone
	b.	Name this part of the bone
15.		What term describes this portion of the vertebral column (marked with red ink)?
16.		What term describes this area of the vertebral column?

POST-TEST #1 - ANSWER KEY

Station Number		Anatomical Structure To Be Identified
1.	a.	zygomatic arch
	b.	coronal suture
2.	a.	parietal bone
	b.	temporal bone
3.	a.	occipital bone
	b.	styloid process
4.	a.	sagittal suture
	b.	frontal bone
5.	a.	mastoid process
	b.	external auditory meatus
6.	a.	occipital condyles
	b.	Foramen magnum
7.	a.	hard palate
	b.	external occipital protuberance
8.	a.	middle cranial fossa
	b.	spenoid bone
9.	a.	orbit
	b.	nasal bones
10.	a.	ethmoid bone
	b.	lacrimal bone
11.	a.	frontal sinus
	b.	maxillary sinus
12.	a.	nasal septum
	b.	sellaturcica
13.	a.	head of mandible (condyloid process)
	b.	ramus of mandible
14.	a.	mandible
	b.	body of mandible
15.		lumbar
16.		cervical

APPENDIX C

Post-test Two

Post-test Two Answer Key

POST-TEST #2

Station Number		Station Question referring to Tagged Anatomical Structure
1.		Name the area of the bone marked with red ink
2.	a.	Name the structure marked with red ink
	b.	Name the region marked with green ink
3.	a.	Name the process colored with red ink
	b.	Name the process colored with green ink
4.	a.	Name this bone (be specific)
	b.	Name this bone (be specific)
5.	a.	Name this process (colored with red ink)
	b.	Name the region of the bone that is colored green
6.	a.	What type of rib is this?
	b.	Name this bone
7.	a.	Name the region of the bone that is colored red (i.e. just where the red line is)
	b.	Name this process on the bone (the area marked in green
8.	a.	Name the depressed area marked with red ink
	b.	Name this structure (or what material is it composed of)
9.	a.	Name the structure marked with red ink
	b.	Name the process marked with green ink
10.	a.	Name the area marked with red ink
	b.	Name this bone
11.		Name this border of the bone - i.e. the border marked with red ink
12.	a.	Name this process (marked with red ink)
	b.	Name the region marked with green ink
13.	a.	Name the process marked with red ink
	b.	Name the region marked with green ink
14.	a.	Name the depressed area marked with red ink
	b.	Name the depressed area marked with green ink
15.	a.	Name this roughened area marked in red (indicate whether it is medial or lateral)
	b.	Name the depressed area in green
16.	a.	Name the region of the bone marked red
	b.	Name the region marked with green ink (i.e. just the region of the green line)

POST-TEST #2 - ANSWER KEY

Station Number		Anatomical Structure To Be Identified
1.		body (of vertebrae
2.	a.	spine (of vertebrae)
	b.	lamina (of vertebrae)
3.	a.	transverse process
	b.	inferior articular process
4.	a.	atlas
	b.	axis
5.	a.	Dens (odontoid process)
	b.	head (of rib)
6.	a.	Floating rib
	b.	clavicle
7.	a.	neck (of rib)
	b.	tubercle (of rib)
8.	a.	Suprasternal notch
	b.	costal cartilage
9.	a.	Spine (of scapula)
	b.	acomion
10.	a.	glenoid fossa
	b.	sternum
11.		Axillary (lateral) scapula border
12.	a.	lesser tuberosity
	b.	capitulum
13.	a.	deltoid tuberosity
	b.	trochlea
14.	a.	radial fossa
	b.	coronoid fossa
15.	a.	medial epicondyle (humerus)
	b.	olecranon fossa
16.	a.	head (of humerus)
	b.	anatomical neck (of humerus)

APPENDIX D

Post-test Three

Post-test Three Answer Key

POST-TEST #3

Station Number	Station Question referring to Tagged Anatomical Structure
1.	a. Name the region colored in red b. Name the area marked with green line
2.	a. Name the process colored in red b. Name this process (colored green)
3.	a. Name the process colored red b. Name the region colored green
4.	a. Name the depressed area (colored red) b. Name the bones colored green
5.	a. Name the bone colored red b. Name the bone colored green
6.	a. Name the region colored red b. Name the region colored green
7.	a. Name this bone (colored red) b. Name this bone (colored green)
8.	a. Name this cavity (colored red) b. Name this structure (colored green)
9.	a. Name this bone b. Name the region colored green
10.	a. Name the region marked with red ink b. Name the region marked with green ink and indicate whether it is lateral or medial
11.	a. Name the ridge marked with red ink b. Name the structure colored green (be specific as to lateral or medial)
12.	a. Name this bone b. Name the region colored green
13.	a. Name the region colored red b. Name the region of the bone colored green (be specific as to lateral or medial)
14.	a. Name the region colored red b. Name this bone
15.	a. Name the region of the bone colored red b. Name this bone (colored green)
16.	a. Name the bone colored red b. Name the bone colored green
17.	a. Name the bone colored red b. Name the bone colored green (be specific)

POST-TEST #3 - ANSWER KEY

Station Number	Anatomical Structure To Be Identified
1.	a. head (of radius) b. neck (of radius)
2.	a. tuberosity (of radius) b. Styloid process (radius)
3.	a. olecranon process b. Trochlear (Semilunar) notch
4.	a. radial notch b. metacarpal bones
5.	a. trapezium b. scaphoid
6.	a. Posterior superior iliac spine b. Anterior superior iliac spine
7.	a. ilium b. ischium
8.	a. acetabulum b. ischial spine
9.	a. pubic b. intercondylar notch
10.	a. greater trochanter b. medial epicondyle
11.	a. Linea aspera b. medial condyle
12.	a. tibia b. intercondylar eminance
13.	a. tuberosity (tubercle) of tibia b. lateral condyle (tibia)
14.	a. medial malleolus (tibia) b. fibula
15.	a. lateral malleolus (fibula) b. patella
16.	a. talus b. calcaneum
17.	a. cuboid b. middle cuneiform

APPENDIX E

Cumulative Post-test

Cumulative Post-test Answer Key

CUMULATIVE POST-TEST

Station Number	Station Question referring to Tagged Anatomical Structure
1.	a. Name this general region (colored red) b. Name this opening
2.	a. Name this bone b. Name this bone
3.	a. Name this process (colored red) b. Name this suture
4.	a. Name these structures (colored red) b. Name this region
5.	a. Name this complete bone b. Name the portion of the bone colored green
6.	a. Name this process (colored red) b. Name this articular process (colored green)
7.	a. Name this bone b. Name this process (colored green)
8.	a. Name this bone (colored red) b. Name this bone (colored green)
9.	a. Name this bone b. Name this depression on the bone
10.	a. Name this process (colored red) b. Name this grooved area (colored green)
11.	a. Name this process (colored red) - be specific with regard to medial or lateral b. Name this process (colored green)
12.	a. Name this process (colored in red) b. Name this bone (the complete bone)
13.	a. Name this bone b. Name this area (colored green)
14.	a. Name this bone (colored red) b. Name this bone
15.	a. Name this process (colored red) b. Name this structure (colored green) - be specific with regard to lateral or medial
16.	a. Name this specific region b. Name this bone
17.	a. Name this process (colored red) b. Name this depression (colored green)

Station Number	Station Question referring to Tagged Anatomical Structure
18.	a. Name this bone b. Name this process (colored green)
19.	a. Name this grooved area (colored red) b. Name this process (colored green)
20.	a. Name these holes (be specific) b. Name these folds of bone (colored green)
21.	a. Name these sinuses b. Name this sinus
22.	a. Name this bone b. Name this part of the bone (colored green)
23.	a. Name this bone b. Name this bone
24.	a. Name this bone b. Name the area of this bone that is colored green
25.	a. Name this region of the bone (colored red) b. Name this process (colored green)
26.	a. Name this portion of the bone b. What is this portion of the bone called?
27.	a. What kind of rib is this one? b. Of what type of tissue is this area composed of?
28.	a. Name this depressed area (colored red) b. Name this opening
29.	a. Name this opening b. Name this area (colored green)
30.	a. Name this region of the vertebral column (colored red) b. Name the opening through which the pencil projects (NOTE: the pencil corresponds to a nerve)

CUMULATIVE POST-TEST - ANSWER KEY

Station Number	Anatomical structure To Be Identified
1.	a. Anterior Cranial fossa b. foramen magnum
2.	a. parietal b. temporal
3.	a. mastoid b. coronal
4.	a. occipital condyles b. hard palate (maxillae)
5.	a. mandible b. coronoid process
6.	a. greater tuberosity b. capitulum
7.	a. radius b. styloid (radius)
8.	a. hamate b. pisiform
9.	a. humerus b. olecranon fossa
10.	a. olecranon b. trochlear (semilunar) notch
11.	a. lateral epicondyle b. linea aspera
12.	a. Intercondylar eminence b. tibia
13.	a. fibula b. lateral malleolus
14.	a. talus b. cuboid
15.	a. greater trochanter b. lateral condyle
16.	a. pubic symphysis b. pubic
17.	a. ischial tuberosity b. acetabulum

Station	Anatomical Structure To Be Identified
18.	a. clavicle b. Name this process (colored green)
19.	a. suprasternal notch b. xiphoid
20.	a. frontal sinus b. concha (turbinates
21.	a. sphenoid b. maxillary
22.	a. scapula b. acromnion
23.	a. Patella b. hyoid
24.	a. axis b. Body (vertebrae)
25.	a. pedicle b. Superior articular process
26.	a. manubrium b. body
27.	a. false b. cartilage costal
28.	a. articular surface of the tempromandibular joint b. optic foramen
29.	a. jugular foramen b. cribriform plate
30.	a. coccygeal b. intervertebral foramina

APPENDIX F

Facsimile of Investigator's Anatomy and Physiology Laboratory Manual (pp. 1-26)

ANATOMY and PHYSIOLOGY

Lab Manual

G. Kennedy

INTRODUCTION

This Laboratory Manual is designed to supplement the course material in BIOLOGY 160-161 ANATOMY AND PHYSIOLOGY.

The sections on histology, the skeletal and muscular systems will provide a useful reference for studying this material in the laboratory.

Various questions have been placed throughout the lab manual. You will find it advantageous to answer these questions during or immediately after you complete the laboratory exercise.

TABLE OF CONTENTS

LETHBRIDGE COMMUNITY COLLEGE

LAB #1 THE SKELETAL SYSTEM

TERMS:

Fossa - a shallow depression or furrow
Foramen - a hole in a bone for passage of vessels or nerves
Condyle - a rounded protuberance at the end of a bone forming an articulation

Be able to identify the following bones and processes on the skeletal models provided in the laboratory

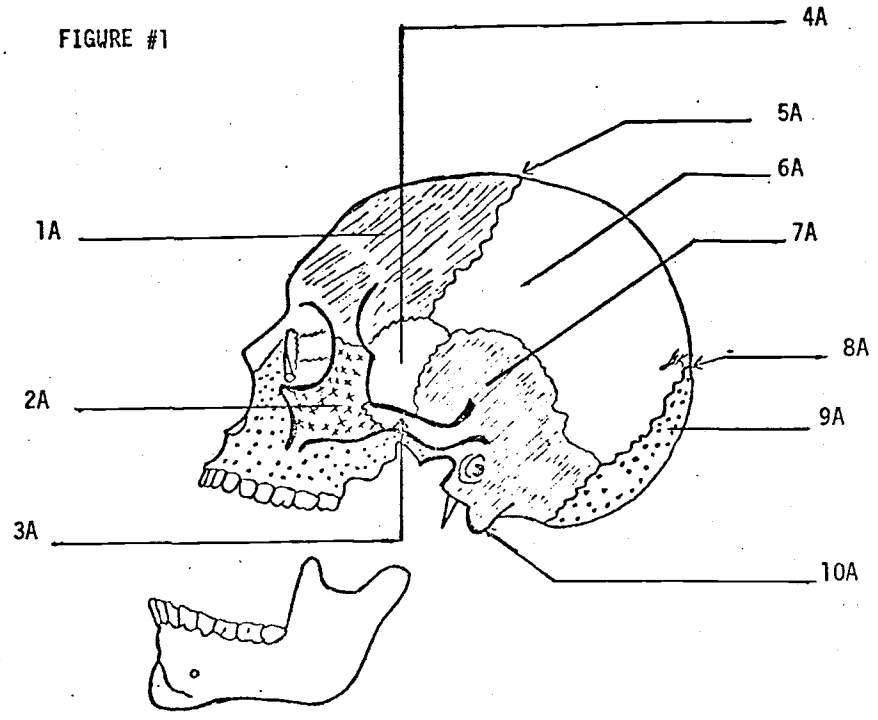
A. THE SKULL

1. Frontal Bone:
2. Zygomatic Bone: (Malar - Mā´lar)
   - Cheekbones
3. Zygoma: (The arch that joins the Zygomatic process of the temporal bone with the zygomatic process of the Malar Bone).

   Zygoma = Zygomatic Arch

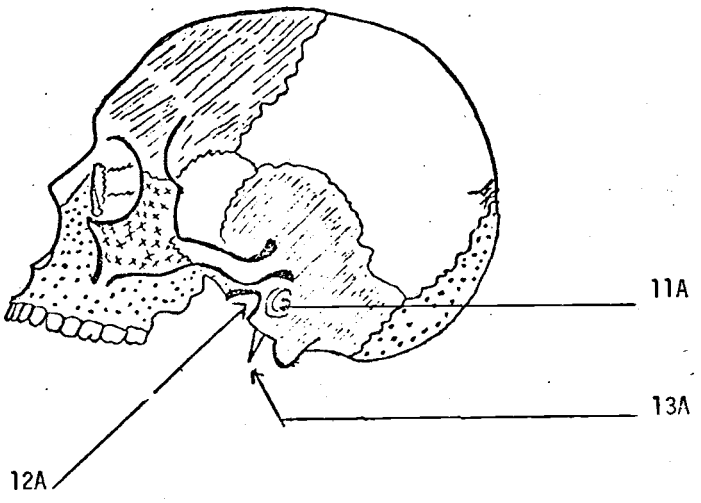
4. Sphenoid bone: (sella turcica depression on posterior of this bone contains pituitary gland - this will be noted in diagram #5)
5. Coronal Suture:
6. Parietal Bone:
7. Temporal Bone:
8. Lambdoid Suture: (Lam´Doid)
9. Occipital bone:
10. Mastoid Process: (Of Temporal Bone)

FIGURE #1



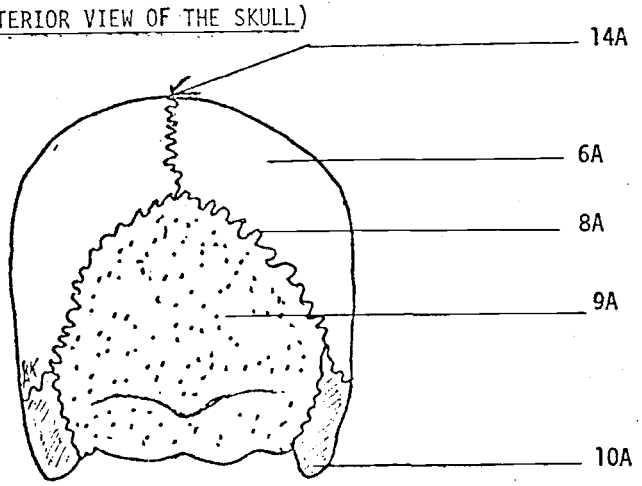
11. External Auditory Meatus
    (Auditory = Ear) (Mē–ā´ tus)
12. Articular Surface of Tempromandibular Joint (Tempro = Temporal Bone Mandibular = Lower Jaw Bone)
13. Styloid Process

FIGURE #2



14. Sagittal Suture (Note: Does this suture continue through the Frontal Bone?)

FIGURE #3 (POSTERIOR VIEW OF THE SKULL)



15. Carotid Canal (Check this on Bone Skulls as plastic models in lab do not have the canal drilled through)

    - stick a wire through the canal and note its exit in the interior of the Skull (Figure # 5)

16. Jugular foramen (follow its route as with #15)

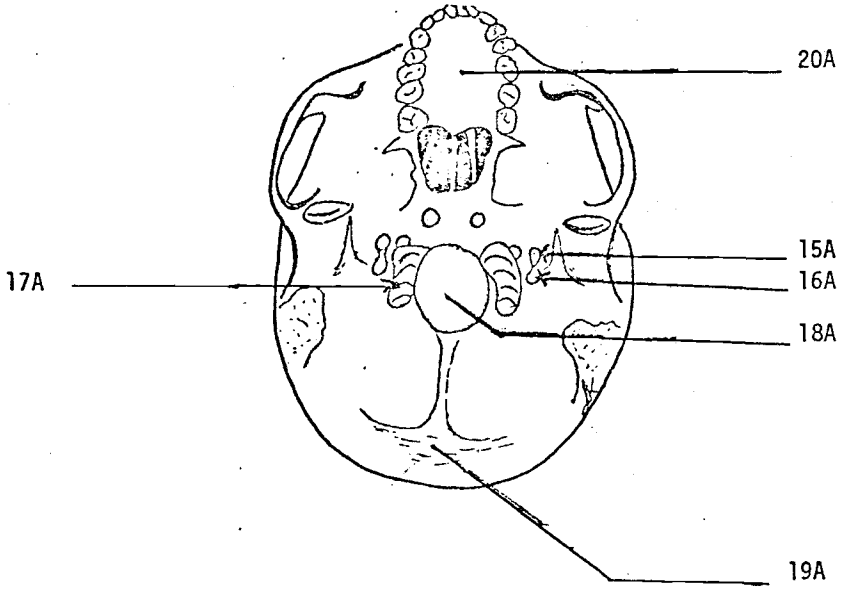
17. Occipital condyles (Articulate with the vertebral column)

18. Foramen Magnum

19. External occipital protuberance (can you feel this projection on the back of your own head?)

20. Hard Palate: (A portion of the maxillary bone)

FIGURE #4 (INFERIOR VIEW OF SKULL)



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B. THE FLOOR OF THE INTERIOR OF THE BRAIN BOX (Top of Skull removed in figure) - This area is divided into three fossae: (Depressed areas)

1. Anterior cranial fossa: (cribriform plate of ethmoid bone is in this area)
   (Krib´ri˘ - form)

2. Middle cranial fossa: (Note: Pituitary) fossa is located here - refer to #4A)

3. Posterior cranial fossa

4. Cribriform plate of the Ethmoid Bone (Note the pores in the bone) This is the horizontal portion of the ethmoid bone. Its lower portion forms the root of the nasal cavity

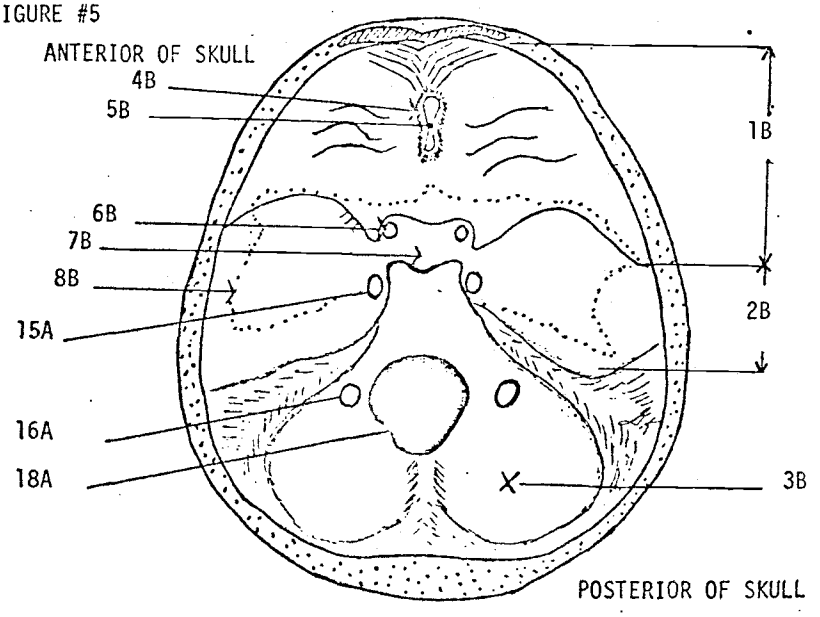
5. Crista galli portion of Ethmoid Bone

6. Optic foramen (does the optic chiasma sound familiar from previous Biology courses? i.e., the cross-over of the optic nerves?)

7. Sella turcica - the depression that contains the pituitary gland
   (Refer to #4A Figure #1)

8. The Dotted Line respresents the Sphenoid Bone as viewed from the interior of the skull - its shape is similar to the wings of a butterfly - identify the sutures on the bone skull. (Refer to 4A Diagram #1)

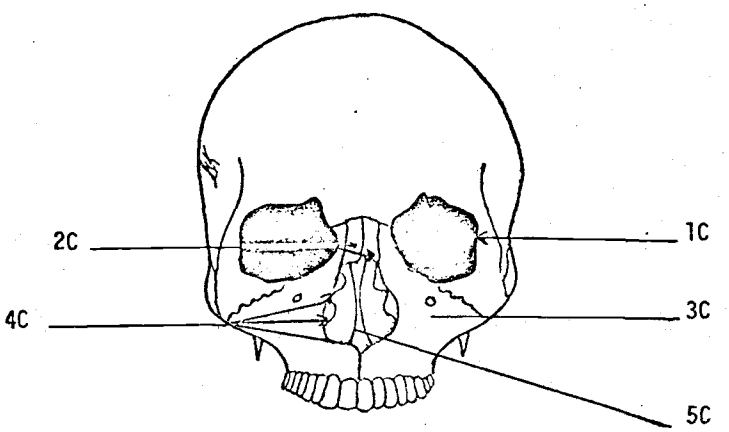
FIGURE #5



C. THE SKELETON OF THE FACE

1. Orbits
2. Nasal bones (two in number)
3. Maxilla (maxillary bone - upper jaw)
4. Superior, middle and inferior concha (turbinates): - (Note: these structures are very vascular - what function would they serve?)
5. Nasal septum

FIGURE #6



6. Ethmoid Bone: (Between orbits - forms roof of nasal cavity)
7. Lacrimal Bone: (Lacrimal = tear)
8. Lacrimal Fossa: (the depression in nasal corner of orbit)
9. Naso - Lacrimal canal
   ↳ (The diagram shows the opening to this canal - probe the canal on the model with a wire)

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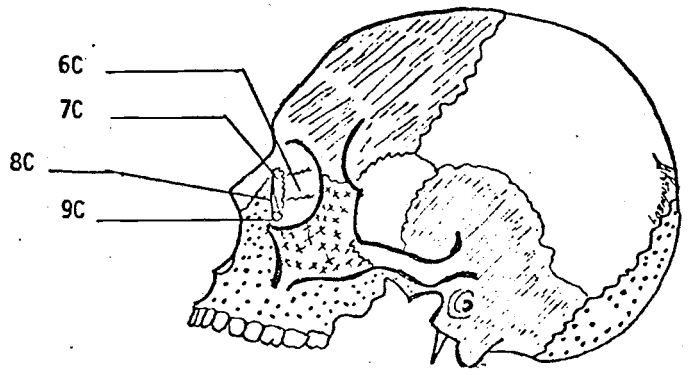
FIGURE #7



* 6 and 7 show up better on the Actual Bone Skulls rather than on the plastic models

D. THE SINUSES

1. Frontal sinus (see Figure #5 - The Frontal Sinus can be seen in the Anterior portion of the frontal bone)

2. ETHMODIAL SINUSES

3. MAXILLARY SINUS - probably the most common sinus involved in sinusitis

4. Sphenoidal sinuses - in the greater wing of the sphenoid bone (note: this is a difficult sinus to show on a drawing - ask to have it pointed out on the torso models in the lab)

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FIGURE #8

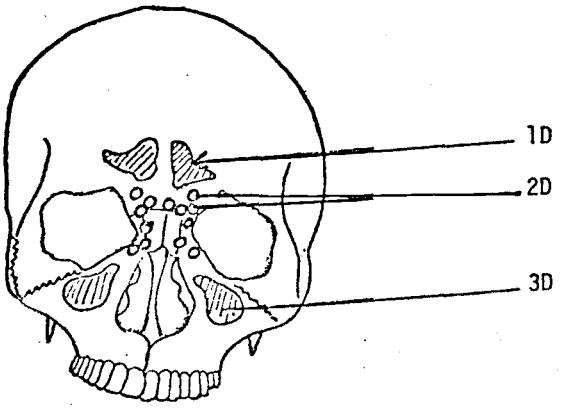
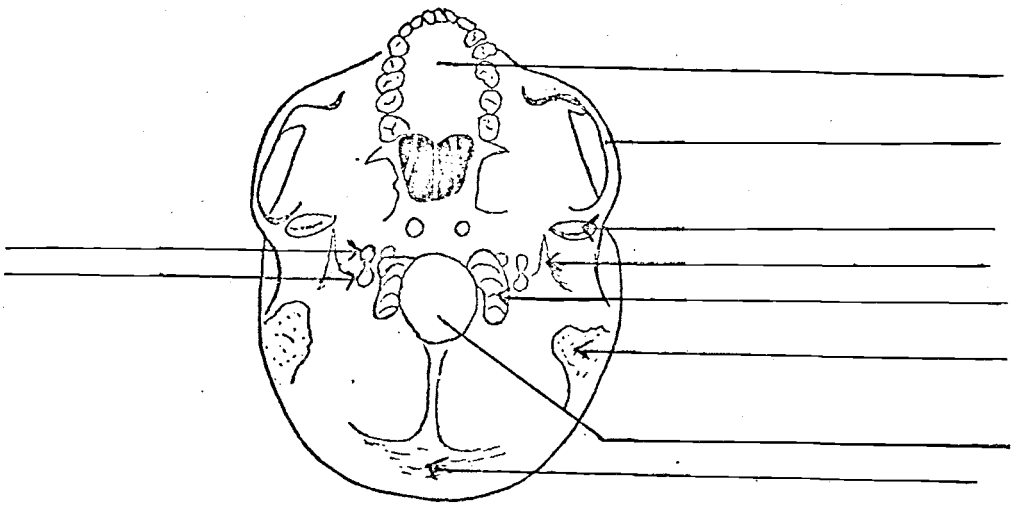


FIGURE #9 INFERIOR VIEW OF SKULL

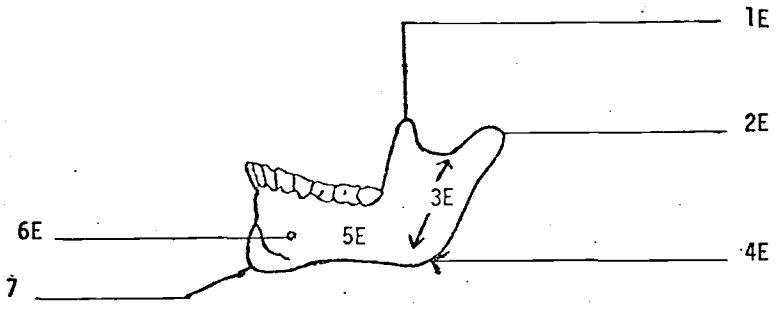
Identify the structures indicated on the figure



E. MANDIBLE: (Lower Jaw Bone)

1. Coronoid process (Note: when you get to the arm, the Ulna also has a coronoid process - Figure #25 Lab #3)
2. Head (condyloid process)
3. Ramus
4. Angle
5. Body
6. Mental foramen (mental vessels and nerve)
7. Mental protuberance (a triangular area on the point of the chin)

FIGURE #10

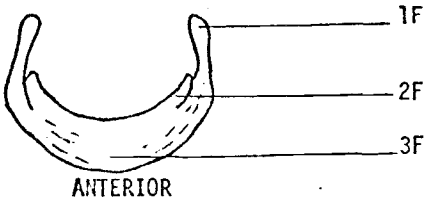


F. HYOID BONE: (NOTE: This bone is not shown on the plastic models - ask to have it pointed out on the actual skeleton) This bone is located under the mandible. What function does it possibly serve?)

1. Greater Horn (cornu)
2. Lesser Horn (cornu)
3. Body

FIGURE #11

POSTERIOR



ANTERIOR

G. VERTEBRAL COLUMN:

1. Vertebrae (33 in total)
2. Cervical (neck) Region - 7 vertebrae
3. Thoracic (Chest) Region - 12 vertebrae
4. Lumbar (Lower Back) Region- 5 vertebrae
5. Sacral (sacrum) Region - 5 vertebrae
6. Coccygeal (Tail-Bone)Region-4 vertebrae

33 vertebrae

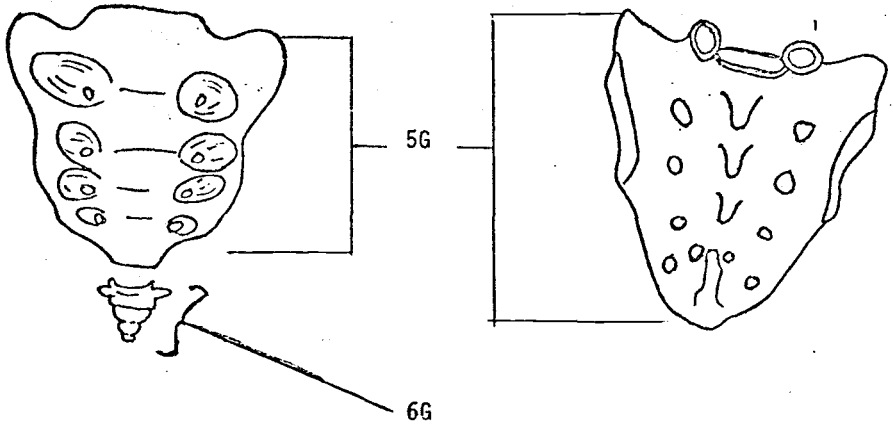
Be able to identify these five areas on the Skeleton.

FIGURE #12

ANTERIOR VIEW

FIGURE #13

POSTERIOR VIEW



LAB #2 THE SKELETAL SYSTEM - continued

A. VERTEBRA:

1. Body
2. Neural Arch
3. Pedicle (Ped i - kl)
4. Lamina
5. Spine
6. Transverse Process
7. Superior articular process
8. Inferior articular process
9. Vertebral canal (what passes through this canal?)
10. Intervertebral foramina (what emerges through this foramina)

FIGURE #14 LATERAL VIEW OF LUMBAR VERTEBRAE

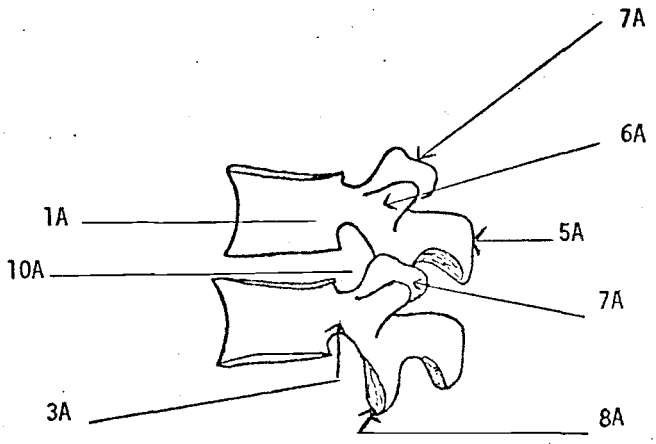


FIGURE #15 SUPERIOR VIEW OF LUMBAR VERTEBRA

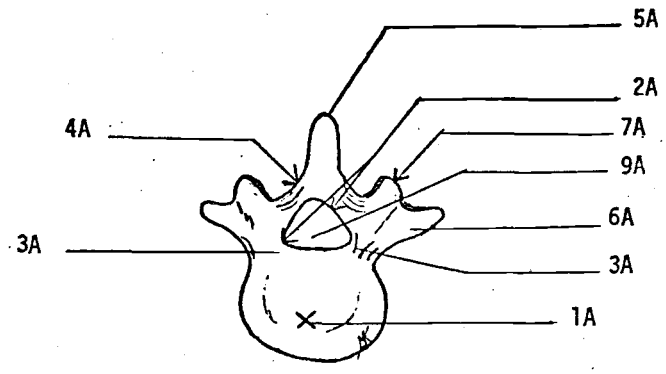
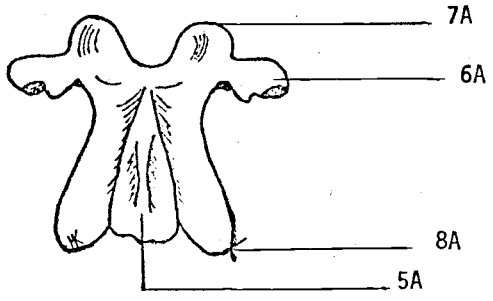


FIGURE #16A POSTERIOR VIEW OF LUMBAR VERTEBRA



11. Atlas (Vertebra #1 - for articulation with occipital condyles (17A Lab #1) of the Skull

12. Axis (Vertebra #2 - with Dens (Odontoid Process)

13. Dens (Odontoid) Process

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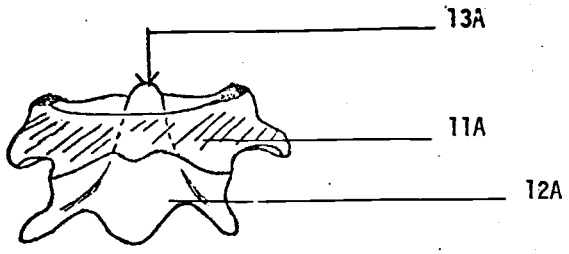
FIGURE #16 B ATLAS - AXIS



B. RIBS

1. TRUE RIBS - the first seven ribs (Note: Directly attached to Sternum by Cartilage)

2. FALSE RIBS - The next three ribs (Note: The cartilage attaching these ribs to the sternum fuses with the cartilage of Rib number 7)

3. FLOATING RIBS - The remaining two ribs
   - No cartilaginous attachment with sternum

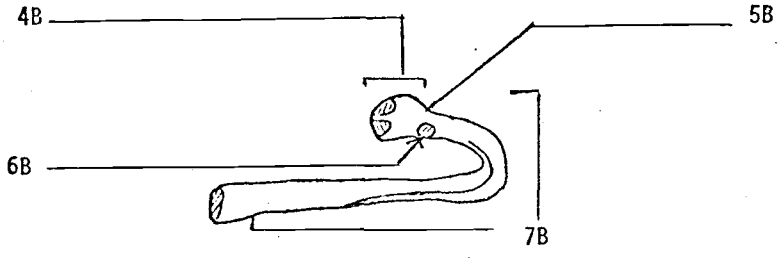
4. HEAD (with two Articular facets
   - note on the skeleton what each facet articulates with)

5. NECK

6. TUBERCLE (for articulation with the transverse process of the Thoracic vertebrae - check this on the skeleton)

7. SHAFT

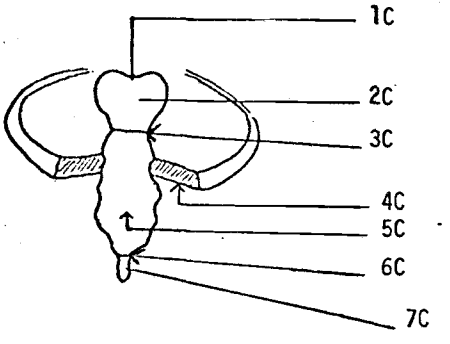
FIGURE #17 RIB



C. STERNUM

1. Suprasternal Notch
2. Manubrium of the Sternum
3. Sternal Angle
4. Costal Cartilage
5. Body of the Sternum
6. Xiphisternal joint
7. Xiphoid process (Zĭf´oyd = greek for sword)

FIGURE #18 STERNUM WITH 1 PAIR OF RIBS



D. SCAPULA ("SHOULDER BLADE")

1. Clavicle (Collar Bone) - this bone is included here as it articulates with the Scapula and the Sternum - check this out on the Skeletal Model and examine its shape
2. Spine of Scapula
3. Acromion (ă - krō´mĭ on)
4. Glenoid fossa
5. Coracoid process (Greek for Raven ie; it is shaped somewhat like a crow's beak)
6. Superior angle
7. Inferior angle
8. Suprascapular notch
9. Axillary (lateral) Border
10. Medial (vertebral) Border ie; the edge closest to the vertebral column

FIGURE #19 RIGHT SCAPULA - POSTERIOR VIEW

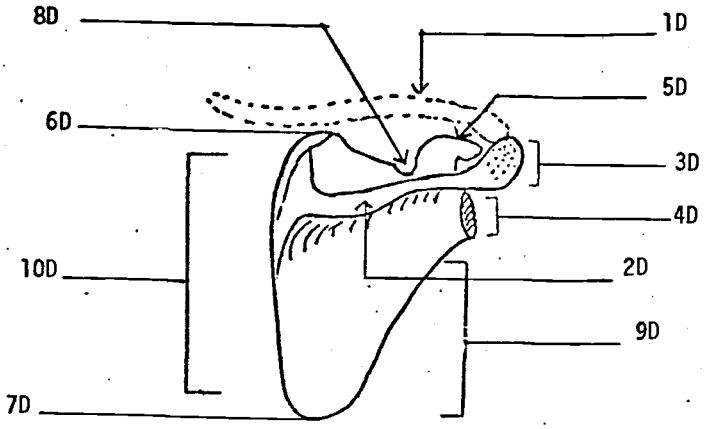


FIGURE #20 RIGHT SCAPULA - ANTERIOR VIEW

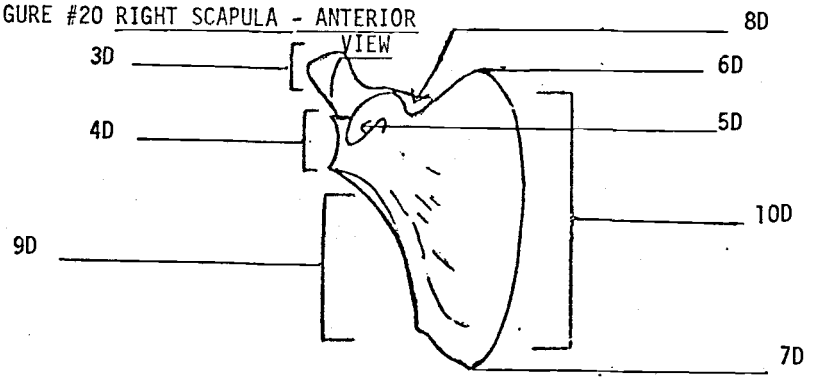
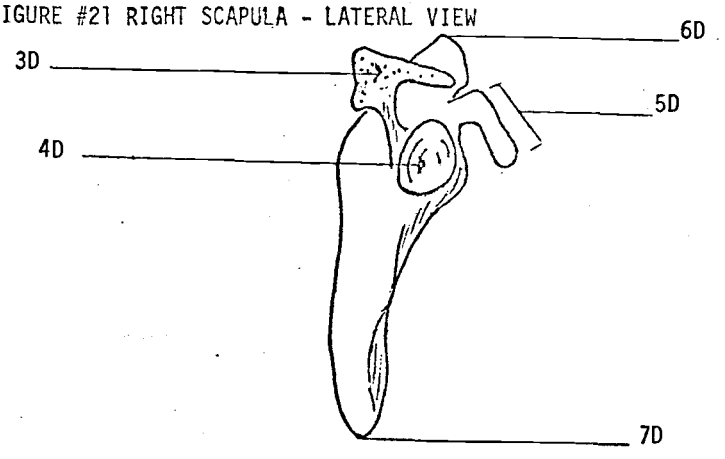


FIGURE #21 RIGHT SCAPULA - LATERAL VIEW



E. HUMERUS ("Upper Arm")

1. Intertubercular groove (note: a tendon of the Biceps muscle runs through this groove)
2. Greater Tuberosity)
3. Lesser Tuberosity) The area between these tuberosities is the intertubercular groove
4. Surgical neck of the humerus
5. Deltoid tuberosity (the Deltoid or Shoulder muscle attaches to this ridge of bone)
6. Radial fossa (this depression accommodates the head of the Radius when the elbow is bent - bend the arm of the skeleton and note this)
7. Lateral Epicondyle (roughened area above articular surface of this bone)
8. Capitulum (This condyle articulates with the head of the Radius # 1A - Lab 3)
9. Coronoid fossa (this depression accommodates the Coronoid process of the ulna when the elbow is bent - bend the arm of the skeleton and note this)
   - REVIEW Lab #1
     FIGURE #10 (The Coronoid process of the Mandible)
10. Medial Epicondyle
11. Trochlea (This condyle articulates with the Trochlear notch of the ulna - Figure # 25 # 2B Lab #3

    TROCHLEA = Latin for pulley -

    Does its shape suggest this?
12. Head of the Humerus
13. Anatomical neck
14. Olecranon fossa (accommodates the olecranon process elbow) of the ulna

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FIGURE #22 ANTERIOR VIEW (Anatomical Position)
of the RIGHT HUMERUS

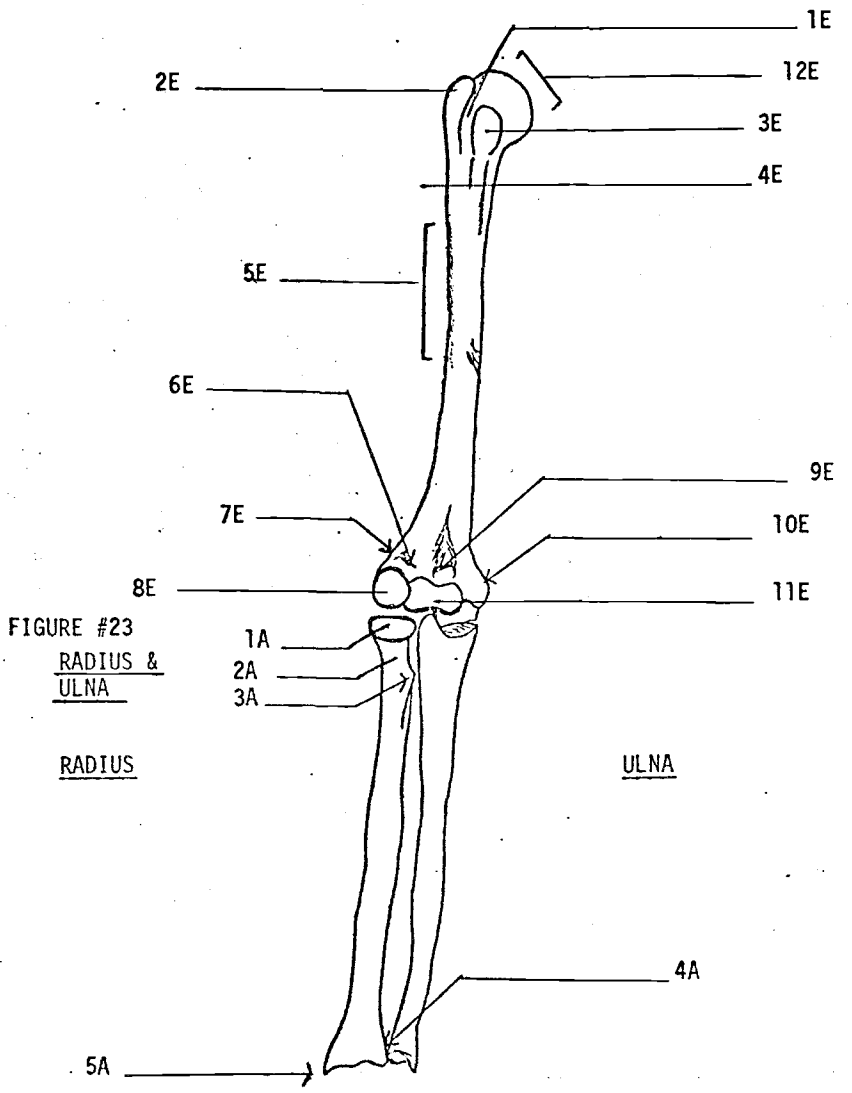

FIGURE #23
RADIUS & ULNA

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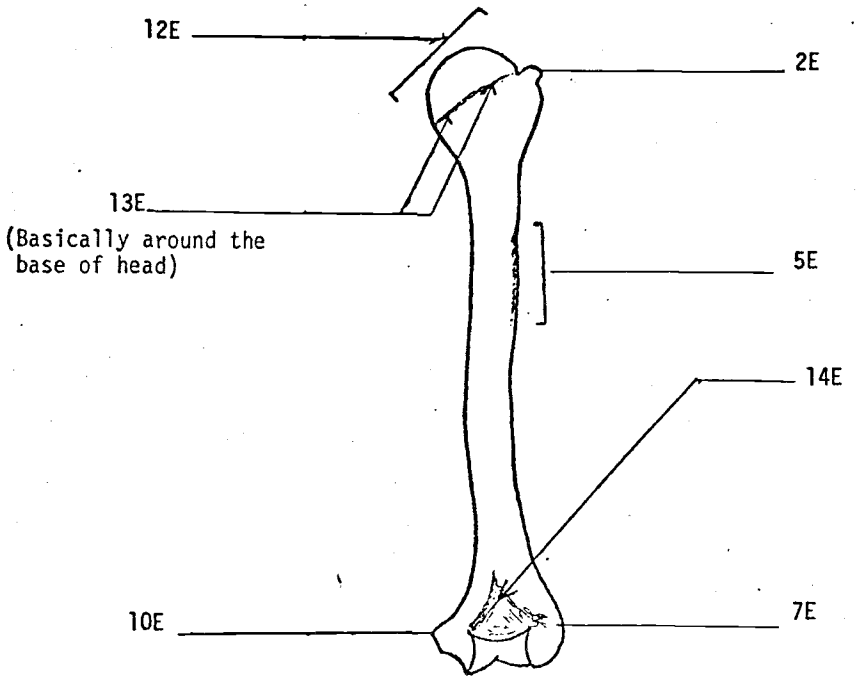
14. OLECRANON FOSSA

FIGURE #24 POSTERIOR VIEW OF THE RIGHT HUMERUS



LAB #3 THE SKELETAL SYSTEM - Continued

A. THE RADIUS (Major weight supporting bone in the Forearm)

For the following structures, refer to FIGURE #23

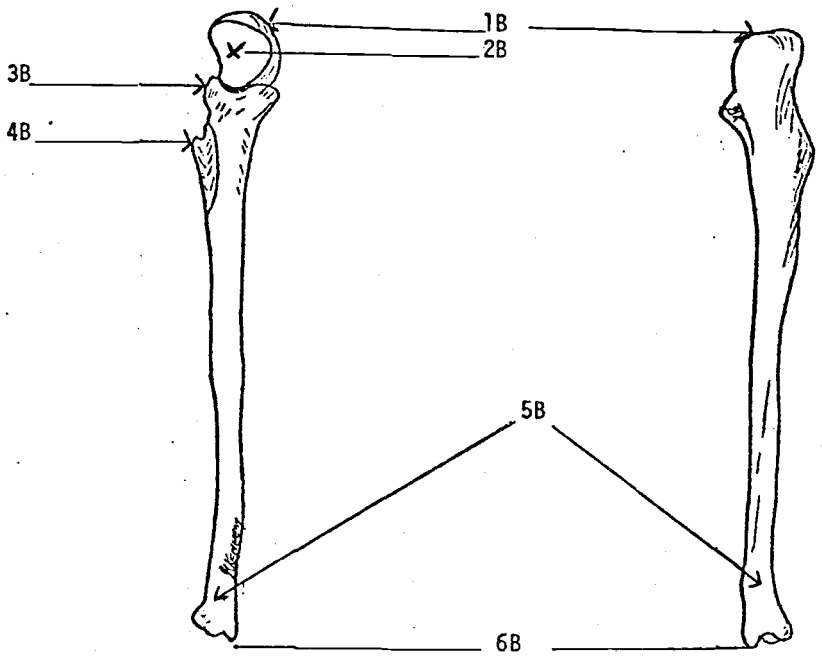
1. Head
2. Neck
3. Tuberosity
4. Ulnar notch (this is a grooved area at the inferior end of the radius where the ulna and radius articulate with each other ie; during pronation and supination - this area of articulation is also referred to as the inferior radial-ulnar joint)
5. Styloid process (can you feel this general area on your own wrist?)

B. THE ULNA (Refer to Figure #25 to become familiar with its relationship to the Radius and Humerus)

1. Olecranon process (the elbow)
   - this process is a good characteristic by which one can identify the ulna
2. Trochlear (Semilunar) notch
   - this notch articulates with the Trochlea of the Humerus (Lab #3 Figure #22 #11E)
3. Coronoid process (Review the coronoid process of the mandible - Lab one - Figure #10 - 1E)
4. Radial notch (superior radio-ulnar joint - in part A of this Lab, the explanation of the Ulnar notch should suffice to explain this structure)
5. Head
6. Styloid process

FIGURE #25 ULNA

ANTERIOR VIEW POSTERIOR VIEW



C. CARPAL (Wrist) Bones

1. Trapezium
2. Trapezoid
3. Capitate
4. Hamate
5. Scaphoid
6. Lunate
7. Triquetral (trī - kwĕt răl)
8. Pisiform

D. 5 METACARPAL BONES

E. 5 DIGITS (PHALANGES)

1. Thumb
2. Pointing finger (forefinger)
3. Middle (index) finger
4. Ring finger
5. Little finger

FIGURE #26 CARPALS, METACARPALS AND PHALANGES

POSTERIOR VIEW (PRONATION) OF RIGHT HAND

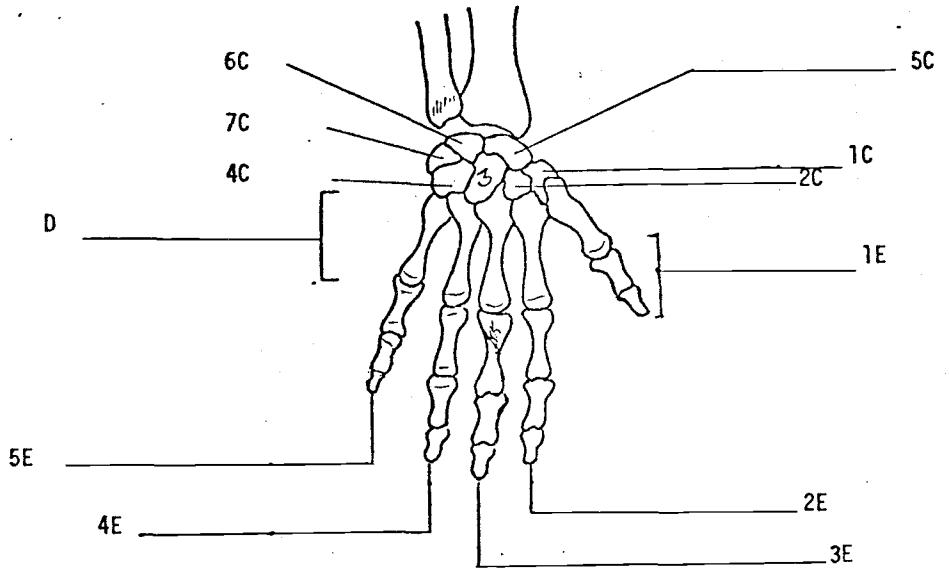


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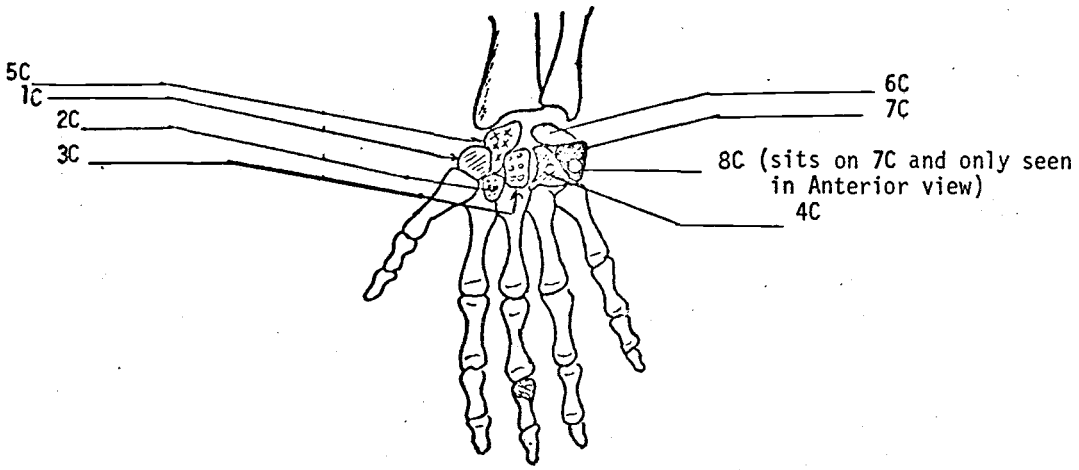
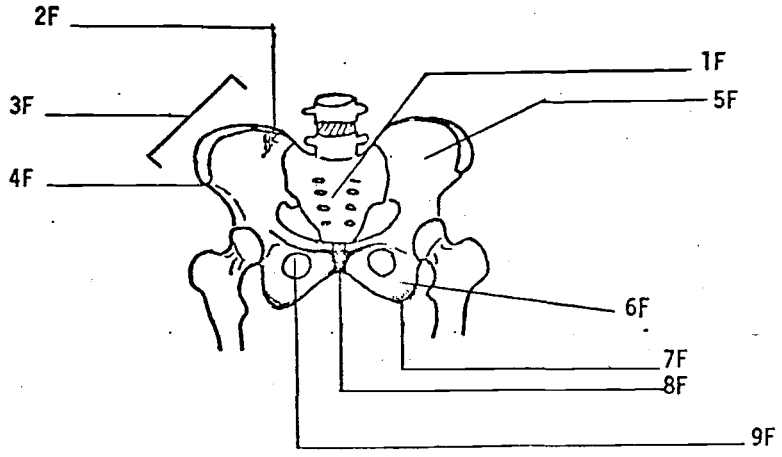
FIGURE #27 ANTERIOR VIEW (SUPINATION) OF RIGHT HAND



F. PELVIC REGION

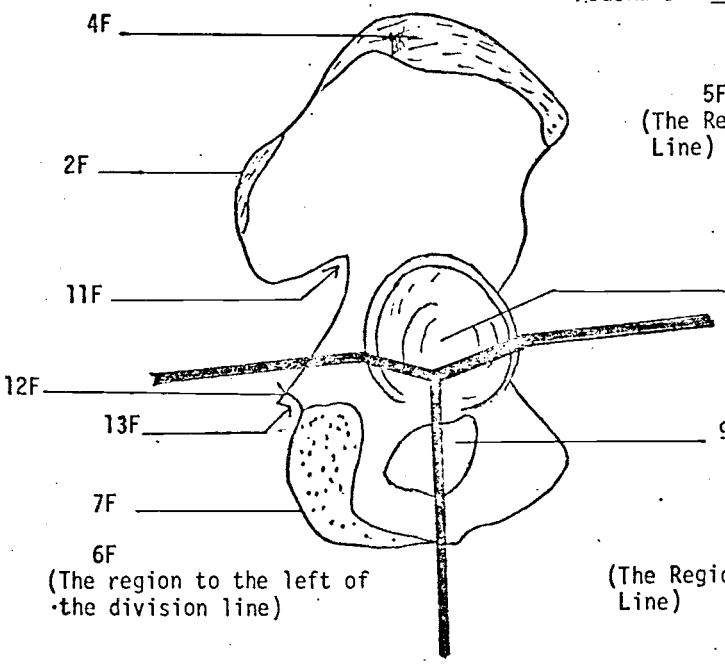
1. Sacrum (also see lab #1 Figures #12 and #13)
2. Posterior - superior iliac spine
3. Iliac crest
4. Anterior - superior iliac spine
5. Ilium
6. Ischium
7. Ishial tuberosity
8. Pubic symphysis
9. Obturator foramen (ob´ tū - rā´´ tor)

FIGURE #28 PELVIS (ANTERIOR VIEW)



10. Acetabulum
11. Greater Sciatic notch
12. Ischial spine
13. Lesser sciatic notch
14. Pubic Bone

FIGURE #29 LATERAL VIEW OF RIGHT PELVIC BONE

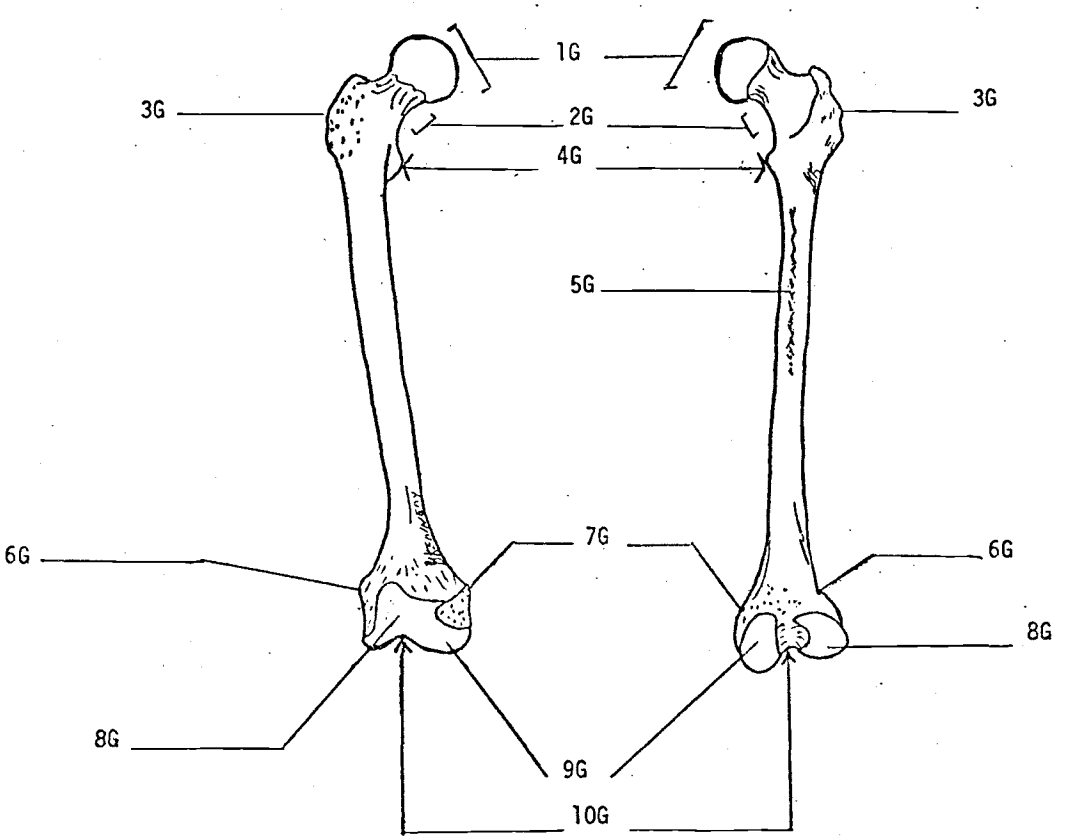


G. FEMUR (THIGH BONE)

1. Head
2. Neck
3. Greater trochanter - the muscles of your "bottom" attach here
4. Lesser trochanter
5. Linea aspera (ridge of bone on posterior)
6. Lateral epicondyle
7. Medial epicondyle
8. Lateral condyle
9. Medial condyle
10. Intercondylar notch

FIGURE #30 RIGHT FEMUR

ANTERIOR VIEW POSTERIOR VIEW



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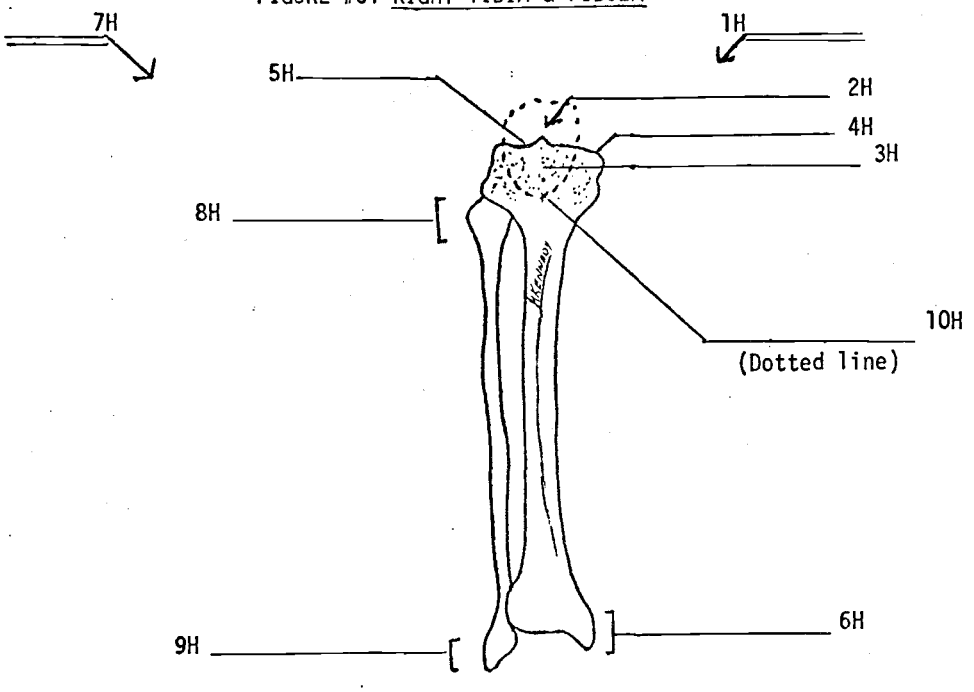
H. RIGHT TIBIA & FIBULA ANATOMICAL (ANTERIOR VIEW) POSITION

1. Tibia (weight bearing bone of lower leg)
2. Intercondylar eminence of tibia
3. Tuberosity (tubercle) of tibia
4. Medial condyle of tibia
5. Lateral condyle of tibia
6. Medial malleolus of tibia (can you feel this area on your ankle?)
7. Fibula
8. Head of fibula (can you palpate this head on your own leg?)
9. Lateral malleolus of fibula (palpate this structure in your own leg.)
10. Patella - represented by dotted line in diagram

FIGURE #31 RIGHT TIBIA & FIBULA



I. TARSAL BONES

1. Talus (attaches to Tibia)
2. Calcaneum (Kal - kā´ - nē - um)
   - Heel
3. Cuboid
4. Navicular
5. Medial cuneiform
6. Middle cuneiform
7. Lateral cuneiform

J. METATARSALS

K. PHALANGES

FIGURE #32 RIGHT FOOT